Evolution of the Po Delta, Italy

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&
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Dynamics and Vulnerability of River Delta Systems workshop
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CSDMS
Community Surface Dynamics Modeling System

UNIVERSITY of NEW HAMPSHIRE

NASA

Outline

21,000 years ago……

- Effects of the ever changing natural driving forces on the Po River; long term simulations

1,000 B.C. – 1,600 A.D.

- Coast line progradation (natural and controlled by humans)

1950 - 2007

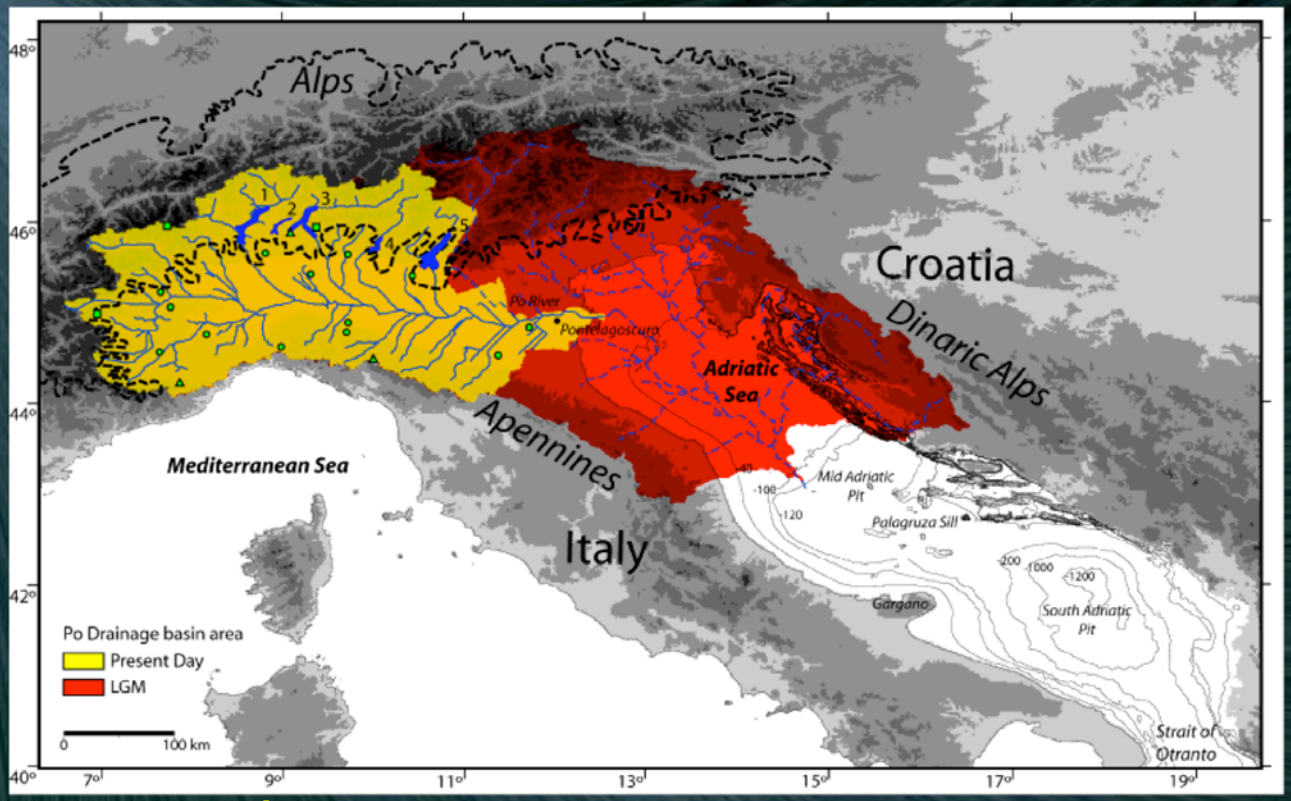
- The effect of man-made reservoirs
- Subsidence of the Po Delta
- The different land uses of Po Delta

Summary, Future study

Po characteristics

a) Watershed ~75,000 km^2
b) Alps 4500m, Apennines 2000 m
c) 15.5 million inhabitants
d) One of EU'S most agriculturally productive areas; irrigated
e) 30% of total discharge is filtered by 5 lakes.
f) Qmean = ~1525 m^3/s, Qpeak = ~10,000 m^3/s
g) Qs = ~12 MT/yr, range = 2.9 to ~22.4 MT/yr

Evolution of the Po drainage basin; natural influences



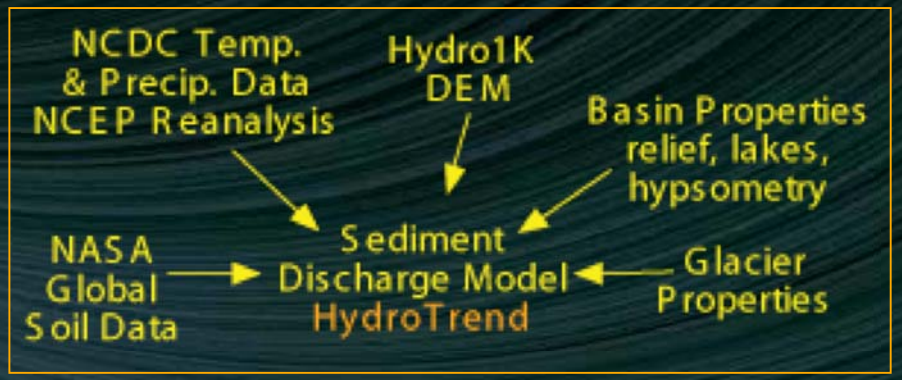
Kettner & Syvitski, in press

LGM versus present day:

- 120m lower sea level →2.6 times larger drainage area
- Alpine ice sheet → sediment flux increases
- According to climate models: 2.4°C colder and 18% less precipitation

