DESYCO: key functionalities for stakeholders across case studies

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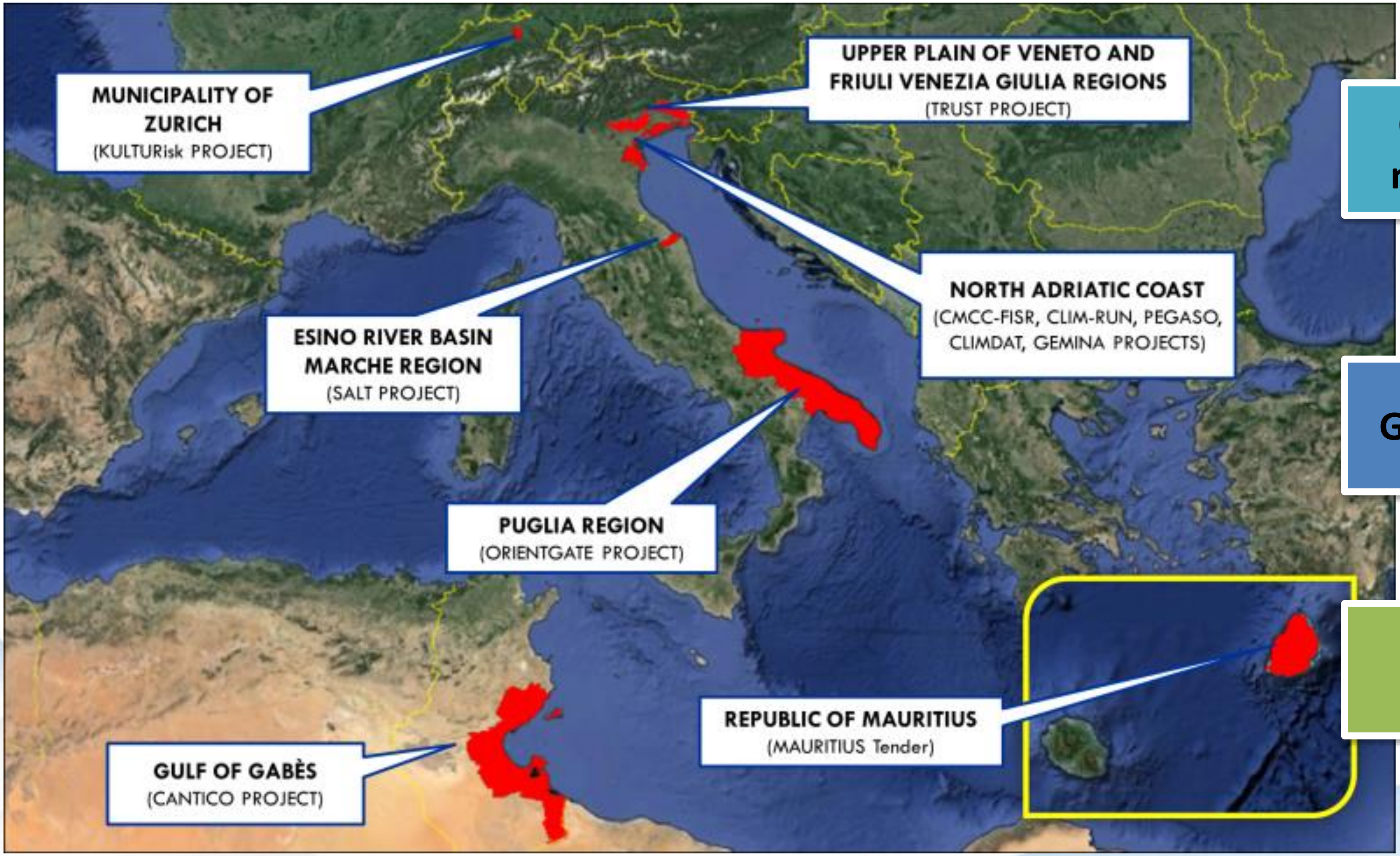
Outline:

- Overview of case studies highlighting main DESYCO output and their functionalities for SHs.
- Focus on the case study of the Gulf of Gabes, Tunisia.
- Cross-cutting conclusion.

Case studies:



Coastal and marine areas

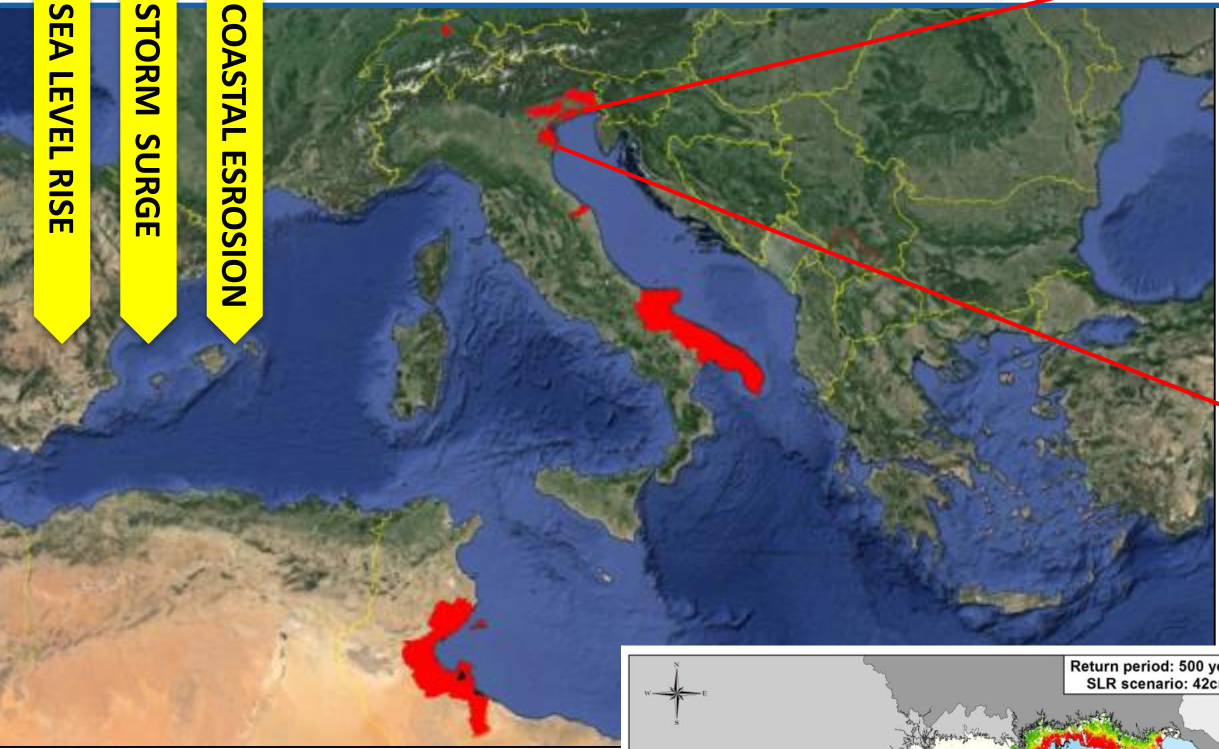
Groundwaters

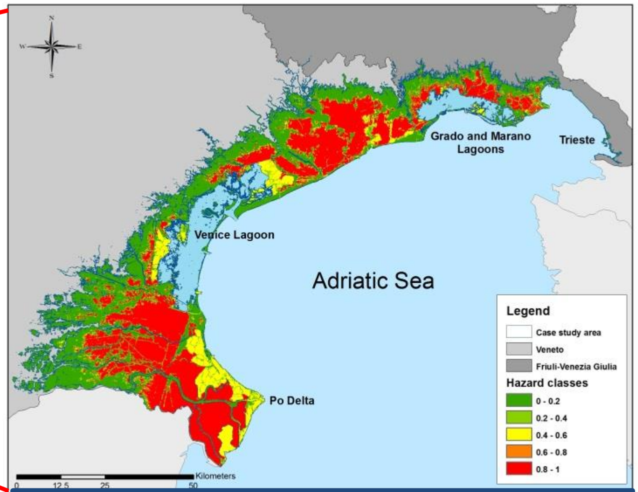
River basins

Coastal and marine areas

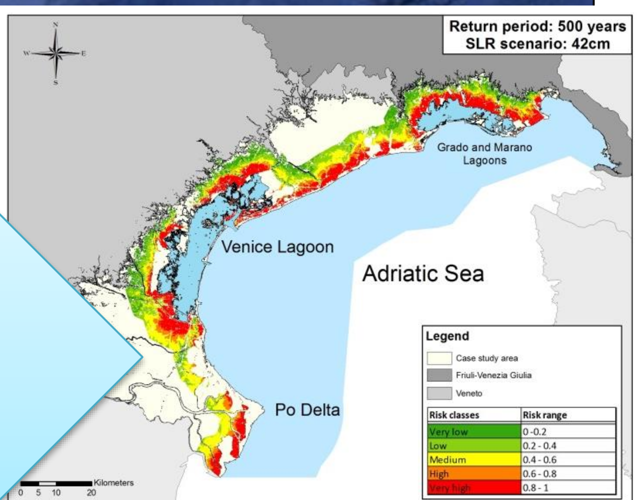



North Adriatic coastal area

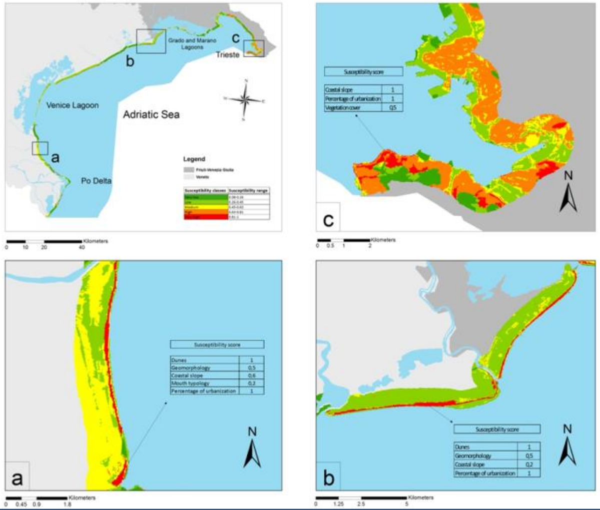




Hazard map for the sea level rise inundation (SLR scenario : 27 cm)



