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COASTANCE

Eu project COASTANCE

REPORT D1

Regional policies and littoral management practices

phase A Component 4

Territorial Action Plans for coastal protection management

Region of Eastern Macedonia & Thrace (GR) - *Lead Partner*

Regione Lazio (IT)

Region of Crete (GR)

Département de l'Hérault (FR)

Regione Emlia-Romagna (IT)

Direction Régionale de l'Équipement du Languedoc-Roussillon (FR)

Junta de Andalucia (ES)

The Ministry of Communications & Works of Cyprus (CY)

Dubrovnic Neretva County Regional Development Agency (CR)

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Introduction on COASTANCE project and aims

Coastal erosion and flooding represents a major threat for the well-being and prosperity of the 70mi Europeans living within 500m from the coastline and their assets of 500-1000 bi€. Lost or seriously impacted area by erosion is estimated to be 15 km^2/year. The UN-IPCC estimates that by 2020, due to Climate Change, 50% of Europe's coastal wetlands is expected to disappear as a result of sea level rise at a cost of 5,400 mi€/year. According to the EC EUROSION project, the regulatory EIA framework, knowledge base, and traditional measures for erosion control have been weak or inappropriate.

COASTANCE proposes innovative techniques for mid-long term coastal protection Master Plans capitalizing on the Good Practices developed under several European projects (INTERREGIIIB & IIIC-RFO). It focuses on those practices that resulted from thorough scientific studies and understanding of coastal erosion phenomena obtained by previous experience. The concrete results -Realistic Submersion Risk Forecast Systems, Specific EIA/SEA Procedures and concrete coastal protection Master Plans will be proposed as Governance and Public Policy Tools for erosion control by regional, national and EU administrations.

COASTANCE focuses on the entire Mediterranean basin. The partners have jurisdiction on 3700 km of coast of which 1600 km are beaches representing 5 out of 7 EU MED member States that cover 95% of EU MED coastline and all characteristic coastal typologies of the Mediterranean:

- Low-land areas around big river mouths with long beaches (East Macedonia-Thrace, Languedoc-Roussillon, Hérault, Emilia-Romagna)
- Mixed rocky and sandy coastlines (Crete, Lazio, Andalusia, Cyprus)

By achieving such a complete geographic coverage, the COASTANCE partner are looking upon the entire set of characteristics that are related to erosion phenomena in the Mediterranean and thus their work will lead to the development of coherent, plausible and applicable results.

The increasing erosion phenomena and marine flooding risks arising on the mid-long term related to the effects of climate changes (sea level rising, extreme storm events, increasing frequency

and intensity etc.) pushes Public Administrations towards strategic approach for the Integrated Coastal Zone Management (ICZM) with a particular emphasis on coastal protection.
The loss of rivers solid transport (due to hydraulic works, bridles, crossbars, dams, on rivers), the presence of hard protection works and harbours along the coasts (that intercept the natural distribution of sediments) and the effects of climate changes increased the vulnerability of coastal stretches, today affected by diffuse erosive processes and marine flooding hazard.
In this frame it is evident the need of a strategic and sustainable management of coastal sediments, paying attention to the new environmental aspects involved in the related activities. It is noteworthy that the E.U. project EUROSION stressed both the "Shortage of coastal sediments…" (Finding n°1) and the improperness of the "Current Environmental Impact Assessment (EIA) practices..." (Finding n°2) in addressing coastal erosion matter. COASTANCE project is based on two main operative purposes:
A) Capitalization of knowledge and resources already acquired in the field of coastal protection:

- Sustainable Technologies for exploiting sand stocks (behind river barrages, upstream harbour structures, geological sea bottom deposits, etc.) based on Eurosion project, Beachmed, Beachmed-e/GESA/RESAMME Subprojects;
- Sustainable Technologies for coastal protection and adaptation (marine-climate survey, beach nourishments, soft structures, use relocation etc.) based on Eurosion project, Beachmed, Beachmed-e/NAUSICAA/MEDPLAN/ICZM-MED Subprojects, Plancoast, Cadseland projects;
- Environmental Impact Assessments of the new technologies (dredging activities, nourishment work etc.) and Strategic Environmental Assessment on coastal plans based on Beachmed, Beachmed-e/EUDREP/POSIDUNE Subprojects.

B) Mid to long term planning actions for climate change effects adaptation of coastal zones in line with the EU Directive 2007/60/EC:

- Development of Territorial Action Plans for adapting coastal zones to climate change, against erosion effects and submersion risk: Analysis of the erosion and submersion phenomena, Plans for coastal protection management, Guidance and Recommendations for the development of Coastal Protection Management Plans based on previous EU projects findings (eg. Safecoast, Comrisk and Messina);
- Definition of Sediment Management Plans (SMPs) for both off-shore and littoral deposits exploitation (location, characteristics, radius of competence/beaches to feed, exploitation technology, treatments needed);

- Appropriate Environmental Impact Assessment Protocols in order to assure the right procedures in intervening along coastal zone.
- COASTANCE project develops in three technical Components plus a Communication & Dissemination Component and a Management & Coordination Component.

	Techincal components
C2	Coastal risks: Submersion and Erosion
C3	Territorial Action Plans for Coastal Protection and Management
C4	Guidelines for Environmental Impacts focused on coastal protection works and plans

Introduction on COASTANCE Component 4 Territorial action plans for coastal protection management

The main aim of Component 4 is the formulation of plans for coastal protection and management and adaptation to climate change effects such as erosion and submersion risks. The focus is on low sandy or pebbly coastal zones and their inlands, the most exposed to sea level rise, erosion and submersion risks.

Hard defence structures (e.g. breakwaters, seawalls, groynes), built in the past to remedy suffering situations, often relocated the problem down-drift or anyway to another part of the coast. Very quickly, the limits of these accommodations appeared. New guidelines based on pro-environmental engineering are emerging, focused on the so-called "soft protection" works. Soft options like beach nourishment, while also being temporary and needing regular replenishment, appear more acceptable, and go some way to restore the natural dynamism of the shoreline.

According with the concept that considers the beach as the main defence "structure" for inland areas, actions should be focused on beaches preservation. A sustainable management of low beaches should therefore be based on two main pillars:

- the alimentation of beaches with sediments coming from out of the system, while in most cases rivers are no more able to provide enough sediment to the coast;
- the correct management of sediments within the system in order to balance accumulating vs. retreating coastal stretches and strongly reduce or avoid losses from the littoral system (seaward, eg. by waves and storm actions, land lowering by subsidence phenomena, or landward, eg. wind action, human activities/exploitation).

In this frame they assume fundamental relevance the knowledge of possible sediment sources (off-shore, littoral and inland) for beach nourishment and the set up of good practices of beach sediment management and preservation.

So the first Phase (A) of Component 4 is focused on the review of state-of-the-art of such knowledge, together with coastal assets and policies of partner's regions, and on littoral management practices nowadays carried on. This Phase provides the information framework and data reorganisation dedicated to plans formulation (Phase C) but also the individuation of information gaps to be filled or practices to be introduced or enhanced. These will

be object of deepening in Phase B in order to set up proposals/ recommendations, that will be included in Plans coming out from Phase C, for a correct management of beach sediments and for the sustainable exploitation of sediment deposits.

Feeding the system (nourishment)	1 **from out of the system**	Inland extractions	- dam basins dredging - building excavations - quarries
		River solid transport enhancement	- sediment bypass hydraulic works - hydraulic works re-modulation - river vegetation management
		Off-shore deposits on continental shelf	- relict beaches - relict river fans/deltas
	2 **within the system**	Littoral accumulations	- by harbour piers, groynes - breakwaters, landward side - natural accumulation zones
		Submarine accumulation	- submarine river fans - littoral submarine accumulations
	Littoral sediment management	Hydraulic or navigation managements	- river mouths dredging - harbour mouths dredging - harbour basin enlargement

Reducing losses from the system	1 **beach sediment management**	Beach cleaning/ maintenance operations	- in situ sifting or by plant sifting - possible use of landed bio material for dune restoration (branches, boles, etc)
		Aeolian catchments	- break-wind barriers (temp, permanent) - vegetation planting
		Protective winter levees	- sediments from rear beach zone - avoid use front beach sediments
	2 **subsidence reduction anthropic component**	Reduction of u-ground water drawings	- water provision policies - water wells authorisations control
		Reduction of hydrocarbons extraction	- limitation for hydrocarbon-fields extraction near the coast
		Mitigation policies	- fluids re-intro in hydrocarbon-fields - compensative measures

Regional policies for coastal protection against erosion and submersion risk

Region of Eastern Macedonia & Thrace

Excavation of sand and gravel from beaches is prohibited since 1938 (Ministerial decision 422/1938, Ministries of Finance, Transport, State Health, Press and Tourism). Sand excavation from rivers is allowed under special permit from the local authorities and it is not permitted in a 1000 m distance from cities, in touristic sites, in archeological sites and environmentally protected areas.
The latest National law (Law 2971/2001 "Seashore, Coasts and other provisions") does not make references on erosion and submersion risk.
The most recent national strategy for the protection of coastal zones was presented in the Report of Greece on Coastal Zone Management (Ministry of Environment and Public Works (YPEHODE) 2006) it describes the National strategy for the protection of coastal zone. This would constitute a national strategy for the entire coastal space including continental and island parts of Greece. The idea was to develop a policy for the coastal areas at three levels:

- at national level, there would be spatial planning objectives, orientations and criteria for a further concretization of the policy at different lower-scale levels of management,
- at regional level, there would be identification of geographical zones where the policy could be more effectively applied, with more concrete orientations and targets, and
- at local/municipal level, within specific geographical zones, there would be concrete master-plans and regulatory measures for the management of the specific coastal zones, providing for all relevant sectoral policies and land-use in a sustainable perspective.

The major purpose of this strategy was to identify mid-term actions and policies for inclusion in the Operational Programme 2000-2006, so that the Greek coastal areas could be managed in a rational way, sustaining the population and the necessary development activities and protecting, at the same time, the natural resources and ecosystems.
On 21/1/2008 Greece ratified the Protocol on Integrated Coastal Zone Management in the Mediterranean.

Taking in consideration the results of the 2006 report, it was decided to first prepare three separate "Special Frameworks of Spatial Planning and Sustainable Development" (SFSPSD) on Tourism, Industry and Renewable Energy Resources and then prepare a "Special Framework of Spatial Planning and Sustainable Development of the Coastal Areas and Islands" which would be harmonized with the above mentioned special frameworks. The SFSPSD on Renewable Energy Resources was issued the 03/07/2008, the SFSPSD on Industry was issued the 03/12/2008, the SFSPSD on Tourism was issued the 11/06/2009. Both three of them mention activities, land-use and practices that should and should not be permitted on coastal zones. The SFSPSD on Coastal areas and islands is currently (second quarter 2010) under preparation and it is expected to be issued till the end of the year. This report includes a clear definition of the coastal zones and to the activities allowed in these zones according to the 2008 Protocol on Integrated Coastal Zone Management in the Mediterranean.
The focal point of Greek policies is the protection of the public character of the immediate coastal zone and the moderation of activities on the general coastal zones, rather than the concern on erosion and submersion risks.

Lazio Region

The regional policies and strategies for the management of Lazio Region's coastal stretch were translated into the Regional Law, 5th January 2001 no. 1 (Legge Regionale 5 gennaio 2001 n. 1), called "Rules to Enhance and Develop Lazio Littoral" ("Norme per la valorizzazione e lo sviluppo del litorale del Lazio"). This instrument proved to be very useful, mainly because it bridged the gaps of the coastal regional plan, allowing the planning and implementation of concrete actions aimed to solve coastal critical issues, in order to promote Lazio littoral economic and social development. Indeed, Art.7 of the L.R. 1/2001 defined the "Integrated programme of interventions for the development of Lazio littoral" which was approved with the Regional Council deliberation no. 143 of the 31st July 2003. This programme envisaged a series of specific Actions to requalify coasts (table 1)
Among these actions - as regards the objectives of the Component - Actions I.1.1. "Littoral defence from coastal erosion phenomena and reduction of risk factors" and I.1.7. "ICZM (Integrated Coastal Zone Management) experimentation in pilot areas", are reserved to the Regional Administration. These actions have been integrated with the works in progress financed by other planning instruments (in particular, as regards littoral defence, by Measure I.1. of the DOCUP Ob.2 Lazio 2000-2006 and the Framework Programme

table 1

Agreement "Soil Defence and Coast Protection" ["Difesa del Suolo e Tutela della Costa"] - APQ5 draft signed in December 2003).

- Action I.1.1 "Littoral defence from coastal erosion phenomena and reduction of risk factors".
- Action I.1.2 "Preservation and increase of biodiversity, and safeguard of (coastal and marine) natural ecosystems".
- Action I.1.3 "Integrated improvement of coasts quality and bathing waters".
- Action I.1.4 "Strengthening of evaluation instruments and control of the impact of anthropic activities and environmental education".
- Action I.1.5 "Energy saving"
- Action I.1.6 "Increase and adjustment of the services for the differentiated collection of urban solid wastes".
- Action I.1.7 "ICZM (Integrated Coastal Zone Management) experimentation in pilot areas".
- Action I.2.1 "Redevelopment and recovery of degraded areas".
- Action I.2.2 "Requalification of the settlements"
- Action I.2.3 "Shore planning and requalification for ensuring free access to bathers".
- Action I.3.1 "Knowledge, safeguard and enhancement of historic and cultural resources".
- Action I.3.2 "Support to integrated territory enhancement programmes".
- Action II.1.1 "Improvement and rationalisation of accessibility to the littoral and the Pontine islands".
- Action III.1.1 "Requalification and development of hotel facilities and other".
- Action III.1.2 "Requalification and adjustment of seaside facilities".
- Action III.2.1 "Enhancement of the tourist product and its information, welcoming and assistance system".
- Action III.3.2 "Enhancement of the ship-building industry (for yachting and fishing)".

Actions foreseen by the "Integrate Programme of Interventions for the Development of Lazio Littoral".

In particular, Action I.1.1. included the following types of interventions that can be financed:

- Reconstruction or maintenance of shores by means of beach-nourishment interventions using sand from inland or marine caves, to be carried out with or without rigid or semi-rigid defence works;
- Protection and defence of littorals subject to erosion by using environmental low-impact technologies, including submerged works and drainage systems;
- Water drainage and disposal aimed to recover coastal areas to be reclaimed;
- Restoration of the natural balance of inland solid transport along rivers;
- Restoration of the natural balance of solid transport along littorals;
- Environmental recovery and reset of sea-cliffs;
- Studies and surveys on coastal dynamics and hydro-geologic problems along littoral sea-cliffs.

The following planning documents elaborated by regional tech-

nical offices – "General Programme for the Defence and Reconstruction of Littorals" ("Programma Generale per la Difesa e la Ricostruzione dei Litorali") and "Overview of Priority Interventions" ("Quadro degli interventi prioritari") approved with the Determination of the Regional Council, DGR No. 61 of 2004 – identified the Lazio littoral critical points, in terms of erosion and coastal degradation, as well as the interventions required to face these emergencies.
On the other hand, the first step of the implementation of Action I.1.7. was the establishment of the "ICZM Commission" (D.G.R. No. 345 of the 30th April 2004), in charge of defining the working plan, identifying pilot coastal areas for integrated management; defining and managing communication and interinstitutional understanding protocols to involve interested actors; coordinating and verifying the implementation of the action, in particular as regards the development of territorial I.T. systems; expressing views and monitoring the carrying out of the action, even during its implementation. The same D.G.R. identified 3 Universities – Università La Tuscia di Viterbo, Università La Sapienza di Roma, Università di Cassino – having tecnical-scientifical tasks for the implementation of the ICZM on the territory.

Département de l'Hérault

The national coastal law of 3 January 1986 determines the conditions of use and enhancement of land-based, maritime and riparian areas. It applies to the riverside towns of oceans, seas, salt ponds and natural or artificial lakes of more than 2,400 acres. This law is a development and town-planning law whose purpose is:

- the protection of biological and ecological balances, the conservation of sites, landscapes and the cultural and natural heritage of the coastline;
- the conservation and development of economic activities linked to the proximity of the water;
- the implementation of a research and innovation effort concerning the particularities and resources of the coastline.

The Public Maritime Domain (PMD) on which the coastal law applies in a very sustained, inalienable, inconstructible and imprescriptible way. It is situated between the lowest and highest tide excluding exceptional weather phenomena. The PMD also includes silt-relay, ponds in direct and permanent communication with the sea as well as the soil and subsoil of the sea up to 12 nautical miles from the coast. It is comprised of the coastline's most protected areas.
Some sectors of the coastline also benefit from protection mea-

sures by ranking, according to the law of May 1930 whose purpose is to protect sites and landscapes. The Maguelone Cathedral, for example, is a historical monument and therefore protected by a vast protection zone of 2,026 acres. Most of the protection measures can be found in the Environment Code which governs by the law of the protection of Nature. For the protection of ecosystems, the conventions of Berne, Ramsar and Washington, the bird and habitat guidelines and the special conservation zones integrated into the Natura 2000 network apply worldwide. Biotope orders, ZNIEFF and the protection of areas coveted by the Coastline, Mountain and Forest laws apply on a national level. Here is an outline of the instruments of protection:

- the prefectorial orders of the protection of biotopes;
- the ranking and registration of sites;
- the national nature parks;
- the regional nature parks;
- the nature reserves.

Emilia-Romagna Region

Emilia-Romagna Region has more than 30 years experience in protection of the coastal zones, since the regional administrative level was created, in Italy, in the '70ies. The first regional Act concerning coastal protection was the Regional Law no. 7/1979. From this act came out the first coastal plan 1981 (approved in 1983) followed by a second project plan of 1996, and status reports in years 2000 and 2007. The first Coastal Plan indicated soft options, like nourishment, as the way to better contrast the erosion phenomena and submersion risk, instead of the realisation of new hard defence works. Moreover Emilia-Romagna Region stopped the excavation of sand and gravel from river beds (deliberation of Regional Council n.1300 in year 1982), in order to enhance the river solid transport useful for littorals natural nourishment. In addition with deliberation of Regional Council n. 72 in year 1983 it has been ruled and limited the pumping off underground fluids within coastal areas, in order to reduce the subsidence rate (land lowering) and the vulnerability of the coastal zone and its hinterland to marine ingression.

After a first period of experiences in artificial nourishment intervention with sand coming mainly from quarries, by the end of 90ies it affirmed the use of sediments coming from littoral accumulations and then, in the early 2000 decade, the use of submarine deposits. Two main interventions with sand coming from off-shore deposits were realised in 2002 and 2007.

It's to be considered that the competences on coastal defence were transferred by the Italian Government to the Regions only in year 2001. In the mean time (2002-2003) the Region, involving 6 internal Councillorships and Directorates General, 14 coastal Mu-

nicipalities and 4 coastal Provinces (all components of a permanent ICZM Institutional Committee), started a process for the implementation of the Integrated Coastal Zone Management (ICZM), based on the EU Recommendation of May 2002. The process completed its first phase with the formulation of ICZM Guidelines approved in 2005, now introduced in local spatial and urban planning instruments.

Junta de Andalucia

The Spanish Constitution, in its article 132.2 declares that the maritime-terrestrial zone, beaches, territorial sea, and the natural resources of the economic zone and continental platform, are competences of the State (National Level). Therefore, policies for coastal protection are responsability of the Central Government in Madrid. The Ministry of Environment, Rural and Marine Affairs - MARM through its Special Division for Coastal Areas (Dirección General de Sostenibilidad de la Costa y del Mar), is the administration in charge of coastal protection.
The main legal instrument in this regard is the Spanish Shores Act 22/1988 (Ley de Costas). This Law encourages the conservation of natural coastal environments and the establishment of buffer zones through set-back policies. This law contains the principles of the European Recommendation 29/1973 (European Council) about coastal protection and the European Coastal Letter of 1981. Following these recommendations the Shores Act (art.44.4) limits sand and gravel extraction from river beds, and promotes alternative solutions for sediments supply, trying to stop the critical situation produced by the decrease of sediment supply to the coast. In 2004 The Ministry of Environment announced the need for a new and more integrated approach to coastal management. Different policies and instruments were then elaborated:

- main re-orientating lines for coastal policy-2004. (Principales líneas de reorientación de la Política de costas);
- master Plan for the Sustainability of the Coast -2004-2006. (Plan Director para la Sostenibilidad de la Costa);
- strategy for the Sustainability of the Coast-2007. (Estrategia de Sostenibilidad de la Costa).

Based on these strategies, several measures were taken by the competent Ministry to improve coastal protection: expropriation of critical areas involved in erosion processes, creation of coastal soft- defence structures, dismantling of artificial obstructing barriers to sediment transport, beach nourishment or beach maintenance particularly in sensitive coastal areas.

More recently the MARM has elaborated three guidelines regarding coastal works:

- guidelines for coastal stretch treatment -2008. (Directrices para el tratamiento del borde costero);
- guidelines for beach interventions-2008 (Directrices sobre actuaciones en las playas);
- guidelines for environmental management of marine sand deposits-2010. (Directrices para la gestión ambiental de las extracciones marinas para la obtención de arena).

These guidelines establish specific criteria about when and how costal works are to be carried out and which requisites must be fulfilled.

The Ministry of Communications & Works of Cyprus

In Cyprus sand and gravel mining was permitted in coastal areas until the early 1970's, when it was prohibited by law. Estimations based on the data from the Mines Service of Cyprus give the figure of 300,000 m^3 within the period from 1955-1970. It maybe the most important reason for beach erosion.

At the early 90's the government of Cyprus took the political decision to carry out an integrated study that would define the measures and means for the protection and improvement of the coastal zone.

The first effort to implement ICZM in Cyprus was throught the project "Coastal Zone Management of Cyprus". The project was co-founded by European Union, through the MEDSPA Program and the Government of Cyprus. The project was carried out by Delft Hydraulics, supported and working together with the staff of the Coastal Unit of the Public Works Department.

The main objective of this study, was primarily to find proper methods to protect the coastline and improve the quality of the beach where necessary without any serious consequences for the environment (Project duration: 1993-1996).

Types of intervention realised

Region of Eastern Macedonia & Thrace

In the REMTH in general, the social-economic pressure is not as important as in other Greek regions, but touristic and recreational activities have been developed. Even though coastal erosion phenomena are visible in many areas of the region, no hard defenses have been realized. A number of hard defense works have been realized in other Greek coastal areas, namely in Samos, Crete (Rethymnon, Anissaras, Gournes) and Rodos.
Data from the European project Eurosion 2004 reveal that 43,8% of the beaches of REMTH is undergoing “probable erosion but not documented”.
In a total shoreline of 287 Km (Data taken from the project Eurosion 2004) sand shifting is been practiced (rearranging the sand in the same beach in order to have maximum tourist capacity) only in two pocket beaches (Bati - 220 m and Toska - 190 m) by private companies (a hotel and a restaurant-bar) who have private interests on the beaches.
However, the regional development plan promotes the touristic development of the coast line and the more densely concentrated population. In the last decade regional road network has been greatly improved, the access from and to Bulgaria has been facilitated and tourism activities are gaining speed.
Thus the socio-economic pressure for coastal protection from erosion is gradually rising.
Recent (2008) results from the BEACHMED-e project reveal that most users and local authorities would prefer soft defenses for future protection of the coast.

Lazio Region

Over the years, many defence interventions with a different typology and efficacy have been carried out along the about 290 Km of Lazio littoral (islands excluded) - of which 220 km are beaches. In some cases, the former have even strongly modified the littoral natural landscape. The problem of coastal protection have been emerging as a social need since the Sixties and Seventies due to a number of direct and indirect factors, among which the most

important are:

- general decrease of solid transport along the rivers, due to dams, excavations of sediments from the watercourse, inland soil protection, with the related turnaround of many littorals (from moving forward to regression);
- increase of urbanisation along the coasts and subsequent destruction of dunes (a natural sand reserve to offset extreme events); construction of rigid works near the water-line (containment walls, reefs, etc.);
- increase of tourist flows and higher demand for bathing areas.

The socio-economic development choices linked to these factors have created such a macroscopic structural deficit along the littoral areas that it can no longer be solved using local passive defence measures to decrease or limit the erosion phenomenon. Therefore, a general plan for the reconstruction of lost beaches and maintenance of large littoral stretches is now required.

