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Geomorphometric effects of a migrating uplift wave in the Rhenish shield (western Europe)

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A synthesis of geomorphological, in particular fluvial terrace data of the western Rhenish shield recently led to the conclusion that the Quaternary uplift of the massif was characterized by a S-N migration of the uplift axis. The present study is an attempt to define geomorphometric indices that would be able to track this migrating uplift pulse and thus provide an insight into its relative age. While the basin's hypsometric integral refers to the broadest spatial scale (in the sense that it takes the entire basin area into consideration) and thus reflects the longer term erosion stage, the indices describing the individual river long profiles consider the front line of fluvial erosion and point up the most recent evolution, leaving a gap in the information at the intermediate temporal scale (105-106 years). To fill this gap, I introduce the fluvial system's hypsometric curve and the corresponding "fluvial system's hypsometric integral". Normalizing the three curves of the basin's hypsometry, the fluvial system's hypsometry and the main stem's long profile and subtracting their integrals from each other, I obtain two indices Ib and Ir, respectively expressing how much the fluvial system is incised in its catchment and how far the regressive erosion has proceeded towards the headwaters. In a context of similar climatic and lithological conditions, the ratio Ir/Ib should in principle provide a relative figure of the time elapsed since the tectonic pulse affected a region.
Based on the SRTM 3" filled DEM, I calculated these morphometric indices for 77 rivers of various sizes in the western Rhenish shield. All rivers drain mainly slaty areas, with subordinate quartzite and sandstone outcrops. They are distributed in three spatial subsets corresponding, from south to north, to regions of older to younger Pleistocene uplift. From the analysis of various relationships between the measured indices, it appears that the ratio Ir/Ib is strongly positively correlated with the natural logarithm of the drainage area. Moreover, the three regions display significantly different relations (at the 95% significance level), whose variations are geomorphologically consistent with the relative age of their uplift.
The first results of this exploratory study are promising and suggest that extending the calculation of the Ir/Ib index to other regions and geomorphic settings with uplift of known age could pave a new way for estimating the age of a tectonic motion from geomorphometric data.