22 maggio 2019 – Mestre Venezia

SEMINARIO MORFOLOGIA LAGUNARE: STATO E PROSPETTIVE

L'evoluzione storica della Laguna di Venezia – Stato delle conoscenze

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Direttore, Consorzio per il coordinamento delle ricerche inerenti al sistema lagunare di Venezia

NASA SeaWiFS Image

Venice is placed almost at the top North of the Adriatic sea,
and experiences the tide with the largest excursion in the Mediterranean (1m) .

Location: 45°10’ N 12°40’ E, Length: ab. 51km. Width: ab. 12km. Perimeter: 157km.

Total surface: 540km^2, of which 8% land above sea level (littorals, reclaimed areas, islands, embankments) and 92% “water system”: channels (11,9%), shallows, mud flats and salt marshes (80,1%).

Channels and open waters (depth >150cm): 66km^2.

Shallows (depth between 150 e 40 cm): 243km^2.

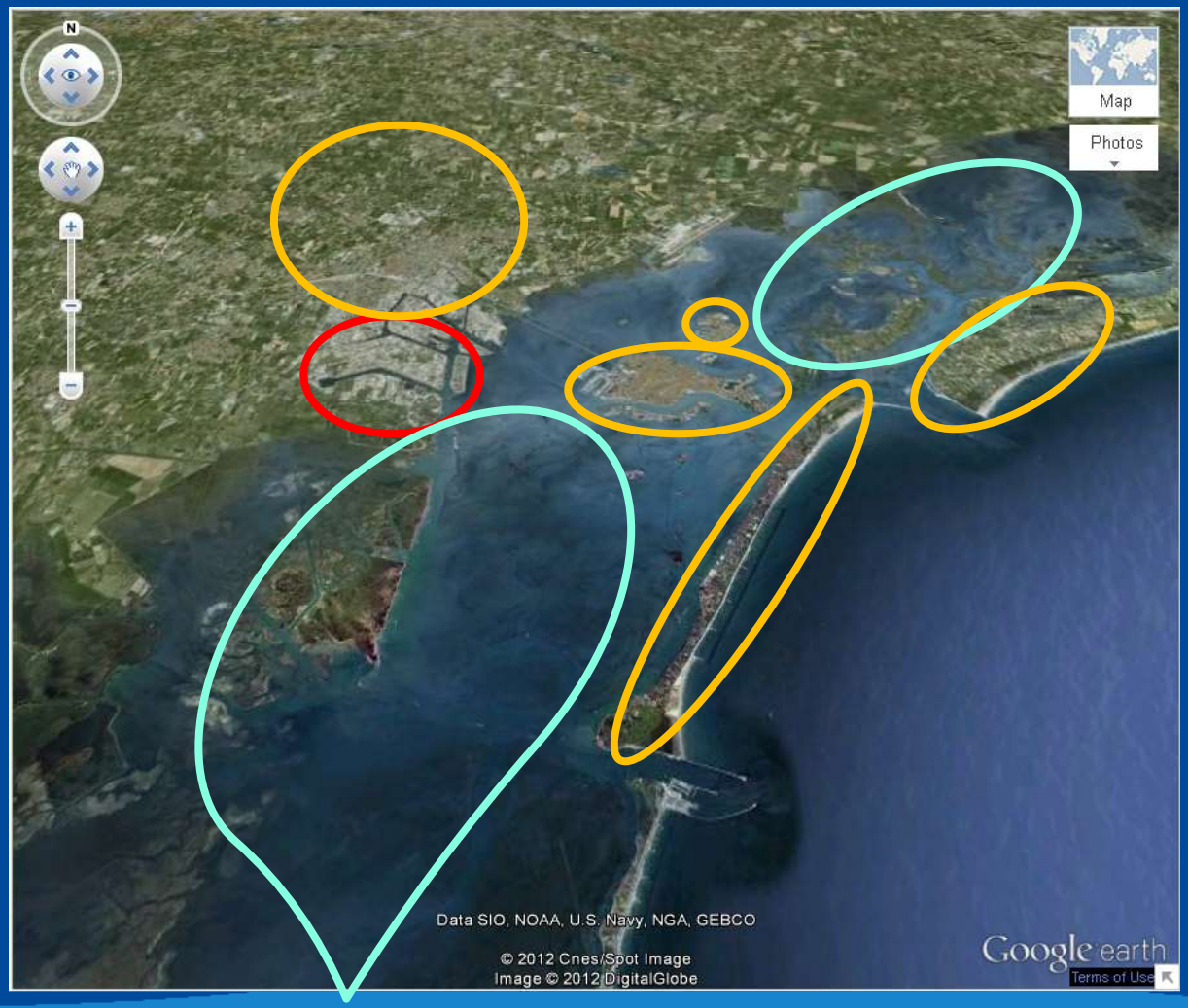
Mud flats (inertial areas between –0.40 and +0.24 on the m.s.l.): 98km^2.

Salt marshes (areas higher than +0.24m, but flooded by high tide): 11km^2.

Embanked fish farms: 92km^2.

Islands: 29km^2.

Venice and its environments



- The INDUSTRIAL AREA

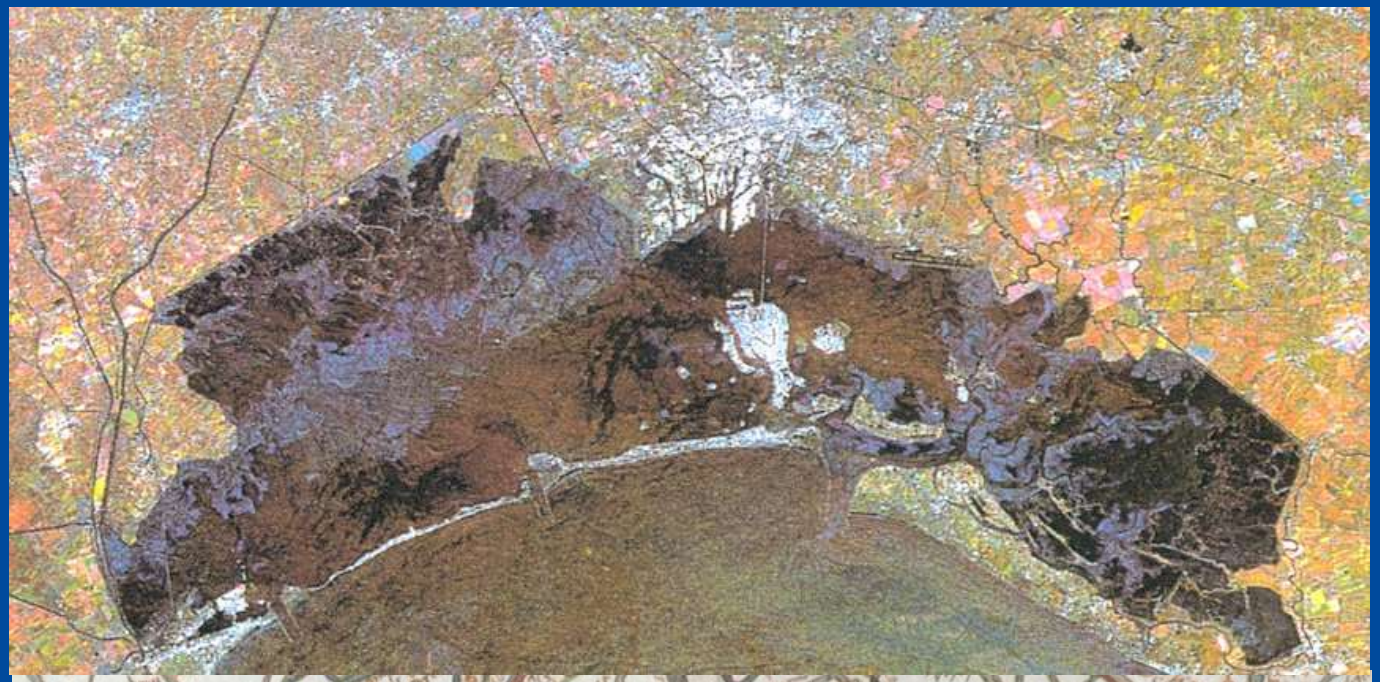
- The WATER SYSTEM
  - Channels and open waters
  - Shallows
  - Mud flats
  - Salt marshes

The URBAN AREAS
- In the mainland
- In the islands
- In the littoral

WHAT A LAGOON IS MADE OF?

