ENVIRONMENTAL CHARACTERISATION OF THE VENICE CANALS: FIRST RESULTS OF THE ICARO PROJECT

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Abstract

Venice canals are a sink of particulate matter and associated pollutants deriving from sewage effluents and erosion of urban surfaces. Due to the progressive silting of the canals, restoring interventions are necessary to reduce the input of materials, improving water quality and hydrodynamic conditions in the network. To acquire the scientific knowledge which is necessary to evaluate the effectiveness of the policy actions, a project named ICARO started in 2002. First results are described, concerning the definition of circulation pattern and the study of transport mechanisms, as well as physico-chemical variations in a test canal system of the Venice historical centre.

Keywords: Venice canals, hydrodynamics, sediment transport, urban wastewater

Large amounts of particulate matter from untreated sewage effluents and the erosion of urban surfaces are delivered to the about 40 Km-long canals of the City of Venice, determining a progressive silting of the network. A comprehensive program of interventions aimed to the general improvement of the canals network has recently started, to obtain better water quality conditions, to restore and preserve the building foundations and to renew the urban utilities. The program activities include sediment dredging and the reduction of the amount of materials directly delivered in the network. Thanks to the collaboration between INSULA - the public limited company constituted by the Venice City Council in charge of the interventions on the City - and the Venice Institute (ISMAR) of the National Research Council, a project named ICARO was started on February 2002, to study the functioning of the canal network. The main objectives of the project are the description of the canals hydrodynamics and the study of transport and accumulation mechanisms governing the sediment and associated pollutants. The obtained results are expected to be useful to test the efficiency of the restoring interventions, and to address the planning of future activities to the maintenance of the canal network functionality. The investigation is initially focused on a test canals system corresponding to about 10% of the whole network. The definition of the water circulation and the study of the variability of physico-chemical parameters, as a function of both tidal exchanges and season, are the basic knowledge for the interpretation of the acquired data. These information are obtained from time series of hydrodynamic variables (tide level, current speed and direction) and physico-chemical parameters (salinity, temperature, dissolved oxygen, pH, redox potential and turbidity), recorded in few stations. These continuous acquisitions are integrated by a large number of point measurements performed in several sites, to investigate the variations occurring within the system. The hydrodynamic data are also used to calibrate a bidimensional model, that simulates the tide propagation in the canals, permitting to describe the water circulation and the sediment transport within the whole network. The water pollution is periodically monitored during dedicated field surveys: hourly samples are collected and analysed to determine the concentration of suspended particle matter (SPM), heavy metals and nutrients (nitrogen and phosphorus species). The amount of suspended material transported in the system is estimated by means of sediment traps; the collected materials is submitted to both the dimensional and chemical analyses. The trends of SPM concentration and turbidity in the water column highlights the important role of the boat traffic in determining the mobilisation of particulate matter in the canal network. The resuspension induced by tide circulation is, in fact, less effective than the whirling-up of sediment caused by boat traffic. As a consequence, the turbidity in the water column is mainly determined by the navigation, in function of the intensity of boat traffic, water level and tide conditions. The comparison between turbidity and the fluxes measured by sediment traps is useful in the evaluation of the solid transport processes. Figure 1 shows, for example, the clear correspondence between the trend of the sediment flux in a time interval of two weeks and the average value of the turbidity. Although the measured fluxes are an integrated signal on a given time interval, the periods characterised by a large sediment yield correspond to higher turbidity values.

Concerning the pollutants, the main focus of the project is to identify the species that are more useful in understanding the transport within the canals network, and the processes that determine quality variations in the water column. A good example is the trend of the dissolved nitrogen and phosphorus species (Fig. 2), in particular ammonia and orthophosphate, which are also strongly correlated. The concentrations of these compounds in the inner canals is essentially determined by both the discharge of urban effluents and the intensity of water exchange with the tide. The more the water stands within the network, the higher the concentration of ammonia and orthophosphate. Therefore, these species are a valid tracer of the quality variation in the water column, permitting to trace circulation patterns and to evaluate residence times in the system.

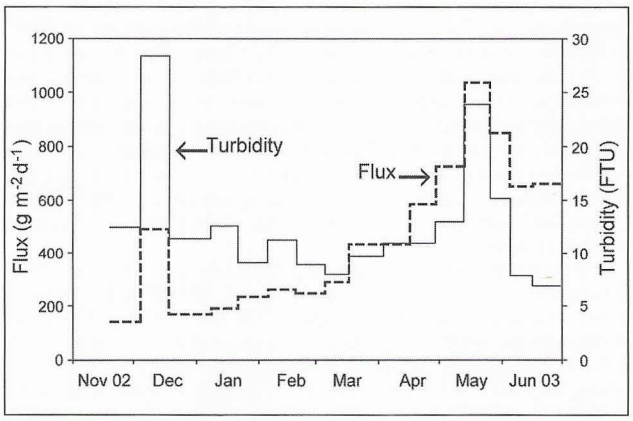

Fig. 1. Comparison between the trend of the sediment flux to the traps in a two-weeks interval and the average value of the turbidity.

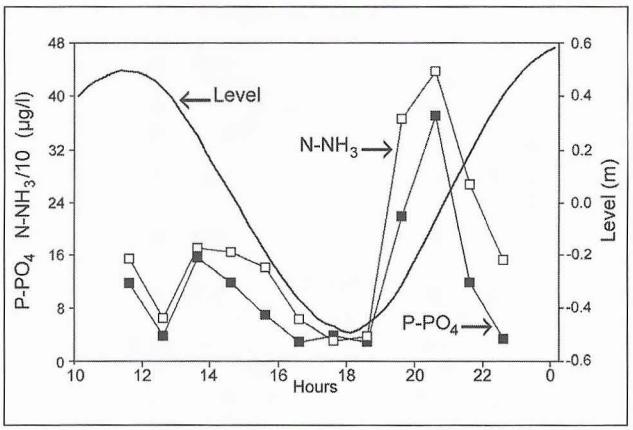

Fig. 2. Concentration of orthophosphate phosphorus and ammonia nitrogen during a tide excursion.