Risk map for storm surge flooding impact (return period 500 years, SLR 42cm)

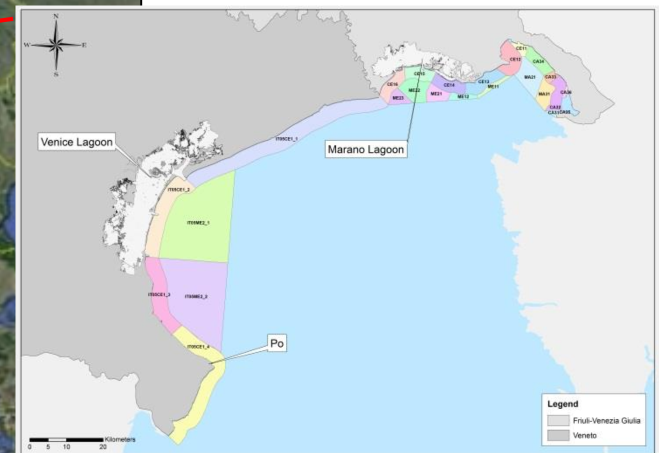


Vulnerability map for the coastal erosion impact (2070-2100)

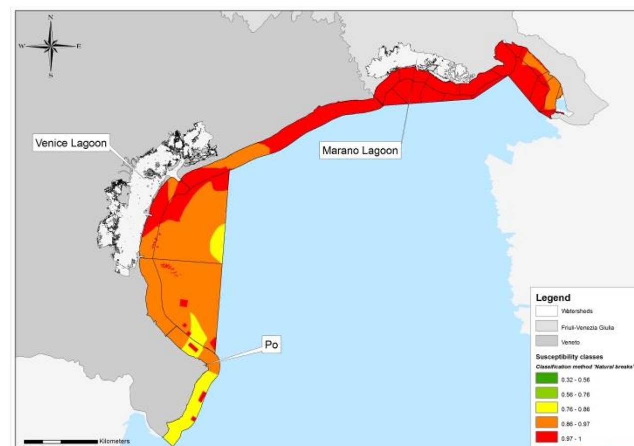
Improve coastal zone management and planning considering **impacts on coasts coming from both land and marine physical hazards** related to climate change

North Adriatic coastal water bodies

SEAWATER QUALITY VARIATION

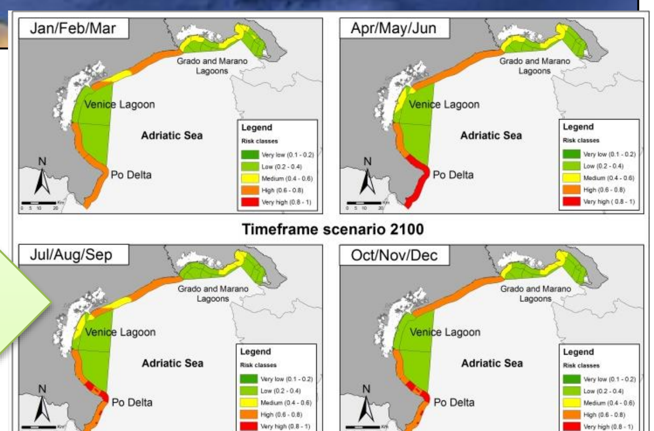


Exposure map for the water quality variation



Vulnerability map for the water quality variation

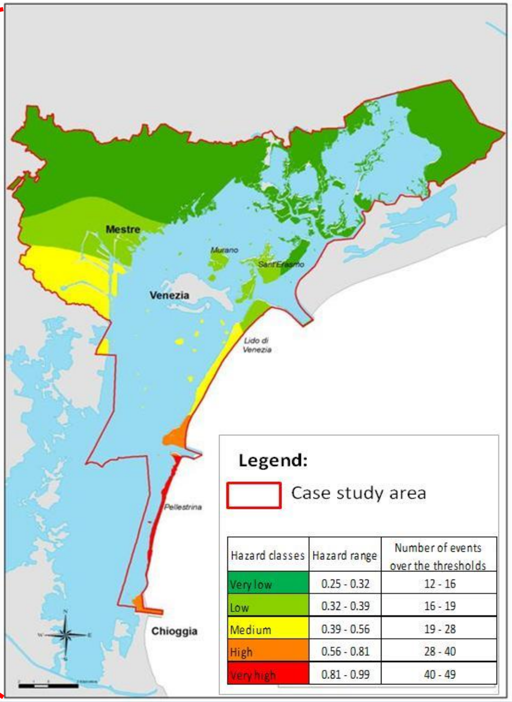
Identify measures and policies for **maintaning marine ecosystems in a healthy, productive and resilient condition** in wiev of climate change



Risk map for the water quality variation (emission scenario A1B, 2100).

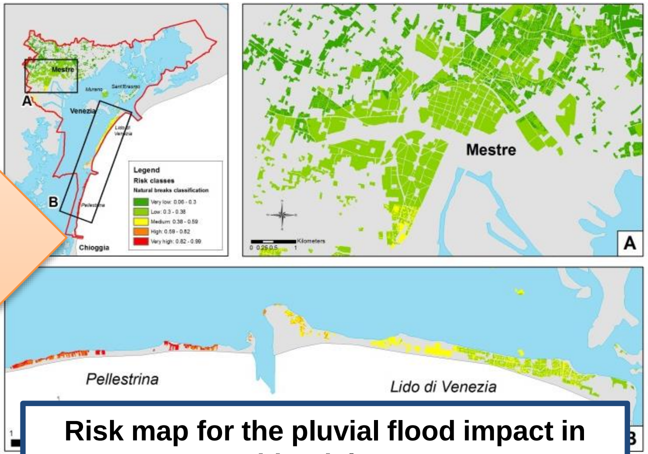
Municipality of Venice (Italy)

PLUVIAL FLOODS

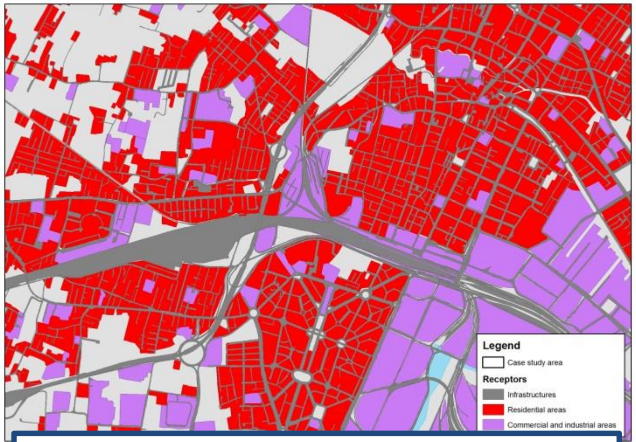


Hazard map for the pluvial flood impact

Integrate informations concerning future climate change scenarios in the development of **new building regulations and urban plans** as well as in the definition of **action plan for risk reduction**



Risk map for the pluvial flood impact in residential areas

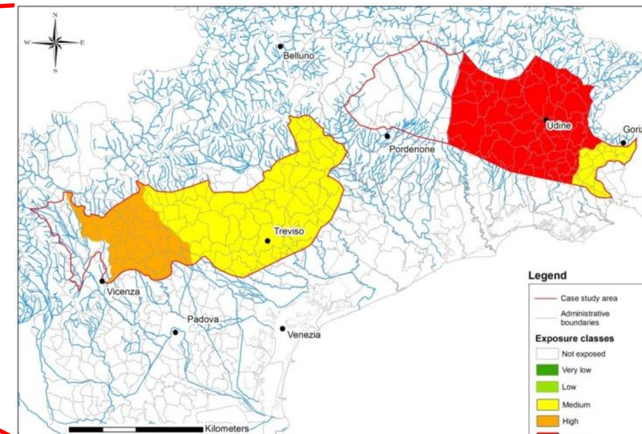


Exposure map for the pluvial flood impact

Groundwaters

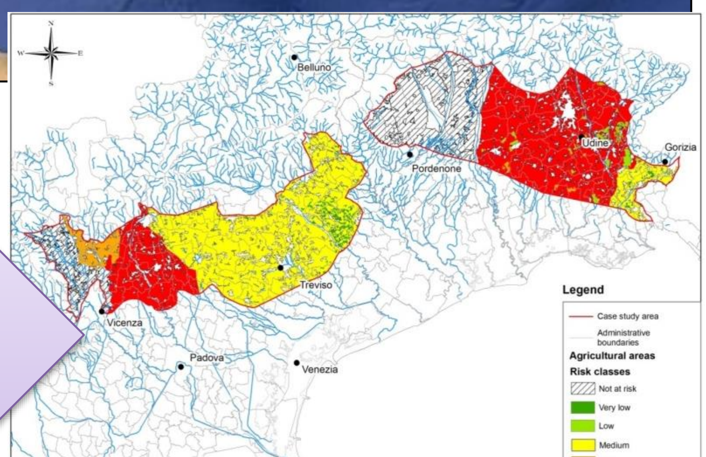



Upper plain of Veneto and Friuli Venezia Giulia regions (Italy)

