United Nations Educational, Scientific and Cultural Organization

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Biosfera Delta Po
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FORUM MONDIALE DEI GIOVANI 2017

2nd INTERNATIONAL CONFERENCE ON DELTAS AND LAGOONS
CLIMATE CHANGE EFFECTS ON COASTAL ZONES

a cura di DELTAMED

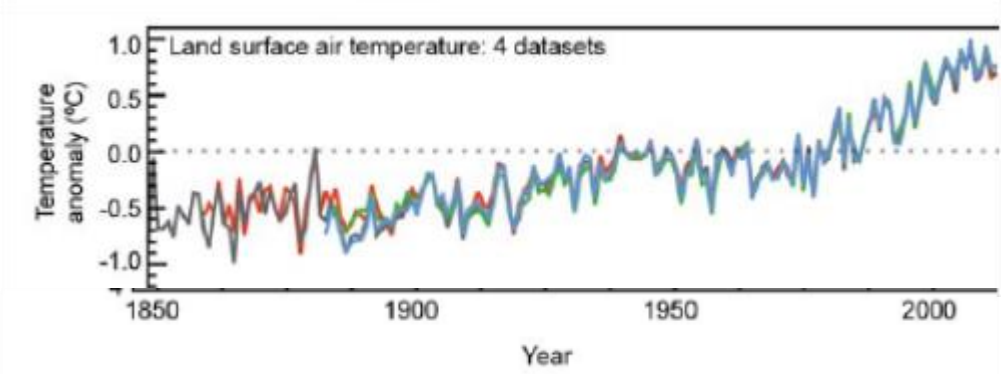
deltamed

SEA LEVEL RISING: CONSEQUENT PROBLEMS ON DELTAS AND COASTAL ZONES IN MEDITERRANEAN AREAS AND OTHER PARTS OF THE WORLD

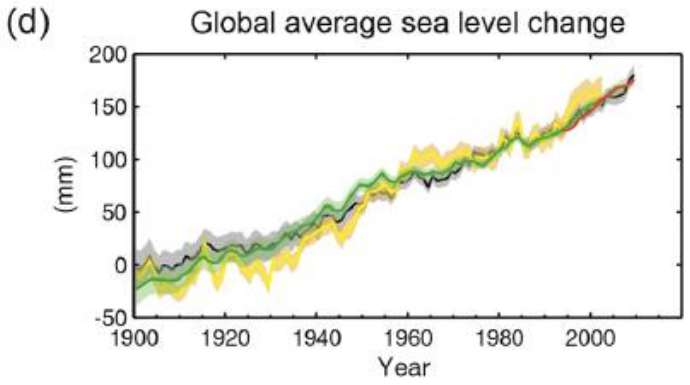
L. Berga

OBSERVED CHANGES. AR 5

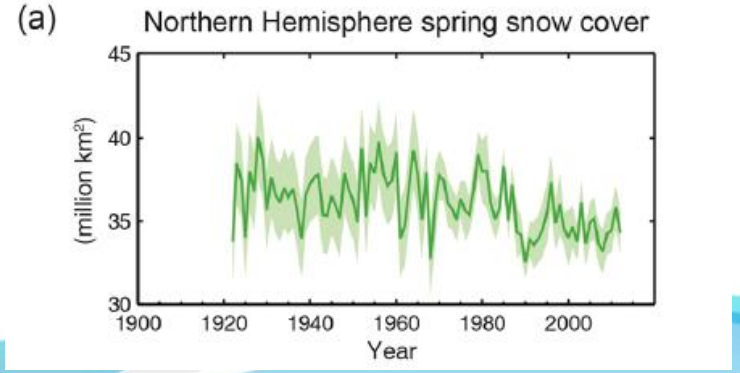
temperature



sea level



snow and ice cover

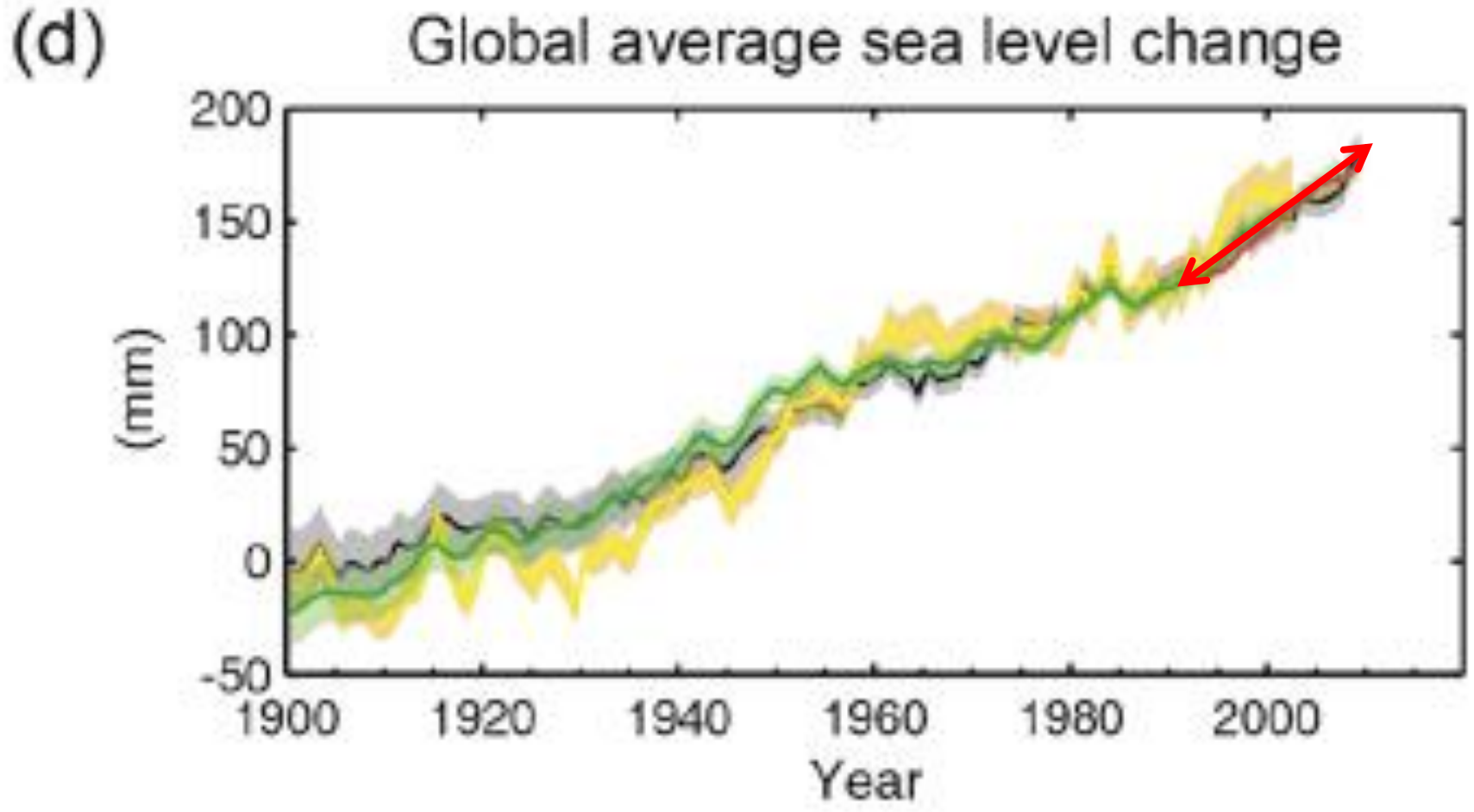


OBSERVED SEA LEVEL RISE. IPCC. AR 5

1901-2010 : 19cm (17-21)

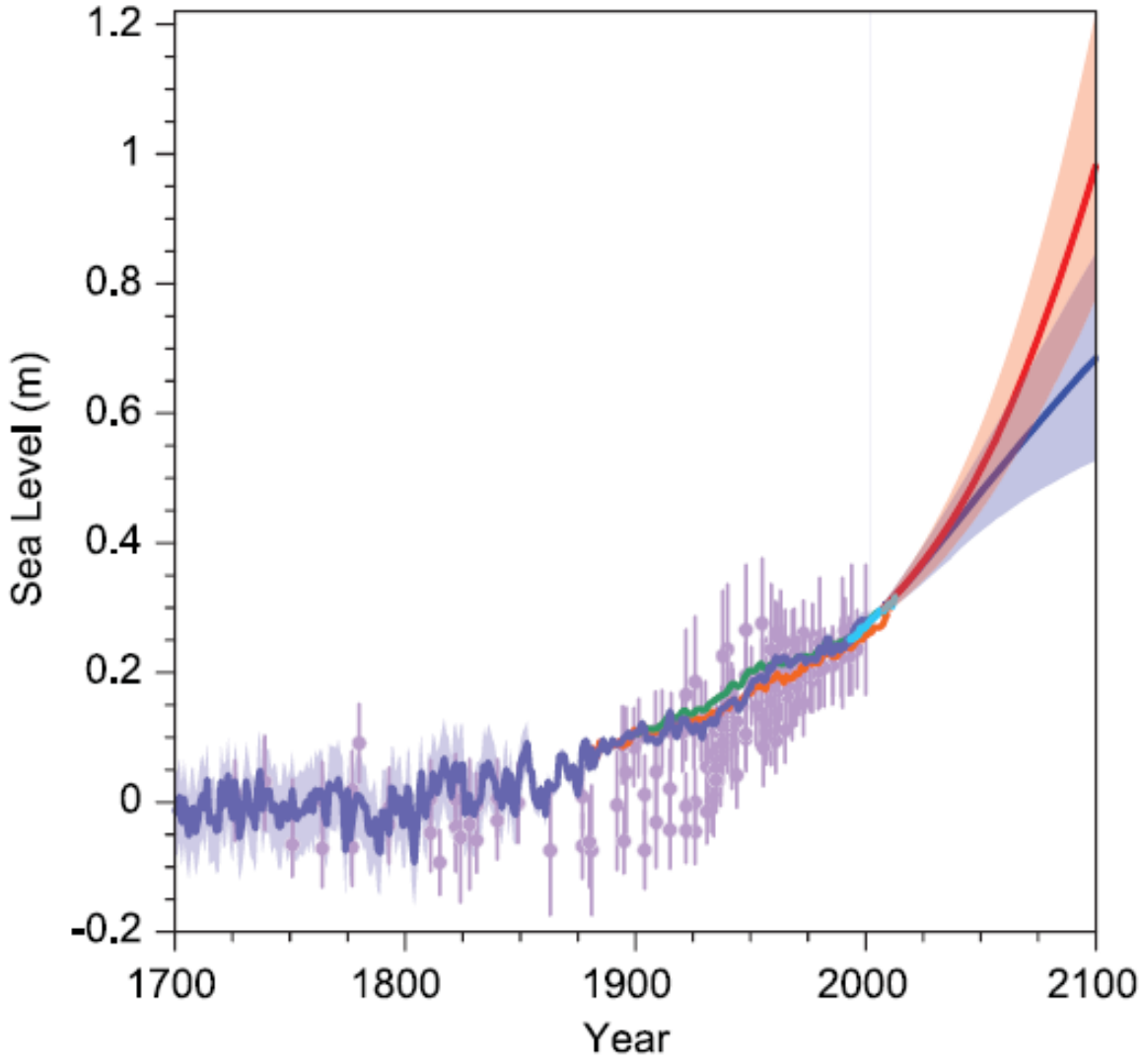
1901-2010 : 1,7mm/year (1,5-1,9)

