

Multidisciplinary study to highlight interaction between anthropogenic disturbance and natural coastal sedimentary processes

Complementarity of geochemical and granulometric methods: proposal for a new spatial geostatistical approach

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Sedimentary sources studies

Classical methods

Spatial distribution of constituents one by one

To go further

- Multivariates analysis (PCA, CA...)
- Spatial analysis

Static approach

Sedimentary processes studies

Sediment trend
vectors

- Sediment Trend Analysis (STA) model
- Grain Size Trend Analysis (GSTA)

Dynamic approach

Objectives



Comparison

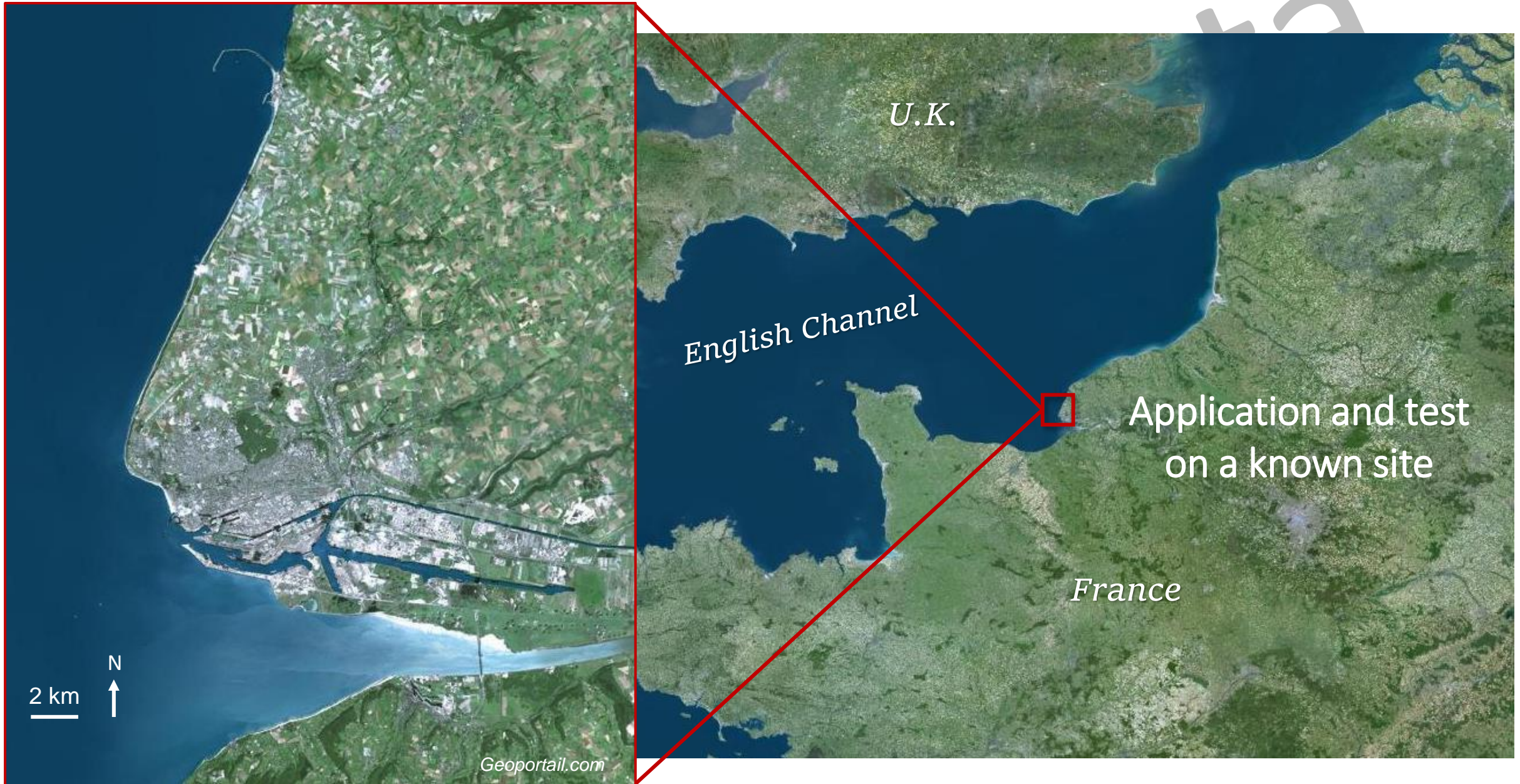


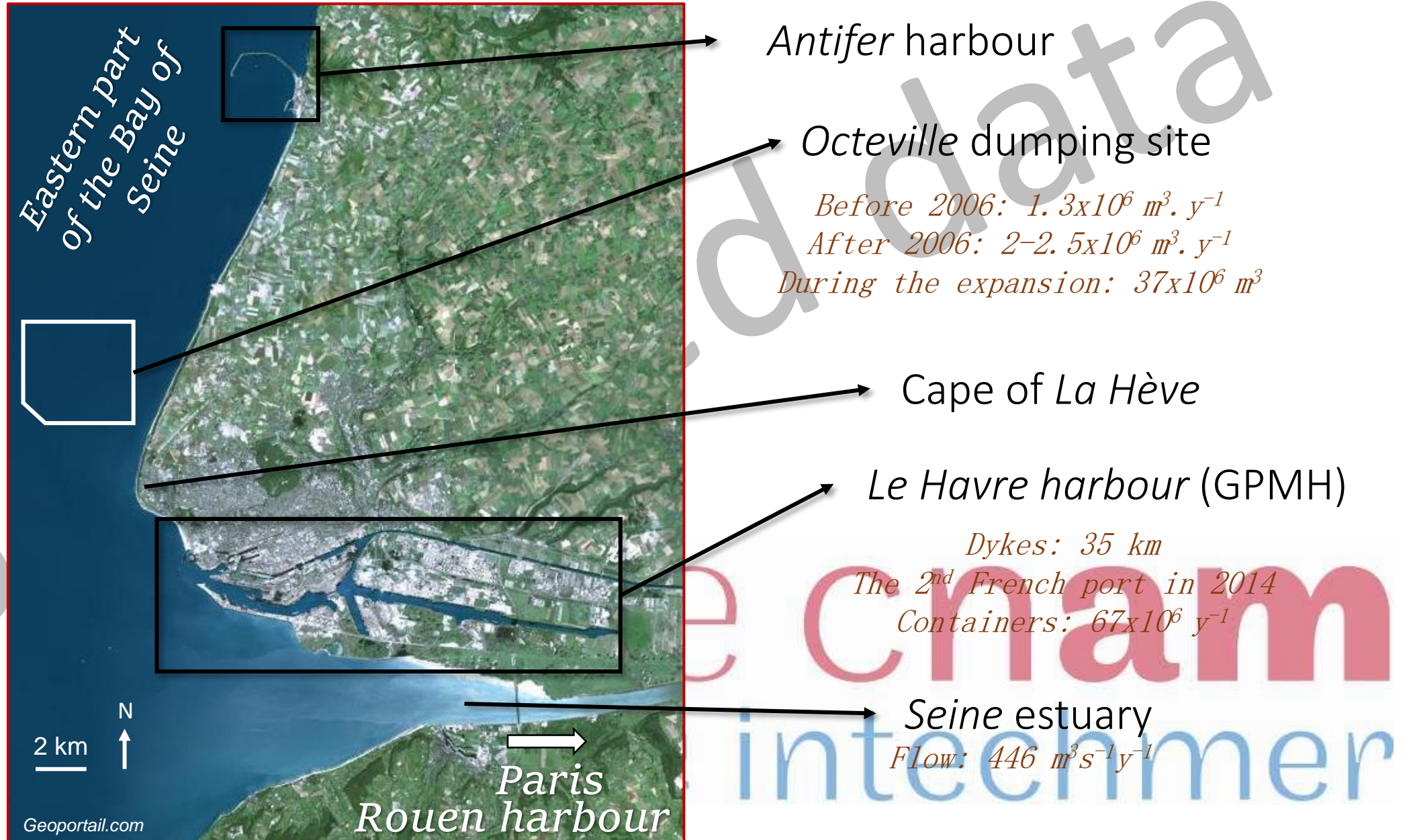
Coupling

Sources and sedimentary processes

New methods: « GSTA* » and « MSTA »
Gradient of concentrations

Robust dynamic approach



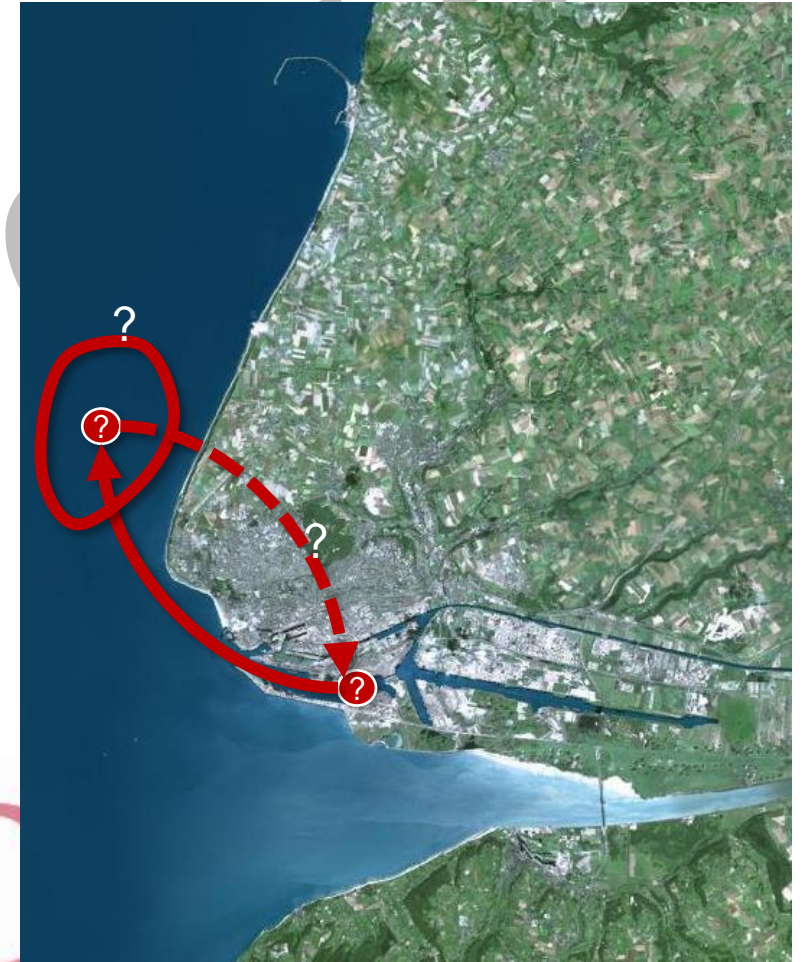


Is there a tracer of
harbour basins sediments?

Can we track harbour
sediments after
dumping activity?

Can we spatially delimit
the disturbed area?

Do the dumped
sediments go back to
harbour basins?

