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Ecosystem services in coastal wetlands: Investigating bio- and hydro-mechanical traits of salt marsh vegetation

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Biodiversity and nature conservation play an increasingly important role with growing societal awareness, which is reflected in current European legislative frameworks such as the Marine Strategy Framework Directive or the Water Framework Directive, calling for integrative solutions and restoration of good environmental status. Salt marshes provide ecosystem services which can help mitigate climate change and sea level rise threats and simultaneously address coastal squeeze problems. The periodical submergence due to tidal changes creates a special ecosystem with different zones delineated by a landward increasing marsh elevation, which are inhabited by different plant and animal communities. In addition to their ecological value, salt marshes provide coastal protection, as they dissipate wave energy and stabilize otherwise exposed coastal soil lining sea dikes.

The "Gute Küste Niedersachsen" research project investigates which environmental properties account for livable and safe coastal conditions along temperate climate coastlines, focusing on the symbiosis of human settlements, nature conservation and sustainable coastal protection. Specifically, the identification of vegetation-mediated ecosystem services within salt marshes at the North Sea coast of Lower Saxony, Germany is addressed here. The overarching goal of the transdisciplinary project is to gain knowledge of natural or nature-based systems and their processes within real-world laboratories at the coast to incorporate proven ecosystem services into standardized coastal protection design guidelines and promote integrated coastal zone management.

Methods include field observations and experiments, hydraulic laboratory experiments and numerical simulations over the course of 5 years. During the first years, a systematic observation of vegetation regarding distribution patterns, growth, density, and bio-mechanical (e.g. flexural rigidity, area moment of inertia) as well as root properties (e.g. root length density, tensile strength) and their respective seasonality is conducted. Through comprehensive monitoring covering large areas of halophytic meadows, a physical model of heterogeneous salt marshes will

be developed. Simultaneous measurements of environmental parameters covering waves, currents and soil properties yield a comprehensive data set for analysis, numerical and analytical modeling purposes.

Hydraulic experiments modeling the wave-vegetation-soil interaction will be devised based on field data, developing dynamically and geometrically scaled vegetation surrogates. Besides vegetation properties aboveground, a focus will be on previously sparsely considered root system effects that is hypothesized to govern erosional processes in salt marshes.