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Bottom trawl fishing and dredging decrease marine CO_2 sequestration by stimulating pyrite oxidation

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Coastal and shelf sediments play an important role in regulating Earth's climate through the production of alkalinity, which increases the seawater's capacity to store CO_2. Sulphate reduction and subsequent precipitation of pyrite generate nearly a fifth of the total sedimentary alkalinity efflux, with carbonate dissolution contributing the remaining fraction. Coastal sediments are also subject to intense human activities like trawling and dredging which resuspend and homogenise the sediment. Through this continuous sediment reworking, anoxic sediment layers or exposed to oxygenated conditions and natural biogeochemical cycles are disturbed. Specifically, the re-exposure of pyrite to oxygen can drive pyrite reoxidation, thereby removing alkalinity. The anthropogenic impact on natural sediment generation is, however, still poorly quantified.

We present model simulations of the impact of bottom trawling and dredging on the sedimentary alkalinity generation. Both bottom trawling and dredging cause reoxidation of pyrite in muddy coastal sediments, thereby decreasing the alkalinity efflux. In muddy shelf sediment, trawling increases the alkalinity generation by introducing reactive organic matter to deeper sediment layers, which stimulates sulphate reduction and concomitant pyrite precipitation. However, the alkalinity gain from increased pyrite precipitation is 2-6 orders of magnitude lower than the alkalinity loss from pyrite oxidation. On a global scale, bottom trawling and dredging decrease the natural alkalinity release from sediments by ~27.5 Geq. yr^{-1}, equivalent to a reduction of the natural marine carbon sink by 1 Tg CO_2 yr^{-1}. This loss in marine CO_2 storage is of the same order of magnitude as some proposed carbon dioxide removal technologies. Our results show that the loss of alkalinity due to anthropogenic activities causes considerable indirect CO_2 emissions, which need to be taken into account when performing carbon budgeting in coastal systems.