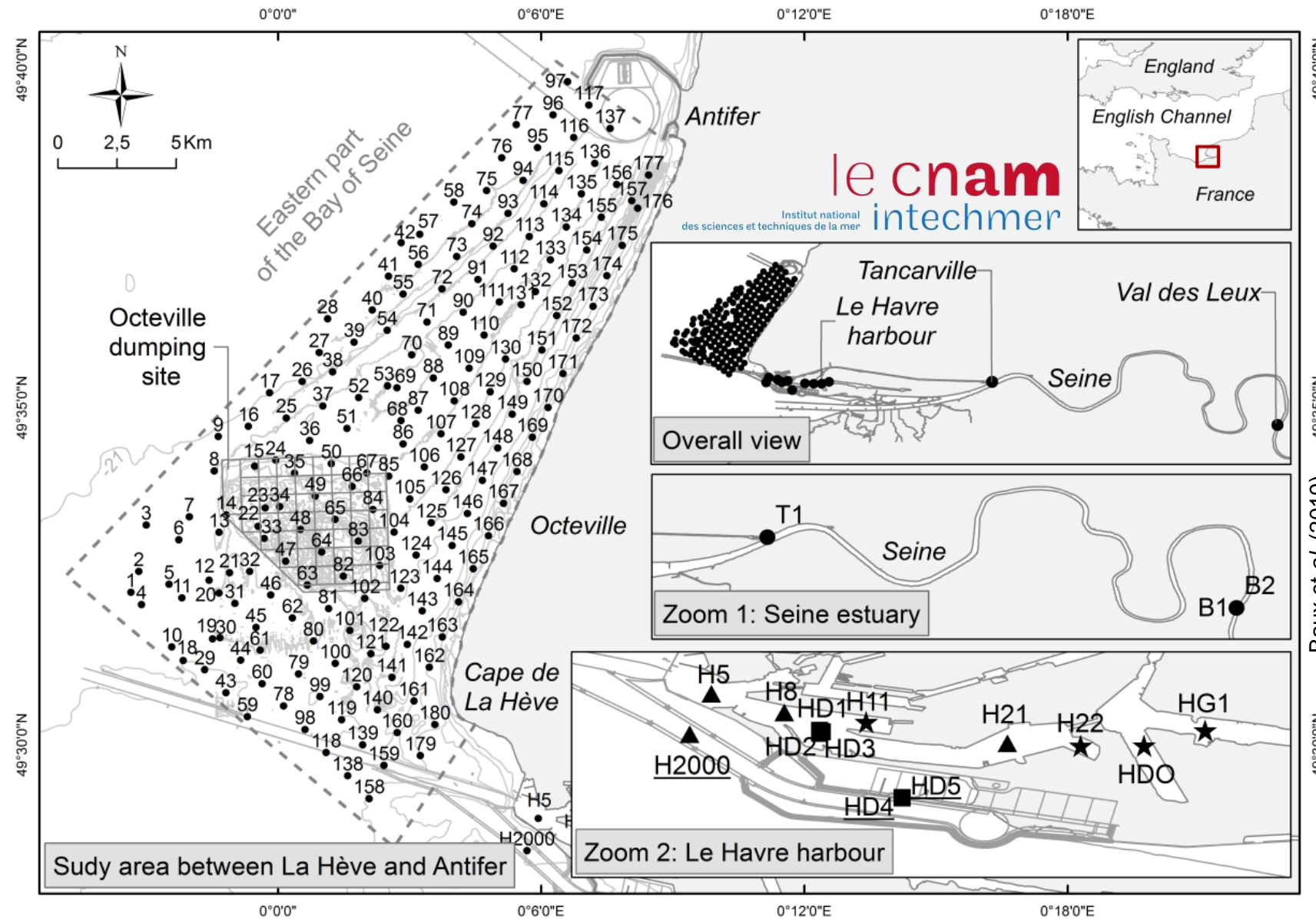


→ Using geochemical data to study sediment
sources and sedimentary processes