1993-2017: 3.4 mm/year (3.0-3.8)



OBSERVED AND PROJECTIONS SLR. IPCC: AR5 2014

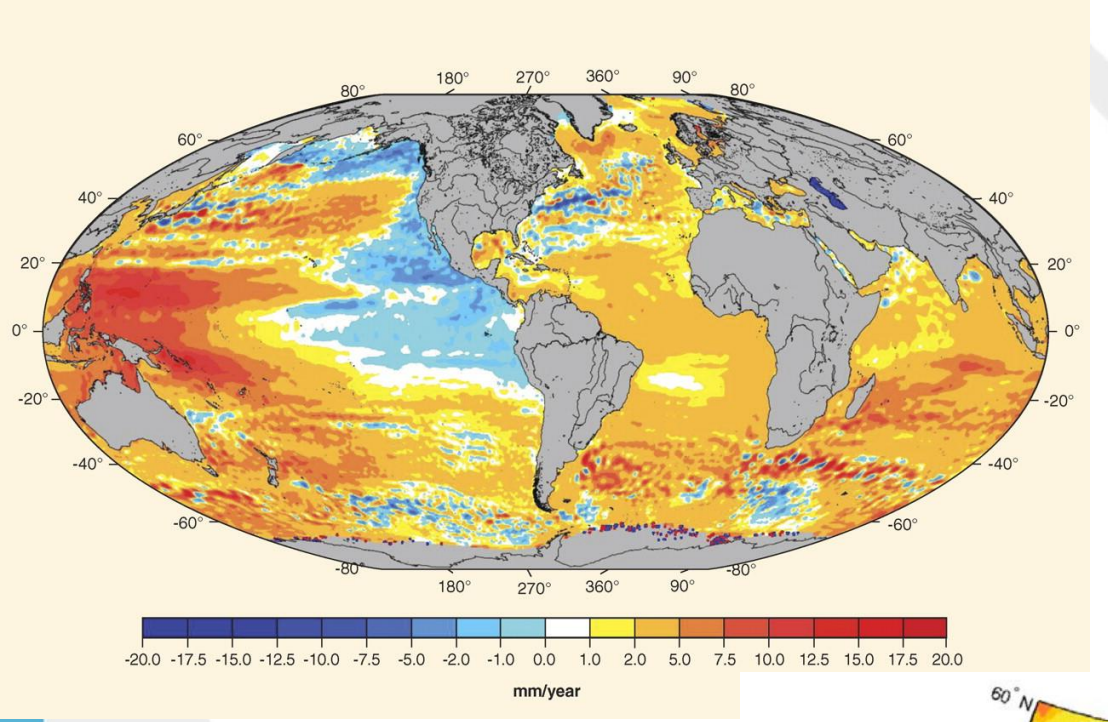
1900-2100: ≈ 50-120 cm. CENTRAL VALUE: ≈ 80 cm

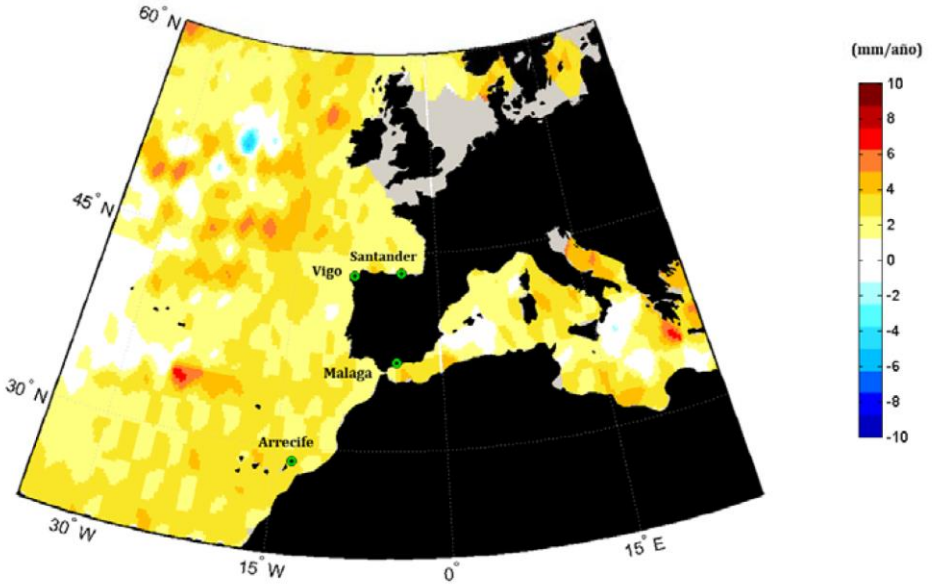


RCP2.6 (blue)

RCP8.5 (red)

SEA LEVEL RISE. REGIONAL VARIATION





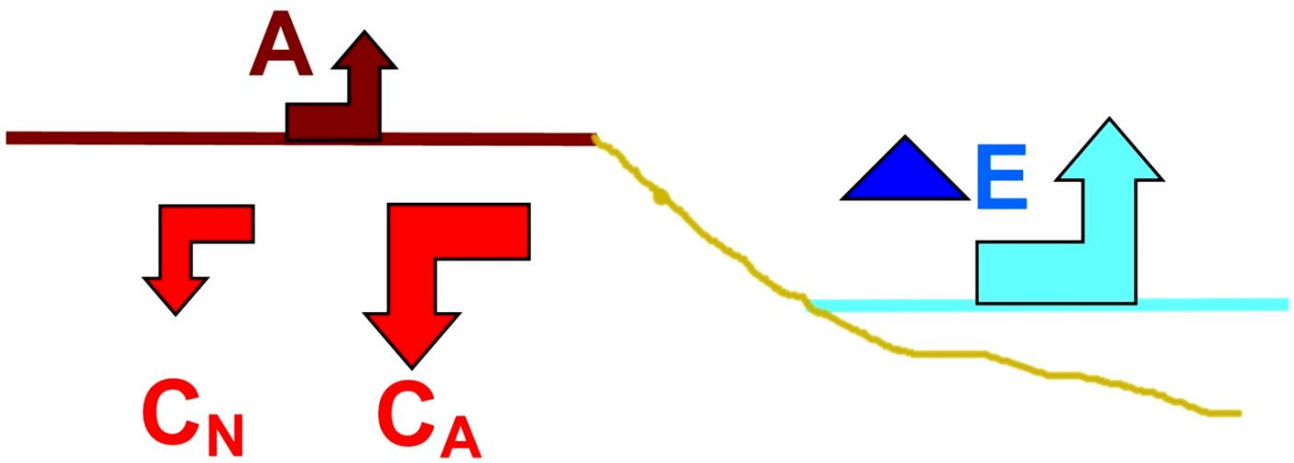
DELTAS SUBSIDENCE RATE. Δ (mm/year)

	NATURAL	ANTHROPOGENIC
PO	3	10 extraction of methane gas (1930-64). Average :2.00 m MAXIMUM: 3.00-3.50 m
NILE	4-5	
EBRO	3	
RHONE	0,4-1,5	

