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Sediment sources in a complex river basin affected by coal mining: generating areas, processes and time periods. The case of Jiu river basin, Romania

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Deciphering the origin of alluvia is an ongoing research question at the boundary of several geosciences. The most important fine sediment sources are slope erosion, river processes (channel scour and bank erosion) and gravitational processes (landslides). Nevertheless, the complex relationships between sediment-generating processes and sediment transfer rates towards the riverbeds have not yet been completely elucidated.
The purpose of this paper is to analyze geomorphic processes functioning as fine sediment sources in a fluvial system with high sediment dynamics and characterized by human interventions
The study focuses on the Jiu river basin (the largest tributary of Danube river in south-western Romania), well-known for its coal-bearing deposits (lignite and bituminous coal), the exploitation of which greatly affected water turbidity and fine sediment quality. Across its 10,070 sq.km, the study area overlaps a region with high rate of suspended sediment load (exceeding 10 t/ha/yr), considered to be the second in Romania in terms of the amount of fine sediment transited (the multiannual suspended sediment load of the Jiu River reaches 165 kg/s).
To address the issue of fine sediment sources, a detailed mapping of geomorphic processes was conducted within a buffer of 1 km on each bank along the main rivers. To gain more insight into hillslopes' capacity to mobilize and supply rivers with sediments, a multi-temporal approach (2005–2012) was adopted, using remotely sensed images. Landslides, rill and gully erosion were taken into account as sediment generating geomorphic processes, their further evaluation including mechanism classification, estimating dimensions, deriving movement rates and recurrence intervals. The relation between daily liquid discharge (Q) and suspended sediment loads (R) from the analyzed period served to establish a discharge threshold able to discriminate between hillslope and in-channel sediment sources. Additionally, the relation between sediment sources and delivery was validated by means of geochemical fingerprinting of coal content in fine sediments.
The geomorphic processes inventory led to identifying potential sediment sources in terms of slope deposits, including man-made ones. Hillslope-channel contact zones are described using nominal classification systems as well as simple quantitative measures (length of the affected channel, number and area of the slope processes affecting riverbeds). In this sense, priority was given to mapping and evaluating the degree of slope – riverbed coupling in the area of coal spoil heaps, which are very unstable and behave as a supplier of fine sediments for the rivers during storm events. The relative contribution of hillslope sources to suspended sediment transport was estimated to be above 80% during summer high waters and flood periods, while during low water intervals in winter, it can drop even below 20%. Established R-Q relation allowed for the prediction of the relative contribution of the hillslope domain in the suspended sediment yield for river sections where sediment measurements were not available. Uncertainties are discussed in terms of frequency-magnitude relations affecting sediment detachment and transport processes.
The findings on slope-processes providing fine sediment inputs represent a preliminary research in understanding sediment connectivity, especially in the context a drainage basin strongly affected by coal mining.