G. Di Silvio (UNIPD)

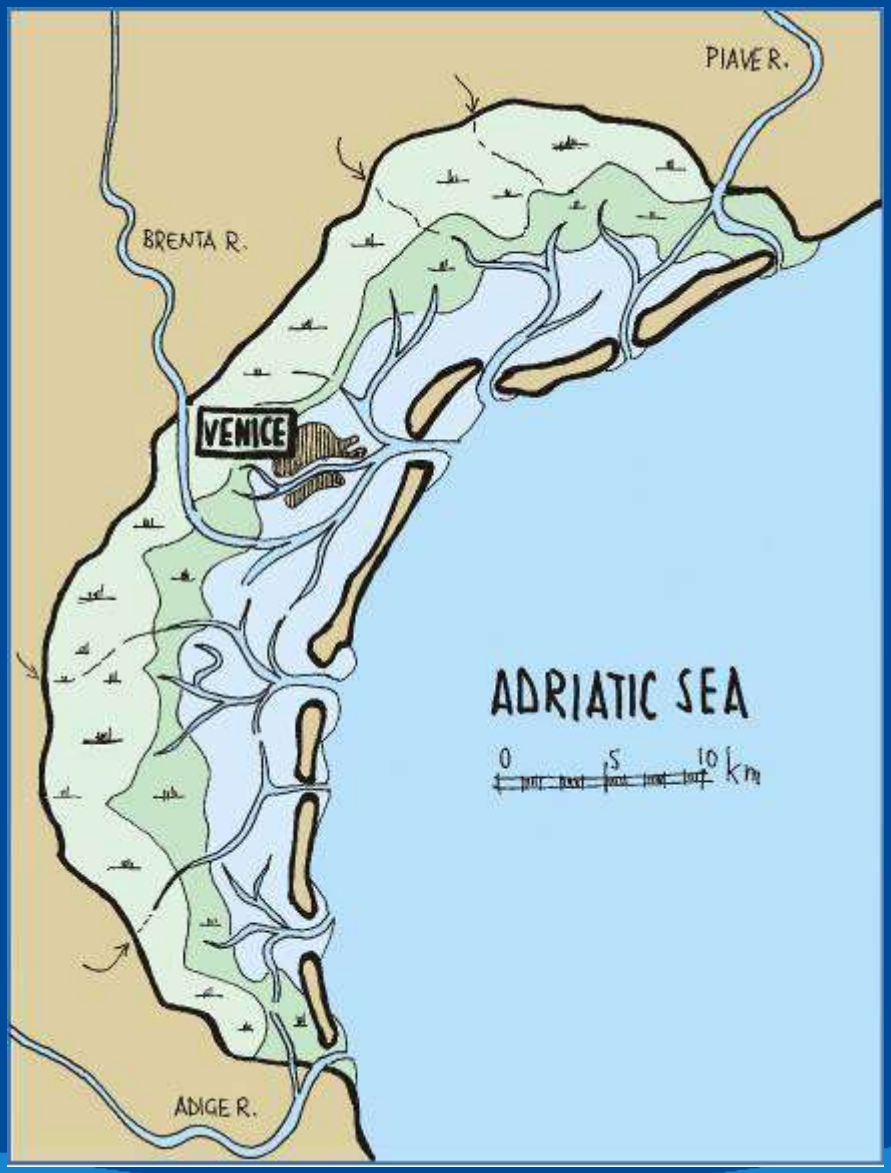
La laguna: il presente ed il passato



In the XIV century, the lagoon of Venice was different from today:

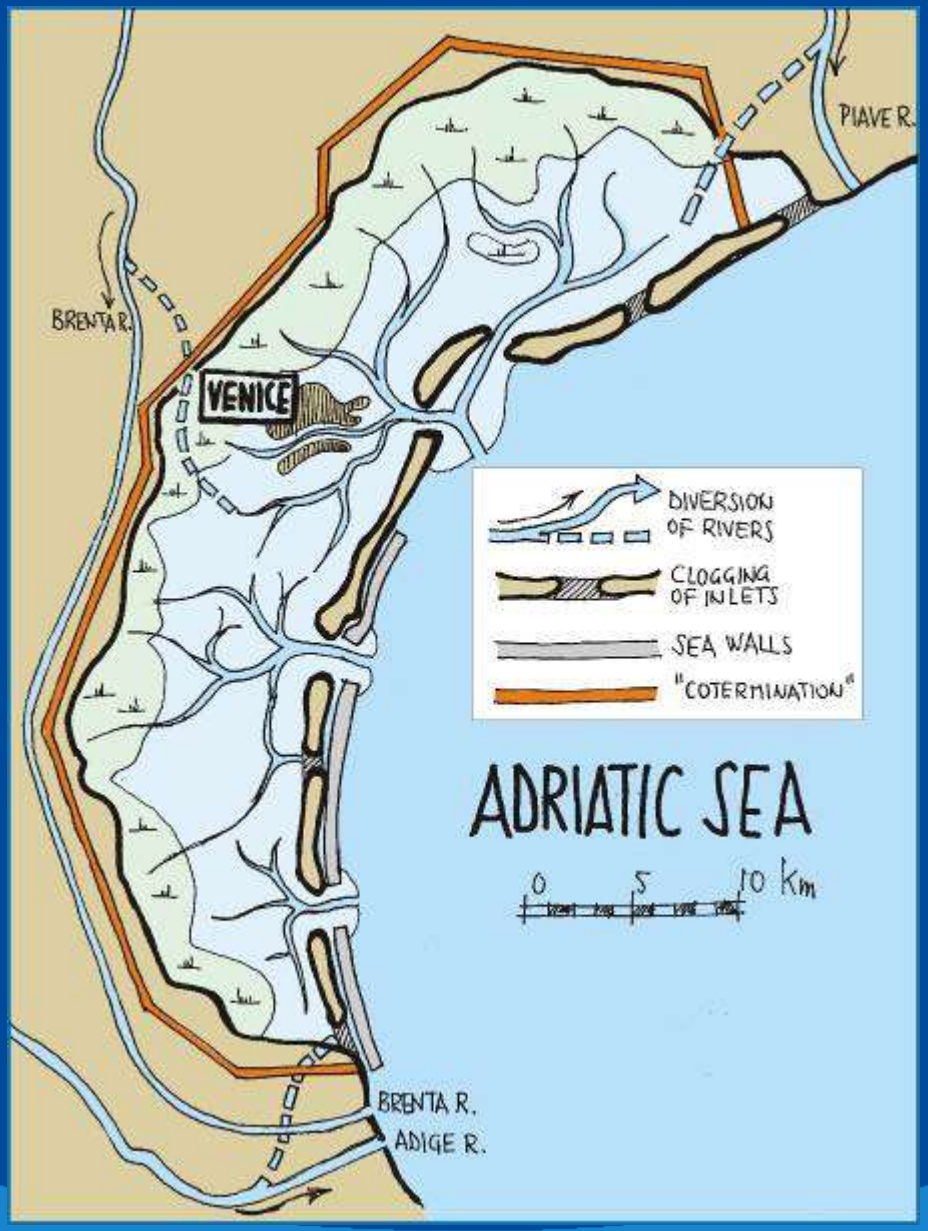
- large rivers flowing into the lagoon
- 5 - 8 unstable inlets
- large extension of marshes
- tendency of tidal flats to become silted

risk of infilling of the lagoon



The survival of Venice (commercial, military and even physical) was put in jeopardy by the siltation of the lagoon

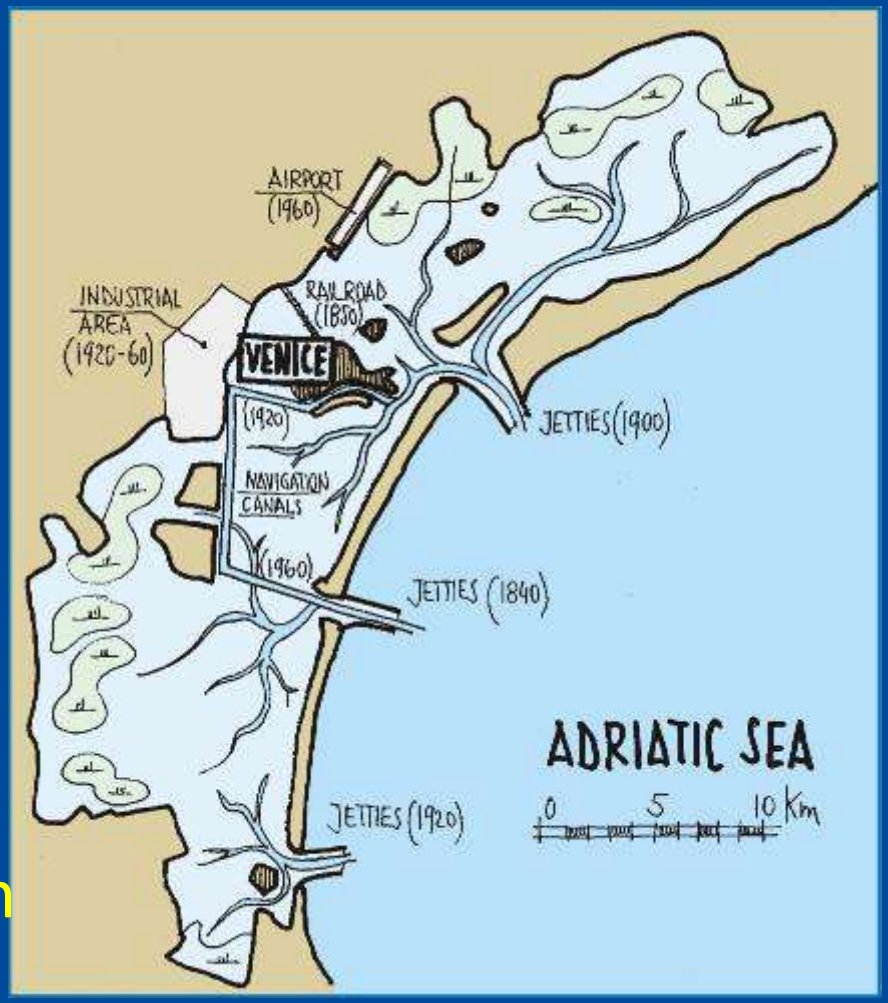
From the XIV to the XVII century great care was taken by the *Serenissima Repubblica* to defend its lagoon “against sea, rivers and man”



