MAritime REgions cooperation for MEDiterranean

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Adaptation to Climate Change on Coastal Areas

Summary report

Rome, June 2013

Project full title	**MAritime REgions cooperation for the MEDiterranean**
Project Acronym	***MAREMED***
European Program	***MED (www.programmemed.eu)***
Agreement n.	**2G MED09-209**
Project Partners	*Région Provence-Alpes-Côte-D'azur (FR), Comunidad Valenciana FEPORTS (ES), Liguria Region (IT), Toscana Region (IT), Lazio Region (IT), Marche Region (IT), Emilia-Romagna Region (IT), Corse (FR), Larnaca Development Agency (CY), Crete Region (GR), CRPM CIM.*
Thematic full title	*Adaptation to Climate Change on Coastal Area*
Thematic Coordinator	*Lazio Region (IT)*
Project Components	*C3, C4*
Thematic Phases	*Diagnosis phase, Pilot Actions*
Deliverable	*Summary report*
Deliverable full title	*Adaptation to Climate Change on Coastal Area Summary report*
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Project official website	*www.maremed.eu*
Project total budget	*1.982.000,00 €*
Project start date (duration)	*June 1st 2010 (36 months)*

ACC Maremed deliverables

European project MAREMED “Maritime Regions Cooperation for the Mediterranean”, approved in the MED SPACE program (2010-2013) with Region PACA leader partner and other 11 Mediterranean Regions, foresees 6 sections of interest:

- Coastal Pollution
- Integrated Coastal Zone Management
- Coastal Adaptation to Climate Change
- Fishery
- Coastal Geo-data management
- Governance

Lazio Region is in charge for the Coastal Adaptation to Climate Change (ACC) in order to develop four specific issues:

- Compared analysis between coastal vulnerability maps (Book n.1);
- Shared tools for the forecast and management of the CC effects along the coast (Book n.2);
- Implementation of a coastal observatory network in the Mediterranean basin (Book n.3);
- Shoreline Management Program. A methodology for the monitoring and maintenance of Sustainable Project Shoreline (Book n.4).

Digital versions of ACC Books are available on Maremed official website www.maremed.eu

ACC Diagnosis Results

Main Objectives of the questionnaire:

•Understanding the knowledge level of the "flood directive" effectively demonstrated by the Maremed partners, and especially understanding the real capability of Mediterranean administrations to meet the milestones proposed by the European Commission.

•Research of tools and methods currently available to address the problem of risk map elaboration, also collecting some experiences and suggestions coming from MAREMED partners for the next financial programme (2014 - 2020).

A sample group of 11 Med Coastal Administration answer the questions
Crete, Lazio, Emilia-Romagna, Toscana, FEPORTS (Gen. Valenciana), Murcia, PACA, Liguria, Marche, Cyprus, Corse

State of the art: inventory of the atlases and databases regarding coastal risks: erosion, submersion, flood

Maremed regions prove to have a good level of knowledge of the dangerous flood events occurred in the past. About 73% of them have already acquired information on floods and submersions already occurred in the past which had a significant adverse impact on coastal zones. In general the most part of the Regions are ready to develop the 1st (preliminary) level of map requested by FRD (Preliminary flood risk assessment - art.4).
63% of Regions have already defined a methodology to identify priority areas of risks (erosion, submersion, flood), but only 54% have already produced risk maps on coastal areas, only 4 Regions declare to meet the Flood Risk Directive 2007/60/EC requirements for the 2nd level of map (Hazard and Risk maps - art. 6) and 3rd level of map (Flood Risk Management Plans - art. 7). 73% of Maremed Regions have already produced atlases and/or databases regarding coastal area management. 5 regions adopted specific guidelines. Nevertheless existing Atlases are in general only a qualitative representations of the coastal risk/hazard and cannot be compliant with the Flood Directive requirements.

Cartographic and morphological data

The level of knowledge of coastal morphology is very high. 91% of regions have already acquired morphological and cartographic data on their coastal zone. The methodologies adopted to survey this area are very heterogeneous. Some regions have already acquired information using advanced technologies such as Lidar, WebCam or Satellite images, and other regions utilize only air-photo. This could cause some problems for the harmonization of the geographic digital data according to the INSPIRE Directive.

Meteorological and wave climate data, climate change effects

A good level of knowledge of climate data is demonstrated. 73% of regions have collected information on offshore meteorological characteristics (wind speed, wind direction, atmospheric pressure, water and air temperature, ..) and 82% have collected information evaluating offshore (about -100 m) wave characteristics (Wave height H, Wave period T and main direction), and 64% have collected the same wave characteristics nearshore (about -20 m). Only 18% of regions have collected information evaluating sea level evolution in the medium/long term (100÷200/500 years).

Social economic data, exposed values

91% of regions have already developed land use map on coastal area, but only 36% have assigned economic values to this areas.

Future scenarios

6 regions out of the 11 interviewed have already been developing adaptation measures to climate change for the last 10 years, but problems linked to budget availability and lack of technical competence and tools were reported during the diagnosis.

ACC Diagnosis Results

Emerged Problems

•Med Regions are surely the most furnished and liable dataset-keeper but they are ready to meet the Flood Risk Directive deadlines only in part. They need to better understand economic values of their coasts and how to produce the risk maps. In particular how to represent the characteristics of inundation (as requested by EU flood Directive) and the impact of inundation on coastal area. A common methodology to produce the risk map of inundation/erosion on coastal area is not yet available.

•A deepen level of knowledge of sea level rise at regional level and climate change effect on coastal area did not emerge on this diagnosis phase.

•A gap of knowledge and experiences among med regions on coastal zone management is evident. Some Regions already acquired an high level of technologies for the monitoring of coastal area, other region are not prepared to the future challengers that climate change will propose.

•The production of geographic digital data necessary to the coastal management, it is guaranteed on grand part of the partnership, but a lack of harmonization of this data among partners is evident.

