Estuarine biodiversity and ecosystem functioning under benthic and pelagic sediment change

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Within estuaries and shallow coastal seas, ranked among the most productive marine ecosystems, shallow soft-sediments provide essential ecosystem services. Among these services are filtering of pollutants, recycling of nutrients and sustenance of coastal food webs. An important link in the cycling of material and energy within estuaries and between estuaries and the adjacent coastal seas is the exchange between sedimentary habitats and the water column (benthic-pelagic coupling). Both physical (e.g. sediment resuspension) and biological factors (e.g. bioturbation and bio-irrigation by macrobenthic organisms) determine this coupling, as they have a large impact on the (re)mineralization of organic matter and fluxes of solutes across the sediment-water interface. As a result, hydro-morphological alterations that change the balance between sediment resuspension and deposition will affect the biodiversity and functioning of estuarine ecosystems through changes in macrobenthos populations. Because interactions between turbidity and macrobenthos can induce critical changes in soft-sediment ecosystem functioning, fundamental ecological knowledge is needed about the stability of biodiversity and ecosystem functioning in shallow coastal habitats subjected to sediment change.

In the heavily impacted Scheldt Estuary (Netherlands and Belgium), the relation between macrobenthos and sediment properties is generally well understood. However, it is unknown how resilient these populations, and the relations within their ecosystem interaction network, to sediment change are. The relationships between, and the responses of, biodiversity and ecosystem functioning to changes in sediment properties in the benthic and pelagic compartment of the estuary will therefore be studied in this PhD project. Benthic-pelagic fluxes of solutes for the major benthic habitats will be quantified along the entire estuarine gradient. Sediment-water exchange of nutrients, organic matter remineralization, bio-irrigation and bioturbation will be measured in different *in situ* benthic communities and periods of the year. We hypothesize that the governing mechanisms of the measured benthic-pelagic coupling will depend on the environmental context, and thus vary along both the spatial gradients in salinity, granulometry and depth; and the seasonal changes in biological and physical sediment and water column properties.

In addition, the influence of suspended sediments on macrobenthos-mediated biogeochemical cycling will be investigated by documenting species behaviour under experimental conditions. This will be done by using luminophore reworking rates, hydraulic signatures and time-lapse observations in mesocosm experiments that contain communities from the different benthic habitats along the estuary. Experimental variation in suspended sediment concentrations is hypothesized to alter benthos-mediated change in benthic-pelagic coupling through changes in benthos condition and behaviour.

A field experiment where fine silt deposition events are simulated, will provide further insights into the resilience of estuarine soft-sediment habitats to sediment change. Because these deposits will change the sediment surface cohesiveness and nutritional characteristics, and the macrobenthos' ability to maintain contact with the sediment-water interface, we hypothesize that deposition events will inhibit transport of material and solutes across the sediment-water interface, altering benthic-pelagic coupling.

Eventually, the insights into benthic-pelagic coupling obtained from measurements along the estuary under both natural and manipulated conditions will be integrated to understand the consequences of benthic and pelagic sediment change for estuarine biodiversity and ecosystem functioning.