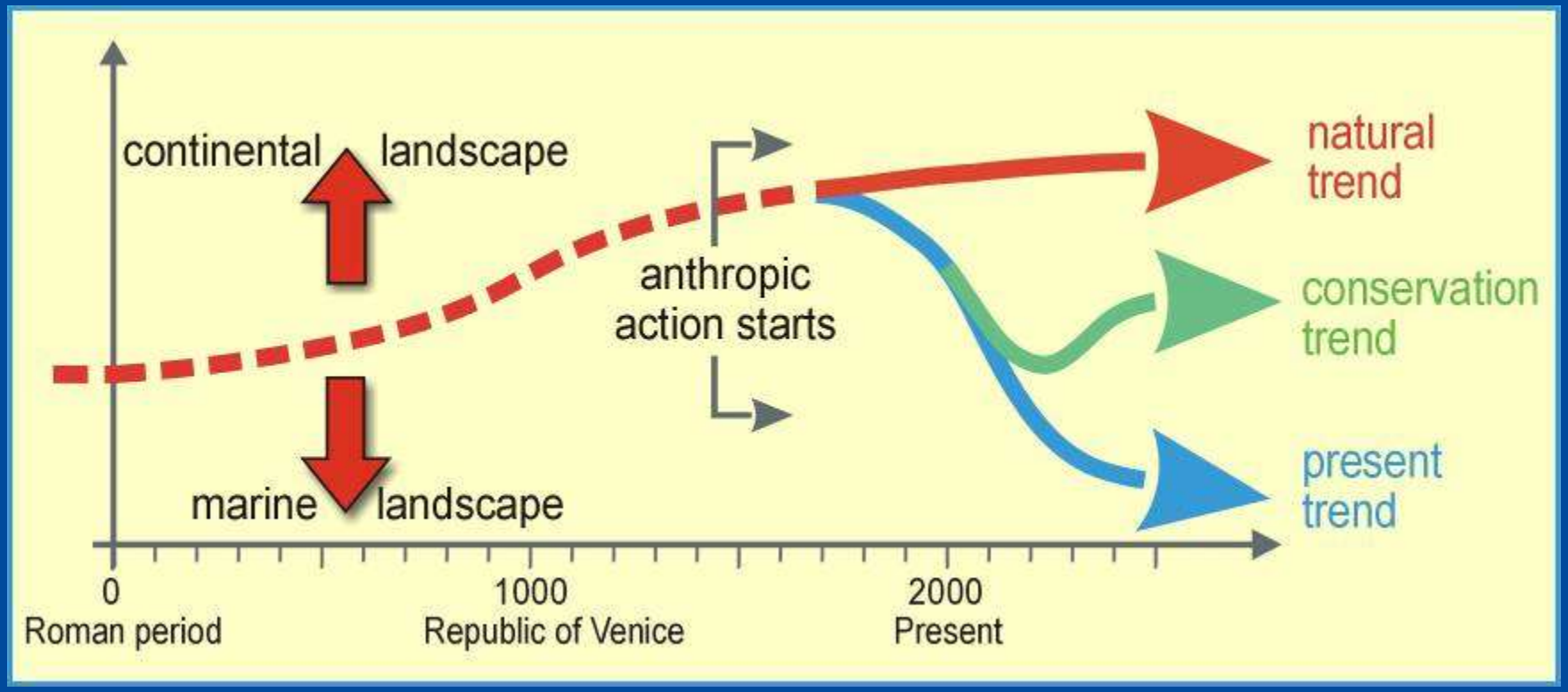
Around the XVIII century the political decadence of Venice brought to a halt the interventions in the lagoon

Over the past 150 years, by contrast, the lagoon was subject again to large modifications

In 1950-1970, groundwater withdrawal produced 13-14 cm of soil subsidence,
pushing the total altimetry loss in last 100 years (including sea level rise) up to 23 cm s.m.l.



Morphological evolution of the Lagoon of Venice



Present conditions are somehow reversed with respect to the XIV century

- No large river flows into the lagoon
- Long jetties prevent sediment input from the sea
- Deep navigation canals trap sediments
- Soil subsidence increases water depth

