



## **The evolution of the Lagoon of Venice as a paradigm of anthropogenic alteration of ecosystems: a palaeoenvironmental reconstruction through wide-area acoustic surveys and core sampling**

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The Lagoon of Venice (Italy) is the unique result of natural and anthropogenic changes. Through the centuries, human activities, steadily modified its environment, bringing it to the point that the Lagoon of Venice is itself a signature of human activities. Moreover, the historical city of Venice, a world heritage site, is threatened by flooding caused by sea level rises, so much so that major modifications of the lagoon inlets are ongoing in order to protect it. For these reasons, the Lagoon of Venice is at the same time a paradigm of a relatively circumscribed ecosystem in which the Anthropocene has started long ago, and a sensitive testbed of the environmental changes that are taking place at the global level.

In this context, a large geophysical survey was carried out to explore the Holocene sediments in order to establish the natural evolution of the lagoon and the impact of human activities. The survey is the basis of an interdisciplinary study that has allowed the reconstruction of ancient landscapes of the lagoon from before its origin to present days. In particular, thanks to acoustic and geologic investigation of the lagoon sub-bottom, and by crossing our data with the environmental records provided by archaeological findings and by the city's historical archives, we could distinguish different phases of the lagoon evolution and evaluate the weight of human-induced changes

We first mapped the position and the depth of the alluvial plain that was flooded during the last marine transgression, about 6000 years before present (BP), when the lagoon originated. Then, we mapped the areal extension of a dense network of palaeochannels and palaeosurfaces corresponding to different hydrological conditions and relative mean sea levels. Using many radiocarbon dating and the acoustical sub-bottom reconstruction, we could establish an average sedimentation rate of about 1 mm/year from 2500 and 1500 BP and 0.5 mm/year from 1500 BP up to present and an average migration rate of the natural channels ranging from 10 to 20 m/century with a filling rate between 0.5 and 2.5 mm/year. As a further result of this investigation, we found a general simplification of the morphologies over the centuries with a drastic reduction of the number of channels and salt marshes. This simplification can be explained by natural causes such as the general increase of the mean sea level, and by human activities such as artificial river diversion and inlet modifications causing a reduced sediment supply and a change of the hydrodynamics. Finally, we observed that this tendency accelerated dramatically in the last century as a consequence of the construction of a deep industrial canal, dredged between 1961 and 1969 to allow navigation of large containers. These results can contribute to planning effective environmental strategies for the Lagoon of Venice.