



Agenzia nazionale per le nuove tecnologie,
l'energia e lo sviluppo economico sostenibile



CONFCOMMERCIO
IMPRESE PER L'ITALIA

“PERICOLO” MEDITERRANEO PER L'ECONOMIA DEL MARE

L'impatto dell'innalzamento delle acque per le attività turistico-balneari e marittimo-portuali

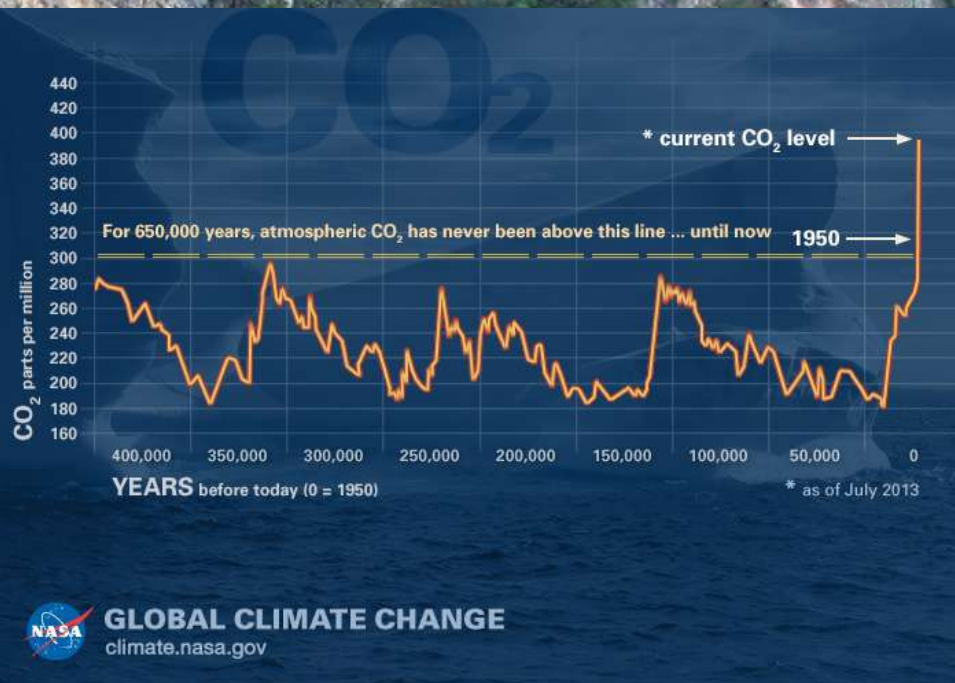


ENEA - Casaccia Laboratorio Modellistica Climatica e Impatti
Fabrizio.antonoli@enea.it

Sardegna, Golfo di Orosei

Solco di battente fossile, 125.000 anni fa:

+ 8 m, 290 parti per milione di CO²



Il Mare è destinato a salire...

CAUSE

**Solco di battente : OGGI
411 parti per milione di CO²**

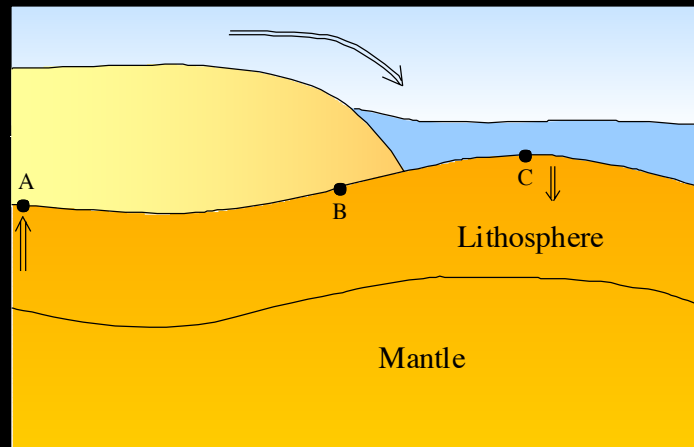
Le variazioni relative livello del **mare**

costituiscono la sommatoria di:

Eustatismo (Scioglim. Ghiacci + dilatazione termica) + **isostasia** + **tettonica**



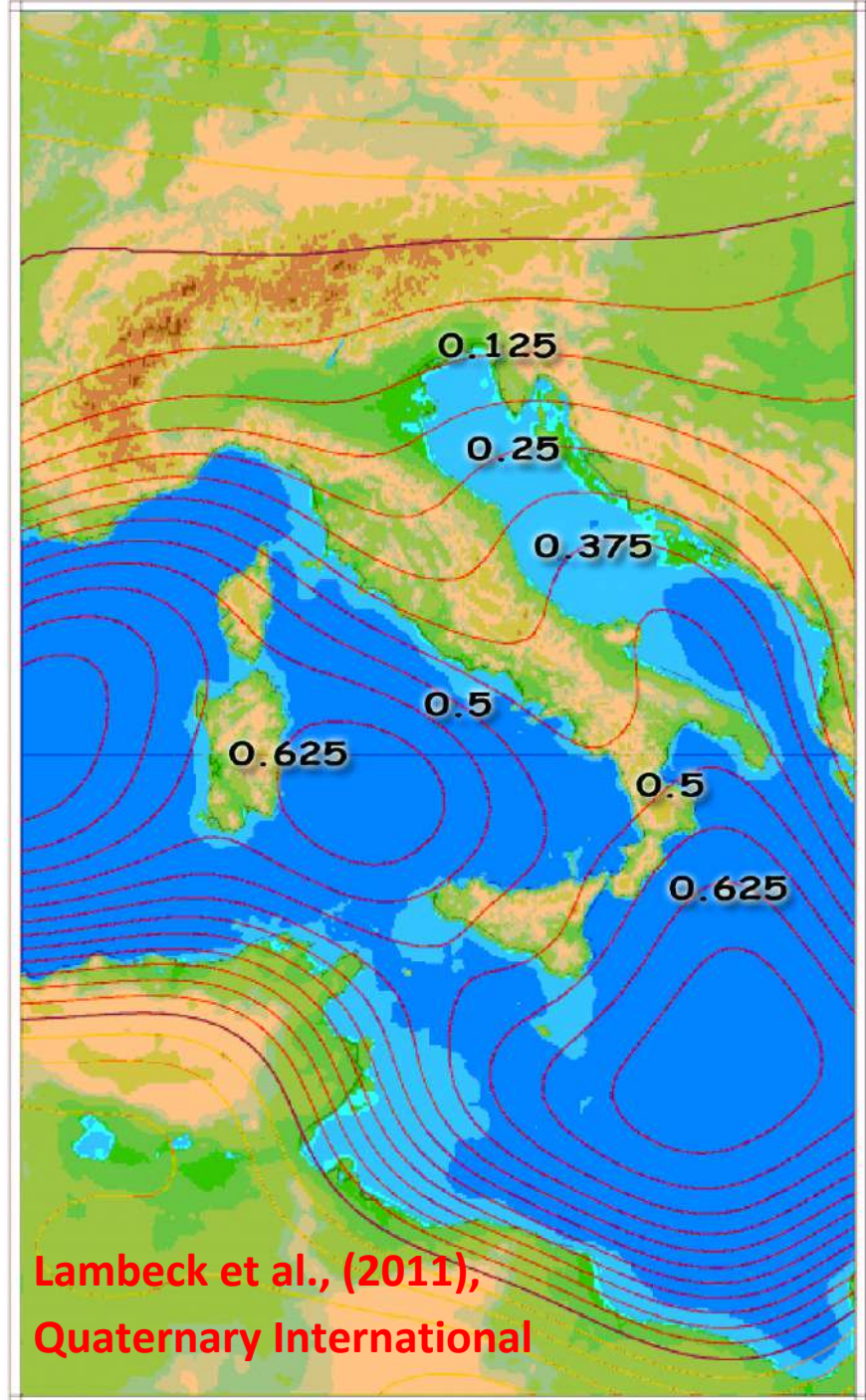
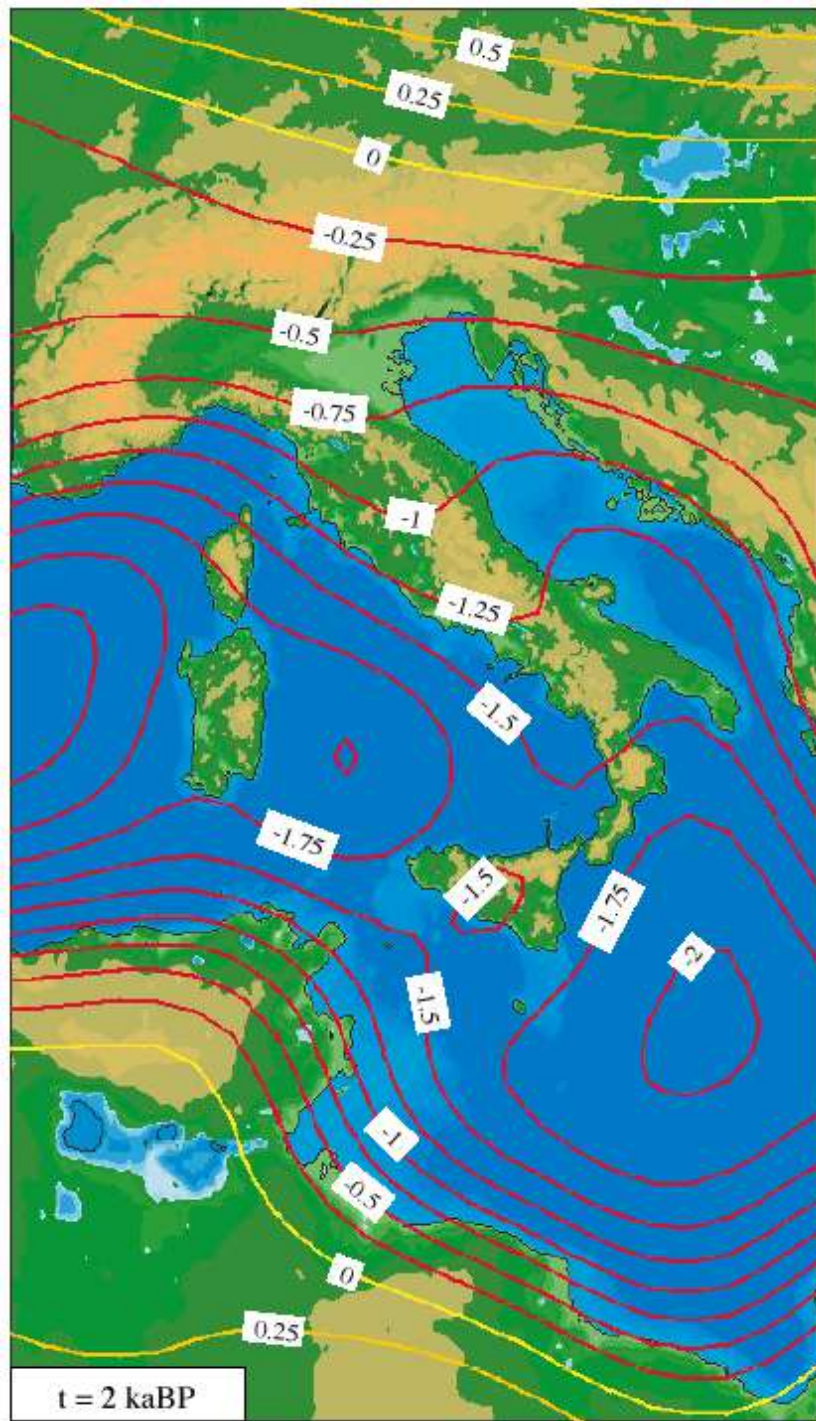
Scioglimento dei ghiacci e dilatazione termica