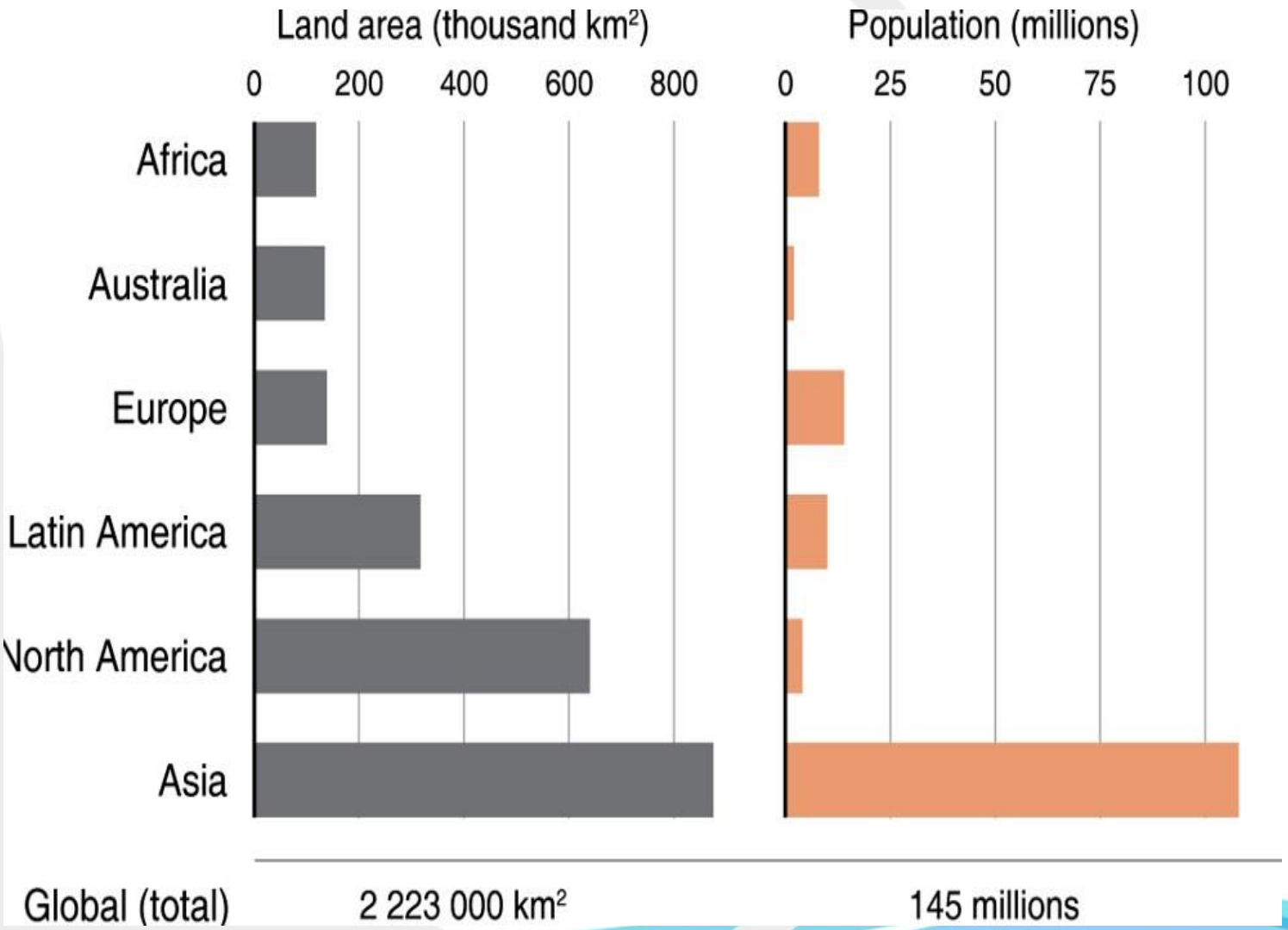
RELATIVE SEA LEVEL RISE. RSLR

ESSENTIAL FACTORS

$$\Delta_{RSL} = A - \Delta E - C_N - C_A$$



GLOBAL IMPACTS ON THE COASTS, ISLANDS, AND DELTAS FOR A RISE SEA LEVEL OF 1 m.



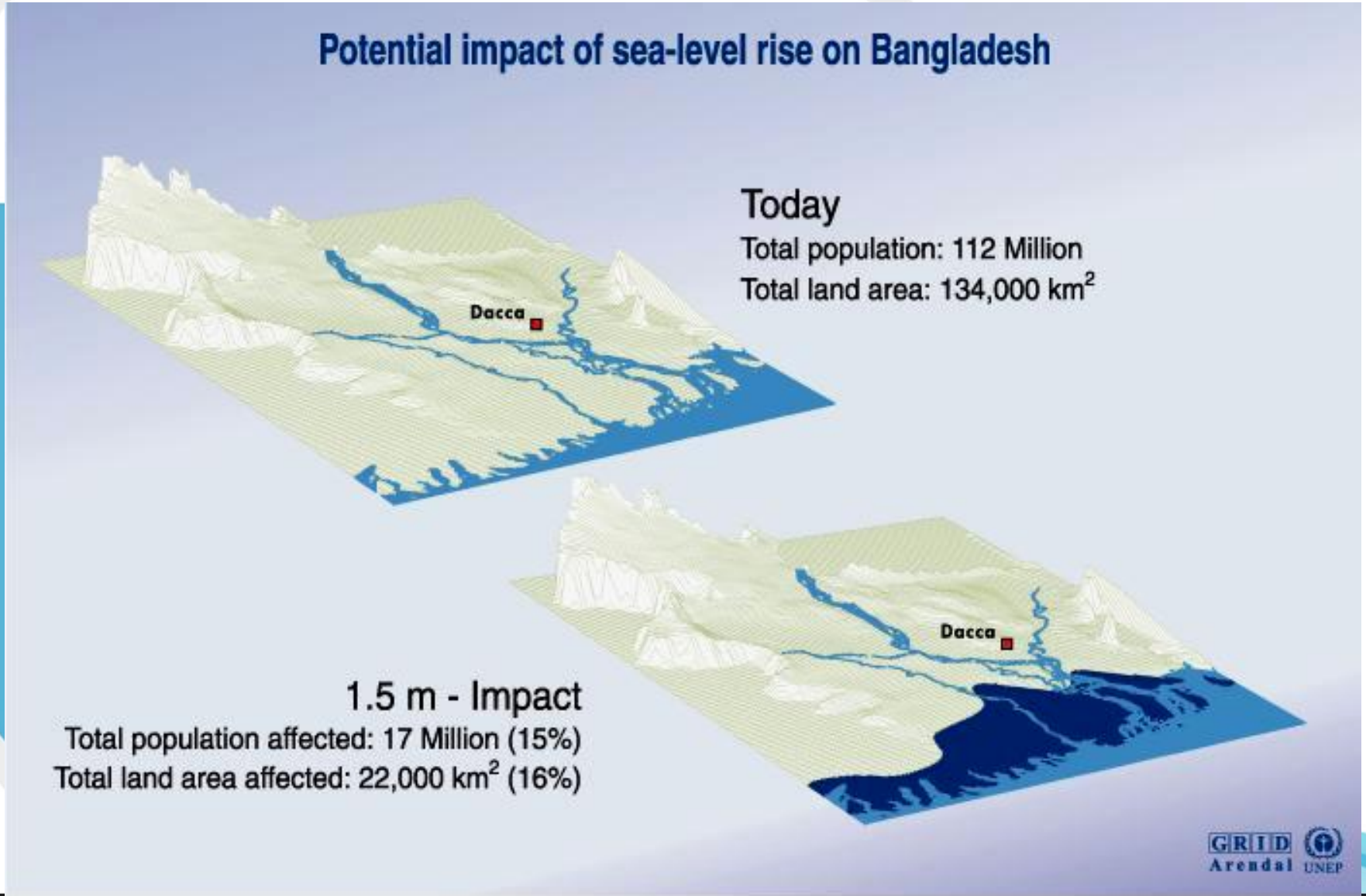
DELTAS VULNERABILITY

- The deltas are very fragile and very **vulnerable to sea level rise**, which can lead to the **submersion** of very sensitive parts of their current socio-economic and environmental existence

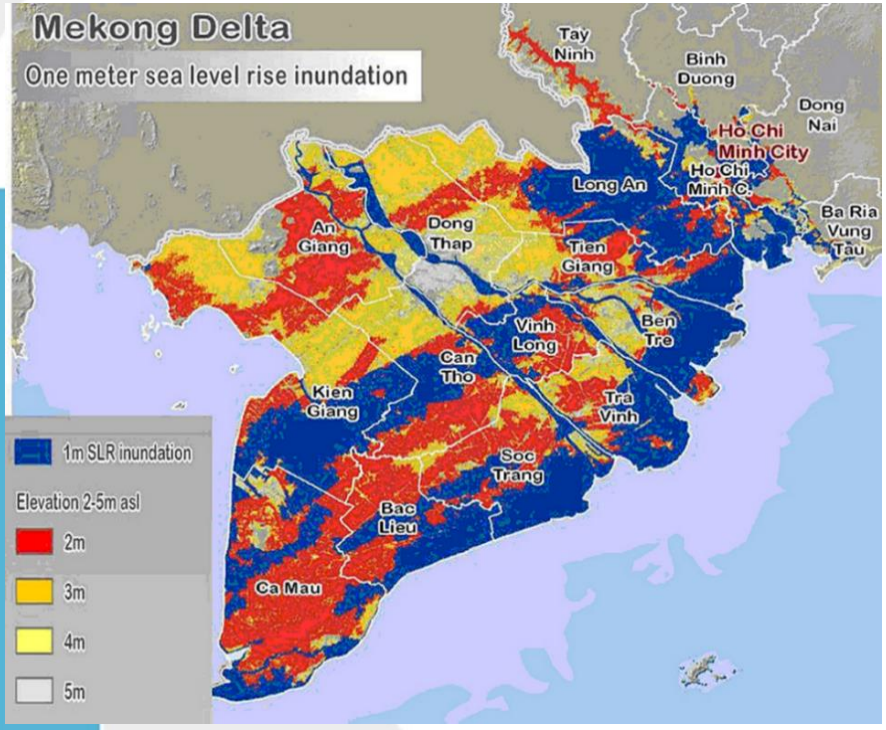
- At present the most important risk of the deltas is the rise in sea level. **Severe risk**, which could affect their own existence, because they have large areas that are at levels below 50 cm, or the meter.