•A lack of budget and technical competence and tools is expressed by grand part of partners, a coordination of local administration at Mediterranean level is not evident.

Solution to propose

•Improving current coastal Atlases along the Flood Directive lines, i.e. by a quantitative evaluation of the hazard/risk.

•Following European and extra EU realities with more experience on coastal risk evaluation and management (Netherlands, USA, etc..).

•Creating of a Mediterranean Interregional Observatory of coastal zone is recommended in order to remove the gap actually registered among Med Regions in terms of technical competences, management tools and budgets.

•Creating a Spatial Digital Infrastructure of Harmonized geographic digital data among Mediterranean local administration.

"…Floods are natural phenomena which cannot be prevented. However, some human activities (such as increasing human settlements and economic assets in floodplains and the reduction of the natural water retention by land use) and climate change contribute to an increase in the likelihood and adverse impacts of flood events…"

EU flood directive 2007/60/CE

Suggestions for the next ERDF financial period 2014-2020

Producing of Best practices for adaptation of coastal zones to climate change;
Re-launching EUROSION Initiative, with a particular focus on the Med basin;
Fostering the creation of an Interregional Network of Observatories for the coast of the Med basin;
Involving northern Africa Med Countries on future Mediterranean policies;
Forecasting Model to evaluate the morphologic response of the coastal plains to the rise in sea level;
Promoting Barcelona Convention and ICZM Protocol;
Establishing a clear, well-defined and differentiating ICZM policy between coastal regions;
Monitoring Program of Mediterranean Coast;
Creating data and atlases shared among the Mediterranean regions, especially between neighbour regions;
Financing of methods used to protect the coastal zone by ERDF funds, if compliant with the orientations of the white paper on adaptation to climate change;
Implementing the EU Flood risk directive 2007/60/EC and its flood risk management plans;
Dedicating a budget line to inform, to teach operative staff (es. Municipalities directly involved in civil protection on flood risk);
Improving prevention on urbanized coastal areas;
Obtaining a method to reduce the risk on coastal zone.

Links between diagnosis results an pilot actions

Diagnosis phase emerged problems & needs → **Pilot actions proposal**

- **Inhomogeneity between risk map representation**
- **EU Flood Directive implementation**

→ Coastal Flood/Erosion Risk Map model shared by MAREMED and COASTANCE Partners

- **Evaluation of Benefits of Coastal Adaptation to climate change**

→ Shared tools for the forecast and management of the CC effects along the coast

- **lack of coastal data harmonization among partners**
- **lack of budget and technical competence and tools**

→ Implementation of a coastal Observatory Network in the Mediterranean Basin

- **high level of technologies for the monitoring of coastal area erosion**

→ Shoreline Management Program. A methodology for the monitoring and maintenance of Project Shoreline

Summary of ACC Maremed Activities

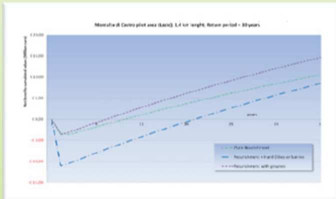
INPUT DATA
Morphologic
Hydrodynamic
Land Uses
Economic Values

COFLERMap
Coastal Flood/Erosion Risk Map Model

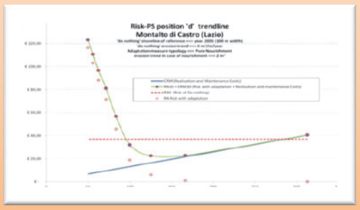
INPUT DATA
Realisation and Maintenance costs of Adaptation Measure to Climate Change