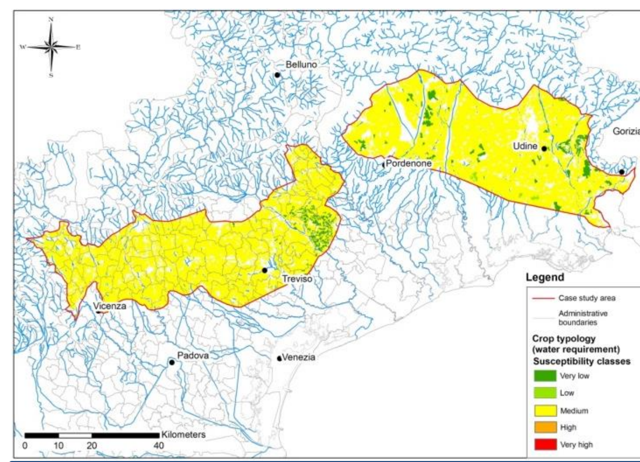


Hazard map for changes in water availability for irrigation related to agricultural areas

Implement concerted and coordinated climate adaptation actions in order to **improve water resources management and planning**



Risk map for changes in water availability for irrigation related to agricultural areas

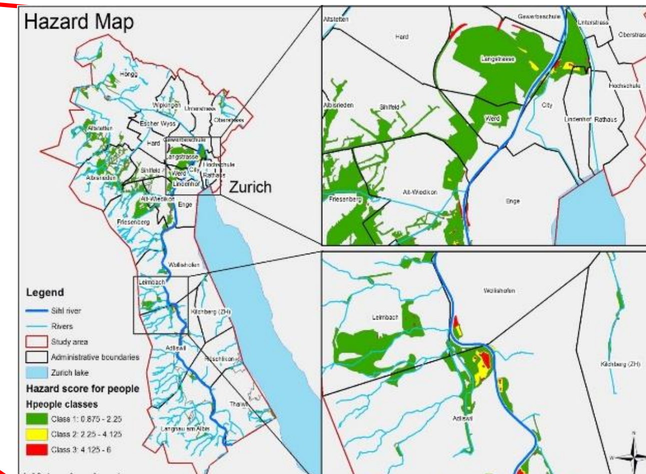


Susceptibility map for changes in water availability for irrigation related to agricultural areas

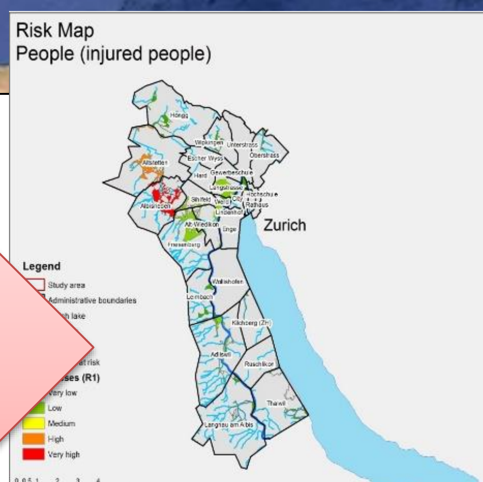
River basins

Sihl river, Zurigo (Switzerland)

URBAN FLOODS

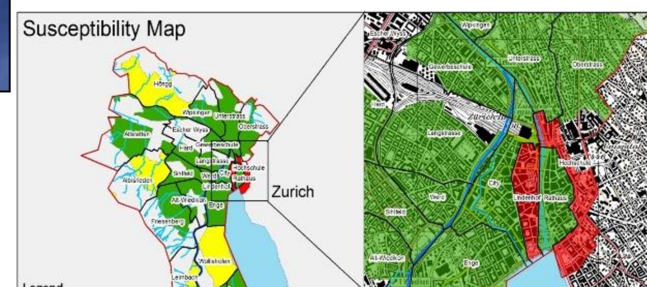


Hazard map for the urban floods impact



District	R1: number of injuries per district
Hochschule	0
Rathaus	0
Escher Wyss	0
Hard	0
Unterstrass	0
Gewerbeschule	0
Rüschlikon	1
Kilchberg (ZH)	3
Enge	4
Wollishofen	6
Lindenhof	9
City	9
Oberstrass	9
Thalwil	22
Langnau am Albis	23
Leimbach	27
Werd	31
Höngg	42
Wipkingen	44
Adliswil	55
Alt-Wiedikon	68
Friesenberg	77
Langstrasse	93
Sihlfeld	96
Altstetten	155
Albisrieden	223
TOTAL NUMBER OF INJURIES	1000

Risk map for the urban floods impact related to the receptor 'people'



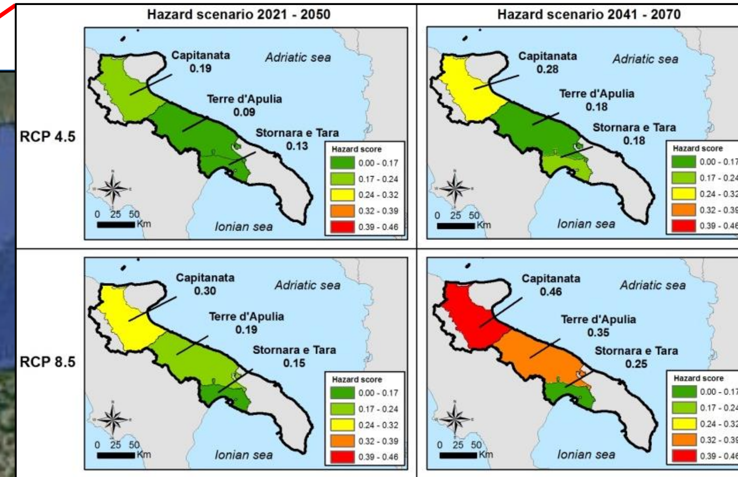
Susceptibility	SF people (%)	sf_1: people aged 76 years or over (%)	sf_2: disable people (%)
Lindenhof	32.32	27.32	5.00
Hochschulen	25.41	20.41	5.00

Vulnerability map for the urban floods impact

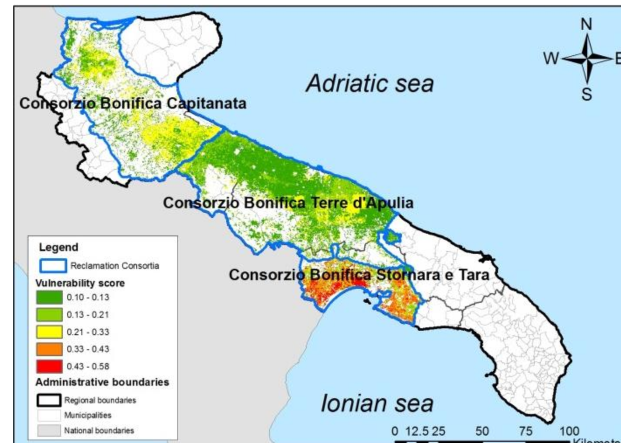
Identify risk hotspots requiring the implementation of specific **early warning systems and preparadness actions** for disaster risk reduction

Puglia region (Italy)

HYDROLOGICAL DROUGHTS

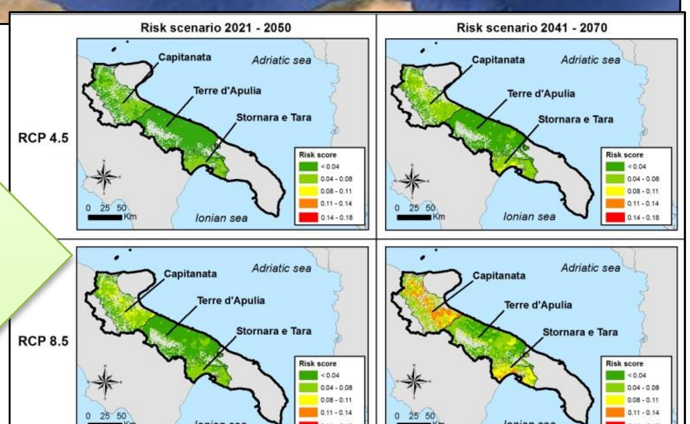


Hazard map for the hydrological droughts on water quantity



Vulnerability map for the hydrological droughts on water quantity

Support **management of the agricultural sector in order to reduce economic losses** in future climate change scenarios (implementatin of diversified and drought-resistent crops).