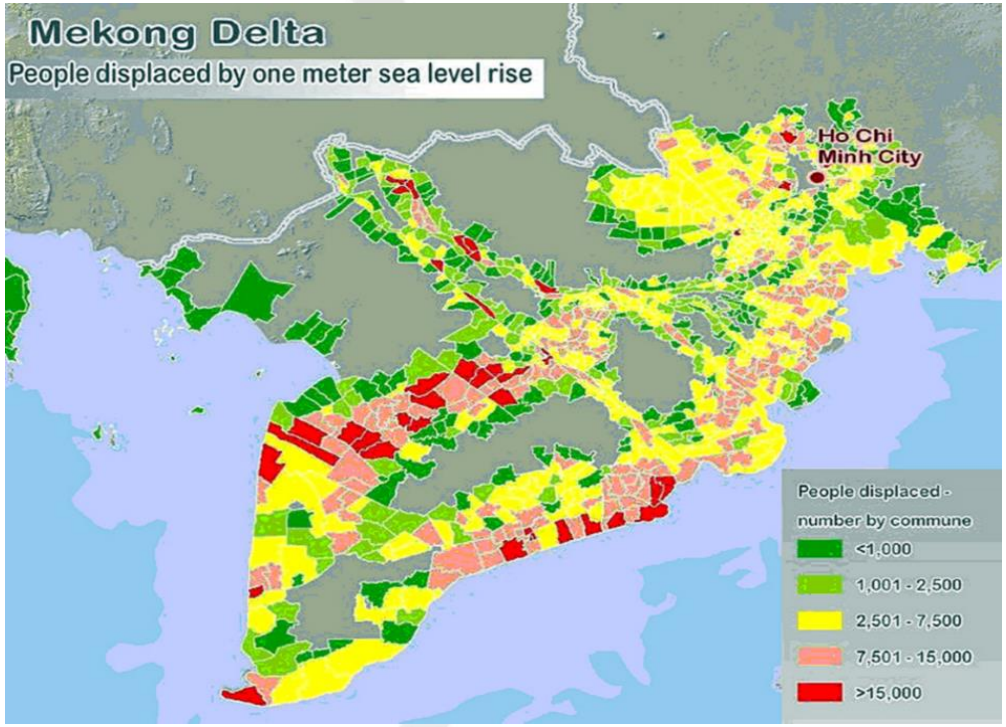
- This is compounded by the effect of adjacent **subsidence**, which makes that **relative sea level rise (RSLR),** would reach dangerous levels that could cause the submersion of a large part of the delta plains.

GANGES DELTA. BANGLADESH. +1.5 m



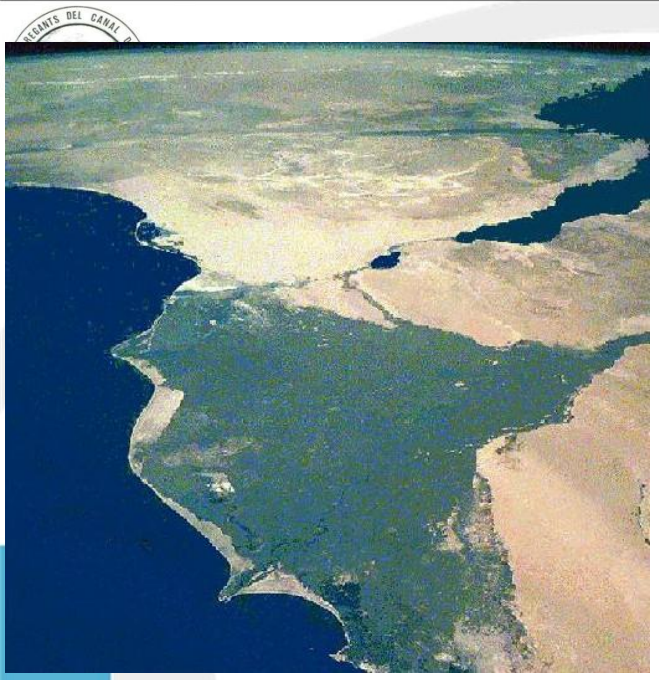
MEKONG DELTA. VIETNAM
+1.0 m



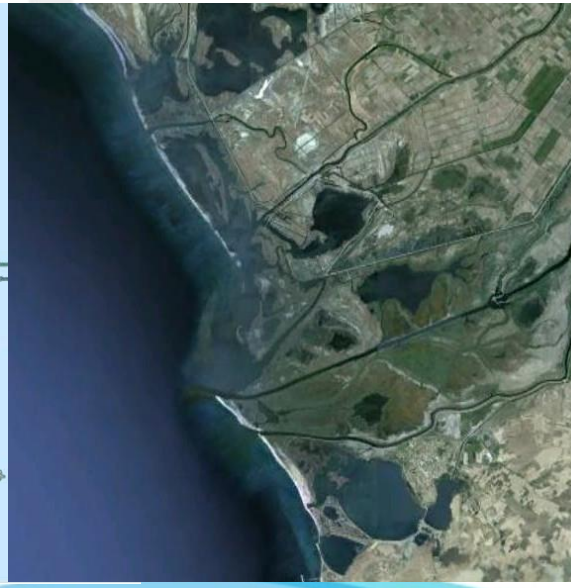


1/3 DELTA AREA

12% VIETNAM POPULATION
HO CHI MINH PERIPHERAL AREAS




Golf
de
Roses
MAR MEDITERR

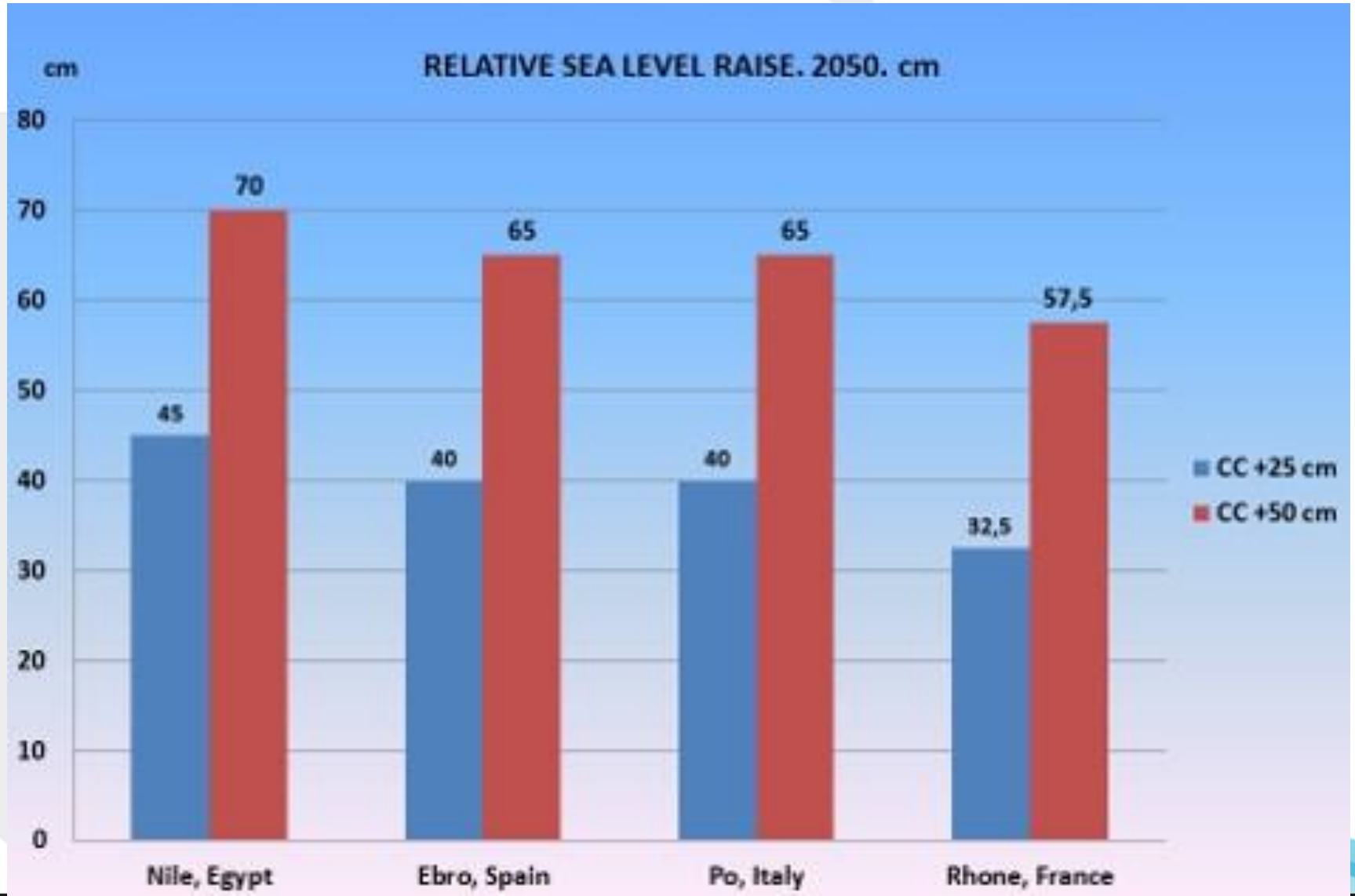


MEDITERRANEAN DELTAS

	AREA Km^2	POPULATION	DENSITY Inh/ Km^2	MAIN ACTIVITIES
NILE	**50.000**	**45 Million**	900	AGRICULTURE FISHING
DANUBE	**5.800**	**16.000**	3	NATURE AGRICULTURE, FISHING
RHONE	**750**	**7.500**	10	NATURE, TOURISM, AGRICULTURE
PO	**420**	**27.500**	80	AGRICULTURE, FISHING TOURISM,INDUSTRY NATURE
EBRO	**320**	**15.000**	45	AGRICULTURE, FISHING NATURE

DELTAMED
Mediterranean Deltas Association

MEDITERRANEAN DELTAS
RELATIVE SEA LEVEL RISE (RSLR). 2050.



Δ. NILE
SEA LEVEL RISE

Potential impact of sea level rise: Nile Delta

GRID Arendal UNEP IUCC

0 50 km

Sources: Otto Simonett, UNEP/GRID Geneva; Prof. G. Sestini, Florence; Remote Sensing Center, Cairo; DIERCKE Weltwirtschaftsatlas.

