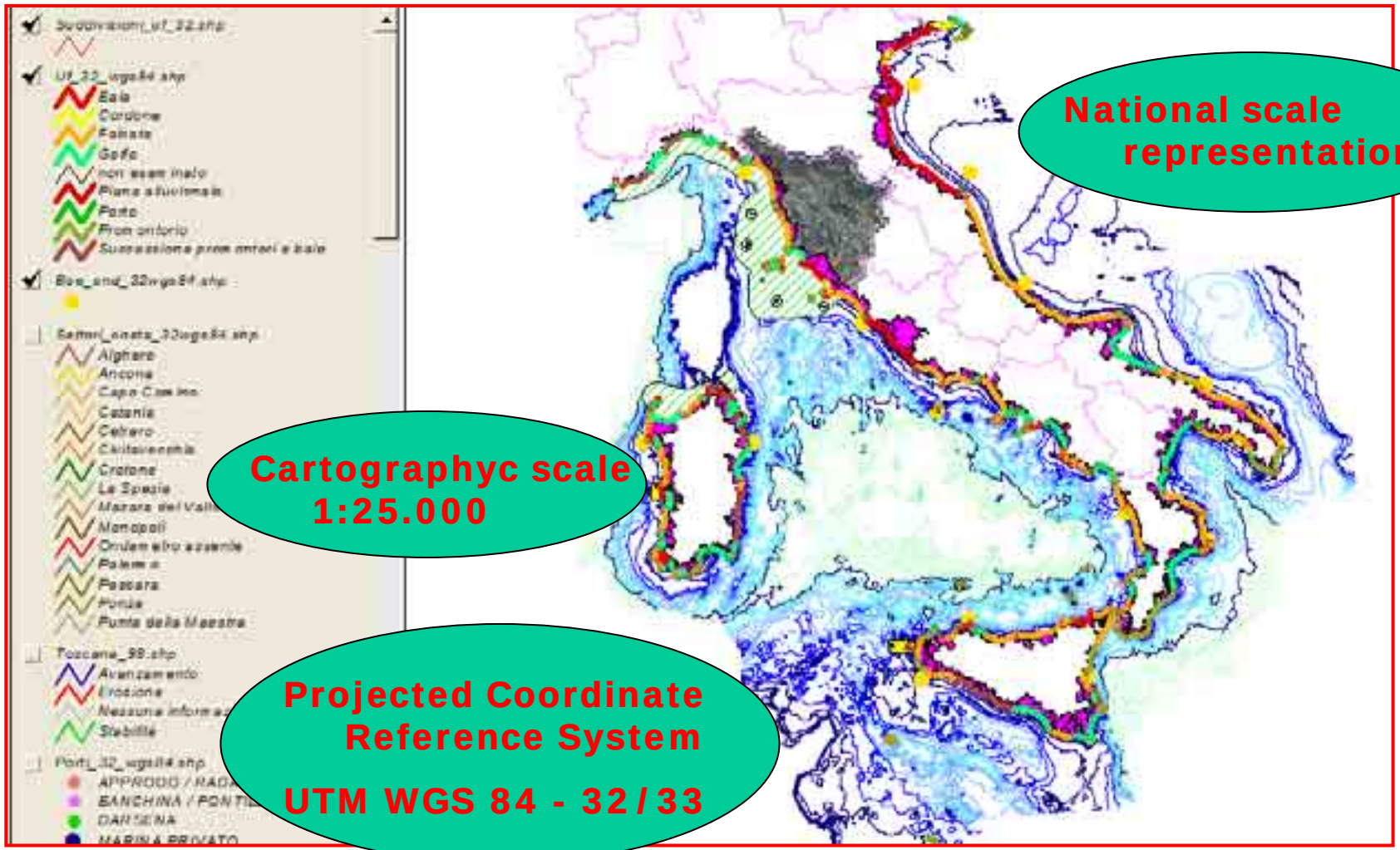
Observation, monitoring and reporting. Knowledge to support strategies

Mr. Stefano Corsini

APAT

Agency for Environmental Protection and Technical Services

THE COASTAL GEOGRAPHYCAL INFORMATION SYSTEM



BACKGROUND CARTOGRAPHY VECTORIAL DATA

Environmental Data

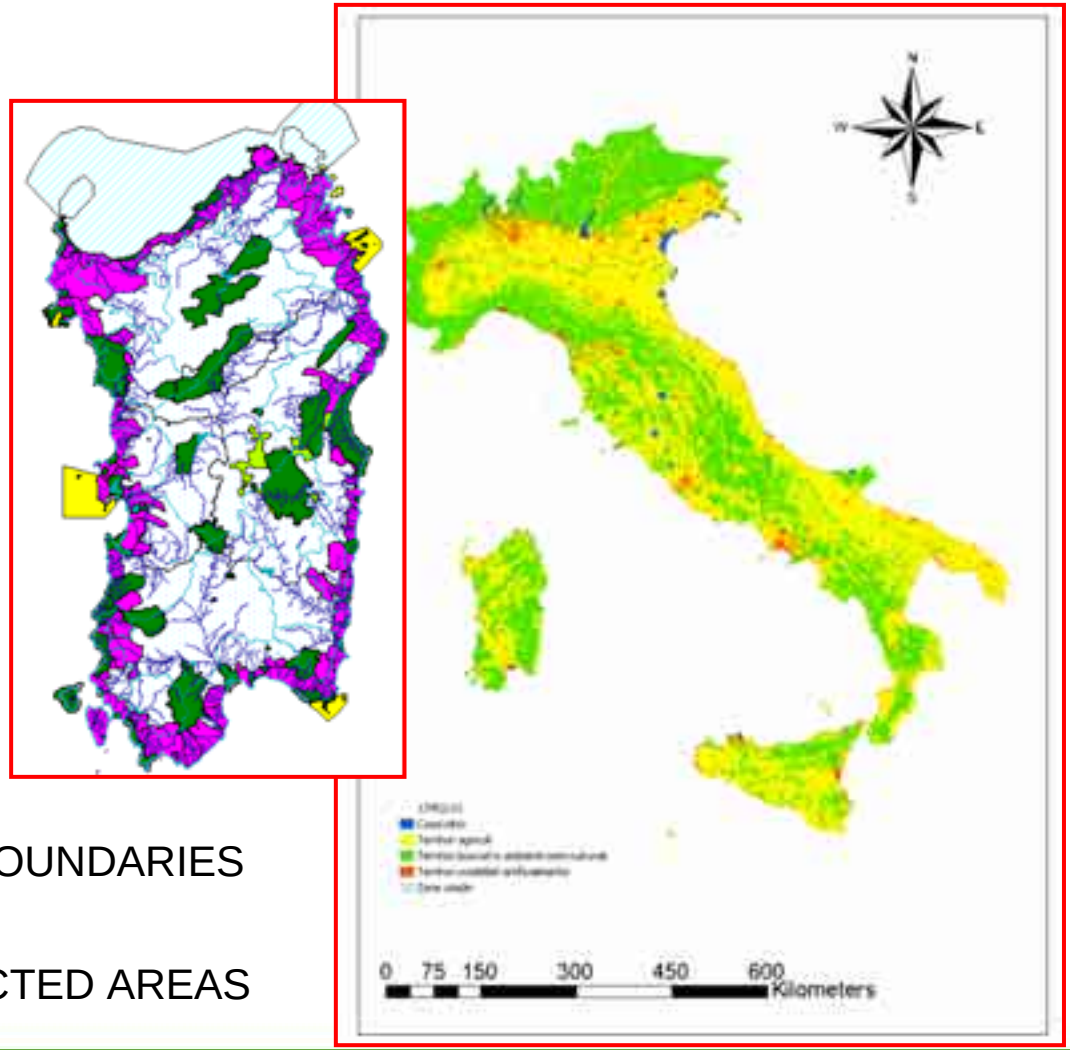
- BATHIMETRY
- HYDROGRAPHY and LAKES
- LITOLOGYC MAP
- LAND USE MAP (CLC2000)
- SUBMARINE VOLCANOS
- 20-mt DTM

Infrastructures

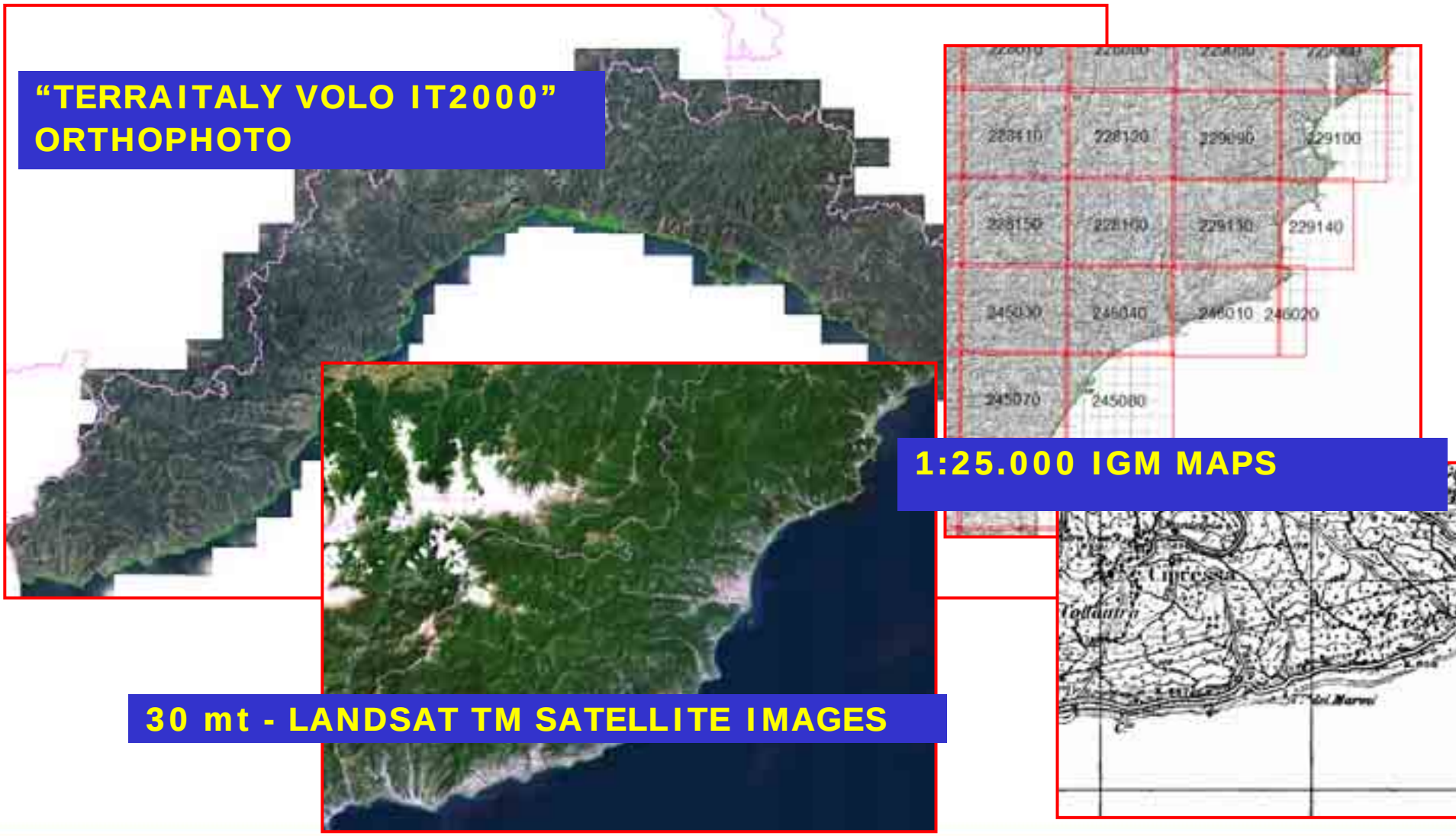
- ROADS, RAILWAYS, AIRPORTS DAMS, other

Administrative data

- COMMUNAL/PROV./REGIONAL BOUNDARIES
- TOPONYMS, URBAN CENTERS
- MARINE / TERRESTRIAL PROTECTED AREAS



BACKGROUND CARTOGRAPHY RASTER DATA



DATA PROCESSING AND OUTPUTS THEMES

Coastal line

- Physiographic units (census and classification)
- Coast line digitized on the “IT2000” orthophoto’s
- Coast line derivated by 1:25.000 IGM maps
- Coast classification