Sampling map

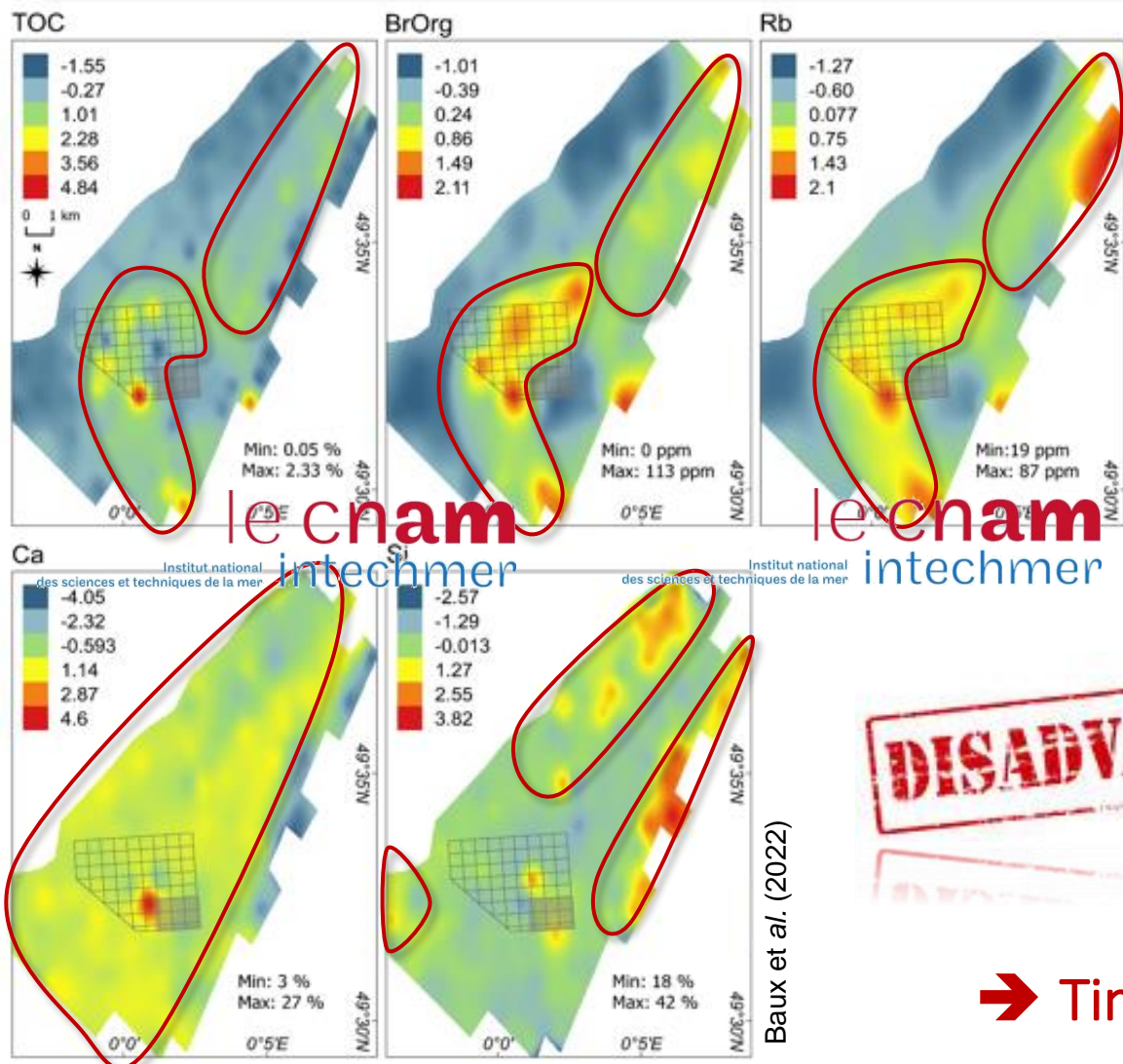
179 samples + 16
samples into harbour
bassins and Seine river