Risk evaluation of Adaptation measure to Climate Change

COFLERTools
Coastal Flood/Erosion Risk Management Tools Model



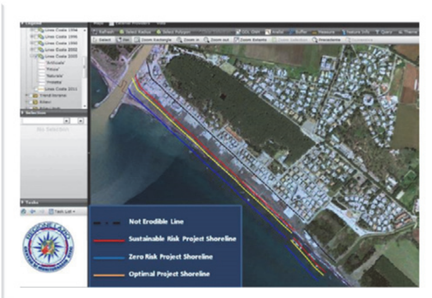
SMP
Shoreline Management Program



INPUT DATA
Not Erodible Line Position

Net Benefit Evaluation of Adaptation Measure to Climate Change

Optimal Project Shoreline position

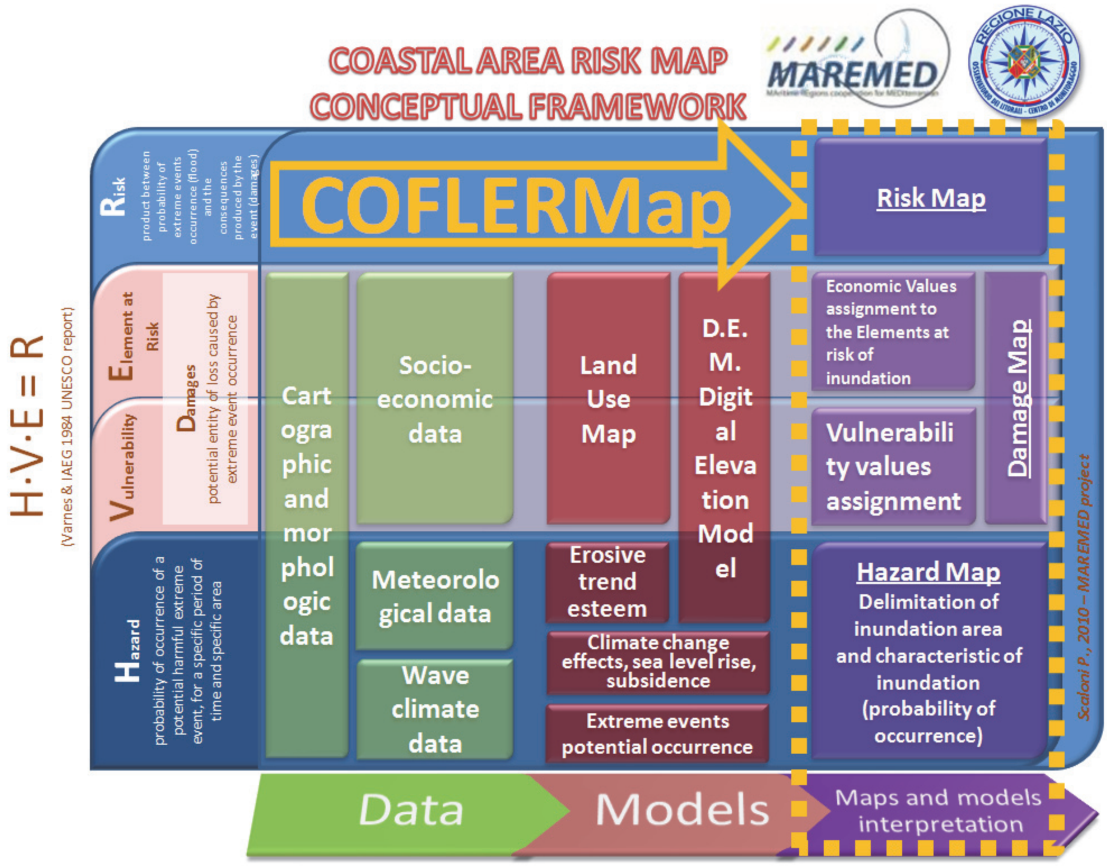


pilot action n.1
COFLERMap: Coastal Flood/Erosion Risk Map model

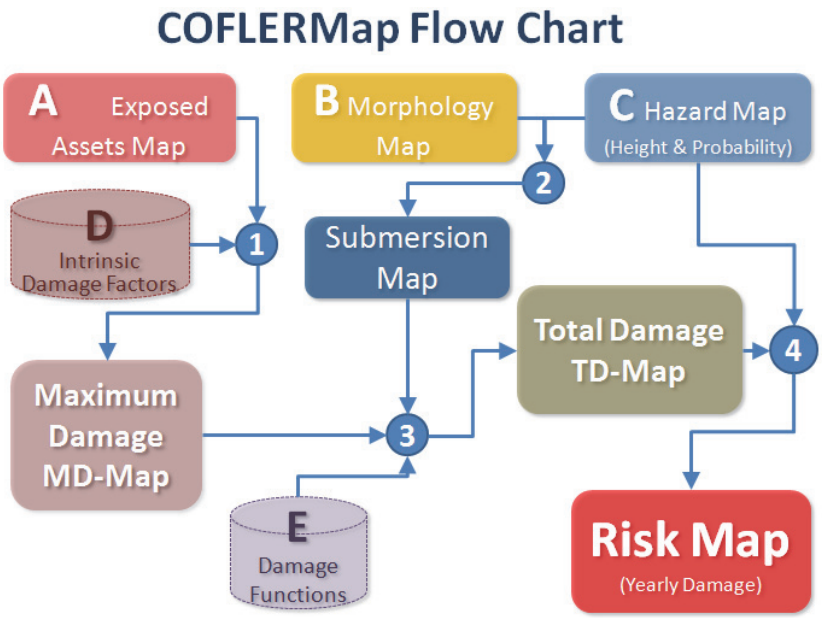
COFLERMap conceptual framework

On 18th January 2006, the European Commission proposed a guideline "regarding flood evaluation and management" which was approved in September 2007 and came into effect in November 2007. This directive aims to improve flood risk management across Europe. It helps Member States by equipping them with a scheduled procedure to assess the risk of flooding and implement coherent plans to reduce the impact of floods on human health, the environment and economic activity (Flood Risk Management Plan). It concerns floods "temporary covering by water of land not normally covered by water" and encompasses specifically "floods from the sea in coastal areas". The risk management methodology suggested by the directive can be divided into 3 stages : The preliminary evaluation of flood risks; The cartography of flood zones and the susceptible damages caused by the floods; The carrying out of flood risk management plans. This work focuses on a suitable model for the coastal hazard/risk mapping representation according to the Flood Directive.

The concept of the model was developed during the MED MAREMED Project (2010-2013) by the Lazio Region and it has been shared for dissemination and discussion during the MED COASTANCE project technical meetings by 15 Mediterranean coastal public Administrations.
The model concerns risk mapping i.e. the methodologies to cross basic territorial data (hazard, exposed values, morphology) among them, in order to achieve a geographic and quantitative distribution of risk, compliant with Flood Directive requests.
The reliability of this model was also tested through some valuable direct comparisons among international Projects and experiences such us: the VNK Project (or in English "Flood Risks and Safety in the Netherlands - Floris") elaborated by the Rijkswaterstaat (National Agency of the Dutch Ministry of Infrastructure and the Environment); the Flood Risk Management Strategy in the US by the Army Corps of Engineers; European projects like THESEUS and MICORE (7FP); the "*Handbook on good practices for flood mapping in Europe*" issued by the European exchange circle on flood mapping (EXIMAP).
The conceptual framework was developed on the basis of the Varnes UNESCO formula, where Risk is defined by the product of Hazard and Damage.



pilot action n.1
COFLERMap: Coastal Flood/Erosion Risk Map model



The Risk Map does not represent tout court the Priority Map but only the expected economic damages in terms of €/year/area. These economic consequences will surely influence the priorities but the risk for human health must be considered first following a separate route.
The Geographical Information System necessary to apply COFLERMap on a specific Assessment Coastal Zone, must include the following main layers: Exposed Assets present on the assessment Coastal Zone and their economic values, Ground Elevation of the Assessment Coastal Zone, Flooding water level and associated yearly probability.
In addition to the above geographical datasets, COFLERMap also requires two numerical datasets: Intrinsic Damage Factor and Damage Factor.

