Geophysical Research Abstracts
Vol. 15, EGU2013-5848, 2013
EGU General Assembly 2013

Spatial distribution of soils in weathering mountain landscapes

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This contribution explores our knowledge and methods of knowledge creation about soil patterns in weathering mountainous landscapes. Knowing, and if possible predicting these soil patterns and their changes allows us to better assess the effects of a changing climate on mountain hydrology, ecology and natural hazards. These effects are expected to be both significant and negative, and a better assessment of them would allow for better informed mitigation policies.
I use two new datasets of high-mountain soil variation in the Swiss Alps (122 soils) and the Colorado Rocky Mountains (24 soils) to illustrate two main points. The first is that soil studies focussed on chronosequences run the risk of underestimating total soil variation and oversimplifying soil-landscape relations. The second is that patterns of soil properties can only partly be related to soil development time and topographic position. It can be concluded that it is more difficult to predict mountain soil-patterns than soil patterns in other areas. I argue that the complex co-evolution of soils and landscapes is an important reason for this difficulty. Geomorphological history and soil development are intensely related to each other in mountainous landscapes.
Landscape evolution models, or rather soilscape evolution models, where vertical soil-development and lateral landscape evolution are simulated in a coherent framework, are suitable tools to summarize our understanding of this co-evolution and the testable hypotheses that follow from this understanding. There is much interest in the development of such models, and important steps have recently been made. However, conceptual, technical and implementation difficulties remain.
I show results of a prototype soilscape evolution model (LORICA) and contrast these results with a third new dataset describing 100 soils in a second, forested and topographically complex catchment in the Colorado Rocky Mountains. Results of this comparison indicate that 1) prediction of soil profiles in a topographically complex landscape remains difficult and is currently unsatisfactory, yet 2) that soilscape model outputs are already valuable independent variables in regression of soil properties.