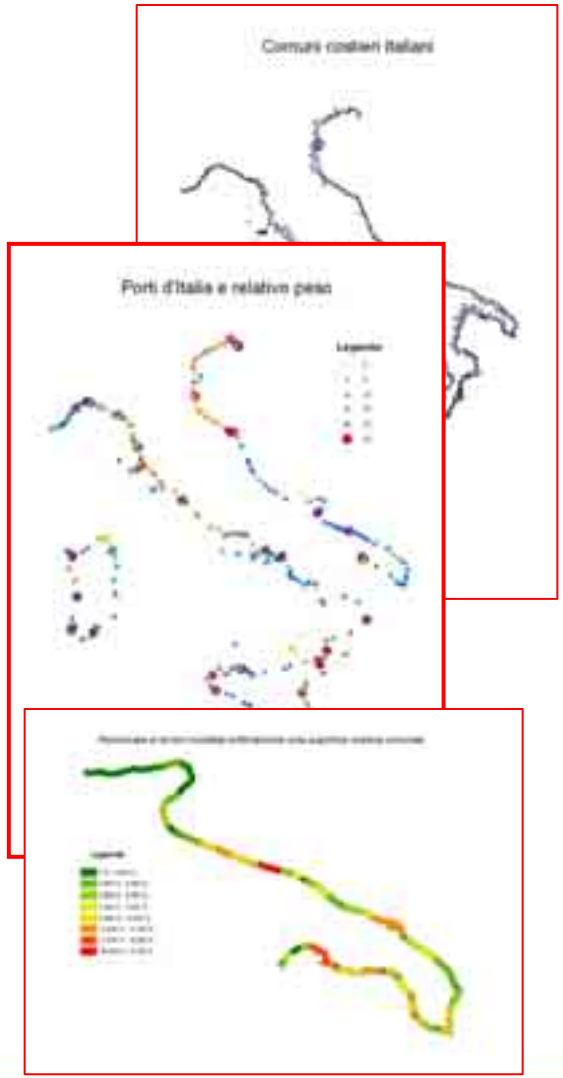
Infrastructures

- Harbours (census and classification)
- Hard works (census and classification)
- Measure stations: Wave Buoys and Tide Gauges

Meteo-marine data

- Coastal sectors in front of the Wave Buoys
- Meteo-marine climate

Coastal administrative data



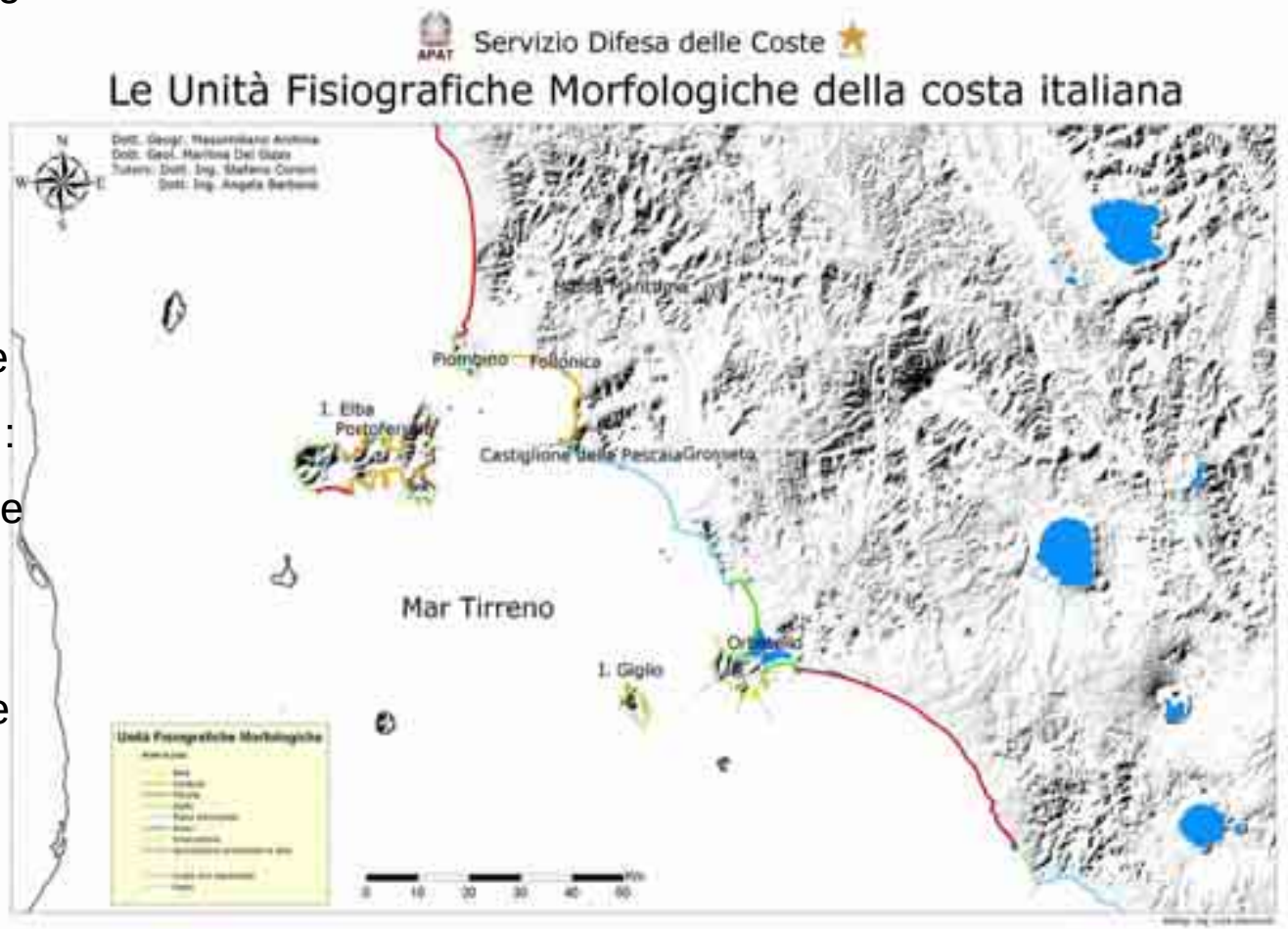
MORPHO-PHYSIOGRAPHIC UNITS

Coastal stretches where sediments move remaining confined between the two extreme limits (along these limits, the changes are null)

330 physiographic units have been created by processing the coastal line

Criteria for their definition:

- terrestrial and submarine coastal geomorphology
- shoreline orientation
- the assumption that the solid transportation along the coast not exceed the 10mt - bathymetry line



MORPHO-PHYSIOGRAPHIC UNITS

Morpho-type

- Bay
- “Cordone”
- “Falcata”
- Gulf
- Alluvial plain
- Harbour
- Promontory
- Promontory/bay alternancy

METEO-MARINE DATA

Wave Climate: coastal sectors

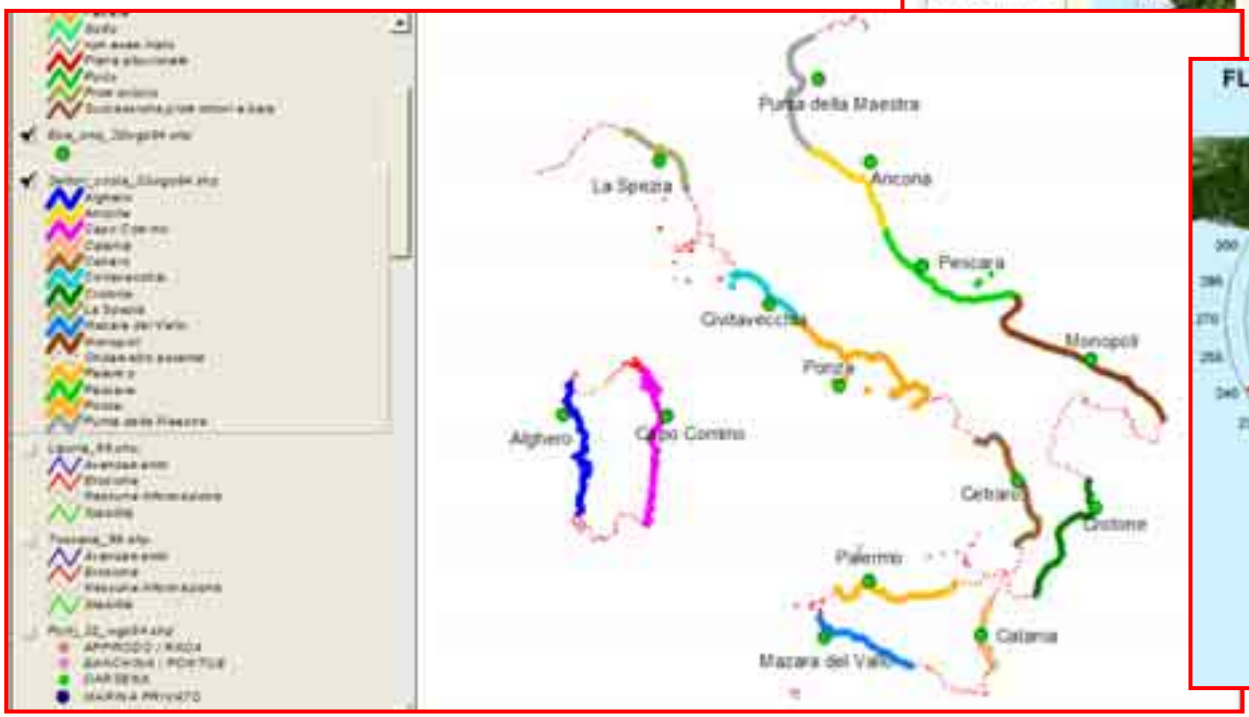
Specific coastal stretches have been defined where, by numeric processing, the wave climate measured off-shore is trasposed on the shoreline

Criteria to select each sector:

- Being in front of a wave buoy
- Depending on the shoreline geographycal orientation
- Having a homogenous lenght

METEO-MARINE DATA

For each coastal sector, it is possible to jump to a html page containing information about the wave climate statistics