On the grounds of the aforementioned 3 geographical and 2 numerical datasets, the application of the model COFLERMap can be summarized in 4 steps:
•In order to draw up the Maximum Damage Map (MD-Map), the values of the Exposed Assets must be multiplied by the correspondent Intrinsic Damage Factor. If the Maximum Damages are already available for the Exposed Assets interested by the elaboration, this step can be omitted. This Map is a theoretical representation of the maximum damage as if all the considered exposed assets (independently from their elevation) were struck uniformly by the maximum event.
•By calculating the Submersion Map, the intensity of the flood in terms of its real capacity of submerging the exposed goods is determined in every point of the Assessment Coastal Area.
•By using Damage Functions applied to the overlapping of the Submersion Map (for each adopted return period Tr) with the MD-Map, the Total Damage Map (TD-Map) is obtained. This map represents the geographical distribution of the global damages in case of the Tr event occurring.
•Each event considered is referred to a specific probability. Then the real risk of damage for an event corresponds to the integral of the varying damages occurring up to the considered event in relation to the corresponding variation of the exceeding probabilities. In simple terms, the summatory of the products of the average damage occurring between two events and the relative ΔP (difference between the correspondent exceedance probabilities), leads to the Risk Maps as requested by the Flood Directive.
It is worth noticing that all the mentioned maps correspond to specific values defined for each point of the Assessment Coastal Zone.

pilot action n.1
COFLERMap: Coastal Flood/Erosion Risk Map model

The Geodatabase at support of the model

The application of the model is subdivided on three different temporal Steps: starting from the elaboration and restitution of geographic data from the Geodatabase (Step 1), all the data are reported on a spreadsheet. Values of hydrodynamics, vulnerability and economical values are assigned to the spreadsheet (Step 2) in order to have the computation of the risks (COFLERMap - Maremed Book n.1, 2012). Third and last step is assigned again to the Geodatabase for the graphic restitution of the hazards, damages and risks values on thematic maps.

Monetary results are expressed for experimental uses

pilot action n.2
COFLERTools: Management Tools for the evaluation of the benefits of coastal adaptation to climate change in the Mediterranean coastal areas

COFLERTools model receives input data from COFLERMap model (monetary sum of the risks values expressed in terms of monetary cost per year) and gives as outputs data a feasibility study of coastal defense works in terms of costs and benefit for the community.

The application of the model is subdivided on three temporal steps:
•Step 1 - Computation of risks in the case of Adaptation measures;
•Step 2 - Study of economic feasibility of an Adaptation measure;
•Step 3 - Choice between different typologies of Adaptation measures.

First step is assigned to COFLERMap model that recalculate the values of risks in the case of adaptation measures. The level of protection of defense work reduces the impact of the inundation and the level of risk.
Second step is necessary to evaluate the economic feasibility of coastal defense work in proportion of realization and maintenance costs and the benefit obtained during the period of life of the opera (reduced risks). We assumed that an adaptation measure is economically feasible when the following simple inequality is verified:

Risk without adaptation - (Risk with adaptation + Cost of adaptation) > 0

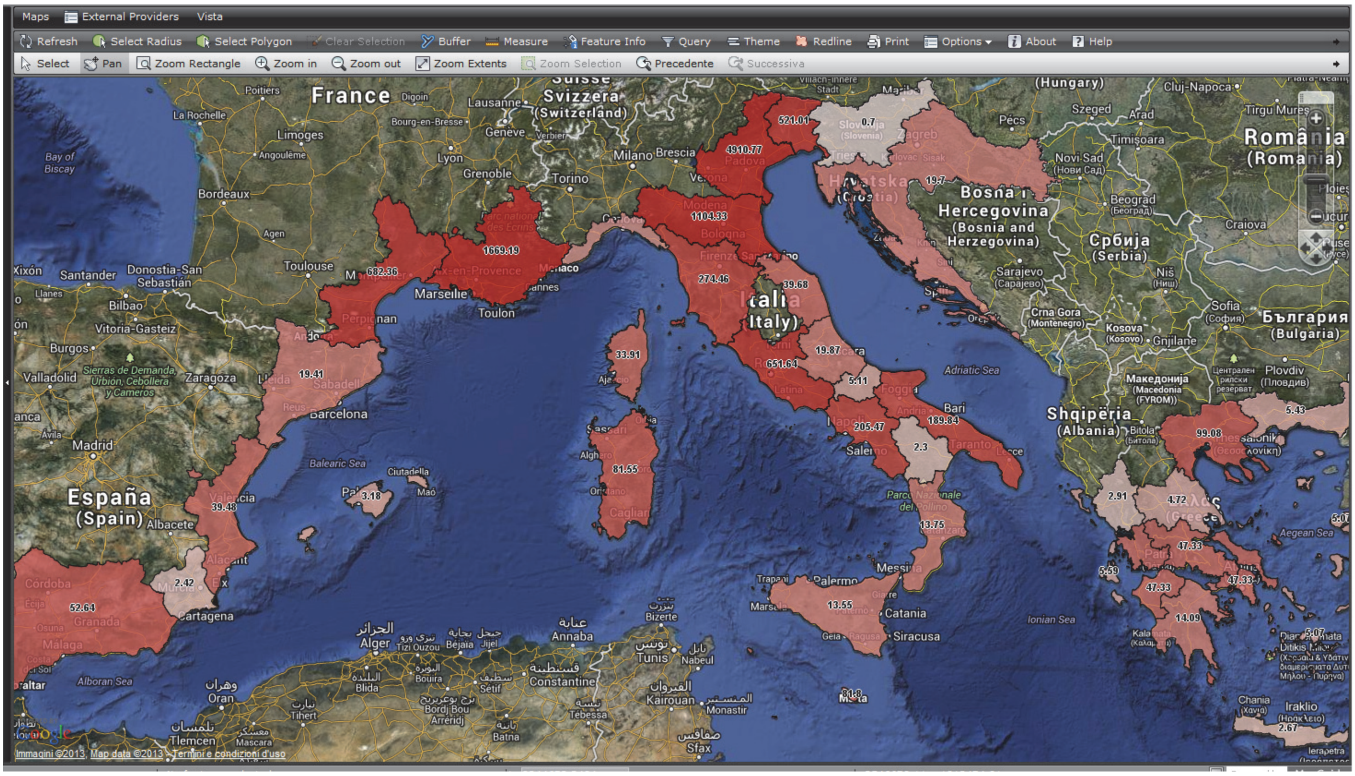
Third step consists on the choice between different typologies of adaptation measures. Which is the most convenient by the economic point of view? This evaluation could be made only in the case we know the net benefit of the adaptation (difference between benefit and costs) of each typologies of feasible adaptation.

