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Assessment of sediment connectivity in a densely drained vineyard catchment: contributions from graph theory

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In agricultural catchments, the landscape structure elements (ditches, hedges, pounds etc.) are recognized to play a major role in hydro-sedimentary transfers. It determines not only sediments availability, but also sediment pathways, water and sediments (de)coupling and connectivity patterns from source to sinks. However, linear drainage infrastructures remain often poorly represented in hydro-sedimentary modelling. Therefore, understanding the link between the catchment landscape structure and the transfer processes at its outlet is still a major challenge. Graph theory has been proved to be a significant tool to investigate sediment connectivity among agricultural catchments as it allows an explicit representation of linear and punctual elements of the landscape.

Based on a detailed inventory of linear landscape elements and a continuous monitoring of sediment fluxes, we built a new graph theory framework to comprehend sediments transfers in a dense agricultural drainage network in the Beaujolais vineyard (France). It integrates all types of linear infrastructures that might canalize water and sediment fluxes (tracks, ditches and soil bunds) and sediment traps used by winegrowers. From the intersection of the drainage network and a topographic graph, we went for spatial analysis to take indices out (IC and RF indices), to extract effects of (dis)connectivity and to compare with a null model (i.e. topographic graph excluding linear infrastructures). Drainage network outlets were extracted to distinguish direct connections to the river in comparison to sediment sinks. The network structure emphasizes a reduction of sediment connectivity on the upper slope unlike on the lower slope where it is increased. Describing sediment structural connectivity through landscape structure analysis allows to identify the drainage infrastructures efficiency and might be of interest in a management perspective.