Geophysical Research Abstracts
Vol. 16, EGU2014-749, 2014
EGU General Assembly 2014

Emergent Soil-Production Functions: Rooting from Ecogeomorphic Feedbacks?

Adam Trueman, John Wainwright, Alex Densmore, and Laura Turnbull
Department of Geography, Durham University, Durham, United Kingdom (adam.trueman@durham.ac.uk)

The rate of soil production from bedrock or saprolite has long been hypothesised to vary according to overlying soil depths, with both humped and exponential decay soil-production functions (SPFs) supported by previous work. Recent cosmogenic radionuclide data have supported the exponential decay SPF (e.g. Heimsath et al., 2000), which is thus commonly utilised within landscape evolution models (LEMs). However, we present preliminary modelling results that emphasise that the functional form and nature of the SPF is dependent on the ecogeomorphic feedbacks active both upon and beneath Earth's surface. Our model is mass-balance based and incorporates subsurface and surface water/sediment transfers, vegetation dynamics, and bedrock weathering. Through altering the ecogeomorphic process interactions active within the model, our model can generate different functional forms of the SPF with our results suggesting that the SPF functional form is most sensitive to modelled root density down the soil profile. When assuming that soil production follows an exponential decay SPF, our results imply that LEMs are potentially over-estimating soil-production rates at thin soil depths (i.e. where the humped SPF implies a positive correlation between soil depths and soil-production rate), and under-estimating soil-production rates at intermediate depths that correspond to the peak of the humped SPF. Such misestimations result in potentially erroneous inference of transport-limited conditions and detachment-limited conditions at thin and intermediate soil depths, respectively. Moreover, through influencing soil conditions (e.g. soil depths and soil moisture capacity down profile) it is possible that misestimated SPFs could cascade into an erroneous representation of modelled vegetation cover composition, amount and patterning.

Following our results, we hypothesize that vegetation dynamics impart an ecological "signature" upon SPFs, with plant structural and functional attributes contributing in determining the nature and form of a region's SPF. We therefore propose a number of critical research questions: (1) What are the influences of different plant physiological attributes upon SPF functional form? (2) How do climate driven (and geomorphic process driven) vegetation dynamics (in both space and time) influence SPF functional form? and (3) What impact do different SPF functional forms have upon catchment response and long-term landscape evolution? LEMs would be ideal research tools to investigate these questions further - however we argue that their inadequate representation of soil production processes and their overly simplified representation of vegetation dynamics makes them unsuitable for investigating these key research questions. We conclude therefore that, in order to address these questions, LEMs should incorporate vegetation heterogeneity both above and beneath Earth's surface, alongside a more implicit representation of bedrock weathering processes.