Isostasia



Tettonica e compattazione



Lambeck et al., (2011),
Quaternary International

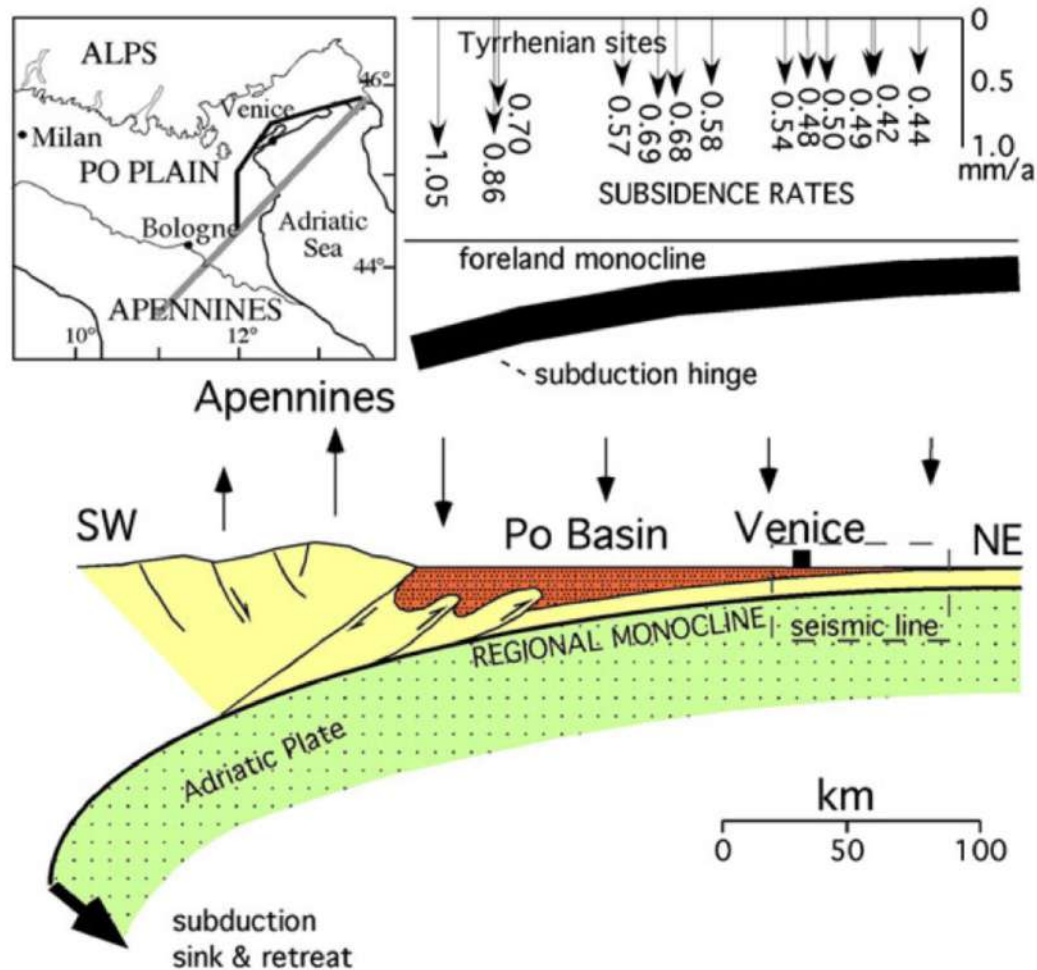
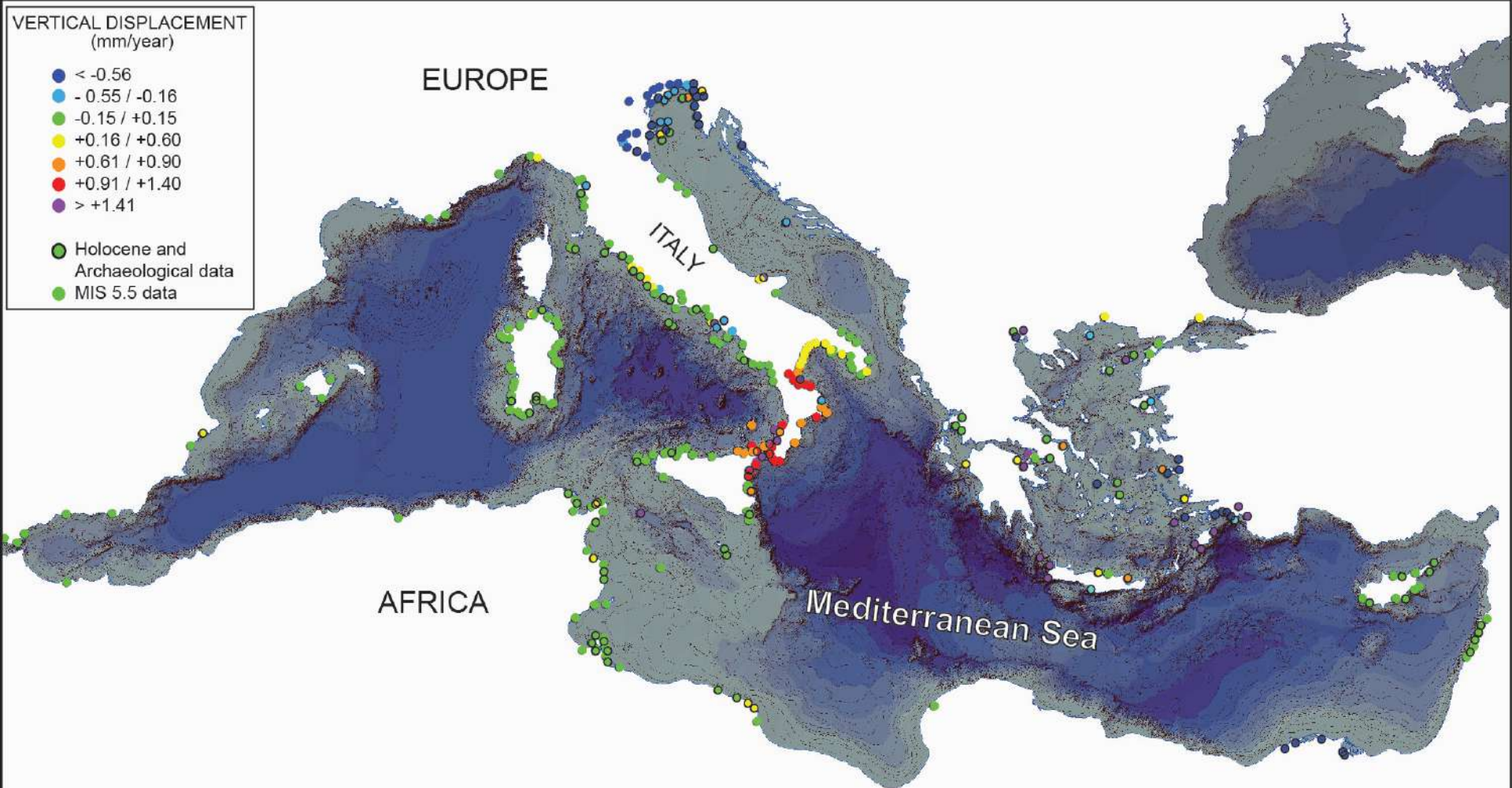


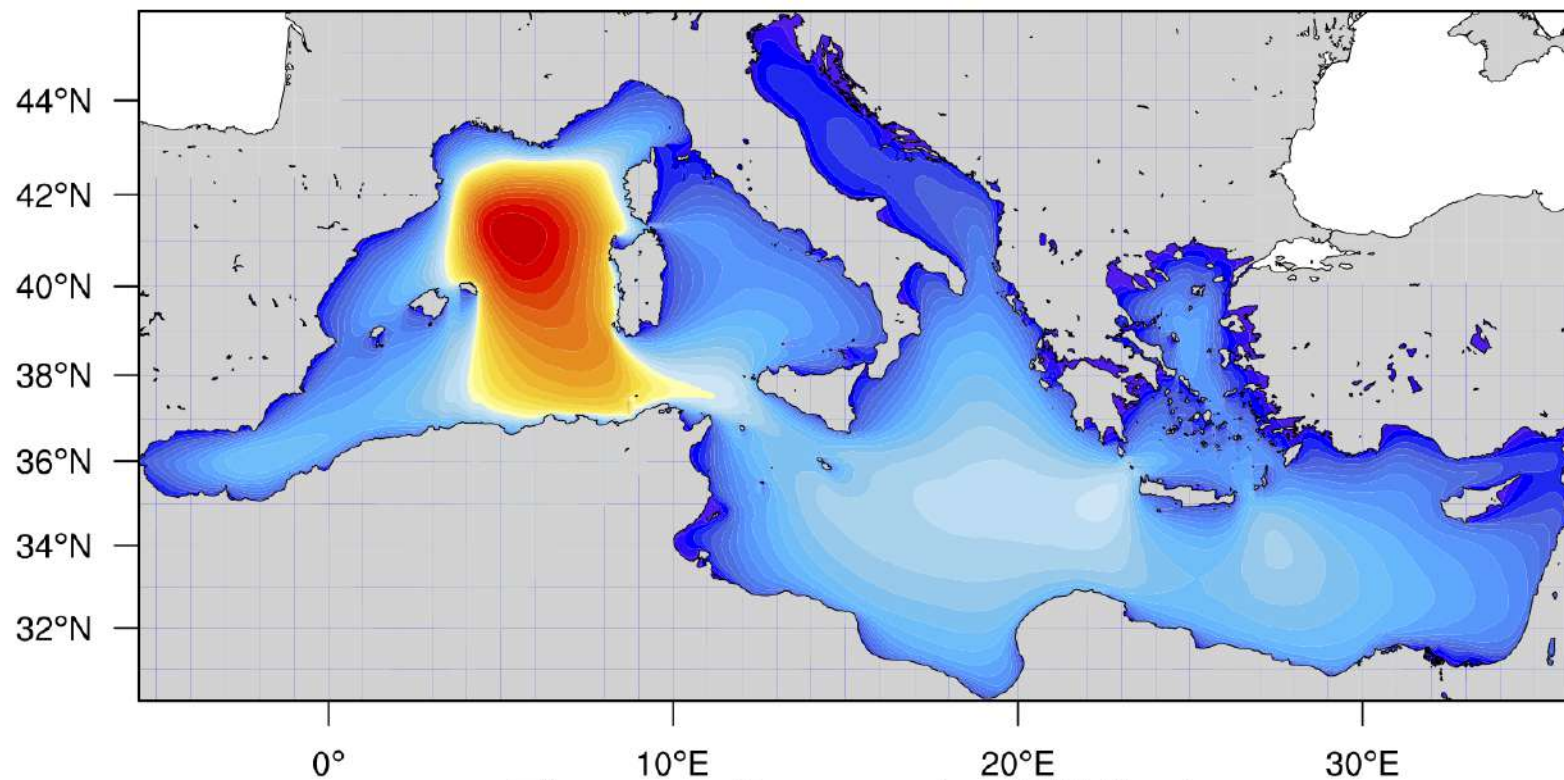
Fig. 10 Subsidence rates determined by the depth of the Tyrrhenian (MIS 5.5) layer cored mostly along the gray line running on the coast are displayed in the top panel (data after Antonioli et al. 2009). These rates indicate faster subsidence in the southwestern part of the profile, i.e., an asymmetric active subsidence, coherently with the independent data of the previous figure. The dip of the regional monocline in the northern Adriatic Sea recorded the faster subsidence to the southwest and it can be explained by the northeastward slab retreat of the Adriatic slab. The *dashed box* labeled as “seismic line” shows the position in this profile of the cross-section shown as Fig. 9

