Geophysical Research Abstracts
Vol. 15, EGU2013-13129, 2013
EGU General Assembly 2013
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The long term impact of vegetation on the topography of the Chilean Coastal Ranges

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The 1600 kilometre long Chilean Coastal Range varies in climate from hyper-arid in the north to humid-temperate in the south. Traversing this range is a series of east-west trending valleys. The vegetation density within many of these valleys varies with the aspect of the underlying topographic surface. Previous studies have shown that the aspect sensitivity of vegetation density in regions with a Mediterranean climate is due directly or indirectly to the difference in insolation of north and south facing slopes. Thus, the north-south trending Chilean Coastal Range provides a unique opportunity to assess the impact that life has on topography, or more specifically, the systematic response of topography to changes in vegetation density.

In this study, we use a novel application of statistical topographic analysis to provide insights into the relationship between vegetation, topography and sediment transport. Specifically, we observe the following relationships between vegetation density and topographic form. Firstly, where vegetation is currently absent (in the hyper-arid climatic zone north of 26 degrees South) the mean angle of hillslopes appears to be insensitive to the aspect of the hillslope. In contrast, in the Mediterranean climatic zone between 26 deg S and 38 deg S hillslope angles depend, on a local and on a regional scale, on the aspect of the hillslope. Finally, we observe that where vegetation density does not vary with the aspect of the hillslope (i.e. in the humid-temperate climatic zone south of 38 deg S), aspect-sensitive hillslope steepness is only detected in areas that are underlain by largely isotropic, plutonic lithologies.

These observations lead us to conclude that within the same climatic zone, all else being equal, equilibrium hillslope that are densely vegetated will tend to be steeper than hillslopes which are less densely vegetated or barren. Thus, hillslopes which have suffered an increase or decrease in vegetation density will remain out of equilibrium until either the mean hillslope angle is lowered or vegetation density is restored.