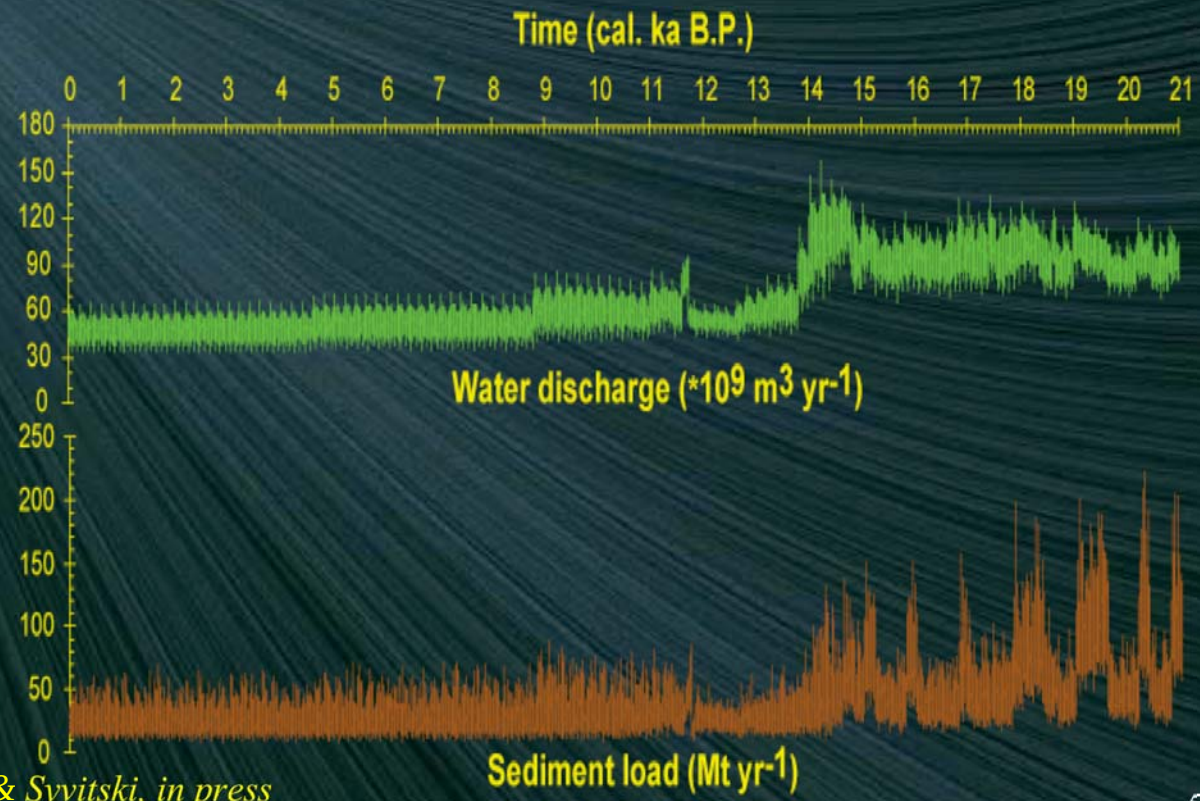
Simulated Water and Sediment flux since the LGM

HydroTrend: Climate-driven hydrological transport model that uses basin properties as well as biophysical parameters to simulate water and sediment fluxes at the river mouth



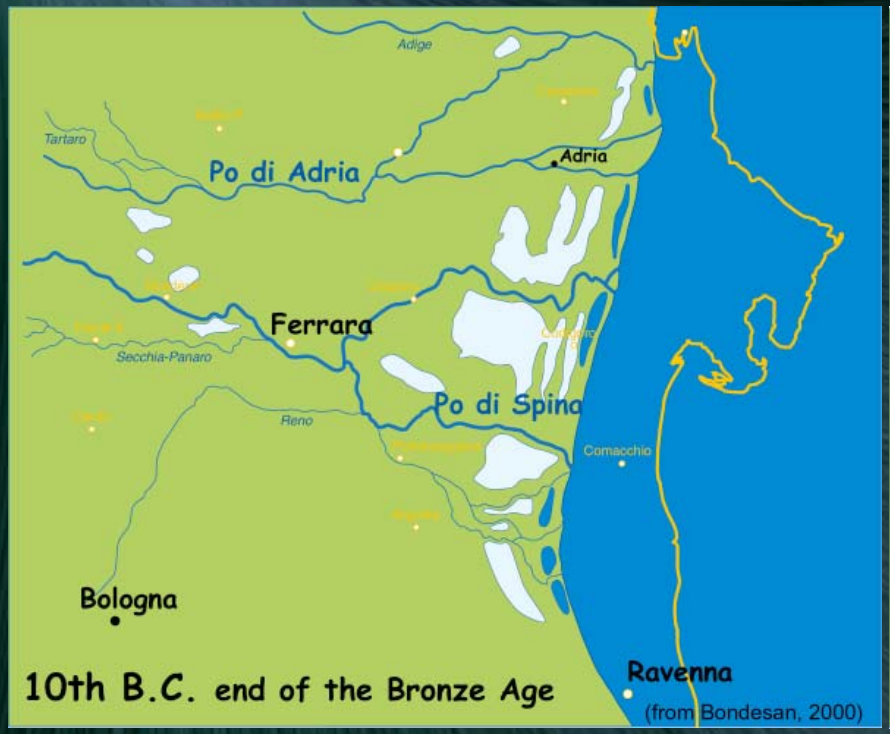
Results:

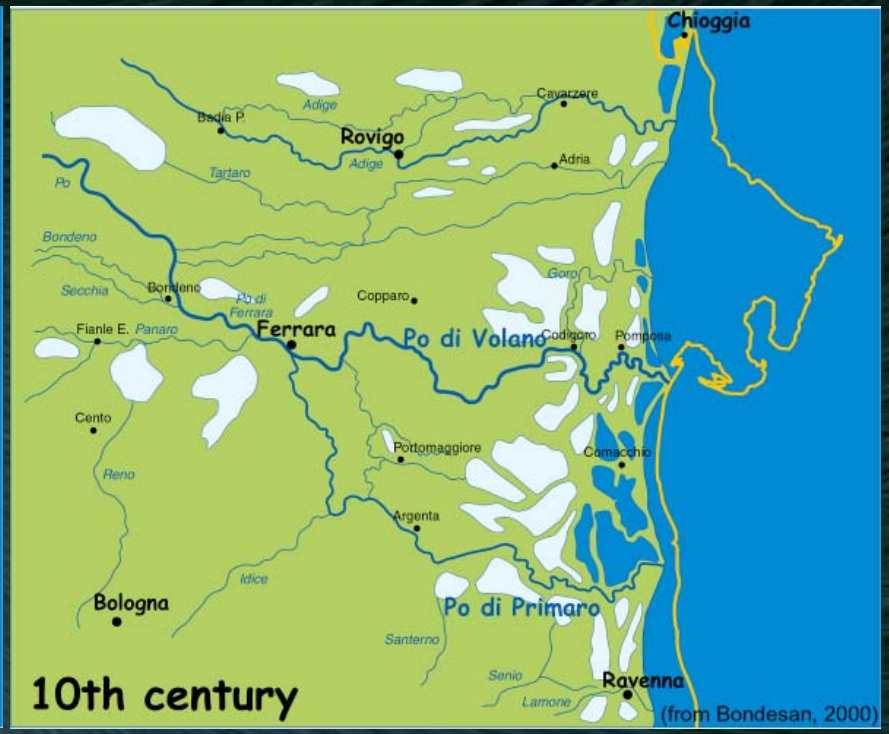
- Decrease in water discharge by a factor of 1.9
- Decrease of Sediment load by a factor 3.5



Kettner & Syvitski, in press

Historical coastline before human control



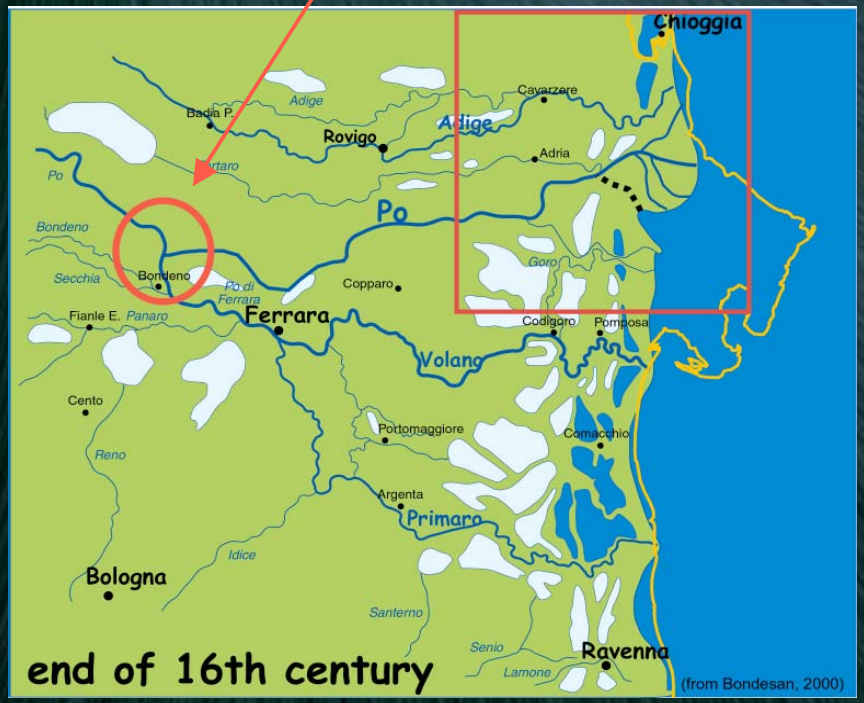


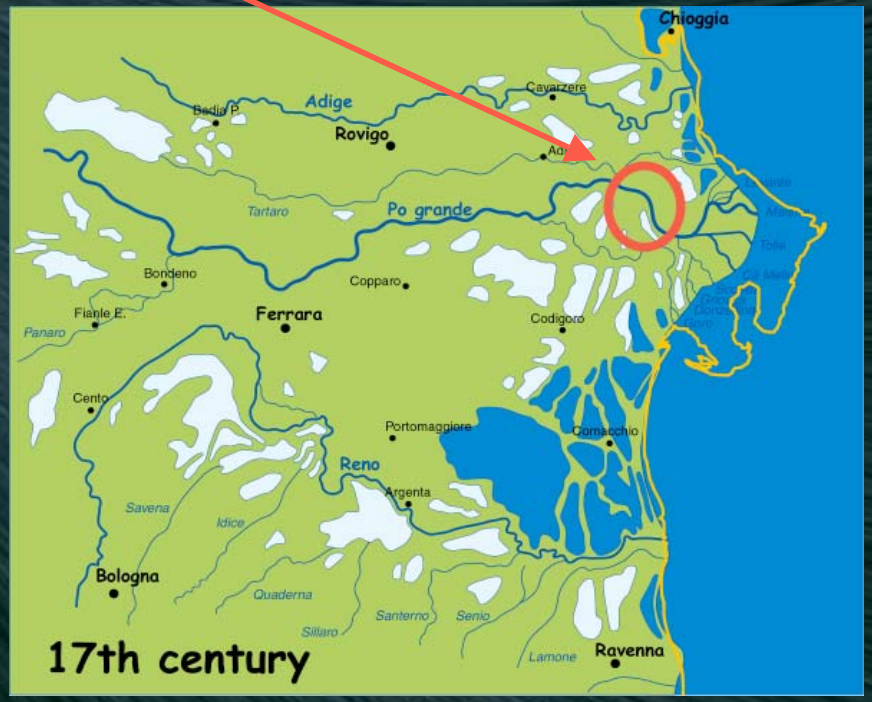
Before human control

- Natural rate of coastal progradation 4 m/y from 1000 B.C. to 1200A.D.
- Seven points of discharge described by Pliny the Elder

Human interference that forms the modern delta

- abandonment of Po di Primaro
- 1152 AD a major natural avulsion
- northward shifting of distributary channels
- Venice Republic is threatened by the potential infilling of the lagoon
- 1604 AD digging of a diversionary canal (Taglio di porto Viro)