Risk map for the hydrological droughts on water quantity

Regional Risk Assessment addressing the impacts of climate change in the coastal area of the Gulf of Gabes (Tunisia)

CANTICO – The case study area – Gulf of Gabes

Gulf of Gabès –Tunisia

Defined between 33.8°N - 35.3°N; 10°E - 11.2°E

Input data – Vulnerability factors

IMPACTS	BEACHES	WETLANDS	TERRESTRIAL BIOLOGICAL SYSTEMS	URBAN AREAS	AGRICULTURAL AREAS
HYDRODYNAMIC IMPACTS					
Slr inundation	- Elevation	- Elevation	- Elevation	- Elevation	- Elevation
Storm Surge	- Elevation	- Elevation	- Elevation	- Elevation	- Elevation
	- Distance from coastline	- Distance from coastline	- Distance from coastline	- Distance from coastline	- Distance from coastline
	- Artificial and natural protections	- Artificial and natural protections	- Vegetation cover	- Artificial and natural protections	- Artificial and natural protections
	- Vegetation cover	- Vegetation cover	- Coastal slope	- Coastal slope	- Coastal slope
	- Coastal slope	- Wetland extension			

Yellow	pathway factors
Pink	attenuation factors
Orange	susceptibility factors

Input data – Vulnerability factors

Factor	Definition	Data source
Pathway factors		
Elevation (cm)	The height of a geographic location (e.g a pixel of the map) above Mean Sea Level.	DEM (raster).
Distance from coastline (cm)	The distance of a location (e.g. a pixel of the map) from the coastline.	Coastline (polyline).
Attenuation factors		
Artificial and natural protections	Natural or artificial protections (e.g. cliffs) for the defence of the coastline from storm surge and coastal erosion impacts.	Artificial protections (polyline), natural protections (polyline).
Susceptibility factors		
Vegetation cover	The typology of vegetation that cover an area (e.g. rangeland, bare soils, forests).	Land use (Raster)
Wetland extension (km^2)	The extent of wetlands in square kilometres.	Wetland extension (polygon)
Coastal slope (degrees)	The inclination of the coastal land measured in degrees.	DEM (raster)

Input data – Definition of receptors

Receptor	Definition
Beaches	This receptor analyzes beaches and the vegetation associated to them. Furthermore it analyzes natural and artificial protections to limitate impacts. coastal areas are important for tourism, recreation and residential development (Voice et al., 2006). Sand grade sediments are generally defined to be those predominantly composed of grains ranging between 0.06 to diameter (Pettijohn, 1975). In the coastal environment, unconsolidated sediments within this grain size range are highly mobile and small enough to be easily eroded and transported by waves, currents and winds that frequently act on most shorelines, in contrast to larger (pebble/cobble/boulder) particles that are only moved by very energetic waves and hardly at all by wind (Sharples, 2006).
Wetland	The wetland receptor includes coastal wetlands along with vegetation, animal life and artificial and natural protections located in wetlands areas. Wetland is an environment at the interface between truly terrestrial ecosystems and aquatic systems making them inherently different from each other yet highly dependent on both. (Mitsch et al., 2009). For the purposes of this assessment the following categories were considered: inland wetlands, salt marshes and intertidal wetlands.
Terrestrial biological systems	This receptor includes animal and plant terrestrial life, their habitats and the ecological functions they provide. Specifically, terrestrial biodiversity encompasses the total variety of life forms including plants, animals and micro-organisms and the processes and ecosystems they form (EPA, 2002).
Urban areas	This receptor includes areas cover by countries, residential areas, commercial zones and industries. It includes areas in which a majority of the people are not directly dependent on natural resource-based occupations (http://www.mhhe.com/biosci/pae/glossaryu.html). Specifically, it includes areas mainly occupied by dwellings and buildings used by administrative/public utilities or collectivities, including their connected areas; areas mainly occupied by industrial activities of transformation and manufacturing, trade, financial activities and services, transport infrastructures for road traffic and rail networks, airport installations, river and sea port installations, including their associated lands and access infrastructures; areas voluntarily created for recreational use (Bossard et al., 2000)
Agricultural areas	This receptor includes areas comprised of arable land, gardens and other perennial plants, meadows and natural pastures (http://regionai.stat.gov.lt/en/savokos.html#Agricultural%20land). It includes: arable land (lands under a rotation system used for annually harvested plants and fallow lands, which are permanently or not irrigated), permanent crops (all surfaces occupied by permanent crops, not under a rotation system), pastures (lands, which are permanently used for fodder production) (Bossard et al., 2000).

Definition of the methodological approach. The model chain

Climate change forcing

SRES: A1B

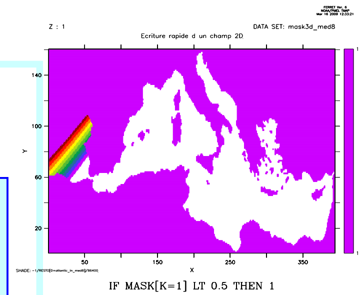
Anthropogenic forcing

Global/Regional Circulation Models:

ARPEGE:
50 km grid
2001-2099
resolution 50 km
Vertical resolution
31 levels
Meteo France

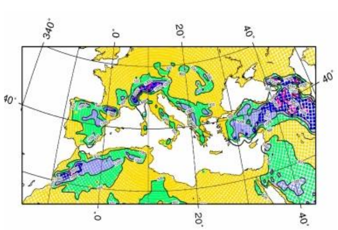
ATM: LMDZ:
30 km grid
2001-2050
Coupler: OASIS

Med: NEMOMED8
CNRS



Local Sources of Pollutant:

Toxic industrial discharges, port activities, urban and industrial development, tourism



Coastal high resolutions models:

Hydrodynamic models:

CMCC:
Mediterranean model

Regional simulation
(Gulf of Gabès)

Biogeochemical models:

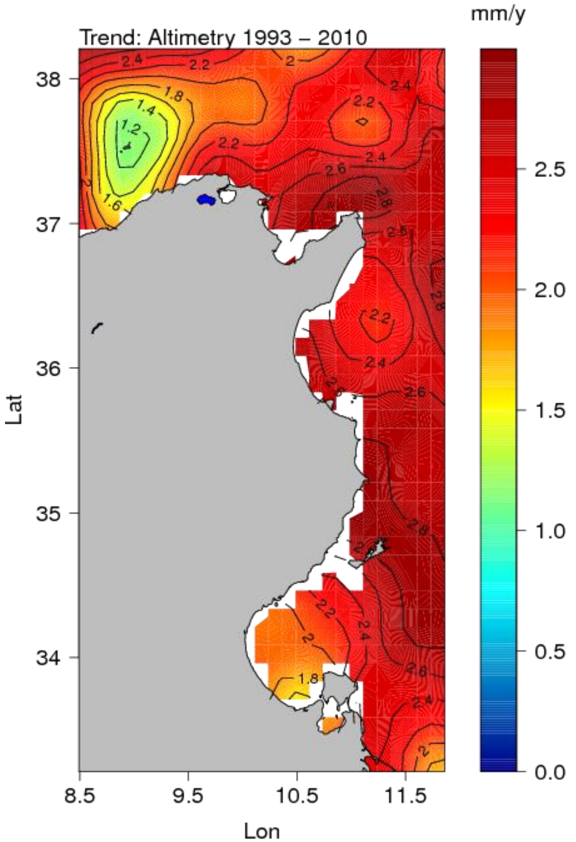
OGS:
Mediterranean model

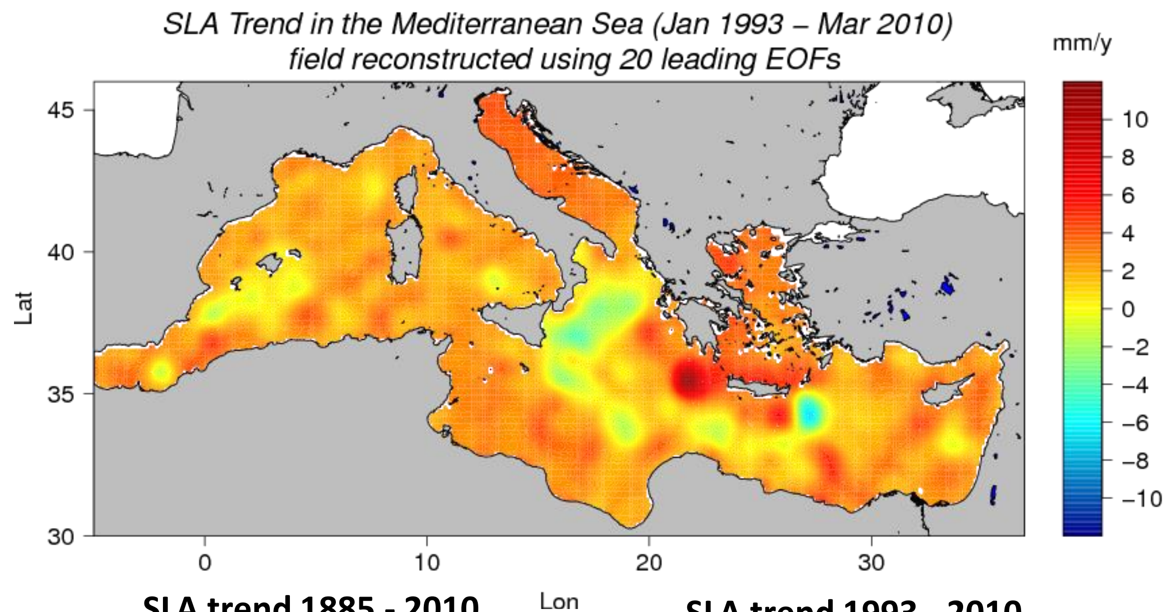
Regional simulation
(Gulf of Gabès)

1) Hazard assessment – Sea level rise

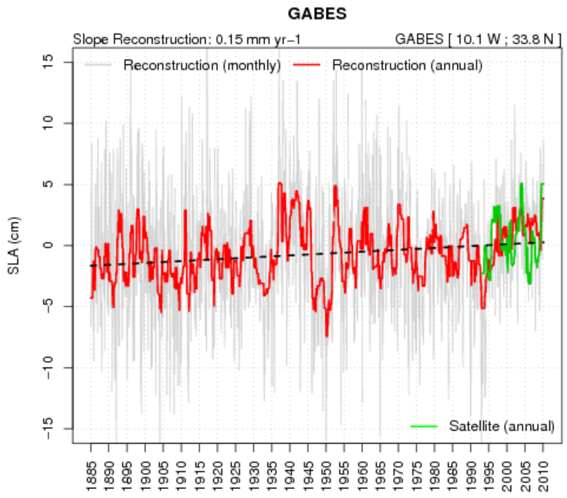
SLR scenario for 2100:
14 cm.

