DATAMINE

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kartotrak

CUSTOMER STORY

HAROPA PORT
Le Havre
Rouen
Paris

How can more than 500,000 m³ of excavated soil be managed in a context of heterogeneous soil quality while keeping costs under control? HAROPA PORT relies on a probabilistic geostatistical approach to estimate volumes, anticipate disposal routes, and secure the project budget.

Client
HAROPA PORT

Maître d'ouvrage
PORT

Localisation
FRANCE

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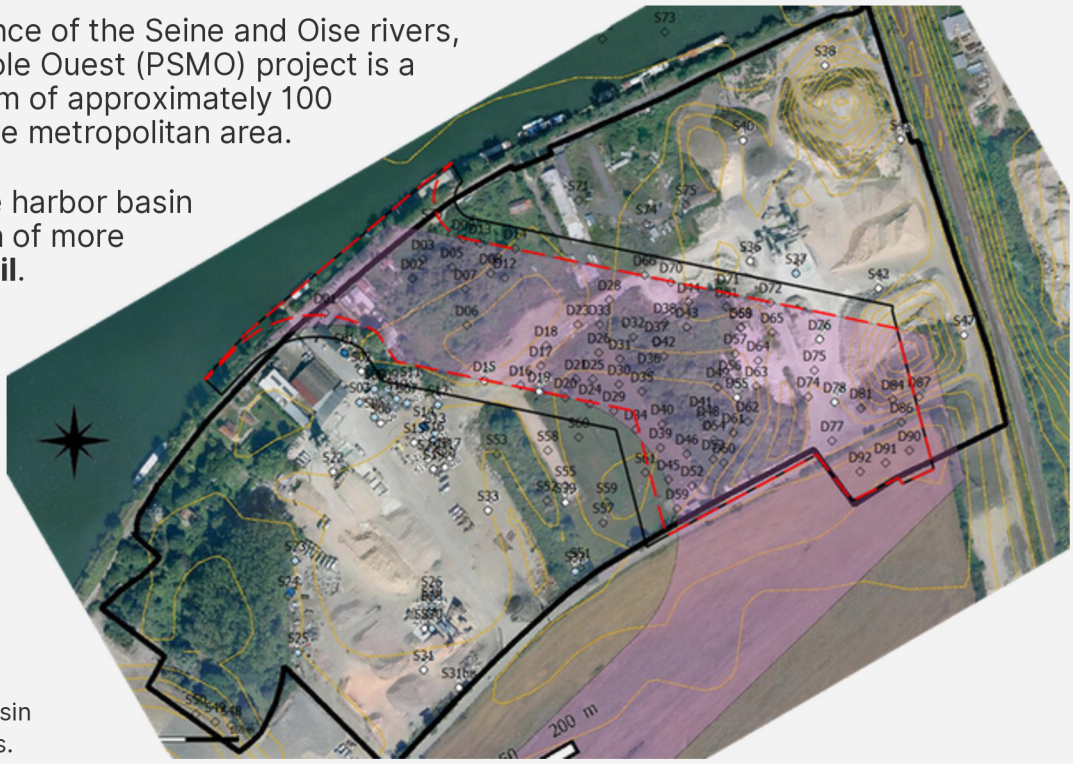
A STRATEGIC PRIORITY

Securing excavation costs through geostatistical risk management

Located at the confluence of the Seine and Oise rivers, the Port Seine-Métropole Ouest (PSMO) project is a multimodal port platform of approximately 100 hectares, supporting the metropolitan area.

The construction of the harbor basin requires the excavation of more than **500,000 m³ of soil**.

Given the volumes involved, accurately estimating quantities based on soil characteristics was a major financial issue.



Site overview : aerial view, basin outline and sampling locations.

THE CHALLENGE

A complex problem

The management of excavated soils had to account for:

- **5 potential disposal routes** (biocenter, ISDND – non-hazardous waste storage facilities, quarry backfilling, ISDI+ and ISDI – inert waste storage facilities)
- **9 to 10 contaminant concentrations** to analyze
- **Multiple thresholds**, sometimes not hierarchically ordered
- **A specific criterion** based on the soluble fraction / sulfates ratio (FS/SO_4)

Some disposal routes (ISDI+ and quarry) are not strictly ordered, making soil classification more complex.

In this context, a conventional deterministic approach was not sufficient to properly control uncertainty on volumes and associated costs.

SOLUTION

Integrating uncertainty to support decision-making

Geovariances implemented a comprehensive geostatistical methodology combining:

- Statistical analysis and correlations between parameters
- Spatial structure analysis (variography)
- Estimation using kriging
- **Conditional simulations** using turning bands to explicitly account for uncertainty

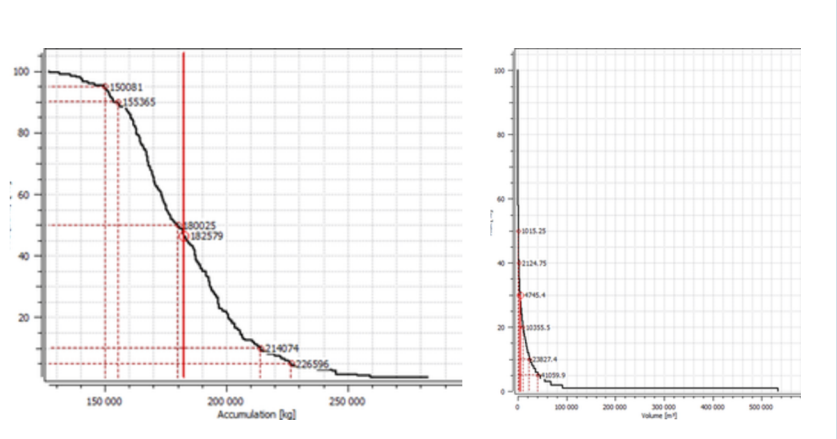
Kartotrak, the integrated solution dedicated to contaminated site characterization, and **Isatis.neo**, the advanced geostatistics software, both flagship solutions from Geovariances, were used in this study.