The regional knowledge and experience

The review and critical analysis of the regional experiences acquired, especially of the most recent ones, have showed that it is possible to face this problem with a new approach, which is more advanced if compared to the experiences carried out in the Eighties for the soft defence of the littorals of Terracina, Latina, Formia and Tarquinia. Over the years, Lazio Region has created a series of instruments and studies to support the coordinated and organic planning of the activities for littoral recovery and defence, and in particular:

- coastal monitoring, with local and large-scale surveys of the emerged and submerged beach, aimed to define a general framework of the maintenance need; to plan and verify the efficacy of interventions; to examine cartographic bases, aerial and satellite photos to compare the shorelines and their evolution over the years; management and analysis of the remarks made by interested actors (Local Bodies, Seaside Operators, Environmental Associations, etc.) and direct observations. From the methodological point of view, a distinction has been made among the type of needs: that is to say the need to maintain and the need to reconstruct littorals. The above-mentioned monitoring and their subsequent evaluations have been used within the programme of interventions identified by the Regional Law LR 1/2001;
- verification of the defence systems adopted, which are not limited to the evaluation of results compared to the protection capacity and the efficacy of interventions, but also include the

cost-benefits analysis to assess the real convenience of the system adopted. This verification does not limit the scope of further research and experimentation to find new and more efficient technologies, but it rather redefine it. As concerns the verification of the interventions carried out, we can take into account the parameter "beach extension" before and after the beach nourishment; the results of the monitoring are quite encouraging. Even as regards the parameter "liking of the intervention" by directly interested seaside operators, the surveys made show some very positive results;

- verification of natural resources, given the need to use large quantities of sand to reconstruct and maintain beaches subject to erosion. The activities carried out even at a EU level (BEACHMED and BEACHMED-e projects) show that there are huge potentially available resources, in particular marine sands, but also synergic resources linked to the dredging of outer ports, and other resources (more difficult to exploit) which are blocked inside artificial basins by the existing barrages. In this sector, the experience gained by Lazio Region enabled the latter to improve the knowledge of sand marine caves both on

Table 2
Main littoral defence interventions carried out in 2001-2003

Littoral	*Interventions*
Anzio	Reconstruction of the beach between Tor Caldara and Capo d'Anzio, 1st lot, by means of a soft beach nourishment with sand dredged from the Port of Anzio
Fiumicino	Reconstruction of the beach of Focene by means of a beach nourishment protected by groins
Fiumicino	Completion of the submerged barrier of Focene, radar zone, and construction of a central groin
Formia	Reset of the existing defence works along the beach between Torre della Mola and Torrente di Acqua Fredda (detached cliffs), beach nourishment and cliff environmental recovery
Ladispoli	Reconstruction of the beach by means of a beach nourishment protected by groins
Latina	Protection of the mouth of Mascarello Channel and of the Eastern beach by means of submerged barriers and beach nourishment.
Roma	Reconstruction of the beach of Ostia (central and Western part) by means of a beach nourishment and reset of the submerged barrier
Roma	Extraordinary maintenance of the beach of Ostia (Eastern part) by means of a soft beach nourishment
Tarquinia	Reconstruction of the beach between Port Clementino and the mouth of Marta river by means of a beach nourishment and reset of the existing defence works (submerged groins)
Terracina	Reconstruction of the beach between Foce Sisto, Port Badino and Terracina by means of a beach nourishment and reset of the existing defence works (submerged groins)

the sedimentological (quantity of the resource) and the environmental impact (actual possibility to exploit the caves) point of view. This fostered the elaboration of two methodological protocols for the research of submerged sand deposits and the environmental impact estimation of sand exploitation;

General Programme of Interventions

The General Programme of Interventions has been elaborated on the basis of the monitoring made, the requests received and verified, and the critical issues confirmed by the highly urgent interventions. The General Programme stems from the one already approved with the Determination of the Regional Council, D.G.R. 1835/2001, which has been updated and integrated with the needs emerged from the territory, keeping into account also the works already built in 2001-2003 and described in Table 2. Instead, Table 3 presents the "General Programme for the defence and reconstruction of littorals".

Evaluation criteria and comparative methodology

The General Programme for the Defence and the Reconstruction of Littorals has been elaborated from the indications contained in the DGR No.1835/2001, on the basis of the criteria and intervention priorities of this deliberation, as well as further criteria specifying and/or integrating the original ones. In order to select the interventions to be financed with the resources coming from the Regional Law, L.R. 1/2001, other specific criteria have been identified and applied to assess the importance of the individual proposals outlined in the general programme of interventions (feasibility of the yard, integration and territorial re-equilibration). The scheme of the criteria and the associated importance is shown in Table 4.
Therefore, the assessment of interventions has been related to the following aspects:

- Planning: the evaluation depends on the condition of deficit verified and its intensity (detection, great emergencies, etc.);
- Reporting: in this case, the evaluation is linked to the intensity and gravity of the condition of deficit reported to the Region;
- Interest: this evaluation is linked to the value of the endangered asset. Assets are classified according to the presence of inhabited zones, zones having an archeological-architectural interest, zones having an environmental value and tourist areas;
- feasibility of the yard: this aspect is classified according to the level of project detail in conformity with the Law 109/94, and ensures the rapidity of the intervention implementation;

Table 3 - General Programme for the Defence and the Reconstruction of Littorals

Littoral	*Interventions*
Whole littoral	Activities concerning coastal monitoring, for the planning of interventions and their controls, and the verification and updating of planning
Anzio	Defence works of the ancient Porto Neroniano
Anzio	Defence and Reconstruction of the beach between Lido Garda and Capo d'Anzio by means of groins and the reflow of local sand
Fiumicino	Reset of existing cliffs between Passo della Sentinella and the Navigable Channel
Fondi	Reconstruction of the beach between Foce Canneto and S.Anastasia Channel by means of a beach nourishment and defence works (submerged groins)
Formia	Reset of existing defence works along the beach between Torre della Mola and Torrente di Acqua Fredda, beach nourishment and environmental recovery of the cliff
Gaeta	Extraordinary maintenance of the beaches
Ladispoli	Defence of the borgo di Palo and the Odescalchi Castle by means of a grazing breakwater barrier. Defence of Torre Flavia. Defence of Villa Romana
Ladispoli	Reconstruction of the beach of Marina di Palo and Marina di S.Nicola by means of a beach nourishment protected by groins
Latina	Reconstruction of the beach by means of a soft beach nourishment, safeguard of the dunes and reset of the strengthened mouths of the channels
Latina	Protection of the mouth of the Mascarello Channel and of the Eastern beach by means of submerged barriers and beach nourishment.
Minturno	Reconstruction of the beach of Scauri by means of a beach nourishment and rethinking of the existing defence works
Montalto di Castro	Reconstruction of the beach of Pagliete by means of a beach nourishment and safeguard of the dune
Ponza	Reconstruction of the beach of Chiaia di Luna
Roma	Planned and extraordinary maintenance of the littoral and protection works
Roma	Reconstruction of the beach of Ostia by beach nourishment and reset of the barrier
S.Felice Circeo	Reconstruction of the beach between Circeo and Foce Sisto by means of a beach nourishment and rethinking of the existing defence works
S.Marinella	Defence and reconstructions of mini-beaches in the South part of Capo Linaro by means of beach nourishments and groins
S.Marinella	Defence of the beach North of S.Severa Castle by means of a submerged barrier and beach nourishment
Sabaudia	Reconstruction of the beach by means of a soft beach nourishment, safeguard of the dunes and reset of the strengthened mouths of the channels
Sperlonga	Protection of the Grotta di Tiberio
Tarquinia	Defence and Reconstruction of the Spiaggia delle Saline
Terracina	Reconstruction of the beach between Foce Sisto, Porto Badino and Terracina by means of a beach nourishment and rethinking of the existing defence works (submerged groins)
Ventotene	Reconstruction of the beach of Cala Nave

- Integration and territorial re-equilibration: it keeps into account the interventions for works already carried out and/or underway, as well as the position in areas where funds for under-exploited zones cannot be used; however, the same typology of interventions in these areas is eligible to benefit from EU funds ERDF and CIPE funds.

The evaluation factors adopted range from 1 to 1.7. They are linked to different levels identified by letters (A, B, C, D) and to a score obtained by multiplying the factors.
This kind of methodology highlights the presence of high factors, since it more evidently stresses the "emergencies" of each intervention. Then, the final score is normalised on a 0-100 scale in order to compare the interventions more easily.
Example of an intervention with the following evaluation levels:

- Planning A (Factor 1.1)
- Remarks B (Factor 1.5)
- Interest D (Factor 1.5)
- feasibility of the yard B (Factor 1.2)
- Integration and territorial re-equilibration B (Factor 1.2)

The raw score is: 1.1 x 1.5 x 1.5 x 1.2 x 1.2 = 3.564
The normalisation is made by dividing the raw score by the maximum possible score, and then multiplying the result by 100. The result is an evaluation of the importance, ranging from 0 to 100.
As regards the environmental compatibility of interventions, we estimated that it was not necessary to make a distinction between the works, since all of them are finalised to recover natural habitats such as beaches and rocky coasts; their aim is the defence against the various kinds of erosion by means of different project solutions keeping into account the environmental characterisation of the locations. However, the implementation of these interventions must abide to the applicable environmental legislation.
Table 5 shows the general list of interventions planned by Lazio Region and their evaluation.
Table 5 has been filled out on the basis of the evaluation criteria of the methodology already indicated above.
Finally, the framework of the priority interventions is based both on efficacy criteria in terms of the project solutions envisaged, and on efficiency criteria in terms cost effectiveness (the fact that the interventions are implemented by the Region ensures that interventions on a territorial scale for coastal are more cost effective), as well as on the real regional funds available.

Table 4 - Criteria and level of importance for the assessment of interventions

Intervention assessment criterion		
Planning	***Level***	***Factor***
Littorals indicated by regional surveys and monitoring as coastal stretches affected by strong retrogradation;	A	1.1
Conformity with the planned orientations already approved	B	1.2
Littorals with the presence of infrastructures (presence of inhabited, roads, railways, environmental and archaeological assets, seaside facilities, etc.) in need of urgent structural defence interventions	C	1.3
Littorals with the presence of infrastructures where Lazio Region has carried out "highly urgent" interventions or has completed interventions already started	D	1.5
Reporting		
Littorals reported by private actors as being in a critical situation due to high erosion phenomena and the risks for the exposed infrastructures;	A	1.1
Littorals reported by institutional bodies as being in a critical situation due to high erosion phenomena and the risks for the exposed infrastructures;	B	1.5
Littorals repeatedly reported by different institutional bodies (Municipalities, Archaeological Superintendence, Harbour Offices, Consortia for land reclamation, etc.) as being in a critical situation due to high erosion phenomena and the risks for the exposed infrastructures;	C	1,7
Interest		
Littorals affected by erosion having a particular TOURIST interest	A	1.2
Littorals affected by erosion having a particular ENVIRONMENTAL interest	B	1.2
Littorals affected by erosion having a particular ARCHEOLOGICAL-ARCHITECTURAL interest	C	1.2
Littorals affected by erosion having a particular interest and with the presence of INHABITED CENTRES	D	1.5
feasibility of the yard		
Interventions whose feasibility study has already been made	A	1.1
Interventions whose preliminary project has already been made	B	1.2
Interventions whose final project has already been carried out	C	1.3
Interventions whose executive project has already been carried out	D	1.5
Integration and territorial re-equilibration		
Interventions integrated with works already carried out and/or in progress	A	1.1
Littorals not belonging to under-exploited zones	B	1.2
Max score		6.885
Min score		1.75692
Relative max score (P*S*I*C*A/Pmax)		100
Relative min score (P*S*I*C*A/Pmax)		26

Table 5 - Overall list of the interventions with a comparative assessment index

Littoral	Interventions	*planning*	*Reporting*	*Interest*	*Feasibility*	*Integration*	*TOT. PRIORITY*
Whole littoral	Activities concerning coastal MONITORING, the PLAN OF CAVES and the elaboration of the PLAN OF COASTS						100
Fiumicino	Reset of existing cliffs between Passo della Sentinella and the Navigable Channel	D	C	D	C	B	87
S.Felice Circeo	Reconstruction of the beach between Circeo and Foce Sisto by means of a beach nourishment and rethinking of the existing defence works (detached cliffs and submerged groins)	D	C	D	C	B	87
Ladispoli	Defence of the borgo di Palo and the Odescalchi Castle by means of a grazing breakwater barrier. Defence of Torre Flavia. Defence of Villa Romana	C	C	D	C	B	75
Terracina	Reconstruction of the beach between Foce Sisto, Porto Badino and Terracina by means of a beach nourishment and rethinking of the existing defence works (submerged groins)	D	C	A	C	B	69
Roma	Planned and extraordinary maintenance of the littoral and protection works	D	C	A	B	B	64
Ponza	Reconstruction of the beach of Chiaia di Luna	C	C	D	A	B	64
Anzio	Defence works of the ancient Porto Neroniano	C	B	A	A	B	45
Anzio	Defence and Reconstruction of the beach between Lido Garda and Capo d'Anzio by means of groins and the reflow of local sand	C	B	A	A	B	45
Ladispoli	Reconstruction of the beach di Marina di Palo e Marina di S.Nicola by means of a beach nourishment protected by groins	C	B	A	A	B	45
Ventotene	Reconstruction of the beach of Cala Nave	C	B	A	A	A	41
S.Marinella	Defence of the beach North of S.Severa Castle by means of a submerged barrier and beach nourishment	A	B	A	B	B	41
Tarquinia	Defence and Reconstruction of the beach Spiaggia delle Saline	B	B	B	A	A	38
S.Marinella	Defence and reconstructions of mini-beaches in the South part of Capo Linaro by means of beach nourishments and groins	A	B	A	A	B	38
Latina	Reconstruction of the beach by means of a soft beach nourishment, safeguard of the dunes and reset of the strengthened mouths of the channels	B	A	A	B	B	33
Sabaudia	Reconstruction of the beach by means of a soft beach nourishment, safeguard of the dunes and reset of the strengthened mouths of the channels	B	A	A	B	B	33

Département de l'Hérault

The coastlines of the Gulf of Lion and the Department of Hérault were essentially developed between the 50s and 80s. In this period, the sedimentary contributions of the rivers were still considerable and the natural character of the coastline favoured a good sedimentological functioning of the system. Since then, the anthropisation of the rivers and the coastline, the urbanisation of the sand dune cordons, the over-activity of certain sectors, have upset this fragile balance. Today, the retreat of the high tide line, although unequally divided, has almost generalised. This phenomenon is still made worse by climatic change. During the development of the coastline by the Racine Mission, the creation of harbour works divided up the coast into compartments that were relatively independent of one another: sedimentary cells. Furthermore, the urbanisation of the sand dune cordons (La Grande Motte for example) has deprived the system of a considerable volume of sand. In parallel to this, the decrease in the sedimentary contributions of the rivers has accelerated: channelling, dams, extractions of sediments in flood plains are the main causes of this. For the Department of Hérault, a strong increase in the number of rip-raps can be observed between 1960 and 1990. Indeed, their number has multiplied by 10 in the last 30 years, more than half of which are protection measures against the tide like dykes and breakwaters.

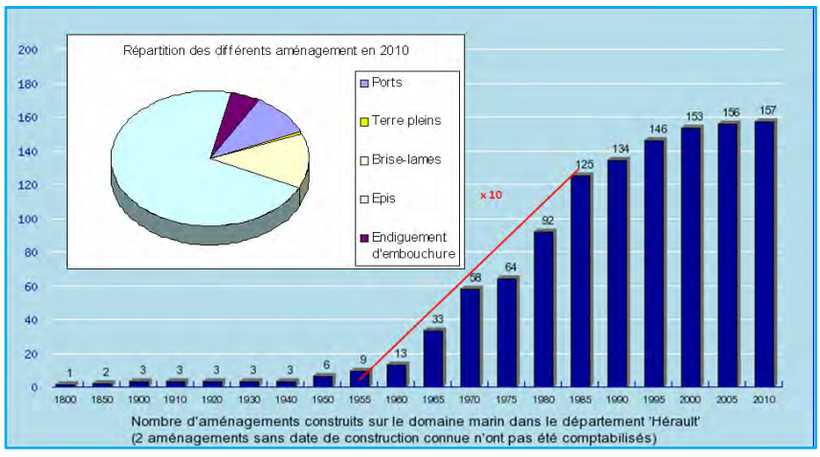


Figure 1

number of coast defence builded on Herault coastal zone

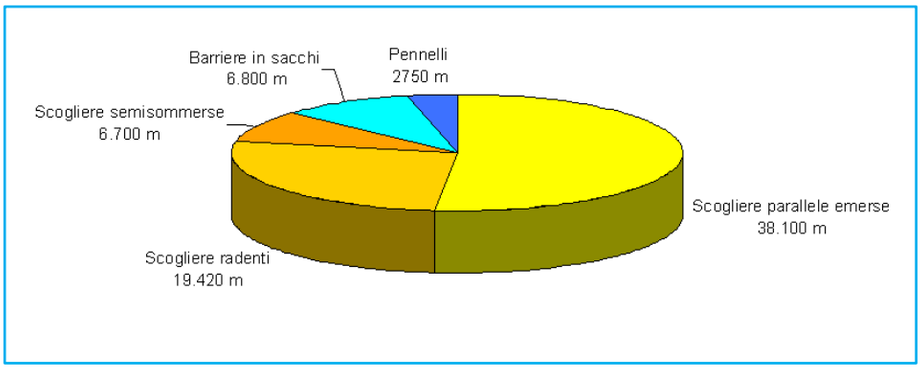
Up until the 90s, the response to erosion was local. Even though a few development plans have attempted to coordinate these actions, they have only been partially applied as they are often badly coordinated and under-financed. Although the implementation of "hard" or "soft" protection works has, for several decades, enabled the local erosion of some sectors of the coastline to slow down or stop, the mid-term effects of these works on the evolution of the

coastline and on the environment have revealed themselves to be more negative than anticipated (displacement of erosion zones, negative effects of some structures after a short positive period, impact on the landscape of dykes and breakwaters, etc.). Despite the undeniable success of certain operations, the global assessment, as much environmental as economic, remains mitigated and uncertain to this day. The presence of more than 250 works in Languedoc-Roussillon has not, however, definitively resolved the problems of erosion. Furthermore, the growing necessity for maintenance and restoration of these facilities has lead to additional financial costs which are generally unplanned for in the initial construction budgets.

Emilia-Romagna Region

During the 20th century, the Emilia-Romagna coastal system has undergone deep anthropic changes, which have led to the disappearance of most original landscape-environmental features: dunes have mostly been leveled, different valleys have been reclaimed, wasteland and woodland have substantially shrunk.
The early erosion phenomena emerged already during the early 20th century close to a few cuspate rivers and in the beaches to the North of Rimini and Porto Garibaldi jetties, after their extension. Yet, it was especially in the second post-war period that the environmental deterioration (beach erosion and eutrophication of inshore waters) became extremely serious and exacerbated to the point of risking jeopardising what had by now become the European leading marine tourism industry during the Seventies.

Figure 2



coastal defense works built along the regional coast in 2007

Coastal erosion management policies had already been implemented by the central government since the Thirties, with the early construction of longshore breakwaters in Porto Garibaldi.
Massive beach protection technical and economic efforts were resumed in 1947 and then continued during the following decades. During the 1950-1980 period, hard defence infrastructures were

built along a 54 km long stretch of the coastline, whereas between 1980 and 2006 a further 12 km long stretch was protected (Fig. 2). This reversal of the trend in the defence strategy occurred following the issuing of the 1981 Coastal Plan guidelines. They highlighted the heavy landscape-environmental impact deriving from these works and for the first time in Italy it suggested beach nourishment as an alternative.

In 1983, the Regional authority launched the first major nourishment campaign ever developed in Italy by mainly using sand from off-shore and inland quarries.

Despite some difficulties and a certain discontinuity, this technique has been implemented over the following few decades by using off-shore and inland sources (Fig. 3), until 2002 and 2007. Two major interventions were carried out by harvesting sand from off-shore underwater sand deposits in 1984 (Idroser 1985), with further detailed analyses in the framework of sea research campaigns (1990, 2001, 2009).

As shown by the calculations made in the framework of the most recent study by ARPA (2008), the total volume of sandy material used for nourishment purposes (deriving from different sources) along the Emilia-Romagna beaches from 1984 to 2007 amounts to about 8.1 million m^3.

The 1981 Coastal Plan and the following studies (1996, 2000, 2007) have given rise to the first major initiatives aimed at identifying and addressing the other major cause for coastal erosion: subsidence.

Subsidence is a phenomenon involving sinking of the earth's surface that might be due to natural causes (tectonics, Isostasy, Sediment compaction) as well as anthropic causes (e.g. pumping off underground fluids, reclamations etc.).

Subsidence along the Emilia-Romagna coastal area is due to natural causes, with a lowering of a few millimetres a year, whereas anthropic subsidence has reached a peak velocity of 50 mm/y during the 1940-1980 period. The main causes are underground water and natural gas pumping.

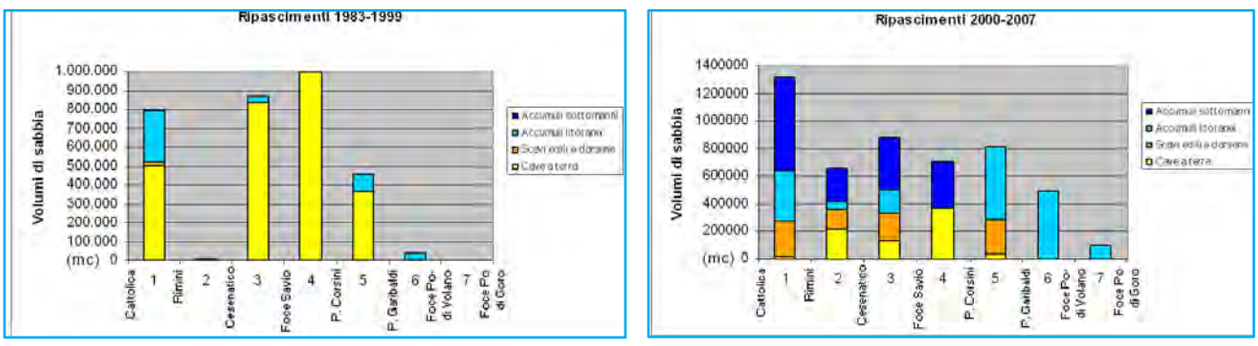
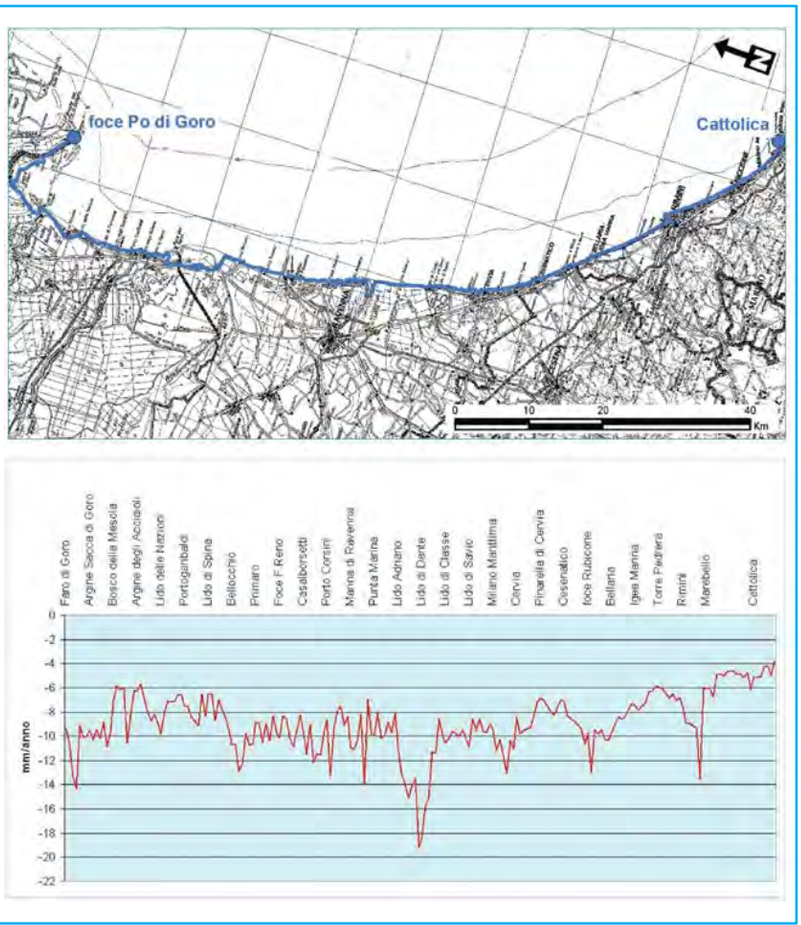


Figure 3
Nourishment campaigns carried out along the Emilia-Romagna coast during the 1983-1999 and 2000-2007 periods and sand sources (ARPA, 2008; Annual Publication, 2009).