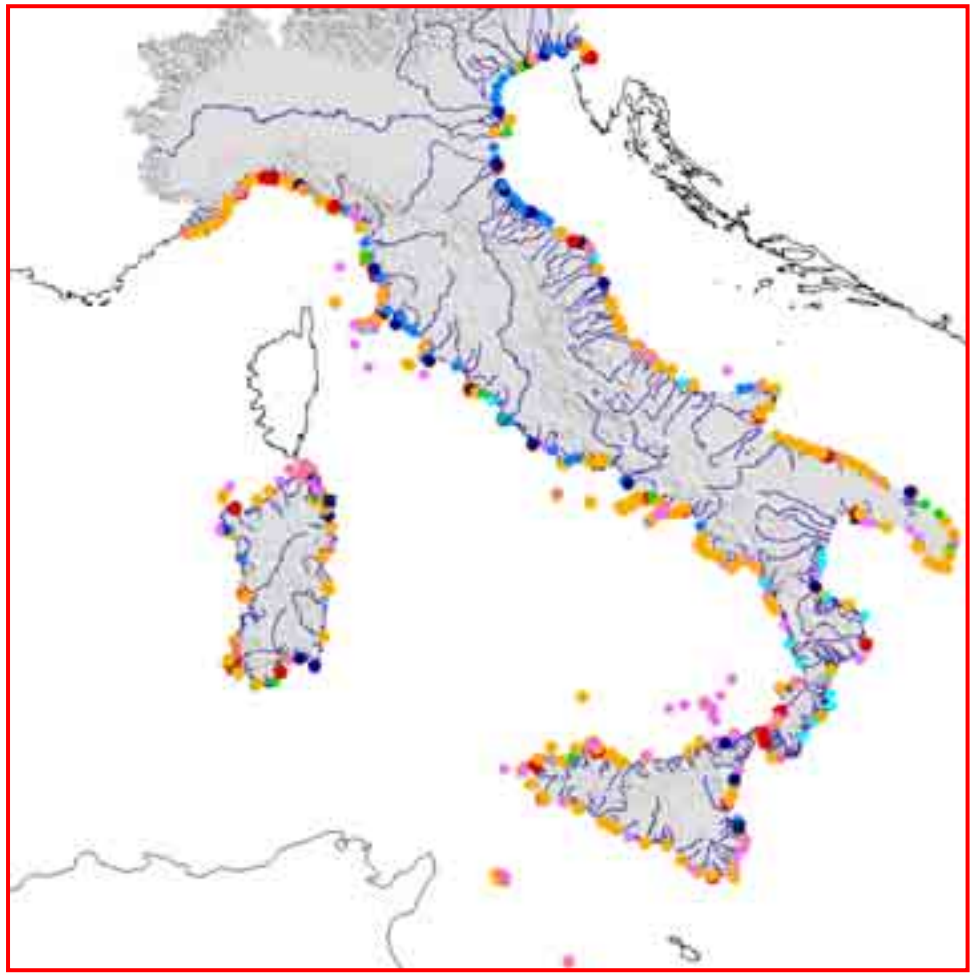
HARBOURS

653 harbours georeferenciated

- Region, provincial, communal code
- Typology
- Description html web pages

TIPOLOGIA DI PORTO

- APPRODO / RADA
- BANCHINA / PONTILE
- DARSENA
- MARINA PRIVATO
- PORTO / PORTICCIOLO
- PORTO CANALE
- PORTO INDUSTRIALE / COMMERCIALE
- PORTO MILITARE
- SPIAGGIA ATTREZZATA



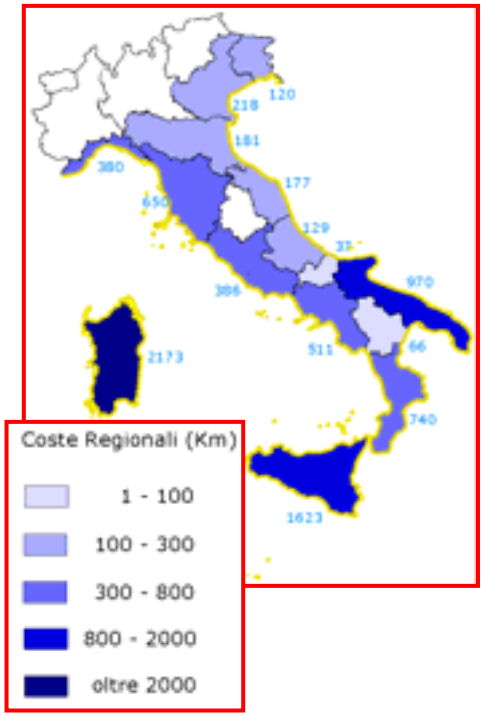
HARBOURS - Description

THE COASTAL LINE

– Available data at national scale coming from “Atlante delle Spiagge Italiane”

Regioni	Opere portuali e banchine		Coste alte		Spiagge in erosione		Spiagge in accrescimento		Spiagge stabili		Totale spiagge		Totale litorali	Codice regione
	km	%	km	%	km	%	km	%	km	%	km	%	km	
Friuli Venezia Giulia	29	28	15	14	2	3	2	3	56	94	60	58	104	6
Veneto	0	0	0	0	18	11	20	13	122	76	160	100	160	5
Laguna	63	15	145	35	70	33	3	1	138	66	211	50	419	7
Emilia Romagna	2	1	0	0	31	20	16	10	108	70	155	99	157	8
Toscana	14	3	242	51	122	57	22	10	72	33	216	46	472	9
Marche	4	2	37	22	57	44	7	5	65	51	129	76	170	11
Lazio	13	5	61	21	117	54	12	6	87	40	216	74	290	12
Abruzzo	3	2	23	19	48	48	2	2	49	50	99	79	125	13
Molise	1	3	2	6	26	81	0	0	6	19	32	91	35	14
Campania	23	6	200	54	100	67	0	0	50	33	150	40	373	15
Puglia	58	7	450	56	89	30	1	0	212	70	302	37	810	16
Basilicata	0	0	19	32	40	98	0	0	1	2	41	68	60	17
Calabria	5	1	44	6	300	43	23	4	369	53	692	93	741	18
Sicilia	44	4	375	36	167	27	34	5	420	68	621	60	1040	19
Sardegna	12	1	960	71	62	17	17	4	295	79	374	28	1346	20
Mari														
Tirreno	136	4	1796	50	659	40	74	5	896	55	1629	46	3561	
Adriatico	80	6	353	28	229	27	48	6	568	67	845	66	1278	
Ionio	55	4	422	29	361	37	37	4	586	59	984	67	1461	
Italia	271	4	2571	41	1249	36	159	5	2050	59	3458	55	6300	

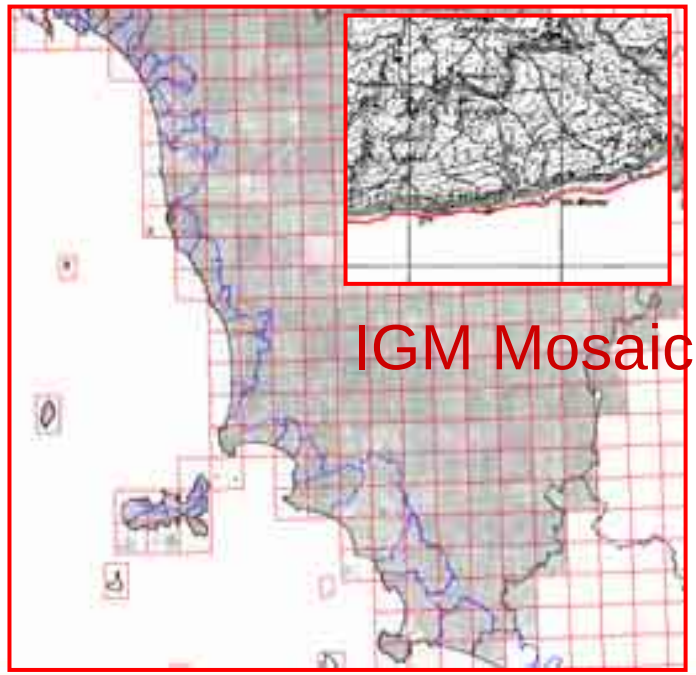
Al valore relativo alle spiagge in erosione occorre aggiungere un ulteriore 9% (oltre 300 km), per quei litorali che sono stati resi stabili mediante opere di protezione. Pertanto le spiagge "naturalmente" stabili costituiscono circa il 50% del totale
Il totale dei km dei litorali italiani comprende l'Isola d'Elba ma non comprende le isole minori, i cui litorali hanno uno sviluppo di circa 1200 km (per la gran parte coste alte)
Fonte: Atlante delle Spiagge Italiane, C.N.R. - M.U.R.S.T., 1985-1997



–IT BECOME CRUCIAL:
– HAVING UPDATED AND HOMOGENOUS DATA ON
–SHORELINE DYNAMICS
–SPATIAL AND DIACHRONICAL MODIFICATIONS
–UPDATED BACKGROUND CARTOGRAPHY

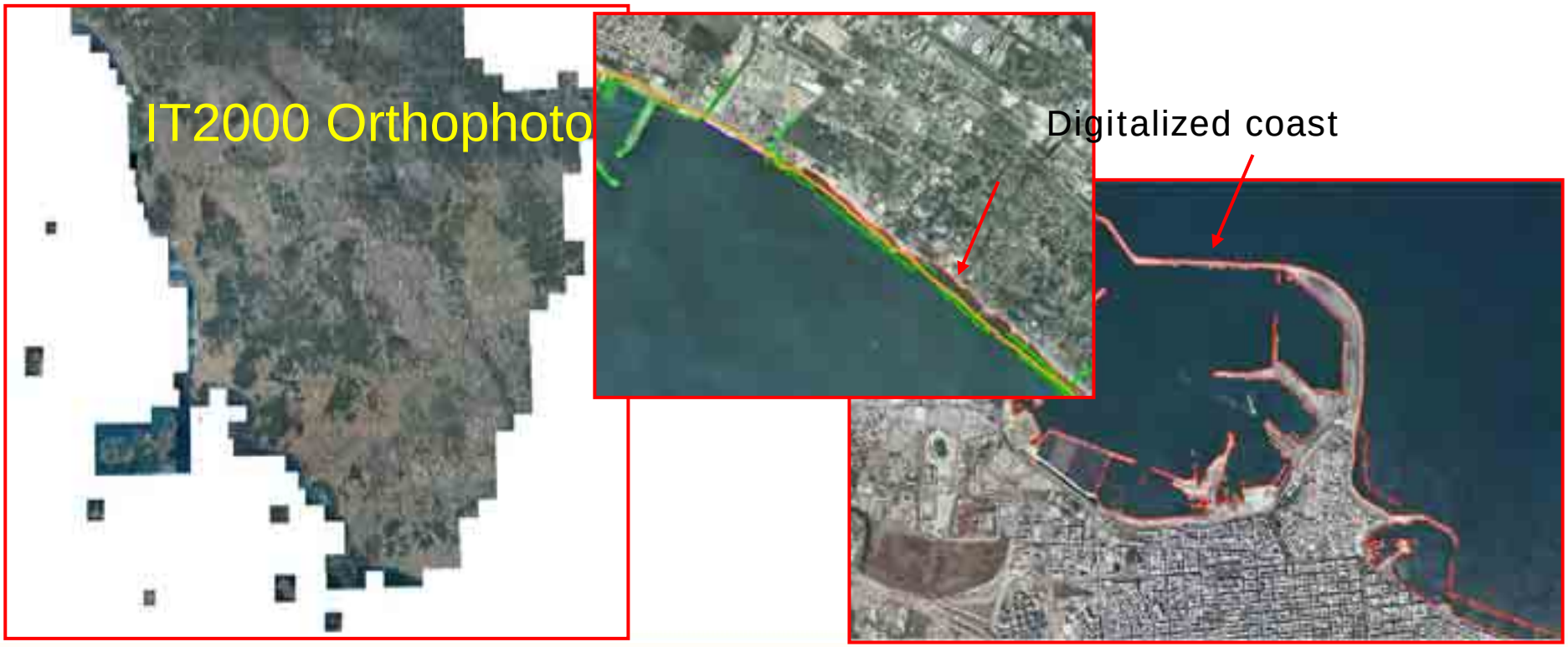
IGM COASTAL LINE

- Derived by a GIS processing on the italian administrative boundaries theme
- Checked and re-edited, in some parts, on the 1:25.000 IGM Maps
- It is a homogenous theme at the 1:25.000 national scale



