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Preface

Landforms and processes in arid and semi-arid environments

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There is widespread concern that the magnitude and frequency of extreme climatic events such as floods, droughts and heat waves will increase as a result of global climatic changes caused by human activities and natural variations (Wu, 2003; Dodson, 2010). If these trends continue, those regions of the world that already experience large variations in precipitation from year to year are thought likely to experience an even higher degree of variability, which will require more flexible strategies of risk management among the pastoral and agricultural communities concerned. These areas most at risk are likely to be the arid, semi-arid and dry sub-humid regions of the world, which today support over a fifth of the world's population (IPCC, 2007; Williams, 2014).

Arid (including hyper-arid) and semi-arid areas occupy some 36% of the land area of the globe. If we include the dry sub-humid regions of the world, with their long dry seasons and short wet seasons, then we are dealing with about half the land area of the earth (Fig. 1). These regions contain an unequaled record of past environmental and climatic fluctuations (e.g., Williams, 2014). The very aridity of the deserts has allowed evidence of previously wetter conditions to be remarkably well preserved in the form of now dry lakes, defunct drainage systems, and prehistoric occupation sites (e.g., Yang et al., 2011). The dry sub-humid regions also contain evidence of previously more arid conditions in the form of now vegetated and stable but once active desert dunes and wind-blown desert dust or loess mantles (e.g., Goudie, 2002).

Desertification processes are operating in every one of the world's dry lands (Mensching, 1990; UNEP, 1992; Williams and Balling, 1996; Zhu, 1999). Some of these are entirely natural geomorphic processes, some are linked to prolonged regional droughts, and some are linked to a variety of human activities, both direct and indirect (Williams and Balling, 1996). A recent study in northern China shows that changes in geomorphological and hydrological processes may even cause irreversible desertification (Yang et al., 2015). If we are to achieve ecologically sustainable development of the natural resources within the drylands, we need to understand the geomorphic processes operating within these regions, both now and in the geologically recent past.

Geomorphic, climatic, hydrologic and vegetative change in dryland landscapes has profound impacts on the entire Earth system. Research on aeolian systems and arid- and semi-arid-zone geomorphology has progressed rapidly in recent years with significant new studies of aeolian, fluvial and lacustrine processes and their interactions in arid regions being conducted worldwide. The papers published in this special issue are a useful step in understanding drylands in particular and Earth system in general. The research presented in these papers covers both hemispheres and most of the major desert regions of the world. In addition to careful analysis of the processes involved in the formation of aeolian landforms, whether desert dunes or desert loess deposits, they also consider the interactions between aeolian and fluvial systems, a topic that has been relatively neglected in geomorphology.

By challenging the early assumptions of the predominant role of the winds in deserts, the special issue starts with Williams (2015) demonstrating a long history of fluvial and aeolian interactions in the Sahara and arid Australia. Not only are the desert dunes in these large arid regions sourced from alluvial deposits, but also the fine-grained valley-fills are often reworked loess sediments. The aeolian sediments like loess are found to be of significance in shaping hydrological processes like balancing between infiltration and runoff in hot deserts (Williams, 2015). Pain and Abdelfattah (2015) studied the landforms and their long-term changes in the northern United Arab Emirates, a typical part of the deserts in the Arabian Peninsula, showing that the arid landscape has been mainly shaped by the interaction of wind and water. They found that fluvial and alluvial processes were active in the early to mid-Quaternary, although modern river flow is rare and largely confined to the mountains in the north. To answer the fundamental scientific question about relationship between aeolian processes and global climate change, Veit et al. (2015) present the first terrestrial record in Chile, consisting of coastal aeolian sand and dunes with intercalated palaeosols, covering the last 190 ka. On the basis of OSL chronology, they found that palaeosols formed in periods with stable surface conditions and a relatively dense vegetation cover, and sand accumulation occurred while aeolian activity increased under dry periods.

On the basis of semi-quantitative mineral compositional studies of various sediments, grain size and wind data, Lancaster et al. (2015) made a detailed and systematic contribution to the key questions about the sources and transport pathways of aeolian deposits, showing that the dune sands in the Owens Lake basin, California, southwestern USA are primarily from the Sierra Nevada via the Owens River from the north as well as from granitic rocks in the Coso Range to the south. On the basis of long-term field research, Bazhenova and Tyumentseva (2015–in this issue) assessed the level of land degradation and identified the modern cycles of the alternation between aeolian and fluvial processes in the semi-arid regions of Siberia. The work by Sebe et al. (2015–in this issue) reported bedrock ventifacts in Austria for the first time, demonstrating that wind erosion and wind-blown sands might be common during Quaternary cold times even in the presently humid regions like middle Europe.

