Macrobenthos-mediated nutrient cycling in offshore windmill farm environments under future ocean climate settings

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The installation of offshore wind farms (OWFs) in the Belgian part of the North Sea (BPNS) introduces large surfaces of artificial hard substrates (AHSs). These AHSs are expected to modify the physico-chemistry and ecology of the adjacent seabed due to, among others, altered hydrodynamics and organic enrichment originating from the fouling OWF fauna and proposed aquaculture activities in the OWF concession area. In addition to local habitat changes associated with the AHSs, global climate change stressors such as ocean warming and acidification also challenge coastal ecosystems. They can, for example, influence the benthic communities and the way in which the (affected) biodiversity contributes to ecosystem services such as biogeochemical cycling. Through bioturbation and bio-irrigation macrofauna reworks the sediment and alters both physical structure and chemical composition, often facilitating microbial activity and removal of nitrogen via coupled nitrification-denitrification processes. A consequence of this process is however the production of the potent greenhouse gas nitrous oxide (N_2O), produced during nitrification and denitrification. Hence there is need for knowledge on the cumulative effect of local anthropogenic impacts associated with OWFs and global climate change on the coastal ecosystem and its effect on the production of the greenhouse gas N_2O.

The project PERSUADE (ExPERimental approaches towards Future Sustainable Use of North Sea Artificial HarD SubstratEs) aims to investigate ecosystem-wide responses to combined global and local stressors and the effect on the production of N_2O in a future climate setting, by quantifying the interactions between the biotic and abiotic compartments in an OWF environment. We therefore consider both the fouling and soft substrate fauna and their effect on nitrogen cycling. A four-step approach is envisaged to provide an empirically based mechanistic understanding of the biogeochemical response of the benthic environment to the installation of OWF. First the behavioural activities that are relevant for mediation of biogeochemical cycling (i.e. particle mixing, burrow ventilation, feeding) will be investigated by recording hydraulic porewater signatures in the polychaete *Lanice conchilega* and the bivalves *Ensis directus* and *Abra alba*. These species are expected to represent dominant members of the benthic community in the OWF environment in the BPNS. Secondly, the effect of density and allometry of these species on the N_2O production will be studied. The developed techniques and insights gained in the first two parts of the project will then be used to study the benthos-mediated biogeochemical cycling under future ocean conditions. Organisms will be incubated under different climatic conditions (higher temperatures and lower pH) and their behavioural responses will be observed. To determine the effect on nutrient cycling, oxygen consumption rates will be determined and the solutes exchanges across the sediment-water interface will be measured. Finally, the acquired results will be incorporated in the development of a model to investigate and predict the long-term production of the greenhouse gas N_2O in OWF environments under future climate scenarios.

Keywords: macrobenthos; ocean acidification; ocean warming; offshore-windfarms; aquaculture; biogeochemical cycling