BSG Postgraduate Research Grant Report:
Dune Landscape Transformations Driven by Vegetation Changes

Na Yan
Department of Geography, King's College London, United Kingdom

Introduction

Desertification, land degradation and loss of vegetation may result in the reduction of global food production by as much as 12% and an increase in world food prices by 30% over the next 25 years. Furthermore, climatic variations arising from global warming exacerbate the situation of desertification and relatively small climatic changes may contribute to abrupt changes in vegetation cover. Vegetation change is one of the most essential agents for desertification associated with geomorphic transformations in the aeolian dune landscape system (Hack, 1941; Moreno-Casasola, 1986). Different dune transformations to a large extent manifest the future trends in the intensity of aeolian activity. Therefore, understanding the mutual responsive relationship between vegetation and dune transformations is essential to curb desertification, guide land management, and predict landscape evolution under the impacts of climate change.

Research aims and outcome

The complex mutually responsive relationship between vegetation and dune transformations is still poorly understood. The proposed research aims to understand how changes in biological characteristics and distribution of vegetation lead to landscape transformations from a shrub-field with nebkhas, to semi-fixed parabolic dunes, to highly mobile barchans, a novel transformation hypothesis (Fig. 1). The postgraduate research grant has provided partial funding to support fieldwork in the Kubq Desert, on the Ordos Plateau in China in 2012. Three prototypical dunes in different stages have been investigated in detail. The plant communities were mapped and surveyed using quadrats including vegetation species, heights, lengths, widths, densities, coverage, and vitality of individual plants. Meanwhile, the quadrat locations and the associated three-dimensional dune topography were surveyed by differential-GPS. Based on the empirical field data, the most significant factors of vegetation pattern and change that influence dune transformations were translated to parameters and boundary conditions for use in the simulation model (Fig. 2). Then, by combining fieldwork with computer simulations using the DECAL model (Baas and Nield, 2010), the research has deepened our understanding of landscape development and dune field re-activation in desert regions and assisted in prediction of potential future landscape changes as a result of climatic forcing as well as anthropogenic activities. This project was the first to combine empirical field data from a real-world semi-vegetated dune field into a reduced-complexity (CA) computer simulation model for realistic long-term predictive scenarios that may help the local government take proper and effective strategies for ecosystem restoration.

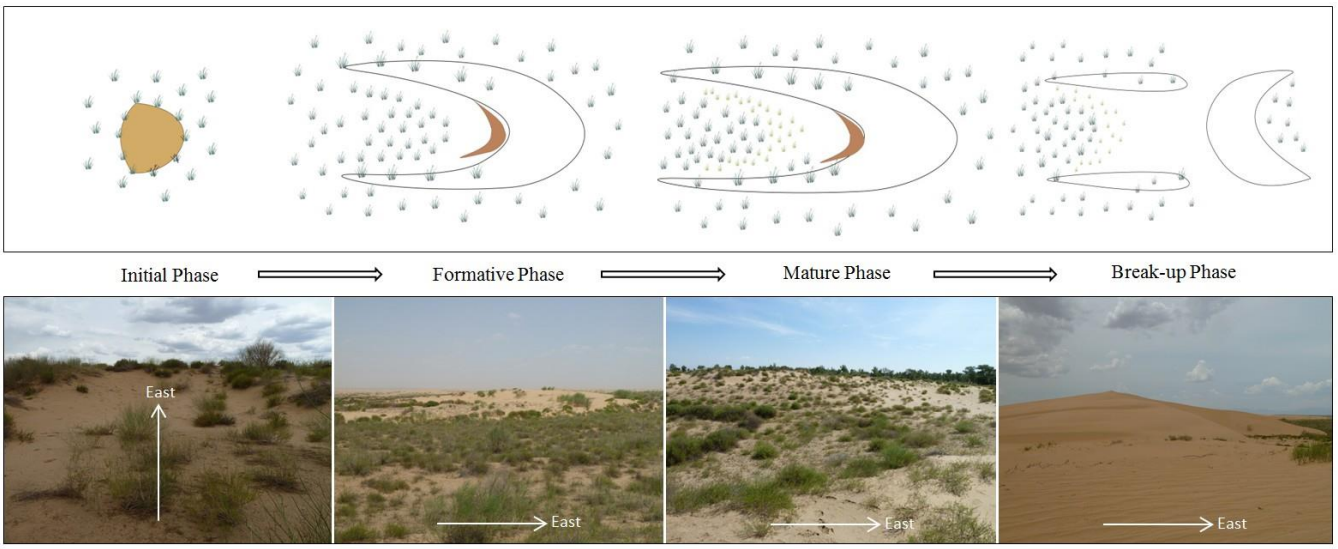

Fig. 1. Hypothesis of transformation pattern from nebkhas, to parabolic dunes, to barchans; dominant wind direction from West to East.