During the 80s-90s in order to reduce subsidence, major aqueduct works were carried out to bring surface water to the coast and thus limit pumping off underground water.
At present, the regional coast sinks by 10 mm a year on average; lowering velocity peaks are detected at Lido di Dante (19 mm/year) and between Pineta di Classe and Lido Adriano (15 mm/year) (Fig. 4). It has been estimated that about 100 million m^3 of material have been rescued from subsidence along the coast, between 1950 and 2005, and over the past 1999-2005 period a quantity amounting to a bit less than 1 million m^3 has been saved on an annual basis (ARPA, 2008).

Figure 4



The map at the top reports in blue the subsidence measurement grid along the Emilia-Romagna coast. At the bottom, it reports the subsidence velocity during the 1999-2005 period for all the coastal area ranging between Cattolica and Foce del Po di Goro (ARPA, 2008; Annual Publication, 2009).

Junta de Andalucia

The body in charge of coastal works in Spain is the Ministry of Environment, Rural and Marine Affairs - MARM through its Special Division for Coastal Areas (Dirección General de Sostenibilidad de la Costa y del Mar).

Common hard defense works include: seawalls, groynes (including hammer-head groynes), breakwaters (emerged/sumerged), etc. Soft defense works consist mainly in beach nourishments, sand dune stabilisation and dunes re-forestation.
Both hard and soft defense coastal works have been carried out in Andalusia.

The Ministry of Communications & Works of Cyprus

Table 6

Site	*Type of intervention*	*characteristics*	*Length*	*year*
Zygi	Zygi fishing shelter	natural rock & concrete	900 m	2008/11
Zygi	5 parallel breakwaters	natural rock	500 m	2008/11
Maroni	3 groynes	natural rock	40 m	illegal
Vrisoudhia	1 groyne	natural rock	50 m	illegal
Kambourias	coastal road revetment	natural rock	200 m	2008
Niolima	2 groynes	natural rock	20 m	illegal
Pentaschinos	2 groynes	natural rock	80 m	illegal
Yanoudhia	2 groynes	natural rock	30 m	illegal
Yanoudhia	coastal road revetment	natural rock	200 m	2008
Platy	3 groynes	natural rock	90 m	illegal
Platy	coastal road revetment	natural rock	200 m	2007
Alaminos	4 parallel breakwaters	natural rock	600 m	2000
Alaminos	boat fishing shelter	natural rock	270 m	2000
Softades	2 illegal groynes	natural rock	70 m	illegal
Kokkinadhia	coastal road revetment	natural rock	600 m	2004/08

Hard defenses on Cyprus coast

After the Turkish invasion in 1974 there was an effort to restore the economy and tourist industry. Between 1974-1980 a number of hard defense structures were constructed. The main type was groynes which were constructed illegally by hotel owners in an attempt to create more attractive protected sandy beaches. In addition, a number of breakwaters were constructed by the government. In 1992, the Government decided to adopt a moratorium in the construction of the hard structures until the completion of the study ICZM for Cyprus.
The study was completed in 1996 and until then no construction/development has taken place. In 1998, the required financial resources were obtained and the Cyprus Government started the implementation of these Master Plans.
Based on the available data along the free part of Cyprus Coast

there are 22 km of hard defence works mostly groynes, breakwaters and seawalls (includes legal and illegal constructions). Most of the works were constructed in the period 1980-90 (Table 6).
Beach Nourishment was applied on a specific area in Limassol. The material was brought from the extension works in Limassol Port. The total amount of sand brought was 20.000 m^3.
In certain area in Famagusta region a number of hotel owners use sand nourishment to improve the quality of the beach and create more friendly access to the beach (in rocky areas). In addition small pilot nourishment projects with sand was carried out in Larnaca and Pafos District.

Application of beach sediments management practices

Region of Eastern Macedonia & Thrace

Except of the sand shifting on the two beaches of Bati and Tosca no sediment management practices are applied. In few beaches sand cleaning is applied during the summer season.

Département de l'Hérault

The management method that you should foster, as far as its implementation is possible, is the strategic retreat of the activities and issues at stake. Two management methods are employed when the strategic retreat is not possible: the modification of sedimentary transit and the reinforcement or restoration of the natural mechanism.

The modification of sedimentary transit

During the tourist enhancement of the 20th century, the techniques have been 'heavy' (dykes, breakwaters, etc.). This type of management, the most widespread on the Mediterranean coastline, offers a local and sporadic response, thus simplifying (at least in principle) the setting up of the project. It is reassuring for the riverside residents and only takes up very little private space, being generally carried out on the Public Maritime Domain (PMD). It is opposed to the natural dynamic and therefore cannot be sustainable without maintenance and monitoring which can sometimes be heavy. The negative impacts, downstream with regards to the transit, are considerable, mainly due to the artificialisation of the coastline. Indeed, part of the transit is stockpiled on site and thus reduces the capacity of the system to find a new balance. This type of management, although suited to emergency situations, does not resolve the problem of erosion and even makes the phenomenon worse on the downstream sectors. Moreover, it is not really in line with a sustainable development perspective as it consists of blocking a natural process.
Today, by integrating the principles of Sustainable Development into our actions, we encourage the use of methods from ecological engineering (vegetalisation, ganivelles, etc.). In any case, the requi-

red result is the same: on-site stockpiling of moving sand in front of the sector to be protected.

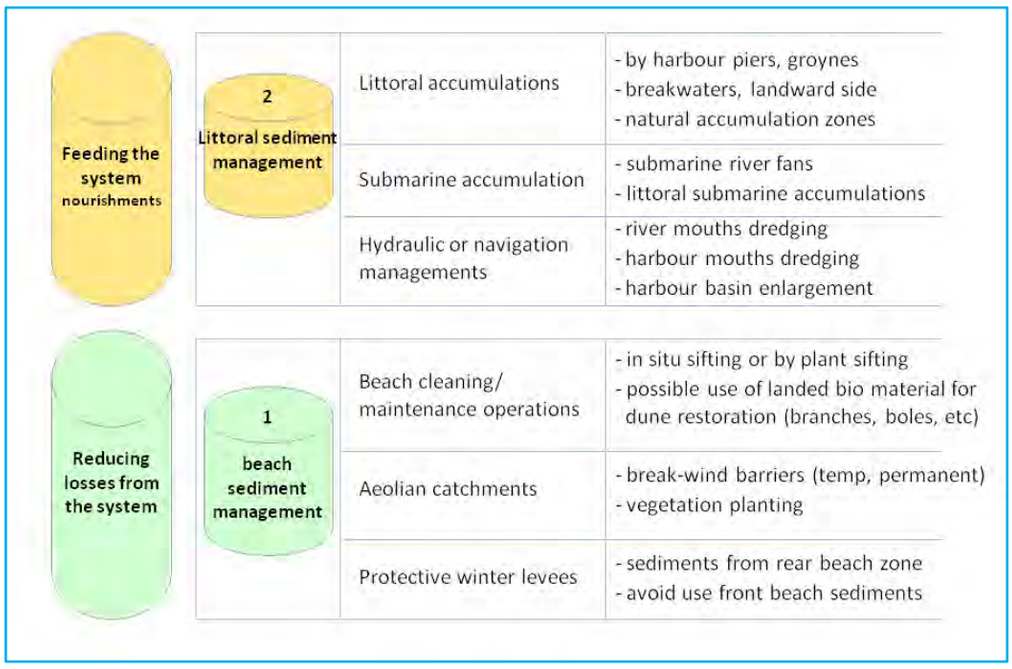
The reinforcement or restoration of the natural mechanism

Contrary to the preceding type of management, it does not involve blocking the natural process of sedimentary transit, but re-establishing it or supplying it if it is lacking sediment. This management method groups together all the techniques which aim to restore a natural mechanism that has been disturbed (restoration of sand dune cordons, by-pass of works, etc.) or those which enable the sediments to be supplied to the natural system (beach surfacing, suppression of river thresholds, etc.). The benefits of this management method are those of sustainable development: the main benefit comes from the fact that instead of fighting against a natural phenomenon, it adapts to it or even uses it, which guarantees the perennity of this management method. It does not have a negative impact on the downstream sedimentary transit as the transit is uninterrupted.
Its effectiveness is more global. It not only responds to the problem locally, but contributes to restoring the whole system and even tackling the causes of erosion. In many instances, it preserves or even improves the biological and environmental qualities of the sites.
On all our beaches, the dismantling of seasonal installations is obligatory

Emilia-Romagna Region

The beach sediment and coastal accumulation management in Emilia-Romagna Region is based on a set of operational practices suggested by the ICZM guidelines (approved by Deliberation of the Regional Council n. 645/2005).
On the one hand, these practices are designed to implement beach sediment management to reduce sand resource waste, thus avoiding the loss of sediments in the coastal system, and on the other hand, to implement coastal accumulation management, aimed at the management of critical coastal section sediment close to coastal defense works, piers, port or river mouths.
These seasonal beach management practices are accompanied by sound nourishment interventions, with a multiannual frequency, by using materials coming from outside the coastal system: mainly from off-shore sand stocks, hydraulic maintenance work along waterways, and also from quarries, dredging artificial catchment areas, and building works excavations.
The main beach management practices, which are most frequently

used in the Emilia-Romagna region are:



The Regional authority is the main operator in charge of the coastal accumulation management. The beach sediment management practices are only partially directly implemented by the Regional authority, through its Basin Technical Services. The other providers are the Municipalities and private operators in charge of a few beaches (mainly sunbathing establishment managers). One of the most important tasks of the Region is the standardisation of these activities carried out by different providers, in view of the introduction of best practice standards deriving from the experiences acquired over the past decades. For this purpose, the Regional Authority is engaged in the implementation is not only of the ICZM guidelines, but also in the issue of technical opinions, through its competent services, about the activities carried out by the Municipalities and by private operators in the sector.

Beach cleaning

At present, also thanks to the initiatives undertaken by the Regional authority, the beach cleaning and the harvested sand management system has substantially been improved in a few Municipalities, even though it is far from being optimal. The regional coast defence coordination task force is made up of the Basin Technical Services (STB Po di Volano and coast, STB Romagna) and by the Soil and Coast protection Service. According to their estimates,

about 60,000 m^3/year of sand are harvested from sandy beaches and carried to temporary stock areas and landfills, where until a few years ago they were only partially screened and brought back to the beaches they belong to.
The main issues that have been addressed to improve such practices and to reduce the sand resource wasting have concerns two main aspects in the cleaning process:

- the waste disposal system needs to be improved, by reducing as much as possible the quantity of sand disposed of along with waste, by means of an early on-site sand screening, directly on the beach;
- after the waste disposal, the residual sand has to be fully brought back to the beaches affected by erosion, after being recovered through the screening process (hence, it cannot be sold, as is often the case, given its high market value).

Over the past few years, this practice has proved to be very successful, thus getting close to 100% screened sand recovery and beach reallocation in a few coastal areas.
Various beach cleaning service management authorities (i.e. AREA, HERA, GESTTURIST, etc.) operate at the regional level. The different local branches of ARPA (Regional Agency for Environmental Protection) and AUSL (Azienda Unità Sanitaria Locale - Local Health Authority) behave differently for the characterisation of materials, in terms of number and types of analysis. Therefore, it is necessary to assess the difference approaches adopted by the various authorities informed to standardise both material characterisation and cleaning operations, in view of sand reuse on the beach.

Winter seawalls and windbreak barriers

Figure 5

Fixed windbreak net installed in the free beach of Porto Garibaldi in 2005

According to a widespread but improper practice, sand is harvested from the shoreline by means of mechanical means. This technique affects the cross-shore profile: thus entailing a reduction in the backshore slope close to the shoreline and often in the distribution of dunes. The sea will successively reshape the natural shoreline profile, to the detriment of the nearshore seabed that becomes deeper. The effects will be a smaller damping of the wave motion energy in case of a sea storm, even an ordinary one. A steep artificial seawall is generally built (with a slope not the word than 1 out of 3); the height is generally oversized in view of the envisaged peak high tide (+2 m) or even + 4 m at the mean sea level. Waves breaking against the seawall find a sub-vertical surface of non compacted sand and thus much more vulnerable to erosion. These works are more frequent on narrow beaches af-

fected by erosion, much more exposed to the action of the sea and, if they are protected by breakwater barrier beaches, only a portion of the material taken away by sea storms is successively replenished to nourish the eroded beach; a part of the material is lost in front of the barrier beaches, on the seabeds and wouldn't be easily restored to the beach.
Seawalls are then dismantled in spring and the material is straightened out on the beach; sand is often levelled off also in the water in order to extend the beach surface. Useful for recreational and tourist activities; this entails a greater amount of sediment moving due to longshore drift.
Losses due to this action cannot be estimated, since the loss material remains on the nearshore seabed and then moved by longshore drift. The effect is anyway negative, since by varying the profile and by reducing the backshore with, the erosion hazard increases with detrimental effects on tourism activities themselves.
Starting from 2002, the regional coastal defence coordination unit has issued various technical opinions to regulate the widespread practice of building artificial dunes on the beach in autumn a to protect bathing establishments. A few clear indications have been provided to the Municipalities, trade associations and individual bathing establishments, as described here below:

- use of sand coming from outside (for example from authorised excavations or from recovery by means of harvested sand screening and beach cleaning);
- use of sand coming from the beach itself but also from excavation in the backshore area to be used in the frontshore;
- application of alternative methods, such as the installation of barrier beaches and longshore windbreak barriers; this method proves to be effective, but also in narrow beaches (40 m) and after a short time, it leads to the formation of symmetrical dunes, having a 60-70 cm height and a 4-6 m base width.;
- given the seawall size and shape a maximum 2,5 m height at the mean sea level is recommended as well as a seaward slope not lower than 1 out of 4; that seawall should be positioned backward, possibly above the ordinary sea storm line.

In the Emilia-Romagna Region the coastal zone is densely populated and built. That is why sand transported by them wind is elite reaches streets and squares and private courtyards, and from there directly to the sewerage, without any recovery possibility. The wind erosion determines a net sand loss amounting to roughly 100,000 m^3/year in the Region. A few windbreak barriers had been recommended in bathing establishments to reduce wind erosion, whose height varies between 1 and 1.5 m, and whose grid mesh size varies between 1 and 2 mm; they are positioned at the end of the bathing season by bathing establishment managers and remo-

Figure 6

Not properly built Winter seawall

Figure 7

Mobile (seasonal) windbreak nets

Figure 8

Sand losses due to wind transport

ved the following spring. On free beaches, a few fixed nets have been installed, and in a short time (1-2 years) they have led to stable vegetated dunes as high as the net.

Port dredging and nourishment

Several ports are located along the Emilia-Romagna 130-km coast: from North to South, the ports of Goro, Porto Garibaldi, Ravenna, Cervia, Cesenatico, Bellaria, Rimini, Riccione, Cattolica. Given the morphological characteristics of this low and sandy coastline, ports have always been built by using river mouths or by building artificial canals on the backshore and shoreface. This was the only way to create a link between internal sheltered mooring basins and the open sea. For this reason the ports along the Emilia-Romagna coast are all characterised by port canals.
It is clear that given the location, the length of piers, and the direction and distribution of longshore sediment transport, all port canals tended to silt up.
A true waste of natural and financial resources, took place in the past, when dredged sand was transported and discharged off-shore outside the entrance of ports.
Whereas, it is possible to think of a better use by restoring nearby eroding beaches with dredged sand, provided that it is not polluted.
Starting from January 1996 the legislation regulating material dredging and discharge activities along the coast has been updated by a special decree by the Ministry of the Environment (DM 24 January 1996), which envisages strict technical and juridical recovery measures. Hence, thanks to the use and management of dredged sand (which was previously generally wasted away and discharged off-shore), since 1996 it has become possible to use dredged sand for beach nourishment purposes, provided that a favourable physical and environmental consistency report is issued by ARPA.
The Emilia-Romagna Region supports the regional and municipal port action programme, on an annual basis, in compliance with Regional Law no. 11/1983 and allocates the national funds for sea bottom excavation. It provides financial support and plans coastal defence actions according to law decree no. 112/98.
The ICZM guidelines, in the framework of theme 3.1 - Nourishment by means of underwater and coastal sand - promote the use of (bypass and dredging) port and coastal sand for beach nourishment purposes for backshore (bypass) and shoreface (materials coming from port dredging).
From 2003 to 2007 beach nourishment by means of sand coming from port dredging in the Region accounted for 8% of the total

volume (245,800 m^3 out of 3,263,250 of the total nourishment material).

Dredging of the port entrance and reuse of materials for nourishment purposes

Port of Goro	2003 – Municipality of Goro - dredging of the port entrance channel of Goro with beach nourishment of Lido di Volano
Port of Cesenatico	2003 - Municipality of Cesenatico - dredging the Cesenatico port canal entrance with beach nourishment to the West
Porto Garibaldi	1997 and 2007 – Municipality of Comacchio - dredging the port canal entrance of Porto Garibaldi with beach nourishment of Lido di Spina South; 2010 - dredging with nourishment a ridosso delle scogliere foranee fra Lido degli Scacchi and Lido di Pomposa
Port of Ravenna	2007 – Port Authority of Ravenna - port entrance dredging with beach nourishment di Casal Borsetti South; 2009 – Port Authority of Ravenna - port entrance dredging with beach nourishment di Marina Romea to the North.
Port of Cervia	2007 – Region – dredging of the port of Cervia with beach nourishment of Milano Marittima to the North; 2009 – Municipality of Cervia - dredging the port of Cervia with beach nourishment of Milano Marittima to the North.

Other regional actions

In addition to the field activities, the regional coastal defence coordination task force is committed to preventing the seaward advancement of bathing establishments, according to the ICZM guidelines - sheets 1, 4 and 5 (and to Deliberation of Regional Council 468/2003), aimed at further increasing the impact on the coastline, by promoting regeneration projects that envisage the retreat of bathing establishments.
The regional authority is also engaged in limiting clam fishing activities inside the offshore barriers, which provoke morphological and sedimentary changes of the substrate, the ban of offshore sediment disposal, including even finer material, by increasing the negative balance of eroding beaches.

The Ministry of Communications & Works of Cyprus

The measure of nourishment was used in a number of areas as pilot projects but the responsible Municipality/Local Authority did not have the financial resources to continue the project and replace any sand losses undertaken during the year.
In addition in certain areas hotel owners use nourishment (the material was taken from inland resources) to improve their beach quality and the access to the sea (sand was placed above rocky areas).

ICZM process activated with reference to EU COM/00/547 e 2002/413/CE

Region of Eastern Macedonia & Thrace

The most recent national strategy for the protection of coastal zones was presented in the Report of Greece on Coastal Zone Management (Ministry of Environment and Public Works (YPEHODE) 2006) it describes the National strategy for the protection of coastal zone. This would constitute a national strategy for the entire coastal space including continental and island parts of Greece. The idea was to develop a policy for the coastal areas at three levels:

a) at national level, there would be spatial planning objectives, orientations and criteria for a further concretization of the policy at different lower-scale levels of management,

b) at regional level, there would be identification of geographical zones where the policy could be more effectively applied, with more concrete orientations and targets, and

c) at local/municipal level, within specific geographical zones, there would be concrete master-plans and regulatory measures for the management of the specific coastal zones, providing for all relevant sectoral policies and land-use in a sustainable perspective.

On 21/1/2008 Greece ratified the Protocol on Integrated Coastal Zone Management in the Mediterranean.

Taking in consideration the results of the 2006 report, it was decided to first prepare three separate “Special Frameworks of Spatial Planning and Sustainable Development”(SFSPSD) on Tourism, Industry and Renewable Energy Resources and then prepare a “Special Framework of Spatial Planning and Sustainable Development of the Coastal Areas and Islands” which would be harmonized with the above mentioned special frameworks. The SFSPSD on Renewable Energy Resources was issued the 03/07/2008, the SFSPSD on Industry was issued the 03/12/2008, the SFSPSD on Tourism was issued the 11/06/2009. Both three of them mention activities, land-use and practices that should and should not be permitted on coastal zones. The SFSPSD on Coastal areas and islands is currently (second quarter 2010) under preparation and it is expected to be issued till the end of the year. This report includes a clear definition of the coastal zones and to the activities allowed in these zones according to the 2008 Protocol on Integrated Coastal

Zone Management in the Mediterranean.
Meanwhile two demonstration projects were carried out in the coastal zone of the Region of East Macedonia & Thrace.
LIFE project :"Concerted Actions for the Management of the Strymonikos Coastal Zone", collected data, created GIS tools and a local information office mostly about the flora and the fauna of the pilot site area. The project was implemented by the Greek Ficheries Research Institute and the Greek Biotope/Wetland Centre. The project ended in 2000. The new pilot, site Kariani Beach is in the Strymonikos Gulf.
TERRA project: "Integrated Management Plan for the Kavala Prefecture Coastal Zone" focused on collecting the available information on coastal activities from different services and organisations so as to create a GIS system and digital maps of the pilot site area. The project was implemented by the Prefecture of Kavala. The project ended in 2001.
Both projects focused on the mapping of the local environmental, environmental, social, economic and administrative features of the area to be managed.
The REMTH has not yet issued ICZM guidelines, every development plan is handled separately according to the relative national legislation and the above mentioned SFSPSD.

Lazio Region

Integrated Coastal Zone Management (ICZM) is the EU methodology used to face in due time the problems of European littorals on the long run, involving local actors and not limiting the study of the main coastal issues to a mere empirical approach. Some main areas are identified and their current trends are analysed, trying to understand the future ones. Then, all the aspects of each main area converge in an integrated programme, based on the principles of sustainability and compatibility.
Therefore, ICZM is no longer an abstract concept but rather a systemic approach for the use and management of the territory and its resources. The transition from the assumption of "sustainability" to its practical application is made when practical problems of territorial management (the most important ones have been analysed above) are dealt with. Action I.1.7 envisaged the identification of some pilot areas along Lazio littoral where the EU methodology will be implemented. In detail, in their study, the 3 Universities of Lazio Region elaborated a scientific-experimental methodology and wrote the Guidelines for an integrated planning aimed to guarantee a sustainable development of Lazio littoral. Building on a vision of the coastal stretch as a place where rela-

tionships and interdependencies of the different marine and coastal environmental components coexist, the Guidelines provide planning criteria and axes that can ensure:

- Environmental and landscape sustainability of the transformations;
- compatible tourist development;
- promotion of innovative forms of integrated planning/project;
- participation and involvement of the different public and private actors.

The study has different work phases:
Phase 1. Analysis of Lazio littoral and identification of local coastal environment: acknowledgment of homogenous territories by means of an integrated review of the physical-environmental systems, the settlement and functional situation, the historical-cultural reality system, and the economic-productive resources.
Phase 2. Selection of pilot areas: identification of the areas where the ICZM methodology will be preliminarily implemented.
Phase 3. Identification of the resources and critical points of the pilot areas: identification of critical points and synergies, relations and interdependencies between the different systems: physical-natural; historical-cultural; settlement-infrastructural and socio-economic systems.
Phase 4. Criteria, axes and recommendations for the scheduling, planning and project (Guidelines): redaction of project criteria capable of promoting the eco-friendly development of the targeted local areas.
On the basis of the results of phases 1 and 2, the following pilot areas have been identified:

- pilot area 1: the sequence of reclaimed valleys and plains of the coast of Montalto and the coastal stretches, the reclaimed plain and the hill of Tarquinia;
- pilot area 2: the littoral of Ostia in Rome and the park of Castelporziano;
- pilot area 3: the agricultural plains of Terracina and Fondi.

During Phase 3, in these areas having been carried out in-depth surveys to understand the functioning of the pilot areas, highlighting the relationships between the physical-natural; historical-cultural; settlement-infrastructural and socio-economic systems.

Guidelines for the application of ICZM in pilot areas.