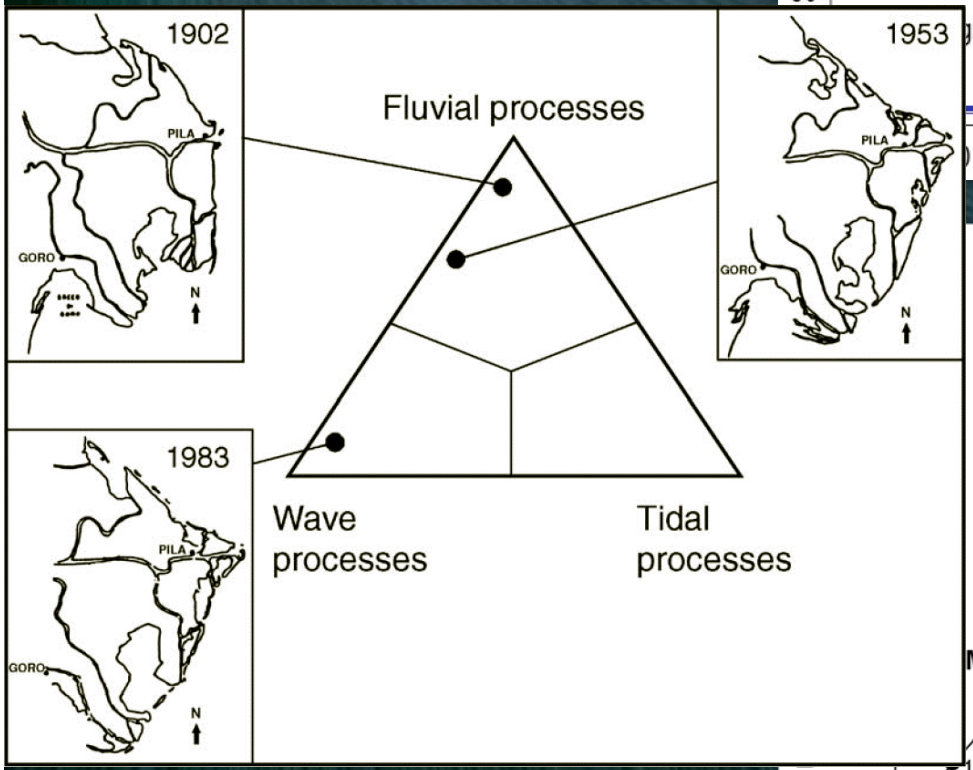




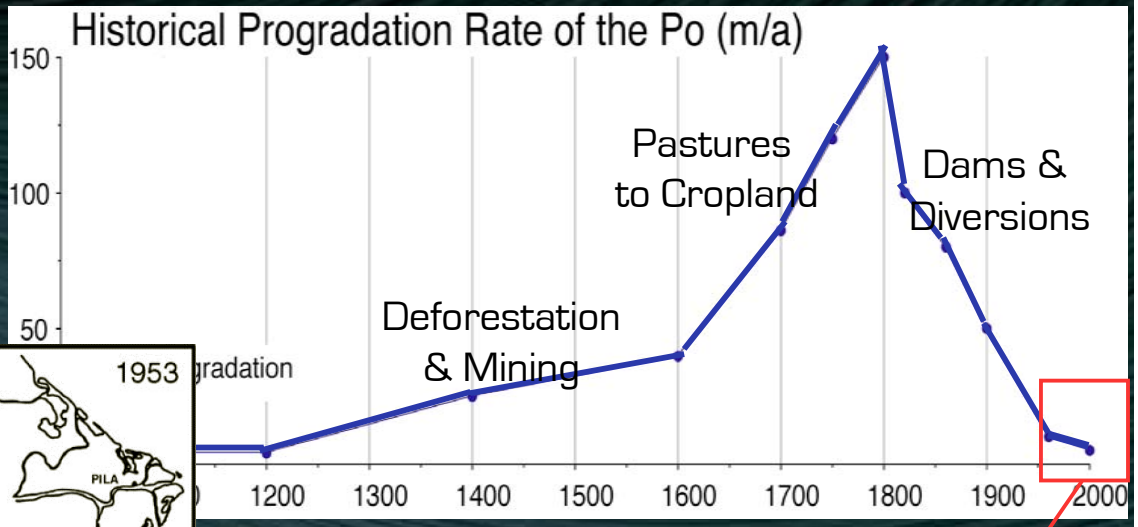
Effect of human impact on sediment flux

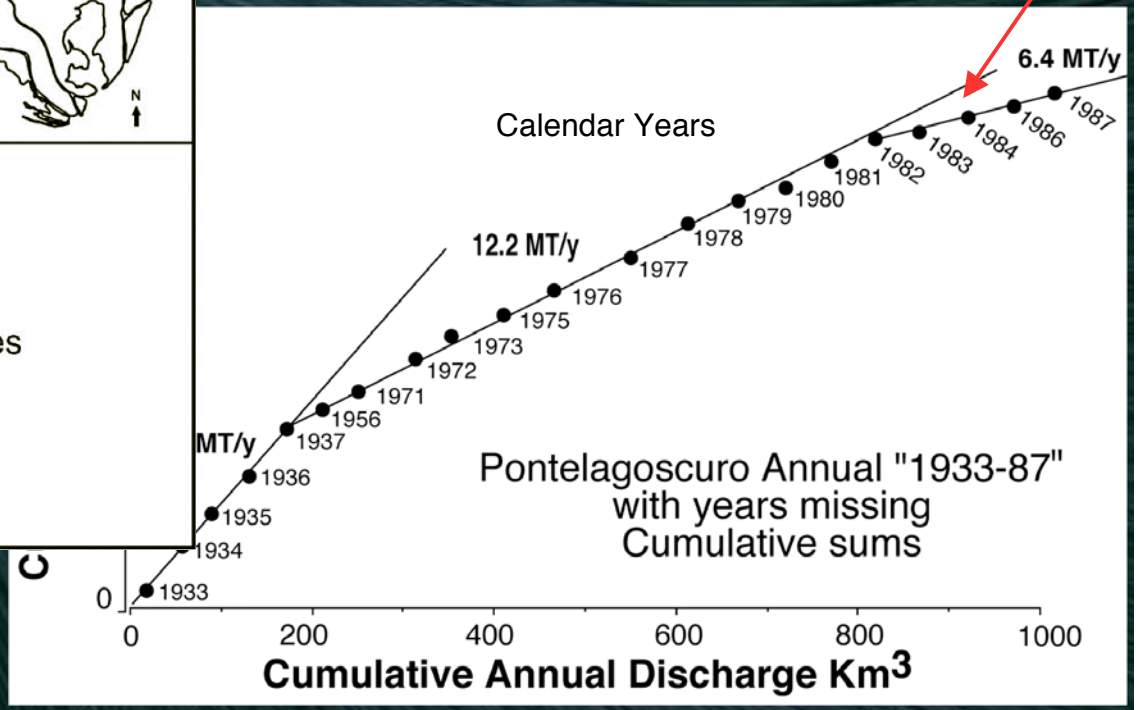
Resulting in:

Morphological evolution



Simeoni et al., 2006



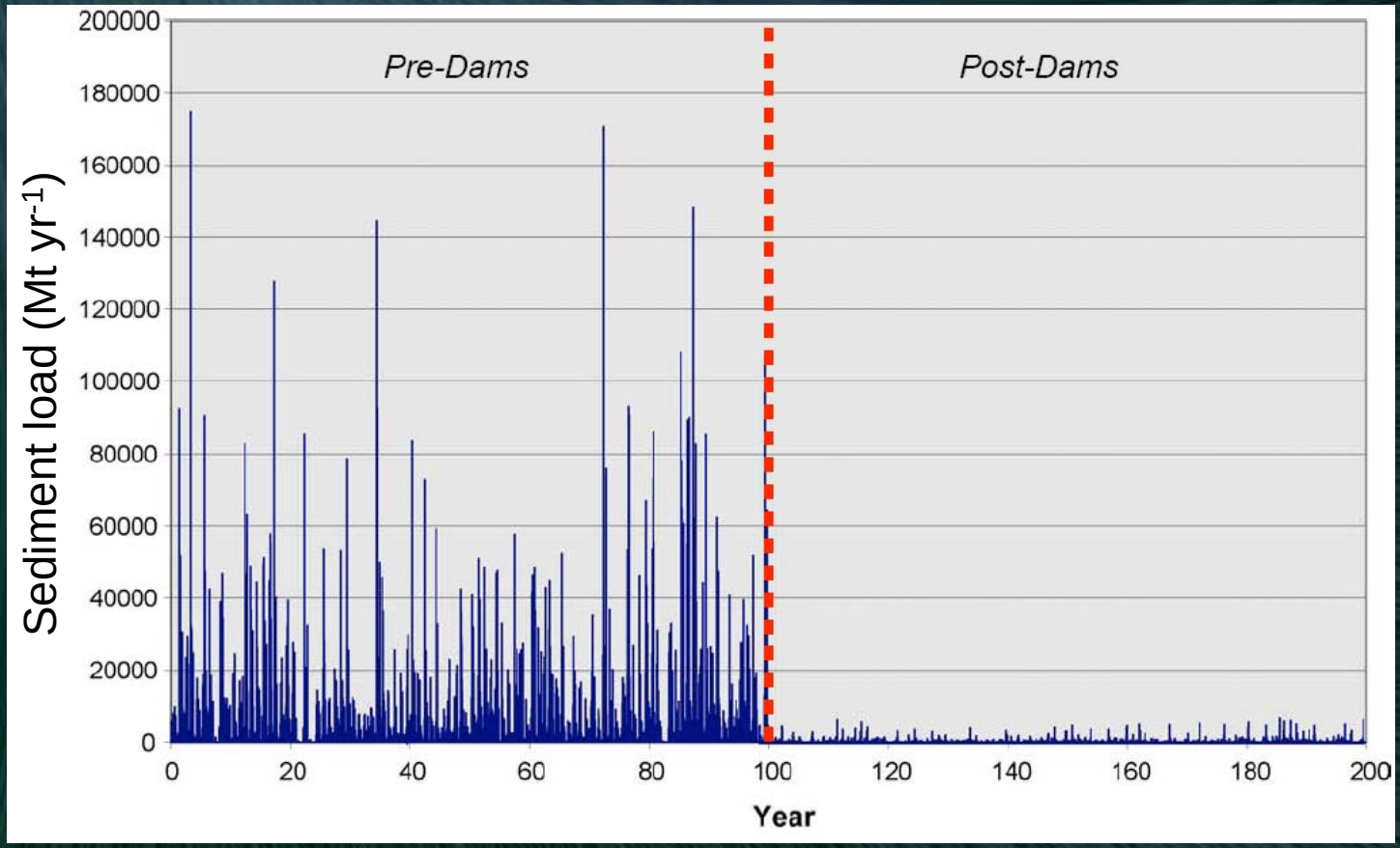


Syvitski & Kettner, 2007

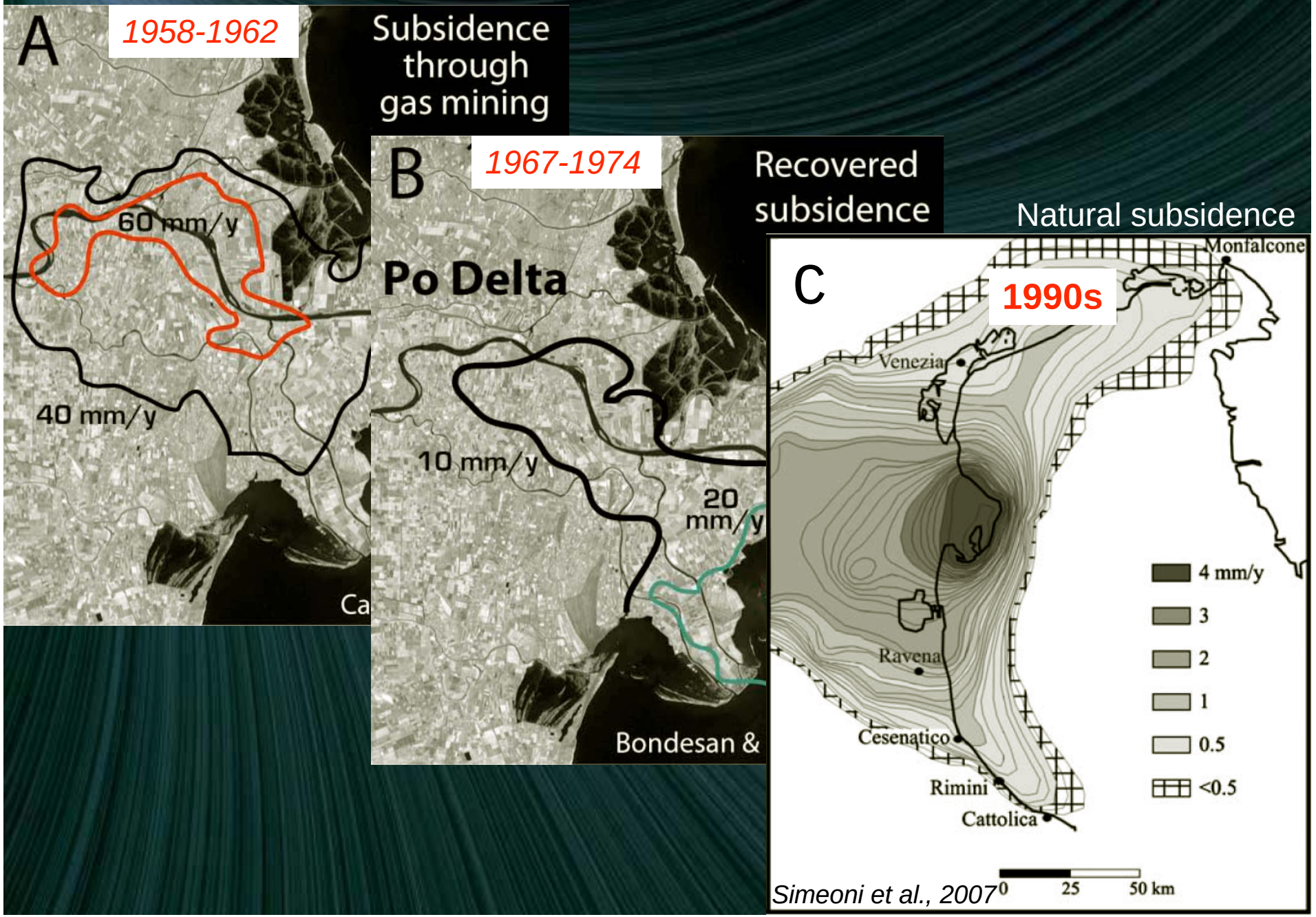
Model simulations of the effect of reservoirs

HydroTrend simulates the trapping efficiency of reservoirs based which is a function of the volume of the reservoir and its receiving discharge (Brune equation).