T = 30 years	A	B	C	A-(B+C)	(A-B)/C
Typology of adaptations	Risk without Adaptation (M€)	Risk with Adaptation (M€)	Cost of Adaptation (M€)	Net Benefit of Adaptation (M€)	Benefit/Cost ratio
 Pure Nourishment		3,9	9,6	10,6	210%
 Nourishment + Hard Dikes or barrier	24,1	0,26	15,2	8,6	156%
 Nourishment with groynes		1,1	8,3	14,7	278%

COFLERTools Model was applied to Montalto di Castro study case area of Lazio and results are reported on the table on right for three different typologies of adaptation measures to climate changes.
Monetary results are expressed for experimental uses

pilot action n.2
COFLERTools: Management Tools for the evaluation of the benefits of coastal adaptation to climate change in the Mediterranean coastal areas

DIVA Model elaboration for MAREMED Regions….

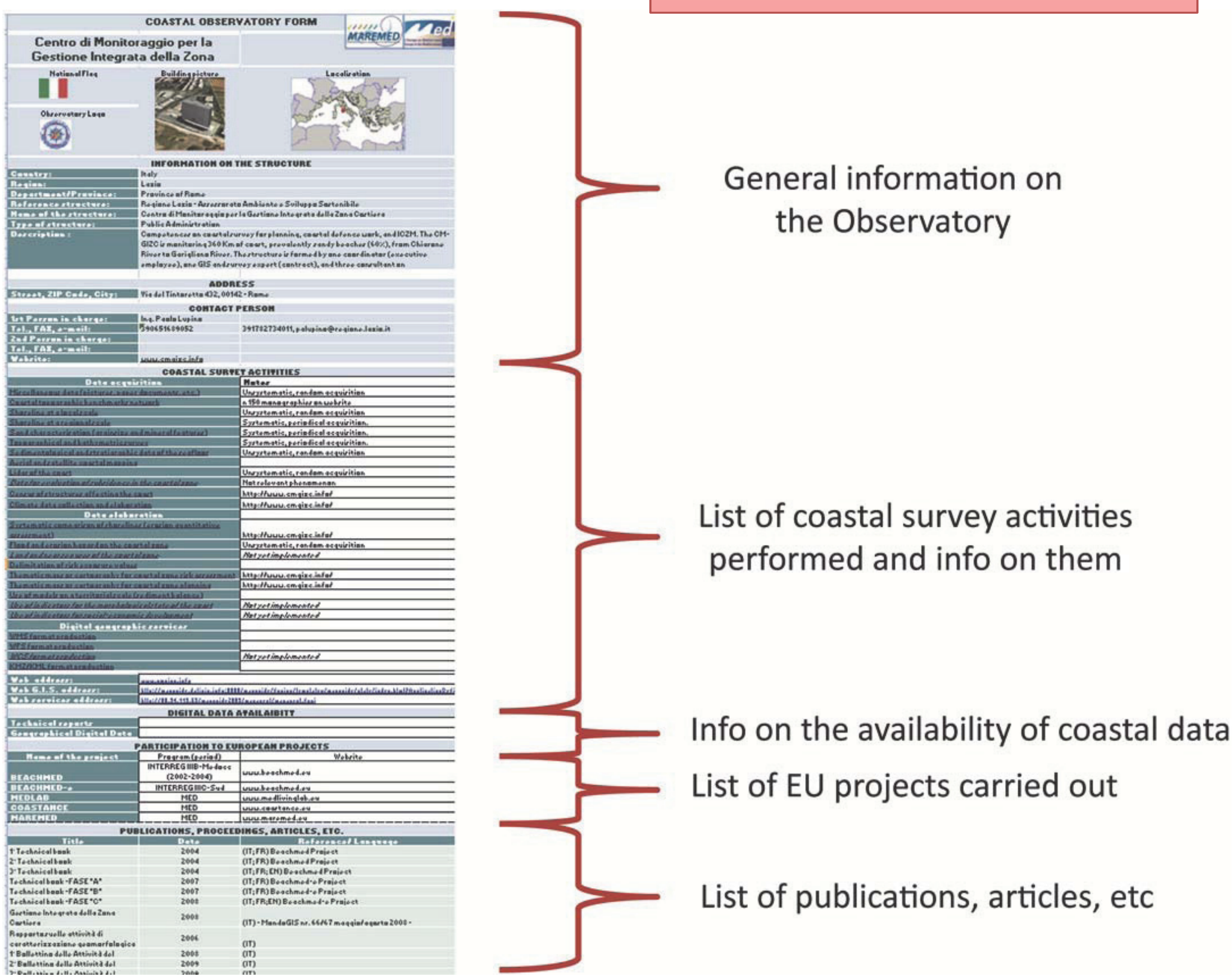


In cooperation with University of Kiel
The results of DIVA Model are published on FACECOAST WebGIS (www.facecoast.eu)
Damage costs of climate change on Mediterranean coastal areas are represented at <u>regional scale</u>

pilot action n.3
Implementation of a coastal observatory network in the Mediterranean basin

The census of Observatories is carried on with MAREMED Project, with the help of FACECOAST cluster. A new layout has been adopted for the form of the database, so that consultation of observatory information can be more clear and immediate. The form is divided into five different sections, reporting:
- General information on the observatory;
- List of coastal survey activities performed and information on them;
- Information on the availability of coastal data;
- List of EU projects carried out;
- List of publications, articles, etc.