} Frequent flooding and morphological deterioration

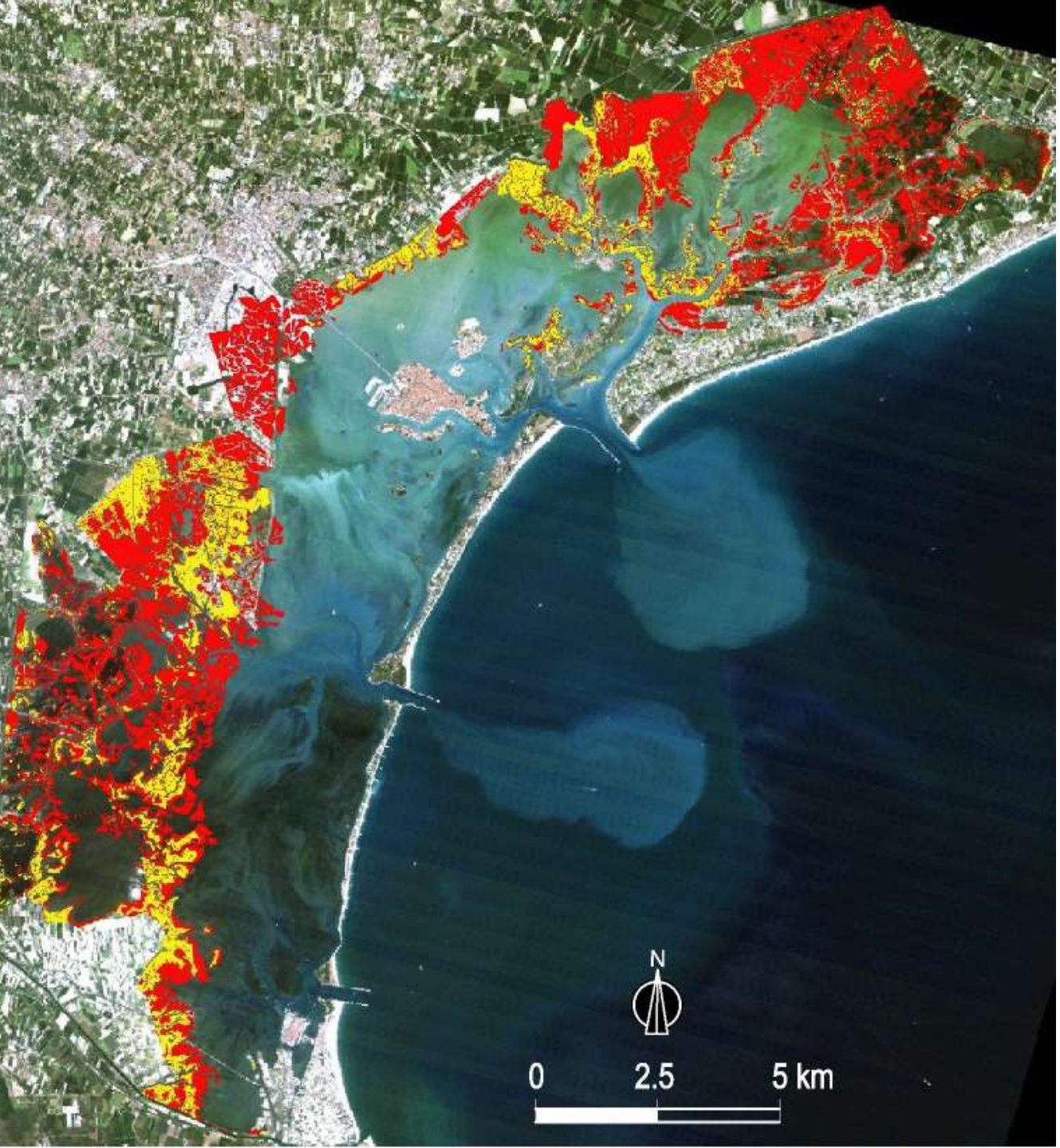
Murazzi e ripascimenti

Cavallino

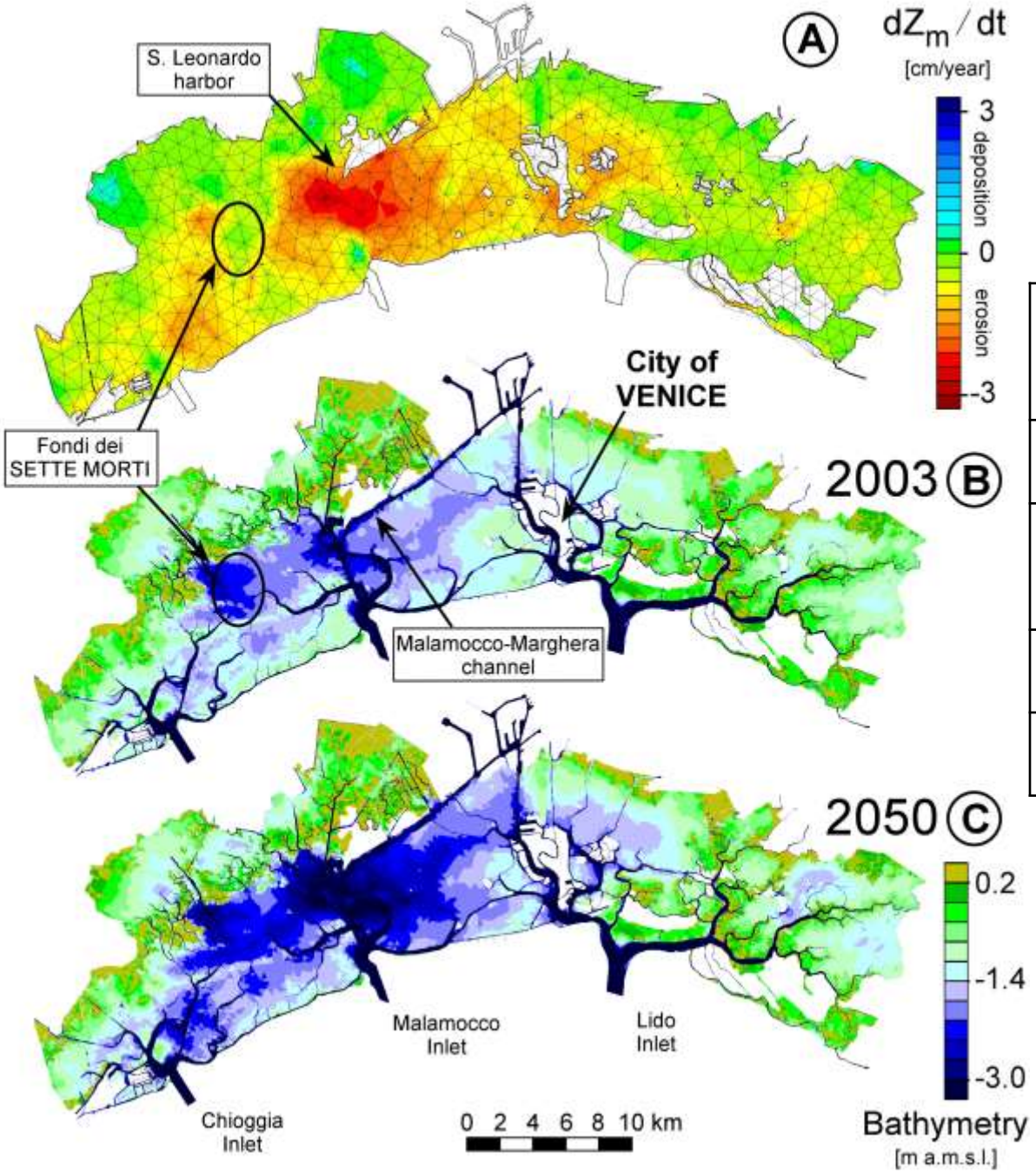
Pellestrina

Una nuova spiaggia 9 km - 5,000,000 m^3 di sabbia.
18 celle di contenimento, collegate da una diga sommersa parallela alla costa, 300 m dalla battigia.

11 km of di spiaggia,
2,000,000 m^3 of sabbia presa dal mare a 20 km dalla costa



Le forme lagunari erose nel corso del ‘900

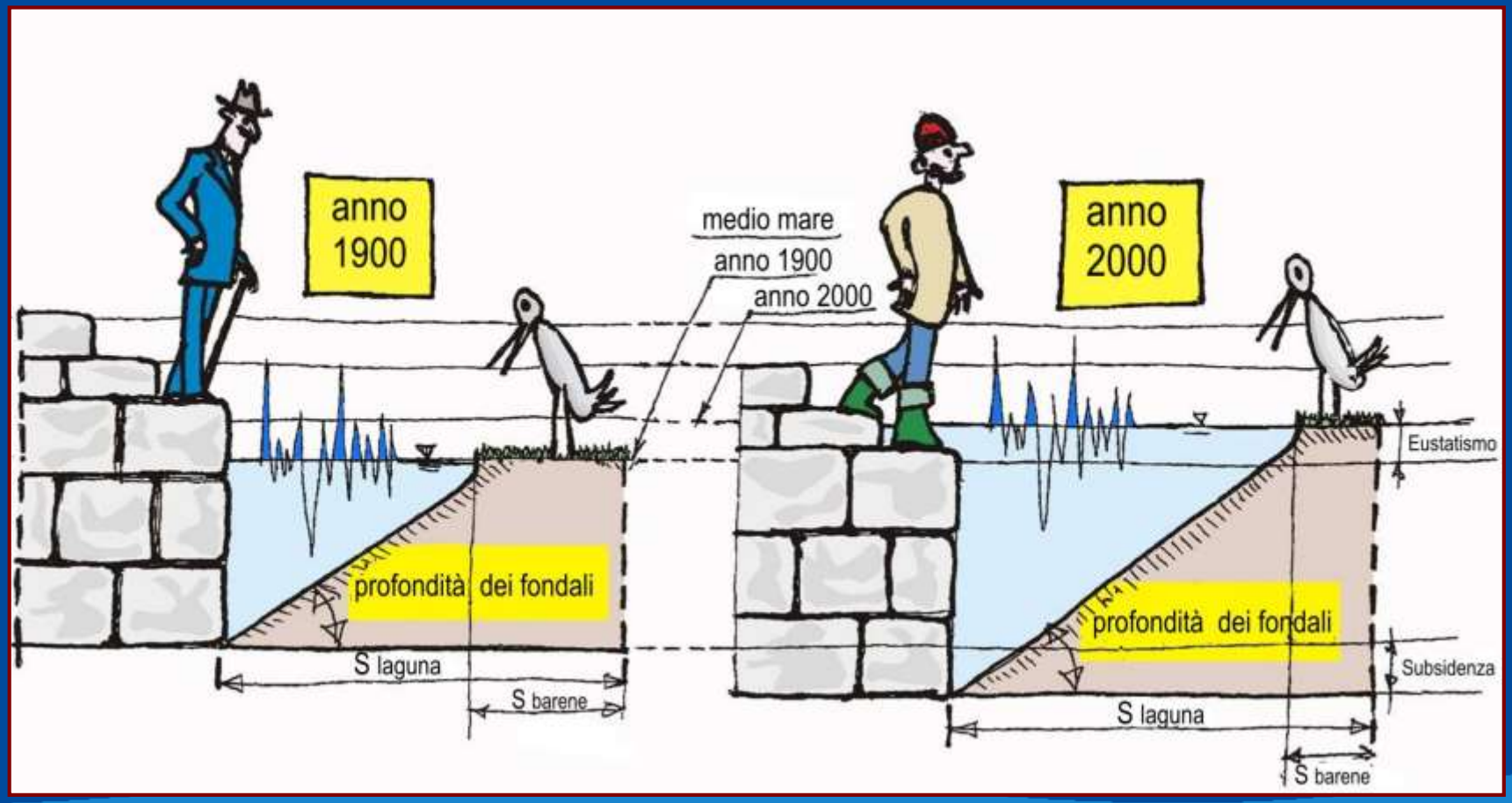


Erosione da bassofondi e velme (Carniello et al., 2009)

Bacino	Tasso erosivo (10^6 m^3/anno)
Chioggia	0.21
Malamocco	0.74
Lido	0.21
Total	**1.16**

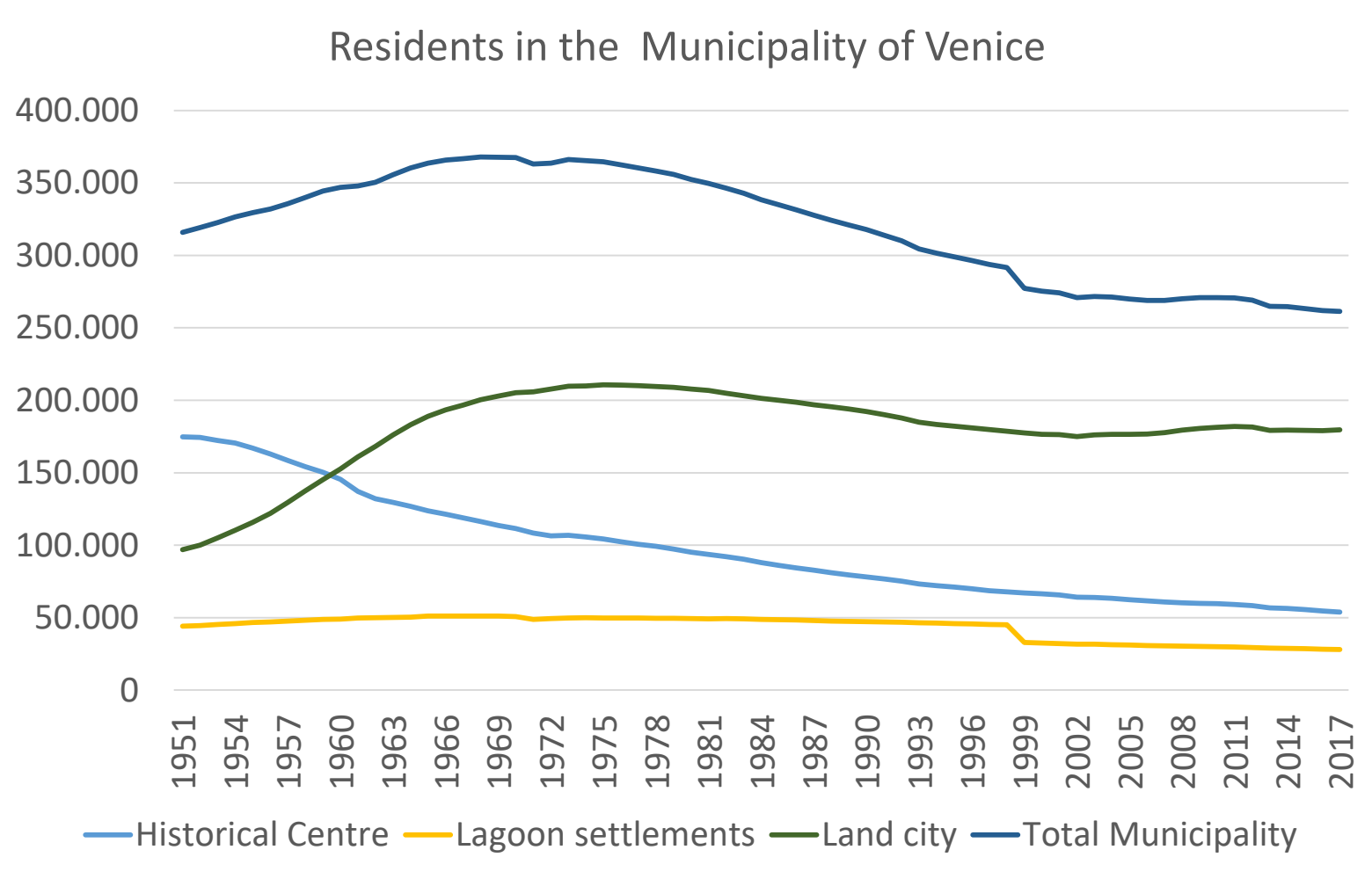
PROSPETTIVE ECO-GEO-MORFOLOGICHE DEGLI AMBIENTI A BARENA

Diverso effetto dell'innalzamento relativo del mare sulle superfici artificiali e naturali