HydroTrend simulation of the Pescara River (Apennines) pre and post dams

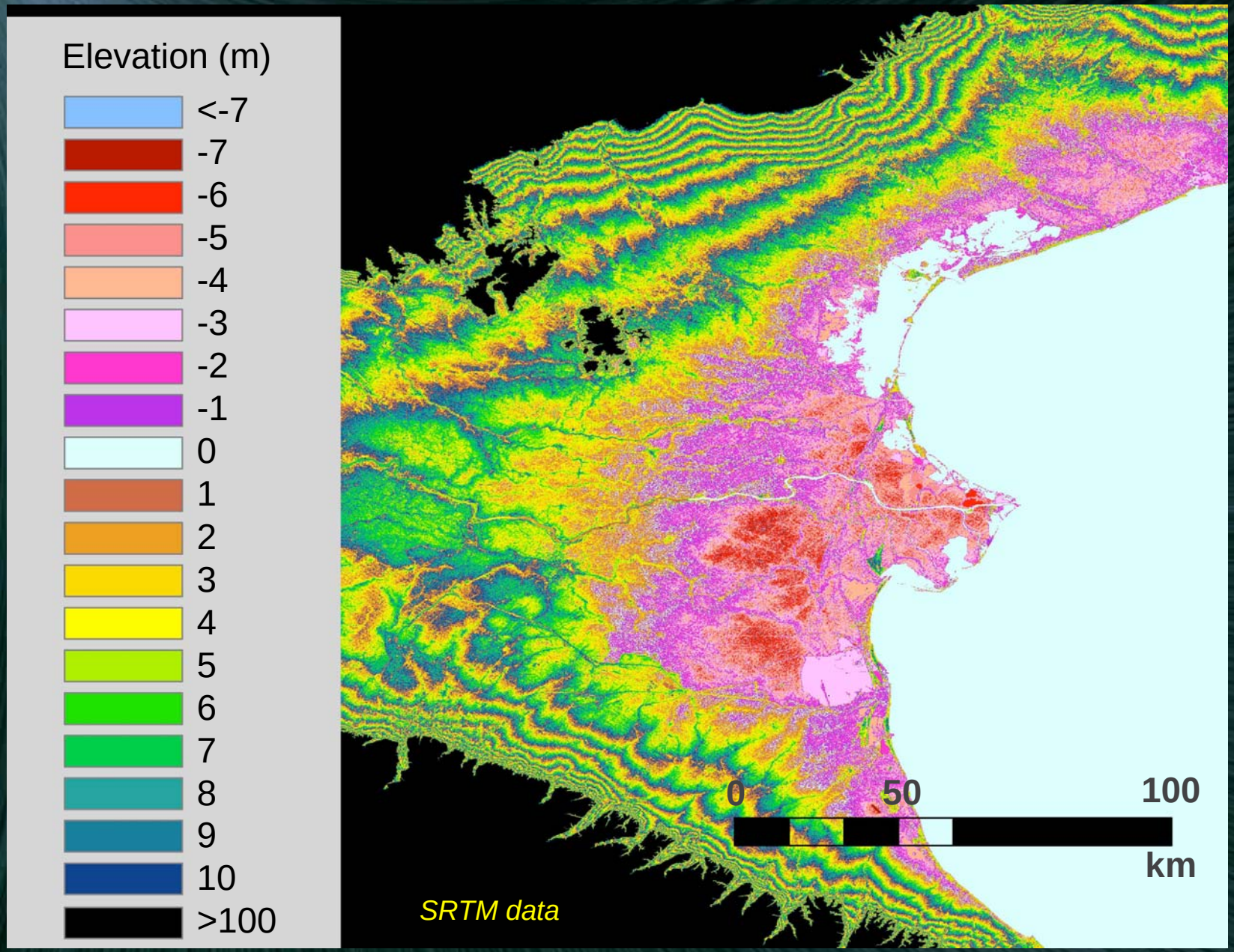


Subsidence of the Po Delta

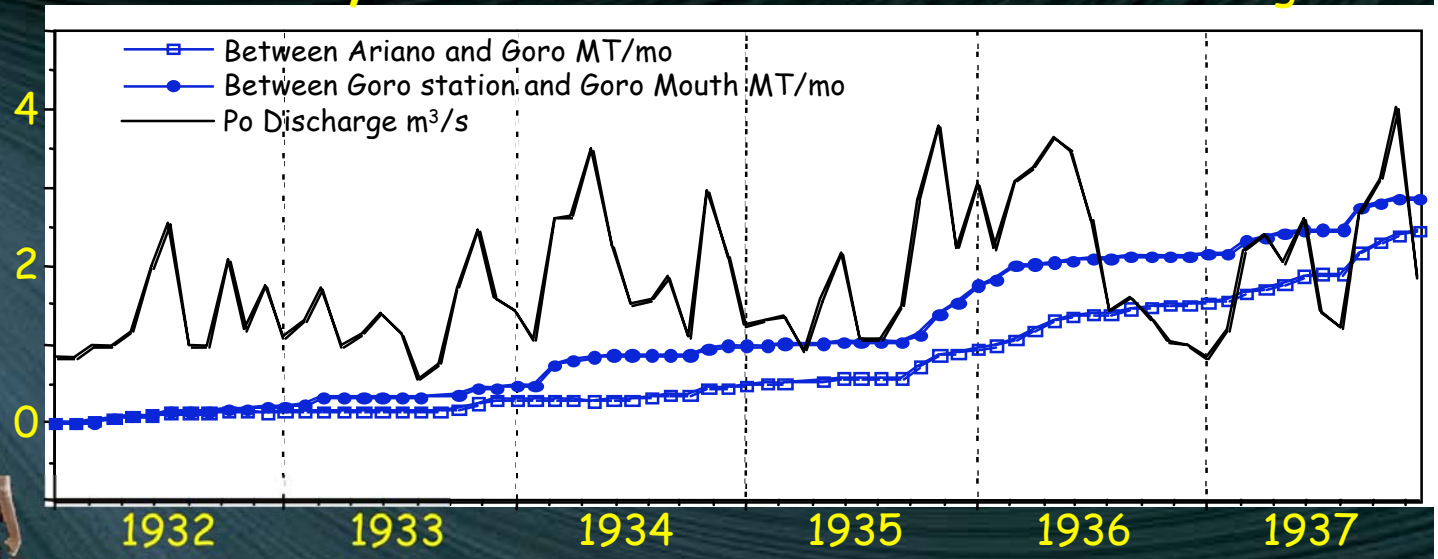


