ESTIMATED LOADS AND GEOCHEMICAL BASELINES OF HEAVY METALS IN SEDIMENTS IN A WATERSHED OF NORTHEASTERN BRAZIL

Francisco José de Paula Filho, C.L.M. de Oliveira, J.E. Aguiar, M.O. Santiago, M.G.S. Lima, J.M. Godoy.

Federal University of Cariri, Science and Technology Center, Juazeiro do Norte, Brazil
francisco.filho@ufca.edu.br

Keywords: Emission factor; Background; Semiarid; Trace metals; Geochemical survey.

Introduction

This study is a pioneering work focusing on estimates of heavy metals loads (Zn, Cu, Pb, Cr and Cd), emitted by different land uses, and regional geochemical baselines for metals in the sedimentary environment of the Salgado river basin, NE Brazil. Anthropogenic inputs of heavy metals to aquatic ecosystems are a worldwide environmental problem that has received increasing attention over the last few decades because of its adverse effects. These contaminants have a frequent and ubiquitous presence in several effluents from human industrial, urban and agricultural activities. The relative contribution of heavy metal inputs to watersheds can be estimated using empirical emission factor models (De Paula Filho, 2015a). Furthermore, several metal accumulation studies conducted in Brazil have sought to establish the geochemical basis for the assessment of natural and/or anthropogenic metal loads that may potentially reach the coastal environments in areas subject to urban and industrial pressures (Silva et al., 2016). Only few studies related to this theme have been conducted in specific impacted basins in the semiarid region of the Brazilian northeast (De Paula Filho et al., 2015b).

Methods

The Salgado River stretches over 308 km and its drainage area is 12,865 km^2, with a total population is 909.000 inhabitants. Its increasing urbanization has resulted in rising pollutant loads, leading to environmental consequences such as water and soil contamination and the consequent human exposure to such pollutants. These impacts and their effects may extend downstream of the basin, even reaching the Castanhão reservoir, the largest in Latin America. Its waters are intended primarily to supply the city of Fortaleza, the fifth largest in Brazil. The soil of the basin is made up of crystalline (85%) and sedimentary (15%) rocks. Emission factors of natural processes and anthropogenic activities were used to estimate metal loads (De Paula Filho et al., 2015a). Sampling of surface sediments was randomly done in 20 points distributed along the river in September 2015, during the local dry season. Metals were extracted according to USEPA method 3051a (USEPA, 2007). Concentrations of Zn, Cu, Pb, Cr, Cd, Mn and Fe were determined by Flame Atomic Absorption Spectrometry (Varian 50B) with a deuterium lamp background correction. The validation was performed by testing a standard material (NIST 1646a).

Results

The total loads of Zn, Cu, Pb, Cr and Cd from natural and anthropogenic sources to the Salgado River are shown in Table 1. Anthropogenic emissions of Zn, Cu and Cr outweigh natural sources by 73%, 65% and 51% respectively, which is related to the presence of galvanic, jewelry and tannery industrial operations in the urbanized areas of the basin. The concentrations of metals in sediment varied between 36-187 mg $Zn.kg^{-1}$; 4-80 mg $Cu.kg^{-1}$; 11-55 mg $Pb.kg^{-1}$; 1.4-51 mg $Cr.kg^{-1}$; 0.2-10 mg $Cd.kg^{-1}$; 8-628 mg $Mn.kg^{-1}$; 0.8-4.0 %

Fe. Heavy metals recovered for certified reference material were Cr (72%); Zn and Pb (82%); Cu (102%); Cd (110%).

Table 1. Estimated emissions of Zn, Cu, Pb, Cr and Cd (t.year^{-1}) to the basin of the Salgado River from natural and anthropogenic sources.

Source	Zn[a]	Cu[a]	Pb[a]	Cr[a]	Cd[a]
Soil Runoff	29.1	21.0	25.1	15.2	0.80
Atmospheric inputs	4.2	1.3	3.0	0.4	0.77
Domestic wastewater	5.8	3.4	1.5	0.1	0.19
Livestock farming	78.9	9.9	0.6	8.2	0.05
Agriculture	1.1	13.6	0.2	0.4	0.13
Municipal solid waste	3.4	1.0	1.3	1.9	0.04
Urban runoff	0.3	0.3	6.0	0.2	0.11
Industrial solid waste	1.5	13.4	4.0	5.4	0.07
Total (natural + anthropogenic)	124.3	63.9	41.7	31.8	2.18

[a.] The methodology of emissions estimates is available in De Paula Filho et al. (2015a).

The Box–Whisker element concentration plots were used to evaluate the variation in the sediment samples (Figure 1). The determination of background values was made based on the upper quartile (75%) of the analytical results: 135 mg Zn.kg^{-1}; 28 mg Cu.kg^{-1}; 32 mg Pb.kg^{-1}; 27 mg Cr.kg^{-1}; 1.4 mg Cd.kg^{-1}.

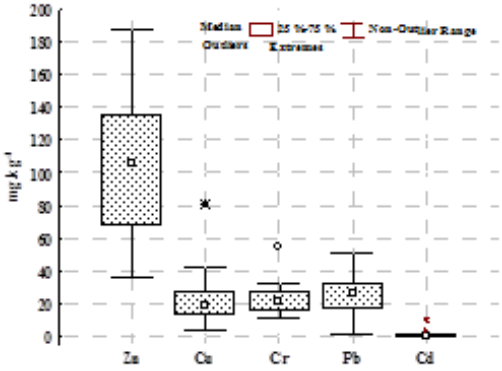

Figure 1. Box–Whisker plots of Zn, Cu, Cr, Pb and Cd concentrations in surface sediments (<63μm).

Conclusion

The identification and prioritization of the main vectors, pressures and impacts is an important tool in the design of measures aimed at the monitoring and mitigation of impacts, while this work allows the inclusion of the Salgado River basin within the context of the other basins of the Brazilian East and Northeast coasts, where studies of this kind have already been conducted. The results of the tested metals were compared to the threshold levels recommended by the Brazilian environmental legislation, suggesting that most of the contamination levels show a low probability of adverse effects on the area´s aquatic biota.

References

De Paula Filho, F.J.; Marins, R.V.; Lacerda, L.D. (2015a). Natural and anthropogenic emissions of N and P to the Parnaíba River Delta in NE Brazil. *Estuarine, Coastal and Shelf Science*, 166, 34–44.

De Paula Filho, F.J.; Marins, R.V.; Lacerda, L.D.; Aguiar, J.E.; Peres, T.F. (2015b). Background values for evaluation of heavy metal contamination in sediments in the Parnaíba River Delta estuary, NE/Brazil. *Mar. Pollut. Bull.* 91, 2, 424–428

Silva, Y.J.A.B.; Cantalice, J.R.B.; Singh, V.P.; Cruz, C.M.D.A; Silva Souza, W.L. (2016). Sediment transport under the presence and absence of emergent vegetation in a natural alluvial channel from Brazil. *Int J Sediment Res*, v. 31, p. 393.

United States Environmental Protection Agency – USEPA. (2007). Microwave assisted acid digestion of sediments sludge, soils, and oils. EPA SW 846 3051a. 30p.