Potential impacts of sediment dredging on a contaminated stream in an abandoned sulphide metal mining area in Southern Portugal

Joana Araújo (jfaraujo@uevora.pt)**,** Rita Fonseca (rfonseca@uevora.pt), Natália Silva (motasilva.n@gmail.com) (University of Évora, IES, Portugal), Teresa Albuquerque, (teresal@ipcb.pt), (Cernas-IPCB, IES-University of Évora, Portugal)

Background/Objectives. Dredging is one of the most efficient techniques for recovering a water body: the only one capable of removing all, or a part of sediments, which are the most common site for accumulation and retention of pollutants. This is an economically viable method and one of the major advantages, compared to chemical or biological methods, is the non-introduction of external substances into the system. To restore contaminated rivers from active or abandoned mining areas, the environmental assessment of the dredging of metal-rich sediments, are important contributions to the design and implementation of sediment remediation since they might have negative impacts, sometimes being a misadjusted methodology in a recovery project. It should be mandatory to assess and predict the five Rs linked to dredging activities: (1) effective removal of sediments, (2) potential effect of sediment resuspension, (3) contaminant release to the water column, (4) residual sediments and (5) associated risks with these processes. This study aims to evaluate the potential environmental risks associated with dredging of sediments from contaminated shallow streams, under the direct influence of large areas of waste accumulation, from an abandoned Cu-Pb-Zn-Ag-Au mine (Caveira mine) included in the Iberian Pyrite Belt, in South Portugal.

Approach/Activities. Stream sediments were collected in a 1Km x 1Km grid in all small streams impacted by tailings in the area around the old mine. We performed analyses of physicochemical parameters, and determined the levels of metals of variable toxicity (As, Cd, Co, Cr, Cu, Hg, Mn, Ni, Pb, Zn, V) and of important elements in lithogenic sources (Fe, Al), evaluated the capacity of solubilisation and mobilisation of these elements and mapped the contamination. The evaluation of the metal's mobility was based on (1) partial digestion analysis (using *Aqua Regia*) and (2) quantification of the bioavailable forms through the extraction with ammonium acetate (1M, pH~4.5). A laboratory scale simulation of an invasive dredging procedure in specific sectors of these watercourses was also carried out, using simultaneously sampled sediment and water, followed by their collection and chemical analysis at regular periods of up to 7 days. The objective was to determine the effect of the sediment's removal on the water quality and to assess the main limitations of the sediment's dredging as a remediation technique for the area.

Results/Lessons Learned. Very high levels of Pb, As and Hg were found in sediments in a stream closer to the mine tailings pile and in an accumulation area near its confluence with a larger and important multi-purpose river in the region. These concentrations, reaching 3.8% Pb, 750$\mu g g^{-1}$ As, 120 $\mu g g^{-1}$ Zn and 340 $\mu g g^{-1}$ Hg, are well beyond the intervention values imposed by the Netherlands legislation (2009), which includes reference values for freshwater sediment. These elements are mostly (60-90%) associated with easily available fractions, occurring mostly in soluble and exchangeable forms, so, any sediments removal would release these elements to the water column, increasing the environmental hazard of the larger waterway. The laboratory dredging simulation indicated the presence of high levels of metals in soluble and in particulate forms which remain reactive a few days after dredging. The removal of sediments would be effective only in the short term since the contamination is mainly done through the diffusion of salts in solution in the interstitial water and groundwater feeding the hydric system impacted by the tailing heaps. The geochemical analysis and the dredging simulation at a lab scale, allowed to discourage the removal of the sediments as an adequate remediation technique for the contaminated sediments from this old mining area, except in periods of severe drought, which tend to intensify given the frequent scenarios of climate change in this part of Europe.