COASTAL LINE 2000 DIGITALIZATION

- Coming from a GIS digitalization on the “Volo IT2000” - orthophoto’s
- Scales of the digitalization: 1:5.000 in corrispondence of natural tracts; 1:3.000 in corrispondence of harbours and hard structures
- It is a homogenous theme at the 1:10.000 national scale



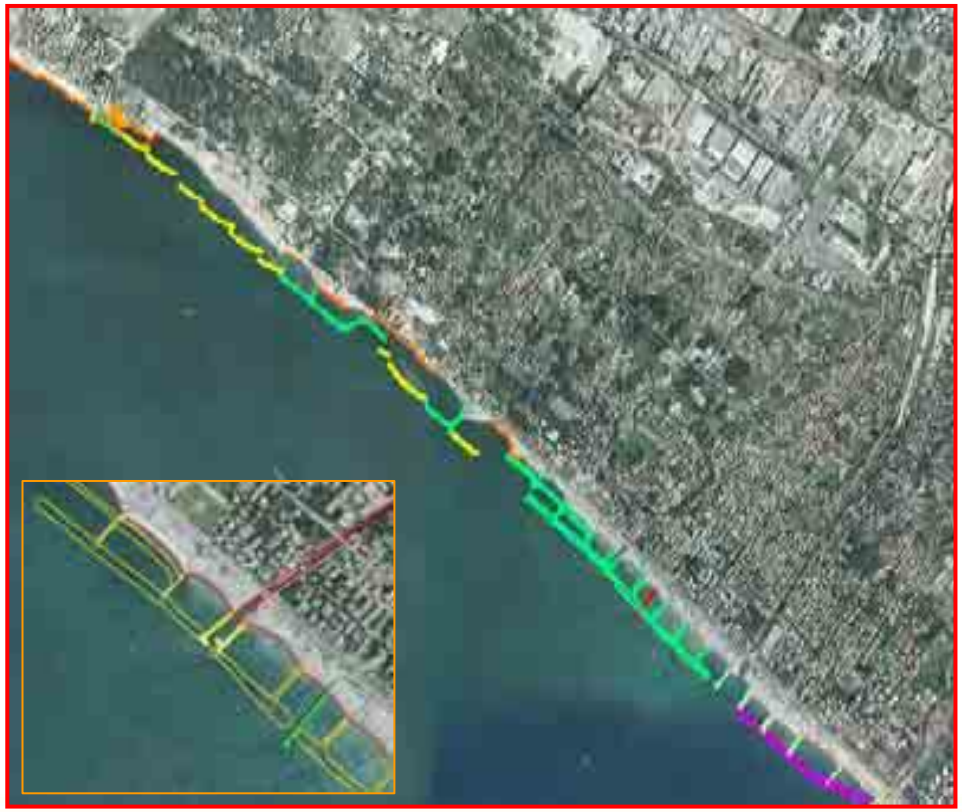
COASTAL LINE 2000 CLASSIFICATION

The digitized coastal line has been classified in : natural, artificial and fictitious.

The natural coast has been divided in : high coast tracts and low coast tracts.

COASTAL LINE 2000
Harbours and hard works

Each portual and coastal hard structure recognized on the orthophoto's has been digitized and classified by typology



Tipologia_utm32_wgs84.shp
- Altro (lidi, pontili, ecc.)
- Opere di difesa costiera-Foci armate
- Opere di difesa costiera-Isolotti
- Opere di difesa costiera-Opere miste
- Opere di difesa costiera-Pennelli a T emersi
- Opere di difesa costiera-Pennelli a T sommersi
- Opere di difesa costiera-Pennelli a Y emersi
- Opere di difesa costiera-Pennelli obliqui emersi
- Opere di difesa costiera-Pennelli obliqui sommersi
- Opere di difesa costiera-Pennelli ortogonali emersi
- Opere di difesa costiera-Pennelli ortogonali sommersi
- Opere di difesa costiera-Radente a gettata
- Opere di difesa costiera-Radente a muro
- Opere di difesa costiera-Scogliere emerse con varchi
- Opere di difesa costiera-Scogliere emerse senza varchi
- Opere di difesa costiera-Scogliere sommerse con varchi
- Opere di difesa costiera-Scogliere sommerse senza varchi
- Opere Portuali

SHORE LINE MODIFICATION

- The two coastal lines (“2000”, IGM) have been compared at the 1:25.000 cartographyc scale
- Linear and areal modifications on the last 40-50 years have been estimated

METHODOLOGY

- Starting from the IGM reference coastal line, a 5-mt buffer zone and a 30-mt buffer zone have been created in a parallel direction;
- The two coastal lines (IGM and 2000) have been overlaid in order to make a spatial analysis;
- After comparing the two lines, shoreline tracts resulting in accrescion or in erosion have been individuated;
- The dimensions of the linear and areal modification have been calculated.

OUTPUTS

- The italian coastal line is updated (to the year 2000)
- Background cartography data allows to analyse the shoreline modification
- Statistical reports for each administrative unit and for each physiographic unit

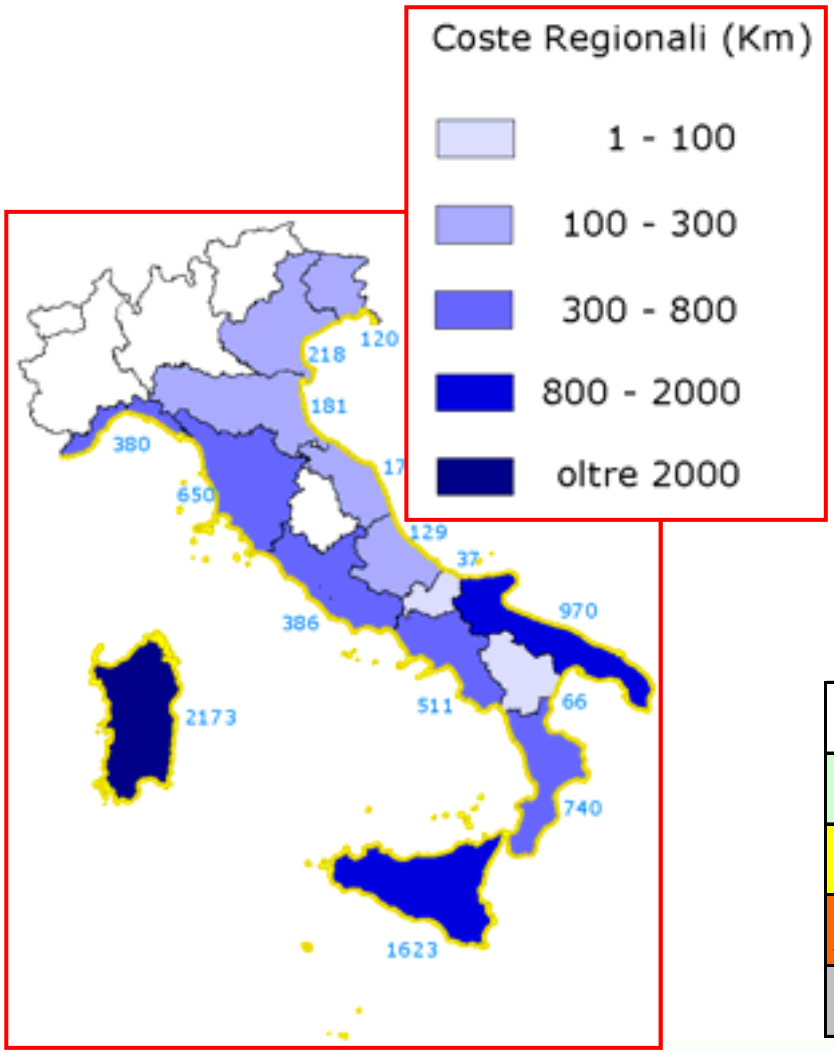
Analisi estesa alle coste basse

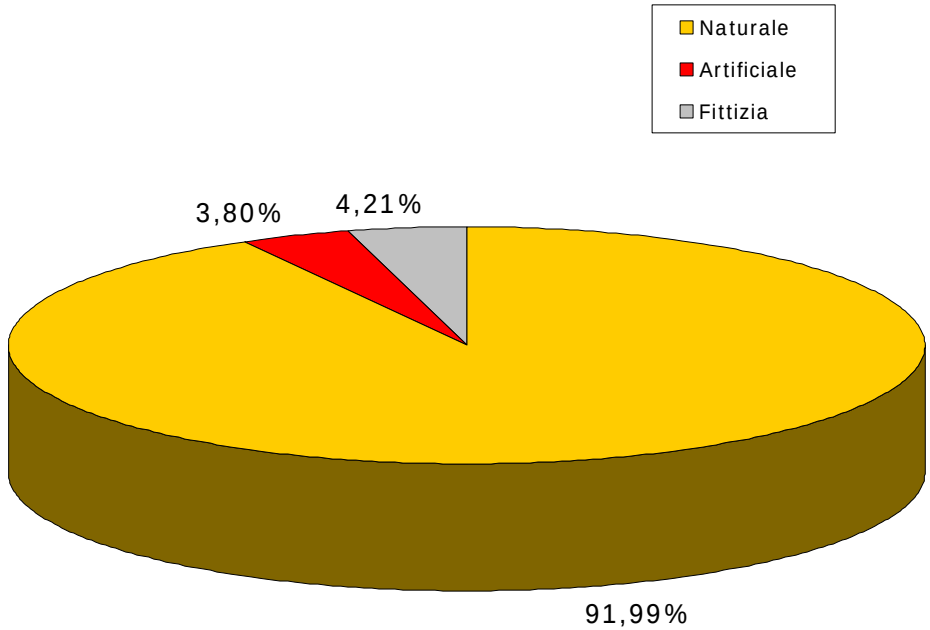
	Lunghezza [m]	[%]
Coste	4.863.285	100,0
Stabili	2.387.415	49,1
Modificate	2.227.431	45,8
Non definito*	248.439	5,1
Coste modificate	2.227.431	45,8
Arretramento	1.169.823	24,1
Avanzamento	1.057.608	21,7

Analisi estesa a tutte le coste

	Lunghezza [m]	[%]
Coste	8.353.264	100,0
Stabili	5.385.058	64,5
Modificate	2.448.213	29,3
Non definito*	519.993	6,2
Coste modificate	2.448.213	29,3
Arretramento	1.284.978	15,4
Avanzamento	1.163.235	13,9