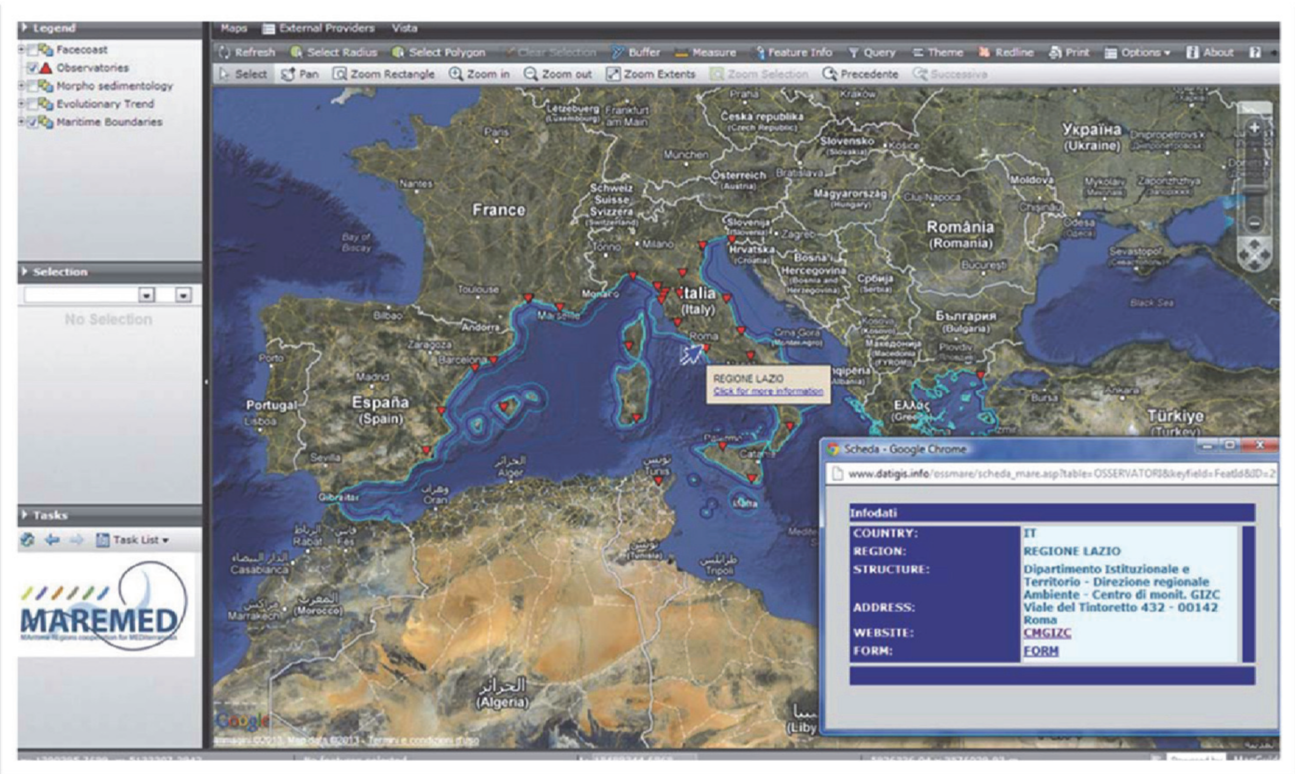
The database has been implemented through the FACECOAST WebGIS.



pilot action n.3
Implementation of a coastal observatory network in the Mediterranean basin

Coastal monitoring services

The updating and further analysis of coastal monitoring services which had already been carried out in its First version by Beachmed-e/OBSEMEDI ("COASTALSERVICES Operative and consultative services for the Coastal Monitoring") is developed in two European projects: RESMAR and MAREMED.
The challenge is to compare definition and assessment of the main monitoring services and merge them in a report shared by MAREMED and RESMAR.
Each service will be widely illustrated according to the following template