Potential impact of sea level rise: Nile Delta

Population: 3 800 000
Cropland (Km²): 1 800

Population: 6 100 000
Cropland (Km²): 4 500

EBRO DELTA. RELATIVE SEA LEVEL RISE

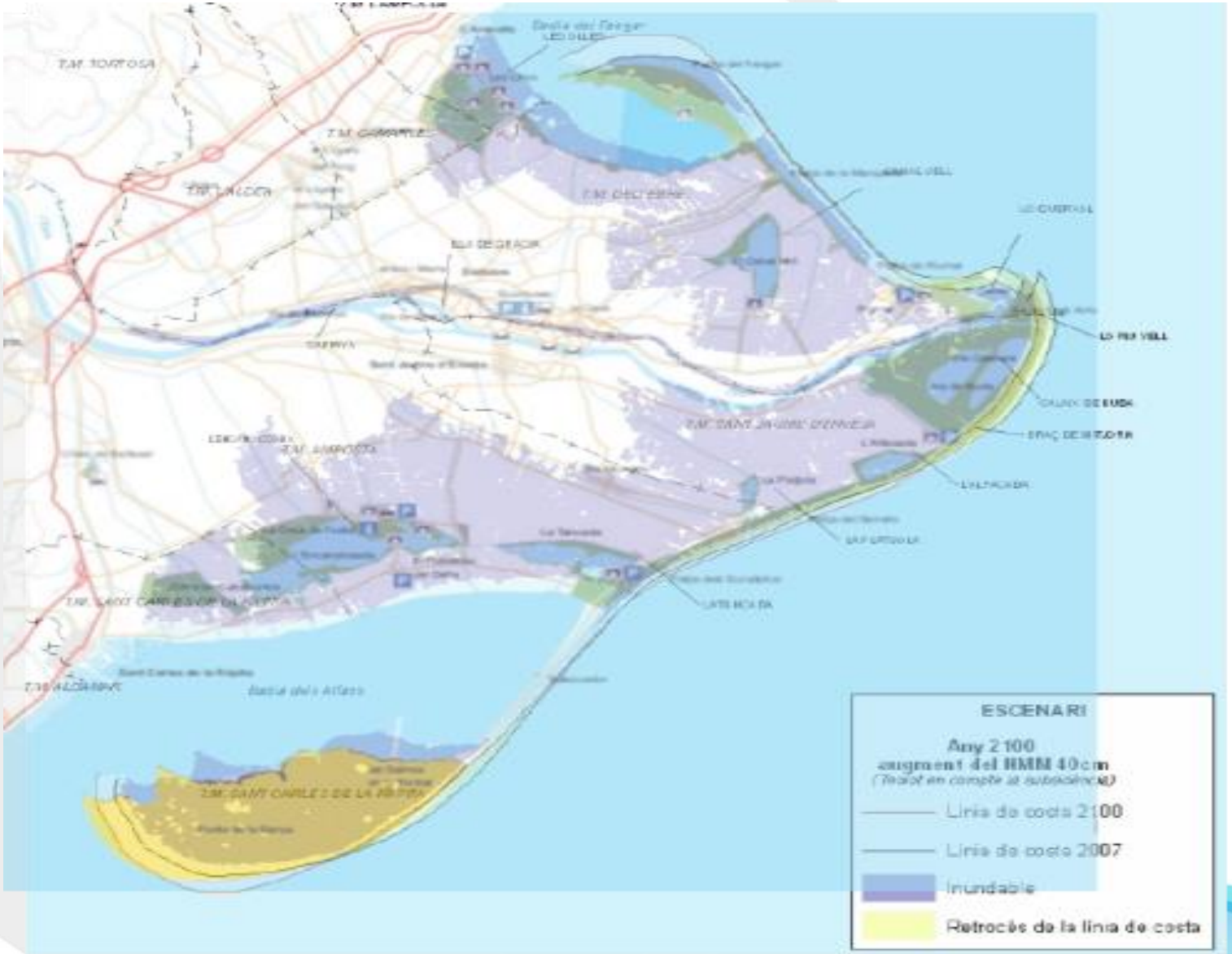
- The relative sea level rise (RSLR) is assessed for two emission scenarios (RCP4.5 and RCP8.5) **between 60 cm and 90 cm**, toward the end of the 21st century . In a shorter period, by **the middle of this century**, the RSLR would be **between about 30 cm and 45 cm**
- The Ebro delta is a very **flat plain** with maximum levels of around 1m, and most of its surface (about 50%) is at levels lower than 50cm.