NATURAL / ARTIFICIAL COASTLINE

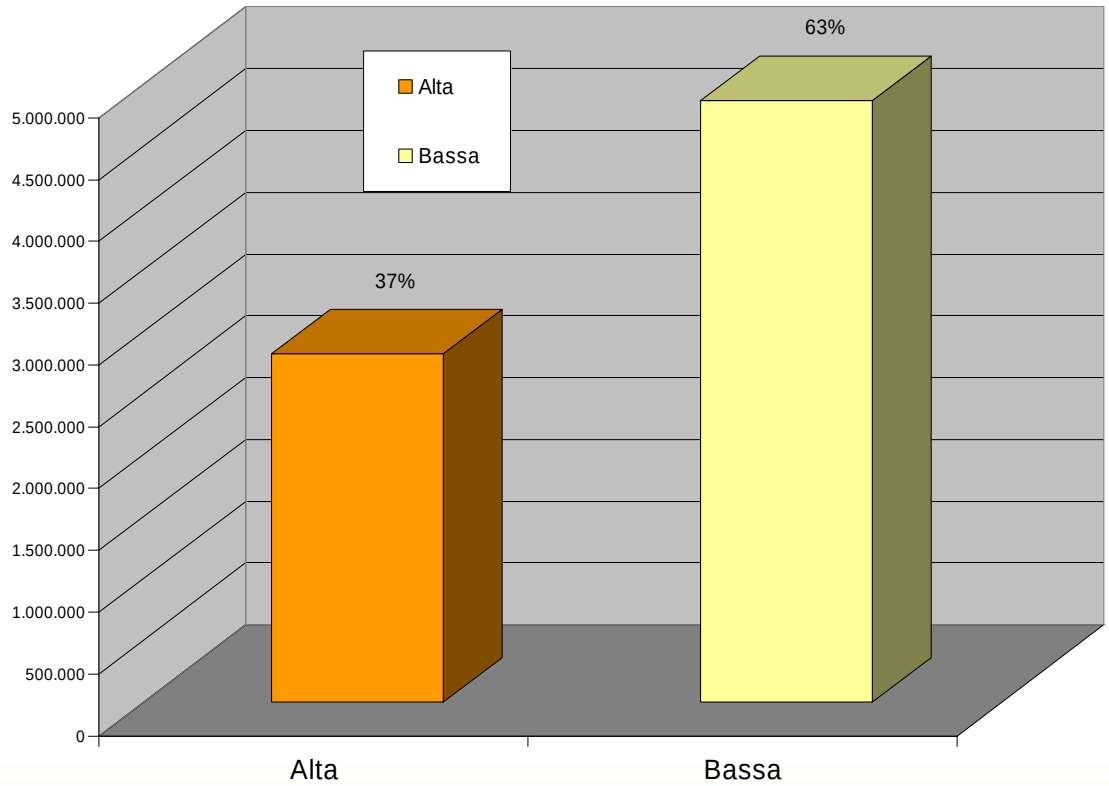




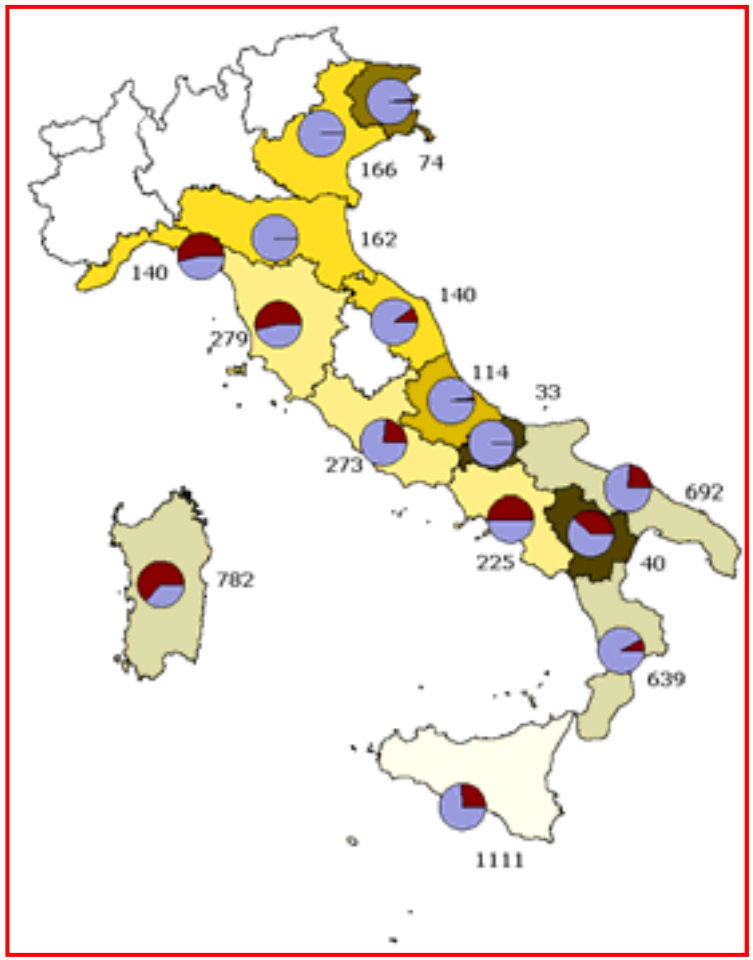
Lunghezza della costa (metri)		
Totale	**8.353.264**	**100%**
Naturale	*7.687.574*	*92%*
Artificiale	*313.766*	*3,80%*
Fittizia	*351.924*	*4,20%*

HIGH / LOW NATURAL COASTLINE

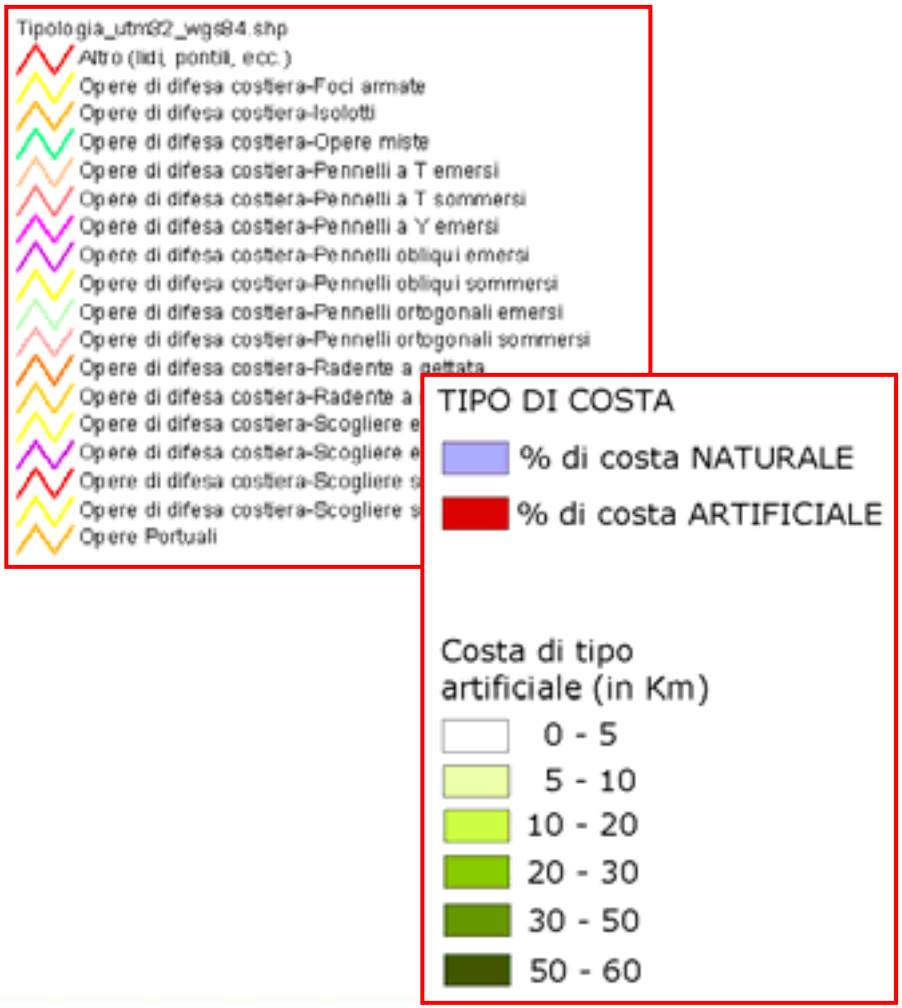
Lunghezza costa in metri		
Naturale	**7.687.574**	**100%**
Alta	*2.824.288*	*36,7%*
Bassa	*4.863.286*	*63,3%*

