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Transport of sediment and associated contaminants in dynamic streams: a case study in the River Douro basin (North Portugal)

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Mountainous rivers transport significant sedimentary loads and associated contaminants in short periods of time, owing to the low water-storage capacity and the quick response to short precipitation episodes. This study presents results of a sediment monitoring plan of a small mountainous catchment mainly rural, underlain by crystalline rocks in a temperate climate, located in north Portugal (River Corgo basin in the major River Douro basin). The aim was to evaluate, at a first stage, the retention and/or mobilisation of metals derived from agricultural and urban activities in oxic fluvial sediments, as well as its variability in space and time overall the basin area. Sampling of bottom sediments was carried out seasonally, and the sediment fractions <63 μm were analysed for mineralogy, granulometry and physical-chemical properties of the particles (SA, CEC). The potential availability of Cd, Co, Cr, Ni, Cu, Zn, Pb was assessed by a chemical sequential approach.

The sediments are composed mainly by detrital minerals (76-95%), and the occurrence of illite and various mixed-layer and poorly crystallized clay species, reflects its origin in the saprolites and topsoils of the basin. It seems that little mineralogical evolution towards more developed weathering products occurs during transport along the drainage network. The silt size class is dominant (84-87%), and in general the sediments show minor spatial and temporal variations of granulometric characteristics, and SA and CEC values. The spatial distribution of metal contents associated to the mobile and semi-mobile geochemical fractions (available + reducible + oxidisable), shows that, in general, it is along the main courses of the major tributaries that the higher contents occur. The pattern of occurrence and distribution of metals through the hydrological year show, in general, that the variation of the relative contents associated with the potentially available fraction increase during the period of low flow. The variation of the relative contents in the residual fraction is of a general decrease after the influence of the first autumn rain.

The results suggest that in mountainous rural catchments the control of metals in the sediments by their mineralogical, geochemical and physical properties is governed primarily at the level of the basin soils system, since the soil particles are a major pathway of transport and entrance of metals in the fluvial network by runoff, especially in the Wet Period, when the sediments are frequently remobilised. The morphology of the streambed exerts a major influence on the distribution of the sediments' associated metals in the fluvial environment. The sites exhibiting the higher and/or anomalous contents are in general located in reaches with less irregular riverbed, where the accumulation of finer sediments is slightly higher. In sampling sites located in the vicinity of identified point pollution sources, there is an increase of sediment bound-metal contents, which indicates that nevertheless even in more energetic streams the sediments are able to control, to a significant extent, the levels of metals in the fluvial water.