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Quantification of human impact on past erosion and sediment dynamics – lessons learned from a case study in the Dijle catchment, Belgium

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Humans have changed the intensities and processes of soil erosion, sediment transport and sediment deposition since the introduction of agriculture. Although the general framework of these changes are well established, we still lack a detailed model of the impact-response relationship to fully grasp how, when and to what extent humans have changed the sediment transfers at the catchment scale.
In this study we provide an holistic approach that combines detailed and well-dated data on erosion intensities and floodplain sedimentation with detailed data on human impact in the landscape, for the Dijle catchment (758 km^2), Belgium. The field data shows increasing erosion and sedimentation rates throughout the Holocene resulting in important changes in floodplain morphology. These changes, however, are not occurring synchronous: large variability in the timing of the system response has been observed both at the scale of individual floodplain transects as well as at the catchment scale. Moreover, a detailed time-differentiated sediment budget, together with pollen-based quantitative measures of human impact , reveals important differences in time-lags, threshold levels and in the impact-response model at the catchment scale. We attribute this to the spatial and temporal variability in hillslope-floodplain connectivity and to differences in the timing and intensity of human activities between subcatchments.
Overall, our data shows that the relationship between the intensity of anthropogenic disturbances and the changes in sediment dynamics is non-linear, both in space and time, and indicates that traditional extrapolation techniques and assumptions in erosion-sedimentation studies can be questioned. In particular, the use of point-specific volumetric sedimentation rates is problematic for obtaining a correct understanding of the human impact on sediment transfers. It also means that regional or global sediment databases needs to be sufficient large to correctly interpret the relationship with human impact. Our results shows that a holistic, multi-proxy approach, integrating data from different study sites within one catchment is needed to better understand human impact on soil and sediment fluxes. Furthermore, studies focusing on a single process within the sediment cascade system (e.g. erosion, colluviation, floodplain deposition) may provide a biased view on how sediment fluxes have changed throughout the Anthropocene.