VERTICAL DISPLACEMENT
(mm/year)

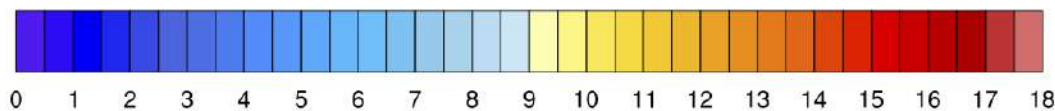
- < -0.56
- $-0.55 / -0.16$
- $-0.15 / +0.15$
- $+0.16 / +0.60$
- $+0.61 / +0.90$
- $+0.91 / +1.40$
- $> +1.41$

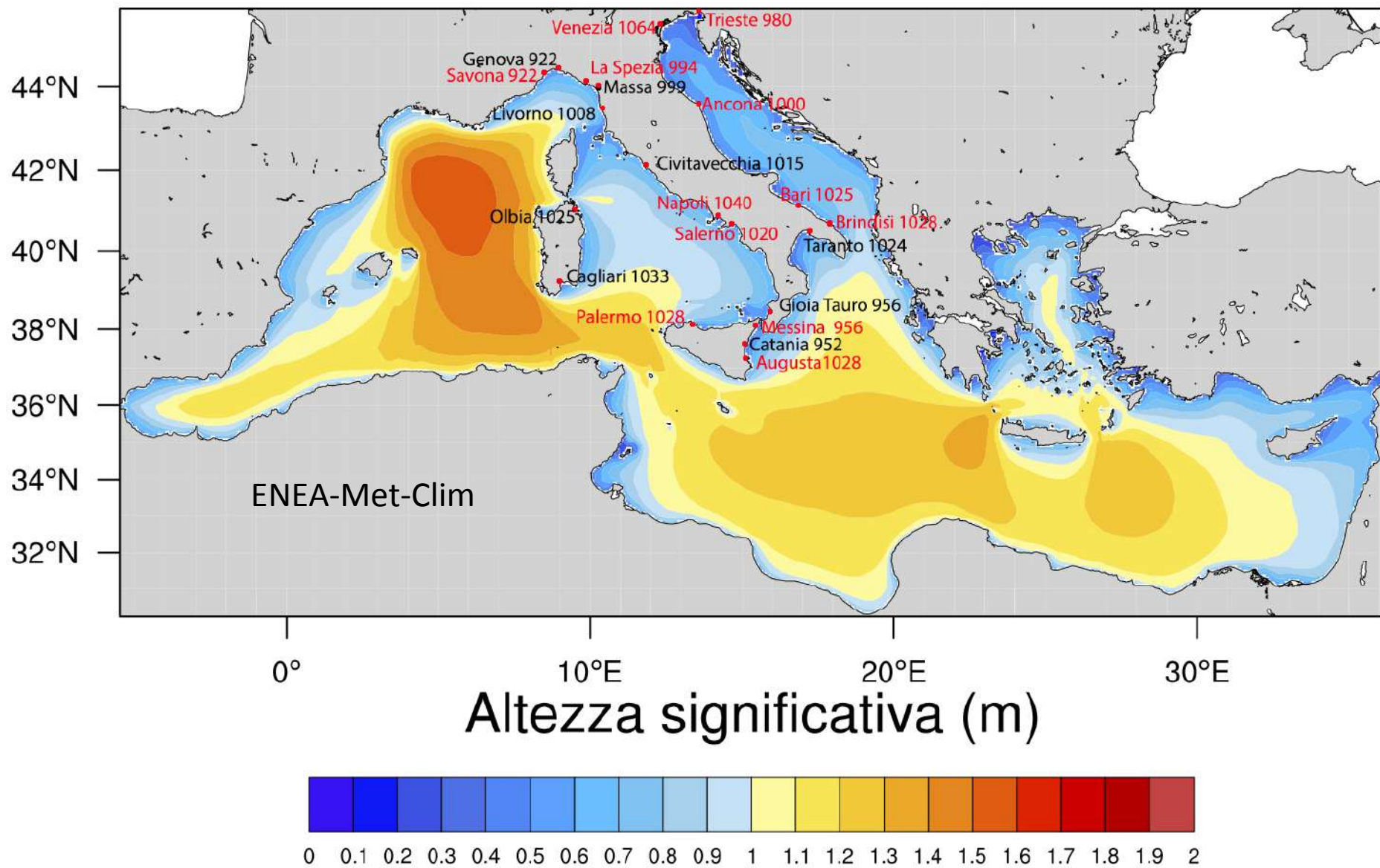
- Holocene and
Archaeological data
- MIS 5.5 data





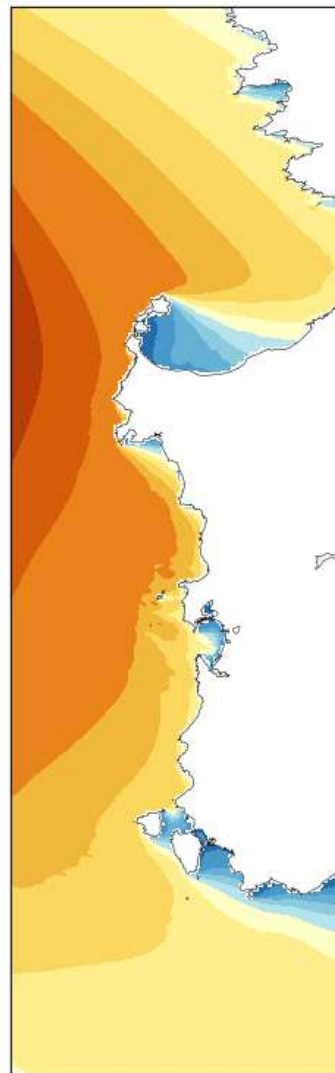
Flusso di energia (kW/m)



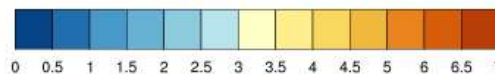


Forecast valid for 09 Jan 2019 at 00h
Init 08 Jan 2019 at 00h

ENEA-Met-Clim

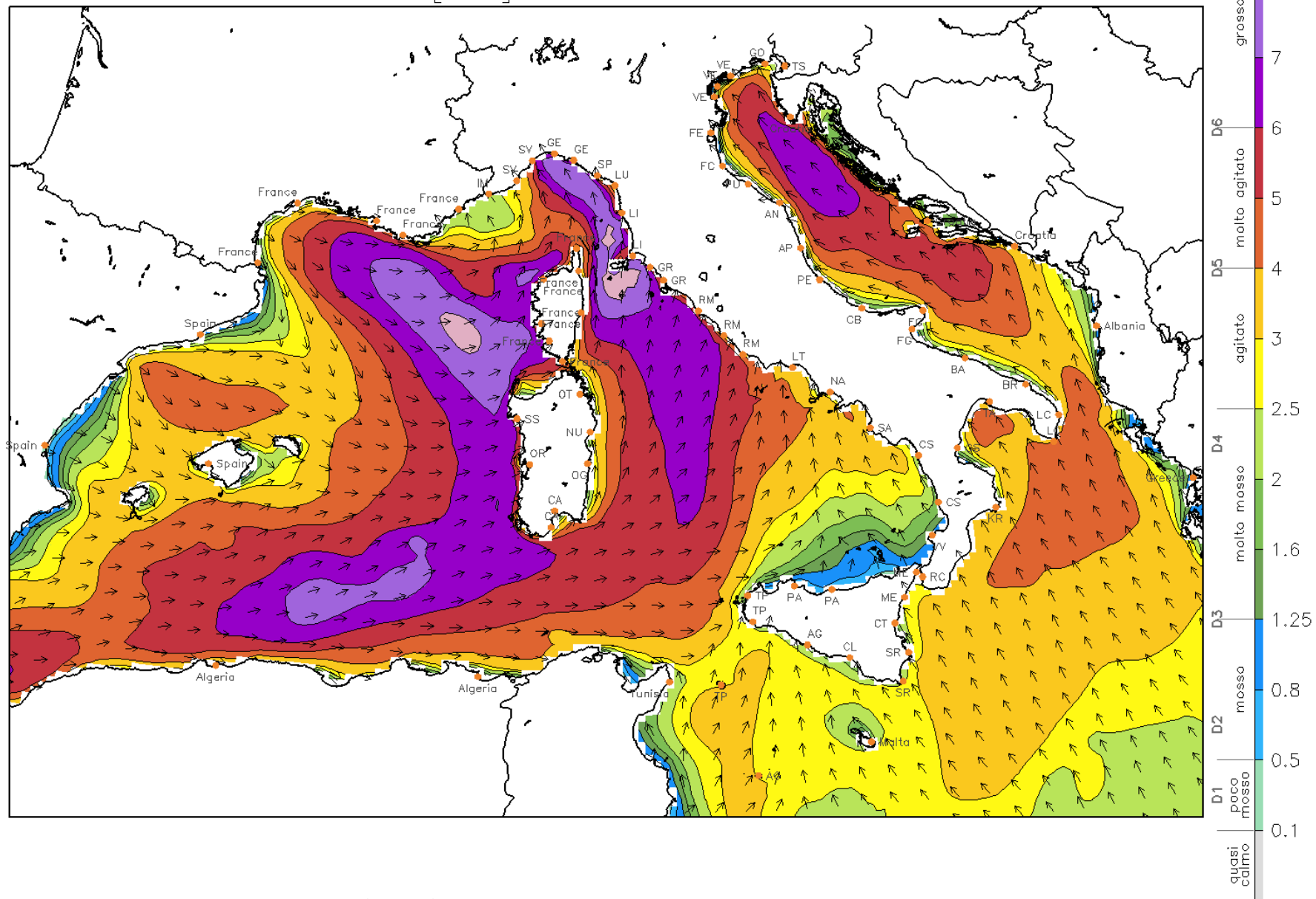


Significant Wave Height [m]



ARPAL (Genoa, Italy) – DICCA (Genoa, Italy)
Significant Wave Height [m], Mean Wave Direction [vectors]

18 [UTC] Mon 29 OCT $\tau = 18h$



Model: **WaveWatchIII** (NOAA)

