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Modelling and Investigating Dune Transformations Driven by Vegetation and Environmental Change

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Despite growing perception of the significant role of vegetation in shaping distinct landscapes in aeolian systems, the complex eco-geomorphic interrelationships between vegetation and dune landforms are not well understood. Projections of future climatic change, meanwhile, in particular increased temperature and drought severity, raise concerns that widespread aeolian activity may intensify as a result of semi-stabilised dunes transforming to highly mobile forms.

Computer modelling of aeolian landscapes and sand transport processes has been in wide use in the past decade, due to its capability of bridging the gap between different temporal and spatial scales. Numerical simulations serve as an important tool to investigate and explore theoretical foundations underlying distinctive landscape patterns and their response to perturbations arising from both natural and anthropogenic impacts.

This research focuses on modelling and understanding the transformation of a semi-fixed parabolic dunefield with shrubs and nebkhas into a highly mobile barchanoid dunefield, and tries to clarify the fundamental mechanisms underlying dunefield reactivation and transformation driven by vegetation and environmental change in Inner Mongolia, China.

Vegetation distribution and topography maps of a number of parabolic dunes on the Ordos Plateau were acquired using quadrat surveys and d-GPS. Sampling transects were established along longitudinal sections, cross sections and lee slopes. Historical trajectories of vegetation and morphologic change of two active parabolic dunes were determined by analysing three satellite RS images in 2005, 2007 and 2010. Vegetation density maps and potential sand transport rates were estimated by combining the DEM acquired from the field and the migration rate determined from the remote sensing image interpretation.

Based on this fieldwork investigation, remote sensing image interpretation, and local climatic context analysis, the DECAL (Discrete Eco-geomorphic Aeolian Landscape) model has been modified to incorporate several new environmental factors impacting on the vegetation dynamics, including seasonality, long-term climatic fluctuations, and groundwater change, to investigate potential dunefield reactivation and transformation scenarios mediated by vegetation and environmental change.