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Enhancing coastal resilience with artificial dunes through bio-geomorphological processes

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Coastal regions worldwide face increasing challenges posed by the impacts of climate change, such as rising sea levels, and intensified and more frequent storm events. In response to these imminent threats, the priority for coastal resilience has gained importance, emphasizing the fusion of nature-based solutions with conventional engineering methods. Among these, coastal dunes stand out as promising protective barriers. This three-year investigation focuses on evaluating the effectiveness of an artificial dune system in mitigating local sand-related issues along the adjoining seawall, featuring the plantation of marram grass in Oosteroever, Belgium. The study delves into a comprehensive analysis of sediment accumulation, dune morphology, and vegetation development. Noteworthy findings reveal a significant increase in dune height, reaching up to 2 m in the area where marram grass was planted, surpassing the adjacent seawall in elevation. Extensive profile and drone surveys unveil a consistent growth rate of 27 m^3/m, in stark contrast to substantial erosion observed in adjacent unvegetated beach areas, where erosion reached up to 30 m^3/m. While one storm event resulted in dune toe erosion of 1.5 m^3/m, the dune exhibited rapid recovery through natural aeolian processes. Importantly, marram grass development proved resilient, unaffected by the initial planting configuration and density, with more pronounced growth observed at the perimeter edges of the dune. This study highlights the success of the 'dune-in-front-of-a-dike' approach, providing valuable insights for the formulation of sustainable strategies in coastal resilience.