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XRF → 18 calibrated chemical element + infrared spectrometry for TOC analyses

Spatial distribution of each element concentration



→ TOC and BrOrg = tracers of Organic Matter (OM)

→ Rb = tracer of clay minerals

→ Ca = tracers of actual marine biologic sources, coarse sediments and fine carbonates (from Seine river)

→ Si = tracers of coarse detrital fraction

DISADVANTAGE

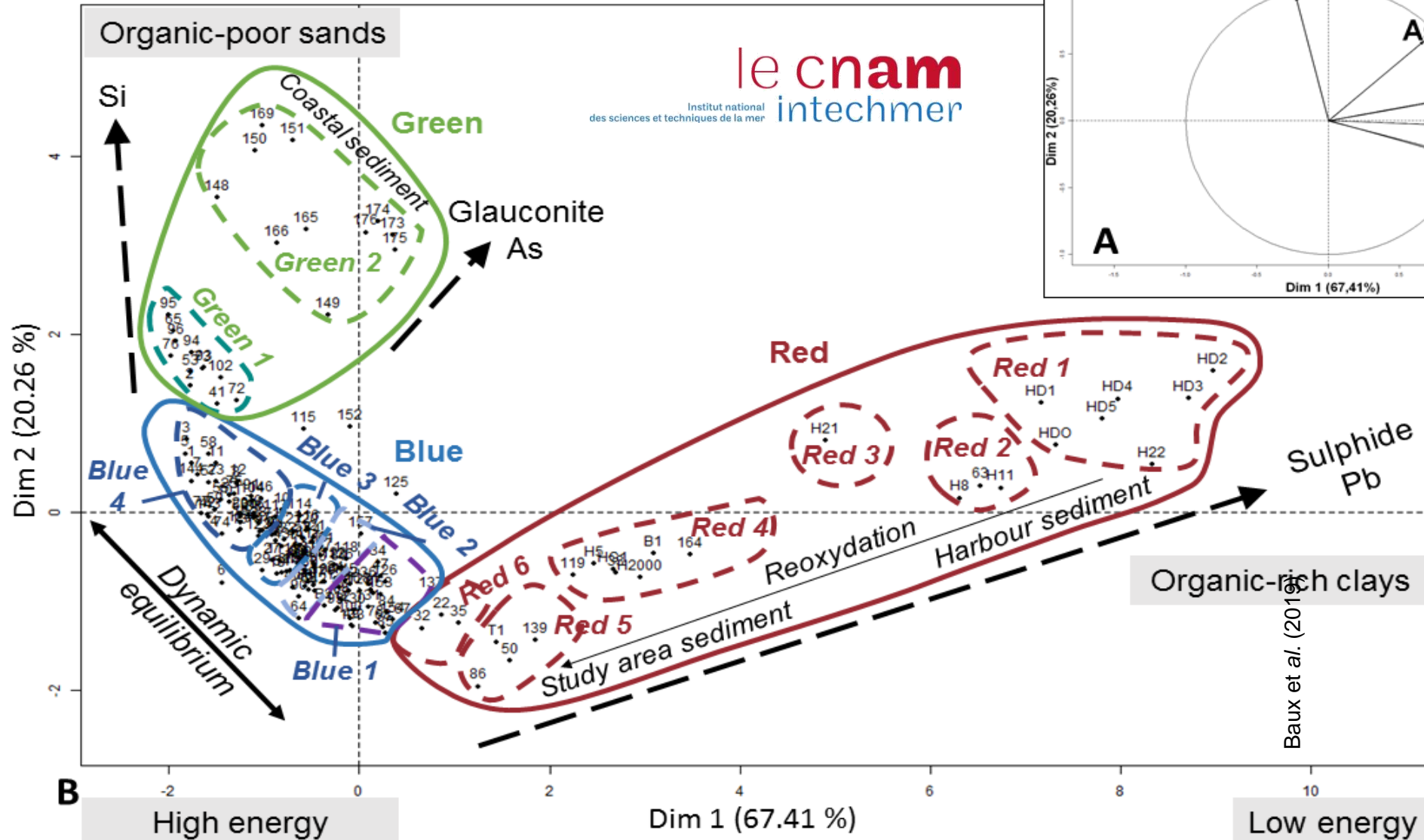
Large number of maps !

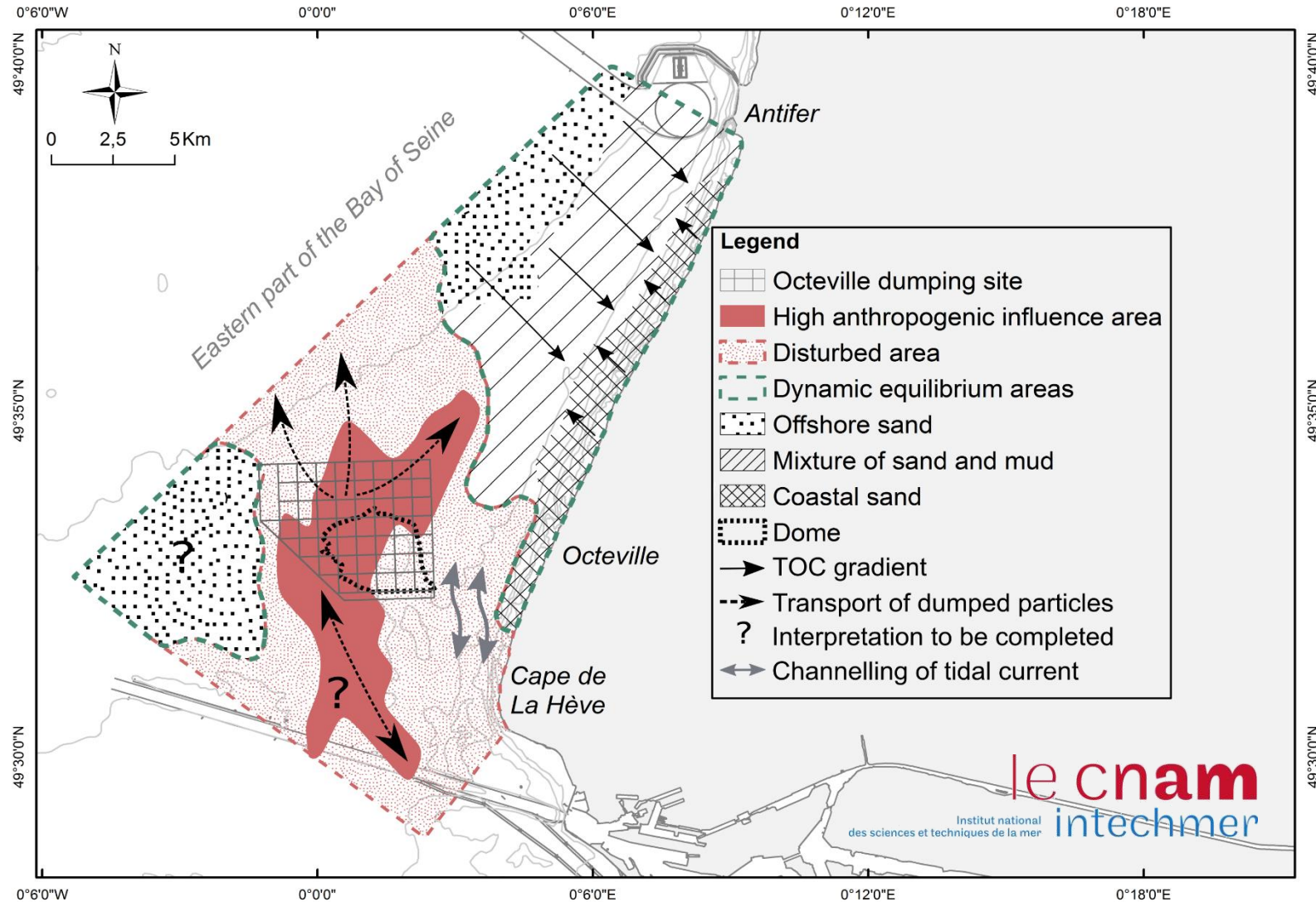
Ex.: Li *et al.* (2019) : 21 maps !