The guidelines for the Integrated Coastal Zone Management are the final result of the study. They are a collective utility tool, both for the decision-makers and for the operators, to be used as a

support instrument to face one of the most urgent issues of the years to come: coastal zone management on the medium-long run. Today, the major conflicts due to their exploitation are already concentrated in these areas and future perspectives suggest a further pauperisation of resources caused by many factors, from the most endemic ones to global scale climate change. Therefore, the Guidelines represent a practical tool to suggest and identify appropriate actions for the sustainable management, recovery and requalification of coastal areas in the view of an integration between the different coastal Plans and Projects, without forgetting future expectations of local populations. In order to be efficient, the Guidelines are not limited to general statements, though valid and shared, but are focused on the local context, with its identity and perspectives. For this reason, the research carried out and the Guidelines derived from it follow the developed methods (phases 1, 2 and 3) and the analysis of the main critical points and potentials of Lazio coasts; they study in depth the problems linked to the management of individual pilot areas and identify the objectives to reach, the strategic actions proposed to deal with these problems and reach the objectives, the recommendations useful to reach them, as well as the framework of the plans, programmes and interventions in progress used to deploy these strategic actions and financially support them.
Therefore, the structure provided by the guidelines is the following (the data indicated are taken from the pilot sub-area of Tarquinia):

Département de l'Hérault

Faced with the negative consequences, for the environment, of the establishment of the Racine Mission's tourist infrastructures, manoeuvres have been carried out to clarify the nature of the erosive phenomena, define the relevant level for handling the problems, envisage perennial solutions which take into consideration all the elements of the surroundings, both natural and human on the sectors that are judged to be priority. This measure is at the origin of the acknowledgement of Sustainable Development on the coastline and the application of the methods of Integrated Management of coastal zones.
In Languedoc-Roussillon, a founding document for the application of the measure of Integrated Management of Coastal Zones (IMCZ) was produced in 2003 at the end of a collective work lead by the Inter-ministerial Mission for Coastal Development. The Department has actively contributed to it. This document includes the management strategy which has been applied along the coastline of Languedoc-Roussillon since 2003. The broad guidelines are re-

called below. Different management methods of an eroding coastline have been listed in the report 'Orientations stratégiques pour la gestion de l'érosion en Languedoc-Roussillon' (Strategic orientations for the management of erosion in Languedoc-Roussillon' - June 2003). This report distinguishes two 'families' of solutions:

- the solutions aiming to stabilise the high tide line in order to preserve and protect background issues;
- the adaptation to the natural phenomenon with the displacement or abandon of the issues (strategic retreat or non-management).

In June 2003, the assembly of the Department of Hérault approved the general orientations of the sustainable development chart and committed itself, at the proposal of the Inter-ministerial Mission for Coastal Development in Languedoc-Roussillon, to participating in the implementation of the Coastline's Sustainable Development Plan. This Plan, combined with the General Orientations, is at the origin of the launch of studies in the region for the protection and enhancement of the coastline which are conducted with the aim of preparing (together with the drafting of a leading plan), the future management of the high tide line by sedimentary cell. It is thus at this level of analysis that the coastline enhancement studies of the last five years have been carried out. They have enabled the start-up of a huge campaign of works on the coastline of Hérault (€100 M between 2007 and 2012, including €20 M contributed by the Department).

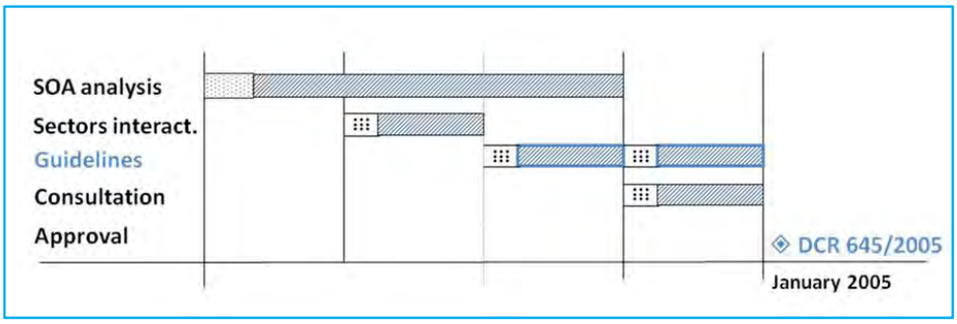
Emilia-Romagna Region

The management of coastal areas focussed on sustainability can be successful only by adopting a complete set of juridical, economic tools, agreements, information delivery, technological solutions, research, education and training.
An improved consultation between subjects is the platform for a sustainable development. It is needed in order to recognise synergies or contradictions between actions deriving from different policies, and to facilitate the compliance with needed arbitration, thus empowering participating subjects.
This consultation and participation effort can be developed only by starting from a complete and understandable information by everyone of the environmental status, the reasons of its changes, the implications of policies and measures at several levels and on available options.
Consultation is a strategic choice, to be further strengthened by defining work methods and mechanisms for the dialogue between subjects from different sectors, as well as by setting up a constant

exchange of information between the diverse territorial competence, at local, national and Community levels.
The ICZM theme has been developed concretely by EU from more than one decade. An EU ICZM Demonstration Program, designed around a series of 35 demonstration projects and 6 thematic studies, was operated by European Commission from 1996 to 1999. This operation gave relevant feedback on ICZM policies implementation that were included in the subsequent official EU documents in this sector: the Communication from the Commission to the Council and the European Parliament on “Integrated Coastal Zone Management: a strategy for Europe” (COM/00/547 of 17th September 2000), and the European Parliament and Council Recommendation concerning the implementation of Integrated Coastal Zone Management in Europe (adopted on 30th May 2002). More recently, a survey on the ICZM implementation was commissioned, and the results published in 2006, by the European Union in order to point out the state of art around Europe: Evaluation of Integrated Coastal Zone Management in Europe (18th August 2006).

Integrated policy for coastal zone in Emilia-Romagna Region

The experience carried out by Emilia-Romagna Region has fostered an exchange of views between inevitably tied sectors in order to have an effect on the ecological healthy state and urban functionality in the coastal area.
The base concept, represented by the idea of “integration”, is the importance of opening up to a full-fledged recognition of the unitary system of the coastal setting, although in the full awareness of the difficulty in construing the singularity provided by the coast as a territorial body.
It should also be remarked that the coast, although somehow emerging imposingly as a unitary object within the framework of different land use plans at provincial level, would be broken up into other territorial contexts, due to its dimensional prevalence – within individual provinces.
The methodological and content framework for regional action on integrated management of coastal areas is the Regional Environmental Protection Program 2001 (Regional Council resolution No. 250 of September 26, 2001), called "Environmental Action Plan for a Sustainable Future", containing also references to the EU environmental programmatic context and to the deliberation of Regional Government n. 2794 of 10/12/2001 that approves the ICZM framework and gives the start up of the ICZM process in Emilia-Romagna.
This process stated operatively in 2002, following different steps as indicated in this scheme:



The state of art analysis (SOA) phase, and the interaction analysis phase, concerned the different sectors having direct influences and impacts on coastal zone, organized in the following 9 themes plus 1, transversal activity, concerning communication and training directed to the wider public and local administrators.

1. the physical system, risk factors and defence strategies;
2. integrated water management at basin scale;
3. port, transport, navigation related risks and management;
4. natural habitats and biodiversity;
5. sustainable tourism;
6. fishing and aquaculture;
7. sustainable agriculture;
8. energy policy;
9. urbanisation and transport;
10. education and dissemination.

The process has been governed by the following boards:

- ***Institutional Committee***, the political level (6 Regional Councillorships, 4 Provinces Presidents, 14 Municipalities Mayors).
- ***Intersectoral Committee***, the integration level, Board of the Directorates General involved (DG Environment, Soil, Industry, Tourism, Spatial Planning, Agriculture).
- ***10 Working Groups***, one on each ICZM theme (almost 200 experts, scientists and stakeholders), the operative level.

The SOA analysis phase individuated specific problems and criticalities related to the different themes through the collection and updating of data and studies carried out in the different sectors by regional, local administrations, boards and institutions offices.
The Sector interaction phase was directed to analyze influences and pressures between the different sectors and to individuate possible mitigations and policy integration areas between sectors in order to overcome conflicts generated by sector specific policies for the coastal area.
The third phase saw the first formulation of Guidelines, for each theme profile, aimed to activate or to enforce integrated manage-

ment processes for the coastal area, with a particular emphasis on their sustainability in the future, together with the definition of lines of intervention: structural actions, support actions (assistance, education, training, dissemination), study and monitoring actions.
The Consultation phase, constituted by several public and technical meetings during the whole year 2004, gave relevant feedback and drove to the tuning up of the ICZM Guidelines in the form finally approved by the Regional council at the beginning of year 2005.
A first implementation of ICZM Guidelines was launched by the Region in the period 2006-2008 with about 8 Million Euro funds (5M by the Regional Administration and 3M by Local Administrations) for the development of pilot projects in the different sectors.
All the coastal provinces (Ravenna, Forlì-Cesena, Rimini, Ferrara) and the 14 Municipalities have adopted the Guidelines at local level within their spatial and urban planning tools. Today ICZM Guidelines represent the tool to address all coastal activities towards economic, social and environmental sustainability, in compliance with EU Recommendation 30 May 2002.

Junta de Andalucia

Following the European recommendations made on EU COM/00/547 and 2002/413/CE, and based on the Proposición no de Ley to the Andalusian Parliament in June 2005, Andalusia has formulated a Regional Strategy for Integrated Coastal Zone Management (Estrategia Andaluza de Gestión Integrada de Zonas Costeras). The strategy was proposed in 2008 and its approval is in process. The main aim of the strategy is to combine the conservation of environmental values and the socio-economic progress through the cooperation and coordination of all coastal stakeholders, and its main objectives are:

- Developing an institutional policy for integrated coastal zone management.
- Improving coordination and cooperation on issues related to coastal areas.
- Encouraging public participation.
- Identifying new institutional roles and responsibilities.
- Modifying, adapting or adopting the necessary policy instruments.
- Providing strategic and operational instruments for the administration and institutional management of the coast.
- Creating tools for the implementation, monitoring and evaluation of their strategy.

- Getting enough financial resources to ensure integrated management of coastal areas.
- Ensuring adequate technical training to the requirements of integrated coastal zone management.
- Educating for sustainability of the coast of Andalusia.
- Providing public information and an adequate and sufficient scientific knowledge to address the change process.

The Ministry of Communications & Works of Cyprus

In 1996 with the completion of the ICZM study the following decisions were taken and supported by the government:

- The study and preparation of master plans for coastal protection and improvements works must be extended to cover gradually the whole coastal zone of Cyprus.
- All future plans and developments must coincide with the concept of the Master Plans.
- The implementation of the master plans should be carried out in phases, so that the proposed coastal works could be evaluated as a pilot case in respect of their coastal/hydrodynamic engineering and environmental impacts.
- During the study and preparation of the Master plans, a Technical Committee from representatives of other Government Departments/Service of different disciplines was formed in order to obtain the best results with respect to the environmental aspects. After the completion of the study the technical Committee was established as an official governmental body to deal with problems and developments within the coastal zone

Physical characterisation of the coast

Region of Eastern Macedonia & Thrace

The coastline of the Region (the islands are not included) has a length about 240km, and has an East –West orientation. The largest part of the coast (around 85%) is generally relatively low and flat with sandy beaches, but there are also low rocky coast and cliffy coasts (around the cape Maronia), characterized by accumulations of gravel and pebbles .

In most part the bathymetry for the entire adjacent sea is gentle and the distance of the isodepth of 20m (contour -20 m) from the coastline varies from 1000m to 10000m, i.e. mean slope of less than 2%. The tide is less than one meter (micro tidal range according to tidal classification of coast) and the regional coasts are wave dominated.

Due to the large length of the coast, we can identify many mechanisms which contribute to the morphodynamics of the coastal region (erosion or accretion). For example in the vicinity of the

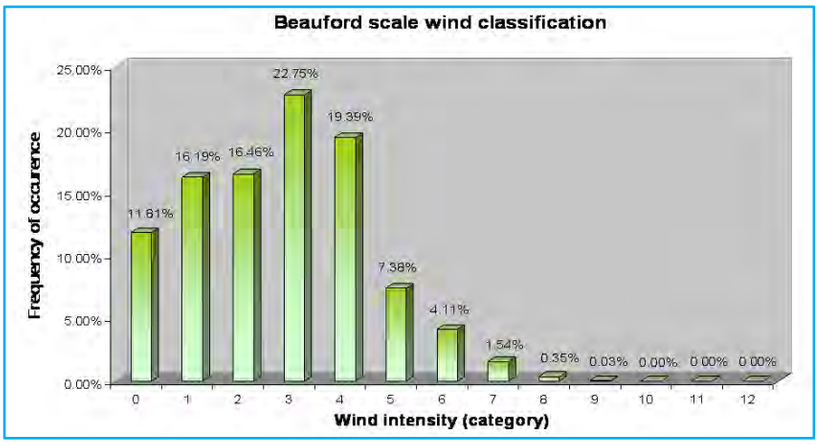
Figure 9

Macrosedimentary cells subdivision

cape of Nea Makri and for a length of about 15 km, we observe natural erosion (retreat 0.5m/year) of the 2-20 m high coastal cliffs, due to high wave energy potential .The erosion in this area is completely natural and independent of anthropogenic or climatic interference.

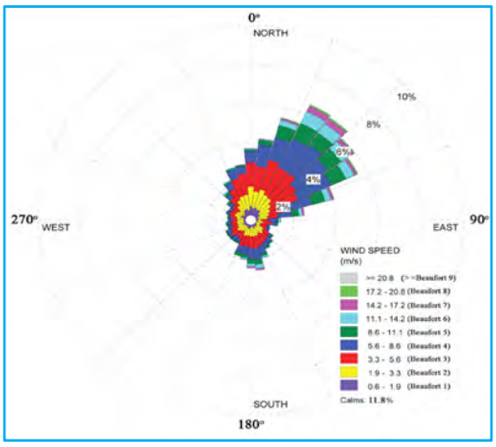
On the other hand, we observe in the entire study area of the REMTH coastline (230km) a general retreat of the coastline i.e. the total area of sandy erosion is larger than the area of accretion. This fact is correlated with the significant reduction of about 74% of the sediment yield, due to human interference (dams). On top on that we may observe erosion problems created by the construction of fisherman small ports, which intercept the sediment transport along the shore, as in case of our pilot site for the COASTANCE program, at Kariani.

Figure 10



Beaufort scale wind classification (frequency of occurrence) for the wind dataset southwest of the Athos peninsula.

Figure 11



Rose diagram for the wind dataset southwest of the Athos peninsula

The division of REMTH coast in sedimentary cells has not been attempted before the present program. REMTH does not have data of in situ measurements to study the sediment transport along the shore and the sedimentary exchange with adjacent cells. In a low sandy beach, usually, the first definition of a macro-sedimentary cell is a coastal stretch characterized by very low or null sedimentary exchange with other adjacent cells (due either to natural barriers, like rock capes or anthropogenic interference like ports which intercept the sediment transport along the shore.

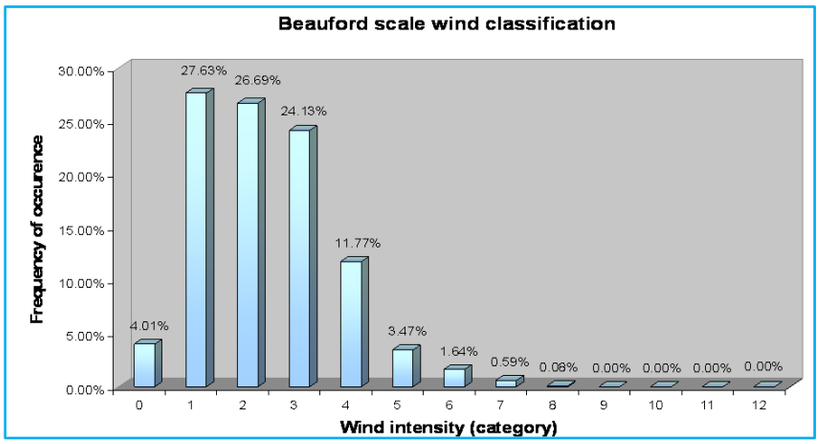
Within the COASTANCE programme we made a first attempt to divide the coastline of REMTH in 5 sedimentary cells, according to the following parameters:

- physiographic characteristics of the coastline,
- natural and anthropogenic factors,

- wave climate,
- main source of sediments (fig 9)

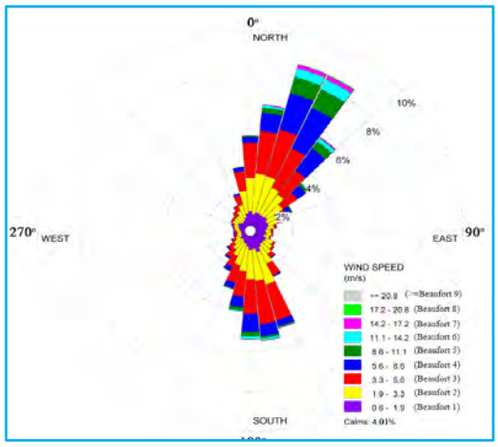
Starting from the west of REMTH, the first macro-sedimentary cell extents from Strimon (or Strimonas) mouth (Fig 9, letter A) up to the cape Vrasidas (B), and has length around 45.5 km. The dominant feature in this cell is the outflow and sediment yield of river Strimon .

Figure 12



Beaufort scale wind classification (frequency of occurrence) for the wind dataset in the area of Nestos river.

Figure 13



Rose diagram for the wind dataset in the area of Nestos river.

The second macro sedimentary cell (BC) extents from cape Vrasidas up to cape Baloustra (Avdira), and has length around 86 km. The dominant natural factor of this cell is river Nestos and the island of Thassos which protects the coast from strong South winds and waves.

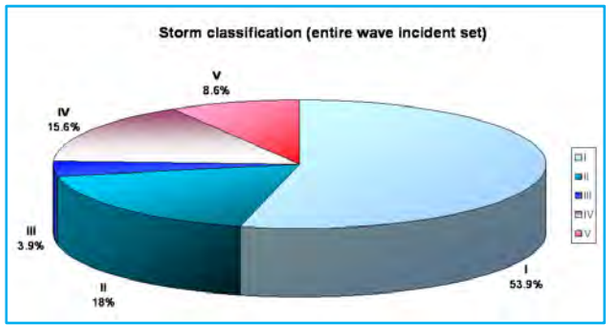
The third cell (CD) extents from cape Baloustra up to cape Kalogiros, and has length around 34 km. The dominant natural factor of this cell is the existence of many estuaries and lakes (Porto Lagos, Vistonis, Xirolimni, Karatza,Aliki, Ptelia), protected by Ramsar convention and by Natura. The sources of sediment feeding are the rivers Kosinthos and Komsatos which outflow to Vistonis Estuary.

The fourth cell (DE) extents from cape Kalogiros up to cape Maronia and has length around 30 km. The source of sediment in (DE) is dominated by river Filiouris. Within the cell (DE) there are two fisherman ports, the port of Imeros and port of Maronia, which in addition to the action of cape, interrupt the sediment transport along the shore.

The fifth cell (EF) extents from cape Maronia up to river Evros, and has length around 51 km. The dominating source of sediments

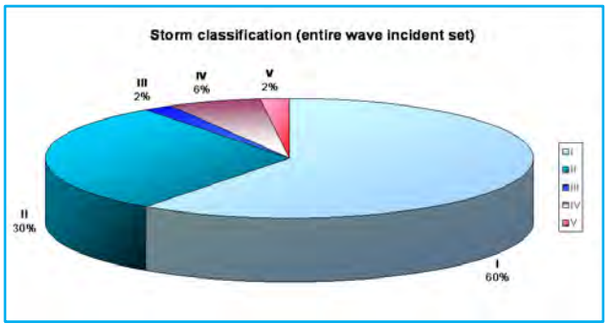
in cell (EF) is river Evros. Within the cell (EF) there are is one big port -that of Alexandroupoli- and a smaller fisherman port in Nea Makri, that both interrupt the sediment transport along the shore. For both wind and wave classification regimes, two databases are used. The databases comprise wind speed, wind direction, significant wave height, mean wave direction and mean peak wave period records every 3 hours from the POSEIDON network's wave buoy sited southwest of the Athos peninsula (2000 - 2006) and from a station in the area of river Nestos in the N. Aegean (1995-2004).

Figure 14



Storm classification for the entire wave incident set southwest of the Athos peninsula

Figure 15



Storm classification for the entire wave incident set in the area of river Nestos

The first database is a limited one with a significant amount of missing data.

For both stations considered, winds are categorized based on the Beaufort scale, considering as an event every record in the wave buoy's measurement archive. Figures 10 and 12 present the frequency of occurrence for each wind intensity of the Beauford scale for both datasets, while Figures 11 and 13 show the respective rose diagrams.

For the first dataset, the Beaufort Scale 3 winds hold the maximum frequency of occurrence (22.75%) with the ones of 1, 2 and 4 Beaufort trailing, maintaining though frequencies steadily above 15%. For the second dataset, the 1, 2 and 3 Beaufort winds hold almost equally high frequencies of occurrence. Percentages referring to "Calm" periods (periods of 0 Beaufort intensity) are 11.81% and 4.01% for the stations in the areas of Athos peninsula and Nestos river, respectively, while it is remarkable that there are no records of intensity greater than 8 Beaufort for both stations. For both stations NE winds are observed to be more frequent and of higher intensity.

Wave incidents at both stations are categorized based on the storm classification scale proposed by Mendoza and Jimenez (2006). This scale comprises five categories representing storms

of increasing intensity, which are also characterized by increasing wave height and energy content. According to this approach, “storms” are defined as events exceeding a minimum significant wave height of 2.0m and a minimum duration of 6 hours. The results of storm event classification are shown in Figures 14 and 15 for both stations examined

The diagrams’ study infers that category “I” storms hold the maximum frequency of occurrence for both datasets (proportions of 53.9% and 60%, respectively). The rest of the scale’s categories are characterized by significantly lower frequencies of occurrence. Category “III” events are limited for both stations, while there are some events of category “IV” and “V” observed southwest of the Athos peninsula.

Département de l’Hérault

Figure 16

Sedimentary cell subdivision of Languedoc Roussillon

The Gulf of Lion forms a large sandy system of the French Mediterranean coast between the Cap Sicié, in Provence, and the Cap de Creus, in Spain, in the Albères chain. Along the Gulf of Lion coastline, the Roussillon plain and the valleys of Aude and Hérault, the hills of Bas-Languedoc and the Rhône Delta have low and straight shores. Coastal cordons attached to islands that have become headlands (Mount Saint-Clair, Mount d’Agde) have isolated the lagoons which communicate with the sea by channels. The only rugged shores on the western side of the Gulf of Lion come together at the foot of the Pyrenees and the Albères, between the Cap Cerbère and Argelès-sur-Mer, where the coast is formed of rocky cliffs and narrow creeks. From the south-west to the north-east of the coastline, you will encounter:

- A rocky coast which stretches from Cap Creus to Racou, slightly to the south of Argelès-sur-Mer; very divided up, it holds within its crevices the ports of Cerbères, Banyuls, Port-Vendres and Collioure.
- A sand strip which is 23 nautical miles long and exposed to the east between Argelès-sur-Mer and Cap Leucate. It borders the ponds of Canet - Saint-Nazaire and Leucate - Salses.
- A straight beach which stretches from Cap Leucate to the Clape Mountains in Narbonne-Plage. It extends to Cap d’Agde by a semi-circular sand beach which borders the Gulf of Narbonne. The ponds of Lapalme, Bages-Sigean, Ayrolle, Gruissan and Mateille border this coastline.
- Between Cap d’Agde and Sète, a straight barrier beach exposed to the south-east, with a sandy beach which encloses a deep harbour: Thau Pond.
- From Sète to Grau-du-Roi, a sandy coastline cordon with a few little pebbles and shingle. This narrow cordon separates the

sea from a string of ponds that are almost joining.

- The little Camargue, between the Grau-du-Roi and the mouth of the little Rhône, which encompasses the Pointe de l'Espiguette and continues to the east by a sandy coastline cordon bordering the ponds.
- The big Camargue, between the little and big Rhône, bordered by a sandy coastline cordon which separates the ponds of the sea, with the sandy arrowhead of Pointe de Beauduc in its centre.

Considering the anthropic changes due to the enhancement of the coastline, we can today count 14 sedimentary cells for the Gulf of Lion, 5 of which are identified for the Department of Hérault.

Emilia-Romagna Region

The Emilia-Romagna coastline is characterised by low and sandy coasts, stretching along 130 km from Cattolica to of the South and to the Goro Po Delta river to the North.

To the North the coast is characterised by a wide Delta plain, whereas to the South to coastline narrows and littoral deposits look like narrow strips located between the Apennine alluvial fan system and the Adriatic sea.