The last two papers deal with current understanding of deserts in China, a large portion of the mid-latitude arid zone in Asia. Precisely interpreting the social impact on the landscape has not been an easy task for research communities. The paper by Zhang et al.

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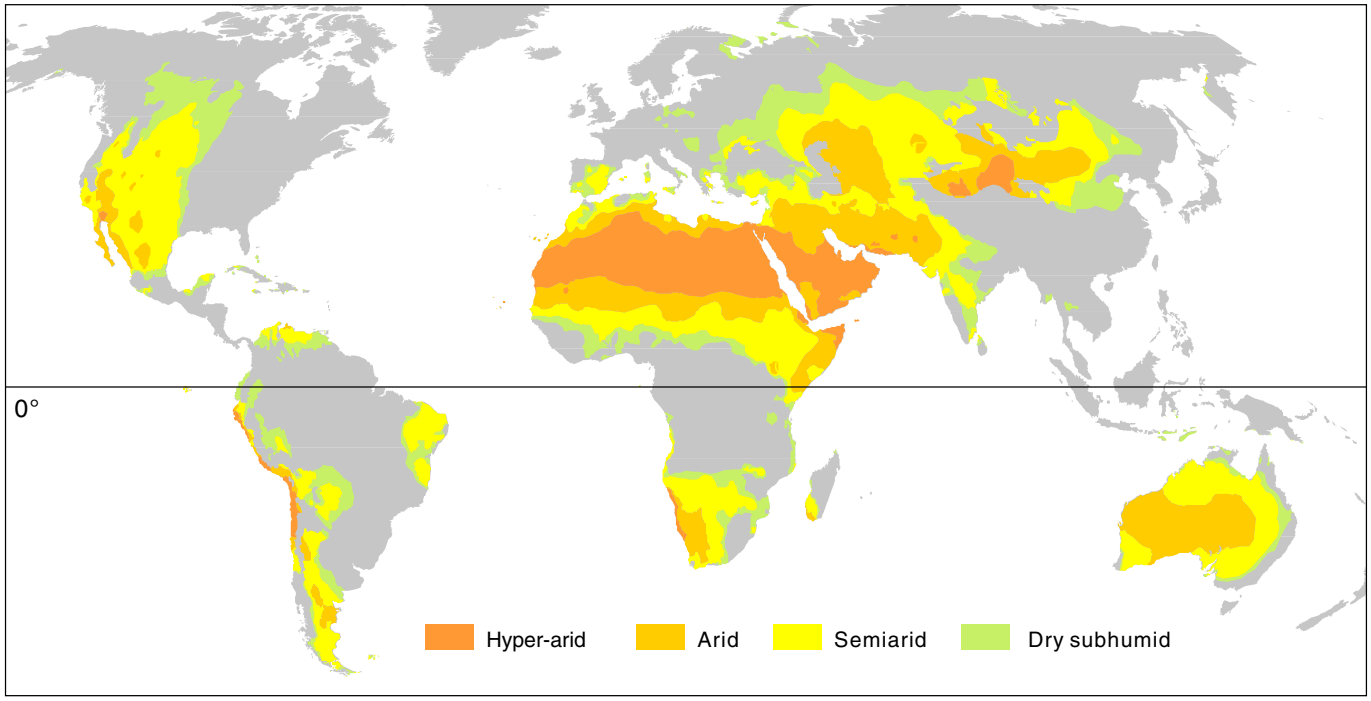

Fig. 1. Global distribution of drylands.
Modified from Millennium Ecosystem Assessment (2005).

(2015–in this issue), however, documents with detailed historical data how and why a district in the present-day eastern Inner Mongolia was transformed from traditional animal grazing to lands for cultivating crops and eventually degraded in the 18th Century, coordinated by foreign missionaries. To overcome difficulties in interpreting site-based geoenvironmental records, Scuderi et al. (2015–in this issue) examined potentials of large regional scale databases for assessing environmental change. They do show that large-scale spatial and temporal patterns exist in desert regions and that database technology is a very useful tool for deciphering these patterns.

The papers included in this special issue address not only the geomorphic processes shaping aeolian systems and characterization of landforms in arid and semi-arid regions, but also rates and causes of landscape change as well as the effects of dryland change on regional and global systems. Both natural and human aspects of this change and complex linkages between the two are discussed. By bringing together a wide range of expertise relating to *landforms and processes in arid and semi-arid environments* it is our hope that we can strengthen the knowledge base required for understanding the pattern and tempo of the geomorphic processes responsible for the formation of these fascinating landscapes (e.g., Lancaster et al., 2013).

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