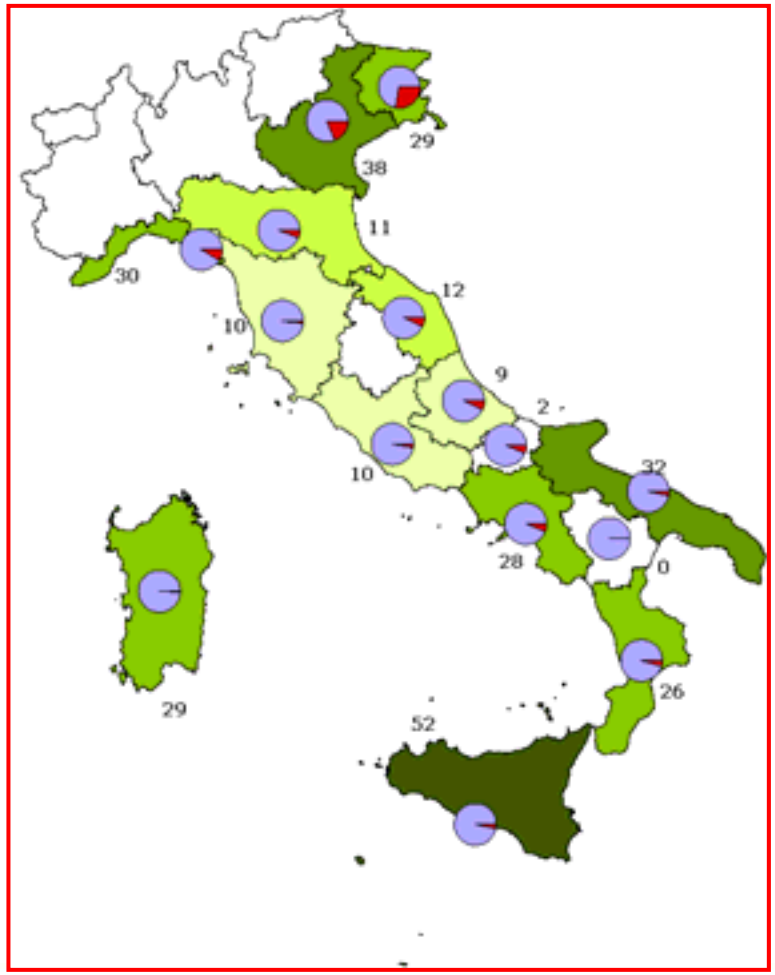


STATISTICS AT A REGIONAL LEVEL : LENGHT and PERCENTAGE OF THE HIGH / LOW COAST

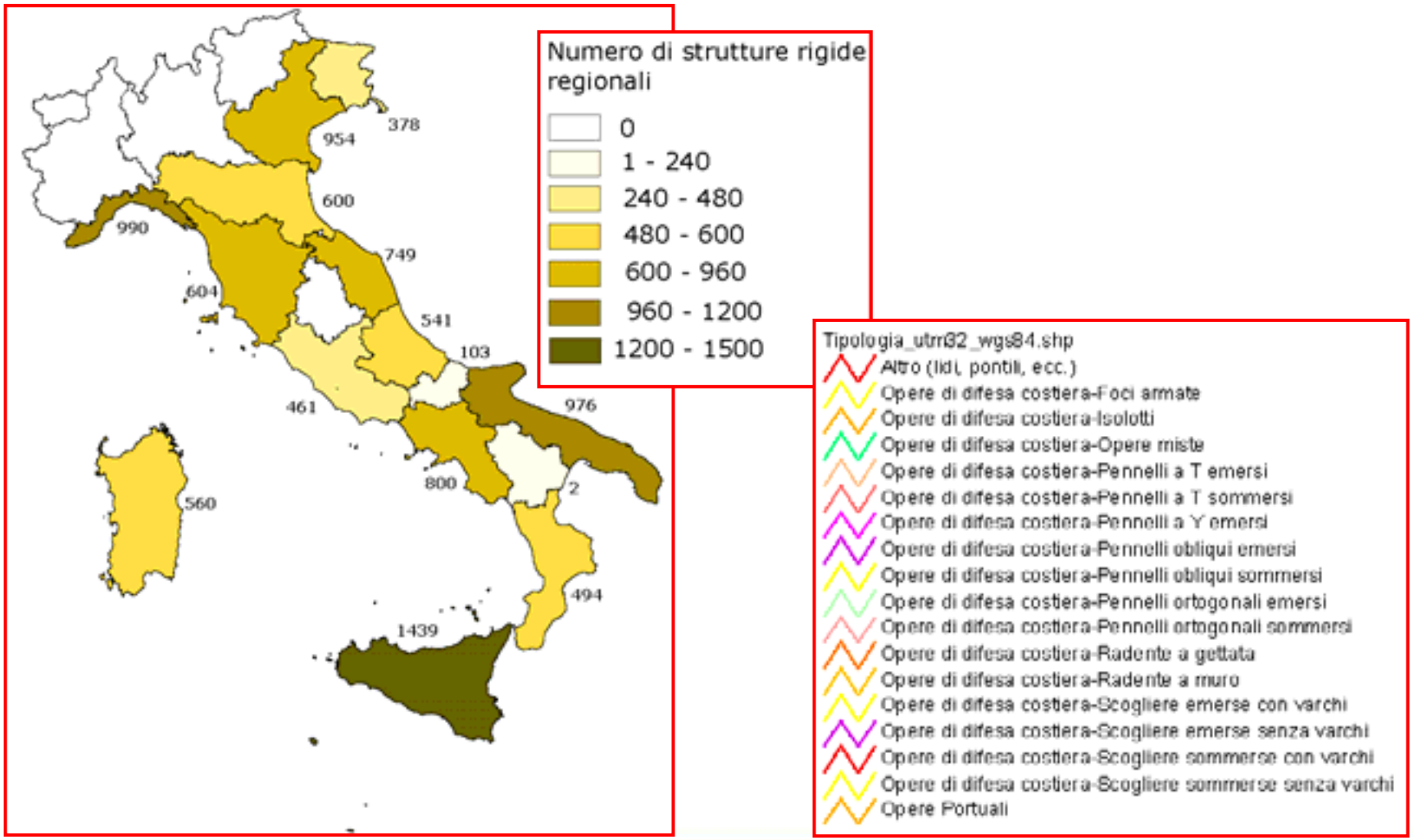


STATISTICS AT A REGIONAL LEVEL : THE ARTIFICIAL COAST

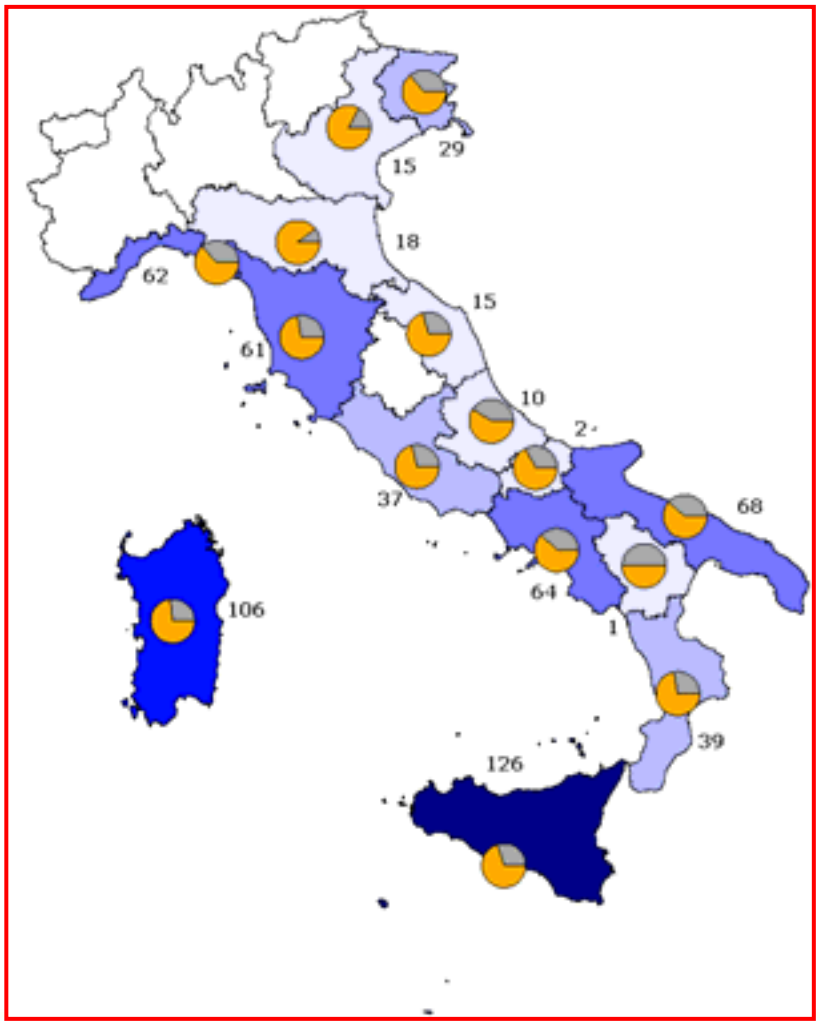




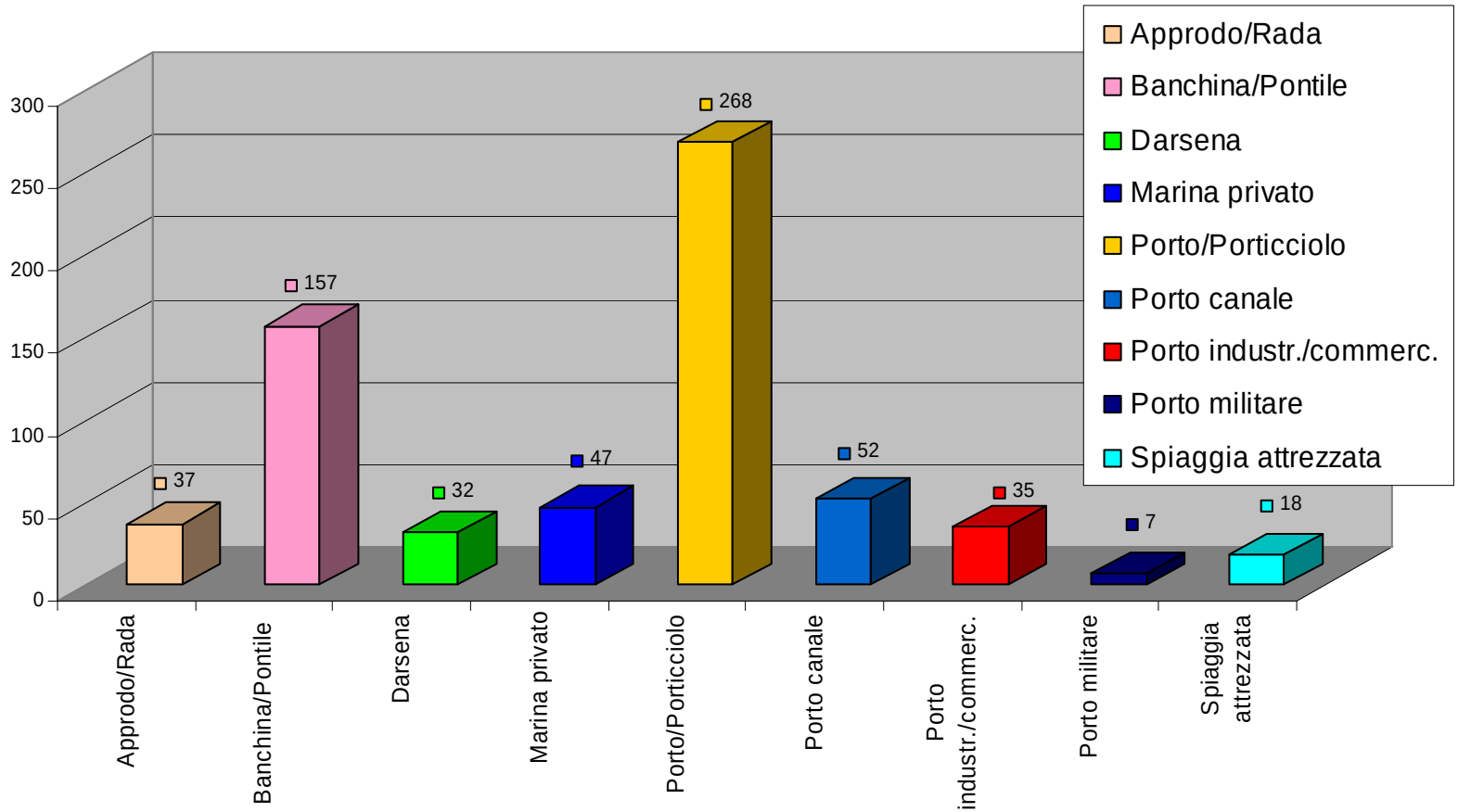
STATISTICS AT A REGIONAL LEVEL : DEFENCE WORKS



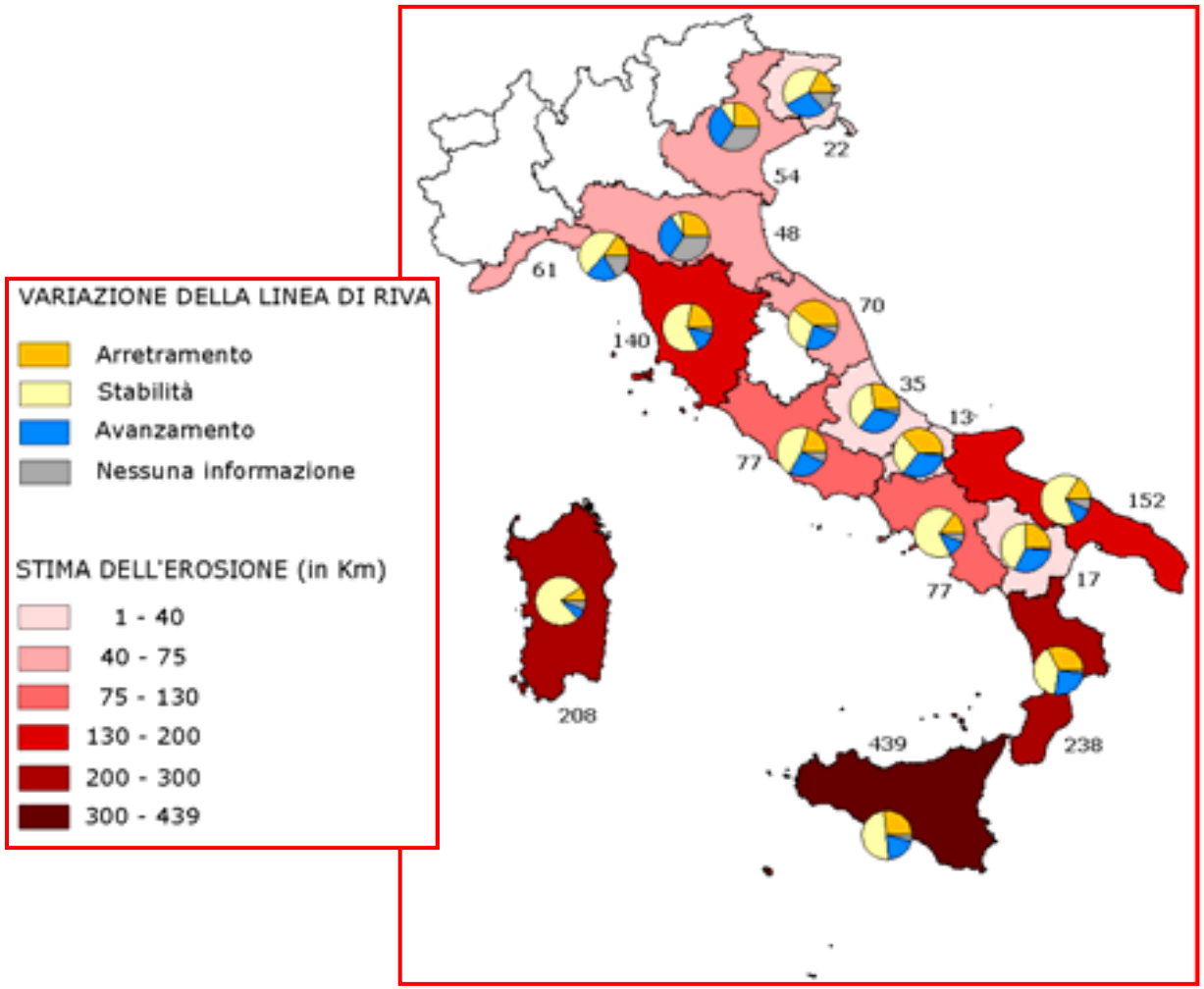
STATISTICS AT A REGIONAL LEVEL : ENVIRONMENTAL PRESSURE BY HARBOURS



HARBOURS : NATIONAL DISTRIBUTION FOR TYPOLOGY



EVALUATION OF THE 1950-2000 SHORELINE MODIFICATIONS



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EXPERIMENTATION: High-Resolution Satellite Imagery (Ikonos)