EBRO DELTA. RELATIVE SEA LEVEL RISE

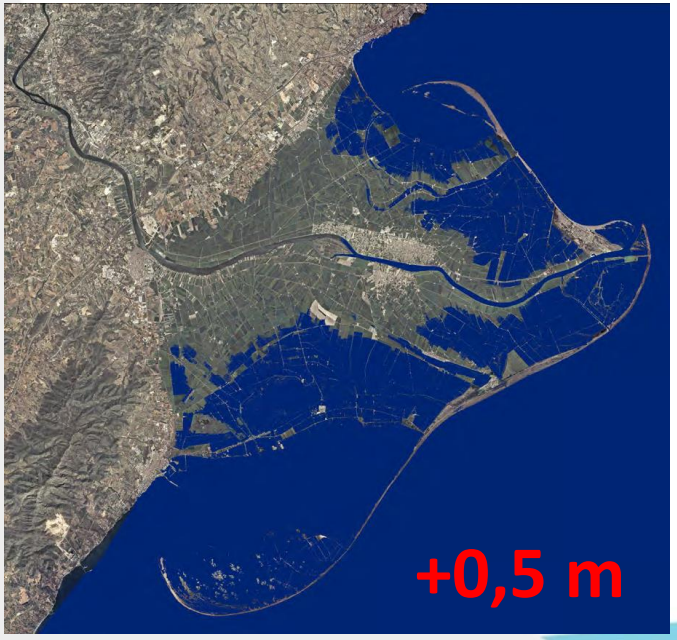
15 cm

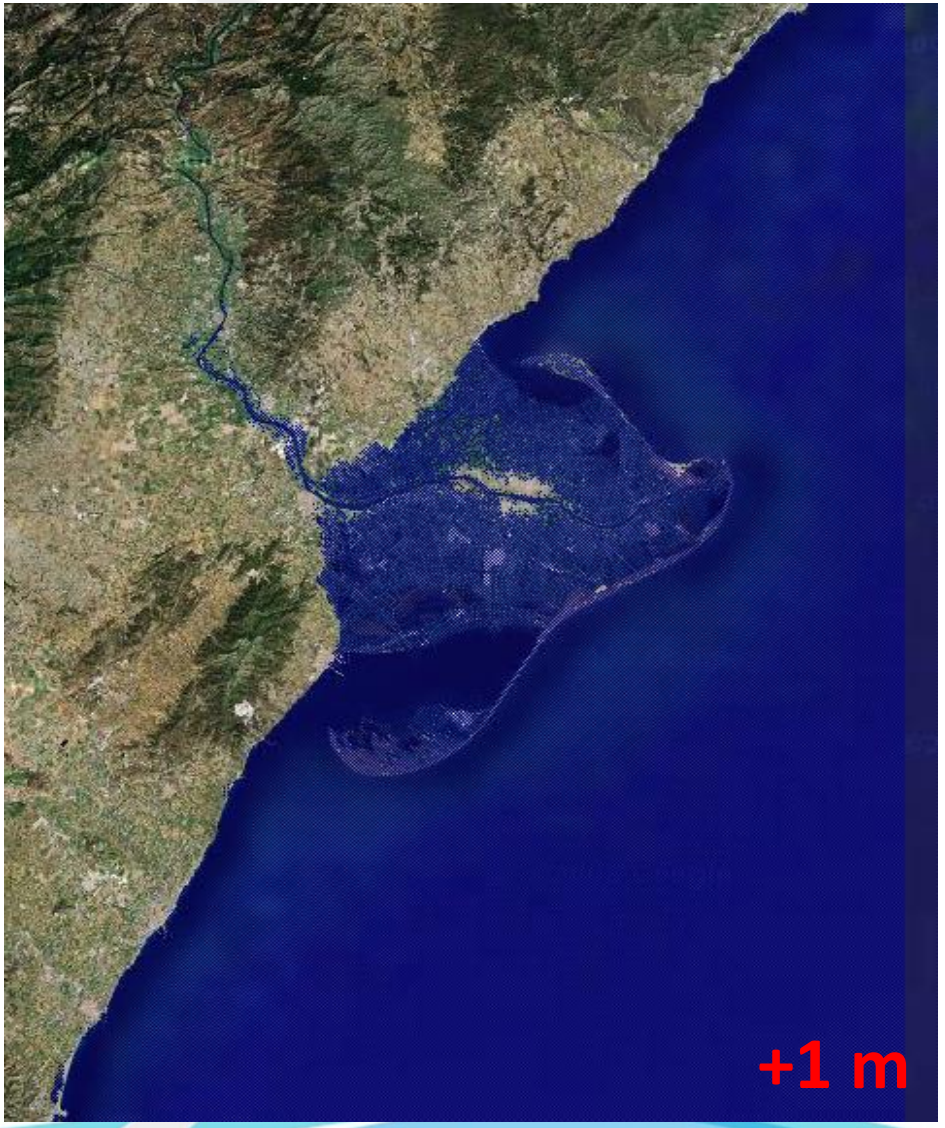
40 cm

EBRO DELTA. SEA LEVEL RISE +0,40 m.
Ebro Delta Natural Park



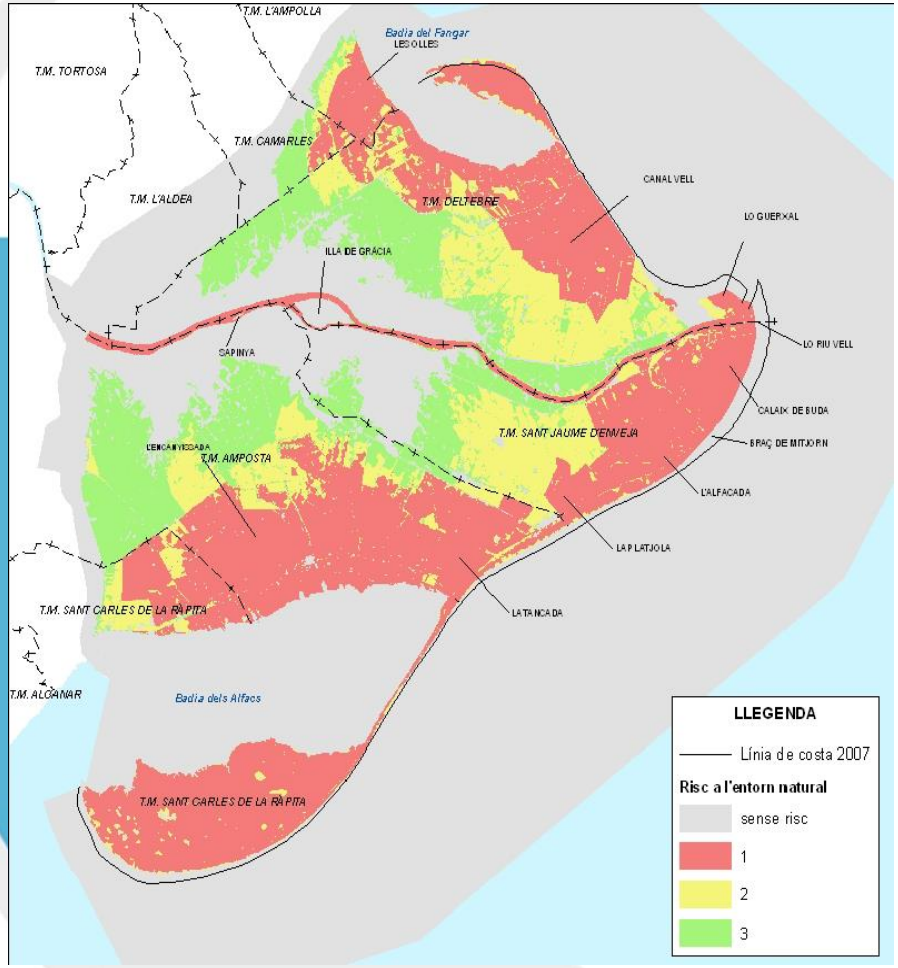
EBRO DELTA. SEA LEVEL RISE. + 0,5 m. + 1 m.

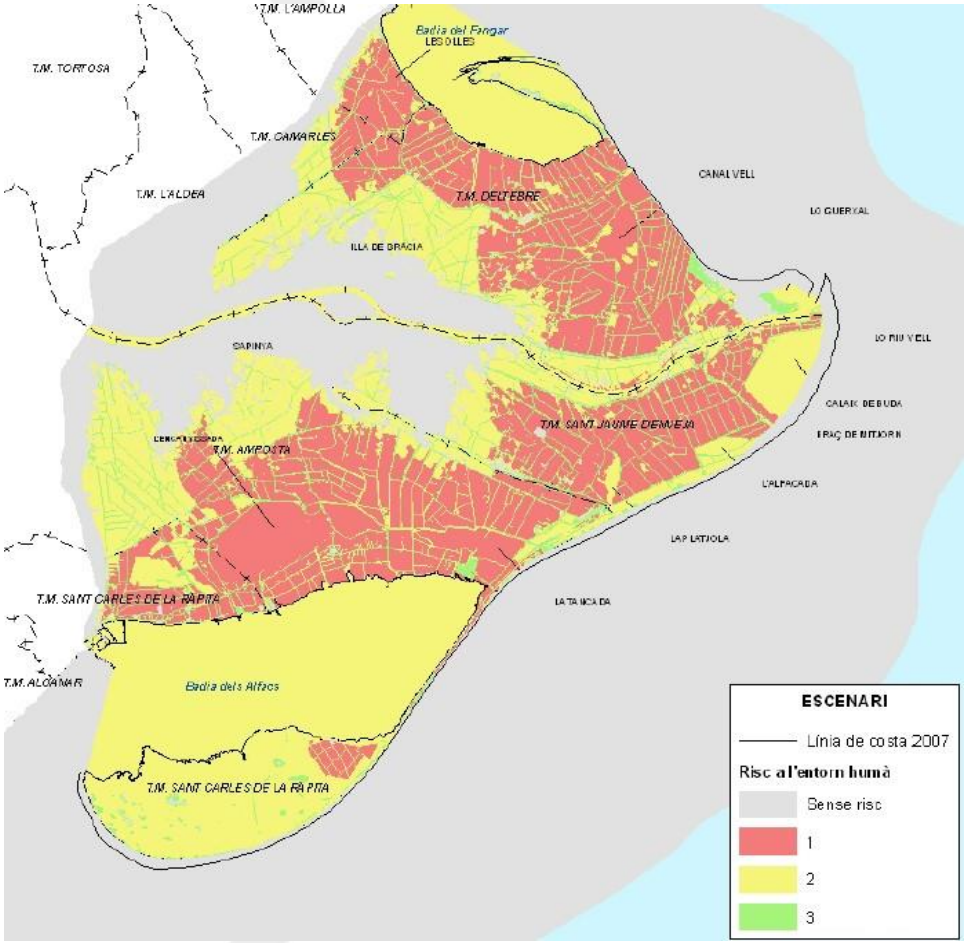




EBRO DELTA. SEA LEVEL RISE . + 2ºC

RISK MAPS





NATURAL SYSTEMS

HUMAN SYSTEMS AND POPULATION

DELTAS. ACTIONS AND MEASURES FOR ADAPTATION TO SEA LEVEL RISE. ALTERNATIVES

- **Renaturalization** of the deltas. Conversion of the delta to earlier, more primitive states

- **Artificial accretion**. Sediment supply to the delta plain

- **Removal of cultivation areas** and other activities in the lower parts of the deltas and their **transformation into wetlands**

- **Non-intervention.** Progressive abandonment of environmentally rich areas and urban and agricultural areas

- **Combination of structural actions**

COMBINATION OF STRUCTURAL ACTIONS

- One of the possible, viable and effective actions to **reduce the vulnerability** of the deltas and **increase their resilience** to climate change are **structural solutions**

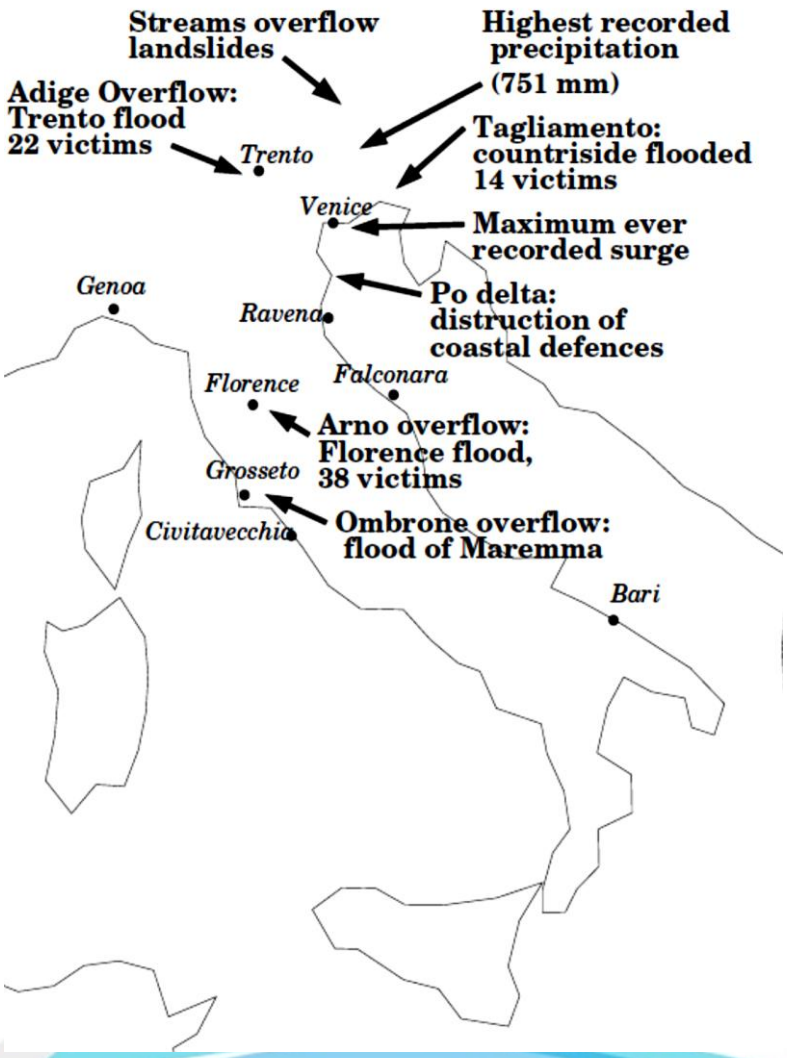
- Combining and coordinating traditional structural types (**gray infrastructure**) with more natural structures (**green infrastructure**). Working with nature.