SLA trend 1993 - 2010

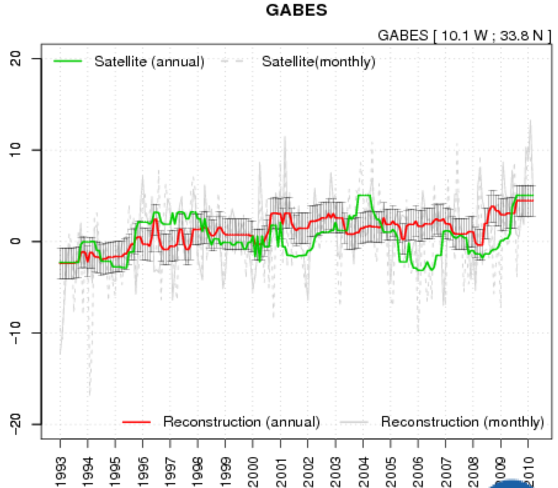




SLA trend 1885 - 2010

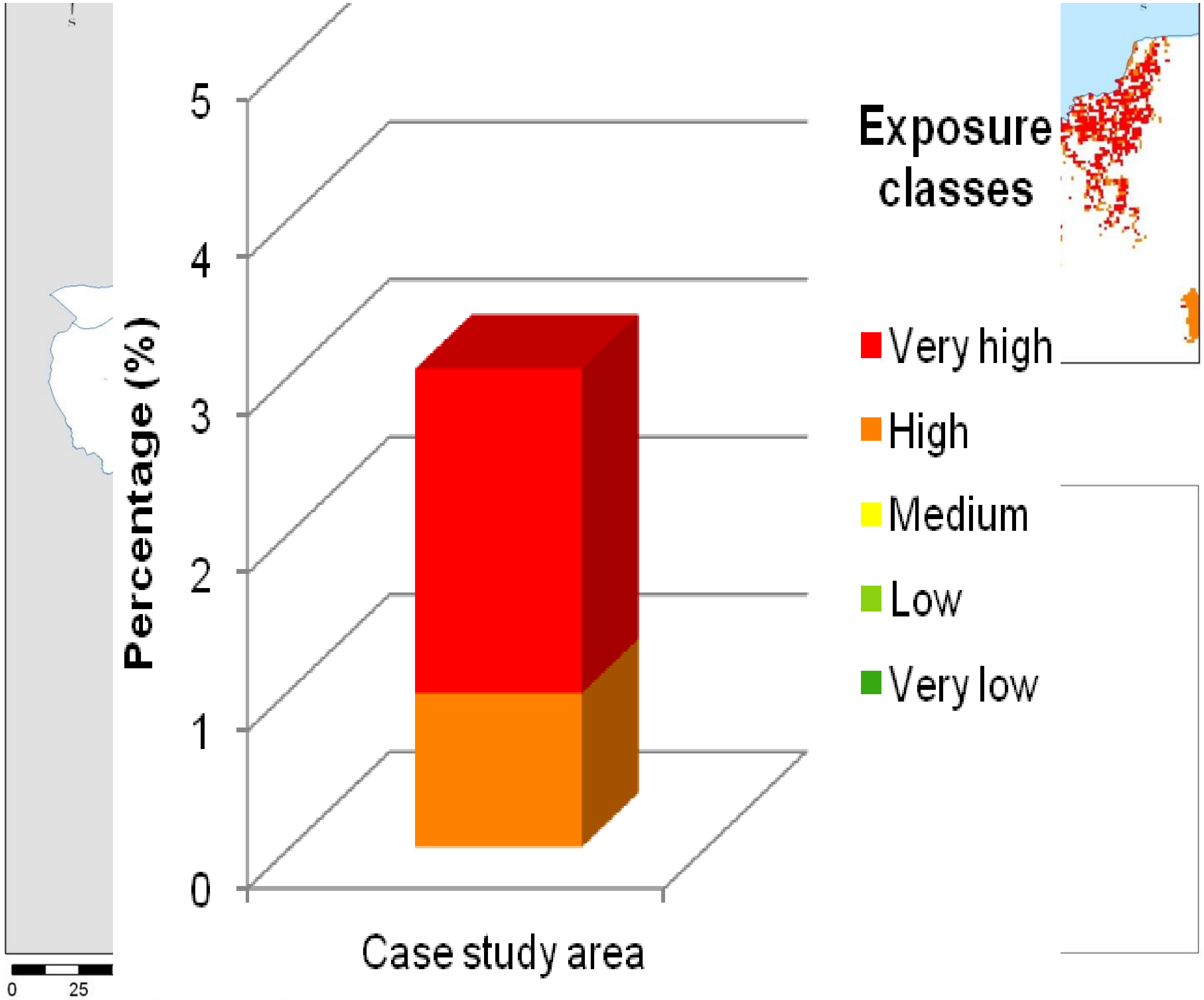


SLA trend 1993 - 2010



2) Exposure assessment – Sea level rise

Distribution of the percentage of surface associated to each exposure class for the case study area for the sea level rise inundation impact.



3) Risk assessment for SLR

HAZARD METRICS
PATHWAY FACTORS
→ Exposure maps

SUSCEPTIBILITY FACTORS → Susceptibility maps

Exposure maps + Susceptibility maps → Risk maps

VALUE FACTORS

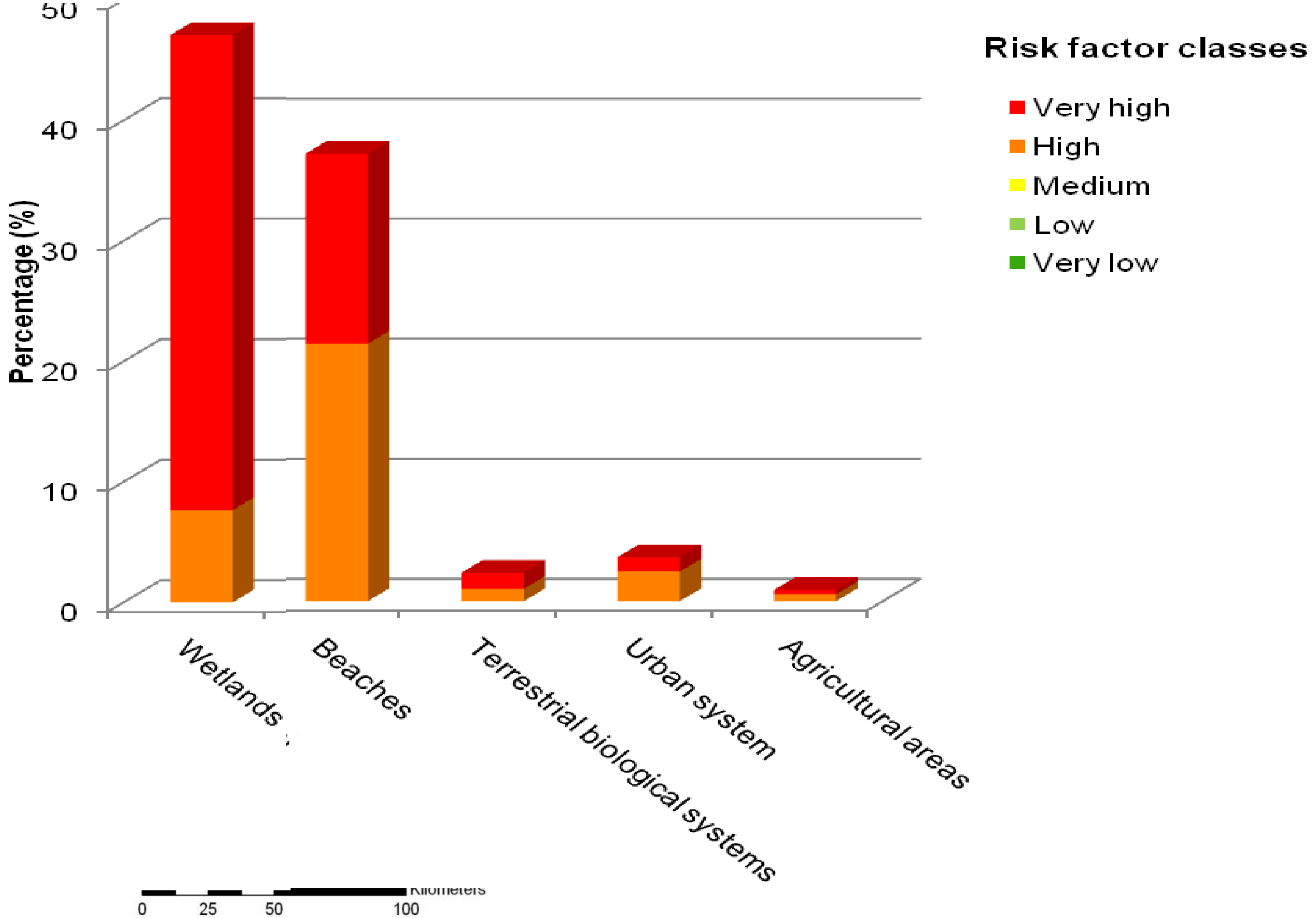
A SLR inundation event affect all the receptors in the same way, causing a **permanent loss of receptors' sub-areas** based only on the elevation of the cells.

Each **cell of the territory** was considered to have the same **maximum susceptibility** to SLR impact.

Susceptibility score equal to 1→ homogeneous susceptibility map for the investigated area.

3) Risk assessment – sea-level rise – Wetlands

Distribution of the percentage of surface associated to each risk class for the receptors located in the Gulf of Gabès for the sea level rise inundation impact.