(credit: Giampaolo Di Silvio)

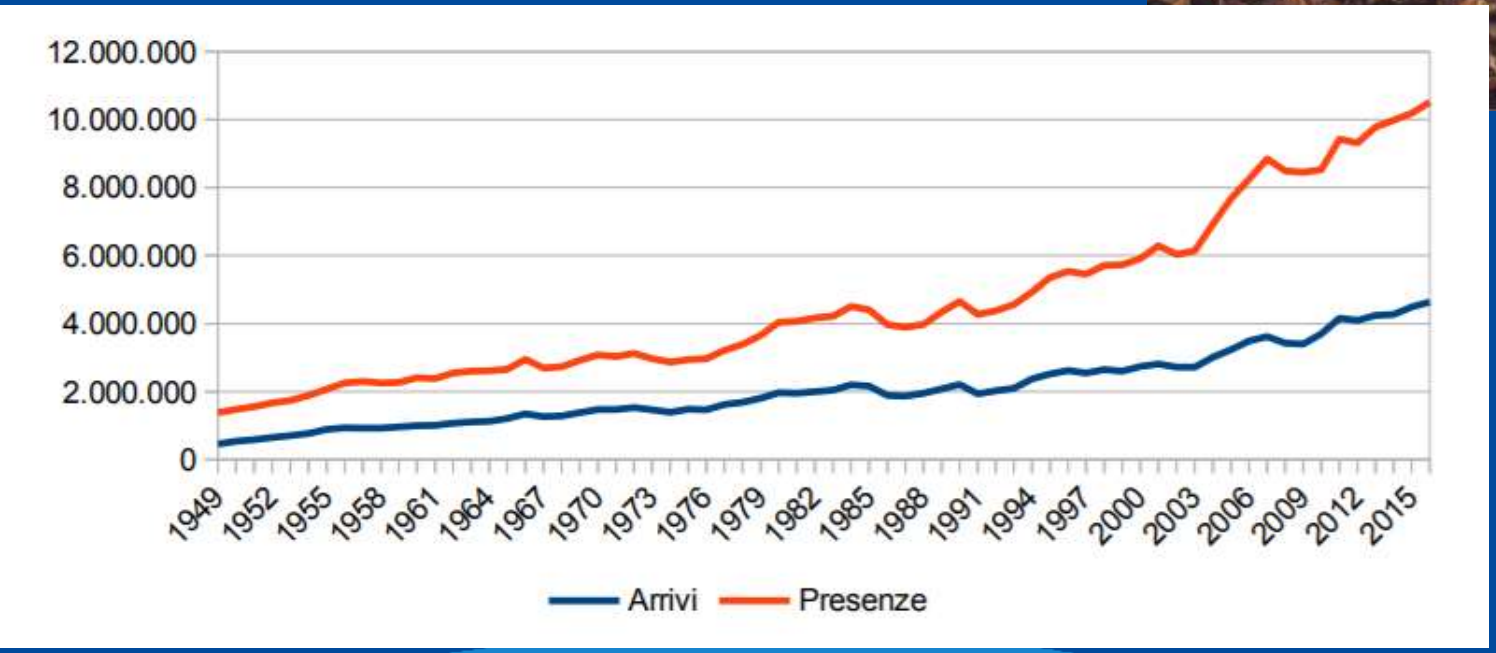
Population (n° residents)



Average age: 47,8

Tourism

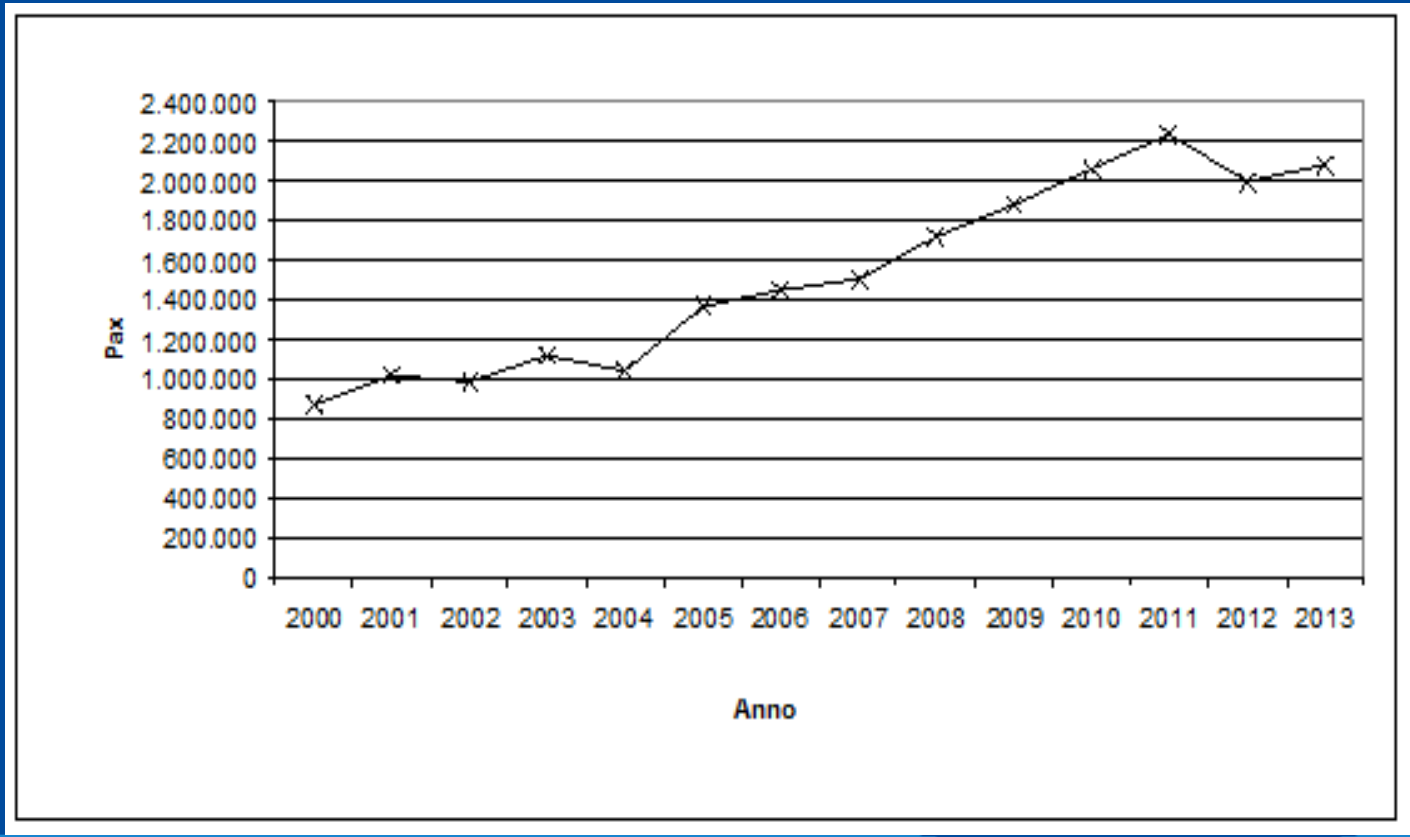
- 10, 5 M visitors in 2016 (nights spent), of which 7M in the historical centre
- Tourism is the main city income



