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Exploring links between tectonics, catchment morphology and hydrographs across Europe

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A growing number of studies show that contemporary catchment sediment yields (SY, [t/km^2/y]) are strongly correlated to patterns of seismic activity at regional to continental scales. Nonetheless, the mechanisms explaining these correlations are still poorly understood. Seismicity may increase SY by triggering landslides or weakening the surface lithology. On the other hand seismicity can be considered as a proxy for tectonic movements, while there is a growing consensus that tectonics exert an important influence on catchment morphology. This morphology influences the properties of runoff events (e.g. peak discharge, stream power). Given the large influence of large runoff events on annual SY, it is therefore possible that observed correlations between SY and seismicity are (at least partly) attributable to tectonic influences on catchment morphology. We test this hypothesis by investigating links between runoff hydrographs and patterns in catchment properties at a European scale using numerous catchment indices such as the slope, channel steepness, circularity, drainage length, river network topology, etc.

From DEMs with a resolution of ca. 100m we randomly delineated over 5000 catchments across Europe with an area of 90 to 100 km^2. For each of these catchments, we simulated a runoff hydrograph, using a simple Hortonian runoff model that routes water through the catchment based on previously proposed flow velocity equations. We made abstraction of rainfall patterns, lithology, land use and all factors other than topography. Hence, the hydrographs only reflect the influence of the morphological properties of the catchments and allow for comparisons.

First results show that, apart from average catchment slope, there are very few regional patterns in catchment morphological properties that may significantly affect hydrographs. In some tectonically active regions, channel slopes are slightly steeper compared to catchments with the same average catchment slope in less active regions. However, the overall difference is minimal. In addition, the potential positive effect of these steeper channels on peak discharges and stream power is mostly compensated for by the fact that catchments in tectonically active regions tend to have a slightly more elongated catchment shape. In conclusion, we find very few evidence that previously observed links between seismicity and SY are attributable to (neo-)tectonic impacts on catchment morphology.