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Comparing conventional and alternative sediment tracing methods to quantify the sources of sediment transiting rivers of South Pacific Islands

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Soil erosion and subsequent sediment transfer in rivers may be intense in tropical regions exposed to heavy rainfall. In New Caledonia, a French island located in the south-west of the Pacific Ocean, these problems are exacerbated by nickel open-mining activities. After more than 150 years of exploitation, the excessive sediment input from mining areas has strongly modified the morphology of rivers (hyper-sedimentation) and impacted the island's ecosystems designated a UNESCO World Heritage Site. Despite the severity of these problems, the contribution of mining activities to sediment transiting rivers of this region has not yet been quantified, and this estimation is required to guide the implementation of efficient management measures to mitigate the fine sediment supply to New Caledonian rivers and lagoons. To this end, a pilot sediment tracing study has been conducted in one of the first sites exploited for nickel mining, the 400-km^2 Thio River catchment.

Sediment deposited during the February 25, 2015 flood was collected according to a 'tributary tracing approach' on the main stem of the Thio River and its main tributaries classified in two types (rivers draining mining sites vs. those devoid of mining activity and where sediment is supplied by landslides, cattle trampling and erosion following forest fires). As nickel mining has mainly developed on peridotite massifs enriched in Mn and Fe oxides, mining sources generate orange or red-coloured sediments, whereas the areas devoid of mining activities rather supply grey material to the rivers. Accordingly, the applicability of alternative sediment tracing method such as spectrocolorimetry in the visible (VIS) range of the spectrum was investigated. The results of this method were compared to those obtained with conventional methods based on fallout radionuclides.

Thorium (Th) contents estimated based on the measurement of Th-228 by gamma spectrometry provided a better discrimination between both sources than Cs-137 and unsupported Pb-210. This is likely explained by the low levels of fallout radionuclides (mainly Cs-137) in this region of the world, and by the natural Th enrichment in the volcano-sedimentary formation rocks, devoid of mining activities. On the contrary, the peridotite massif rocks concentrating the nickel mining activities were depleted in Th. Accordingly, the application of a distribution modelling approach based on Th contents showed that tributaries draining mining sites were the main source of sediment supplied to the Thio River (mean 59 %), although the contributions of no-mining sources was far from negligible. Similar results were found with the spectrocolorimetry parameters. After validation, these two methods will be applied to a sediment core collected in the Thio river deltaic plain to characterize potential changes in sediment source contributions over time. Potential applications in other catchments draining mines in New Caledonia will also be explored.