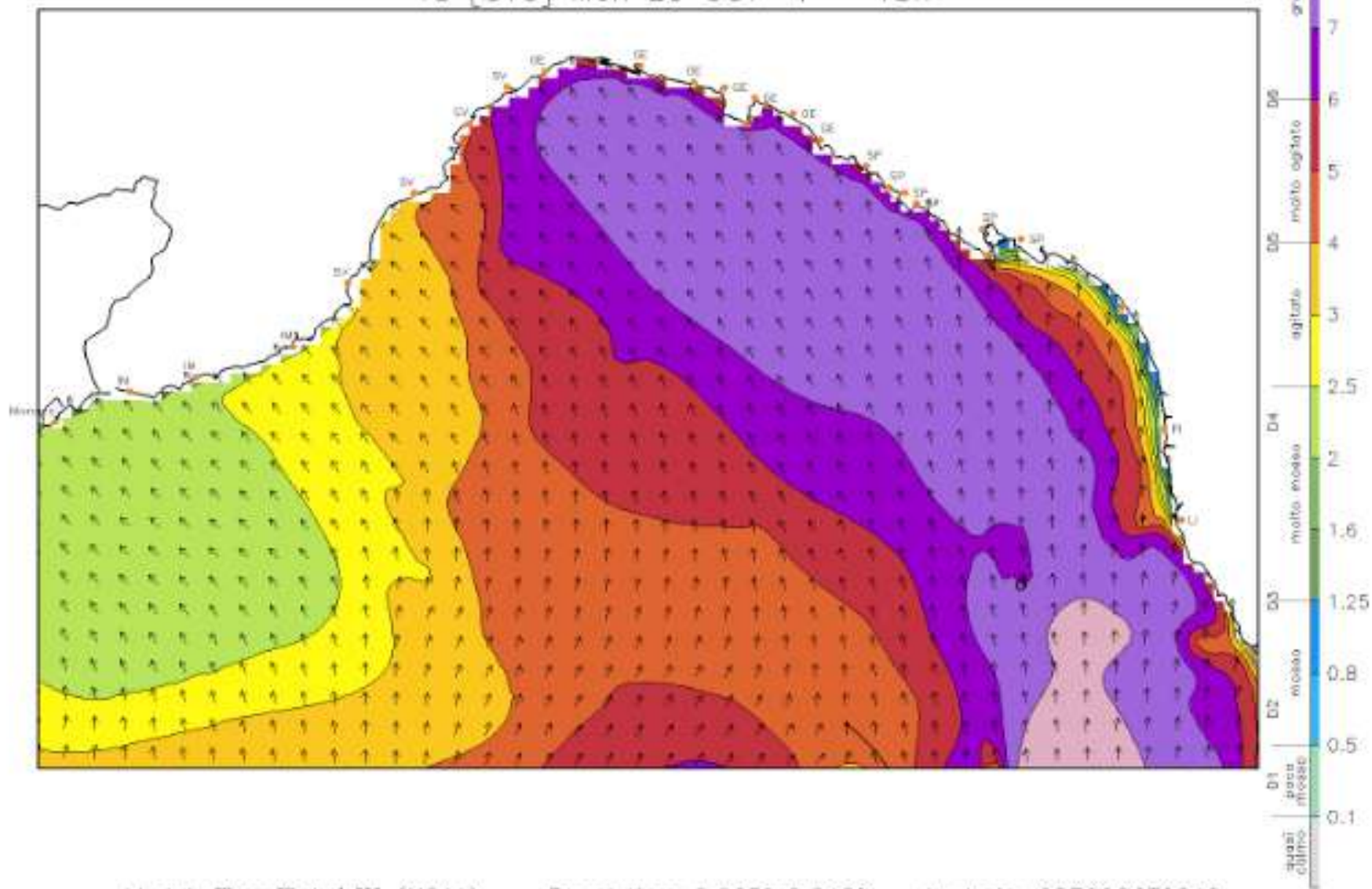
Resolution: 0.127°x0.090°

Analysis: 00Z29OCT2018

unendosi sono state in grado di amplificare l'effetto finale sulla costa.

ARPAL (Genoa, Italy) - DICCA (Genoa, Italy)
Significant Wave Height [m], Mean Wave Direction [vectors]

18 [UTC] Mon 29 OCT $\tau = 18h$



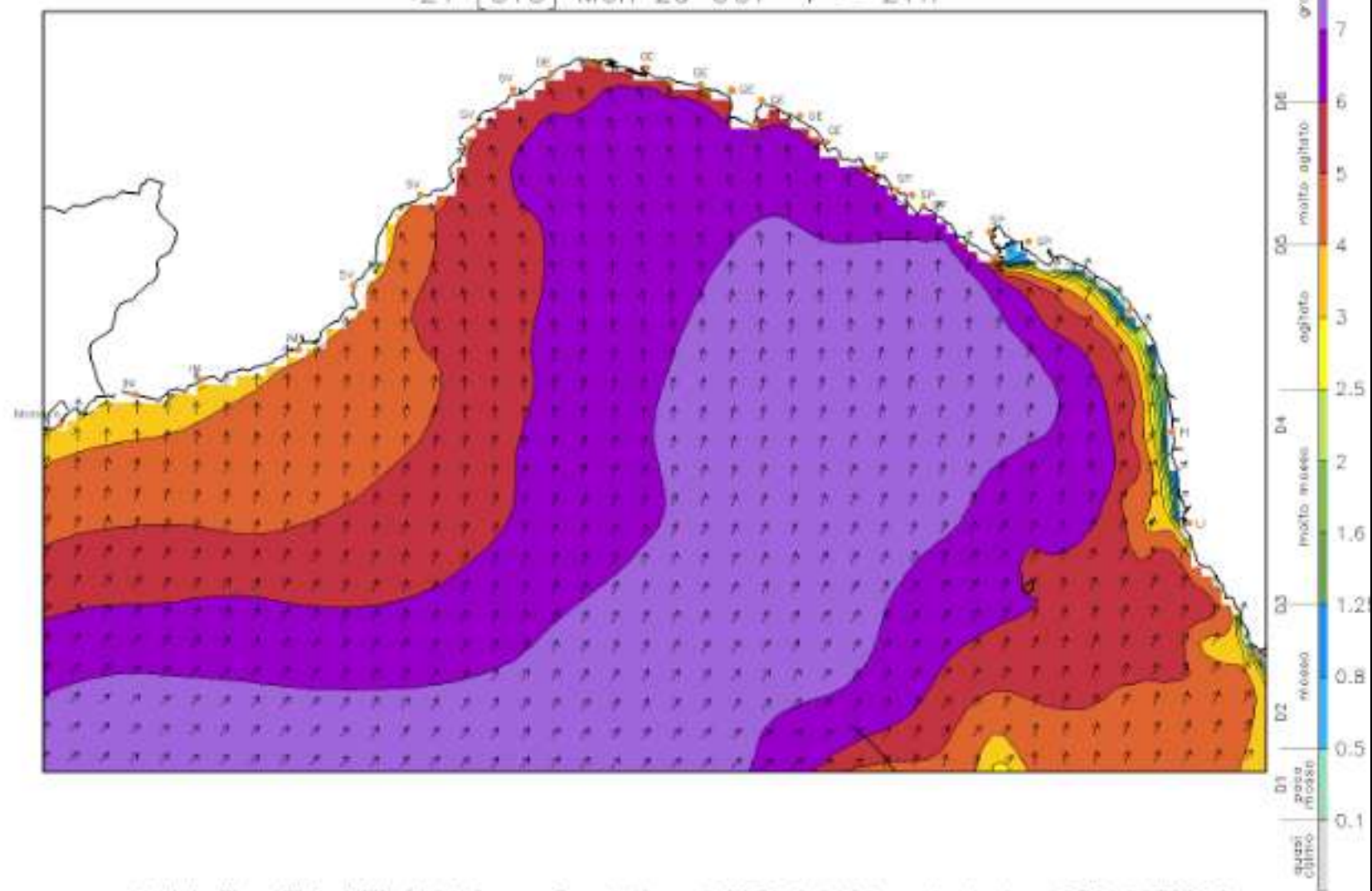
Model: WaveWatchIII (NOAA)

Resolution: $0.025^{\circ} \times 0.018^{\circ}$

Analysis: 00Z29OCT2018

ARPAL (Genoa, Italy) - DICCA (Genoa, Italy)
Significant Wave Height [m], Mean Wave Direction [vectors]

21 [UTC] Mon 29 OCT $\tau = 21$ h



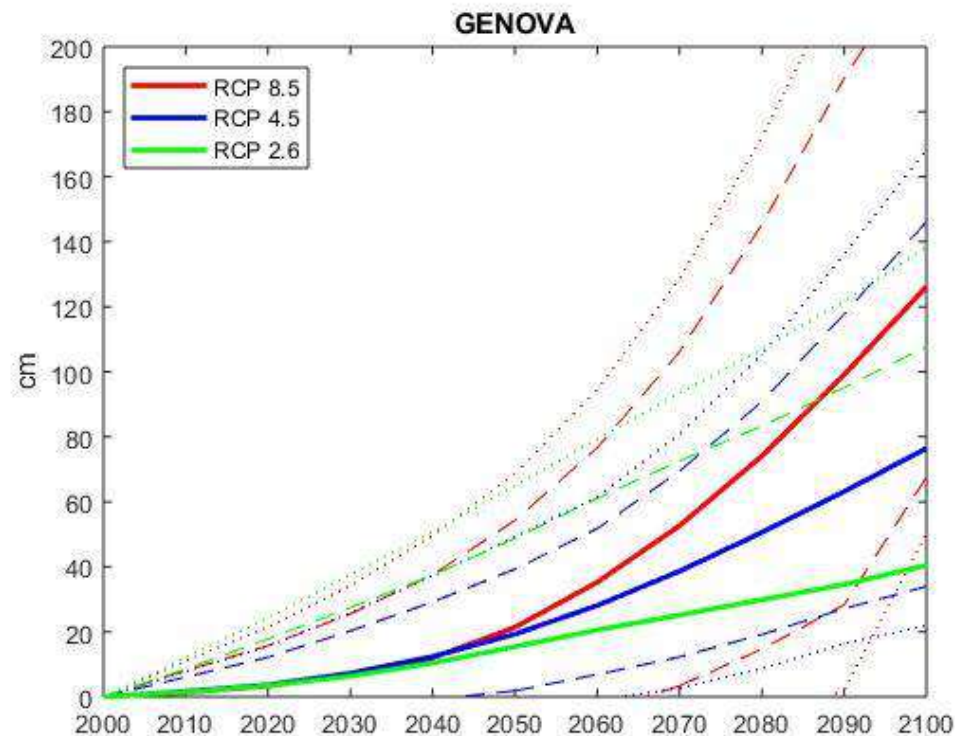
Model: WaveWatchIII (NOAA)