34 M presences in the metropolitan city

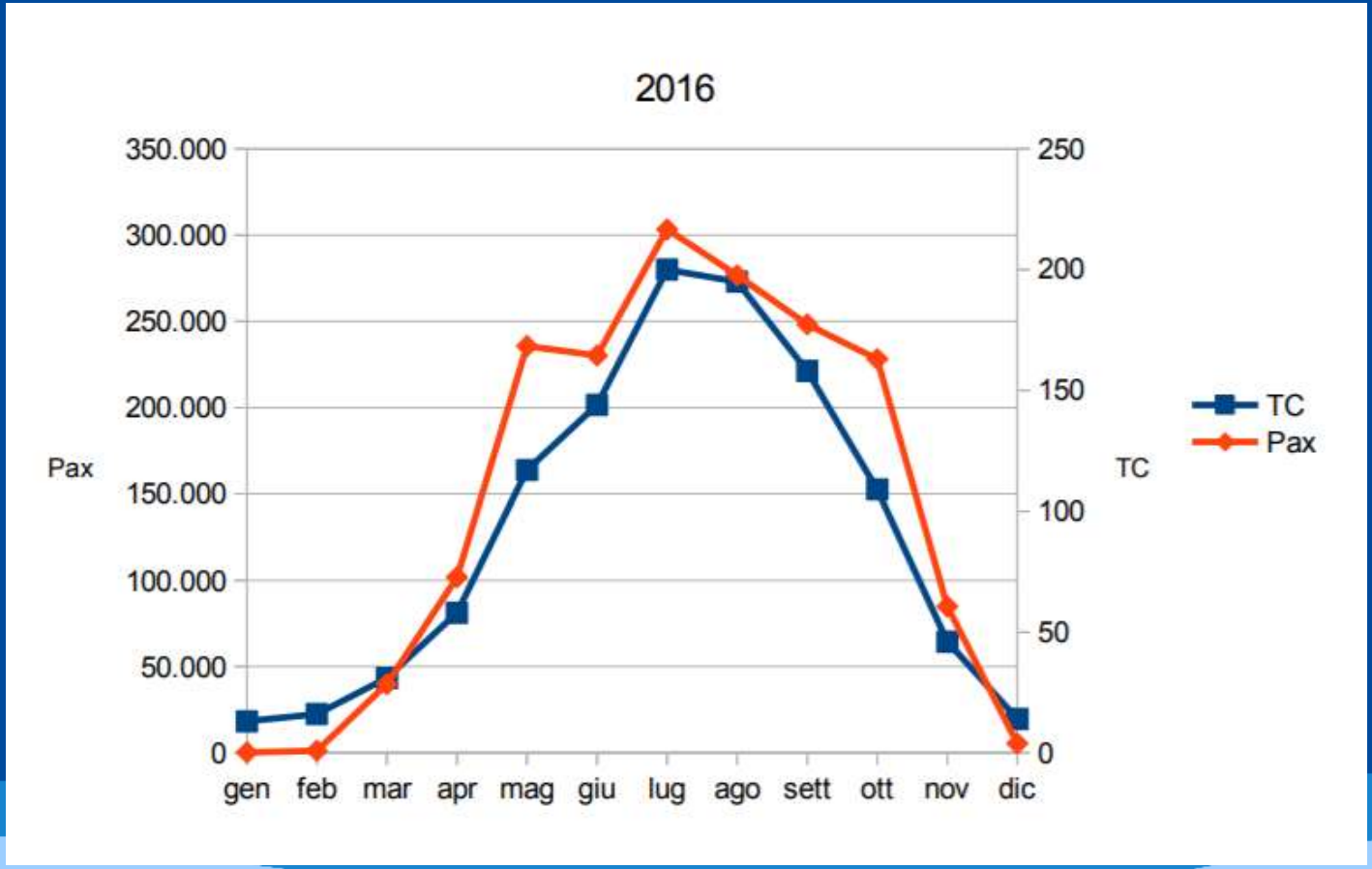
Passengers Port

The increase in number of passengers begun and continues since 10 years. In 2013 the number of passengers was double with respect to 2004 (see figure, from a CORILA report).

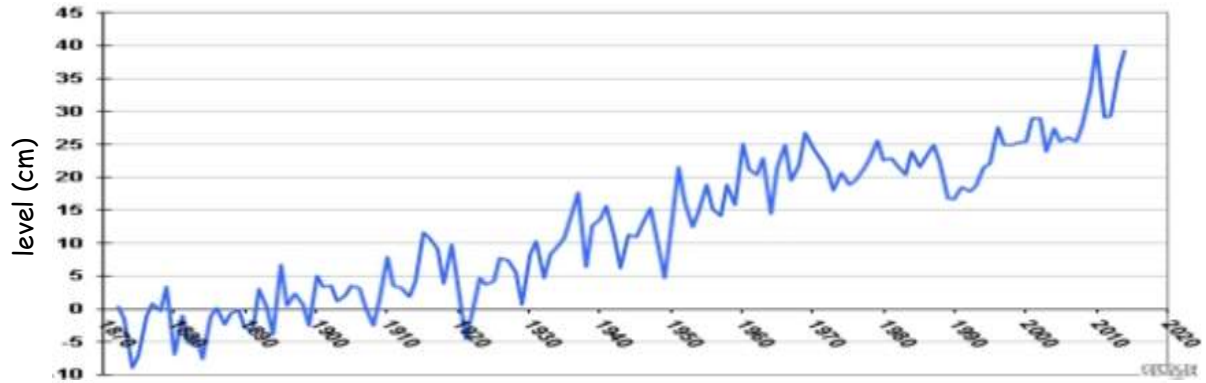


Passengers Port

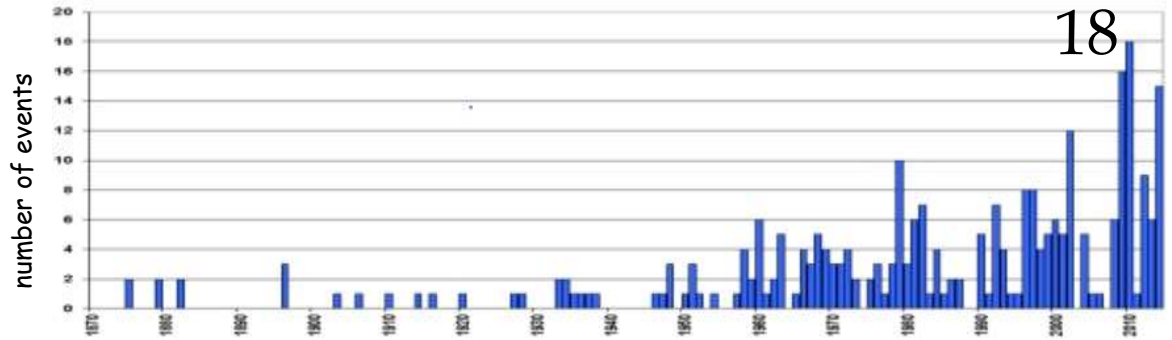
- In 2012, Venice, with its 1.8 million cruise passengers is ranked 9th in the ranking of ports around the world
- Considering only the ports of the Mediterranean area is at the third place in the ranking of ports after Barcellona and Civitavecchia (the first on the Adriatic).



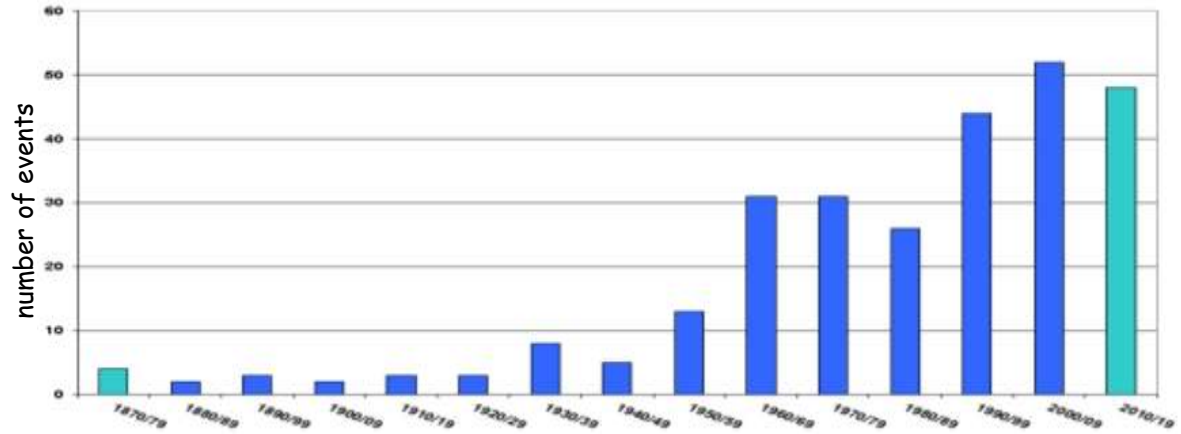
High water in Venice



mean sea level in Venice
1872-2014 : + 30 cm



annual number of
high water events (≥ 110 cm)
1872-2014



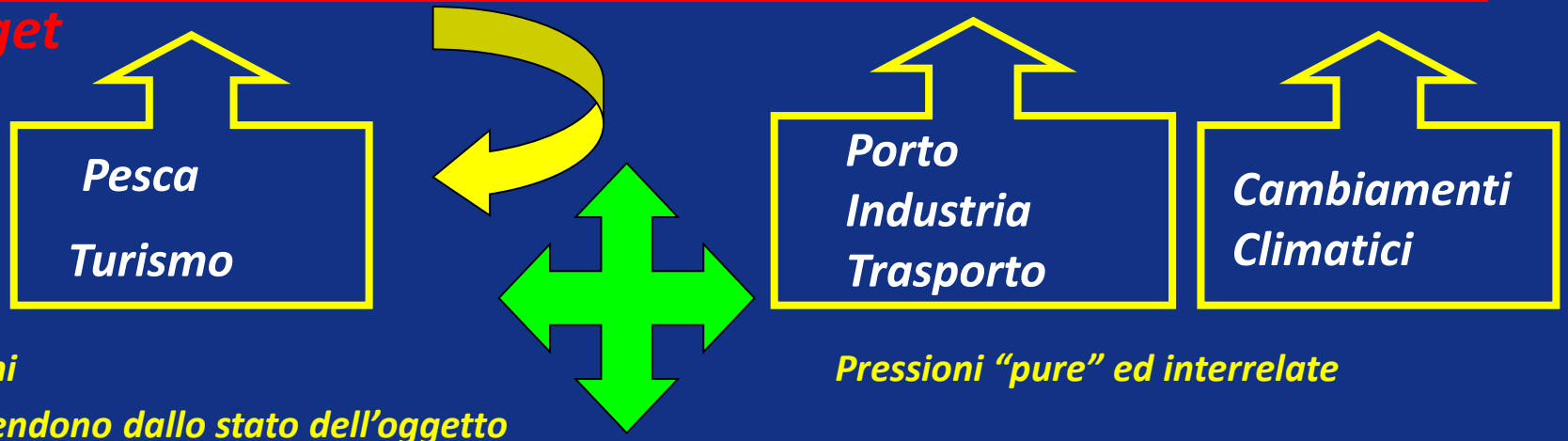
decadal number of
high water events (≥ 110 cm)
1870-2020

During the XX century the frequency of high water events Increased about 13 times.

Cosa vogliamo? Tutto!

