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How soil shapes the landscape

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There has been an increase in interest in quantitative modelling of soil genesis, which can provide prediction of environmental changes through numerical models. Modelling soil formation is a difficult task because soil itself is highly complex with interactions between water, inorganic materials and organic matter. This paper will provide a review on the research efforts of modelling soil genesis, their connection with landscape models and the inexorable genesis of the IUSS soil landscape modelling working group.
Quantitative modelling soil formation using mechanistic models have begun in the 1980s such as the 'soil deficit' model by Kirkby (1985), Hoosbeek & Bryant's pedodynamic model (1992), and recently the SoilGen model by Finke (2008). These profile models considered the chemical reactions and physical processes in the soil at the horizon and pedon scale. The SoilGen model is an integration of sub-models, such as water and solute movement, heat transport, soil organic matter decomposition, mineral dissolution, ion exchange, adsorption, speciation, complexation and precipitation. The model can calculate with detail the chemical changes and materials fluxes in a profile and has been successfully applied. While they can simulate soil profile development in detail, there is still a gap how the processes act in the landscape.
Meanwhile research in landscape formation in geomorphology is progressing steadily over time, slope development models model have been developed since 1970s (Ahnert, 1977). Soil was also introduced in a landscape, however soil processes are mainly modelled through weathering and transport processes (Minasny & McBratney 1999, 2001). Recently, Vanwalleghem et al. (2013) are able to combine selected physical, chemical and biological processes to simulate a full 3-D soil genesis in the landscape.
Now there are research gaps between the 2 approaches: the landscape modellers increasingly recognise the importance of soil and need more detailed soil processes, and the soil profile modellers need to consider material fluxes at the landscape scale.
The IUSS working group (WG) on modelling of soil and landscape evolution has been recently proposed, accepted and established. The WG tries to engage scientists (landscape and pedon scale modellers, critical zone scientists, palaeopedologists, process-quantifying pedologists, and others) to work actively together towards a better soil-landscape model. Some aspects of the work include (i) improving ways to generate boundary conditions (climate, vegetation, human impacts) along the timeline, both at landscape and pedon scale; (ii) better model validation and its consequences for data collection; (iii) finding a more efficient simulation algorithms (iv) an inventory of the (mis-)match between present and needed process coverage to answer societal questions on soil behavior under global change.