Resolution: 0.025°x0.018°

Analysis: 00Z29OCT2018



Schéma d'un phénomène de Vagues-submersion au passage d'une tempête



NUMERI

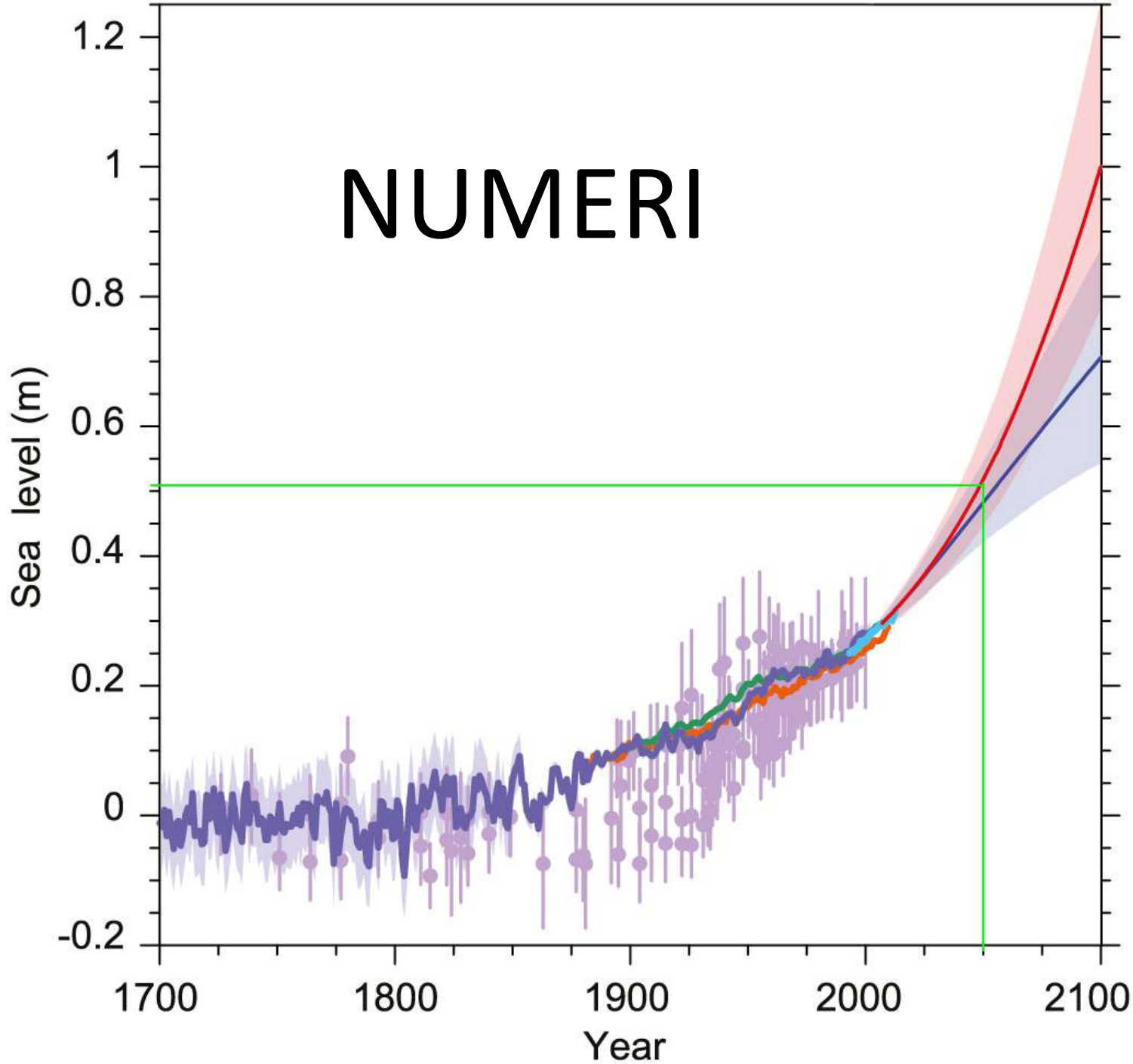


Table 2

1) Investigates area (see maps on [supplementary material S1, 2,3,4](#)). 2) Long term tectonic rates for the investigated areas. Isostatic rates (GIA). 4) the epoch of the LIDAR campaigns. 5, 6) Relative sea-level rise projections for the investigated regions at 2100 for the IPCC 8.5 scenarios minimum and maximum (with GIA and tectonic). 7) Maximum relative sea level rise projections for the investigated regions at 2100 (with GIA and tectonic) for the [Rahmstorf \(2007\)](#) model.

1) Area	2) Tectonic Vertical Movements mm/yr	3) Isostatic rates mm/yr	4) Base Map (year)	5) RSLR 2100 IPCC 8.5 min mm	6) RSLR 2100 IPCC 8.5 max mm	7) RSLR 2100 Rahmstorf max mm
North Adriatic - 1	−0.40	−0.12	2003	565	992	1409
North Adriatic - 2	−0.60	−0.13	2003	584	1011	1428
North Adriatic - 3	−0.95	−0.21	2008	594	999	1395
North Adriatic - 4	−0.78	−0.21	2008	579	983	1379
Gulf of Taranto	+0.14	−0.45	2008	516	921	1317
Gulf of Cagliari	0.00	−0.58	2007	547	956	1356
Gulf of Oristano	0.00	−0.62	2008	545	949	1345

Proiezioni di sollevamento del mare			
AREA	IPCC 2013 8.5 min scenario (cm)	IPCC 2013 8.5 max scenario (cm)	Rahmstorf 2007 max scenario (cm)
North Adriatic - area 2	58,4	101,1	142,8
Gulf of Oristano	54,5	94,9	134,5
Gulf of Taranto	51,6	92,1	131,7
Gulf of Cagliari	54,7	95,6	135,6

Tabella 2: proiezione in centimetri della risalita del livello del mare attesa nelle diverse aree in studio, da Antonioli et al., 2016.

Area	IPCC 2013 scenario 8.5 700 PPM CO ²		Rahmstorf 2007 scenario	
	km ²	distance (m)	km ²	distance (m)
a) Nord Adriatico	4957,6	59132,1	5451,7	61280,4
b) Golfo di Taranto	2,26	903,6	4,2	1730,6
c) Golfo di Oristano	104,20	9787,3	124,5	10374,5
d) Golfo Cagliari	54,00	9137,5	61,2	12358,2

Tabella 3 : previsione dei Km² allagati nelle 4 aree studiate da ENEA e RITMARE e distanza della linea di riva prevista nel 2100 rispetto a quella attuale, da Antonioli et al., 2016.

