Geophysical Research Abstracts
Vol. 20, EGU2018-16923, 2018
EGU General Assembly 2018

The strength of ecosystem engineering effects depends on biological and environmental conditions: a case study on sediment stabilization by the Pacific oyster Crassostrea gigas in the Oosterschelde estuary (the Netherlands)

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The realization of a storm surge barrier and two secondary dams changed the hydrodynamic and geomorphologic characteristics of the Oosterschelde estuary (The Netherlands). This resulted in a disequilibrium between erosion and sedimentation processes, which has led to erosion of the tidal flats. Consequently, tidal flats become lower and slowly disappear, which reduces the habitat of intertidal soft-bottom benthic fauna, an important foraging habitat and food sources for estuarine birds. Additionally, the risk of dike failures and flooding during storm surges will increase, since dikes will become more exposed to wave action without an adjacent tidal flat to dissipate the wave energy .

Ecosystem-based coastal defense is a promising way to climate proof estuaries and coastlines. One of the advocated methodologies is creation, restoration or conservation of intertidal ecosystem engineering species that stabilize shorelines and attenuate waves. The Pacific oyster (Crassostrea gigas) is an ecosystem engineer known for its wave attenuating, sediment trapping and stabilization capacity. We quantified to what extent oysters' ability to stabilize sediment is conditional; investigated if this effect can be predicted based on physical forcing, morphological characteristics of the tidal flat and biological characteristics of the oyster reef; and evaluated the performance of constructed oyster reefs under different physical forcing and morphological characteristics. This was done by correlating reef characteristics and abiotic conditions to long-term sediment accretion patterns of tidal flats covered by natural intertidal Pacific oyster reefs. Furthermore, the performance, development and morphological effects of four constructed oyster reefs, designed for sediment stabilization of a tidal flat nourishment, was investigated.

Results show that stabilization of sediment by oysters increases under erosional conditions. Furthermore, tidal flat shape determines the strength of the ecosystem engineering, as larger elevation changes were found in convex tidal flats versus concave tidal flats. Additionally, there is a relation between sediment stabilization and reef characteristics, as a lower width to length reef ratio and a higher patch or oyster densities increases the ability to accrete and stabilize sediment within the reef.

The ability of C. gigas to shape its environment depends both on biotic and abiotic conditions. Stabilizing effects of oyster reefs on tidal flats stress their importance as ecosystem engineers in erosion dominated estuaries and coastlines. Conservation of oyster reefs, as well as construction of artificial reefs could be an important management tool for tidal flat protection and conservation and ultimately for coastal protection.