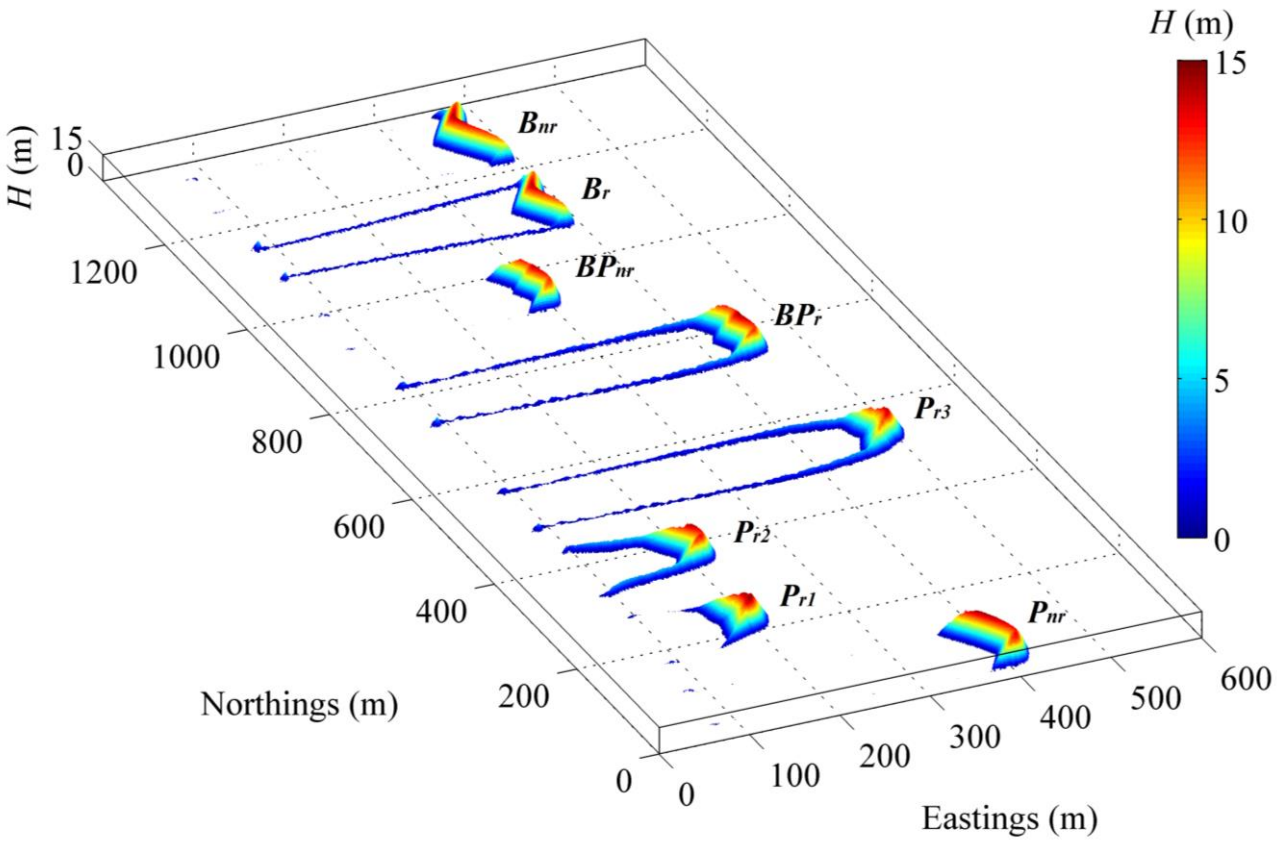

Fig. 2. Examples of different types of dunes from numerical modelling.

Grant value and dissemination

The BSG grant helped fund my fieldwork in summer 2012 and enabled us to obtain invaluable empirical data. Findings of the project have been presented at EGU 2013, ICAR VIII, and EGU 2016. One paper has been published in *Global and Planetary Change* (Yan and Baas, 2015), one has been submitted to *Geomorphology* (Yan and Baas, under review), and one is about to be submitted to *Earth Surface Processes and Landforms*.

References

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Yan, N., Baas, A.C.W. Environmental controls, morphodynamic processes, and ecogeomorphic interactions of barchan to parabolic dune transformations. Geomorphology. (submitted, under review)

Oral presentations

Yan, N., Baas, A.C.W., 2016. Activation of vegetated parabolic dunes into mobile barchans under potential environmental change scenarios. EGU 2016, Vienna, Austria.

Yan, N., Baas, A.C.W., 2014. Dune Transformations Driven by Vegetation Change Arising From Environmental and Anthropogenic Impacts. 20th Windy Day, Oxford, United Kingdom.

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Yan, N., Baas, A.C.W., 2013. Modelling Barchan-Parabolic Mutual Transformations Driven by Eco-geomorphic Interactions. 19th Windy Day, Southampton, United Kingdom.

Yan, N., Baas, A.C.W., 2013. Modelling and Investigating Dune Transformations Driven by Vegetation and Environmental Change. EGU 2013, Vienna, Austria. (Funded by the Keith Runcorn Travel Award from EGU and a Postgraduate Conference Attendance Grant from BSG.)

Yan, N., Baas, A.C.W., 2012. Dune Transformations Driven by Vegetation Changes in the Ordos Plateau, Inner Mongolia, China. 18th Windy Day, Leicester, United Kingdom.