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Modelling vegetated dune field dynamics

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Vegetated aeolian dune fields respond to varying climatic and environmental conditions which collectively help to shape a dynamic and complex landscape. Our interpretation of ecogeomorphic interactions in these environments has largely been limited to descriptive observations. We present a Discrete Ecogeomorphic Aeolian Landscape (DECAL) cellular automaton model that replicates the self-organisation of vegetated dune systems and enables the investigation of conditions necessary for nebkha, blowout and long-walled (hairpin) parabolic dune formation in coastal and semi-arid environments. The model utilises simple transport rules and mutual feedback between geomorphic and ecological components to investigate landscape pattern formation. It facilitates the simulate foredune dynamics and analyse the conditions necessary for blowout evolution which can then be compared to real-world dune fields. Simulated ecogeomorphic interactions can be examined either by exploring internal system mechanics via dune mobility or by external surface patterns in morphology and vegetation which are used to generate a suite of numerical state variables. Both methods can give insight into the divergence of landscape evolutionary pathways in response to variations in environmental and climatic conditions, and the influence of perturbations on a stabilising system. Our understanding of these responses can aid in the management of complex coastal and semi-arid aeolian dune systems.