THE MEASUREMENTS OF WATER EXCHANGES AT THE VENICE LAGOON INLETS

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Abstract

The quantification of the water and sediment exchanges through the inlets of the Venice Lagoon is a fundamental requirement for designing interventions aimed at protecting the lagoon environment against exceptional tides and erosion processes. Acoustic Doppler current profilers are now being extensively used for the continuous monitoring of the ?ow to investigate the hydrodynamic characteristics and sediment transport in the cross-section of three inlets. An overview of researches undertaken and the main results so far obtained is given.

Keywords: Venice Lagoon, Adriatic Sea, water exchange, acoustic-Doppler profilers, sediment transport

The water exchanges between the lagoon of Venice and the Adriatic Sea are ensured by three inlets: Lido, Malamocco and Chioggia (from North to South). Their widths varies from about 450 m, of the Malamocco inlet, to about 900 m of the Lido inlet, while their depth is at most 20 m. The ?ow is essentially driven by the tide excursion in the northern Adriatic Sea even if some in?uence of wind forcing may affect the water circulation under extreme meteorological conditions.

The overall water volume of the lagoon is about 550 millions of m^3. Although the residence times of lagoon waters can vary considerably in the different compartments - in relation to the distance from the inlets, the morphology of the shallow-water areas and the characteristics of the drainage pattern – it can reasonably be presumed that such a volume is renewed on a relatively short time-scale (1-2 days). Flow rate as high as of 8000 m^3/s in a single inlet were in fact estimated by previous investigators with a modelling approach.

The tidal exchange is, therefore, the chief controlling factor for processes affecting the life and evolution of the lagoon ecosystem such as:
– thermal exchanges between the lagoon and the open-sea and their effects on the biological communities and algae production;
– sediment transport within the lagoon and exchanges of materials with the sea and the nearby littorals and their effects on the erosion-deposition balance;
– oxygen supply in the shallows and marginal areas;
– supply of nutrient substances to lagoon organisms and the removal of decomposition products;
– reproduction and migratory cycles of the fauna;
– human activities in the urban areas and minor isles.

Monitoring the exchanges of water, sediments and dissolved substances at the three inlets of the Venice Lagoon is, therefore, fundamental for the management of interventions aimed at safeguarding the lagoon environment and defending it from exceptional high tides. As like many other environmental variables, these evaluations must necessarily be based on sufficiently long records (time series). This will permit to identify evolutionary tendencies and to minimise the negative impacts of ongoing transformations on the planned interventions.

Regardless of the widely recognised priority of studies on the water and sediment exchanges between the Venice lagoon and the Adriatic Sea, the absence of a continuous series of observations of the ?ow at the inlets has always represented a serious obstacle to the progress of the research in the above-mentioned fields.

Acoustic Doppler current profilers (ADCP) have been recently employed for the continuous recording of the ?ow at the sea inlets permitting the acquisition of a two-year long time series of discharge for each of the three inlets. The trend of average annual/seasonal ?uxes, and the variations induced by particular weather and sea conditions, such as those responsible for exceptional tides and ?ooding, are jointly investigated by CNR-ISMAR and OGS research teams. A CNR-ISMAR research group also investigates the hydrodynamics and evolution of velocity fields in the inlet cross-sections as well as suspended sediment transport. The activities so far performed were granted by two main research projects:
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Bottom-mounted ADCPs have recorded current speed and directions along the vertical profile, at approximately the mid portion of the main channel of each inlet, since January 2001. The analysis of time series permitted a description of the temporal evolution of tidal currents. A study of the water exchange rates was also possible after determining the relationship between the vertically averaged current and the magnitude of ?ow rate obtained from transects acquired by vessel-mounted ADCPs. The scatterplot obtained for the Lido inlet (Fig. 1), shows the good correlation found between discharge and the average tidal current. Instantaneous discharge values as high as 8000 m^3/s are associated with the maximum current speeds (about 1.2 m/s) measured in this inlet. The average magnitude of tidal exchanges between the whole lagoon and the open sea is, therefore, of the order of 10,000 m^3/s, which implies a mean residence time of water masses of the order of one day, or a full tidal cycle [1].

It would be expected that the observed magnitude of the exchange rates has strong implications for the transport of suspended sediments, particularly when wind-induced stress in shallow water areas of the lagoon resuspend large amounts of sediments. For these reasons the research work has now been extended to monitoring suspended sediment ?uxes and the study of their variation over time. Sediment transport mechanisms within the inlets will also be investigated by applying the Sediview software procedure to the ADCP transect acquisitions which will permit a better spatial resolution than conventional techniques.

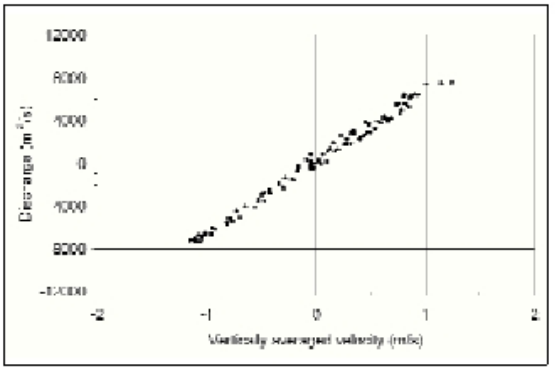

Fig. 1. Scatterplot of vertically averaged current velocity and discharge for the Lido inlet.

References

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