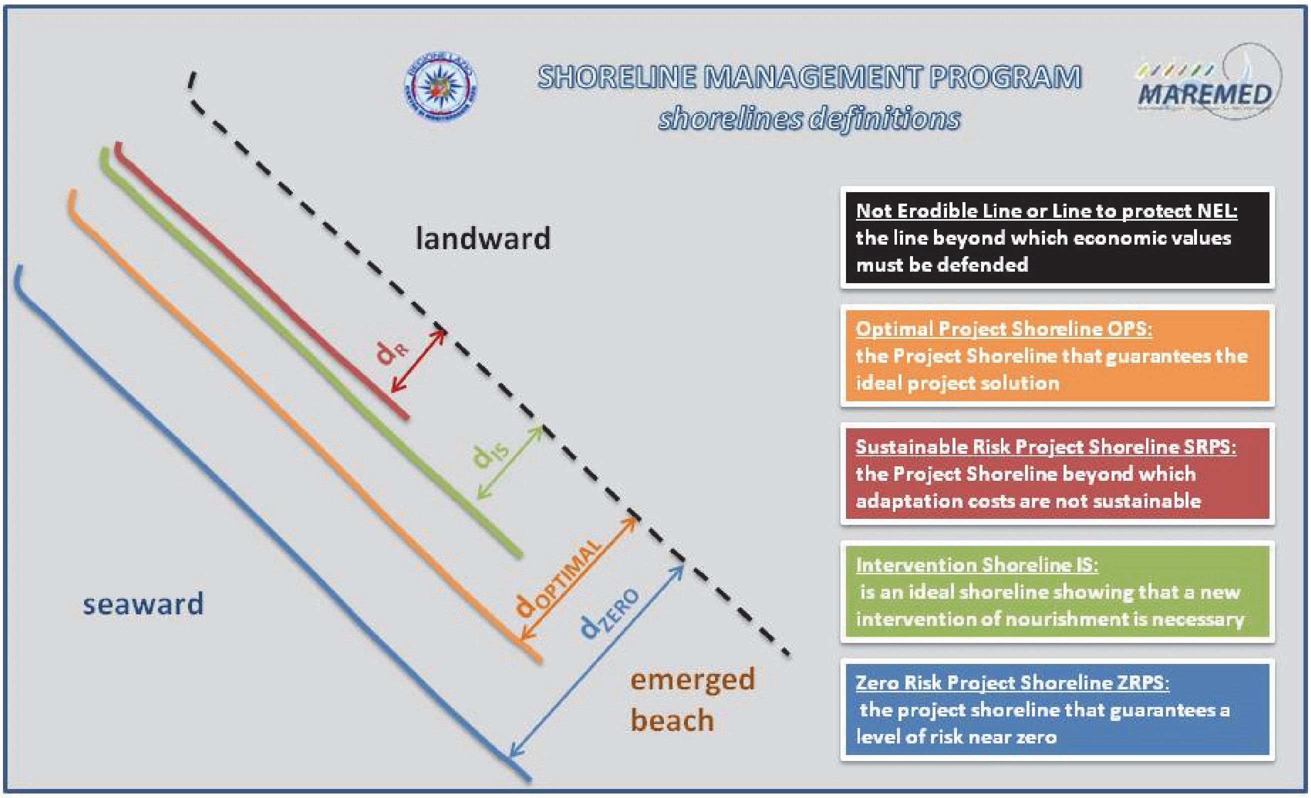


Coastal Monitoring Services on Mediterranean a WebGIS tool available on www.facecoast.org

pilot action n.4
Shoreline Management Program. A methodology for the monitoring and maintenance of Project Shoreline

Starting from an idea adopted by Dutch Government for long term management of their coasts, Shoreline Management Program is a tool developed for Coastal Project Managers in order to have a detailed program of shoreline monitoring and a detailed program of shoreline maintenance operations with the objective to render it more stable and economically sustainable on the time. More stable will be the beach on the time, reduced will be the level of flooding risk.
Cause of the monetary approach that COFLERMap and COFLERTools Models (Maremed Books n. 1 and n. 2) did on the evaluation of coastal risks, they represents the preferably way for the development of a Shoreline Management Program.

The monetary evaluation of coastal risks will be compared with costs of realisation and maintenance of an adaptation measure.
Once established the priority areas of intervention, e.g. at regional scale, and the most convenient and sustainable typology of intervention, next step for an optimal management and allocation of economical resources, could be the evaluation of the area of the new beach.
This tool could resolve the problem of decision makers and project managers to choice the optimal position of Project Shoreline 'PS' by an economic point of view.



pilot action n.4
Shoreline Management Program. A methodology for the monitoring and maintenance of Project Shoreline

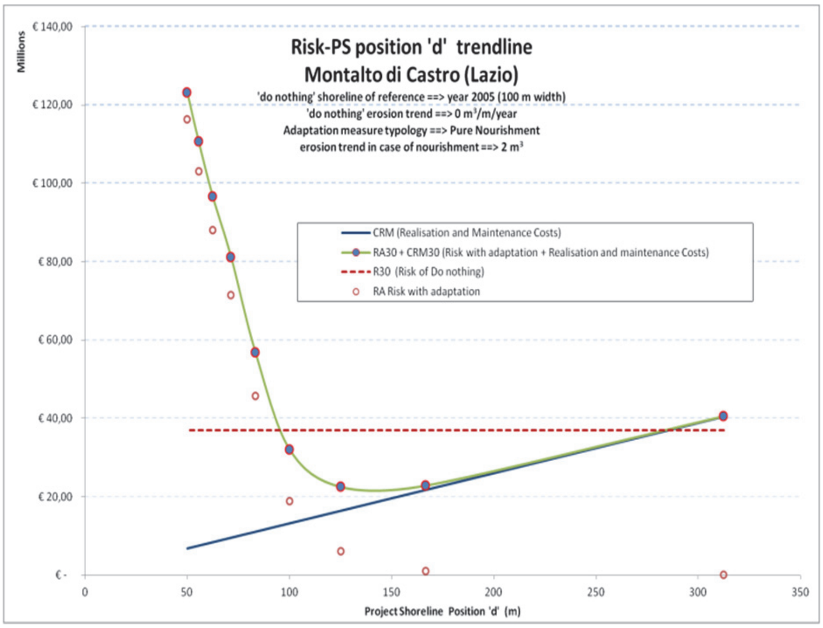
Application of the methodology on a pilot site of Lazio's coast.

We have chosen the area of Montalto di Castro (VT) because of the availability on this area of a good quantity and quality of morphological data and also for the reason that a risk evaluation was already made in this area with the application of COFLERMap and COFLERTools models. Risk evaluation results are preparatory for the application of this methodology.