Natura, paesaggio e conservazione dei beni culturali

target



Pressioni
che dipendono dallo stato dell'oggetto

Pressioni "pure" ed interrelate

Dimesione sociale ("city status" per Venezia)

vincolo

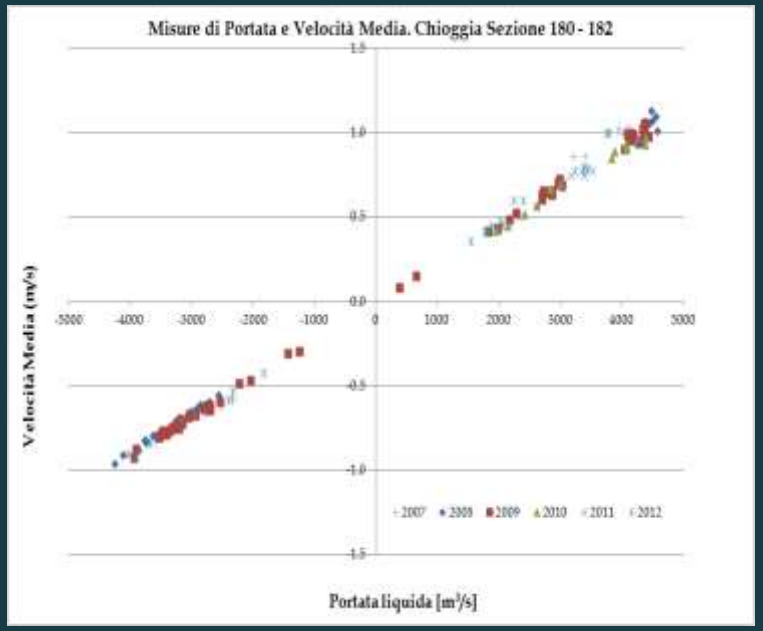
Impossibile ogni auto-regolazione del sistema (zero-action policy), a motivo di:

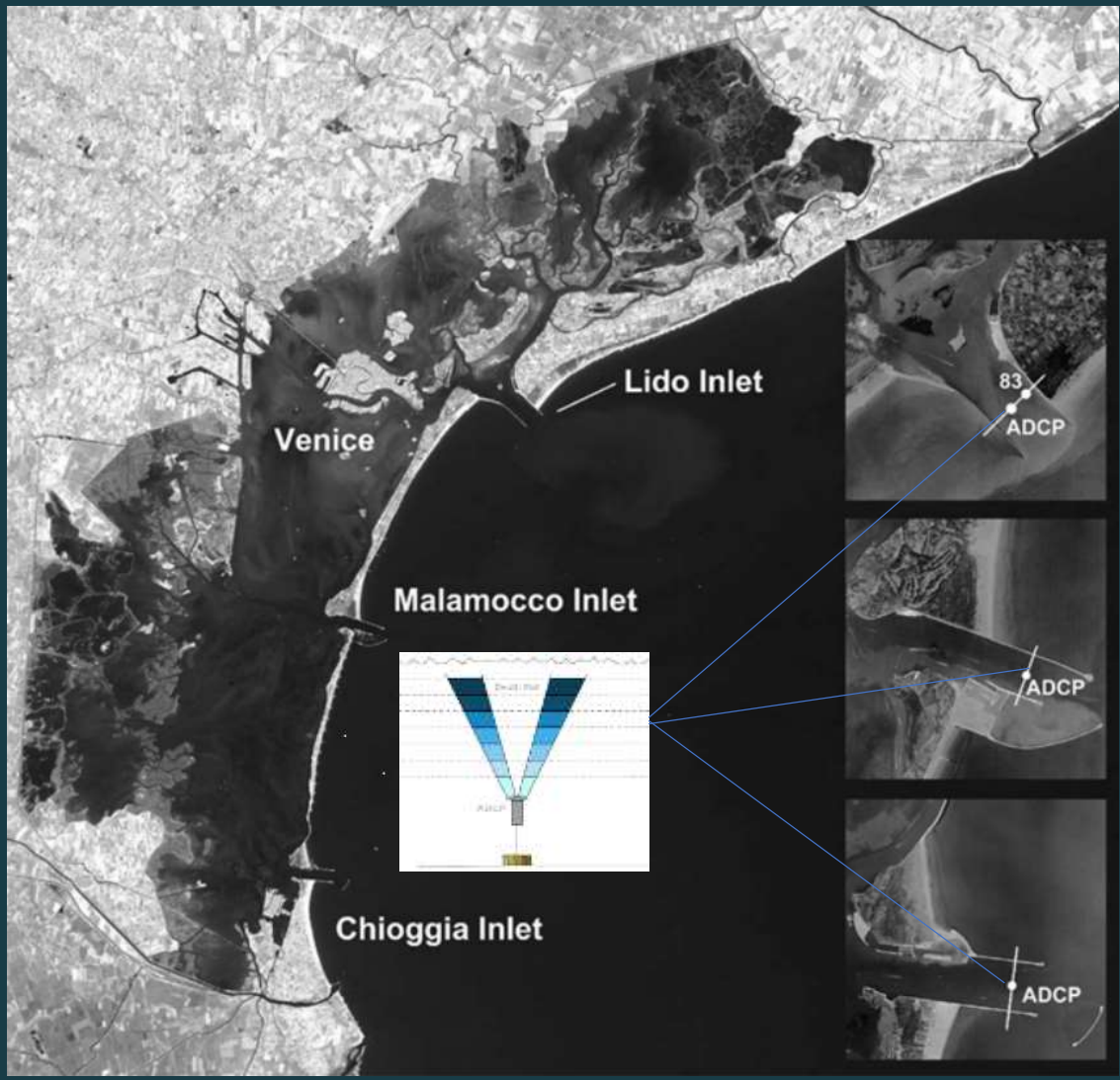
- *Processi naturali già compromessi*
- *Presenza di beni non di mercato di grande importanza*
- *Complesse relazioni di causa-effetto a livello di sottosistemi*

PROSPETTIVE ECO-GEO-MORFOLOGICHE DEGLI AMBIENTI A BARENA (dal 2004)

Stima dei flussi di scambio alle bocche

- Comune di Venezia
- APAT-ISPRA
- CoRiLa
- OGS, Trieste
- NOCS, UK





Valori del bilancio dei sedimenti

Flusso solido alle bocche tidali (2004-2007)

- sospeso: stime da misure + blanking
- bedload: stime da modello calibrato su dati
  - stime da misure
  - stime da modelli

Flusso solido da bacino (DRAIN, 1999)

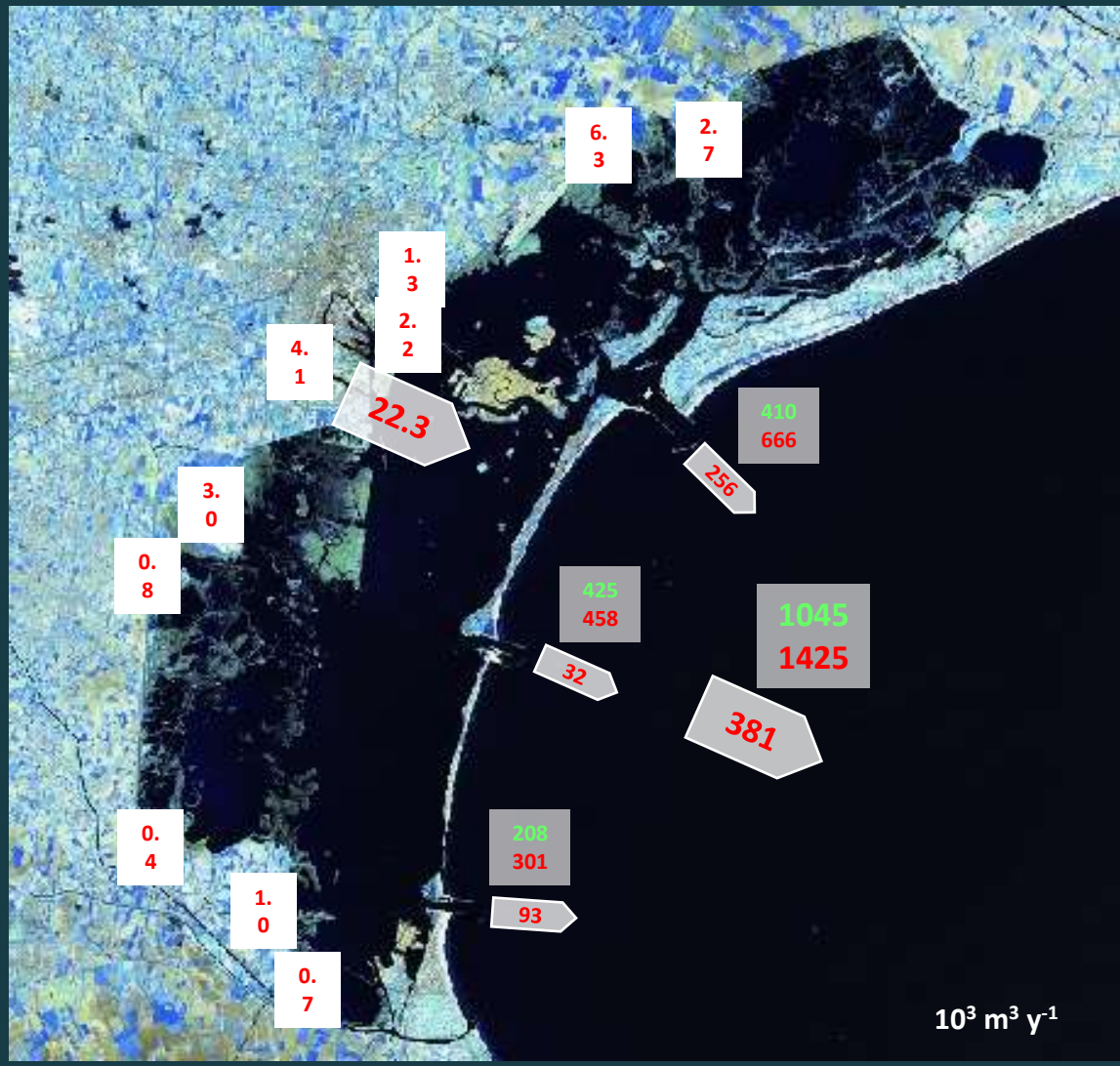
- sospeso: stime da misure

Flusso solido da bacino (Regione-CoRiLa)

