The effects of benthic organisms on sediment erodability in intertidal systems: What effects are relevant for what objectives?

F. Orvain [1], P. Le Hir [2], P.-G. Sauriau [3]& S. Lefebvre [1]

([1]PE2M, laboratoire de Physiologie et Ecophysiologie des Mollusques Marins, UMR1 Université de Caen – IFREMER , Université de Caen, Esplanade de la Paix, -14032 Caen cedex; [2]IFREMER, Centre de Brest, BP 70, 29280 Plouzané
[3]CREMA (CNRS-IFREMER), Place du séminaire, BP 5, 17137 L'Houmeau

The effects of microphytobenthos, macrofauna and marine vegetation on sediment erodability have been widely described, and benthic ecologists have also proposed mathematical models coupling physical and biological factors at the sediment-water interface. Microphytobenthos has been reported to stabilise sediments by increasing their resistance to erosion, this effect being regulated by the secretion of Extracellular Polymeric Susbstances (EPS). Macrofauna effects are extremely complex even for a single species and also greatly vary in both time and space. Generally speaking, epibenthic deposit-feeders on intertidal bare mudflats have been reported to increase the erodability of surficial cohesive sediments through e.g. release of faecal pellets and bed material pelletization, production of large amounts of easily-resuspended pseudofeces, surface tracking and disturbance of microphytobenthic biofilms. These bioturbating processes are mediated by the formation of a "biogenic" fluff layer that is easily resuspended before general bed erosion. The marine vegetation, when forming dense populations, reduces the turbulences under the canopy and has an influence on wave attenuation, both processes promoting sedimentation and/or erosion protection during storm events.

Depending on the aims of the study, these processes appeared not to be relevant at all scales. If one aims to analyse their impacts on the sediment budget, only processes that are likely to change long-term erosion-sedimentation are relevant. On the contrary, if one aims to evaluate their impacts on the contribution of resuspended microalgae and organic material to the diet of cultivated suspension-feeders, all processes that affect short-term erosion will be relevant because these species are subjected to a tidally-variable range of situations where the food acquisition will be completely contrasted.

For this reason, this study aims at giving some order of priority to the effects that must be taken into account in models of sediment-water interactions depending on the objective: modelling the sediment dynamics or modelling the trophic food web. Different runs of a 1DV hydrosedimentary model and of a morphodynamical model of an intertidal mudflat that simulates the equilibrium profile of the shore profile under tide and wave forcings, have been analysed and compared. It reveals that, due to the variations of microphytobenthic biomass following seasonal and spring/neap tidal cycles, the long-term effects of microphytobenthos can be neglected. The impact of macrobenthos is very significant on a long term and the effect of one very mobile species that is widely dispersed on large areas (the gastropod *Hydrobia ulvae*) has been compared to the effect of one sedentary species whose distribution remains confined to upper shores (the bivalve *Scrobicularia plana*). This reveals the strong impact of the sedentary species that induces a high downward shift of the upper shore while the effects of mobile species remain very low. Concerning the vegetation beds, the simulations confirm that saltmarshes induce a spectacular accretion of the upper shore.

On the other hand, data obtained with biomarkers such as natural stable isotopes have the advantage to provide variations in the diet of cultivated suspension-feeders on a time scale of one month. Generally speaking, these techniques show the relative importance of intertidal

microphytobenthos in the trophic web within the water column. The contribution of microphytobenthos to the diet of cultivated suspension-feeders is well recognized in literature, while the contribution of seagrasses seem to be lower. Microphytobenthos resuspension primarily depends on physical forcings, but is also controlled by the microalgae growth and the related stabilisating/destabilisating effects which depend on the physiological status of the biofilm. For this subject, the interacting effects of microphytobenthos and macrofauna on resuspension events must be understood to describe the availability and real incorporations of microphytobenthos as a food item for cultivated suspension-feeders.

The divergence of interest between a sedimentologist and a biologist, when modelling the "biota effects" at sediment-water interface, must be considered in the definition of a modelling strategy depending on the objectives of the study in question.