Characteristics of remote sensing data:

- Large geographic coverage as well as high geometric resolution quality
- Images with high informative content (availability of 4 spectral bands)

Purpose:

- Assessment of the satellite method efficacy for periodical coastal monitoring

Experimental coastal sites:

- Near 20 Km stretch of Calabrian coast (Amantea-Gizzeria)
- Near 20 Km stretch of coast between Molise and Puglia regions (Foce del Saccione-Marina di Lesina)

IKONOS characteristics:

- Space Imaging's remote sensing satellite
- Launched in September 1999
- Approximate altitude of 680 km

Spectral bands	Resolution
1 Blue	4 m
2 Green	
3 Red	
4 Near IR	
PAN Panchromatic	1 m

- By combining multispectral and panchromatic data (*Data fusion*) -> Images at 1 m resolution available on experimental coastal sites

The Calabrian Coastal Site

- Satellite images at the same resolution of the “It2000” orthophoto (1 m)

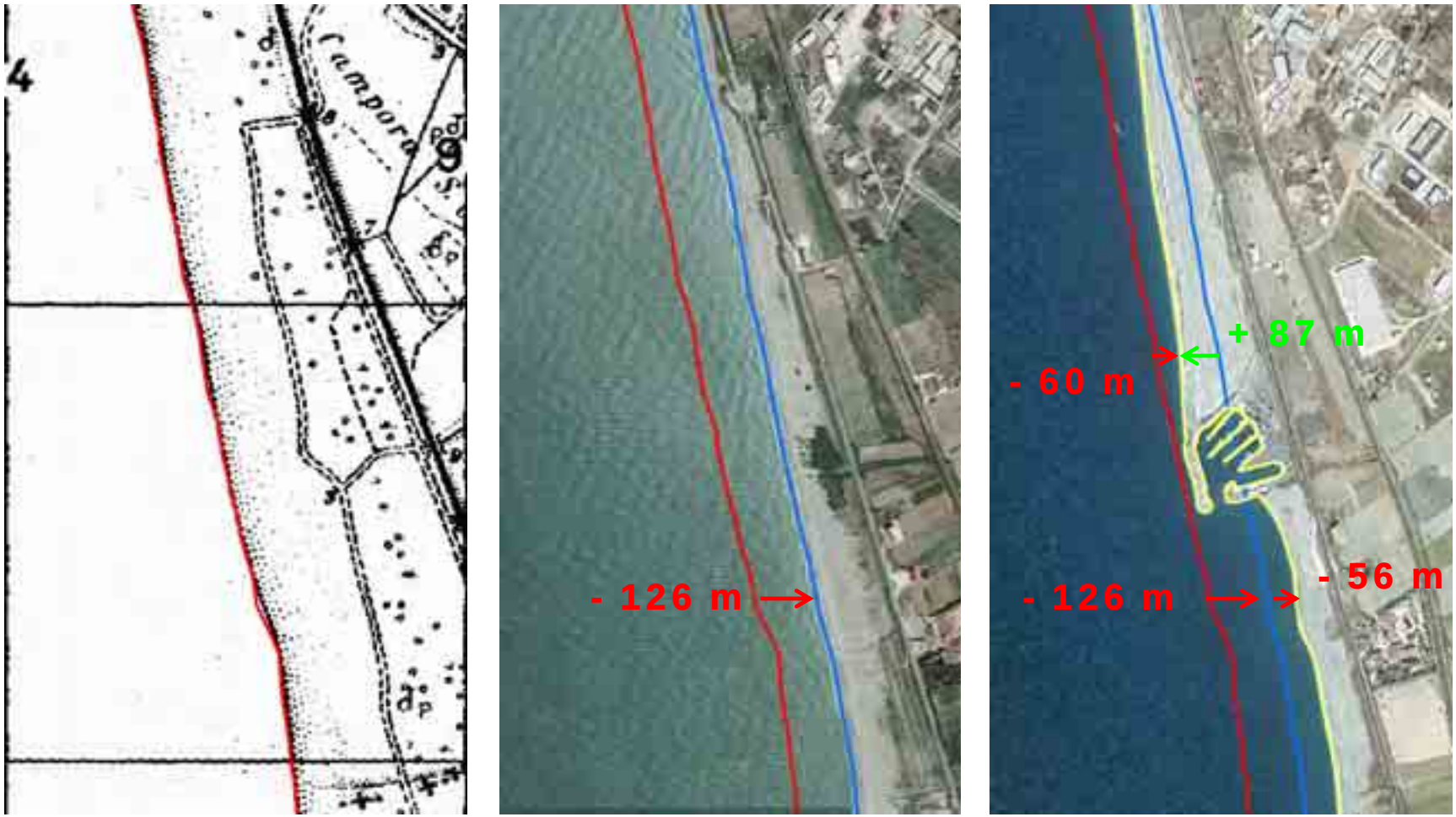
- Near 20 Km stretch of tyrrhenian coast between Amantea and Gizzeria

- Digitalization of shoreline, harbours and defence infrastructures

- Shoreline changes and morphodynamic evolution analysis

AREA 1 – Campora S. Giovanni harbour - Shoreline position analysis

IGM (1959) **ORTHOPHOTO (1999)** **IKONOS (2005)**



IGM Shoreline — Orthophoto Shoreline — Ikonos Shoreline

AREA 1 – Campora S. Giovanni harbour - Surface analysis

IKONOS - IGM

IKONOS - ORTHOPHOTO

Erosion

Progradation

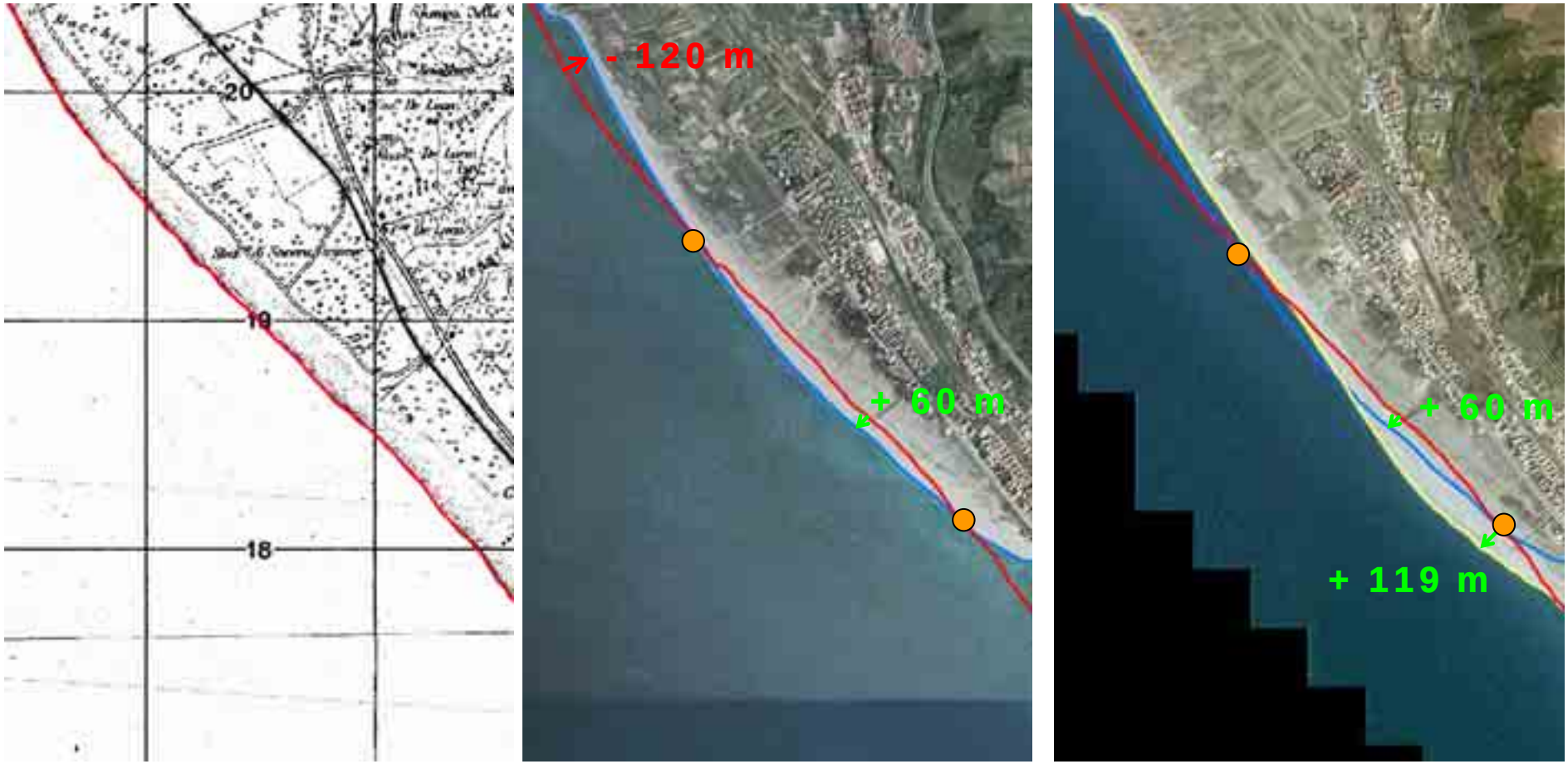
Ikonos shoreline

Orthophoto shoreline

IGM shoreline

AREA 2 – Nocera Tirinese - Shoreline position analysis

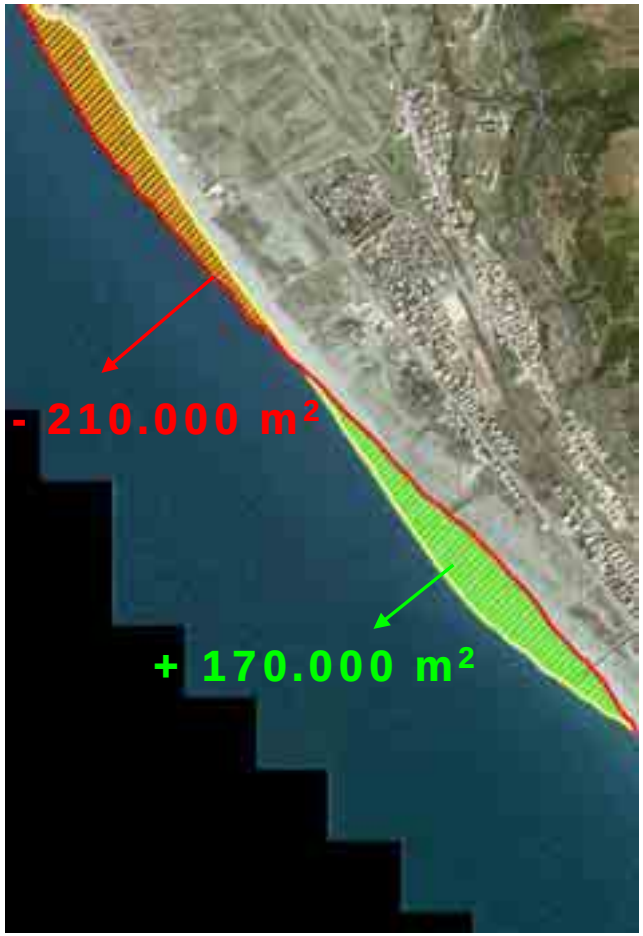
IGM (1959) **ORTHOPHOTO (1999)** **IKONOS (2005)**



