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Combining multi-tracer and multi-sediment fingerprinting models to assess sediment connectivity in a mesoscale watershed

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Knowledge of suspended sediment provenance in meso-scale catchments is important for applying erosion control measures and best management practices on hillslopes on the one hand and for understanding the processes that lead to sediment transport in the critical zone on the other hand. As suspended sediment fluxes are found to be highly variable in time knowledge of sediment provenance at high temporal resolution (i.e infra-event sampling) is crucial.
We studied within- and between event dynamics of suspended sediment fluxes at the outlet of a 42 km2 Mediterranean catchment belonging to the French critical zone observatory network (OZCAR). The spatial origin of the suspended sediments was analyzed at a high temporal resolution using different low-cost fingerprinting approach (Color tracers, X-ray fluorescence and magnetic susceptibility). In addition to the various tracer sets, three mixing models were tested. The comparison of the tracer sets and the mixing models allowed us to evaluate the uncertainty inherent in sediment fingerprinting studies and to assess the challenges and opportunities of using these low-cost tracer sets as fingerprinting properties. Considerable differences in the predicted source contributions were observed when different tracer sets (mean RMSE: 19.9 %) or mixing models (mean RMSE: 10.1 %) were used. These results highlighted the importance of using multi-tracer-multi-model approaches for sediment fingerprinting studies in order to assess and decrease the uncertainty of the method. High sampling resolution that can only be realized with low-cost methods is important to reveal within- and between event dynamics of sediment fluxes and to obtain reliable information of main contributing sources.
All tracer sets and mixing models could identify marly badlands as the main source of suspended sediments. However, the percentage of source contributions varied between 11 flood events in the catchment. While for some events the percentage contribution remained constant between different samples taken during the same event, others showed a high within-event variability of the sediment provenance. Numerical simulations of soil erosion and sediment transfer were performed with a distributed, physically based hydrosedimentary model based on the software Iber in order to assess to which extent rainfall spatio temporal variability could be responsible for the observed variability of sediment provenance.