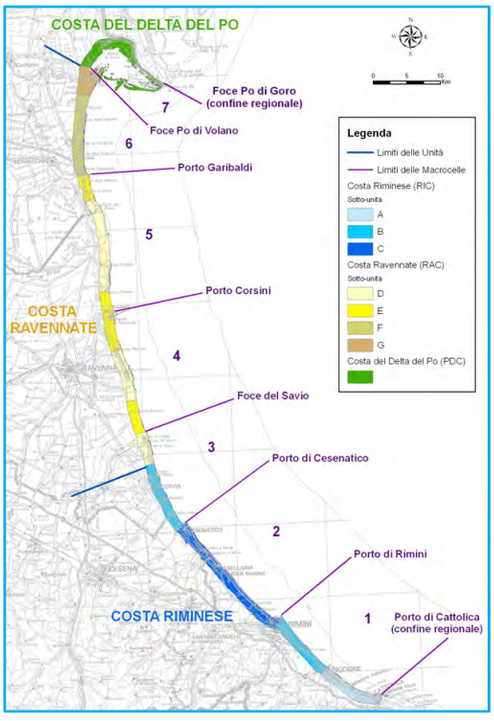
From a sedimentological point of view, the Emilia-Romagna coast is characterised by sandy beaches, with grain size ranging between 0.250 and 0.125 mm (fine sand), more abundant along the shoreline (68%). In the stretches between Po di Goro and Lido di Volano and between Rivabella and Misano Adriatico, the percentage of fine sand attains values ranging between 78 and 94%.

The geological and evolution variability that can be observed along the regional coast, the intensive exploitation of the coastal territory, the building of the long piers and hard coastal defense works to prevent erosion, have changed the coastal dynamics and balance by leading to the fragmentation of the coast into sections with different evolution characteristics and specificities.

In view of an objective coastal sedimentary balance it is necessary to acquire an in-depth knowledge of the coastal sediment transport, which, as already pointed out by the studies carried out in the framework of the 1996 Coastal Plan, is characterised by a discontinuous trend. During the 20th century, the building of long piers has stopped the flow of coarse sediments, thus leading to the fragmentation of the coast into stretches with a limited exchange of coarse material.

In compliance with this phenomenon, ARPA (Regional Agency for Environmental Protection) has suggested the subdivision of the regional coast into 7 macrocells, limited by long piers for by

Figure 17a



Coast subdivision into 7 macrocells, illustrated in the ARPA publication (2008) limited by long piers or "zero" points of the sediment transport* and in the 3 Units (RIC, RAC and PDC) and 7 Sub-units (A, B, C, D, E, F, G) suggested by the SGSS study (2009). *Close to the Po di Volano and Savio River delta a convergence and divergence point of the coastal sediment transport are present respectively.

"zero" points (convergence and divergence) points of the coastal sediment transport, with a variable length ranging between 10 and 20 km (Fig. 17a).
These macrocells, which are characterised by their own sedimentary balance, are regarded as a reference territorial units necessary for the large-scale analysis of the sand loss affecting both the backshore and shoreface.
The presence of several and different types of coastal defense works, which have translated into a further fragmentation of the coast into sections with evolutionary variable lengths sometimes limited to a few hundred metres, has made the regional coastal system even more complex.
Recent studies (ARPA 2008) have made further efforts towards the selection, but providing not only are comprehensive view of the coast, but also a detailed view of individual stretches characterised by homogeneous dynamics and features, which are useful for action management.
Based on further information (shoreline evolution, presence of coastal hard defences, the variation in the volume of the shoreface and backshore, sand harvesting and nourishment) at first subdivision of the 7 macrocells in two 80 elementary cells, characterised by a specific evolution of the backshore and shoreface closely dependent on the history of defence works.
In addition to the subdivision into cells suggested by ARPA, the Geological, Seismic and Soil Survey Service (SGSS) of the Emilia-Romagna Region has suggested a coast classification based on geo-morphology, sedimentology, physical evolution, land use and harbour development. Three Units can be identified in this classification (Rimini-RIC coast, Ravenna-RAC coast, Po Delta coast -PDC) with a variable length ranging between 60 and 15 km and 7 Sub-units with a variable length ranging between 4 and 12 km, inside the RIC and RAC Units (Fig. 17). Throw them a further subdivision into Sub-units was done within the Rimini and Ravenna Coasts, based on the presence of coastal defences, the development of bar complexes and shoals in the shoreface (Calabrese et al, 2009).
This analysis model, which is fully in line with the integrated management principles, has been tried out in the framework of the EU PLANCOAST project in the new PTCP of the Province of Ferrara, where sectors of fine by the classifications have been used as territorial reference units for the coastal vulnerability analysis (AAVV, 2008).

Knowledge reorganisation for the development of shared management tools

During the COASTANCE project A phase, the different regional services dealing with coast defence and management coordinated by the Soil and Coast Defence Service, have launched a revision process of the subdivision of the coast into sedimentary cells, in order to define a shared database for coast defence management and the future implementation of the sediment management plans. In order to develop this share management tool, all the coast management products and expertise developed by the different services involved, and in particular: the database and studies contained in the coast and marine Information System, the report ARPA 2008, the Geological, Seismic and Soil Survey Service book published in 2009 and finally the regional Annual Publication on 2009 environmental data.

Both the cells and macrocells defined by the 2008 ARPA study, including both the geomorphological Units and Sub-units, as also defined by the 2009 SGSS study, have been taken as starting database.

The spatial coast subdivision has been retained in the review, which initially envisaged 7 macrocells, which were in turn subdivided into 80 cells. The subdivision into geomorphological Units has been reviewed by the Technical Basin Services. This review has led to an increase in the number of cells from 80 to 117 (Fig. 17b). Apart from a few cases in which cells are grouped together or subdivided, the increase in the number of cells is due to management reasons, to create additional cells close to the river mouths, wet docks and port entrances.

The following step envisaged the creation of a technical sheet for each cell, containing all the useful information to define it from a physical, evolutionary and management point of view.

The sheet includes 5 information categories:

1. general information defining the location, length and type (e.g. beach, river mouth, wet dock, etc.), the Macrocell, the relevance geomorphological Units and Sub-units;
2. general information concerning the actions to be undertaken, concerning the sedimentary balance and the shoreline, useful for the definition of the cell evolutionary state, in terms of trend towards erosion, balance and accumulation of the backshore and shoreface;
3. general information concerning the morphological characteristics of the beach, land dynamics (subsidence rate) and longshore current;
4. information related to the use of the beach and of the backshore;

5. management information: presence of constrains, suitability of the cell to be used as harvesting point. Or as a strategic recharging point and finally the need to carry out defence actions with reference to the cell.

The section of the sheet concerning the information (category 2) useful for the definition of the evolutionary state of the cell in terms of the tendency to erosion, stability and accumulation, is the fundamental element for the definition of the state of individual cells.
For the implementation of this information, a state indicator has been taken into account and adjusted to the new needs. The "state of the coast indicator" has been specifically covered by a specific article on coastal erosion of the regional Annual Publication on 2009 environmental data.
The workgroup that has been involved in this project has reviewed the data set up and analysis criteria applied with for the definition of the indicator that introducing a few changes.
An analysis methodology on the state of regional beaches has been agreed upon and share by all the factors involved, consisting in the distinction into four types of coastal sections (ASPE classification):

- accumulation stretches (A);
- stable stretches (S);
- precarious balance stretches (P);
- eroding stretches (E).

This classification is based on the integrated analysis of a whole set of information:

- volume variation related to the backshore and shoreface;
- volume losses related to the subsidence;
- nourishment interventions;
- sand harvesting;
- works progress and maintenance status;
- the quality enhancement trend of the shoreline.

This set of data is fundamental for various reasons. A volume loss can be linked to erosion, but also to land sinking due to subsidence or to sand artificial harvesting. At the same time, an accumulation can result either from natural processes or from artificial nourishment. The presence of hard coastal defense works can changes the morphological features of the beach. Information related to the progress of works in terms of effectiveness and maintenance needed is absolutely necessary for proper analysis. Finally, the shoreline, which has always been a fundamental parameter in the study of the coast evolution trends, is affected by interventions

Figure 17b

Example of cells subdivision of Emilia-Romagna coastal zone

taking place on the coast that modify its profile.
Supplementing this classification with further data contained in the data sheet shall provide an objective and comprehensive framework of individual stretches.
The ASPE cell classification is a tool shared by all the stakeholders involved in the integrated management coast.

Junta de Andalucia

The Andalusian coast has a length of 1,101 Km. of coastline, approximately 17,5% of the Spanish coast. At present, 30,4% of the coastline of Andalusia (335 Km) is under some designation of protection (EU, National or Regional), which makes this Region as one with the greatest length of protected coastline in Spain. It is divided between two marine basins: the Mediterranean and the Atlantic coast. The Mediterranean coast of Andalusia is characterised by a narrow intertidal zone, usually with narrow beaches, cliffs and narrow offshore platform, with a tidal regime that can be classified as microtidal (0 to 1,5 m). The environment is wave dominated and subjected generally to low energy levels. The mean significant wave height is 1m with a mean period of 5 seconds, producing a coast dominated by high frequency waves. The average directional components of the dominant win waves are E to W and W to E, which generates intense surf zone longshore drift and active cross shore sediment transport in exposed areas. The effective fetch is limited to an average 500 km. and only rarely do swell waves filter from the Atlantic Ocean. The morphology of the inner shelf is steep and narrow. Oceanic depths are reached within two kilometres from the coast in some sections. This results in a concentration of wave induced processes on a narrow fringe of

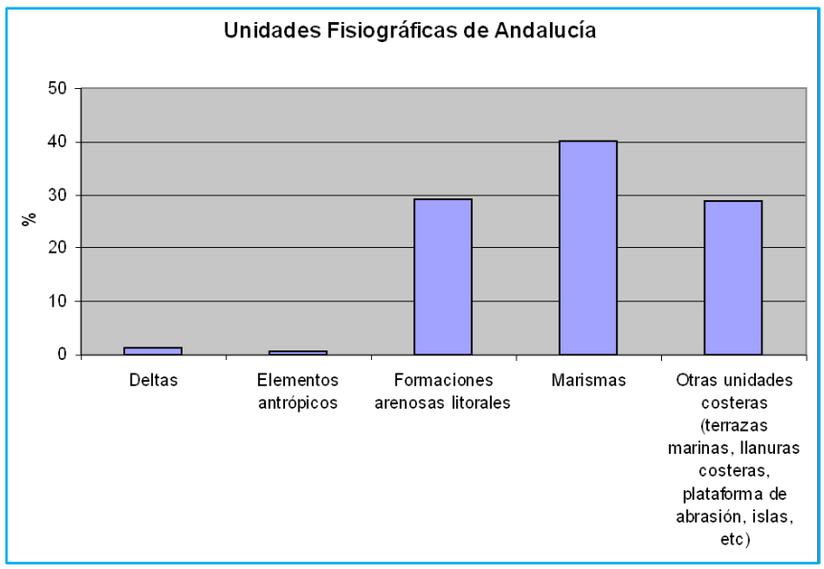


Figure 18

Physiographic unit of Andalucia coast

steep coastal shelf, with predominantly intermediate to reflective beaches. Sediment supply is mainly from reworked fluvial sands and supply is episodic and concentrated in time around seasonal heavy rainfall.
The west coast washed by the Atlantic Ocean, from the Guadiana estuary (border with Portugal) to the Strait of Gibraltar, is characterised by a low lands with wide sandy beaches and tidal marshes and the presence of extensive wetlands. Here is located the complex of dunes and marshes of Doñana National Park. The environment is characterised by a semi diurnal tide of about 2,2 m average (mesotidal). The significant wave height is about 0,76 m. of, producing a low/medium energy coast, with dominant wave direction from the SW. Longshore drift from W to E.
About the physiographic information for the coast of Andalusia, it's possible to produce the following graph, where the % of the area occupied by different physiographic units of the andalusian coast (deltas, sandy formations, marshes, etc) can be compared:

The Ministry of Communications & Works of Cyprus

For Zygi-Kiti area the coastal length (36 km) was divided into subsection based on hydrodynamic and morphological characteristics. These are considered like "closed cells", that is where the exchange of sand between adjacent zones is considered null or non-influent

Individuation of critical coastal stretches by erosion phenomena and submersion risk

Region of Eastern Macedonia & Thrace

Intensive erosion phenomena in REMTH coast are related with the anthropogenic interference. The detailed documentation of these phenomena started within Beachmed-e, where two pilot sites were studied to provide an accurate position of the coastline at various years (1945, 2002 and 2006). The first site with a length of 28 km is located east and west of Nestos river mouth and belongs to sedimentary cell BC. The dominant source of sediment supply used to be Nestos river (Fig 19).

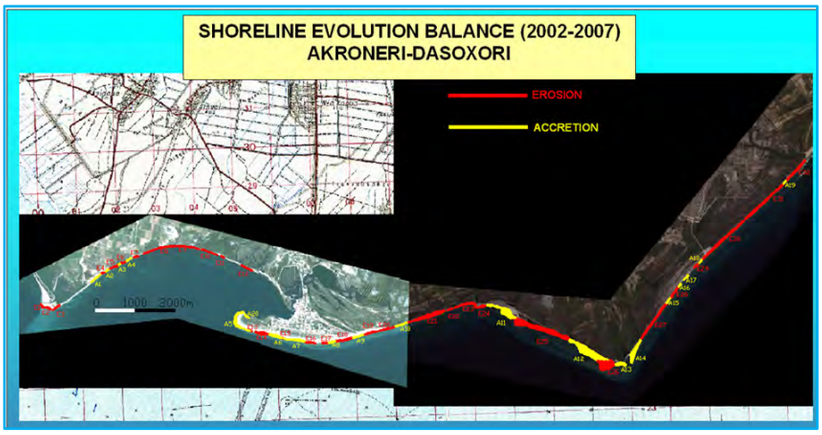


Figure 19

Map of erosion and accretion regarding the coast close to the mouth of river Nestos (BEACHMED-e). The area of erosion is much larger than accretion, due to the construction of dams.

Due to anthropogenic interference (construction of 3 big dams 15 years ago) and the subsequent reduction of sediment supply by 82%, the study of coastline evolution at this pilot site between the years 2002 and 2007 indicates that the total area of erosion is around 400,000 m^2 and the total area of accretion is 260,000 m^2, i.e. the erosion is much bigger than accretion. The average retreat is 2.5cm per year. The pilot site on average lost 20 m^3/m in the period from 2002 to 2007. The accretion in this case is only "fictitious" and is due to the movement of sand in the direction of the long shore currents in response to erosion (Fig 20).The coast in sedimentary cell BC is in a transition process, and it will take many decades to achieve a dynamic balance. Another type of anthropogenic interference is the port of Alexandroupolis, 17 km east of the mouth of river Evros. The local currents have a predo-

Figure 20

Position of coastline east of the mouth of river Nestos for years 1945, 2002 and 2007

Figure 21

Erosion of the coast of Alexandroupolis, east of the port. The erosion is attributed to the interception of the long shore transport due to the construction of the port.

minant direction from east to west. The construction of the port intercepted the sediment transport along the shore at the east of the port. It is estimated that 250,000 m^3 of sediments are deposited each year within the port basin and the dredged entrance channel. Due to the interception of sediment transport, intensive erosion phenomena are observed in the urban area east of port in Alexandroupolis (Fig 21).

It is not possible to consider the whole coast of REMTH as being in a “critical” erosion status. In order to characterize an area as being in “critical” status, the average retreat must be above 1m per year or the sediment losses per year and per meter must be above 5m3. For the REMTH coastline we do not have appropriate data. In the absence of data presently, the methodology that we use in order to identify a “critical” situation is the response to public pressure for local intensive erosion phenomena.

Département de l’Hérault

An overall analysis of the high tide line makes great ensembles appear, which are homogenous in character, over the period 1850 – 2009:

- the west of the Gulf of Lion, from the Spanish border to the Orb, with a general tendency for accretion, even if we can observe points of strong erosion on a local level;
- from the Orb to the Pointe de la Gracieuse, a general tendency towards erosion with a few sectors with strong accretion generally associated with the blocking of the transit by works (sandy arrowhead of Espiguette) or a marked natural tendency such as the Pointe de Beauduc.

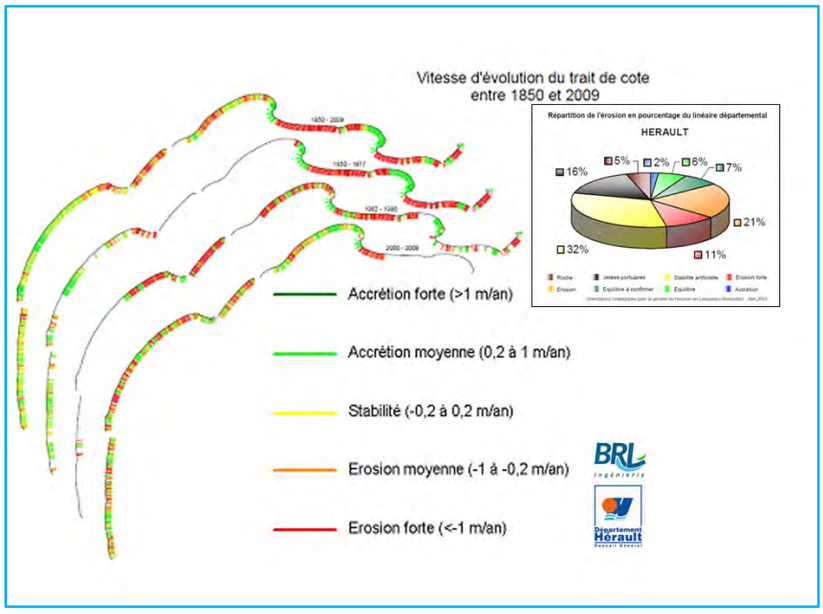


Figure 22
Evolution of Département de l’Hérault coastal zone since 1850

Emilia-Romagna Region

The reconstruction of coastline changes during last century was carried out by SGSS (Calabrese et al. 2009), applying DSAS created by the USGS for ArcView and ArcGis, through which the calculation of annual change rates were obtained for different period intervals (fig. 23). Such analysis highlighted a shoreline rectification trend and smoothing process at regional scale particularly concentrated in the north and central sectors and currently still acting.
Thus is particularly evident in correspondence with the deltaic cusps, where shoreline retreat still exceed 5 m/y, as a result of reduced sediment load of rivers. On the contrary accretion is observed in the intermediate zones and southward harbour piers. Locally, shoreline retreat is also correlated with high rates of subsidence.

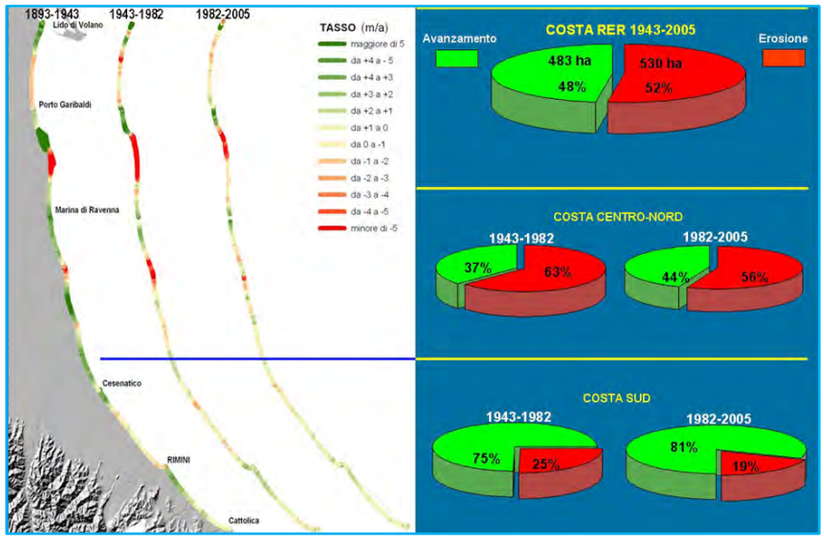


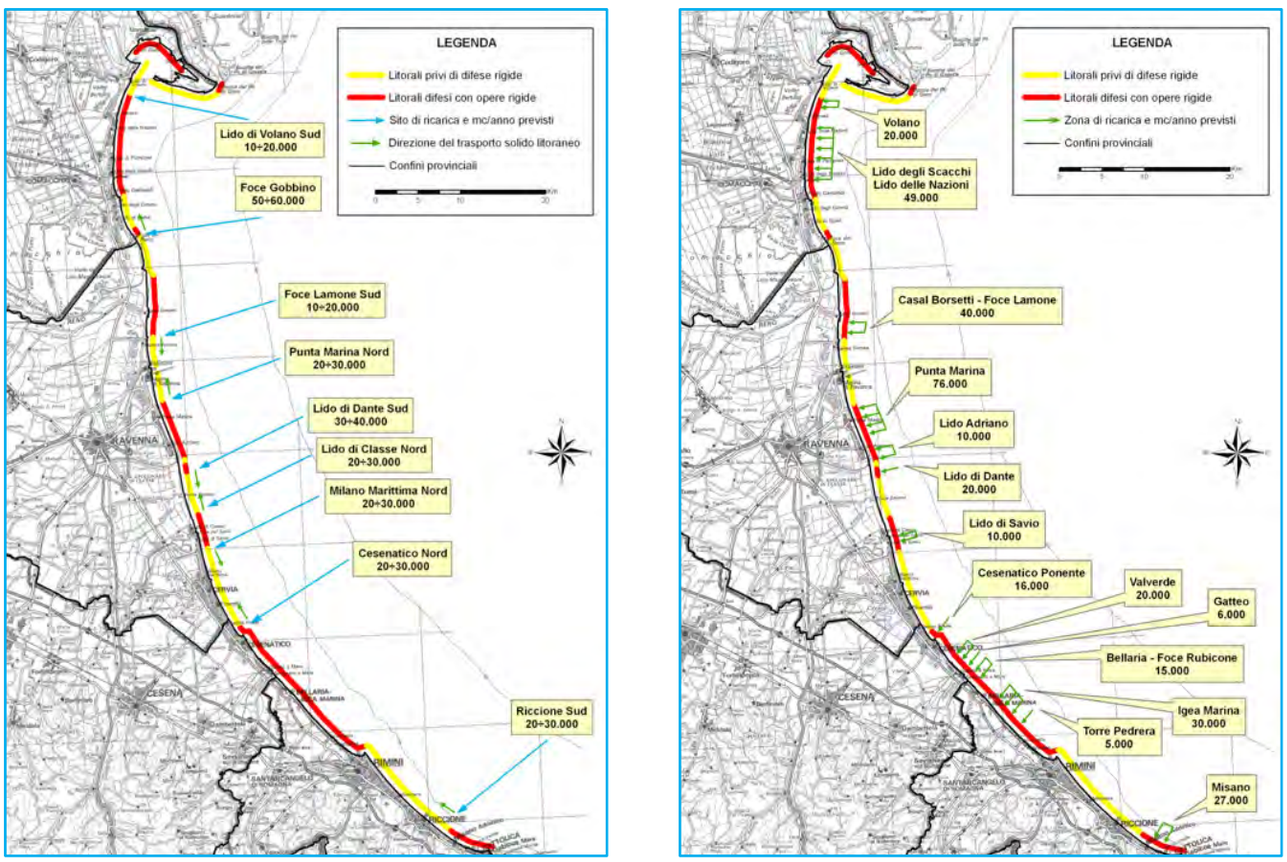
Figure 23

Calculation of annual change rates for different period intervals (green: advancement, red: erosion)

The analysis of the shoreline variation in the most recent period, over the last 60 years, showed that the deepest impact is due to the large harbours that have been able to influence at a regional scale the sediment flux and the over-supply rather than an under-supply of sand of adjacent sectors
The 2008 ARPA study points out the critical regional coast zones, where nourishment will have to take place over the next decade, to maintain their balance or at least to assure their improvement. The identification of these beaches results from an in-depth study of the entire coastline and of all the aspects that characterise it, including both physical, economic and social ones. The analysis has been carried out at different detail levels in order to have an overall framework of the coastal system, necessary for an ef-

fective action management.
The study defines the critical beach stretches affected by erosion or precarious conditions, which jeopardise the assets and the activities present on the coast and the coastal hinterland (residential areas, tourist infrastructures, farmland and valuable natural assets).
The study highlights the critical stretches that are not protected by any hard coastal defense works, as against the protected ones and it estimates the volume of sand necessary to guarantee the balance over the next 10 years (Fig.24).
The most critical unprotected beaches generally are those placed downdrift a hard defence infrastructures, thus highly undernourished and vulnerable to erosion. The study identifies that they play a strategically important role, because they are at the feeding points for long stretches of free downdrift beaches. Due to these natural dynamics, it is believed that for the future coast management it would be sufficient to periodically nourish 9 critical stretches to guarantee the balance of about 40 km long free beaches. The beaches to be taken into account are (Fig.24):

Figure 24



Location on the critical Emilia-Romagna coastal zones identified by the 2008 ARPA study and estimate of the sand volume necessary to guarantee their balance. To the left, critical stretches without any hard defence structures and to the right critical stretches protected by hard defence structures (ARPA, 2008).