- Sospeso: dati ARPAV-CVN, modello ARMA,

(UNIPD-DICEA), misure CNR-ISMAR

2006	33.8	**2009**	65.8
2007	34.7	**2010**	72.7
2008	52.0	**2011**	34.6

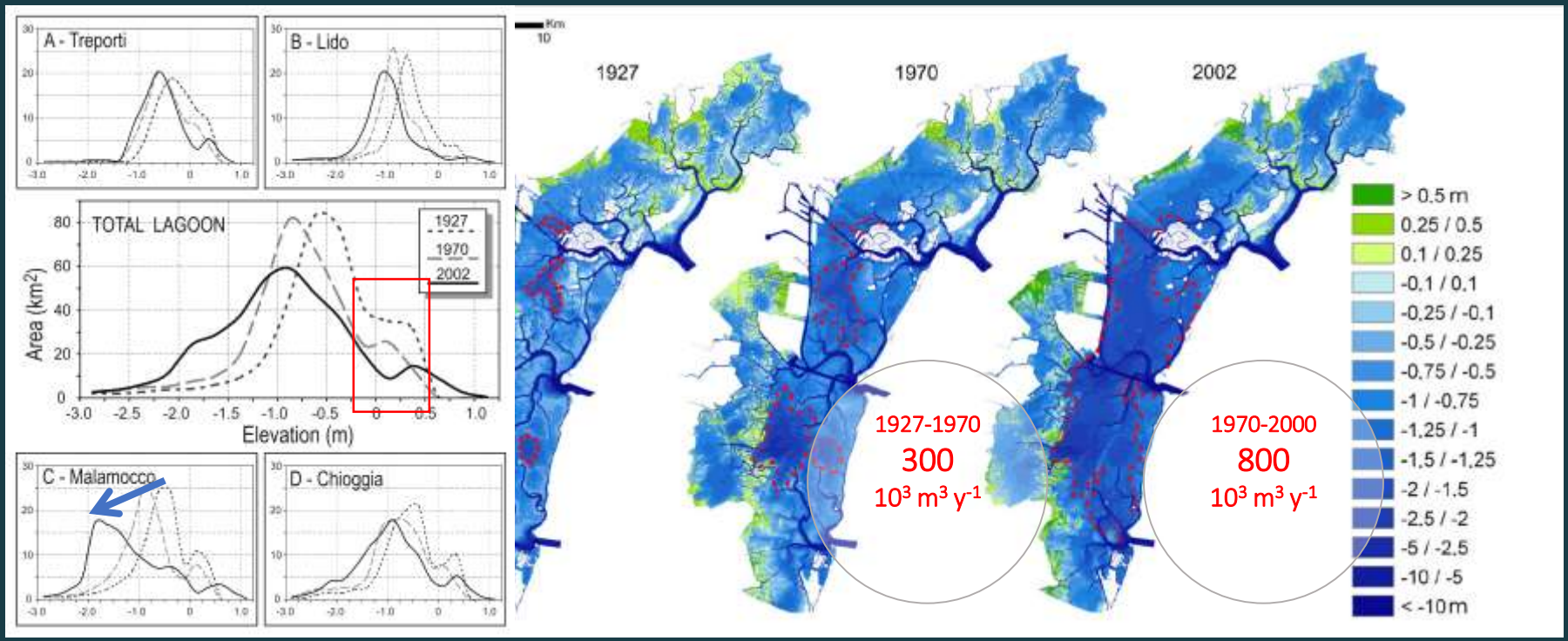


Bilancio da morfologia

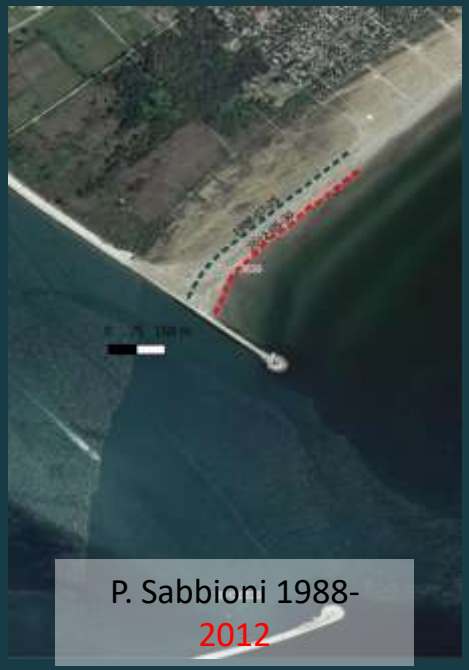
stime da variazioni batimetriche

Changes in bathymetry 1927-1970-2000

From: Sarretta et al. Continental Shelf Research, 2010



Domande scientifiche sul bilancio

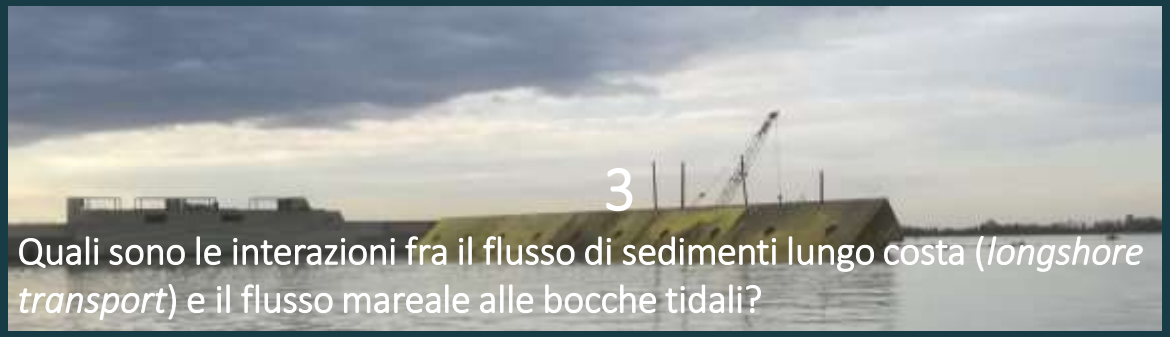


1

È possibile che la differenza fra il bilancio stimato dalle misure dei flussi alle bocche rispetto a quello ottenuto dalle variazioni batimetriche sia il risultato di un recente cambiamento dei tassi di erosione?

2

Per quale motivo la perdita di materiali della bocca di Malamocco è così bassa a fronte di una perdita «storica» ingente? Il paradosso del fetch. Morfologia? Shear stress ridotto?



3

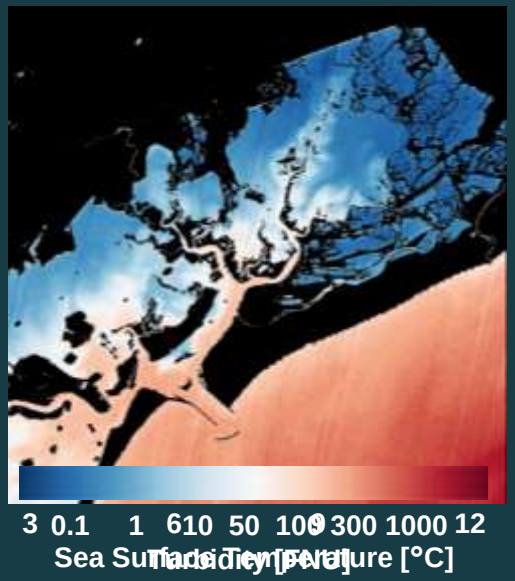
Quali sono le interazioni fra il flusso di sedimenti lungo costa (*longshore transport*) e il flusso mareale alle bocche tidali?

Risposte?

Preview Venezia 2021

Remote sensing: *transport pathways*

ESA - Sentinel 2A - 24/12/2018

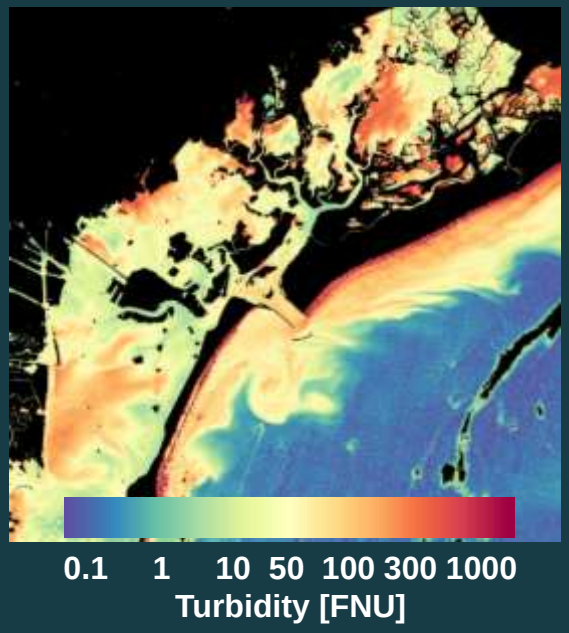


Risposte?

Preview Venezia 2021

Remote sensing: *transport pathways*

ESA - Sentinel 2A - 23/02/2019



Risposte?

Preview Venezia 2021

Remote sensing: *transport pathways*

ESA - Sentinel 2A - 26/09/2018

In fact,
our third conclusion is that the excess supply of sediment driven by the nearly
irrotational flood currents overloaded in the far field by storm events, is mostly deposited **near or inside** the inlets.