ASSESSMENT OF THE CHEMICAL QUALITY OF SEDIMENTS IN THE MARITIME PORT OF REUNION
- Concentrations in trace metals and natural geochemical backgrounds -

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Abstract – The analyzes carried out in the marine sediments sampled in the port and coastal areas of Reunion show, for certain metallic trace elements, significant variations in their contents and regular overruns of the regulatory thresholds for the management of dredged sediments.
Several studies show that the volcanic nature of Reunion Island is the cause of high concentrations of metals in the soil.
The objective of this study is to define, based on existing data, whether the observed exceedances of the management thresholds for dredged sediments (N1 and N2) are due to the geology of the island or to contributions of anthropogenic origin.

Introduction

The analyzes carried out on the marine sediments collected in the port and coastal areas of Réunion show, for certain metals, significant variations in their content and regular exceedances of the contamination levels set by the regulations governing the management of dredged sediments.

Several studies relating to the geochemical context of Réunion show naturally high metal contents due to the geology of the island. However, given the high variability of the results, the cause of the exceedances is not systematically due to the volcanic origin of the sediments.

The objective of this study is, on the basis of existing data, to define to what extent the observed exceedances of the dredged sediment management thresholds (N1 and N2) are due to the volcanic environment of the island or to anthropogenic inputs.

Methods

The analysis of the metal contents of sediments in Réunion is based on the following data:

- Port sediment quality monitoring network;
- sediment analyzes carried out by the Grand Port Maritime de La Réunion;
- measurement campaigns carried out under the implementation of the Water Framework Directive;

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- results of the CARTOMAR program [1];
- monitoring instituted by the water law decrees and impact studies produced in Reunion Island.

In order to avoid grain size variations, the measured concentrations were normalized with respect to an aluminum content of 5 % [2]:

$$[M]_{5\%\ d'Al} = [M]_{mesuré} \times \frac{5}{[Al_{\%}]_{mesuré}}$$

Port activities and different releases may generate heavy metal intakes were identified: careening area, stormwater discharges, refueling stations…

To determine the natural part and the anthropogenic part of exceeding the dredged sediment management thresholds, the measurement results were analyzed using two indices: the enrichment factor and the geo-accumulation index [3]:

Table 1 – Interpretation of sediment enrichment factor values.

Enrichment factor	Interpretation
< 1,5	Natural geological composition
1,5 à 3	Low enrichment
3 à 5	Moderate enrichment
> 5	Important enrichment

Table 2 – Interpretation of sediment geoaccumulation index.

Classe	Valeur	Intensité de la pollution
0	Igeo ≤ 0	Unpolluted
1	0 < Igeo ≤ 1	De non pollué à modérément pollué
2	1 < Igeo ≤ 2	Modérément pollué
3	2< Igeo ≤ 3	De modérément pollué à fortement pollué
4	3 < Igeo ≤ 4	Fortement pollué
5	4 < Igeo ≤ 5	De fortement pollué à extrêmement pollué
6	5 < Igeo	Extrêmement pollué

Finally, the concentrations of elements for which an anthropogenic contribution is suspected were correlated with the concentrations of contaminants of exclusively anthropogenic origin (TBT, DEHP...).

Results

Data from the Cartomar program [1] correspond to analyzes of sediments taken off the coast of Réunion. Considering that anthropogenic inputs are limited there, the results of these analyzes were used to define indicative levels of geochemical backgrounds for trace metals:

Table 3 – Indicative levels of geochemical backgrounds.

mg/kg	Cadmium	Mercure	Chrome	Cuivre	Nickel	Plomb	Zinc
Background (quartile 1)	**0,07**	**0,02**	**215,10**	**15,55**	**138,80**	**1,75**	**219,17**
N1	1,20	0,40	90,00	45,00	37,00	100,00	276,00
N2	2,40	0,80	180,00	90,00	74,00	200,00	552,00

According to the various analyzes of the results, the nickel and chromium concentrations are mainly of natural origin. The indicative levels of the geochemical background for these metals exceed the N2 levels, and they show no correlation with anthropogenic contaminants. Some peaks in concentrations may however be due to anthropogenic inputs.