- Riccione South
- Cesenatico North
- Milano Marittima North
- Lido di Classe North
- Lido di Dante South
- Punta Marina North
- Foce Lamone South
- Foce Gobbino
- Lido di Volano

As for beaches in critical conditions protected by hard defence structures (except for Misano Adriatico that is protected by a groin field and subject to severe erosion processes) the remaining stretches are protected by revetments. Hence, they are less vulnerable than the beaches belonging to the former category. Smaller quantities of sand at lower frequencies are required for these beaches (Fig.24):

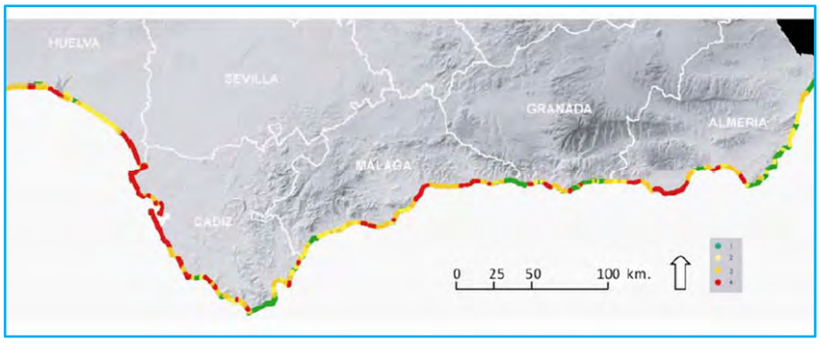
- Misano Adriatico
- Torre Pedrera
- Igea Marina
- Bellaria – Foce Rubicone
- Gatteo
- Valverde
- Cesenatico West
- Lido di Savio
- Lido di Dante
- Lido Adriano
- Punta Marina
- Casal Borsetti-Foce Lamone
- Lido degli Scacchi and Lido delle Nazioni
- Volano

According to the 2008 ARPA study, Reno river mouth, Fiumi Uniti mouth and Misano Adriatico are the most severely affected beaches, which would require nourishment interventions.
The retreat process of the cuspidate delta of the Reno river is intermittent and century-old. Between 1982 and 2006 75 hectares of land have been lost with a 200 m coastline retreat, close to the 5 km long stretch between the river mouth and the first Lido di Spina bathing establishments. During the 80s, the area South of Reno mouth was a protected by revetments. These works are subject to continuous damage, and are often overwashed by the sea, thus flooding the whole surrounding area close to the military firing ground. To the North of Reno mouth the only works that have been built are 1800 m long Longard tubes close to the

Gobbino canal, dating from the early 90s and excessively swept away by the sea.
The Fiumi Uniti mouth area became subject to erosion starting from the first half of the 20th century, but only during the 70s the phenomenon gave rise to concerns when to the South and to the North the Lido Adriano and Lido di Dante bathing establishments were built. Starting from those years a complex system of hard defence structures and several beach nourishment interventions were carried out. The area is undergoing continuous deterioration since it lacks the river sediments transferred and is subject to a severe subsidence rate (19 mm/year) due to the intense exploitation of a natural gas deposit (Angela-Angelina platform).
The Misano Adriatico beach requires high management costs, because it is subject to a severe erosion of the backshore and shoreface. The Conca river no longer transports coarse sediments to the sea due to the building of a dam, a few kilometres away from the coast. The originally pebbly beach in the first stretch to the South is now sandy also due to tourist operator needs. Over the past few years, this beach has been protected by groins and sand nourishment, but after a short time sand tends to migrate to the sea bottom, between 3 and 4 m depth, and to the North.

Junta de Andalucia

Figure 25



Draft vulnerability map of Andalucia coast

Regarding submersion risk produced by sea level rise, work at the regional level is currently ongoing. This work relies on the use of the Coastal Vulnerability Index (CVI), one of the pioneer methodologies for coastal vulnerability assessment (combination of coastal system susceptibility to change and its natural ability to adapt to a changing environment) to future sea level rise associated to global climatic change. The CVI is an “index or aggregated value” of six variables (geomorphology/geology, slope, shoreline change rates, mean significant wave, relative sea level change and mean tidal range). By applying the CVI to Andalusian territory a sea-level rise vulnerability map is obtained. An example map is

presented below (as work is still in progress, final report is not yet published).

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The Zygi – Kiti subsections were described as priority area A , B and C based on the erosion problems occurred (Priority A is the area with the biggest erosion problem). The coastal length of Zygi-Kiti (36Km) includes :

- 4.2 Km of coastal length characterized as priority A
- 15.6 Km of coastal length characterized as priority B
- 6.5 Km of coastal length characterized as priority C

The division was based on field measurements taken by PWD Coastal Section and also from comparison of aerial photos 1973-1993-2003.

Individuation of anthropic and natural areas exposed at risk by erosion and submersion, in relation to expected sea level rise and severe marine events

Region of Eastern Macedonia & Thrace

A well-established framework in environmental risk assessment is the Source-Pathway-Receptor (SPR) model. Phenomena that may change the state of the flooding system, such as climate change, are known as drivers of flood risk. The use of scenarios for policy analysis far into the future has been simulated by the long-term nature of climate change surrounding greenhouse gas emissions. Climate change is the key driver relating to the flooding "source" variables in the SPR model and climate change projections are based on emissions scenarios.

Climate change and sea-level rise (SLR) increasingly threaten coastlines. Worldwide measurements from tidal gauges indicate that global mean sea level has risen by 18 cm on average, with a range of 10–25 cm, during the last 100 years (Warrick et al., 1996). Current research claims that sea level rise for the next century (2100) could be between 30 and 100 cm. In the light of recent studies (IPCC, 2007) sea level rise could reach 59 cm in 2100 depending on the worst-case scenario.

In the Mediterranean Sea before the 1960s, the relative sea level was increasing by about 1.2 mm/yr, a value within the range of the global trend. The mid-1990s altimetric measurements suggest rapid rising of sea level in the Eastern Mediterannean Basin, which have been associated with increases of the sea surface temperature (Cazenave et al., 2001).

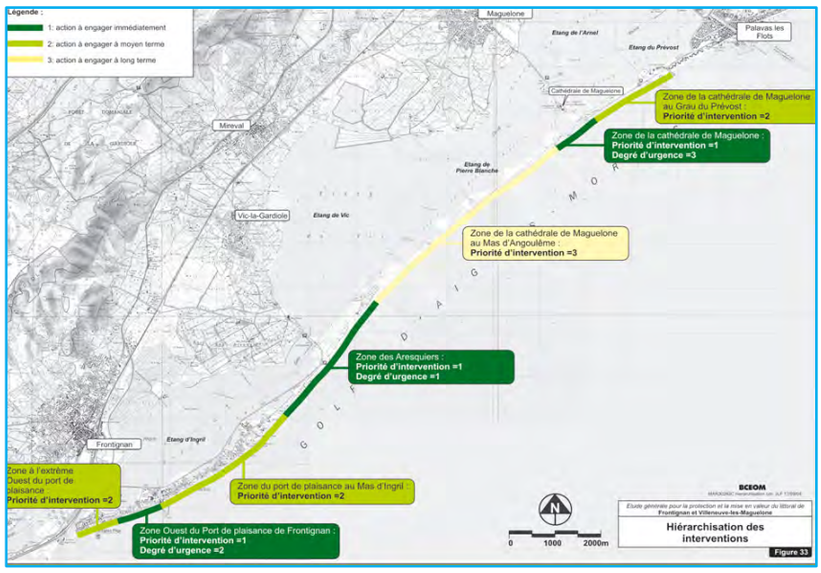
In the present study, following the recent results of IPCC (2007), three different scenarios of sea level rise up to the year 2100 will be examined: a) a minimum rise of 25 cm, b) a sea level rise of 50 cm and c) a maximum rise of 85 cm. The maximum value of 85 cm of the third scenario, corresponds to the upper 90% confidence interval of the IPCC projections.

It is well known that the coastal environment is very vulnerable to changes in mean sea level. Integration of impacts of sea-level rise to coastal zone management practices are performed through coastal vulnerability assessments. Thus, the previously mentioned changes will be included in the analysis conducted using the SBEACH software to assess the impacts of climate change and sea level rise on coastal morphology and on the flooding regime of the

area under study. The study focuses on identifying those regions where the various effects of sea-level rise may be the greatest.

Département de l'Hérault

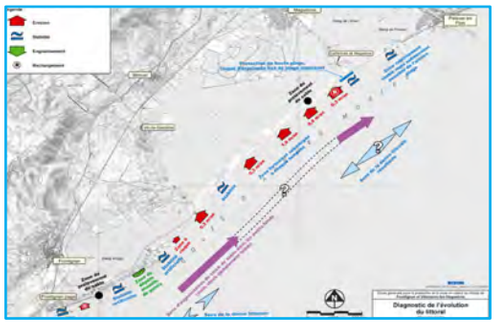
Since the establishment of the strategic orientations of the Interministerial Mission for Coastal Development, a method to determine the priority sectors to be enhanced has been applied in strategic studies carried out on the level of sedimentary cells. This method determines, within a sedimentary cell, the importance of the issues at stake that need to be preserved using socio-economic indicators, and the importance of natural hazards to take into consideration using environmental indicators, the cross-referencing of this data allows the most vulnerable sectors to be defined and thus those which will be priority during the proposal of a development plan. Here is an illustration of the application of this method to highlight the coastline of Frontignan la Peyrade and Villeneuve les Maguelone under the control of the work of the Department of Hérault.



Emilia-Romagna Region

Different methodologies for coasts vulnerability (and risk) assessment are applied at international level. Through the experience of MEDPLAN subproject within the RFO BEACHMED-e (Interreg III C South) the Emilia-Romagna region tested three main methodologies on a pilot area corresponding to the Ferrara Province lit-

Figure 26



Identification of the natural hazards using environmental indicators

Figure 27

Identification of the issues using socio-economic indicators

Figure 28

Highlighting the most vulnerable and therefore the most important sectors for interventions

toral to evaluate the propensity for submersion in case of high waters or storms: the "scoring" system proposed by EUROSION (2004); the multiple regression as put forth by Gornitz (1994); and the "scoring" system according to the STRUREL code (Gollwitzer, 1994). The analyses performed have shown that the probability exists that some inland sectors may be flooded by sea storms with a reoccurrence interval of 5 and 10 years causing damages to settlements, production and vegetation. The results of these methodological approaches provide a further tool to manage coast, while establishing – amongst other things - an order of priorities in terms of interventions. These results have been considered in regional intervention programs 2008-2010 in order to contrast erosion phenomena and to mitigate marine ingression risks along Ferrara littorals.

On the same littoral stretch, through the PLANCOAST project it's been checked the application of regional ICZM guidelines in the Territorial Coordination Plan of Ferrara Province. According to the ICZM recommendation, a detailed vulnerability assessment (VA) has been carried out with particular attention to the evaluation of the most critical factors such as coastal erosion, flooding and salty water intrusion in the ground water.

Most relevant data have been analyzed and combined in GIS by using spatial multiple criteria analysis. For each critical factor vulnerability indexes have been identified as listed in the following table (AAVV, 2008; Calabrese et al. 2009):

Critical factors	*Vulnerability index*
Coastal erosion	Beach width, Beach elevation, Coastal slope, Shoreline accretion/erosion rate, Subsidence rate, Artificial defence
Flooding	Topography, Subsidence rate, Wheather condition (sea state), Sea level rise
Salty intrusion in ground water	Geological setting, Hydraulic parameters, Resistivity, Aquifers exploitation

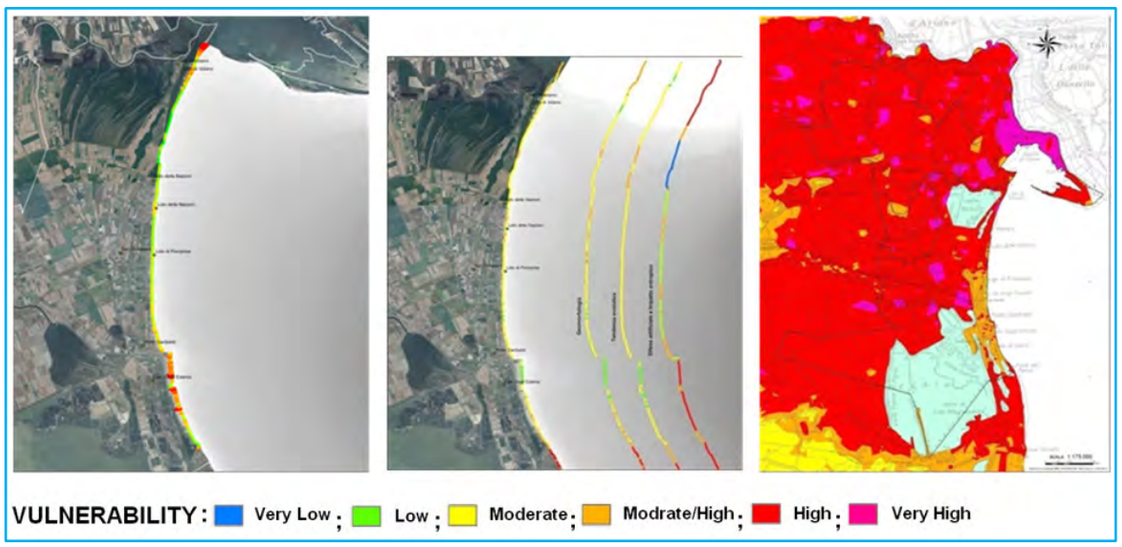
The resulting vulnerability classification has been outlined in several thematic maps, which show
the most critical zones of Ferrara coast.

In a next step, the pilot project had to ensure coherence between the various planning choices and the vulnerability. For this reason an initial series of criteria and suggestions to support planning has been identified. Attention was focused on areas with ongoing planning projects and other investments or where the natural situation is critical.

The final results have been presented in a matrix confronted with

the plan objectives, in order to identify conflicts and to suggest corrective actions. For each critical case analyzed, consequences for the provincial and town administrative bodies could be anticipated.

Figure 29



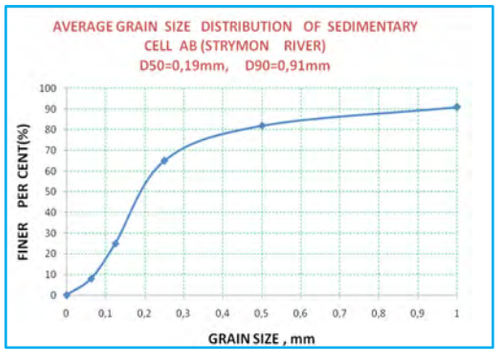
Vulnerability maps relative to shoreline changes due to subsidence rate plus sea-level rise; coastal erosion; elevation plus subsidence rate (AAVV, 2008; Calabrese et al. 2009)

The Ministry of Communications & Works of Cyprus

No risk evaluation study was undertaken.
Many stretches of the south Cyprus coast line are exposed to more severe wave conditions. In certain areas, the existing ground level is closed to the mean sea level and a future sea level rise may cause submersion. No data available. The above mention comments are based on a quick study of the existing contour lines (topography).

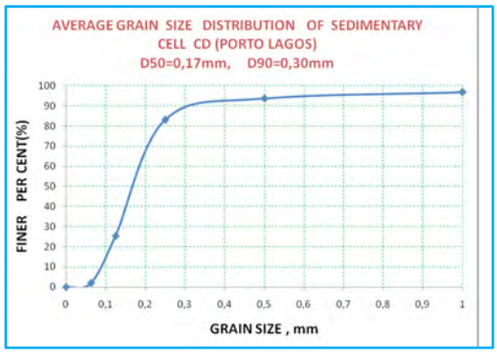
Beach sediments characterisation

Figure 30



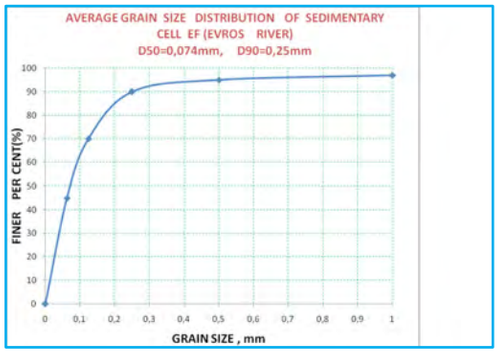
average grain size distribution of sedimentary cells (AB)

Figure 31



Average grain size distribution of sedimentary cells (CD)

Figure 32



Average grain size distribution of sedimentary cells (EF)

Region of Eastern Macedonia & Thrace

In the region of East Macedonia-Thrace most of the shore is characterized by sandy beaches . Many sand samples have been taken from the five sedimentary cells mentioned before (fig 19). These samples are analyzed to determine the grain size distribution. The average distribution of the grain size for some sedimentary cell are shown in Figures 30, 31 and 32. The average D_{50} (mean grain size) diameter for each sedimentary cell are (fig. 33)

- 0.19 mm for cell AB (Strymon) ,
- 0.30mm for cell BC (Nestos),
- 0.17 mm for cell CD (Porto Lagos) ,
- 0.25mm for cell DE (Lissos) and
- 0.074 mm for cell EF (Evros) .

In most part of the coastline the distance of the isodepth of 5m (contour -5 m) from the coastline varies from 50m to 1000 m, with a mean value about 300 m i.e. in most part the bathymetry of the adjacent sea is gentle (mean slope less than 2 %). The above findings regarding the grain size is compatible with the gentle slopes which predominate in the coastal area of REMTH. It is a good approximation to assume that the beach-profile is in equilibrium and is given by the following relationship:

$$h=Ax^{2/3}$$

where
h = water depth at a horizontal distance (x) from the shoreline (m)
A= a dimensionless shape parameter called the 'proportionality coefficient'
x= distance from the shoreline (m)

The "proportionality coefficient" A is defined from the following relation:

$$A=0.21D_{50}{}^{0.48}$$

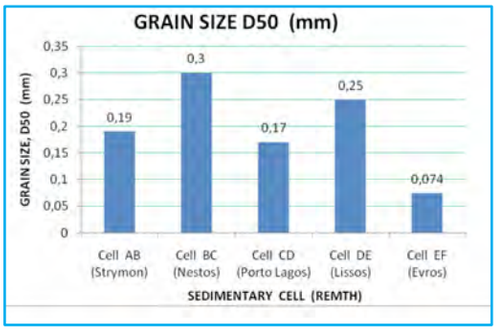
where = mean sediment grain-size diameter (mm). Therefore, by inversing the problem, the mean beach profile and the maps of

isodepths give a valid estimation of the seashore grain size distribution.

Département de l'Hérault

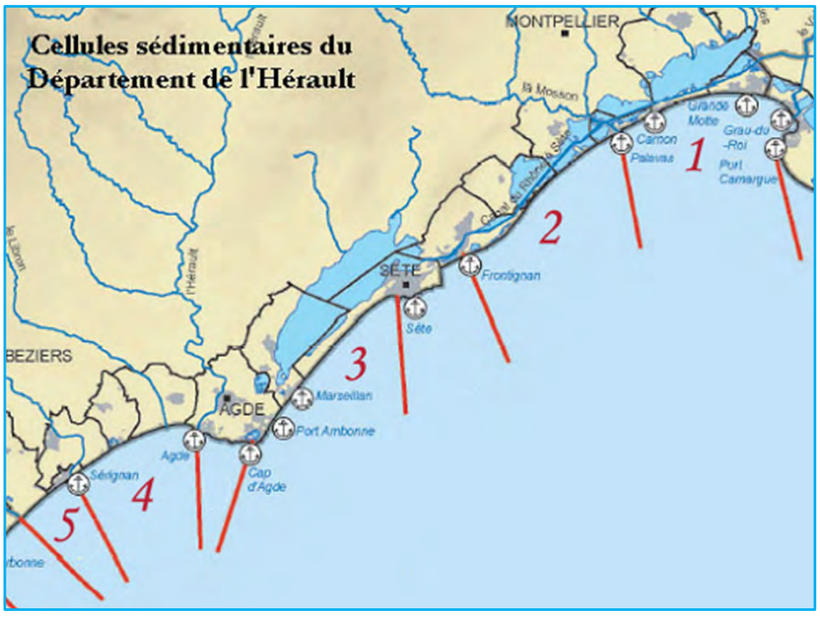
Les 5 cellules sédimentaires du département de l'Hérault sont caractérisées de la manière suivante:
1. from the port of Palavas-les-Flots to the Espiguette dyke:
only the western part (Palavas to La Grande-Motte) of this cell, which stretches to the Espiguette dyke, corresponds to the Hérault coastline. It is made up of fine sand (0.2 – 0.4 mm) in its western part to very fine (0.1 – 0.2 mm) in its eastern part. For the Hérault part of the cell, the width of the beaches is small, especially in the west where housing is in direct contact with the beach. There are no dunes in the west, a sand dune cordon exists in the central part and artificial dunes are present in the eastern part of the Hérault coastline. The slope of the upper shorefaces is gentle and the underwater sandbars in the west are lacking and numbered 1 and 2 in the east (Grand Travers). The artificialisation of the coastline is very widespread in the west and more limited further away.
2. from the Canal of Rhône to Sète (east Sète) to the port of Palavas-les Flots (approx. 15 mi): a coastal cordon of pebbles mixed with sand, the emerging beaches are narrow (25 to 30 metres) and there are no dunes. The upper shorefaces are very flat (0.4 to 0.9%) with 1 to 2 bars. The artificialisation is widespread, except in the central part of the cell. In this cell, we witness a divergence of the coastal drift: it moves in the direction of the NE to SW in the western part (like in the cells situated more in the west and

Figure 33



The D_{50} diameter distribution for each sedimentary cell

Figure 34



Sedimentary cell subdivision of Département de l'Hérault coastal zone

described previously) and SW to NE in the eastern part (like in the cell more in the east described hereafter).
3. from Cap d'Agde (Richelieu dyke) to LAZARET (west Sète) (approx. 11 mi): cell comprised of a coast of fine sand, then the barrier beach of Thau pond, made up of fine sand (0.2 – 0.4 mm) with a larger particle size towards Sète. The width of the aerial beaches varies between 100 metres in the west and 15 metres in the east with a sand dune cordon divided up between Agde and Marseillan, then the well-developed dunes in the west of the barrier beach (Marseillan). The slope of the underwater beaches is low, with 2 underwater bars in the west of the cell, it then becomes low to medium on the barrier beach with 1 to 3 bars. The artificialisation is very widespread at the two extremities of this cell.
4. from the mouth of the Orb to the mouth of the Hérault (approx. 13 mi): the coast is made up of fine sand (0.2 – 0.4 mm) and the width of the beaches is variable, larger in the south than in the north. The dune cordons are well-developed in the south but lacking in the north. With a gentle slope (0.7%), the upper shoreface is constituted of one to three bars.
5. from the Grau (channel) of Vendres to the mouth of the Orb (approx. 4 mi): made up of fine sand (0.2 – 0.4 mm), the emerging beaches have a width of about 100 m in the south and are narrower in the north; a narrow dune cordon is present in the southern part of the cell. The underwater beaches are gently sloping (0.5 to 2%) and are made up of 2 to 3 bars in the south and 1 bar in the north.

Emilia-Romagna Region

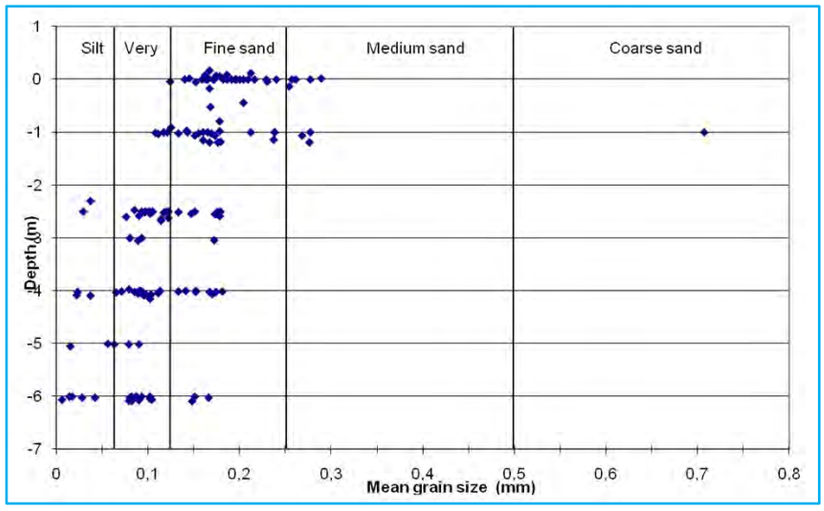
The beach and sea bottom sedimentological study, contained in the "Emilia-Romagna coast defence and environmental regeneration plan Project" by Idroser 1996 (shortly known as the Coastal Plan 1996), was based on the grain size analysis of 158 samples harvested during the bathymetric campaign carried out in 1993, of which 36 samples were collected along the coast and 122 have been harvested from the bottom, along shore perpendicular profiles at regular distances. The sea bottom sampling points have generally been a sampled at -1 m, -2.5 m, -4 m and -6 m depths. These depths have been chosen to have comparable data with other similar studies carried out along these coastlines of the past few years.

