Sediment sampling in mountainous rivers and potential implication for the Water Framework Directive: a case study in Northern Portugal

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Introduction: In Portugal, the Institute of Water (INAG) [1] is responsible for the implementation of the European Water Framework Directive (WFD), which started in the 1990's to restructure national water resources monitoring, comprising meteorological, hydrometric and sedimentological networks. Currently there are no publicly available data from the sedimentological network, but there will be information on the quantity and quality of riverbed and suspended sediments. For pollutant-sediment dynamics at the catchment scale there are few integrated studies in Portugal, especially in the Douro River basin, as mentioned in the Report on the SedNet Round Table Discussion (2007) [2]. Our contribution presents the methodology to assess sediment quality, in terms of Cd, Cr, Ni, Co, Cu, Pb and Zn contents, in a mountainous meso-scale river basin. The study area, the River Corgo catchment up to the gauge station Ermida, with an area of 295 km^2, is located in Northeast Portugal, in the trans-boundary Douro river basin (Fig.1). The altitudes vary between 200-1400 m. The bedrock is composed of crystalline rocks and the land use is mainly forest and agriculture, with scattered urban settlements.

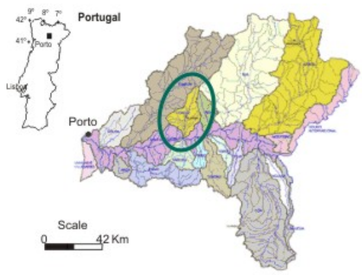

Fig. 1: Locality of River Corgo catchment in the Douro Basin in Portugal (modified from [3]).

Methods: Owing to the low water-storage capacity and the quick response to short precipitation episodes, significant sedimentary loads are transported in short periods of time, mainly in winter. These features pose two main issues concerning sampling design: first, high stream-flow velocity peaks make it difficult or impossible to maintain suspended sediment samplers fixed in the river channel; second, the cycle of deposition and resuspension of finer material, throughout the hydrological year, leads to temporal changes of sediment characteristics. Taking these considerations into account, stream sediment samples were collected during two sampling campaigns: one at the end of the wet period (WP) in April, and the other at the end of the dry period (DP) in October. The finer and most recently deposited sediment was preferentially sampled. Sediments were wet-sieved to separate the <63μm fraction [4]. To assess the bioavailability of trace metals, the modified BCR sequential extraction procedure [5] was used and the element concentrations were obtained by ICP-AES.

Results and discussion: For metals included in the priority substances list (Cd, Ni, Pb), and taking into account the most labile fraction, the analytical results from the end of the wet period and the end of the dry period are in the ranges (ppm): a) WP, Cd [0.1-27.9]; Ni [0.3-11.4]; Pb [2.6-86.6]; b) DP, Cd [0.1-1.8]; Ni [0.0-7.3]; Pb [0.0-118.6]. These results are in agreement with those for suspended sediment samples from the same sampling period. Cadmium and Pb give higher values than the ones specified for drinking water in Council Directive 80/778/EEC. The spatial and temporal variability in elements distribution is clearly influenced by anthropogenic activities (agriculture and urban activities), with some geological control (weathering of granites and schists), and soil erosion in winter.

The results indicate that monitoring of finer fresh bottom sediments gives a good indication of sediment-contaminant dynamics in mountainous rivers. Seasonal sampling and the study of potentially bioavailable fractions is also important to assess the anthropogenic input. Suspended sediment representative samples have to be collected in periods of high flow conditions.

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References: [1] INAG, http://www.inag.pt; [2] SedNet (2007) Report on the SedNet Round Table Discussion, 27p.; [3] INAG (2001) Plan of River Douro Hydrographic Basin, 545p.; [4] Förstner, U. (2004) Trends in Analytical Chemistry, 23:217-236; [5] Rauret et al. (1999) J. Environ. Monit. 1:57-6.