Theme 3 | Soil data for policy and decision-making

Assessing intra and extra channel contamination by iron ore tailings in Doce River Basin, Brazil

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INTRODUCTION

The rupture of Fundão dam, occurred in 2015 in Minas Gerais State, is **the biggest environmental disaster** in Brazil's history.

Fig.1: Satellite images of the downstream area of Fundão dam before and after the collapse. Source: Google Earth

The rupture spilled 39.3 million m³ of iron ore tailings in the Doce River Basin, causing unprecedented social, environmental and economical damages.

After 9 years, there are still environmental and health risks due to the amount of potentially toxic metals contained in the tailings.

Our goals were

(1) to evaluate the contamination by metals in the intra-channel and extra-channel environments of the Doce River Basin;
(2) to identify whether the contamination is related to the collapse of the Fundão dam.

METHODS

We collected 2,939 samples of natural sedment (Natural Substrate) and Tailing, within the river channel (Intra-Channel) and in riparian zones (Extra-Channel) (Fig.2, A).

We used the **USEPA 3051A** method to calculate the semi total levels of **As, Ba, Pb, Co, Cu, Cr, Hg, Ni, V and Zn** by Inductively Coupled Plasma Optical Emission Spectroscopy.

We adopted the **Quality Reference Values** (QRV) as a parameter established in legislation by COPAM 166/2011.

We used quartile analysis by boxplots and Dunn's test at 1% significance to statistically evaluate heavy metal contamination.

STUDY AREA

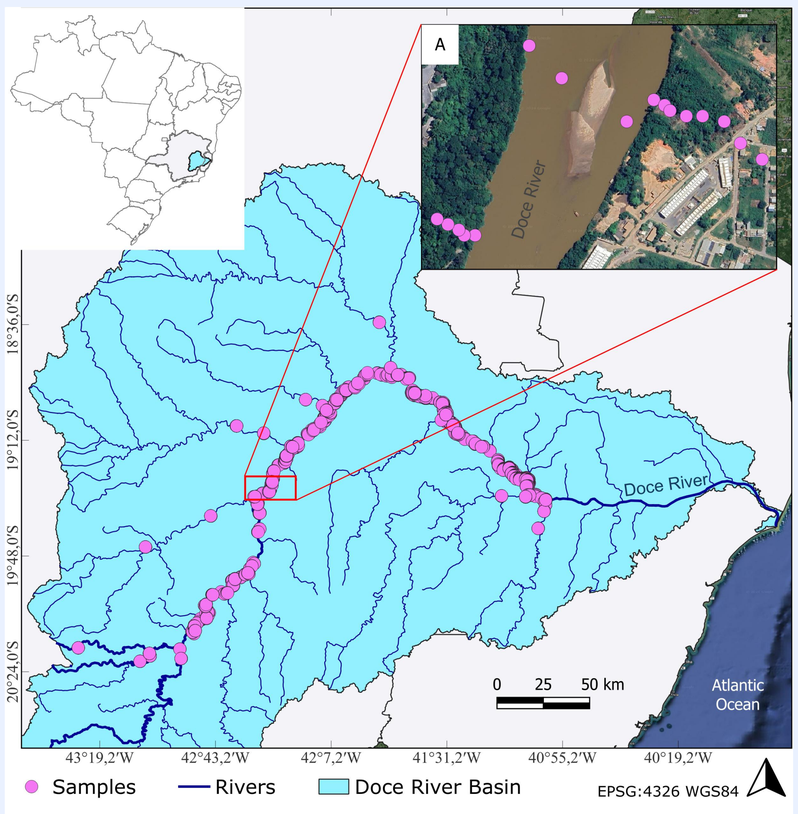

Fig.2: Map showing the location of the sampling points.

The Doce River Basin is located in the states of Minas Gerais and Espírito Santo and is home to approximately 3.7 million inhabitants in 228 municipalities (PIRH Doce, 2023).