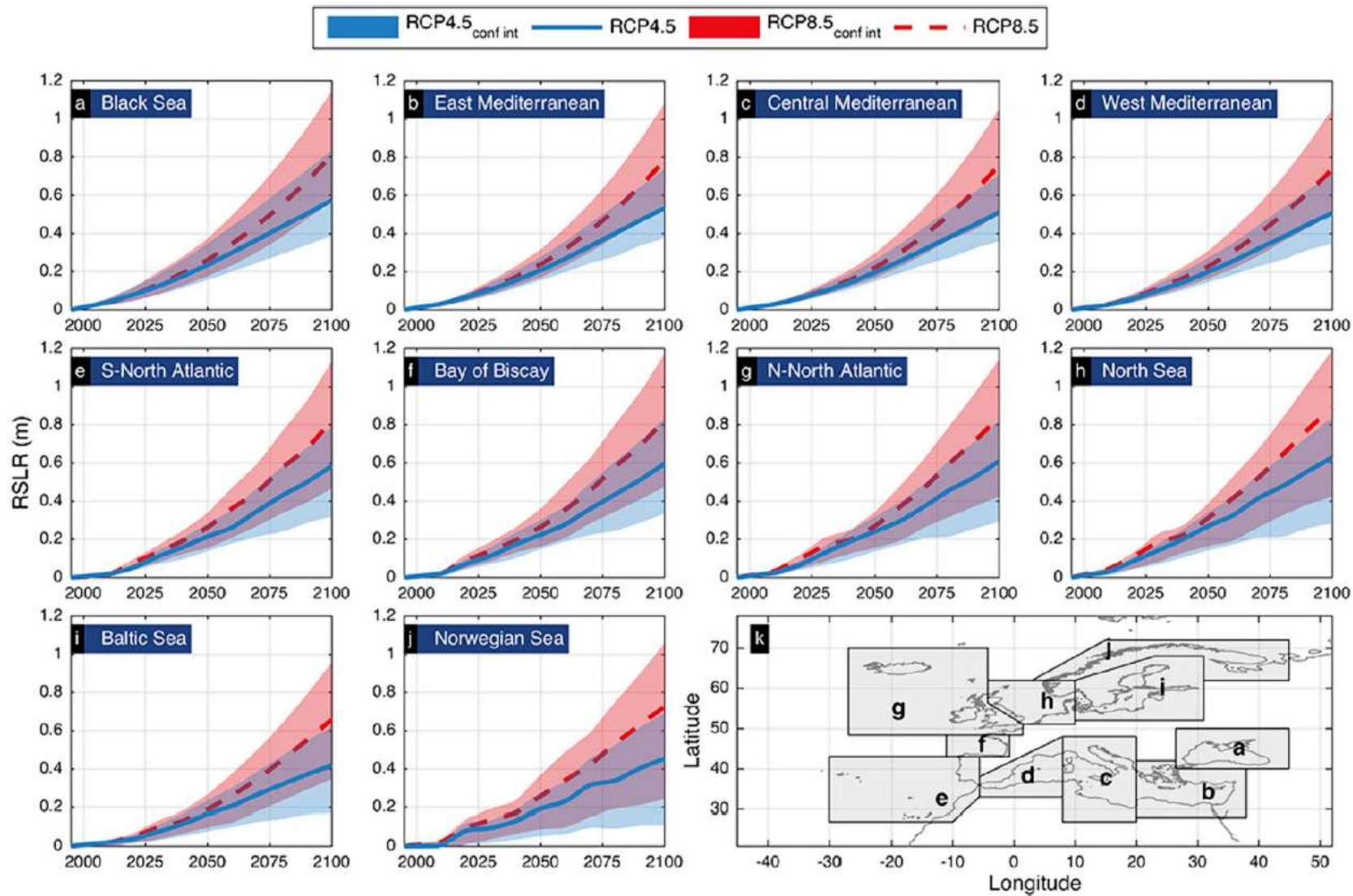


Figure 2

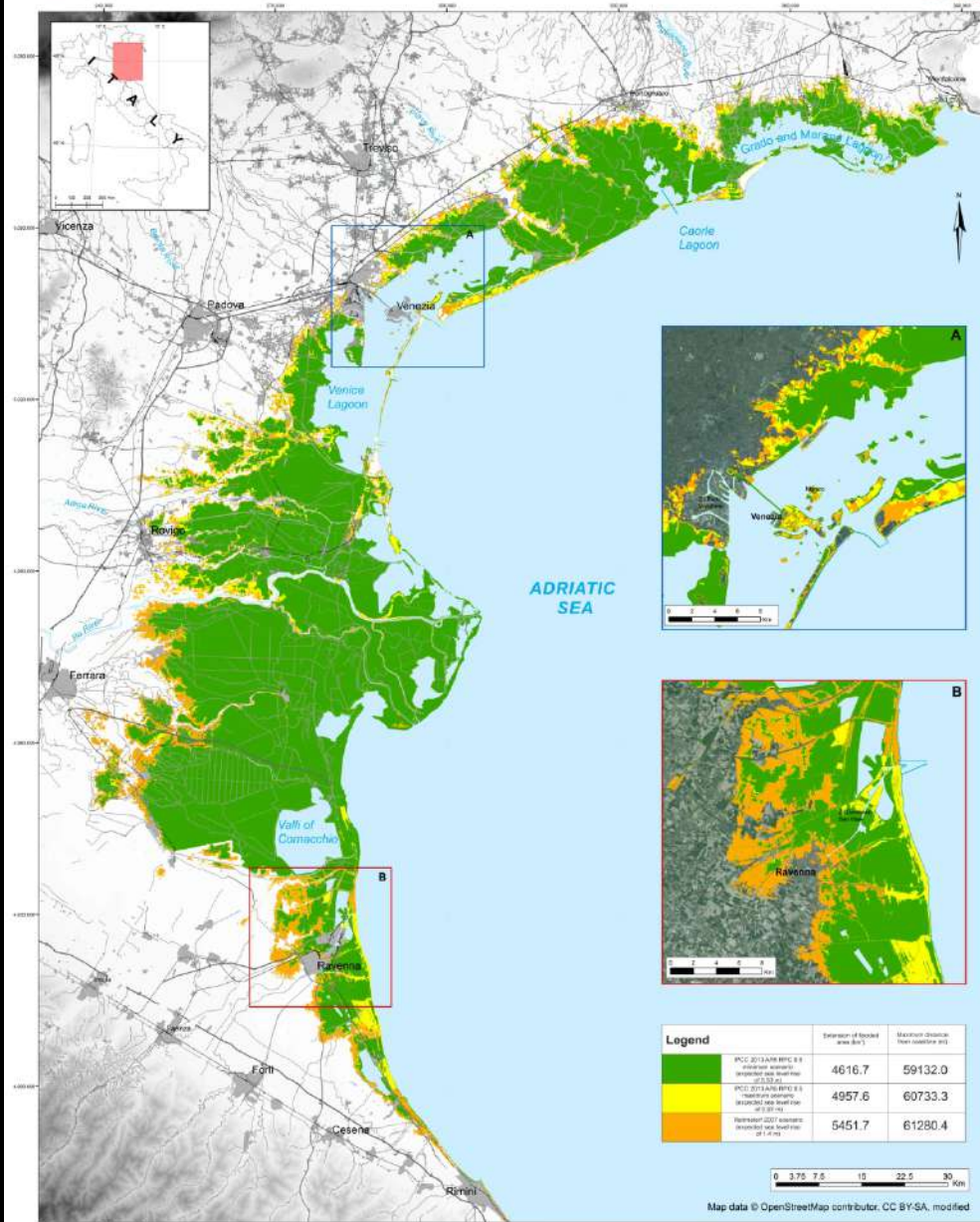
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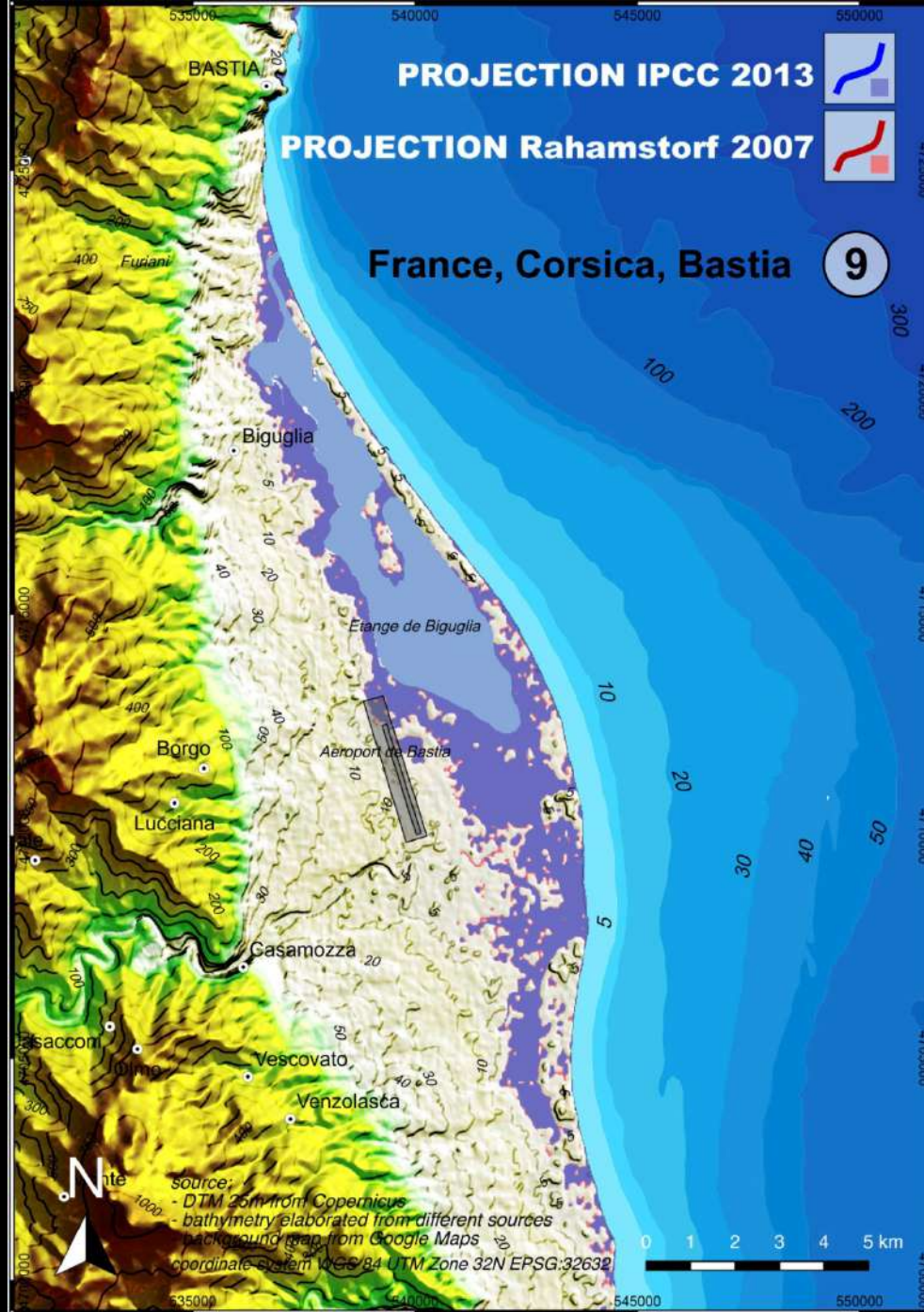
FLOODING SCENARIO AT FOUR ITALIAN COASTAL PLAINS USING THREE RELATIVE SEA LEVEL RISE MODELS: THE NORTH ADRIATIC AREA

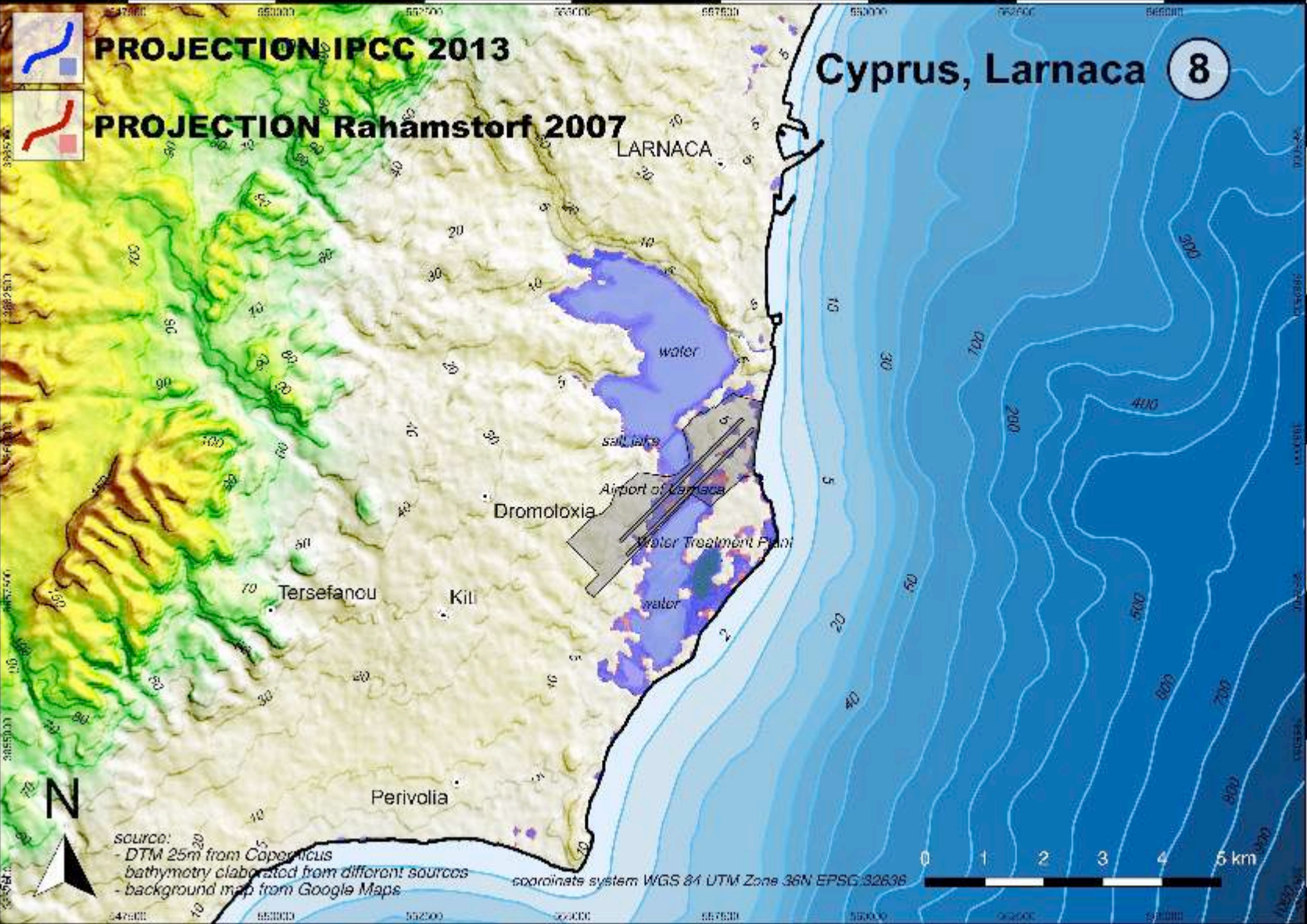


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A. Fontana⁷, G. Fontolan⁸, M. Moretti⁹, P. Orru⁹, G. Sannino², E. Serpelloni¹⁰, A. Vecchio⁶, G. Mastroruzzi¹

