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Evidences of anthropogenic tipping points in fluvial dynamics in Europe

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Abstract

In this study the occurrence of thresholds in fluvial style changes during the Holocene are discussed for three different catchments: the Dijle and Amblève catchments (Belgium) and the Valdaine Region (France). We consider tipping points to be a specific type of threshold, defined as relatively rapid and irreversible changes in the system. Field data demonstrate that fluvial style has varied in all three catchments over time, and that different tipping points can be identified. An increase in sediment load as a result of human induced soil erosion lead to a permanent change in the Dijle floodplains from a forested peaty marsh towards open landscape with clastic deposition and a well-defined river channel. In the Valdaine catchment, an increase in coarse sediment load, caused by increased erosion in the mountainous upper catchment, altered the floodplains from a meandering pattern to a braided pattern. Other changes in fluvial style appeared to be reversible. Rivers in the Valdaine were prone to different aggradation and incision phases due to changes in peak water discharge and sediment delivery, but the impact was too low for these changes to be irreversible. Likewise the Dijle River has recently be prone to an incision phase due to a clear water effect, and also this change is expected to be reversible. Finally, the Amblève River did not undergo major changes in style during the last 2000 to 5000 years, even though floodplain sedimentation rates increased tenfold during the last 600 years. Overall, these examples demonstrate how changes in fluvial style depend on the crossing of thresholds in sediment supply and water discharge. Although changes in these controlling parameters are caused by anthropogenic land use changes, the link between those land use changes and changes in fluvial style is not linear. This is due to the temporal variability in landscape connectivity and sediment transport and the non-linear relationship between land use intensity and soil erosion.

Key words

Fluvial style, rivers, Holocene, human impact, land use change, tipping points

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