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Prediction of organic matter degradability in river sediments

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Under anaerobic conditions, degradation of organic matter in river sediments leads to gas formation, with organic carbon being released mainly as CH_4 and CO_2. Gas bubbles reduce sediment density, viscosity and shear strength, impede sonic depth finding and are suspected to affect the sediments' rheological properties. Moreover, methane (CH_4) is a potent greenhouse gas with a global warming potential (GWP_{100}) of 28-36. Therefore, the climate impact may vary greatly depending on the way sediments are managed (for example, type and frequency of dredging and relocation in the water body or treatment on land). The objective of this paper is therefore to quantify the time-dependent stability, or inversely, the lability of sediment organic matter (SOM) as a basis for prediction of effects on sediment mechanical properties and on the release of greenhouse gases.

Within two years, over 200 samples of predominantly fine-grained sediment were collected from nine locations within a 30 km transect through the Port of Hamburg. All samples were, amongst other analyses, subjected to long-term (> 250 days) aerobic and anaerobic incubation for measurement of SOM degradation, yielding a comprehensive data set on the time-dependent change in degradation rates and the corresponding size of differently degradable SOM pools. SOM degradability exhibited a pronounced spatial variability with an approximately tenfold higher anaerobic and a roughly fivefold higher aerobic degradability of upstream SOM compared to downstream SOM. Lower $\delta^{13}C$ values, higher DNA concentrations and a higher share of organic carbon in the light density fraction as well as elevated chlorophyll concentrations in the water phase support the hypothesis of increased biological sources of SOM at upstream locations and increased SOM degradability in shallow compared to deep layers (Zander et al., 2020).

First statistical and time series analyses indicate that

- Long-term SOM lability appears to be predictable from short-term measurements.
- The relationship between short-term and long-term SOM degradation is site-specific and also differs for layers of different age (depth). This supports the above-mentioned variability between sites regarding the size of differently degradable carbon pools, as well as for the depth profile at any one site.
- The relevance of the available electron acceptors (redox conditions) for SOM degradation, i.e. the ratio between carbon release under aerobic and anaerobic conditions, differs less by site but more so by layers of different age (depth). This is plausible as especially the top layers are exposed to more variability in redox conditions than the deeper layers that are always under

reducing conditions.

Zander, F., Heimovaara, T., Gebert, J. (2020): Spatial variability of organic matter degradability in tidal Elbe sediments. Journal of Soils and Sediments, accepted for publication.

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