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PROJECTION IPCC 2013

PROJECTION Rahamstorf 2007

Cyprus, Larnaca

8

LARNACA

Airport of Larnaca

Water Treatment Plant

Dromoloxia

Tersefanou

Kili

Perivolia

water

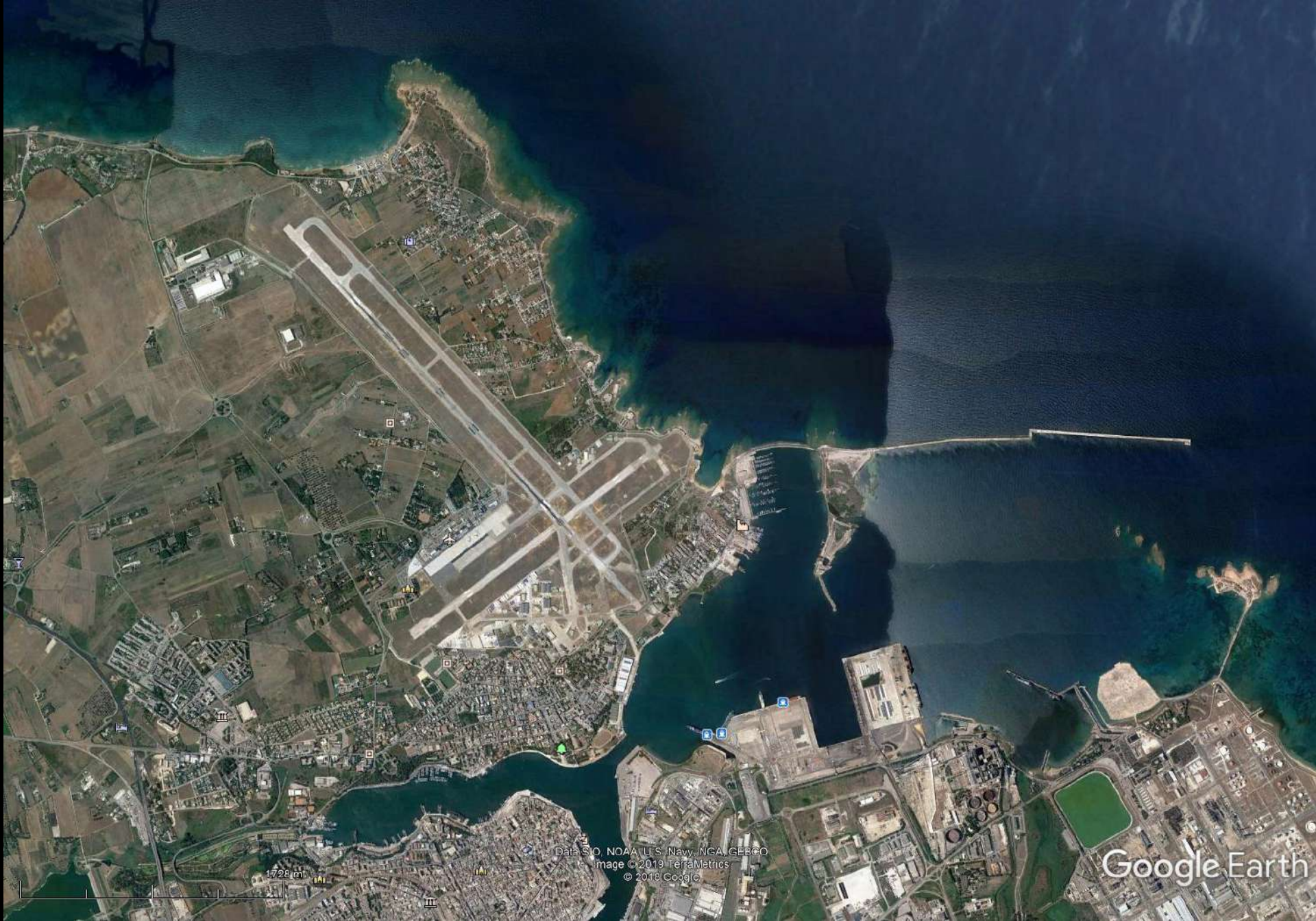
salt lake

water

source:
- DTM 25m from Copernicus
- bathymetry elaborated from different sources
- background map from Google Maps

coordinates system WGS 84 UTM Zone 36N EPSG:32636

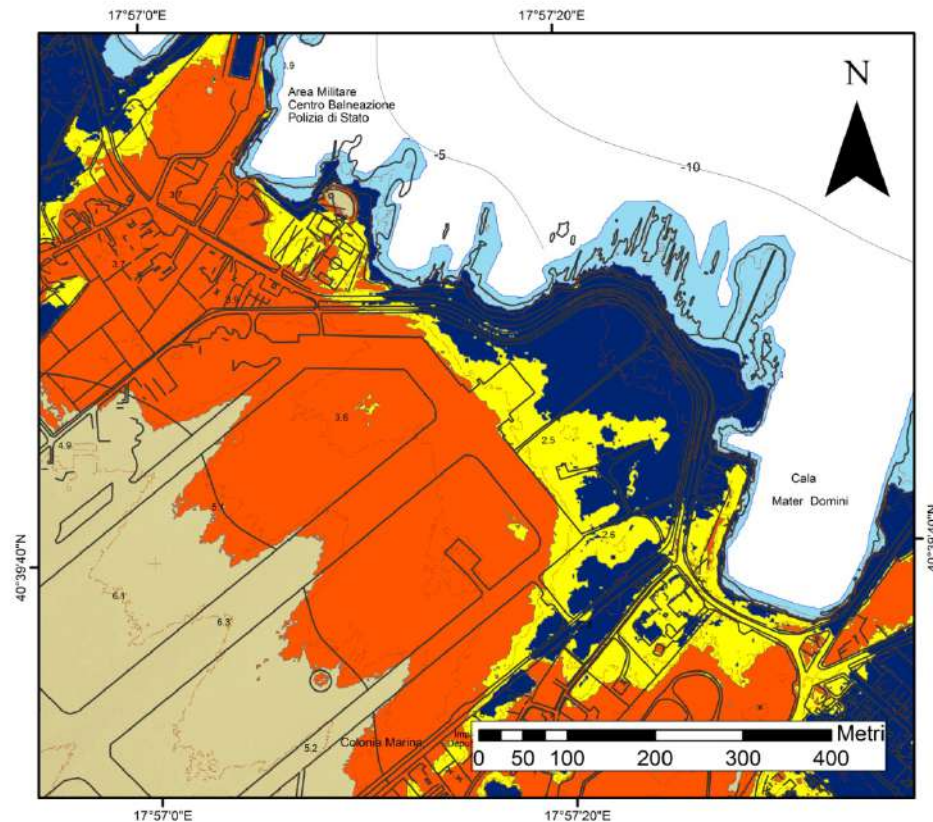
0 1 2 3 4 5 km



Data S.O. NOAA U.S. Navy NGA GEBCO
Image © 2019 TerraMetrics
© 2018 Google

Google Earth

Livello del mare = 1.0 m
 Ampiezza di marea = 0.2 m
 Surge = 0.3 m
 Altezza d'onda = 4.5 m



Legenda

- Isoipse
- CTR
- Isobate

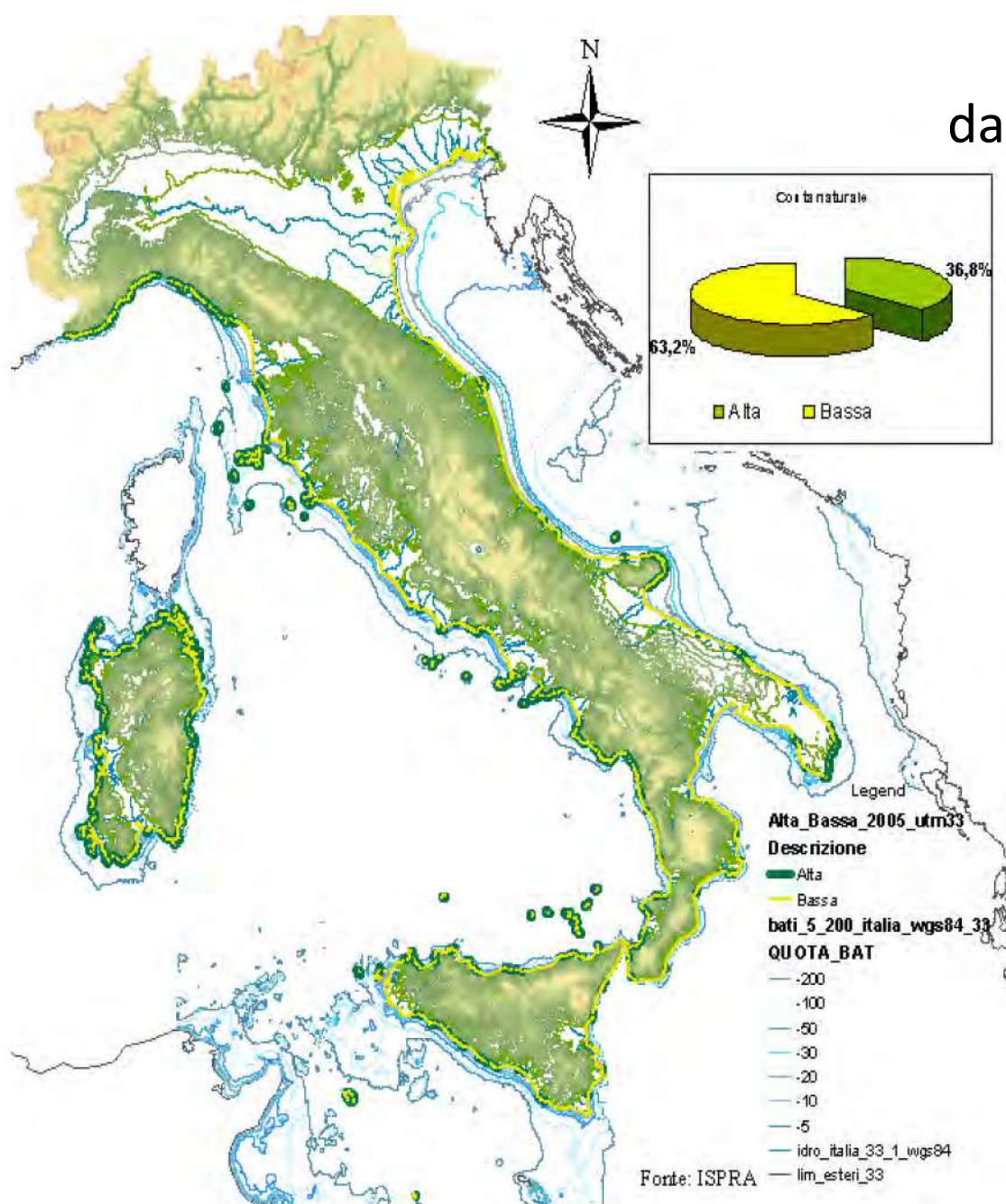
Modelli di inondazione

- Superficie di sommersione
- Modello Stockdon et al., 2006 - Ru 2%
- Modello Holman 1986 - Ru 2%
- Modello Mase 1989 - Ru 2%

LIDAR_BRINDISI

- Quota (m)
- 122
 - 97
 - 72
 - 47
 - 22
 - 0

Erosione da report ISPRA 2017



CAPITOLO 5

MARE E AMBIENTE COSTIERO

Introduzione



Direzione generale per la salvaguardia del territorio e delle acque

L'EROSIONE COSTIERA IN ITALIA

LE VARIAZIONI DELLA LINEA DI COSTA DAL 1960 AL 2012



Elaborazione nazionale dei dati sulle superfici e sui tratti di spiaggia in avanzamento e in arretramento della costa dell'Italia peninsulare, della Sicilia e della Sardegna dal 1960 al 1994 e al 2012. Agg. Mar2017.