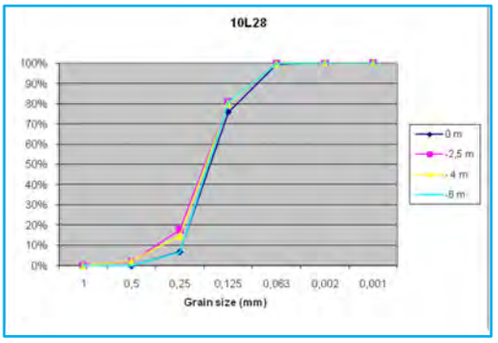
Mean diametre

The sediment mean diameter is the average size of particles that make up the sedi¬ment. "Sand" is defined as the material whose average size ranges between 2 mm and 0.06 mm (between -1.0 m

and 4.0 m); mud is made up of sediments whose average size is lower than 0.06 mm (4.0 m).
Along the coast stretching from the Po River Delta and Cattolica, the sand size on the beaches and in the sea bottom down to -2 m depth is a rather constant and at high values, whereas in the sea bottom between -2 and -6 m depth the main granulometric variations can be detected.
The smallest average size has been a recorded along the coast stretching from the Po River Delta and Lido di Pomposa, beyond 2 m depths. The massive transport of material from the Po River Delta branches, and in particular from Po di Goro, can be detected at this sea bottom. Sediments are mainly made up of muddy materials that is mainly move alarms have North-South and West-North-West direction. Sediment transport decreases towards the south and almost disappears beyond Lido di Pomposa.
Hence, in this area, thanks to the arrival of large quantities of fine sediments transported in suspension by the Po River, the average size of particles that make up the sediment becomes much smaller, so that at a -6 m depth, the sea bottom is mainly muddy.

Figure 35





Up: example of grain size analysis. Left: main grain size distribution on whole coast

The Po River influence and the transport of fine sediments is much more reduced from Porto Garibaldi to Lido di Spina. The offshore sediment mean diameter reaches relatively high values. Whereas from the Reno river mouth to Fiumi Uniti, the mean diameter has substantially decreased to, both due to the Reno river mouth and Fiumi Uniti sediment transfer and due to the effect of Ravenna jetties that dampen the wave energy.
Between Lido di Savio and Cervia, from a depth of -2 m onwards, the mean diameter remains rather high, between 0.177 and 0.144 mm, even at a 6 m depth.
Between Cervia and Cesenatico, the mean diameter goes back to

more common values typical of the Adriatic Sea: 0.088-0.077 mm (3.5-3.7 m) at a 6 m depth. Whereas in the sea bottom between Bellaria and Igea Marina the mean diameter goes back to rather high values even at a 6 m depth.
Between Igea Marina and Cattolica the mean diameter reaches medium high values, except for the area around the Secchia river mouth, South of Rimini, where the average grain size is very low, especially at a 6 m depth.
The sediment mean diameter between Riccione and Cattolica reaches rather high values, 0.109-0.102 mm (3.2-3.3 m) at a 6 m depth. Here, the only sediment transport (very limited) comes from the Conca River and from the Tavollo Torrent, and also to a very limited extent from the dismantling of the Gabicce-Pesaro headland.

The Ministry of Communications & Works of Cyprus

Geology

The south-east coast of Cyprus is characterised a Mesozoic to Tertiary basement of calcareous and igneous material. The coastal area, which is often rocky, is characterised by accumulations of pebble and gravels with few tiny and poor sandy beaches. The material that has accumulated at these beaches originates either from nearby rocks or from the inland bedrock. The elevated marine terraces are composed of conglomerate with well-rounded pebbles, mostly of igneous origin.
The coastal sediments have a characteristic grey colour while the shape of the pebbles and grains range from well rounded to subanqular. About 50% of the grains studied were identified as igneous rocks and 10% as sedimentary rocks. Bioclastics were also observed.

Morphology

The studied area is generally relatively low and flat, largely consisting of elevated marine sedimentary terraces or “raised beaches” containing sand and gravel deposits. The coastline forms a chain of four shallow bights separate by slightly protruding rocky headlands or gravel deltas.
The bathymetry shows a gentle slope from the coastline to approximately the 20th depth contour. The distance between the coastline and the 20m depth contour is about 1,600 m indicating a fairly gentle overall slope of approximately 1:80. Slightly over -20m a steeper drop occurs to a depth over 500 m.

Pilot site knowledge

Region of Eastern Macedonia & Thrace

Kariani beach is located south of Kariani village and is part of the Municipality of Orfano, in the Prefecture of Kavala. The beach lies 12 km east of the Strymonas river delta. The beach is almost linear with parallel to the coastline isobathic lines and a slope of 2.5%. The beach is oriented SSW and is covered by thin sand.

The main currents are from E to W. The beach is exposed to S, SE, and SW waves and winds that are the generating the strongest gales during winter periods.

The pilot site does not lie within the limits of a specifically protected area under Ramsar, Natura 2000 etc.

At 12 km West of Kariani beach, at the Strymonas river delta, the river supplies and accumulates significant quantities of sand. However, due to the E to W currents, the area suffers from severe erosion. As it can be seen from the pictures, depicting fortification works constructed in 1939 along the coast that are now almost completely submerged and at a distance >20 m from the existing coastline (fig 36). As shown at the cadastral maps and tables of the Municipality, a number of coastal properties are now entirely submerged due to the retreat of the coastline. The acuteness and the urgent character of the erosional problem is evident with coastline retreat in the order of 100 m, as it can be seen from the pictures.

The fact that the area is under erosion, was a decisive factor for the selection of Kariani beach for the construction of a fisherman's port, in order to avoid an eventual need for constant dredging of the port, due to sand accumulation in the port basin. After the port construction in 2008, the solid transport from E to W was interrupted, resulting to sand accumulation at the E breakwater while the erosion problems at the west side of the port deteriorated even further.

The hinterland area is very flat and an eventual sea level rise would lead to further retreat of the coastline and the loss of coastal property.

The area is of high economic value and is becoming among the most expensive coastal areas in the REMTH due to the vicinity to Egnatia Highway and the decrease of access time from all major

Figure 36

Kariani beach (12 km east of Strymonas river Delta). The circle shows the shooting bunker constructed in 1939 that was found in the year 2000 at a distance of roughly 100 m from the coastline due to erosion. The picture was taken before the construction of the local port in 2008

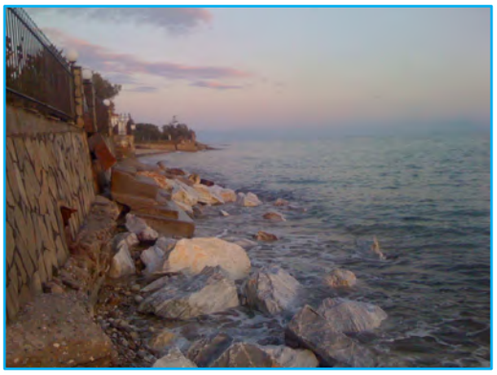
Figure 37

Satellite photo of the area showing the Strymonas river Delta at the W and the location of the fishermen's port at the W

Figure 38

Erosion W of fishermen's port in Kariani

Figure 39



Erosion W of fishermen's port in Kariani

Figure 40

Erosion W of fishermen's port in Kariani

Figure 41

Sand accumulation E of the firsherman's port in Kariani. Picture taken from W (left side) towards the E (right side).

cities of northern Greece, primarily from Thessaloniki. Therefore, there is urgent pressure from the local stakeholders for remedial measures in order to uphold the current loss trends of coastal land.
No measures have been taken yet for the protection of the coast.

Sedimentary Microcells

The area of Kariani beach in situated in the west part of the AB sedimentary macrocell (From Strimon River Mouth to Cape Vrasida). The chosen pilot site is situated from the Strimon River Mouth to Cape Apollonia and it covers approximately 21 km.
In the area the long shore sediment transport is influenced by two factors, the Strimon River Mouth, which is a continuous source of inland sediment and the SE to NW sediment transportation due to the winds, currents and natural bathymetry.
The pilot site has been divided into 5 sedimentary (as it shown in drawing) sub-cells not because there is no sedimentary transportation between them but according to their sediment regime (accretion, stability, erosion) and the sediment dynamics. The sediment transport, before the construction of the fishermen's port at Kariani was unobstructed from Cape Apollonia to Strimon river and beyond to the entire Strimon gulf.
Sedimentary cell ab is the Strimon River Mouth, approximate length 5,500 m. The ab sedimentary cell is in continuous accretion because of the Strimon River sediment transport .The river delta, the near-by beaches and the sea floor are changing rapidly.
Sedimentary cell bc is mainly the Ofrynio beach, approximate length 3,600 m. The bc sedimentary cell is in mild accretion because of the Strimon River sediment transport.
Sedimentary cell cd is mainly Orfano beach and part of Kariani beach, before fishermen's port, approximate length 5,200 m. The cd sedimentary cell was on erosion before the construction of the fichermen's port in 2007. The construction of the port aggravated the problem as it stopped the longshore sediment transport (from SE to NW). Today the sedimentary sell cd is rapidly eroded and even houses are threatened.
Sedimentary cell de is the gulf where the fishermen's port is situated, approximate length 800 m. The area was under severe erosion (max measured 76 m of beach retreat from 1931 to 1975) and it was one of the reasons it was chosen as a site for the port. The construction of the port started in 2007 and the port became fully functional in 2009. Till today no accretion of the port basin was reported. The beach left NW of the port is facing today serious erosion problems and even houses are threatened, measures have to be taken. The beach left SE of the port is accumulating sand

slowly but steadily.
Sedimentary cell ef is the continuation of Kariani beach and Brisi beach, approximate length 6.000 m. This area was also under erosion before the construction of the fishermen's port in 2007. The construction of the port stopped the longshore sediment transport (from SE to NW) and contributed to the accumulation of sediment, mainly in the west part of the sedimentary cell. The sedimentary cell ef is changing dynamically and more data will be collected in the next phases of the COASTANCE project in order to determinate the length of the beach influenced by the construction of the port.

Figure 42

Sedimentary cell subdivision of pilot site area

Beach sediment characterization

Sedimentary cell ab is the Strimon River Mouth. Sedimentary cells bc, cd and ef are gentle beaches. Sedimentary cell de is the fishermen's port.
The shore in all these sub-cells is characterized by sandy beaches. From existing few measuremens, the mean grain size varies from 0.1 to 0.25 mm. More measurements will be taken in the near future, to determine the grain size for each sedimentary cell.

The Ministry of Communications & Works of Cyprus

The pilot area that was selected for this project is Ayios Theodoros - Mazotos section.
Near the coast there is mainly gently sloping agricultural land, mostly extending right towards the edge of the land which in many cases exhibits a cliffy, eroding appearance of rather soft material, several metres high, lined with a narrow beach of mainly gravel and some sand. Tourism has recently started in this Coastal Section. A five star tourist village was constructed in 2005. For the protection from erosion in this area a number of breakwaters were constructed. In addition, for the needs of the hotel users a small boat shelter was constructed too.

Individuation of sediment stocks available

Region of Eastern Macedonia & Thrace

In the REMTH area the available sediment stocks for sand nourishment can be grouped in four categories:

a) off-shore deposits;
b) littoral deposits- port dredging ;
c) inland sediment from river-dams;
d) inland sediment from local quarries.

This is for the moment only an idea. Samples have to be taken from the local quarries in order to estimate if there are suitable for beach nourishment. At this time they will not be included in this report.

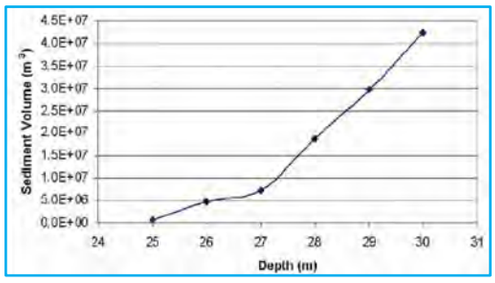
Off –shore deposits

The first attempt to explore off–shore deposits in the area of the Region of East Macedonia-Thrace was accomplished within Measure 2.3 of BEACHMED-e, under the code name "ReSaMMe". The study area was in the sedimentary cell BC (Nestos outflow), close to Thasos island. It was found an important deposit North–East of the island, and a few km from the mouth of Nestos river. The depth of the seafloor ranges between 35 and 24 m at the top of the sandbank. The shape of the sandbank has been also clearly identified and the sediment volume from the seabed at several depths was calculated (fig 43). The total volume of this deposit is very large, about 42 million cubic meters. The results of side-scan imagery for the entire study area indicated that the seafloor consists mainly of biogenic coarse sand. Sediment samples were also collected from the deposit (fig 44). The mean D_{50} grain diameter is 0.25 -0.5mm. The accumulation of sediments at this site probably is related with the “calm” region in the wake of the island under strong southern winds.

The sediments of the deposit are of sufficient quality to be used for beach nourishment. The depth of the deposit (24-35 m) is small, the location of the deposit is only 5 km from the eroding delta of Nestos, and 73 km from the eroding pilot site (coast west of the fisherman port at Kariani).

Although presently only one off-shore deposit has been identified

Figure 43



Off shore deposit sediment volume

Figure 44

Mean grain size diameter of an off-shore deposit sample

within Beachmed-e (because the search was restricted in the small part of the off-shore of REMTH), it is certain that more deposits exist due to the morphology of the continental shelf. The three major transboundary rivers Evros, Strimon and Nestos (or Mesta) for thousands of years delivered huge quantities of terrestrial sediments to the continental shelf of North Aegean Sea. The importance of the sediments transported by these rivers is implicitly shown by the fact that the 50 m depth contour extends more than 30 km from the seashore, from the island of Samothraki up to the island of Thassos, in front and south of the mouths of Evros and Nestos rivers. In situ explorations are needed to determine the exact location, quantity and quality of the off shore sediments in this area of study.

Littoral deposits (local accumulations along the coast, piers accumulation, harbor dredging, etc.)

The most important source of this category of sediments is the dredging of the port of Alexandroupolis. The last extension of Alexandroupolis port and the new access channel were finalized in 2001. Since, annual dredging is required. Every year approximately 250,000 m^3 of sand are extracted. This sand is suitable for beach nourishment. This sand is ownership of the Greek state. There is also periodic dredging of some smaller ports in the region (e.g. Porto Lagos) but the quantity is not sufficient to sustain long term nourishment policy.
Presently, we study the inland deposits at Strymonas Delta and near coast, to determine the location, quantity and quality of the sediments. The results will be presented in the next report.

Inland sources

In principle, inland sources of sediments in the area of the Region of East Macedonia-Thrace are related with the dams which intercepted the transport of sediments to river mouth.
In river Evros, all the dams which are responsible for the reduction of the sediment supply, belong to Bulgaria & Turkey, so that the problem of removal of deposits introduces new interesting management problems and international agreements. Some problems that have to be studied regarding transboundary rivers are an appropriate contribution by the neighbor countries to the cost of removal of sediments,ownership of sediments, transport of sediments in case of multiple dams, like in Bulgaria etc. We expect that these questions will appear in the near future as reservoirs age and sediments accumulate to the point that reservoir performance becomes unacceptably impaired.

In river Nestos, there are three big dams, one in Bulgaria and two in Greece, the dams of Thissavros and Platanovrisi. The dam of Thissavros has a height of 180 m, so that the removal of sediments seems uneconomical for the time being.
In river Strimon, there is only one dam, located in Greece, creating in 1932 an artificial reservoir (called Lake Kerkini), used basically for irrigation and for the attenuation of flood waves. The reservoir is protected, according to the Ramsar convention. The Kerkini reservoir is shallow, was constructed with initial height of dikes 7 m, at a level of 33 m a.s.l. (free surface at 32 m a.s.l.). The initial volume of the reservoir was 311 million m^3 and the area of free surface at +32 m a.s.l. was 70 km^2. After 30 years the volume of the reservoir was only 150 million m^3 (i.e. sediment yield about 161 million m^3 in 30 years or 5 million m^3 per year). At 1982 new, biggest and taller dam-dikes were constructed to a level of 39 m a.s.l., increasing the volume of the reservoir to 600 million m^3. In order to reduce the high sedimentation rate of the reservoir the first few decades, Greece intervened to Bulgaria and Bulgaria agreed to construct various technical works to intercept the sediment transport to Greece (at that time no consideration was given to the problems to the coast). The volume of sediments deposited annually in lake Kerkini is considered now about one million m3(five times smaller than the sediment yield in the years 1932-1962). The Total volume of sediments deposited in the lake is estimated around 210 million m^3.
Sample of sediments were not taken from the lake within this project, but on the basis of limited amount of references, we infer that large percentage of the sediments are fine sand, suitable for beach nourishment.

table 7

Deposits	Off-shore deposit , North –East of Thassos island	Littoral deposits, Dredging of Alexandroupolis port	Inland deposits Lake Kerkini
Area (Km^2)	15	-	70
Depth (m)	24-34	-	7
Silt coverage	-	-	-
D_{50}	0.25-0.50 mm	-	-
Useful V (million m^3)	42	0.25	210

REMTH deposit characterisation

Département de l'Hérault

Making the best of the data available, the following data has been collected concerning:

- the main characteristics (volume of deposits, granulometrics, accessibility)
- the granulometric compatibility of the placed sand with the standard sand of the coastline LR (200µm),
- the constraints associated with each deposit (technical / regulatory / environmental)
- the type of possible use of each deposit (massive surfacing, maintenance or sporadic)
- the period or date of accessibility of each deposit

Gisement	Puissance gisement (m3)	Granulométrie	Délais/ disponibilité	Coût	Aspects réglementaires	Accords préalables nécessaires	Type d'utilisation
Gisements pérennes							
BEACHMED-APE Sud	2.7 milliards de m³	Compatible	10 ans minimum	9.5€/m3	Difficultés, eaux internationales	Autorités Espagnoles	Rechargement d'entretien
BEACHMED-APE Nord	1.25 milliards de m³	Sédiment fin, nécessite un fort coefficient de rechargement	10 ans minimum	12.5€/m3	Difficultés, eaux internationales	Autorités Espagnoles	Rechargement d'entretien
Espiguette sous marin	Supérieur à 300 000 m3	Nécessite un facteur de sur rechargement de 2.25 à 3	2 ans	10€/m3	Procédures règlementaires à mener – Pas insurmontable	Gestionnaires et administrateurs du site	Rechargement initial et entretien
Espiguette terrestre	Jusqu'à 300 000 m³	Nécessite un facteur de sur rechargement de 2.25 à 3	2 ans	16€/m3	Site classé Zone Natura 2000	Gestionnaires et administrateurs du site	Rechargement initial
By-Pass Sud du Lido	100 000 m³ à 200 000 m³	Compatible	Disponible	8.5€/m3	Pas de difficultés majeures	non	Rechargements d'entretien
Gisements d'opportunité							
Exploitation ostréicole	10 000 m3 à 25 000 m³	Compatible	2009/ 2010 mais en attente du projet	8.3 €/m3	Pas de difficultés majeures	non	Rechargement ponctuel
Port de Sète Stock de la Darse 2	De 0 à 400000m3	Granulométrie moyenne à vérifier	Disponible sauf autre usage	6 à 8€/m3 suivant traitement nécessaire	Soumis à autorisation suivant qualité et quantité des sédiments	Gestionnaires portuaires et industriels (ZAC ZIFMAR)	Rechargement initial
Port de Sète Dragages	15 000 m³	Granulométrie moyenne à vérifier	Tous les ans	6€/m3	Pas de difficultés majeures Soumis à Déclaration	Gestionnaires portuaires	Rechargement ponctuel ou stock d'urgence
Déblais de la route du Lido de Sète à Marseillan	~ 100 000 m3 à venir	Vraisemblablement compatible	2009	8.3 €/m3	Pas de difficultés majeures	Non	Rechargement initial
Gisements alternatifs							
Dragage de l'Etang de Thau	Très importants	Très fine et peu homogène selon les zones, nécessite un sur rechargement	5- 10 ans	?	Difficultés, zone très protégée et nombreuses activités	Non	Stock d'urgence
Gisement de carrière	Faible : Difficultés d'approvisionnement	Granulométrie compatible	1 ou 2 ans	Environ 20€/ T	-	non	Stock d'urgence

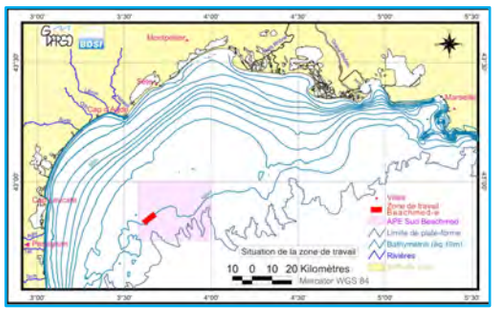
Figure 45

Sand deposits classification

Off-shore sand deposit characterstic (APE south)

- Cartography of deposit: zone studied of 1X4 mi (thickness, geometry)
- Dune-type bathymetry
- Volume of available sand: 244 million m^3
- Volume of directly accessible sub-surface (unit A): 46 million m^3
- Surface unit: medium to fine sand (max. thickness: 6 m)
- Inferior unit (max. thickness: 20-30 m) not affected by drilling, probably fine to medium sand

Figure 47



Off-shore deposit localization

- According to the seismic data, possibility of extending the exploitable zone
- Lithologic and granulometric analyses of Kullenberg coring and GL2 cored drilling
- Confirming the analyses of the seismic data.
- The deposit is essentially of a sandy nature on an average thickness of 15 metres.
- The most superficial part of the deposit (3 to 4 metres) is made up of medium to large-sized sand.
- Considerable variability of the sediments to take into consideration if a later exploitation phase is planned.

Emilia-Romagna Region

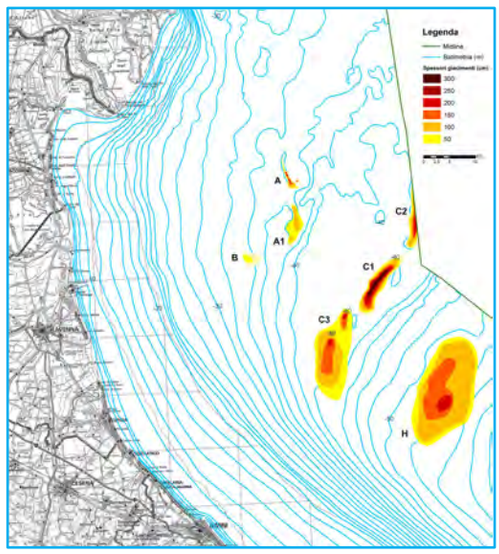
The knowledge collected about off-shore submarine sand deposits in the Northern Adriatic Sea, in the Emilia-Romagna Region, results from seven sea research campaigns carried out between 1984 and 2008 by ARPA Technical Directorate, Special Sea-Coast Taskforce in collaboration with the Marine Science Institute ISMAR CNR of Bologna (former IGM-CNR).
The identification and characterization of these submarine sand deposits required that the design and implementation of complex sea research campaigns (geognostic and geophysical surveys), followed by a long laboratory activity (sequential stratigraphic and sedimentological borehole sampling and seismic profile analysis; granulometric analysis; radiocarbon dating; magnetic susceptibility analysis).
At present, six submarine sand deposits had been identified (Fig. 46), called A, A1, B, C1, C2, C3 and a recently discovered mainly silty body, known as H, in the Northern Adriatic Sea bottom of the Emilia-Romagna Region. These submarine sand deposits result from ancient beaches (dating from 8-11,000 years ago) deposited during landward migration of the shoreline and then sunk.
The accumulation and thinking of these sand deposits occurred in the framework of a transgressive phase (18,000-5,500 years ago) linked to the establishment of temperate climate conditions, following a glacial climate and sea level drop phase (125,000-18,000 years ago FST/LST, Fig. 46).