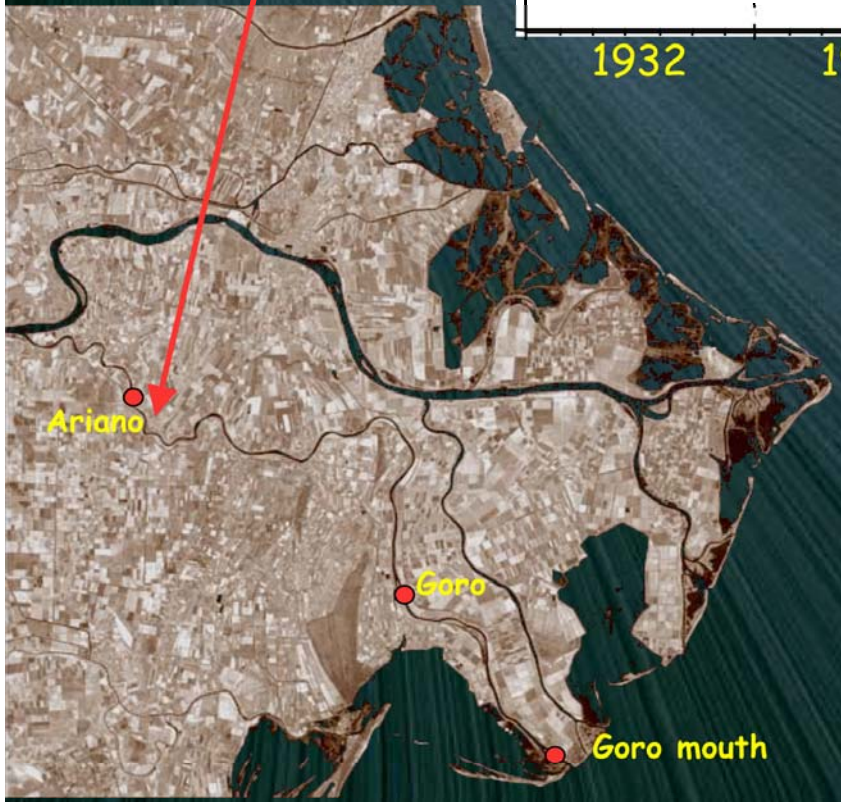
Simeoni et al., 2007

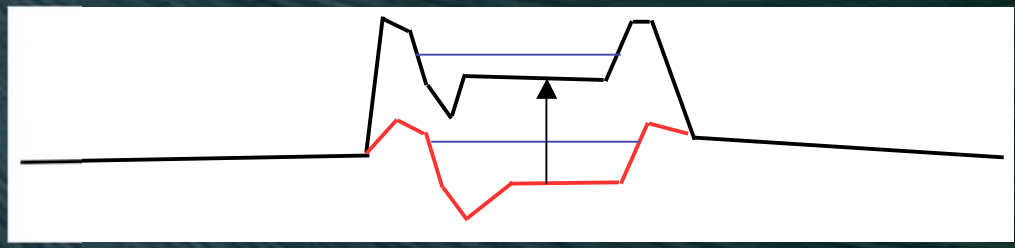
Present elevation of the Po Delta and the coastal lowlands