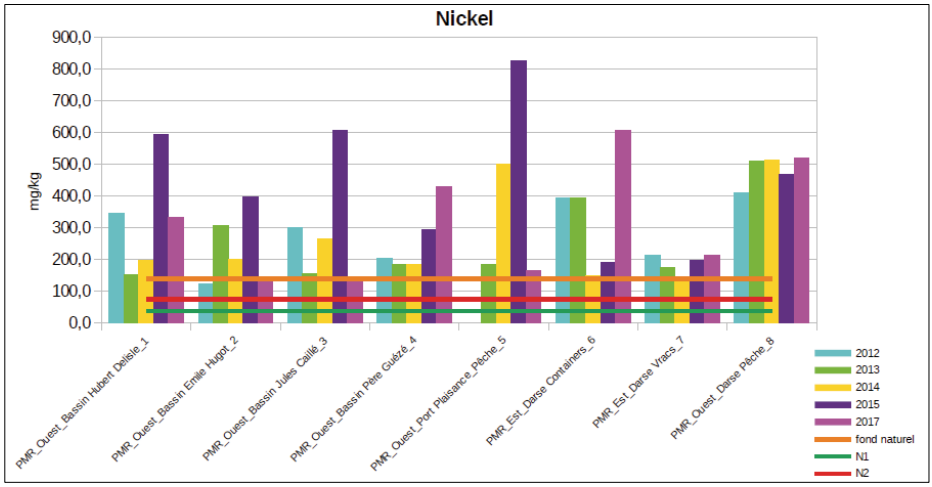

Figure 1 – Variation in nickel concentrations in the sediments of the maritime port of Reunion.

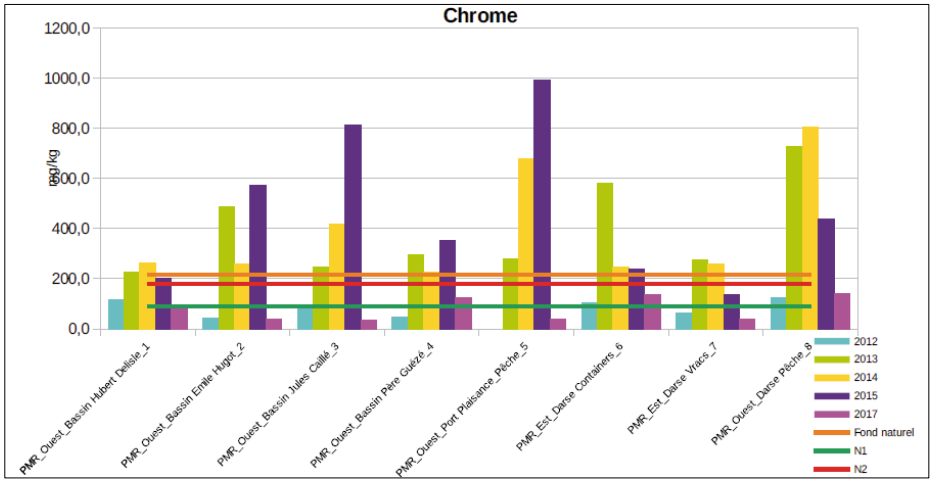

Figure 2 – Variation in chromium concentrations in the sediments of the maritime port of Reunion.

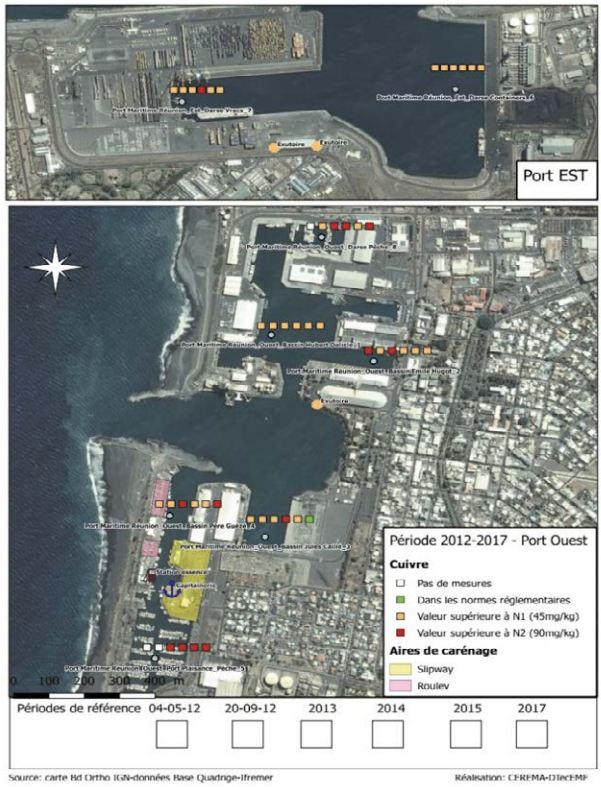

Figure 3 – Variation in copper concentrations in the sediments of the maritime port of Reunion.

For other metals (copper, lead, mercury, and zinc), the indicative levels of natural geochemicals are lower than level N1. The copper, mercury and lead concentrations only occasionally exceed the N1 or N2 levels. However, enrichment factors and iGeo indexes show significant anthropogenic inputs on the entire port area. In addition, the concentrations of these metals are positively correlated with certain anthropogenic contaminants.

Discussion

Regarding the quality of the dredged sediments, the high concentrations of nickel and copper may be due to anthropogenic inputs.

These high levels can lead to sediment management difficulties. An environmental diagnosis of the port area could make it possible to identify the origin of the anthropogenic inputs observed in the different basins and to target the actions to be implemented.

Acknowledgments

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