Macrobenthic functional diversity on tidal mud flats - An experimental approach to quantify the impact of bioturbation on cohesive sediment transport

Laukens Maxime[1], Schwarz Christan[1], Van Ryckegem Gunther[2], Van De Meutter Frank[2] and Kassadi Naveen[1]

[1] Hydraulics and Geotechnics, Department of Civil Engineering, Katholieke Universiteit Leuven, Kasteelpark Arenberg 40 - box 2448, 3001 Leuven
E-mail: maxime.laukens@kuleuven.be

[2] Instituut Natuur- en Bosonderzoek, Instituut Natuur- en Bosonderzoek, Herman Teirlinckgebouw, Havenlaan 88 bus 73, 1000 Brussel, Belgium

In soft bottom estuarine and marine environments ecosystem engineering is often performed by macrozoobenthic organisms. By redistributing inorganic and organic sediments, bioturbators create improved “engineered” environmental conditions for themselves. However the impact of bioturbation is not only limited to the local fauna, continuous reworking of sediments has also implications on the physical composition of the bed, affecting thresholds for sediment resuspension and consequently sediment transport. Understanding how macrozoobenthic organisms, each with different bioturbation traits, shape coastal ecosystems is crucial for sustainable estuarine and coastal management, especially in the application of nature-based solutions to mitigate anthropogenic and climate induced changes.

Previous experimental studies already demonstrated the effect of bioturbation on sediment resuspension. However, thus far collected evidence mainly focused on bioturbation by a single species and/or single-grain size studies limiting our ability to upscale measurement results to bigger spatial scales. Remaining questions include, is the whole really greater than the sum of its parts? Do macrozoobenthic communities bioturbate sediments comparable to the scaled sum of their single species? Is natural bed sediment composition intrinsically linked to the bioturbating community with multiple traits or to a dominant single-trait bioturbation species?

This case study is the first step in the development of a robust framework to improve sediment transport predictions on the estuarine scale based on mechanistic organism-sediment interactions. Through hydraulic flume experiments, we investigate how the presence of natural macrozoobenthic communities alters cohesive sediment resuspension. Flume experiments compare natural sediment beds, in respect to bed composition and benthic communities, to “artificial” sediment beds with altered bed and macrozoobenthic properties. Sediments were collected on a cross shore gradient on a tidal mud flat near Doel in the Scheldt Estuary in October 2022. Measurements of sediment resuspension and bed load transport under increasing bed shear stress allow us to (1) compare natural sediment beds to artificially created sediment beds with the same particle properties under identical hydrodynamic conditions, yet variable densities of the dominant bioturbator present on the field sampling location, and to (2) quantify the impact of bioturbation on sediment transport at different natural beds in a cross shore gradient.

Results show that bed composition and macrobenthic communities vary significantly in the cross shore sampling sites. Initial results from the flume experiments will enable us to make a statement about whether sediment resuspension by a dominant bioturbation trait can be a proxy for total sediment resuspension, which can be seen as a first step in a robust framework for spatial upscaling of the bioturbation impact on sediment transport on the estuarine scale.

Keywords
Macrobenthos; Bioturbation; Tidal Mud Flats; Sediment Transport; Flume Experiments