3) Risk assessment – Sea-level rise – Statistics

Governorate	Km^2	%
Gabès	9.35	17.63
Medenine	388.67	53.13
Sfax	44.97	28.65

Surface (Km^2) and percentage of wetlands at risk to Sea Level Rise inundation impact for the Governorates in the Gulf of Gabès.

Governorate	Km^2	%
Gabès	2.91	13.69
Medenine	11.66	39.27
Sfax	9.54	68.04

Surface (Km^2) and percentage of beaches at risk to Sea Level Rise inundation impact for the Governorates in the Gulf of Gabès.

1) Hazard assessment – Storm surge flooding

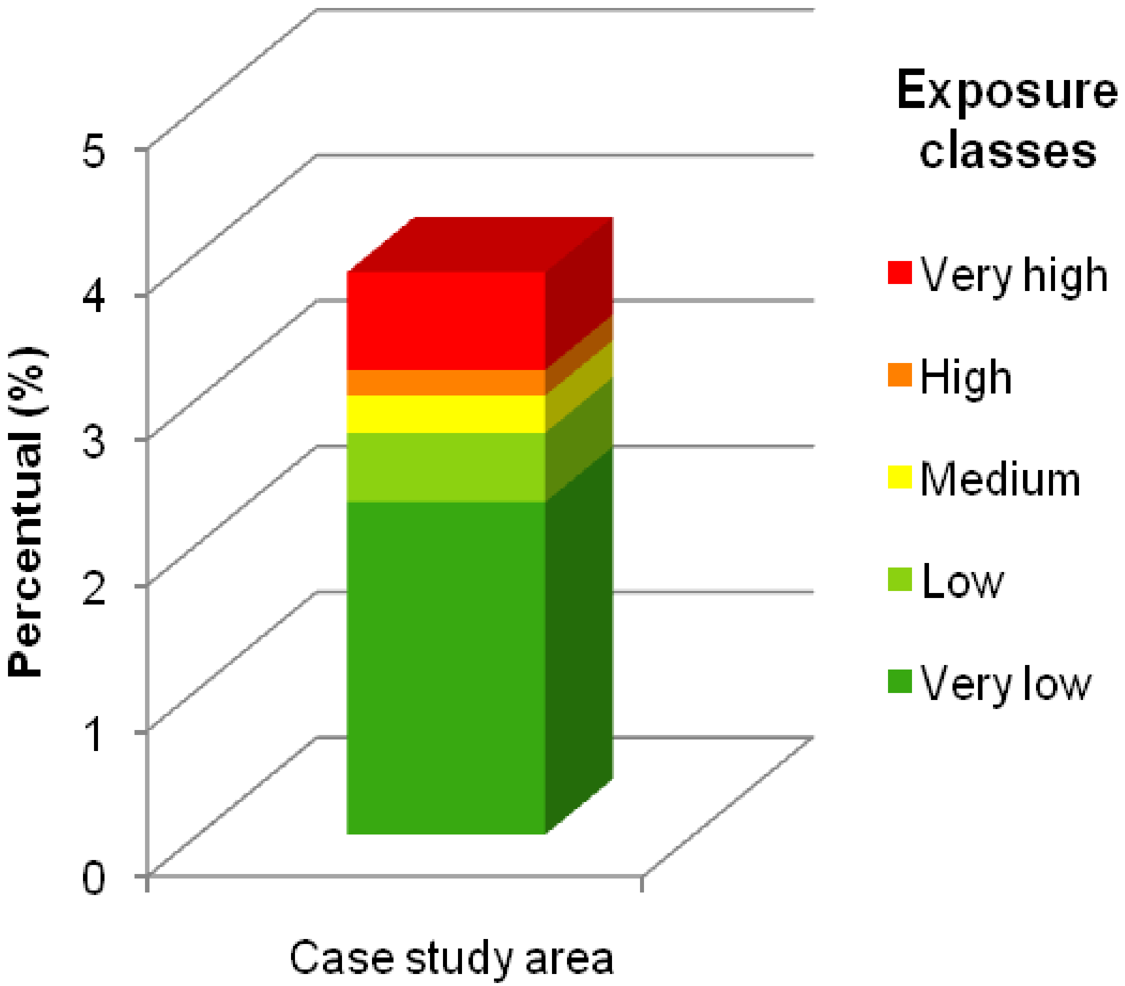
HAZARD MATRIX					
STRESSORS					CLIMATE CHANGE IMPACTS
EXTREME STORMS SURGE	SEA LEVEL RISE	TIDE	WAVE		
					HYDRODYNAMIC IMPACTS
Water level return period	Projected water level	Tidal range	Height Direction		Storm surge flooding

Height of SS with a return period of 100 years: 173 cm.

SS scenario for 2100 (includind SLR): 187 cm.

2) Exposure assessment – Storm surge flooding

Distribution of the percentage of surface associated to each exposure class for the case study area for the storm surge flooding impact.

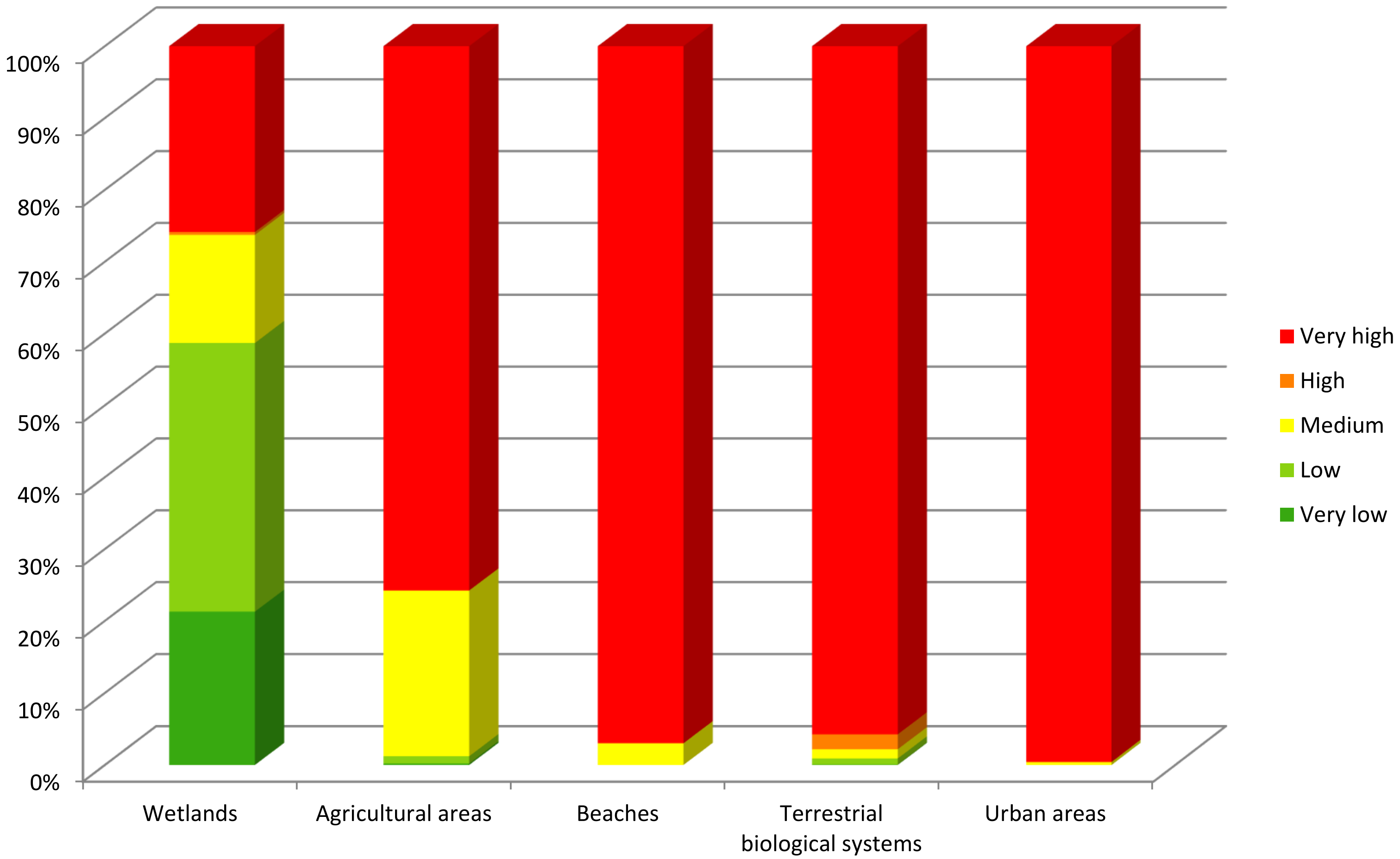


3) Susceptibility assessment – Storm surge flooding

Susceptibility factor	Class	Value	Score SS
Vegetation cover	Rangeland	101	0
	Bare Soil	102	0,25
	Jessour	103	0,5
	Forest	104	1
Coastal slope (degree)	0 - 1,9	101	1
	1,9 - 7,6	102	0,75
	7,6 - 17,1	103	0,5
	17,1 - 37,3	104	0,25
	37,3 - 84,2	105	0
Wetland extension (km^2)	0 - 67	101	1
	67 - 134	102	0,75
	134 - 201	103	0,5
	201 - 268	104	0,25
	268 - 336	105	0

