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Effect of alluvial gold mines rehabilitation on mercury and trace metals release to hydrosystems (French Guiana)

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French Guiana is experiencing a new rush in artisanal and small-scale gold mining (ASGM). Both legal and illegal mining activities have an impact on mercury (Hg) fluxes to rivers as they involve deforestation and soil reworking for the extraction of gold in naturally Hg rich soils. In contrast to illegal ASGM, legal mines extract gold without Hg addition.

The impact of legal mines is however not fully characterised, as their remote location makes continuous monitoring challenging, the exact nature of the geogenic background is poorly characterized and these sites are often impacted by Hg contamination inherited from former ASGM activities.

In this study, we monitored Hg species and trace metal (Pb, As, Cd...) levels and fluxes during 1.5 years, upstream and downstream of a legal gold mining site after exploitation and during revegetation. The combination of continuous monitoring of water flow and turbidity, with discrete sampling during flood events allowed a high resolution (time step of 1h) chronicle of trace metal fluxes. Sources of contaminants to the river were identified through the characterisation of ecosystem compartments (pristine and mining soil, stream, rain and pore-water, mining ponds). This enables a better understanding of background levels ([Hg]=229±19 $ng.g^{-1}$, [Pb]=123±50 $\mu g.g^{-1}$, [As]=6±2 $\mu g.g^{-1}$ in pristine surface soils) and enrichment factors of contaminants in a natural and mine impacted Amazonian tropical system.

Results showed that for major contaminants (Hg, Pb, As), more than 80% of the element is in the particulate fraction. During flood events, erosion of the mining flat is the major source of particulate Hg, as Hg concentrations almost double downstream of the flat compared to upstream. However, other contaminants including methylmercury, Pb and As are not impacted by the mining flat as their concentrations remain constant.

The comparison of soil erosion and contaminant fluxes between rehabilitated and bare soils revealed that erosion was 10 times lower on rehabilitated soils, demonstrating that revegetation efficiently decreases the amount of particulate contaminants transported to the river system. These results highlight that the rehabilitation step must be accomplished shortly after exploitation (i.e., under 6 months) to limit contaminant fluxes to the hydrosystems and favour revegetation.