A natural-scale analysis of Estuarine Cohesive Sediments: the EsCoSed Project

Maurizio Brocchini[1], **Joe Calantoni**[2], **Matteo Postacchini**[1], **Allen H. Reed**[2], **Carlo Lorenzoni**[1], **Aniello Russo**[1], **Alessandro Mancinelli**[1], **Valeria Corinaldesi**[1]

[1]Università Politecnica delle Marche, via Brecce Bianche, Ancona, Italy
[2]Naval Research Laboratory, 1005 Balch Blvd., Stennis Space Center, MS, USA

Phone: +39-071-220-4539
E-mail: m.postacchini@univpm.it

Introduction: Cohesive sediments play a key role in coastal, estuarine and riverine ecosystems by: 1) limiting the ability to remotely determine bathymetry, 2) transporting nutrients, metals and contaminants to the seafloor, and 3) altering the shear strength, erodibility and bearing capacity of nearshore sediment deposits.

Clay minerals, colloidal metals and biopolymers form flocs, which accumulate in the nearshore regions. The floc dynamics is more complicated than that of non-cohesive sediments, because of the complex chemical composition. In particular, they settle to the seafloor faster than the single mineral grain, which is usually transported far offshore, due to elevated densities and lower hydrodynamic drag [1]. Flocs accumulate in seabed deposits of many navigable waterways (harbors, rivers, etc.), this often inhibiting ship traffic or requiring the seabed dredging (e.g. [1], [2]). Further, suspended sediment concentrations provide a primary mechanism for transport and deposition of contaminants in harbors, bays and estuaries due to the association of ionic charges on the clay surfaces that provide numerous binding sites for them. Finally, mud deposits in the nearshore areas can form important natural sea defenses as the suspended sediment and soft mud may induce significant wave damping (e.g. [3], [4]).

Methods: All the above-mentioned processes span wide ranges of temporal and spatial scales, hence there is a need to analyze the dynamic environments at such broad ranges minimizing the scale effects induced by laboratory experiments. However, rigorous inspection of the smallest-scale processes can be reliably carried out only in controlled environments. The only way to investigate such processes is to perform field-scale experiments in a controlled estuarine environment and to monitor the physical, chemical and geotechnical properties of both suspended and deposited flocs. This is the main scope of EsCoSed, a collaborative NICOP Project between the Università Politecnica delle Marche (Italy), the Naval Research Laboratory (MS, USA) and the Office of Naval Research (USA). It will seek to couple hydrodynamics and morphodynamics by analyzing, directly in the field (i.e. in the Misa estuary, Senigallia, Italy), the main aspects of sediment suspension/deposition and by quantifying the physio-chemical and geotechnical properties of the in situ collected flocs (Fig. 1). Further, knowledge on cohesive sediment properties will be implemented in existing numerical solvers for the prediction both of the small-scale sediment dynamics [5] and of the hydro-morphodynamics of relatively large nearshore regions [6]. Thus, EsCoSed will address the main relationships between the physical, geotechnical and mechanical properties of cohesive sediments, which are profoundly affected by sedimentological, biological and geochemical processes, this enhancing applications towards and support of engineering efforts and environmental forecasts.

Discussion: Preliminary results will be extracted from the collected data: surface flow (from lagrangian drifters), flow rates (from current meters), bed morphology (from a pencil-beam sonar), soil characterization (from core samples). A first solver implementation will be also discussed at the Conference.

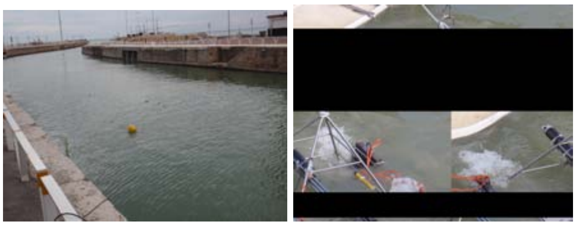

Fig. 1: The Misa estuary (left) and deployment of an instrumented quadpod (right).

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