



Conférence Parmenides IX – GID-CIHEAM – Bari – octobre 2021 Gestion durable des bassins versants méditerranéens face aux impacts des changements sociétaux et climatiques

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The case of Venice and its lagoon, with regard to the risk inundation in different scenarios (climate change, storm surge barriers, sea-levels etc.)

Résumé

Storm surges caused by extreme meteorological conditions are a major natural risk in coastal areas, especially in the context of global climate change. The increase of future sea-levels caused by continuing global warming, will endanger human lives and infrastructure, and will deeply change coastal lagoons and estuaries. Here I will illustrate the case of Venice and of its lagoon, discussing past and foreseeable changes in inundation risk under different climate change scenarios, the effectiveness and impact of storm surge barriers, as well as the possible future dynamics of the Venice lagoon environment as a result of sea-level changes and human interventions.

GID- CIHEAM Parmenides IX Conference - Bari, October 2021 Sustainable management of Mediterranean watersheds faced with the impacts of societal and climate changes

Coastal Flooding and Environmental Sustainability: Venice as a Climate Change Experiment

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Venice and its lagoon: an artificial environment

The Venice lagoon ~1300



a huge plan to keep the lagoon from silting up: Brenta (1324, 1505-1540, 1860) and Piave (>1640)

littorals reinforcements, river diversions, inlet stabilization





The modern configuration is certainly not pristine nor natural

Characteristic Intertidal Landforms



5 km



'Element against element'

Lagoon biomorpholgical dynamics





B. Trevisan, *Trattato della laguna di Venezia*, 1715

Coastal wetlands keep up with sea levels also through organic soil production ~50% (and increased CO2 increases wetland resilience)





BUT, inorganic sediment is needed to keep up with sea-level rise: the Venice lagoon lacks incoming sediment due to anthropogenic interventions over centuries.



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University of Padova lead development of major Management Plan for the Venice Water Authority:

1. Reduction of erosion;

2. Reduction of sediment transport to the sea;

3. Increase of inorganic and organic sediment.

L'evoluzione morfologica



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The watershed draining into the lagoon



A large part of the Lagoon watershed is reclaimed land made of peat soils, which are being oxidized, leading to subsidence, and are subject to saline water intrusion due to SLR

Reclaimed land mechanically draining into the Venice Lagoon

If no remedial strategies are implemented in the near future and soil oxidation continues at the present rate, the entire peat layer is bound to disappear in about 50 years. This might cause an additional 75-100 cm of anthropogenic land subsidence.



Likely future - Sea level in Venice according to IPCC 2013 - RCP8.5 (subsidence =0)



Flooding of the city of Venice – the great storm surge of 4 November 1966



Canaletto, Il Bacino di San Marco dalla Piazzetta, 1750

Effects of the 4 November 1966 storm surge across centuries

 $Z_{t} = MSL_{t} + H_{1966}$

Z for MSL in 1750







The impact on the city



In red + blue the areas inundated twice DAILY by the tide under mild sea level rise scenarios by 2100.



The MoSE system

Protection of Venice from high tides

Effects of MoSE on the lagoon evolution

Effectiveness of MOSE in protecting Venice from extreme storm surges



MOSE is crucial defense: how many closures?





BUT, most of marsh accretion occurs with high water levels during storms: **MOSE** closures reduce the ability of marshes to keep up with sea-level rise by 1-2 mm/year!

(Tognin et al., in press 2021)

Some conclusions

- The MOSE system is essential to protect the city of Venice from extreme flooding
- It will be useful for ~50 more years: new solutions needed! (permanent closure of part of lagoon?)
- The lagoon around Venice is destined to be eroded and deepened to become a marine environment
- Closing the MOSE accelerates the demise of the Venice lagoon: Short-blanket syndrome

Choice of priorities (city vs. lagoon vs. watershed) is problematic and we are running out of time (~50 yrs)