PO DELTA FLOODS. 1966

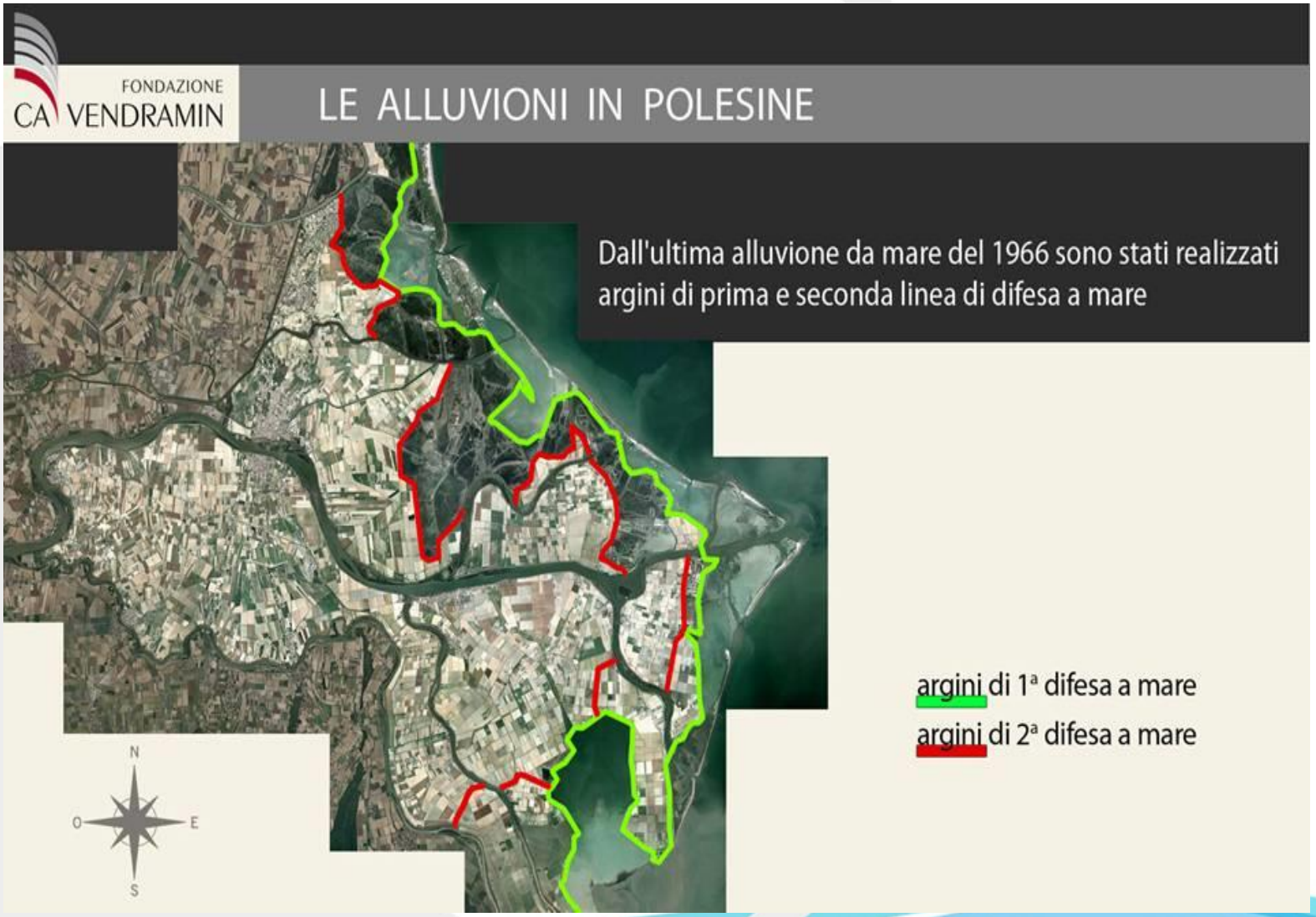
-In November 1966, Italy suffered a **major storm** which caused severe flooding, producing about 120 fatalities and extensive damage.

-The floods in Florence, the highest tide recorded in the Venetian lagoon, with “aqua alte” reaching +2 m, and **the destruction of the coastal defences of the Po delta.**

-After these floods, **the current, sea dikes and river dikes of the Po delta were constructed. Completed in 1980.**



PO DELTA. SEA DEFENCE
DOUBLE LINE OF DIKES



THE FIRST LINE OF DIKES

-The dikes : earth type. , with a protection of rockfill up to level + 1 m.
-The top level is + 4.00 m above sea level, and the length of its base is about 50 m.

THE SECOND LINE OF DIKES

-The dikes :earth. Top level + 2.50 m above sea.
-In the north of the main branch of the Po, these levees divide the agricultural territory from the fishing valleys (fish farms).

COASTAL DUNES

On the coast there are, in some areas, some coastal dunes. Its crest level is variable between + 1.00 m and + 2.00 m above sea level,

DELTA PO. ZONES

-1.Open delta. Area between the coastal dunes and the first line of defence. Connected directly to the sea through the mouths in the dunes.

-2.Closed delta. Area between the first and second line of defense. Separated from the sea by the first line of dikes.

PO DELTA. RIVER DIKES

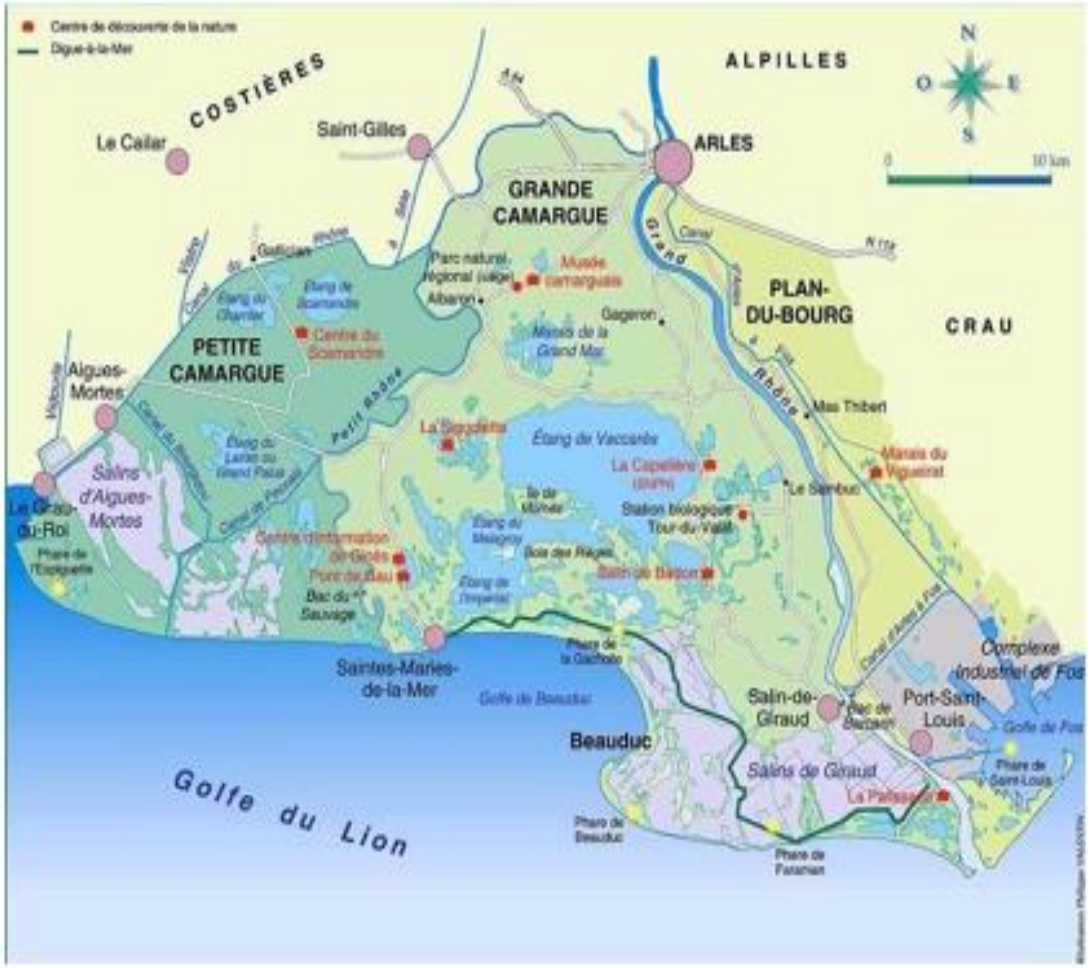
-In the Po river there are also dikes of defense against the fluvial floods, that channel the river through dikes. Dikes crest levels varying between + 4.00 m and + 14.00 m

-In general the river flows very high above the deltaic plain. Hanging waterway

-

RHONE DELTA

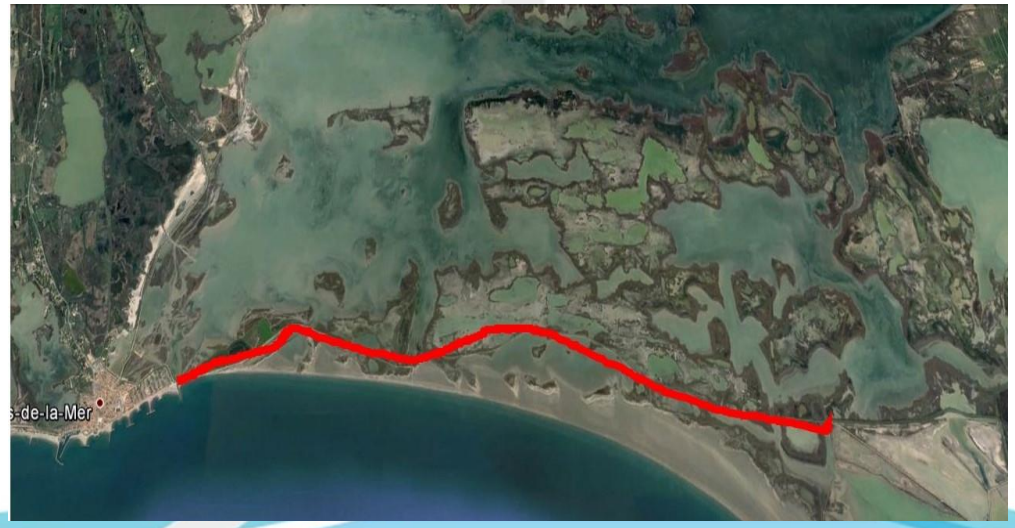
After the severe floods of 1856 Napoleon III made the decision to build new dykes in the river, and also to defend the delta sea front for the protection of the deltaic territory.