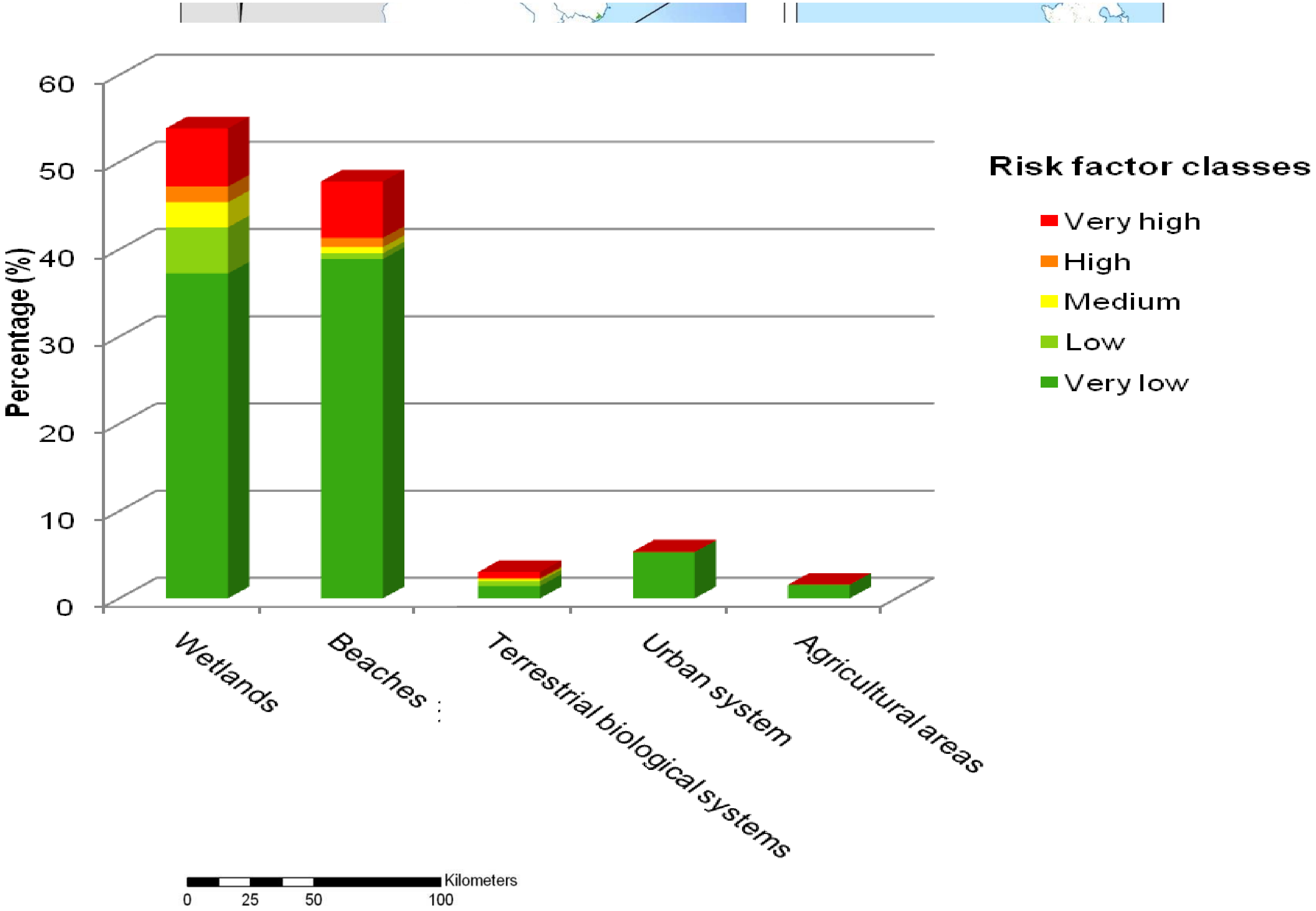
3) Susceptibility assessment – Storm surge flooding

Distribution of the percentage of surface associated to each susceptibility class for the receptors located in the case study area for the storm surge flooding impact.



4) Risk assessment – Storm surge – Agricultural areas

Distribution of the percentage of surface associated to each risk class for the receptors located in the Gulf of Gabès for the storm surge flooding impact.



4) Risk assessment – Storm surge flooding – Statistics

Governorate	Risk class	Km²
Gabès	Very low	1.37
	Low	4.05
	Medium	3.11
	High	1.84
	Very high	3.01
Medenine	Very low	225.59
	Low	112.60
	Medium	36.69
	High	22.04
	Very high	41.11
Sfax	Very low	4.01
	Low	13.40
	Medium	11.93
	High	8.11
	Very high	18.08

Surface (Km²) of wetlands belonging to the different risk classes for storm surge flooding impact and for the Governorates in the Gulf of Gabès.

Governorate	Risk class	Km²
Gabès	Very low	5.202
	Low	0.087
	Medium	0.024
	High	0.016
	Very high	0.004
Medenine	Very low	9.015
	Low	0.456
	Medium	0.627
	High	0.753
	Very high	3.839
Sfax	Very low	10.773
	Low	0.062
	Medium	0.007
	High	0.001
	Very high	0.089

Surface (Km²) of beaches belonging to the different risk classes for storm surge flooding impact and for the Governorates in the Gulf of Gabès.

Cross-cutting conclusion

Adaptation to climate change is a complex issue because it implies the **assessment of a wide range of impacts on multiple sectors**, whose vulnerability and adaptive capacity depend un physical, environmental and socio-economic conditionsvarying from region to region.

The application of DESYCO in different European and Italian projects has confirmed the **flexibility of the tool** to be applied for a wide range of climate-related problem across the land sea-interface of coastal zones, marine ecosystems, river basin and groundwater.

Its **open configuration** allows the users to in selecting different hazard receptors, input data and scenarios, focusing the analysis on several targets and climate change impacts, according to **specific end-user needs**.

Being developed upon a bottom-up approach involving SHs early in the process, DESYCO can be considered as an **adaptation service provider**, effectively supporting policy makers and planners in the development of regional adaptation strategies.

Thanks for your attention!

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For more information:

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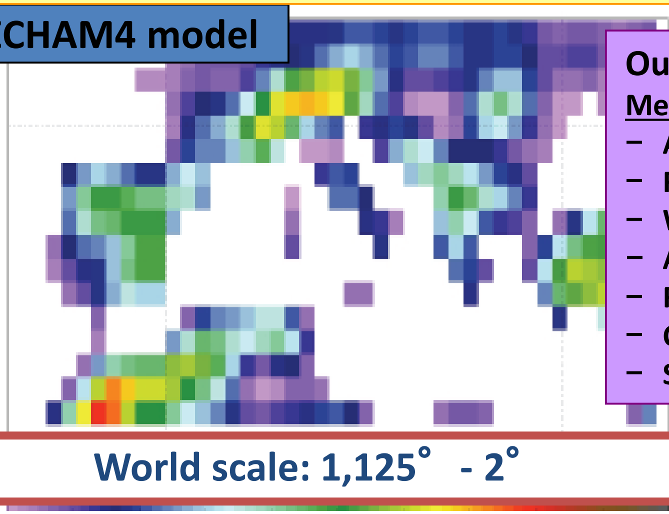
Euro-Mediterranean Center on Climate Change (CMCC), RAAS - Risk assessment and adaptation strategies, Venice: www.cmcc.it/it/divisions/raas

cmcc
Centro Euro-Mediterraneo sui Cambiamenti Climatici

1) HAZARD SCENARIO ASSESSMENT FOR SLR

Global climate simulations

ECHAM4 model



World scale: 1,125° - 2°

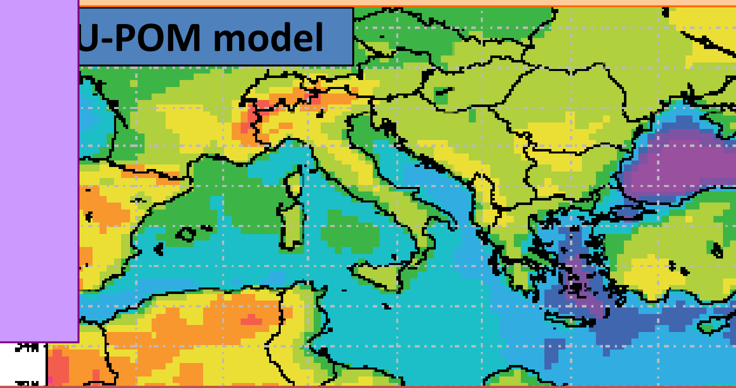
Output EBU-POM:

Meteoclimatic factors:

- Air/sea temperature;
- Rainfall;
- Winds;
- Atmospheric pressure;
- Relative humidity;
- Cloudiness;
- Salinity.

