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Influence of currents and wave propagation on the seagrass meadows development in shallow water systems (near shoreline)

Elena Alekseenko (1), Bernard Roux (2), Alexander Sukhinov (1), and Christian Kharif (3)

(1) TIT SFU - Taganrog Institute of Technology of South Federal Univercity, Taganrog, Russian Federation (lena.alekseenko@gmail.com), (2) M2P2 UMR 6181 CNRS – University of Aix-Marseille and Ecole Centrale Marseille, France (broux@l3m.univ-mrs.fr), (3) IRPHE UMR 6594 - Institute of Research of Non Equilibrium Phenomena, Marseille, France (kharif@irphe.univ-mrs.fr)

This work concerns the 3D hydrodynamics in a lagunar ecosystem subject to tide and wind effects and to a large amount of freshwater inflow. More precisely, in concerns Berre lagoon (near Marseille airport) in which the area occupied by near shoreline seagrass meadows is regularly decreasing year after years. Special attention is paid in view to better understand if the hydrodynamical conditions (especially the wind waves effects for near shoreline areas, i.e. for shallow water condition) can be the main cause of the seagrass regression and how the hydrodynamics and the sediment transport would have to be controlled for a future restoration of such seagrass meadows.

Of course, the ecological and environmental interest of the preservation of such seagrass is well known, not only for the shoreline protection against erosion, but also for the protection of juvenile fishes and for the feeding of migratory birds (e.g., Berre lagoon is listed among the sites to be protected in the frame of the European Commission program Natura 2000).

Our understanding of the regression is that the present density of the meadow (number of shoots per square meter) is far too small to permit these plants to resist against the energy of the currents and maybe the mechanisms of wave breaking. Indeed, Berre lagoon is situated in a windy area, and its size is large enough to permit wave systems to develop in the deep part of the lagoon (9m). One part of the numerical study is to determine the 3D currents induced by the main forcing mechanisms (tide, wind, freshwater inflow) separately or concurrently for a pertinent range of the forcing parameters. About 10 of such scenarios (time-dependent for tide effect, or stationary without tide effect) are considered. The numerical simulation is performed for the whole lagoon, and then, with a finer grid (1m x 1m), in subregions corresponding the restoration areas (typically 100m x 100m). The results concern not only the currents, but also the mean elevation of the free surface and the current energy. In addition, for the subregion, some preliminary results concerning the wave propagation in very shallow water will be given.

For the purpose of restoration, it is needed to add into the model the effect of interaction between the meadow and the flow. Different phenomenological laws have been considered; such laws take into account the characteristics of the meadow (density, height and size of the leaves, in particular), but also the ratio of the water column depth to the meadow height. This is one of the reason for which a fine grid simulation is needed. Again, different scenarios of artificial restoration (by transplantation) will be presented for a range a relevant parameters (size and position of the transplantation areas), in order to provide the tools to the engineers in charge of this restoration.