RHONE DELTA. SEA DIKE

- A dike for the sea defence ("Digue à la mer") was constructed, designed to prevent the effects of storms.

- Length of about 25 km along the coast of the Camargue, south of the lagoon of Vaccarès in the National Reserve of the Camargue. Crest level + 1m



RHONE DELTA
SEA AND RIVER DIKES

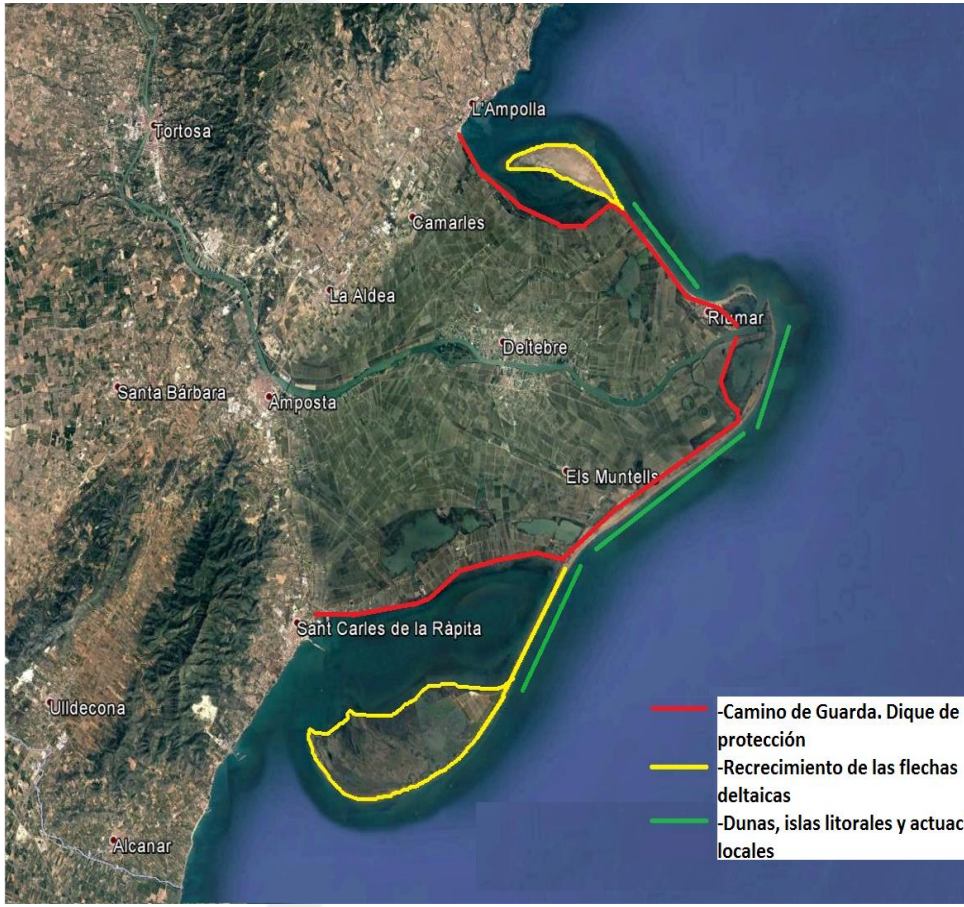
The two active branches of the river Rhône, Great Rhone and Little Rhone, were channelled by dikes in their totality. Thus, as early as the nineteenth Century the Camargue was artificially closed in its entirety, by sea defence dikes and river dikes

EBRO DELTA. ACTIONS PROPOSAL

1.-Perimeter **dike** for the protection of the inland delta plain**(red line)**

2.- **Heightening the coastlines arrows (yellow line)**

3.- **Coastal front protection (green line)**



EBRO DELTA. ACTIONS PROPOSAL

1.-Perimeter **dike (red line).**

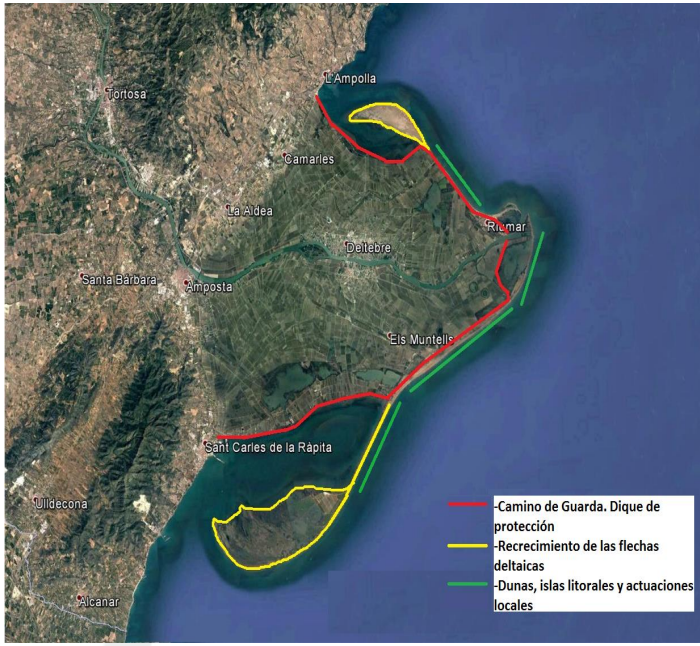
Earth type. Length of about 50 km. Crest: level, + 1.50 m to +2.0 m, width 4-5 m.

2.- **Heightening the coastlines arrows (yellow line)**

Artificial supply of sands up to +1 m to +2 m, to be progressively coupled to the RSLR, and to maintain, in general, its current coastal structure and dynamics.

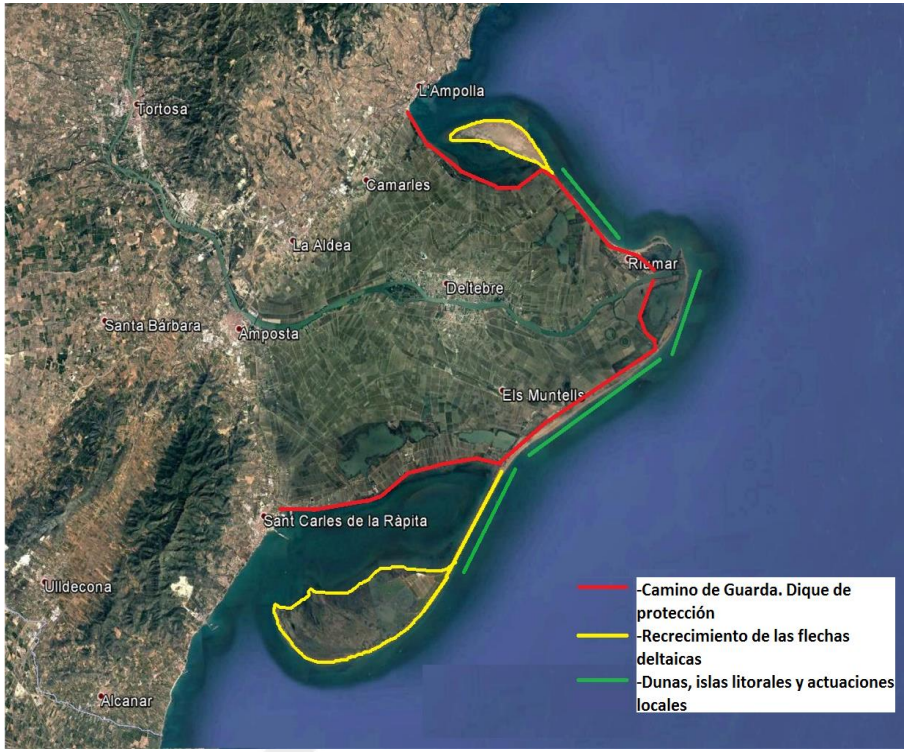
3.- **Coastal front protection (green line)**

Dunes and coastal artificial islands, with various configurations : exempt or low coronation, to partially dissipate the energy of the incident external waves.



EBRO DELTA. ACTIONS PROPOSAL

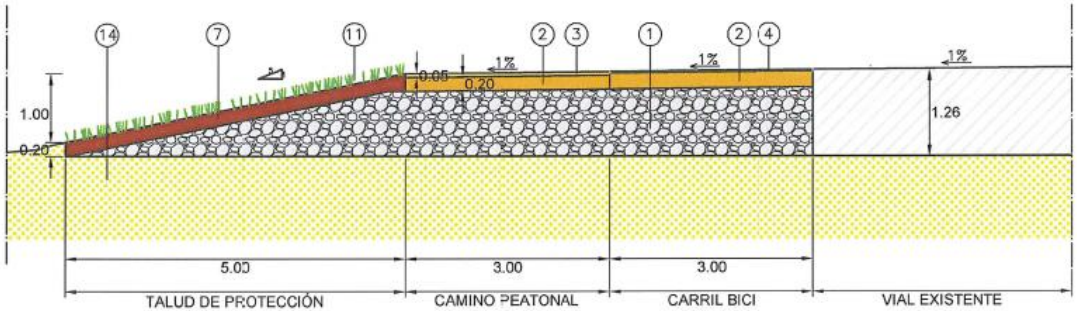
- **Two lines of defence:** the first active and dynamic (yellow and green lines) located on the coastline, the second (red line) with a perimeter dike to avoid submersion and flooding of the inland part of the delta plain.



- Initial assessment of the cost : about 170 M€

PERIMETER DIKE CONSTRUCTION

SECCIÓN A A' Escala 1/100



IMPACTS OF CLIMATE CHANGE IN THE DELTAS

- Submersion of the deltas, due to sea level rise
- Changes and losses in lagoons and wetlands
- Increase of regression and other morphological changes of the coastline
- Changes in river floods and sea storms
- Increase of salt water intrusion. More saline environments
- Increase in penetration and permanence of the salt wedge
- Affection to the drainage network. Increase of drainage pumping.
- Changes in the availability of water resources

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