Habitat type and dredge dumping intensity determine the sensitivity of different benthic ecosystem components in the Belgian part of the North Sea

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Multiple human activities are executed in the Belgian part of the North Sea (BPNS), such as sand extraction, fisheries, offshore wind energy installations and dredging of navigation channels, with the associated disposal of dredged material at sea. We assessed the impact of the dredge disposal activities on the benthic ecosystem, i.e. organisms living in, on and near the bottom, to evaluate the sensitivity of different habitat types and ecosystem components to different dredge disposal intensities.

In the BPNS, dredged sediments are dumped with different intensities at five designated disposal sites. Two sites are situated in the muddy *Limecola balthica* habitat near Ostend (LOO; low intensity) and Zeebrugge (LZO; high intensity). Two sites are located in the fine muddy and sandy *Abra alba* habitat in front of Nieuwpoort (LNP; very low intensity) and on the Sierra Ventana (LS1; high intensities). The fifth disposal site is located in the sandy *Nephtys cirrosa* habitat on the Vlakte van de Raan (LS2; moderate intensity).

Dredge disposal may influence the benthic ecosytem directly by for example the burial of organisms and indirectly by changing the sediment composition. During the period 2005-2019, macrobenthos samples were taken in autumn using a Van Veen grab at the five dumping sites and at predetermined control sites, while epibenthos and demersal fish were collected in spring and autumn by means of an 8m shrimp trawl at the same sites. The BEQI-tool (Benthic Ecosystem Quality Indicator, www.beqi.eu) was used to assess differences in species richness, species composition, density and biomass, according to a control-impact design. The use of a standard indicator approach allows for an objective evaluation of the impact across sites, habitats and ecosystem components. The indicator gives scores between 0 and 1, where 1 means high similarity between control and impact. A BEQI score of 0.6 was set as a threshold, where values <0.6 reflect a clear difference between control and impact sites, indicating a real impact of the dredge disposal activity.

Despite the high dredge disposal intensity at LZO, high BEQI scores were noted for both LOO and LZO disposal sites. This indicates that the *Limecola balthica* habitat is not very sensitive to dredge disposal activities. Equally high BEQI values were calculated for the LNP disposal site, while the BEQI score for LS1 was <0.6, indicating a low similarity with the control site for the latter. This is probably related to a higher sensitivity of the fine muddy sand *Abra alba* habitat in combination with the high dredge disposal intensity at LS1. For the LS2 disposal site, high (>0.6) to very high (>0.8) BEQI scores were found, indicating a relatively low impact of moderate dredge disposal intensity in the sandy *Nepthys cirrosa* habitat. Part of the higher BEQI score for LS2 may be attributed to a slightly 'positive' effect of dredge disposal, related to the creation of a new habitat by dumping fine sediments in a sandy environment. That way, mud-loving species can co-occur together with typical benthic species already living in that sandy environment.

The observed differences in fauna characteristics were similar across ecosystem components, but more pronounced for the macrobenthos, due to the more sessile mode of life of these animals compared to epibenthos and fish. This mid-term environmental impact assessment proves that the impact of dredge disposal activities depends on both the sensitivity of the benthic habitat and the intensity of dredge disposal. This means that multiple factors have to be considered for a sound management of dredge disposal and other human activities in the BPNS.

Keywords: Dredge disposal; BEQI; Impact assessment; Benthic habitat; BPNS