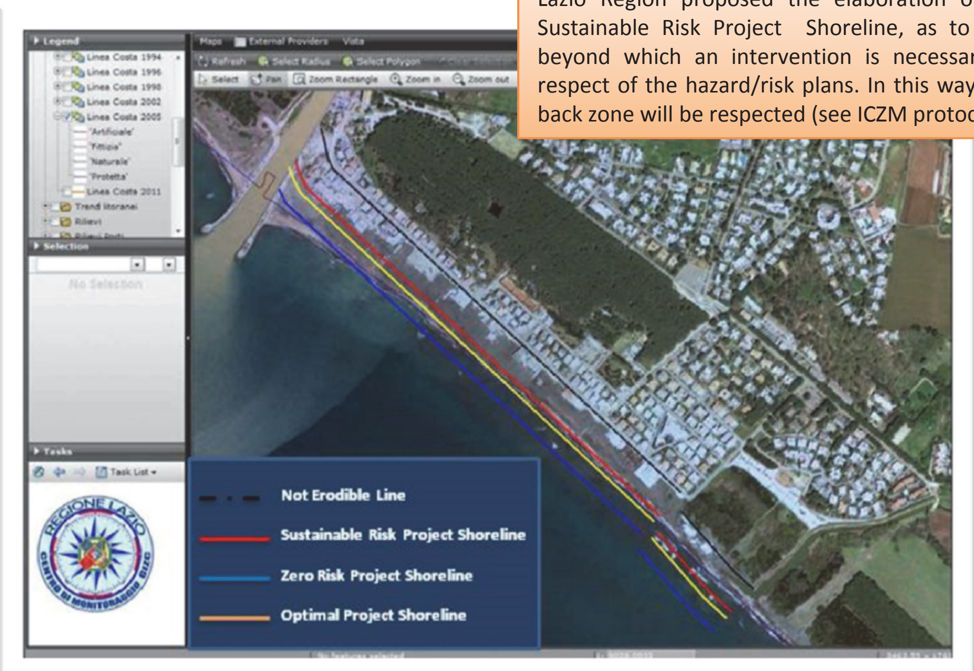
We assume that coastal defence work become economically sustainable when the sum between the risks after the realisation of the opera (R_A) and costs of its realization and maintenance (C_{RM}) become lower than the risk in absence of intervention (R).

$(R_A + C_{RM}) < R$ ***Sustainable condition for coastal defence work intervention***

Both R_A and C_{RM} values are linked to the position of the project shoreline.



Lazio Region proposed the elaboration of a methodology to define a Sustainable Risk Project Shoreline, as to say the position of shoreline beyond which an intervention is necessary in order to reestablish the respect of the hazard/risk plans. In this way also the steadiness of the set-back zone will be respected (see ICZM protocol art. 8).

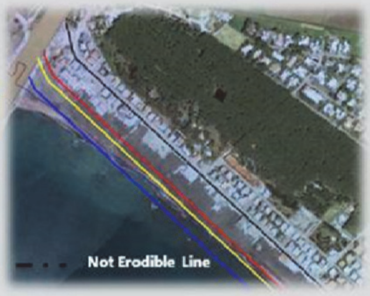


pilot action n.4
Shoreline Management Program. A methodology for the monitoring and maintenance of Project Shoreline

SHORELINE MANAGEMENT PROGRAM

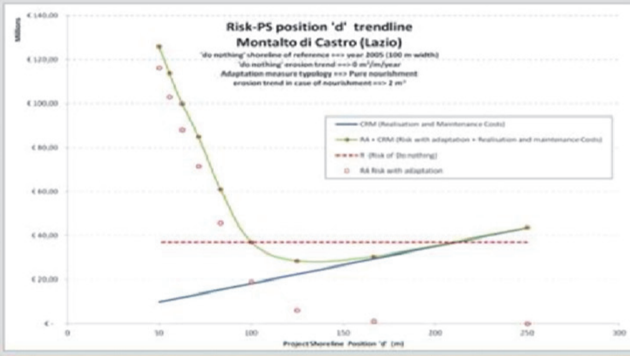
MAREMED

Schedule N. 2/30	(Montalto Marina)
Cell length	1400 m
Territorial delimitation	North: Fiora River South: Sanguinaro Channel
Municipality	Montalto di Castro (VT)



Morphology	
Beach slope	from 1% to 5%
Berm quote	Q_B = + 2,5 m msl
2000 shoreline main position	d_{2005} = 100 m
Erosion trend	Ev = -2 m³/m year

Risk & Costs Computation	
Without adaptation measures	R_{30} = 1,5 M€/year
Sustainable Risk Project Shoreline position	d_R = 100 m
Zero Risk Project Shoreline position	d_{zero} = 180 m
Intervention Shoreline position	$d_S = d_R + 2^*(Ev/Q_B)$ = 101,6 m
Optimal Shoreline position	$d_{OPTIMAL}$ = 125 m
Risk with measure (pure nourishment)	R_{A30} = 0,25 M€/year
Realisation costs Realisation + Maintenance costs	C_R = 11,5 M€ C_{RM} = 22,4 M€
Benefit of intervention (after 30 years)	B_{30} = 8,6 M€



Monitoring & Maintenance Program	
Laying shoreline position	$d_{LS} = d_{OPTIMAL}$ *1,4 = 175 m
Volume of project	Vp = 1188 m³/m
Sand loss during first year	V1 = 475 m³/m (40%)
Monitoring period	each year (Beach Emerged Approach) 5 years (Volumetric Approach)

Results of Shoreline Management Program applied to Montalto di Castro Pilot area (Lazio) are reported on a schedule summarizing all the parameters and results adopted during the application of the model.

Conclusions

• Better knowledge of the level of Flood risk Map implementation along Mediterranean coastal areas;
• Collaboration with international external expertise of coastal risk management (Alkiom Netherlands, Rijkswaterstaat Netherlands, Kiel University Germany, …);
• New shared tools for the management of coastal adaptation to climate change in the Mediterranean (COFLERMap, COFLERTools, Atlas of Coastal Dynamic, Shoreline Management Program);
• Creating the conditions for future implementation of these tools along Mediterranean coasts
• Feasibility of a Network of Mediterranean coastal Observatories

Future developments

PESETA REGIONAL SCALE

?

Comparison between regional level results and local level results on the evaluation of flood risk

COFLERMAP LOCAL SCALE

Rome, November 2011 – ACC Technical Meeting

Rome, December 2012 – Steering Committee

Rome, December 2012 – ACC Technical Seminar

MAREMED

MAritime REgions cooperation for MEDiterranean

Gaeta (LT), April 2013 – Maremed Event at Yacht Med Festival

Med Program
MAREMED N. 2G MED09-209
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