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What role does tillage erosion play regarding landscape evolution of an intensively used hummocky landscape?

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Hummocky landscapes under intensive arable use are substantially affected by erosion processes. Data from the Quillow catchment (size: 196 km²; mean annual precipitation: 500 mm) in North-East Germany are used to estimate landscape-scale water and tillage erosion with the model SPEROS-C. Recent results show that tillage erosion causes substantial soil redistribution that can distinctively exceed water erosion. In consequence, truncated soil profiles can be found on hilltops and steep slopes, whereas colluvial material is accumulated in depressions and along downslope field borders. The resulting spatial variability of soil types with different properties and conditions is known to influence crop growth and leads to a highly variable biomass pattern in hummocky landscapes under highly mechanised arable cultivation.

The main goal of our study is to link tillage-induced erosion rates to landscape development at centennial time scales. By modelling the development of the hummocky moraine landscape of North-Eastern Germany, we explain the spatial distribution of the current soil erosion state. Furthermore, the soil erosion induced impact on crop biomass patterns and the redistribution of soil organic carbon since the beginning of human land use in this area is assessed. To address this goal, a new model component is implemented into SPEROS-C that iteratively rejuvenates topography backwards in time considering modelled erosion and deposition rates. Afterwards, modelling forward in time allows estimating carbon fluxes due to soil redistribution. Furthermore, the extent and location of truncated soils will be validated with historic aerial photographs at different time steps.

The benefits of implementing landscape development into SPEROS-C are that (i) an annual update of topography generates a more realistic soil erosion pattern, (ii) the current crop biomass pattern may be explained by erosion history, and (iii) estimates about the future development of crop yield patterns considering ongoing tillage practices can be drawn from a validated soil erosion and landscape development model.