IGM Shoreline Orthophoto Shoreline Ikonos Shoreline

AREA 2 – Nocera Tirinese - Surface analysis

IKONOS - IGM

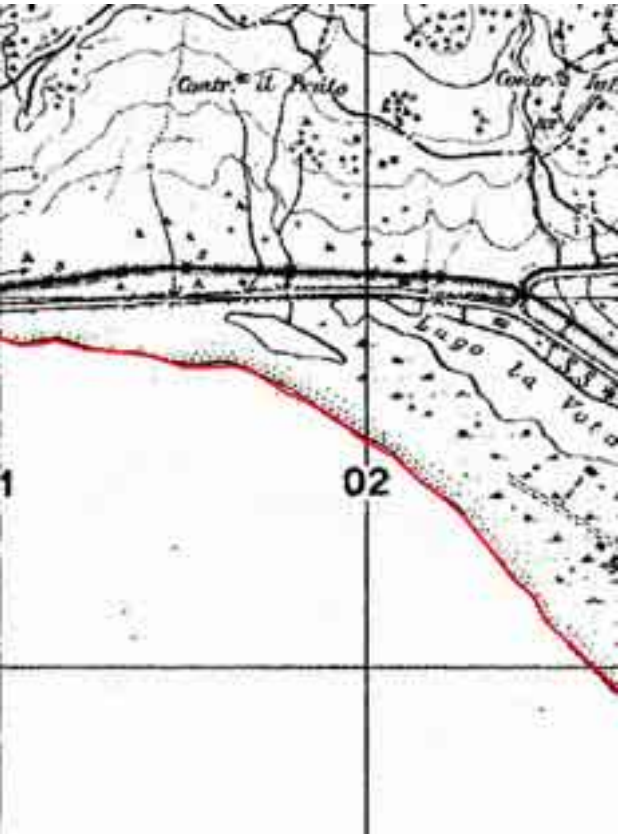


IKONOS - ORTHOPHOTO

Erosion
Progradation
Ikonos shoreline
Orthophoto shoreline
IGM shoreline

AREA 3 – "La Vota" coastal lake - Shoreline position analysis

IGM (1958) | **ORTHOPHOTO (1999)** | **IKONOS (2005)**



IGM Shoreline | Orthophoto Shoreline | Ikonos Shoreline

AREA 3 – "La Vota" coastal lake - Surface analysis

IKONOS - IGM

IKONOS – ORTHOPHOTO

Erosion
Progradation
Ikonos shoreline
Orthophoto shoreline
IGM shoreline

EXPERIMENTATION based on IKONOS Satellite Imagery

Conclusions and Perspectives

- High resolution remote sensing data have revealed to be suitable for multitemporal monitoring and for land change mapping

- On the experimental coastal zones, Ikonos satellite images have turned out to be particularly profitable for analysis of morphodynamic evolution and change in shoreline position

- The availability of Ikonos imagery for all the italian coasts would provide an up-to-date raster support, collatable with IGM charts and “It2000” orthophotos that are nowadays the only homogeneous data at national scale

EXPERIMENTATION: low flying perspective images

EXPERIMENTATION: low flying perspective images

Project

Environmental plane survey, with the acquisitions of several perspective images, to study of geomorphologic characteristics of the coastal sectors, anthropic pressure, harbour and coastal defence structures (groins, break water) dimension .

The aim

- VVideo and photo acquisitions from sea side to obtain the total coastal zone cover of the Ligurian Region.
- DDigital Data-base realization of the whole data acquired, that contains the information and the parameters of the photo and video acquisitions.
- GGIS software development to visualize and analyse the photos and video.

EXPERIMENTATION: low flying perspective images

STAGE 1
Preliminary plane overview

Due to the complexity of the study area we improve a first set of flight plan, also to set-up the instruments under different conditions.

As the instrument set-up are complete, a valuations of results will be carried out to expand the methodology to the whole Ligurian region.

EXPERIMENTATION: low flying perspective images

STAGE 1
Preliminary plane overview

The first preliminary flight was carried out along the coastal zone with 37 km range, from Genova to Cogoleto.

The whole Ligurian land complexity is well defined by the study area as listed below:

- Complex harbour structures (Genova seaport)
- Natural sectors, linear and indented structures
- River mouth
- Defence coastal structures
- Urban areas

EXPERIMENTATION: low flying perspective images

EXPERIMENTATION: low flying perspective images

STAGE 1
Instruments

Aeromobile

- helicopter SA318/ 5 seat
- average speed: 30-35 nods

-System

- GPS model Koden GPS-20

-Fotocamera

- Nikon D2x with 12.4 million pixel resolution

-Camera

-High definition digital camera 1920x1080

EXPERIMENTATION: low flying perspective images

STAGE 1
Flight plan – from Cogoleto to Genova

Prospective acquisitions:

- Flight altitude = 300 m

-Coastal line distance = 300m

- Broadcast angle = 45°

EXPERIMENTATION: low flying perspective images

STAGE 1
Detailed flight plane –Genova area

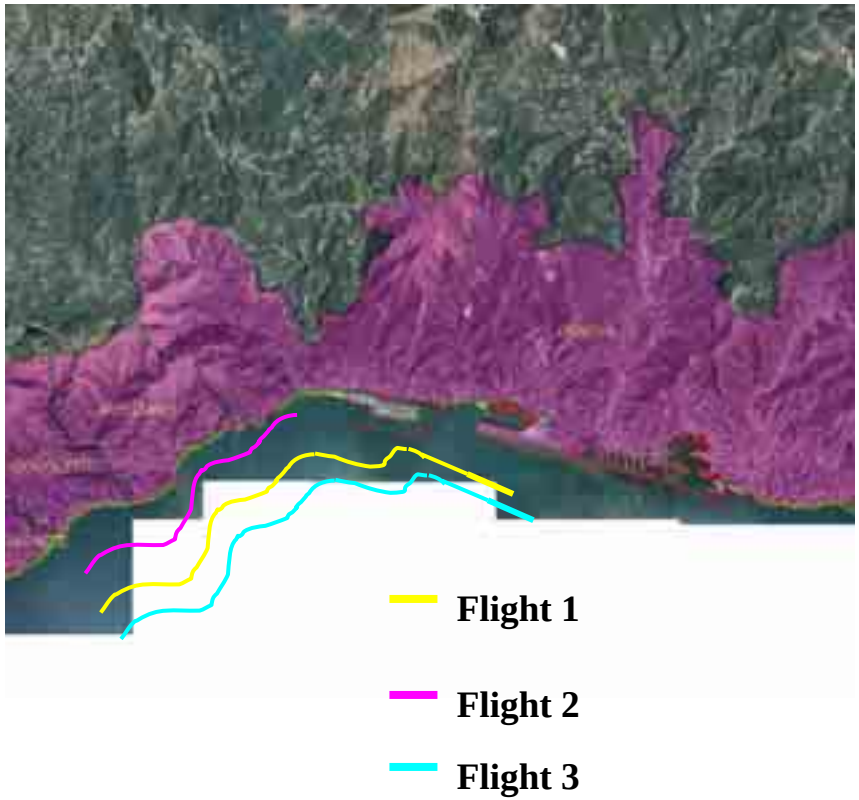
1st flight plane was set-up at 300m from the coastal line

2nd flight plane was set-up at 300m from port structures

Additional flight plane was set-up to analyse the complex structures as the ancient and commercial harbour etc.

EXPERIMENTATION: low flying perspective images

STAGE 1
Detailed flight plane– from Arenzano to Genova



Experimental sector used to set-up the best flight altitude, angle and distance.

Experimental flight parameters

Flight	Altitude	Coastal line distance	Broadcast angle
1	300 m	300 m	45°
2	150 m	200 m	45°
3	500 m	450 m	45°

EXPERIMENTATION: low flying perspective images

STAGE 1
Detailed fligth plane – from Arenzano to Cogoleto

Prospective acquisitions:

- Flight altitude = 150 m

-Coastal line distance = 200 m

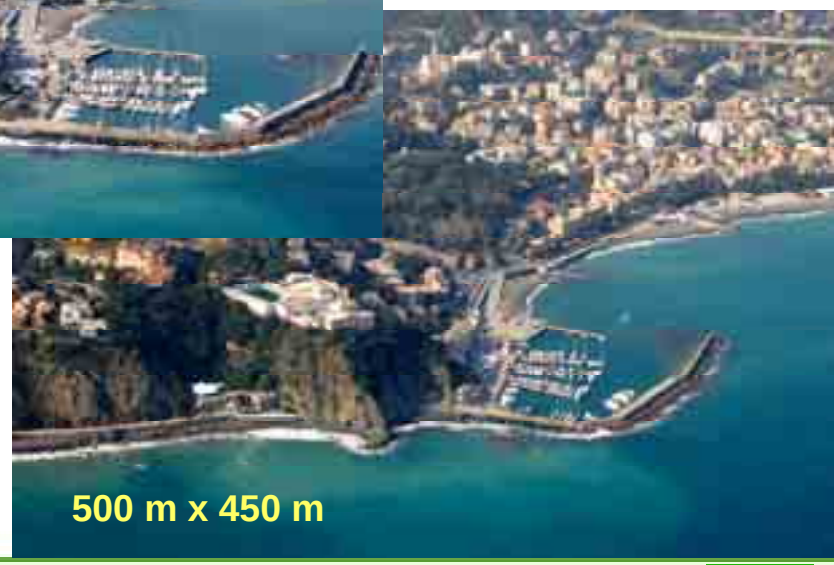
- broadcast angle = 45°

Two different photo-acquisitions procedures was improved:

✓Manual aiming

✓Auto aiming mainly based on the flight speed using GPS.

EXPERIMENTATION: low flying perspective images



EXPERIMENTATION: low flying perspective images

RESULTS

Digital data-base

- Mainly due to further improve the management and consulting of the acquired data set (image and video)

Software

- Interfaced with APAT and Ligurian Region GIS systems.

The system allow us to:

1. Easy access to the whole data base using:
   - text list, coordinate etc.
   - broadcast points vectorial selection
2. Viewing the selected images
3. viewing the movies of the selected images