RESULTS

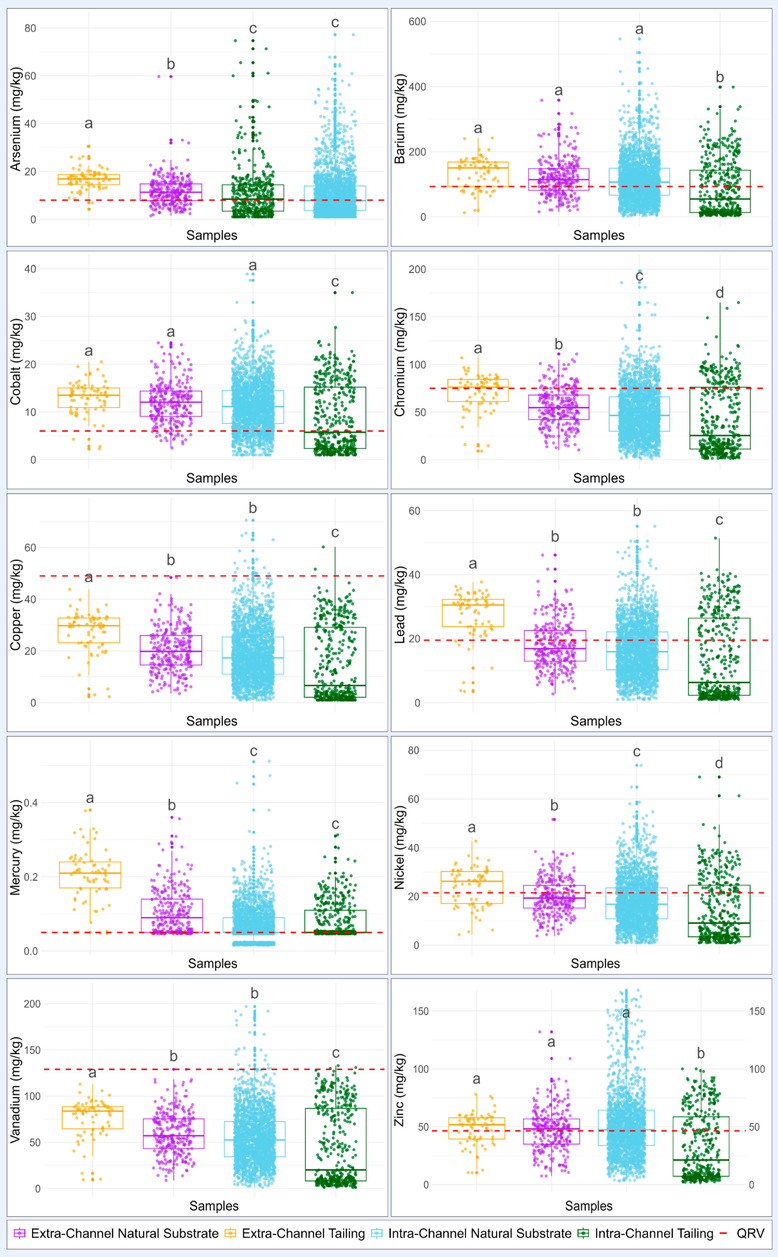

Fig.3: Quartile analysis by boxplots. Boxplots represented by equal letters show no statistical difference between each other at a 1% significance level using Dunn's test.

Table 1: Quality Reference Values (QRV) as established by COPAM 166/2011

	As	Ba	Co	Cr	Cu	Hg	Ni	Pb	V	Zn
	mg kg^{-1}									
QRV	8	93	6	75	49	0.05	21.5	19.5	129	46.5

The samples were divided into **four groups**:

Extra-Channel Tailing, Intra-Channel Tailing, Extra-Channel Natural Substrate and Intra-Channel Natural Substrate.

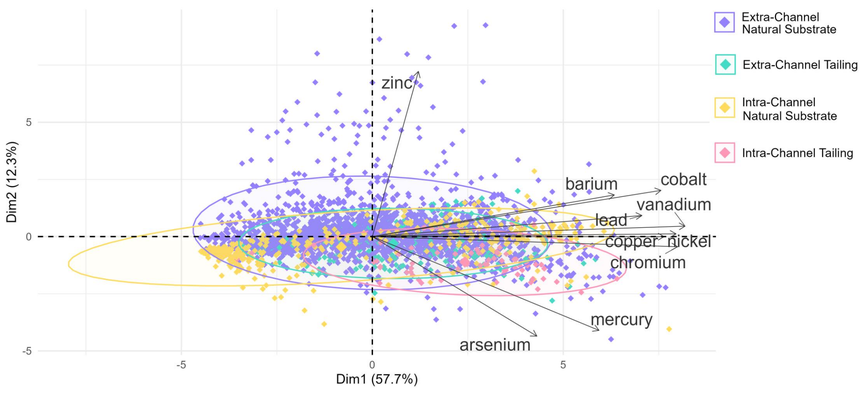

Fig.4: Principal Component Analysis - Biplot Graph.

DISCUSSION

- Virtually **all elements** showed values **above the QRV in the natural substrate**, especially in the extra-channel, showing contamination prior to the collapse of Fundão Dam.

- However the concentration of all elements analyzed was **higher in the tailing than in the natural substrate**, showing that the tailing may **worsen** the contamination levels.

- In addition to the impact of the rupture of the Fundão dam, the water bodies of the Doce River basin have been suffering from the inappropriate discharge of polluting **domestic and industrial waste** for decades.

CONCLUSIONS

The contamination in the tailings and in the natural substrates differ in both type and quantity of metals in and out the river channel, hence carrying out to the need for distinct monitoring and reclamation actions, not only for the tailing-affected sites, but for all Doce River Basin.

PIRH Doce. 2023. Revisão e Atualização do Plano Integrado de Recursos Hídricos da Bacia do Rio Doce. PP07. Consórcio ANA-Engecorps, Brazil, p 460. Available at: https://www.cbhdoce.org.br/pirh-parh-pap/pirh

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