Comparing the discriminating power of contrasted sediment tracing techniques to quantify the impact of nickel mining on river and lagoon siltation in New Caledonia

Virginie Sellier, Olivier Evrard, Oldrich Navratil, J. Patrick Laceby, Michel Allenbach and Irène Lefèvre
Open-cast mining in operation since 1880s

Strong increase in soil erosion and sediment transfer in river systems leading to the island’s ecosystem degradation (e.g. flooding, water pollution)

Two sediment sources: Mining sources & Non-mining sources

Need to estimate the contributions of suspended sediment to guide the implementation of efficient management measurements

Objectives

(1) Quantify the ongoing contributions of sediment sources

(2) Reconstruct the temporal changes of sediment sources
Thio River catchment (397 km²), one of the first areas exploited for nickel mining

(1) Lag deposits collected following the ‘tributary tracing approach’ (Laceby et al., 2017)

(2) Select the optimal sediment fingerprinting method(s) among

5 conventional sediment fingerprinting methods:
- Fallout radionuclides ($^{137}\text{Cs}$, $^{210}\text{Pb}_{xs}$)
- Geogenic radionuclides (Th, U, K)
- Elemental Geochemistry
- Colour parameters
- Elemental Geochemistry + colour parameters

Reliability of the models = Test on artificial mixture samples

One alternative sediment fingerprinting method
- Visible spectrum (PLS regression model)

- 2015: Overbank flood by a tropical depression
- 2017: Overbank flood by Cyclone Cook
- Sediment core in 2016
**Results**

- **Fallout radionuclides**: Low activities in mining and non-mining sources

- **Geogenic radionuclides**

- **Elemental Geochemistry**

- **Colour parameters**: Not provide satisfactory source discrimination

- **Elemental geochemistry + colour parameters**

- **Visible spectrum**: Not provide satisfactory source discrimination

**Elemental Geochemistry**

- 83% of variance explained
- 15% overestimation of mining sources

**Elemental geochemistry + colour parameters**

- 93% of variance explained
- 7% overestimation of mining sources
Results

Recent overbank floods 2015-2017
Elemental geochemistry + colour parameters

Elemental Geochemistry
Colour parameters are not conservative

Legend
Source contributions (%)
- Mining tributaries
- Non-mining tributaries
- Active mining sites
- Abandoned mining sites
- Mining exploration
- Thio River
- Mining tributaries
- Non-mining tributaries

68 ± 25 % of the Thio River sediment originating from mining sources for the 2015 flood event
88 ± 8% for the 2017 flood event
74 ± 13% in the sediment core