

Bio-stabilization of the Venice lagoon tidal flat

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Introduction: The tidal flats of the Venice lagoon are eroding at an alarming rate due to historical causes (relative sea level rise, diversion of river and sediment out of the lagoon) and anthropogenic activities (maintenance dredging of navigation channels, clam dredgers). In the last 70 years the tidal flats higher than -0.60 m a.s.l. have been reduced to almost 1/3 (from 168 km² to 60 km²), triggering an increase of the wind wave action over the remained tidal flats, the salt marshes, the levees and the historical city banks.

Recent studies conducted by Consorzio Venezia Nuova on behalf of Water Authority of Venice, have indicated the dominant role of the benthic communities on the tidal flats stabilization: new techniques of environmental engineering aimed at reintroducing biostabilizing processes are now under development and experimentation.

Methods: on the bases of theoretical studies and field surveys, the more significant biostabilizing processes have been detected (eel grass, abundance of polysaccharides produced by diatoms and cyanobacteria) [1]. In term of abiotic factors the net transfer of sediment out of the tidal flats has been correlated with the wind wave energy and hydraulic distance from the nearest ebb channel.

The other factor controlling erosion is the frequency of resuspension (number of hour in which the turbulent shear stress, τ_b is greater then the critical shear stress, τ_c).

Over more than 100 stations τ_c have been measured by Coesive Strength Meter (CSM) and this value have been extrapolated to different tidal flat tanking in to account sedimentological and biological properties. A correlation analysis between the above dominant factors and the total erosion over the period 1970-2000 has been performed [2].

Results: The critical shear stress (τ_c) is mainly affected by the biological characteristics and in particular the intertidal habitat is 2-3 times more resistant than the subtidal. In terms of the contribution of the total erosion the main factor is the distance of the tidal flat to ebb channel and than the frequency of resuspension.

The contribution (%) to the total erosion of clam fishing is greater in the areas that are more distant from ebb channels.

From the above findings the restoration of the tidal flats can be achieve only by a significative reduction

of net transport (from tidal flat to channel and the sea) and resuspension: a number of artificial shoals and constructed salt marshes has to be located inside the water bodies to reduce fetch and water depth, and along the channel to reduce the flow across the channels.

The construction of this works will require a great amount of sediment of non polluted sediments (above 10 million m³) together with hard structure (stone armouring for containing and protect the sediment filling from wind and motor boat waves). It can be envisaged that the hard structure will be remove after a transitional period of bio-stabilization (increase in τ_c) because of the increase in benthic community distribution after the beneficial of confinements, reduction of wave energy and clam fishing management.

This large landscape transformation can be approved and accepted only through the participation of local authority and stakeholders to the decisional procedure: the upgrading of the hydro-morfological and environmental plan of the Venice lagoon is now underway and the participation will be granted by the VAS procedure required by EU Directive.

Discussion: In order to use the above finding in morphological simulation model able to predict the evolution of the tidal flat and the effect of the different interventions a better description of τ_c in space and time is required.

From the point of view of the landscape acceptability new material and structure are now under sperimentation.

References: [1] Amos C.L., Cloutier D., Cristante S., Cappucci S. and Le Couturier M., 2000. The Venice lagoon study (F-ECTS); [2] Study conducted by Ministero dei Trasporti e delle Infrastrutture – Magistrato alle Acque di Venezia – through the concessionarie Consorzio Venezia Nuova: Study B.12.3/III - Erodibilità del fondale e fattori di disturbo: rilievi dell'erodibilità, 2005; Attività di monitoraggio ambientale della Laguna di Venezia. Secondo stralcio triennale (2002– 2005) MELa 2.