> For a project owner on an earthworks project, classifying excavated soils by treatment route before works begin is a major challenge. In this context, our collaboration with Geovariances enabled us to derive relevant conclusions from borehole data with varying densities.
>
> This approach allowed us to gain a better understanding of subsurface conditions without requiring additional investigations.
>
> — Erwan Le Priol
> Project Manager, PSMO Project - HAROPA PORT

RESULTS

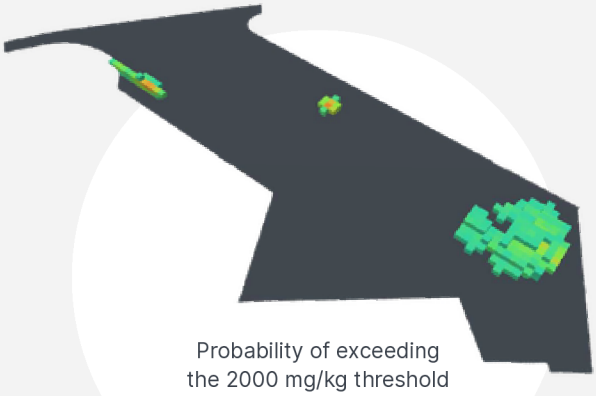
The probabilistic approach based on geostatistical simulations enabled:

- The production of decision-support maps adapted to the excavation grid
- The calculation of threshold exceedance probabilities
- Robust estimation of volumes and masses per disposal route
- Risk assessment with a criterion set at a maximum of 30% probability of threshold exceedance per route

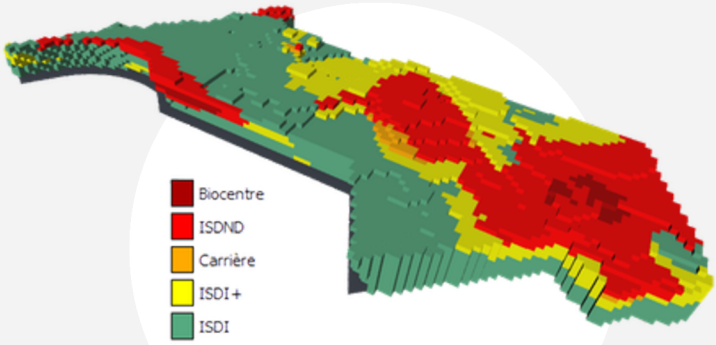


Left: example of a pollutant mass distribution curve, here for total hydrocarbons C10–C40 in place. Mean = 183 t.
Right: volumes of soil with C10–C40 concentrations exceeding 2000 mg/kg, as a function of exceedance risk. At a 30% risk level, the estimated soil volume is 4,745 m³.

"**Risk**" is defined as the maximum probability of sending contaminated soils to a lower disposal route. By allocating the corresponding volumes to a higher route, it ensures that the soils sent to the lower route have at most an x% probability of exceeding the thresholds for that route.



Probability of exceeding the 2000 mg/kg threshold for C10–C40 (only grid cells with a risk greater than or equal to 30% are shown)



Distribution of soils across the different disposal routes over the entire site.

COMPARISON WITH A MORE TRADITIONAL APPROACH

To support decision-making, results were compared with a more traditional approach previously used: estimating volumes per route based on the **75th percentile (Q75)** of simulations, rather than a fixed **30% risk level**.

What is the difference?

— **Probabilistic approach** (30% risk)
Volumes allocated to higher routes ensure that soils remaining in lower routes have at most a 30% probability of exceeding thresholds.

— **Q75 approach**
A conservative value is used for each parameter, but without a direct and explicit link to a defined risk level.

What do the results show?

The maps are very similar: the main spatial patterns of disposal routes remain consistent, confirming the **model's robustness**.

However, the Q75 approach results in slightly higher volumes on the most restrictive routes because it is more conservative. This provides a useful sensitivity analysis.

BENEFITS FOR PROJECT OWNERS

The geostatistical approach offers a key advantage: it directly links estimated volumes to a clearly defined and controlled risk level.

Decision-making is therefore based on an explicit trade-off between safety level and budget impact.

Key benefits:

- Clear and quantified view of volumes per disposal route
- Better anticipation of treatment costs
- Reduced risk of budget overruns
- Informed decision-making based on probabilistic scenarios

By explicitly integrating uncertainty, the methodology helps secure the budget of a critical project phase.

A strategic decision-support tool

Beyond soil quality mapping, this approach demonstrates how geostatistics becomes a key lever for financial and operational management in large infrastructure projects.