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Determining hillslope-channel connectivity in an agricultural catchment using rare-earth oxide tracers and random forests.

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Soil erosion from agricultural areas is a large problem, because of off-site effects like the rapid filling of reservoirs. To mitigate the problem of sediments from agricultural areas reaching the channel, reservoirs and other surface waters, it is important to understand hillslope-channel connectivity and catchment connectivity.

To determine the functioning of hillslope-channel connectivity and the continuation of transport of these sediments in the channel, it is necessary to obtain data on sediment transport from the hillslopes to the channels. Simultaneously, the factors that influence sediment export out of the catchment need to be studied.

For measuring hillslope-channel sediment connectivity, Rare-Earth Oxide (REO) tracers were applied to a hillslope in an agricultural catchment in Navarre, Spain, preceding the winter of 2014-2015. The results showed that during the winter there was no sediment transport from the hillslope to the channel. Analysis of precipitation data showed that total precipitation quantities did not differ much from the mean. However, precipitation intensities were low, causing little sediment mobilisation.

To test the implication of the REO results at the catchment scale, two conceptual models for sediment connectivity were assessed using a Random Forest (RF) machine learning method. One model proposes that small events provide sediment for large events, while the other proposes that only large events cause sediment detachment and small events subsequently remove these sediments from near and in the channel. The RF method was applied to a daily dataset of sediment yield from the catchment (N=2451 days), and two subsets of the whole dataset: small events (N=2319) and large events (N=132). For sediment yield prediction of small events, variables related to large preceding events were the most important. The model for large events underperformed and, therefore, we could not draw any immediate conclusions whether small events influence the amount of sediment exported during large events.

Both REO tracers and RF method showed that low intensity events do not contribute any sediments to the channel in the Latxaga catchment (cf. Masselink et al., 2016). Sediment dynamics are dominated by sediment mobilisation during large (high intensity) events. Sediments are for a large part exported during those events, but large amount of sediments are deposited in and near the channel after these events. These sediments are gradually removed by small events. To better understand the delivery of sediments to the channel and how large and small events influence each other more field data on hillslope-channel connectivity and within-channel sediment dynamics is necessary.

Reference:
Masselink, R.J.H., Keesstra, S.D., Temme, A.J.A.M., Seeger, M., Giménez, R., Casalí, J., 2016. Modelling Discharge and Sediment Yield at Catchment Scale Using Connectivity Components. Land Degrad. Dev. 27, 933–945. doi:10.1002/ldr.2512