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Dunes from above: separating the contribution of vegetation and landform morphology to early dune building

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Development of new coastal foredunes increases nature-based shoreline protection, but relatively little is known about the early phases of dune development taking place at the transition zone between beach and foredune. Here, net dune development is the result of sand accumulation during summer and sand erosion during winter. Understanding the processes affecting accumulation and erosion is necessary to predict future transitions from beach to foredune in a changing climate. Particularly the relative contributions of vegetation and landform morphology on sand accumulation rate and erosion have been poorly quantified.

We explored the relative contributions of vegetation characteristics and landform morphology on dune development in a dune field of 8 hectares using 3D image analysis. We monitored changes in dune volume and vegetation characteristics (density, height, and species) of a natural embryonic dune field over 1 year, using a drone with a camera. The area comprised dunes with both pure and mixed vegetation of dune building grasses Ammophila arenaria and Elytrigia juncea at equal distance to the sea.

We found significant relationships between dune building species and dune volume, with embryo dune volume peaking for dunes having a mix in species. Changes in dune volume over summer were associated with dune size, displaying size-dependent feedback with big dunes growing faster than small dunes. In addition dunes with mixed vegetation increased more in volume than single-species dunes. Changes in dune volume over winter however were related to vegetation density but not to dune volume: dunes with low vegetation density decreased more in volume than high density dunes. In turn vegetation density was related to dune building species.

We show that dune building is modified by both vegetation composition and landform morphology, with their relative contributions depending on season. To our knowledge, our results give the first empirical evidence for relationships between vegetation, size dependency and biophysical feedback in coastal dune building that help to understand the link between landform and process. In our presentation we will discuss the implication of this empirical evidence for natural dune development along sandy coasts.