Distributary Channel Flood Control: Sediment Storage MT







Stop-bank levees cause super-elevation of the channels above the surrounding floodplain.

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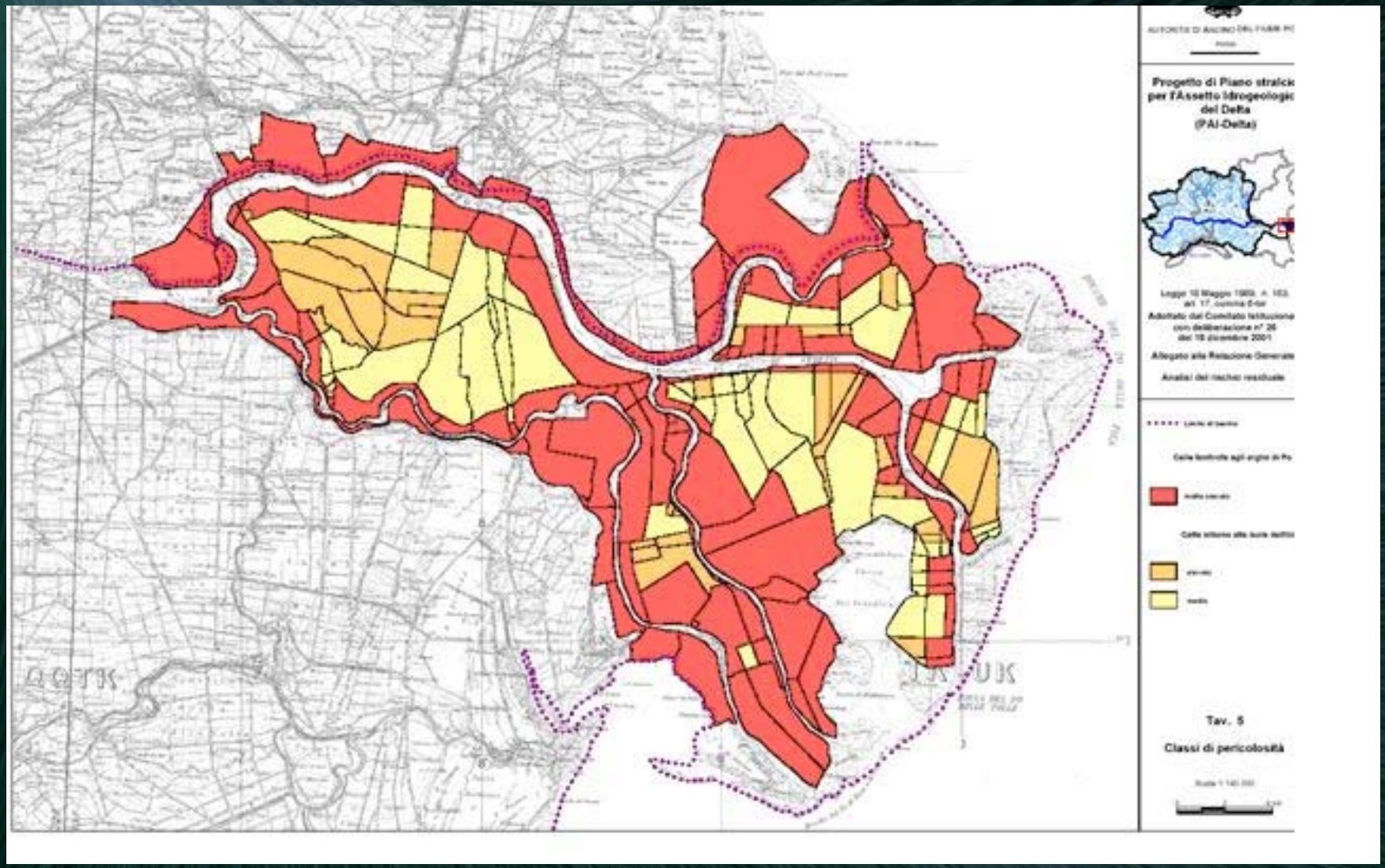
Flood risk map the Po Delta



Autorita' di Bacino del fiume Po, Progetto di Piano stralcio per l'Assetto Idrogeologico del Delta (PAI-Delta), 2001.

Land uses of the Po Delta

agricolture

houses

tourism

energy

aquaculture

Valli da pesca

Sacche
(clams, mussels)

PARCO REGIONALE VENETO DEL DELTA DEL Po

Slide of Sara ARIANO

Summary:

Natural

- Po Delta system is controlled by sea-level rise and sediment flux reduction (21ky →)

Humans

- Delta progradation accellerates caused by confining the Po discharge to a small area. (10 Century →)
- The present delta is artificially held in position within context of the northern Adriatic oceanographic processes
- Natural and artificial subsidence are enhanced by levee construction, which prevents overbank sedimentation
- River-bed excavation and river damming in the drainage basin during the last 50 years led to a marked decrease in sediment supply

Future goals in modeling sediment fluxes

- Summary:
  - HydroTrend simulations of water and sediment flux at the outlet

- Future:
  - Creating a spatially distributed model that determines erosional as well as depositional areas (such as a delta) within a drainage basin that could be used as a decision model for managers (NASA project 2007-2010)

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Aqua modis December 1, 2002