Decoding geomorphological chatter: non-linear communication between hillslopes and channels in dryland valleys

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Project description: Dryland basins are fascinating yet poorly studied fluvial systems which are highly sensitive to climate. They contrast markedly in behaviour and evolution from humid fluvial systems due to differences in surface characteristics and in the nature of the climate, which give rise to distinct hydrological and erosional regimes. It is thought that one of the most important determinants of valley floor evolution in drylands is the communication of sediment from hillslopes to channels during rainstorms. The volume and grain-size characteristics of sediment supplied from hillslopes affect the channel bed material and bedload flux. The problem is compounded by non-linear responses in hillslope supply to rare rainstorms, and ephemeral flow in dryland channels which transports sediment relatively infrequently. The prevailing climatic regime determines whether this balance is dominated by hillslope sediment supply (net valley accumulation) or channel sediment flux (net valley evacuation) over a particular timescale.

However, currently there is little understanding of how dryland valley floors are shaped in response to changes in the relative balance between hillslope and channel processes, especially associated with regional climate and the magnitude and frequency of extreme events. As dryland environments occupy 41% of the Earth's surface and are home to a third of the world's population, understanding the response and evolution of dryland valley floors to climate is important because they impact the availability of water resources, risk of extreme flooding, rates of reservoir siltation, and the fate and transport of contaminants.

The aim of this PhD project is to develop theoretical understanding of the relative roles of hillslope and channel processes which are imprinted in basin characteristics and the evolution of dryland valley floors. In particular, it will build on ongoing work by both supervisors in this field and will combine (and develop) numerical models of hillslope and channel sediment transport (Michaelides & Martin, 2012; Nicholas, 2013) in order to explore the climatic conditions and relative timescales under which net valley accumulation and evacuation occur. Modelling will be supported by fieldwork in the southwest USA in order to characterise hillslope and channels within dryland basins.

Michaelides, K. and Martin, G.J. (2012) Sediment transport by runoff on debris-mantled dryland hillslopes. *Journal of Geophysical Research-Earth Surface* 117, F03014, doi:10.1029/2012JF002415.
Nicholas, A.P. (2013) Modelling the continuum of river channel patterns. *Earth Surface Processes and Landforms*, doi: 10.1002/esp.3431