VARIAZIONE DELLA LINEA DI COSTA DELL'ITALIA PENINSULARE DAL 1960 AL 2012

regione	superfici (kmq)		tratti costieri (km)		bilancio delle superfici (kmq)
	arretramento	avanzamento	arretramento	avanzamento	
ABRUZZO	1,3	1,9	39,9	38,0	0,6
BASILICATA	2,0	1,3	20,0	19,8	-0,3
CALABRIA	12,3	9,1	342,2	237,6	-3,2
CAMPANIA	3,7	2,0	86,0	61,3	-1,7
EMILIA R	20,0*	6,2	63,6	62,3	-13,8
FRIULI VG	1,1	3,2	32,1	30,3	2,1
LAZIO	2,4	4,9	77,3	131,4	2,5
LIGURIA	1,3	1,8	46,3	67,6	0,5
MARCHE	3,2	1,9	67,1	60,0	-1,3
MOLISE	1,5	0,7	14,3	19,3	-0,8
PUGLIA	4,3	3,7	128,2	121,7	-0,5
SARDEGNA	1,5	0,9	90,3	61,0	-0,5
SICILIA	13,4	5,9	363,9	187,9	-7,5
TOSCANA	6,1	5,2	88,7	87,0	-0,8
VENETO	17,9**	7,5***	70,0	80,7	-10,3
Totale complessivo	91,9	56,6	1534,4	1306,4	-35,3

* di cui arretramento Delta F. Po EMR 10.7 kmq

** di cui arretramento Delta F. Po VEN 16.2 kmq

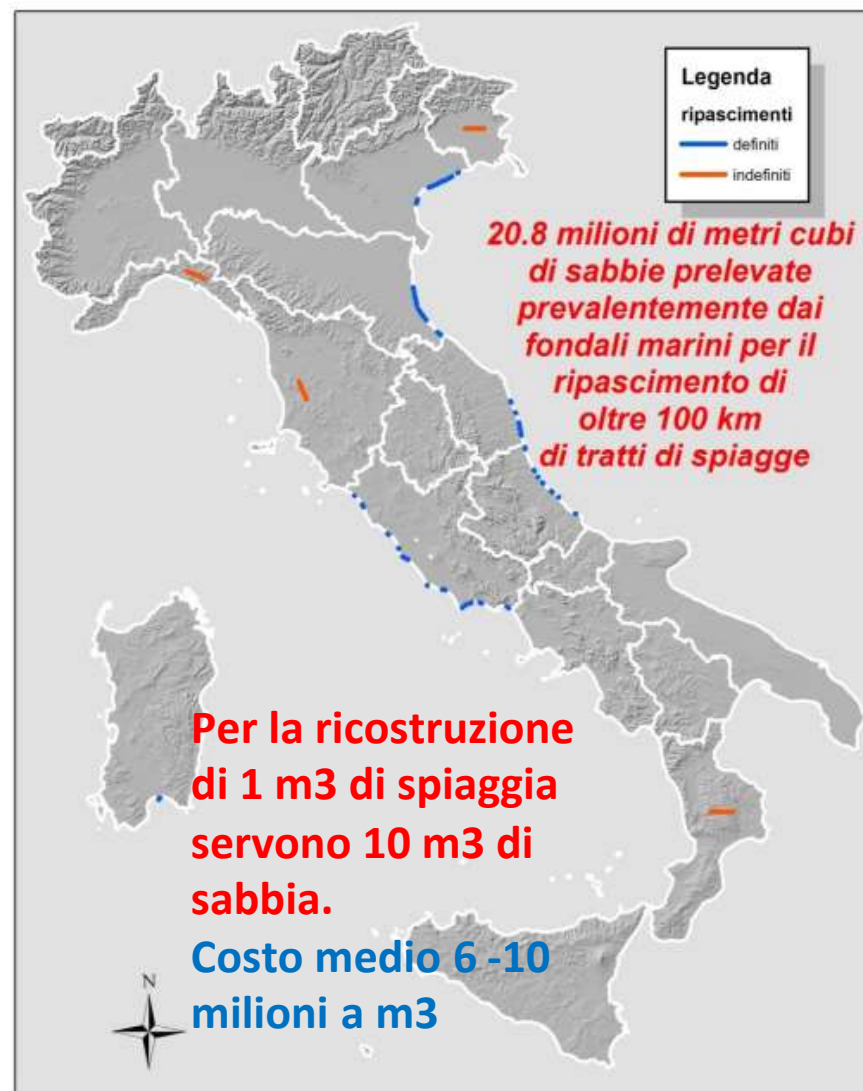
*** di cui avanzamento Delta F. Po VEN 3.1 kmq

Bilancio complessivo superfici Km2: -35,3%

LE VARIAZIONI DELLA LINEA DI COSTA ITALIANA 1960-2012



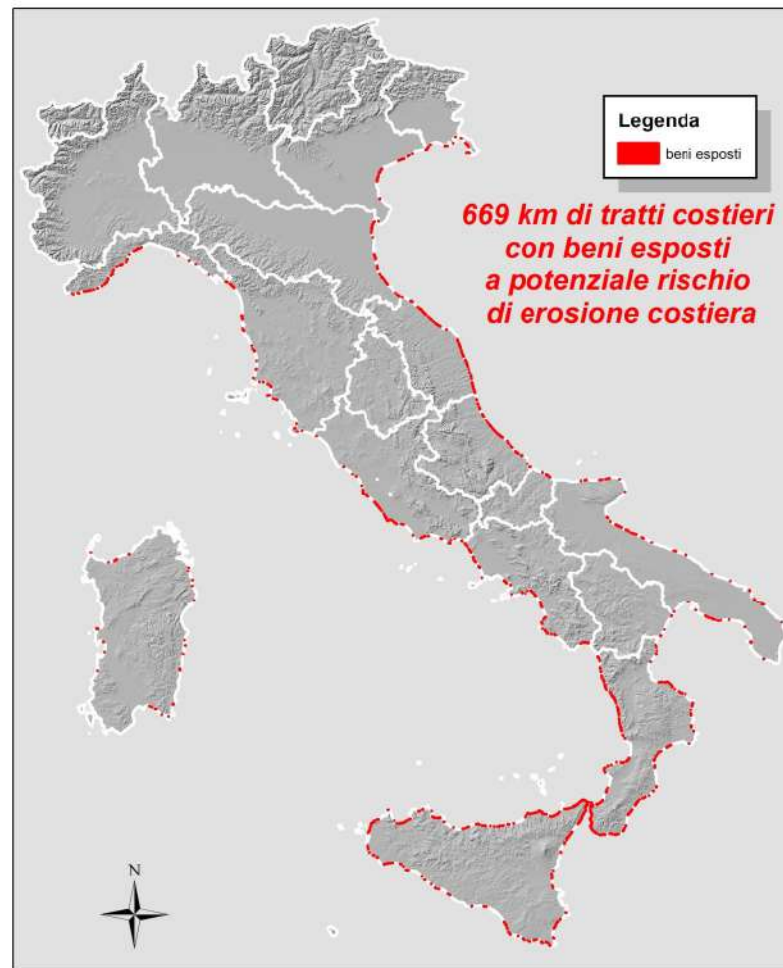
I PRINCIPALI RIPASCIMENTI CON SABBIE PRELEVATE IN MARE DAL 1997 AL 2011



LE VARIAZIONI DELLA LINEA DI COSTA ITALIANA 1960-2012



TRATTI COSTIERI CON BENI ESPOSTI A POTENZIALE RISCHIO DI EROSIONE





Il caso di San Vito lo Capo, non c'è erosione , e pur in assenza di fiumi la spaiggia non si erode **perche?**



519 m

San Vito Lo Capo

Image © 2018 Timelapse
© 2018 Google

Google Earth

Trottire a Vermetidi, scogliere vive
che forniscono carbonato organico



Ferrovie



L'esempio dell'Olanda





Figure 2.1: The Netherlands below sea level (in blue)

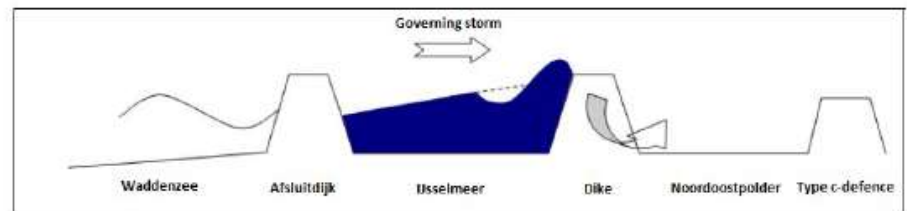


Figure 2.9: Schematization of the IJsselmeer water system during a storm on the IJsselmeer dikes (source: [14])

However, as wind speeds (and direction) influence both possibilities of failure it can happen that failure of the Afsluitdijk also influences failure of the IJsselmeer dikes (see figure 2.10). This amount of influence is investigated in this thesis (see section 5.4).

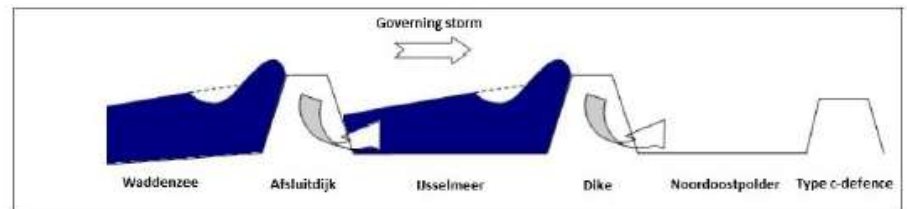


Figure 2.10: Schematization of the IJsselmeer water system during a breach in the Afsluitdijk

If the dikes around the IJsselmeer fail, water will flow into the hinterland. In the case of a still intact Afsluitdijk the water level of the IJsselmeer will go down and water in the polder will rise to arrive at a new equilibrium (see figure 2.11).

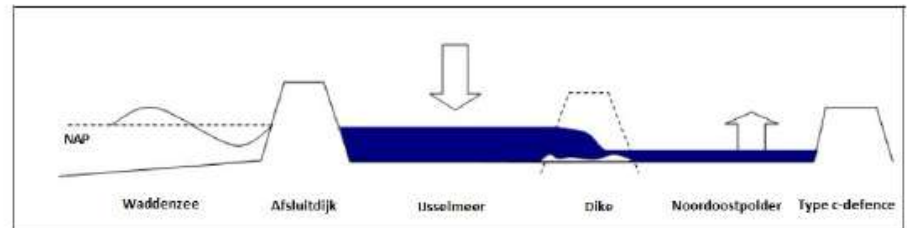


Figure 2.11: Schematization of the IJsselmeer water system during a breach in the IJsselmeer dikes (source: [14])

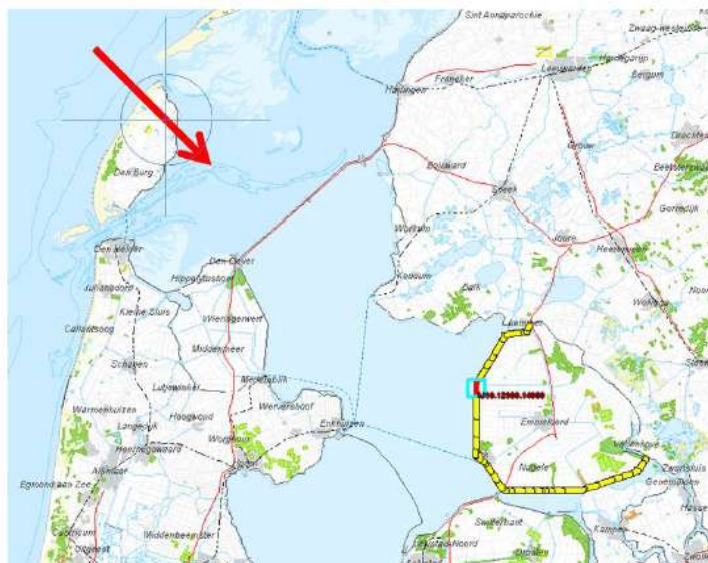


Figure 5.6: Dike ring area 7 in the Southwestern side of the IJsselmeer





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L'impatto dell'innalzamento delle acque per le attività turistico-balneari e marittimo-portuali

Il sollevamento del mare atteso per le coste Italiane nel 2100 sarà compreso tra e **940** e **1035** mm con il modello più cautelativo, tra **1310** e **1450** mm con un modello meno cautelativo. A questi valori bisogna aggiungere un valore di storm surge variabile da zona a zona che saltuariamente, in particolari condizioni di vento, onde e bassa pressione può arrivare a superare **1100** mm