

Mike Kirkby

Co-evolution of hydrology, vegetation, climate, soils and landscape.

There are well known linkages between water, vegetation, soils and landscapes, operating at a wide range of time scales and with response times from hours to millennia, so that there is scope for substantial dis-equilibrium as external drivers (eg land/ water use, climate) change. There is therefore an urgent need for robust models that capture at least the first order relationships and feedbacks in ways that are explicitly sensitive to drivers, are robust when driven outside their original data envelopes, segue seamlessly between process regimes and respond realistically to transient processes as well as representing equilibrium relationships.

The model(s) presented, initially developed as the coarse scale erosion model PESERA, are explicitly built around the water balance, partitioning precipitation between overland flow, surface and subsurface Infiltration, evapotranspiration, subsurface flow and groundwater recharge. They incorporate key feedbacks through vegetation growth, soil organic matter formation and decomposition, with their semi-explicit impacts on the hydrological properties of soils. In an Anthropocene context, they also engage with the impacts of land use, grazing and fire, although the socio-economic feedbacks remain elusive.

The further agenda for development include more explicit incorporation of soil fauna; soil evolution through vertical mixing in the A Horizon, Translocation and leaching in the B Horizon and Weathering in the C Horizon; and the evolution and interactions with drainage density. This agenda shows promise in distinguishing broad climatic, lithological and tectonic of hydrological response, both for long continued states and for more or less transient conditions.