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Distribution pattern of metals in fluvial sediments in mountainous rural catchments: a case study in Northern Portugal

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The management of sediments-associated contaminants, concerning quality and quantity, in mountainous rivers is a pertinent issue; it is well known that mountainous rivers contribute with significant sedimentary loads, transported in short periods of time, in response to short precipitation episodes.
Our contribution presents results of a research study developed in one of the tributaries of the River Douro, the River Corgo catchment (studied area of 295 km2). The River Corgo traverses Vila Real city and encounters the River Douro in Régua, in the West limit of the Douro Region – classified as UNESCO World Heritage. The altitudes vary between 200-1400m. The bedrock is composed of crystalline rocks and the land use is mainly forest and agriculture, with scattered urban settlements. The aim was to investigate the dynamics and availability of sediment contaminants in mountainous rural rivers, in a temperate climate.
Active fluvial sediments (<63μm fraction) were studied with the aim of characterising the spatial and temporal distribution of the contents of Cd, Co, Cr, Ni, Cu, Zn, Pb, Fe and Mn, in the catchment. To assess possible different origins of metals (natural vs. anthropogenic), and potential availability, a sequential chemical approach was used (modified BCR procedure); the element concentrations were obtained by ICP-AES.
The results suggest that Cr and Ni are the main metals from lithological source, with relatively higher contents in the residual fraction, and the lowest in the most mobile fractions. Copper, Zn and, in particular, Pb show higher concentrations in the most labile fractions, suggesting an important contribution of anthropogenic activities to the total contents in the sediments. The spatial distribution pattern of metal contents indicates higher contents of metals in the most mobile fractions occurring along the main courses of the major tributaries (in particular in the flatter reaches, where finer sediment preferentially accumulates). In sampling sites located in the vicinity of point pollution sources, there is an increase of sediment bound-metal contents, which indicates that even in more energetic streams the sediments are able to control, to a significant extent, the levels of metals in the fluvial water.
Complementary studies to estimate the delivered quantities of eroded material and associated contaminants, with the aim to relate to the amount of sediments transported within the catchment, are being performed. A GIS based potential soil loss spatial index model was developed with assessment of sediment yield from different lithologies within the catchment. The results show that about 2% of the study area is classified as highest erosion risk potential, and 22% area is under low to moderate erosion risk; these locate in the west, northwest and southern regions of the study area. The estimated soil losses are related, essentially, with one lithology (48%).