Mediterranean climate simulations

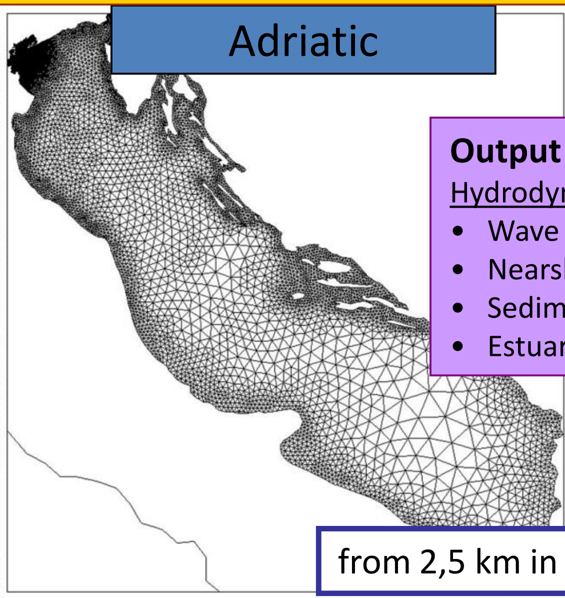
U-POM model



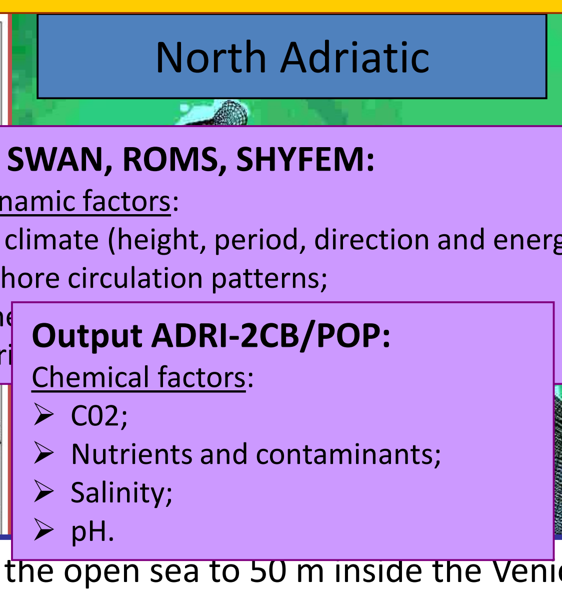
Med scale: 0,2° - 0,25°

High resolution models:

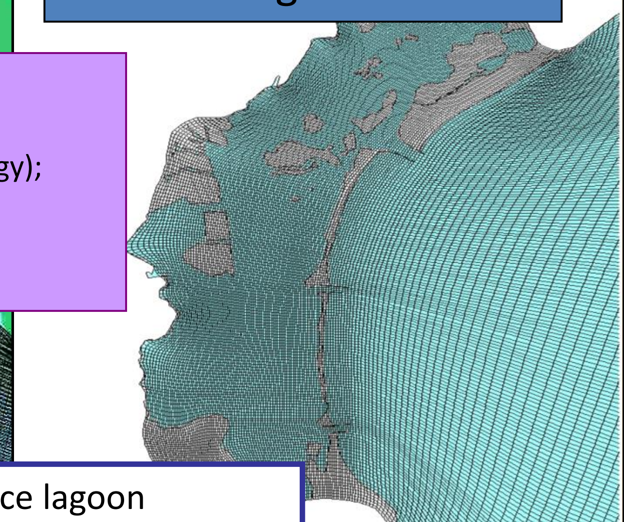
Adriatic



North Adriatic



Lagoon



Output SWAN, ROMS, SHYFEM:

Hydrodynamic factors:

- Wave climate (height, period, direction and energy);
- Nearshore circulation patterns;
- Sedime
- Estuari

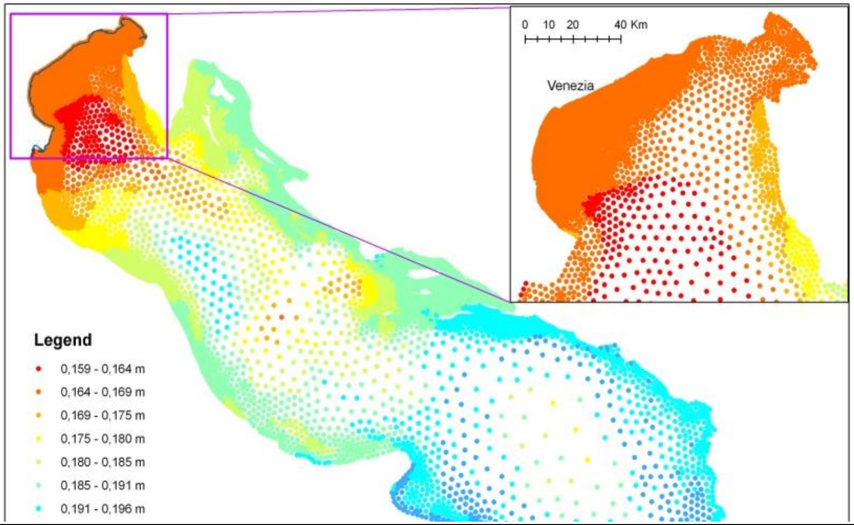
Output ADRI-2CB/POP:

Chemical factors:

- C02;
- Nutrients and contaminants;
- Salinity;
- pH.

from 2,5 km in the open sea to 50 m inside the Venice lagoon

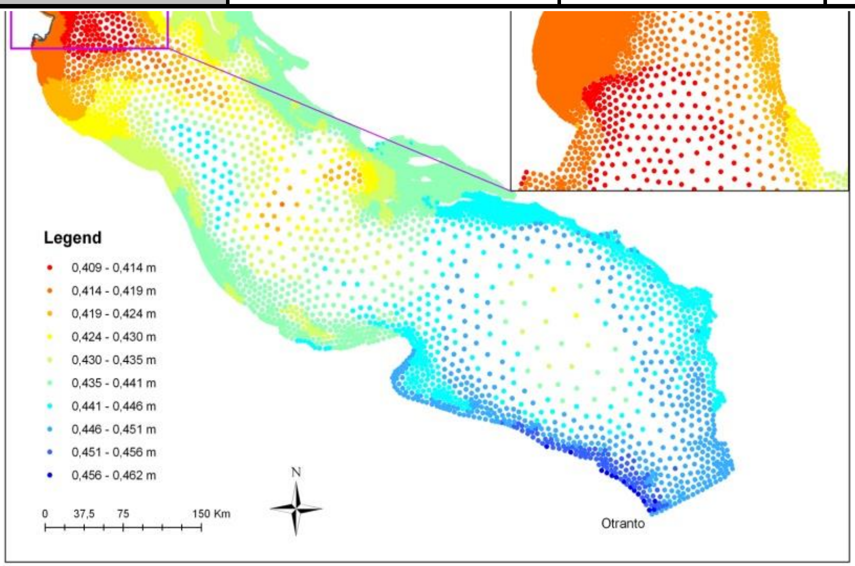
1) HAZARD SCENARIO ASSESSMENT FOR SLR



Low hazard scenario: based on SHYFEM MODEL (emission scenario A1B for the year 2100). Boundary condition: 20 cm SLR at Otranto.

Low SLR scenario: 17 cm along the North Adriatic shoreline.

Scenario	Minimum value (cm)	Mean value (cm)	Maximum value (cm)	Range (cm)	Standard deviation (cm)
Low Sea Level Rise	16,73	16,84	16,97	0,25	± 0.04
High Sea Level Rise	41,73	41,82	41,96	0,23	± 0.04



SHYFEM MODEL (emission scenario A1B for the year 2100). Boundary condition: 45 cm SLR at Otranto.

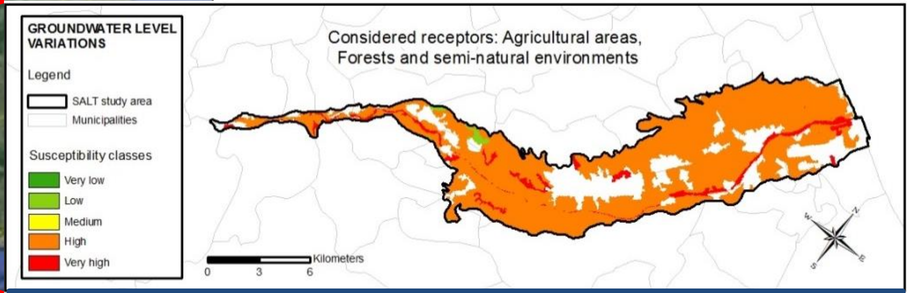
High SLR scenario: 42 cm along the North Adriatic shoreline.

1) HAZARD SCENARIO ASSESSMENT FOR STORM SURGE

	RETURN PERIOD									
height (cm)	**10 years**	**20 years**	**30 years**	**40 years**	**50 years**	**60 years**	**70 years**	**80 years**	**90 years**	**100 years**
100	0,9999546	1	1	1	1	1	1	1	1	1
101	0,9999546	1	1	1	1	1	1	1	1	1
102	0,9999546	1	1	1	1	1	1	1	1	1
103	0,9999546	1	1	1	1	1	1	1	1	1
104	0,9999546	1	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1
105	0,9999546	1	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1
106	0,9999546	1	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1
107	0,9999546	1	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1
108	0,9999546	1	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1
109	0,9999546	1	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1
110	0,9999546	1	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1
111	0,9999546	1	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1
112	0,9999284	1	1	1	1	1	1	1	1	1
113	0,9998448	1	1	1	1	1	1	1	1	1
114	0,9997068	0,9999999	1	1	1	1	1	1	1	1
115	0,9994986	0,9999998	1	1	1	1	1	1	1	1
116	0,9992003	0,9999994	1	1	1	1	1	1	1	1
117	0,9987833	0,9999985	1	1	1	1	1	1	1	1
118	0,9982031	0,9999968	1	1	1	1	1	1	1	1
119	0,9973909	0,9999932	1	1	1	1	1	1	1	1
120	0,9962418	0,9999859	1	1	1	1	1	1	1	1
121	0,9946006	0,9999709	0,9999998	1	1	1	1	1	1	1
122	0,992246	0,9999399	0,9999995	1	1	1	1	1	1	1
123	0,9888755	0,9998763	0,9999986	1	1	1	1	1	1	1
124	0,9840971	0,9997471	0,999996	0,9999999	1	1	1	1	1	1
125	0,9774352	0,9994908	0,9999885	0,9999997	1	1	1	1	1	1
126	0,9683584	0,9989988	0,9999683	0,999999	1	1	1	1	1	1

Estimation of the occurrence probability (ranging from 0 to 1) within a time range between 10 and 100 years (with a time step of 10 years) of at least one event of a certain height between 100 and 140 cm.

Esino river basin – March region (Italy)



Susceptibility map for the groundwater level variation impact

bla