A Area

The A area, situated at about a 50 km distance from the port of Ravenna, was identified in 1987 and characterised in detail in 2000. The sandy body is located at a 34 m depth, it is mainly made up of fine sand and is covered by a few centimetre thick silt coverage. The maximum sand thickness is 2.5 m and the total volume of sand equals to 3.97 million m^3 and the total volume of sand that

can be used, amounts to 2.32 million m³.
About 180,000 m³ of sand has been harvested for the beach nourishment of Lido di Dante and Punta Marina, in the framework of the second underwater sand nourishment intervention, which has been carried out in Emilia-Romagna (Nourishment Project 2) in 2007.

Figure 46



Off-shore deposits localization (area A, A1, B, C1, C2, C3, H)

A1 Area

The sandy deposit A1, located at a distance of 42 km off-shore the Reno river mouth, was discovered in 1987 by Idroser and further studied during the research campaigns carried out in between 2007 and 2008 and partially funded by the project BEACHMED-e.
The submarine sedimentary body is located at a 36 m depth and stretches over about 15.5 km², and it is mainly composed of fine sand and is covered by a few centimetre thick silt coverage.
By pooling together the geophysical and geognostic data, a quantity of about 12.8 million m³ has been estimated in the area under question.

B Area

The B area, located at a distance of about 30 km off-shore and at a 34 m depth, was discovered during a geophysical survey carried out by IGM in 1992, in the framework of the drafting of the Geological Map of Italian Seas - sheet NL33 Ravenna (scale 1:250.000).
The presence of a sand deposit has been confirmed by borehole sampling carried out later during 1994 and 2000.
The sedimentary body consists of about 1 m thick layer of fine sand covered by 70 cm thick prodelta clay cover. A quantity of about 2.82 million m³ sand has been estimated in the area under question over a 7 km² surface.

C1 Area

The C1 sandy deposit, located 57 km off-shore of Porto Garibaldi and at a 40 m depth, was preliminarily investigated by Idroser in 1984 and 1988 and then by IGM-CNR in 1992, 1995 and 1999. The detailed characterization of the sedimentary body has been carried out by ARPA in 2000. In this area the sandy lithosome surfaces at the water-sediment interface, it is mainly composed of fine sand and reaches a 3 m maximum thickness. The deposit stretches over a 40 km² surface up to a total sand volume of 55 million m³. The C1 sandy deposit has been chosen as sand harvesting area for two nourishment intervention is carried out along the Emilia-Romagna coast in 2002 and 2007. As a whole 1,500,000 m³ of sand has been harvested from this area.

C2 Area

The C2 area was investigated by Idroser in 1988, by IGM-CNR in 1992, 1995 and 1999, and by ARPA in 2000. The sandy deposit is located 70 km off-shore the Reno river mouth at a 41 m depth and is crossed by the limits of the continental shelf between Italy and Croatia.
This sedimentary body mainly consists of fine sand and, similarly to C1 sandy deposit, has no silt coverage.
The portion of the deposit located within the Italian sea bottom stretches over a 14.3 km^2 surface with a total sand volume of 16.2 million m^3.

C3 Area

The C3 area, located 45 km off-shore between Ravenna and Cervia, was preliminarily investigated by Idroser in 1984 and 1988, and by IGM-CNR in 1992, 1995 and 1999 and finally, more in-depth, between 2007 and 2008 thanks to the project BEACHMED-e funds.
The area is characterised by two high morphological reliefs located on a sea bottom between 36 and 41 m depth. This sedimentary body mainly consists of fine sand with a maximum 2.5 m thickness.
The sandy deposit has no silt coverage. It stretches over a 107 km^2, surface, with a total sand volume of 104 million m^3.

Area H

The H area, located about 60 km off-shore Cervia at a 52 m depth, was discovered by ARPA at the beginning of 2007, by analysing a few seismic profiles contained in the ISMAR CNR archives. The area was further investigated by ARPA in collaboration with the CNR Institute between 2007 and 2008.
This sedimentary body mainly consists of coarse silt. It stretches over a 187 km^2 surface and has no silt coverage, with a total sand volume of 195 million m^3.

table 8

Deposits	A	A1	B	C1	C2	C3	H
Area (Km²)	5,44	15,27	7,18	39,09	14,35	106,90	187,34
Depth (m)	34	36	34	40	41	36 - 41	52
Silt coverage (m)	0,3 - 0,4	0,05 - 0,1	0,7	-	-	-	-
D_{50}	fine Sand	fine Sand	fine Sand	fine Sand	fine Sand	fine Sand	coarse silt
Useful V (million m³)	3,97	12,82	2,82	55,18	16,21	104,40	195,23

Off-shore sand deposits main characteristics

The Ministry of Communications & Works of Cyprus

Sand deposits main characteristics in Zygi Kiti area

Deposits	A1	A2	A3	A4
Area (Km^2)	20000	12000	70000	1500
Depth (m)	3,5	3,5	3,5	3,0
Silt coverage (m)	0,3 - 0,5	0,5 - 1,0	0,5 - 0,8	0,5
D_{50}	fine Sand	fine Sand	fine Sand	fine Sand
Useful V (million m^3)	6000	9000	50000	750

Estimation of river solid transport

Region of Eastern Macedonia & Thrace

Regarding the coastline of REMTH, three major transboundary rivers discharge into the Aegean Sea:

- Evros (or Maritza or Meric, with a catchment basin around 54,000 km^2);
- Nestos (or Mesta, with a catchment basin around 6,000 km^2);
- Strimon (or Struma, with a catchment basin around 17,000 km^2).

The combined area of catchments basins is around 77,000 km^2. These transboundary rivers drain southeastern Bulgaria, northern-eastern Greece and western Turkey, Nestos and Strymon at the west and Evros at the East. There are also a number of small rivers with their catchment basin in the Greek territory the biggest of which is river Filiouri with a catchment basin around 1280 km2. The total catchment area of rivers entirely in Greek territory is about 3000 km^2, representing a very small percentage (less than 4%) of the catchment area of the three transboundary rivers.

The sediment yield at the mouth of river Strimon, Nestos and Evros before the construction of dams and other structures which intercept the transport of sediments to the river mouth, is called natural sediment yield and is estimated respectively as 5 million m^3 (Strimon), 1 million m^3 (Nestos) and 12 million m^3 (Evros), in total from these rivers around 18 million m^3, see Figure 48. The sediment yield from small rivers of REMTH is estimated around one million m^3. The total sediment transport to the coastline of REMTH was for the last few thousand years about 19 million m^3.

However, the last century the construction of many dams in Bulgaria and Greece interrupted a large percentage of the above mentioned sediment yield. It is therefore apparent the importance of these three transboundary rivers in providing almost exclusively sediments during the last few thousands years to the coast of REMTH. The morphodynamics of the coastline of REMTH are recently in a transition state due to various human actions which reduced the sediment load to coasts, starting from 1930.

In the frame work of BEACHMED-e, it was studied the sediment yield at the mouth of river Nestos before and after the construc-

tion of the dams (around 1990). It was found that the annual sediment yield at the river Nestos mouth before the construction of the dams had a mean value about one million m^3, which is reduced (after the construction of dams) to only 0.18 million m^3, i.e. it was found a dramatic decrease (about 82%) of the sediments supplied directly to the river mouth and indirectly to the neighbouring beaches, with serious impact on the erosion of the coastline.
Such detailed analysis does not exist for the other two big rivers

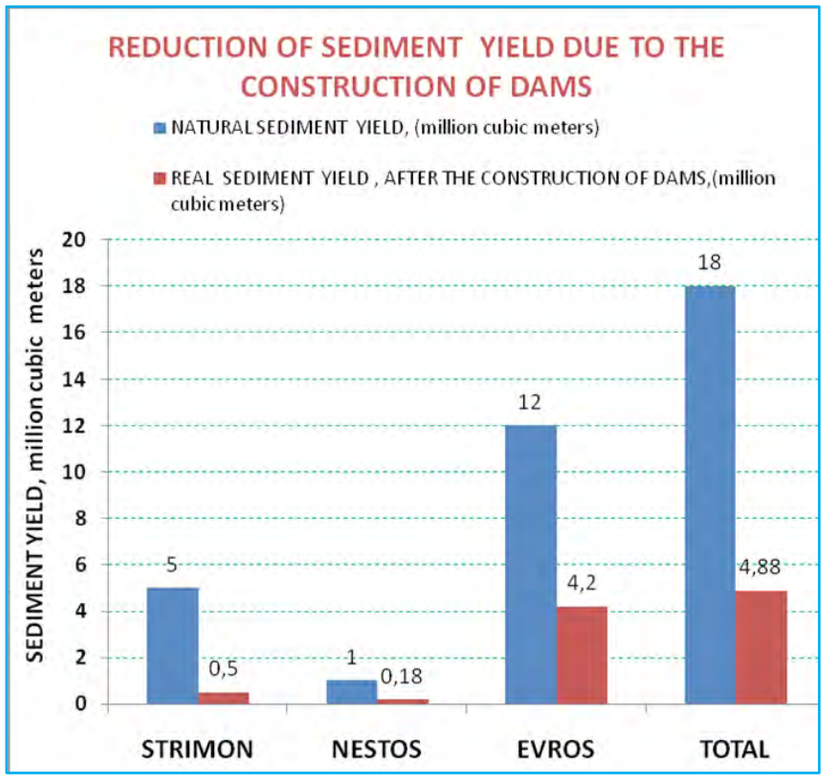


Figure 48

Reduction of sediment yield due to the construction of dams

Strimon (Struma) and Evros (Maritza). The dam Kerkini (constructed in 1932) in Greece at river Strimon intercepted the sediment transport and reduced dramatically the sediment supply to Strymonikos Gulf. Regarding river Evros, there are more than 20 large dams and numerous other small reservoirs that have been constructed in the Bulgarian part of Evros river .We estimate that there is a reduction around 90% and 65% regarding the sediment yield of rivers Strymonas and Evros respectively, due to interventions in these rivers in Bulgaria and Greece.
The sediment yield from the three transboundary rivers is 0.5 million m^3 for Strimon, 0.18 million m^3 for Nestos, and 4.2 million m^3 for Evros, i.e. the total sediment yield is now about 4.88 million m^3. Therefore there is a reduction of the sediment yield for entire REMTH of the order of (19-4.88)/19=0.74, i.e. 74%. This is considered a very significant reduction of sediments. The rivers solid

transport that is useful for natural nourishment decreased considerably the last few decades. This reduction explains the fact that the REMTH coastline is generally retreating .
The replenishment of 15 million cubic meters is practically and economically impossible. Since most of the sediments are deposited to dams in another country, Bulgaria, the possibility of getting the sediments from the Bulgarian Dams to feed the beaches seems unrealistic. The only dams which may be studied for getting sediments are the dams of Kerkini (Strimon) and Thissavros (Nestos).

Policies/interventions for river solid transport enhancement

In Greece sand and gravel excavation is regulated by the ministerial decision of 1938 (422/1938). Sand and gravel excavation is forbidden from beaches, from touristic areas, from archeological sites and within 1000m distance from cities.
To date it is under the jurisdiction of the Prefecture, to grant permits for sand and gravel excavation from river beds. Port authorities can grant permits for sand excavation from the sea bed. Since 1938 many laws have been introduced that ban sand and gravel excavation from protected areas (protection of wetlands, nature protection areas, protection of landscapes etc.)
At the Evros river delta there is a sea water intrusion barrier, that that has been provisionally constructed for the protection of the irrigated fields from saline irrigation. This barrier acts as a sediment barrier as well, disrupting river solid transport to the Aegean sea. REMTH plans to substitute this barrier with a movable structure that would allow free outflow during winter period and would prevent sea water intrusion during summer period. The latter structure will enhance river solid transport and will contribute to the reduction of beach erosion.
Within the Beachmed-e program, it was proposed to advance legislation so that new dams will be constructed allowing continuously the by pass or the flushing or the removal of a percentage of the sediment yield entering the dam reservoir.
The case of lake Kerkini presents an extremely favorable pilot case to study and apply sediment removal from a dam in Greece for multi purpose objectives .The lake is shallow and the volume of inflow water is more than ten times the storage capacity of the reservoir. The storage capacity of lake Kerkini decreased dramatically due to sedimentation, creating problems in the efficient flood protection (attenuation of the peak of flood waves) and in irrigation. So, the removal of sediments will benefit the civil protection from flood hazards, the farmers and the nourishment of the coast at Strymonikos gulf. Hydrosuction technology seems appropriate for this case.

Département de l'Hérault

The sandy coastline of the Gulf of Lion is fed by different rivers. The order of magnitude of the transport of the Languedocian coastal rivers has been estimated at the following annual average values:
The solid transport of the coastal rivers of the Gulf of Lion is of

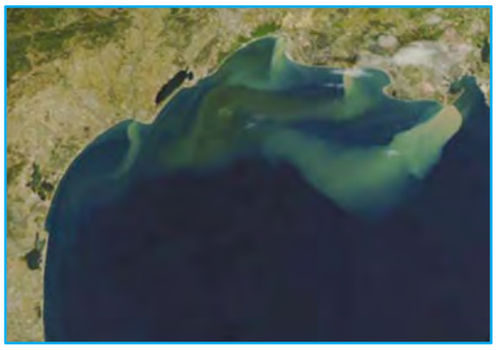
Rivers	*Average,(min-max) daily water discharge (m^3/s)*	*Average annual water discharge ($10^6 m^3/yr$)*	*Mean annual suspended solid flux ($10^6 t/yr$)*
Tech	9.55 (<1 - 625)	301.47	0.032± 0.006
Têt	10.82 (<1 - 471)	341.54	0.061± 0.018
Agly	6.13 (<1 - 1020)	193.44	0.098± 0.030
Aude	37.95 (<1 - 1300)	1197.61	0.194± 0.157
Orb	26.67 (1.05 - 1430)	841.64	0.110± 0.044
Hérault	40.61 (<1 - 1320)	1281.58	0.088± 0.028
Lez	2.17 (<1 - 239)	68.65	0.003± 0.001
Vidourle	6.83 (<1 - 783)	215.44	0.051± 0.016
Rhône	1768.59 (322 - 10861)	55812.43	10.147± 3.360

the order of $0.65x10^6$ tons a year, i.e: less than10% of the solid transport of the Rhône which constitutes the Gulf of Lion's major source of supplies in sediments.
The anthropic developments of the waterways in the course of the last 100 to 150 years has made the solid contributions of the main coastal rivers fall. In 100 years:

- The solid transport of the Rhône has gone from 30,000,000 tons per year to 10,000,000 annual tons today.
- The solid transport of the Aude has gone from the order of 400,000 tons per year to around 80,000 annual tons today.

It is like this for the Têt, and the estimate is probably in the same order of magnitude for Agly, Orb and Hérault. This material is mobilized during stormy periods and often displaced by the coastal drift. Several cells exist with different directions of drift along the coastline of the Gulf of Lion which depends on the angle of incidence of the main waves in relation to the coast. The main cells and directions of these coastal drifts are well-known and have been established by bathymetric methods (Certain, 2002; Durand, 1999) or by radioactive tracing (Anguenot and Monaco, 1967; Courtois and Monaco, 1969).

Figure 49



Turbid plume at the mouth of the Rhône during the flood of November 2002

Policies/interventions for river solid transport enhancement

In France, the ban against the exploitation of sediments in the stream channel of the rivers has been adopted. Excavation is still allowed in the floodplain.

Emilia-Romagna Region

The Emilia-Romagna Region coastal system is mainly fed by sand carried to the sea by several rivers and torrents, whose deltas are located along the coast at a distance of 10-15 km from one another. This arch shaped coastline stretches from the Gabicce mount to the South and the cuspate delta of the Po River to the North, along with the coastal current action from the South and from the North, allows the regional coastal system to receive even limited sedimentary contributions both from the Marche Region coastline (the Gabicce cliff) and from the Veneto Region coast (Southern branches of the Po River delta).

In the past, a small quantity of sand produced by the erosion of the cliff foot stretching from Pesaro to Gabicce has fed the Southern beaches of the regional coastline, yet over the past few years. This source is actually exhausted since the cliff has been protected by breakwaters in several sections. The Emilia-Romagna beach feeding closely depends on the transport of inert materials from rivers that flow into the Adriatic Sea, whereas the contribution provided by the Po River mainly concerns Scanno di Goro and Volano beach.

The progressive reduction of river sediment transport has been and still in the main cause of erosion of the Emilia-Romagna beaches. This problem has been thoroughly studied and quantified for the first time during the drafting of the “1981 Coastal Plan”. In the late 70s the study recorded a reduction of river sediment transport by 3-4 times as against the conditions existing in the 40s, when river basins have not yet been heavily affected by the anthropic impact of the following decades (waterways management, slope erosion control, changes in land, river bed excavations, etc.). Based on this evidence, the Emilia-Romagna Region issued a piece of legislation that would ban the extraction of sediments from river beds (deliberation of the Regional Council no. 1300 24 June 1982) which was gradually applied to regional rivers over the following years, until the issuing of an excavation and also to the national Po river basin, through a specific resolution by the Po River authority, in 1990.

An in-depth survey was carried out on all the regional rivers and based on this evidence in 1981 the Coastal Plan pointed out the widespread presence of river works, which stopped most residual sediment transport as well as land use characterised by the abandonment of arable crops towards less erodible crops such woods and meadows.

The effectiveness analysis of the measures that were undertaken and the assessment of previously made considerations made the object of the new 1981 Coastal Plan, which was completed in

1996. The "1996 Coastal Plan Project" developed to specific research lines on the issue of sediment transport river: the first one was aimed at assessing the state of the art of the regional catchment areas along the Adriatic coast, after about 15 since their early characterization occurred during the 1981 Coastal Plan, and the second one was aimed at the implementation of an innovative procedure for the assessment of sediment transport useful for beach maintenance.

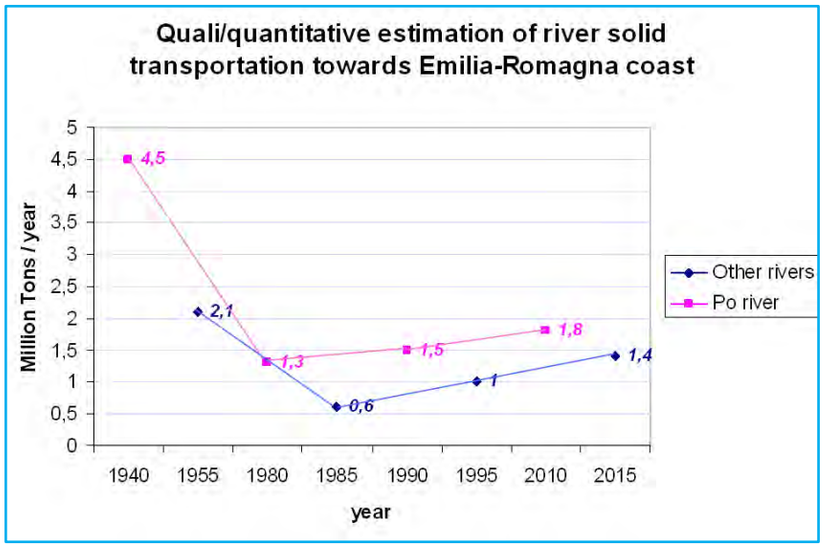


Figure 49

Year	1940	1955	1980	1985	1990	1995	2010	2015
Others river		2,1		0,6		1		1,4
Po	4,5		1,3		1,5		1,8	

Quantitative estimation of river solid transportation towards Emilia-Romagna coast (from 1940 to 2015)

In order to build the sedimentary budget along the coast, when drafting the Coastal Plan in 1980 experts tried to extrapolate the volume of material useful for beach nourishment, by means of "weighed estimates". The National Hydrographic Service as well as literature data was used as source of reference.
Thanks to the analysis carried out on the river basins and along the river courses, a systematic description has been provided concerning the present conditions of the whole geological system, morphological variations of waterways, the different land uses ranging between the early 80s and the mid 90s, the state of the art and development of drainage systems and especially the consequences of the mining activity ban.
The analysis of collected information is allowed to identify, although in a qualitative way, the possible evolution trends in the sand river transport.
The effects and early signs of recovery of river sediment transport

towards the sea can be clearly observed the along the Cattolica beaches, to the North of the Marecchia river mouth, and along the Scanno di Goro.
As far as other rivers are concerned, such as Savio and Fiumi Uniti, the analysis that has been carried out has highlighted no recovery in the resumption of sand contribution to nearby beaches also due to the thick vegetation grown within the riverbeds and not removed for a very long, 25-30 year-old period, and to subsidence loss.
The study has allowed to estimate the phenomenon evolution overtime:

- regional waterways directly flowing into the Adriatic sea, except for the Po river, during the first half of the 50s transported 2.1 million t/year of sandy material useful for the replenishment of beaches;
- this quantity progressively reduced until it reached the minimum value of 0.6 million t/year in 1985;
- after this date, after the ban of inert material extraction from river beds, sediment contributions increase up to an average value of slightly less than 1 million t/year in 1995;
- for the future, the model that has been implemented indicates that in the regional river system an upward trend in the sand transport can be identified, which will translate into a total value of slightly less than 1.4 million t/year in the medium-term, mainly in 2015.

As for the contribution by the Po river, the methodology that has been adopted mainly refers to available turbidity measures, information on the past and most recent evolution of the river Delta, the data related to the river bed morphological characteristics. This analysis has allowed us to calculate the amount of sand transported to the sea, which was estimated to be around 4.5 million t/year in 1940, and 1.3 million t/year in 1980. Based on the same calculation model, in this case as well, it has been estimated that the control action and the following extraction ban introduced by the Po River authority have led to a gradual increase of the sand transported to the sea, from 1.5 million t/year in 1990 two 1.8 million t/year in 2010.
The river beds excavation ban, cleaning and management operations, carried out during the 80s and 90s, have proved to be very important. Unfortunately, the expected effectiveness of these measures has not yet fully emerged, due to different causes, such as:

- the progressive spreading of wasteland, and woodland along the mountain slopes;
- supra-alluvial formations upstream several cross dredging works along the river beds;

- the different and produced rainfall system;
- inert material excavation authorised by the competent offices for hydraulic safety reasons;
- offsetting land sinking due to subsidence.

Although experimental sediment transport measures have been carried out, a bottom transport close to zero has been recorded, according to the comparison of topo-bathymetric network surveys, which confirm a few, although modest positive elements, is already pointed out by the 2000 Coastal State Report.
It refers to the advancement of the shoreline behind the Cattolica rock barrier, to the North of the Marecchia river mouth until Viserba (Southern sector of the regional coast) and to the North of the Savio river mouth (central sector).
No evidence is provided for the Fiumi Uniti river mouth (central sector), since the limited sand recovery is stultified by high subsidence rates in the area, and at the Lamone River mouth (central-Northern sector), where of the past few years, to nourishment operations had been carried out in the severely eroding beach to the South.
No significant improvement has been now achieved in front of the Sacca di Goro (Northern sector) and in a few points the situation has even further deteriorated.
Since the river plays the most important role in maintaining the natural balance of beaches, it is not sufficient to confine oneself to measuring the scope of the problem, but indeed urgent actions should be undertaken to restore the beach balance.
With reference to the above-mentioned causes, said it is not possible to influence the rainfall system, due to climate change under way, the possible alternative solutions are the implementation of policies aiming at the extension of arable land (to the detriment of wasteland), the removal of works that have already accomplished the aims for which they had been built, moving downstream the materials excavated from the river bed for hydraulic safety reasons (by preventing them from being sold on the construction inert material market), the further reduction of the anthropic component of subsidence deriving from pumping off underground fluids (water and natural gas).

Policies/interventions for river solid transport enhancement

The Emilia-Romagna region stopped the excavation of sand and gravel from river beds (deliberation of Regional Council n.1300 in year 1982), in order to enhance the river solid transport useful for littorals natural nourishment.

The Ministry of Communications & Works of Cyprus

Water shortage is a major problem. In order to address this problem, the Republic of Cyprus adopted the slogan “Not a drop of water to be wasted to the sea”. A series of dams has been constructed in recent years, and today almost all (seasonal) rivers and dammed. It is noted that Cyprus has the largest number of dams per area in Europe.
The majority of the large dams are located close to the river delta in order to maximize the size of the catchment area and hence maximize the potential quantity of stored water.
The trapping of sediments in the reservoirs reduces the storage capacity of the dam and arrests the sediment supply to the river mouth/delta. This starvation of sediment supply to the coastal environment results in the termination of the development of the river delta. Depending on the coastal hydrodynamics, recess of the delta and erosion of the coastline are initiated. This problem is acute in Cyprus, where almost all rivers have been dammed and erosion of the beaches is experienced in numerous areas.

Policies/interventions for river solid transport enhancement

Cyprus government stopped the excavation of sand and gravel from river beds in 1970, in order to stop the erosion.(The material removed from rivers was used in the construction industry).

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