→ Time-consuming and complexe interpretation

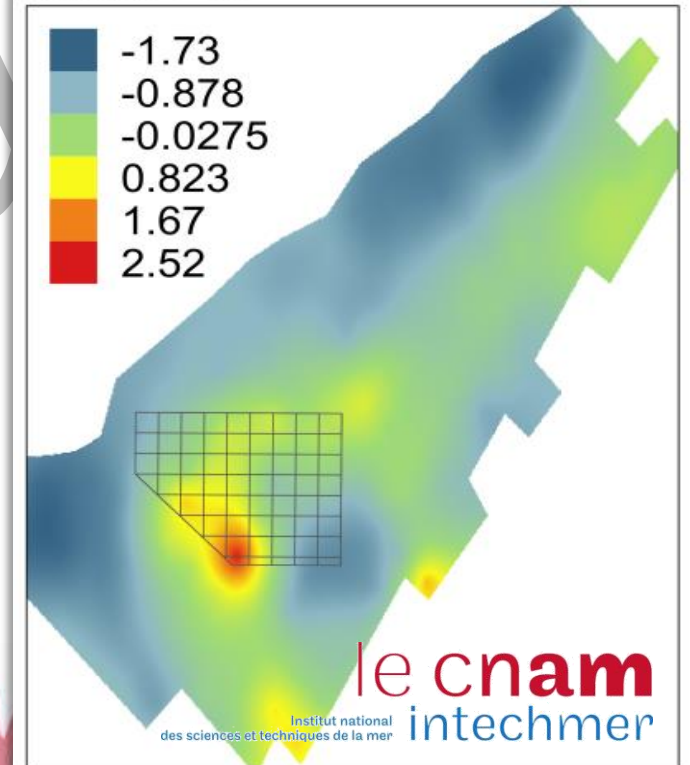
Multivariate analyses: PCA, CA, PMF, etc.

PCA





Axis 1-PCA



Baux et al. (2019)

→ PCA = Robust statistical analyses to select informative variables

→ 2 distinct areas

3 granulometric parameters

Mean, sorting and skewness

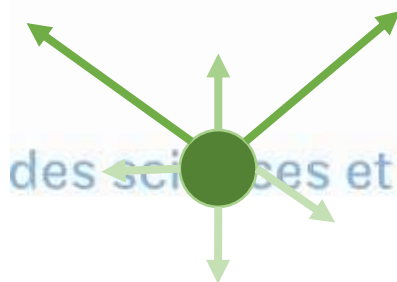
Semivariograms

GSTA = Grain Size Trend Analysis

McLaren (1981); Gao and Collins (1991)
Modified by Poizot *et al.* (2006, 2008)

Sedimentary trend vectors

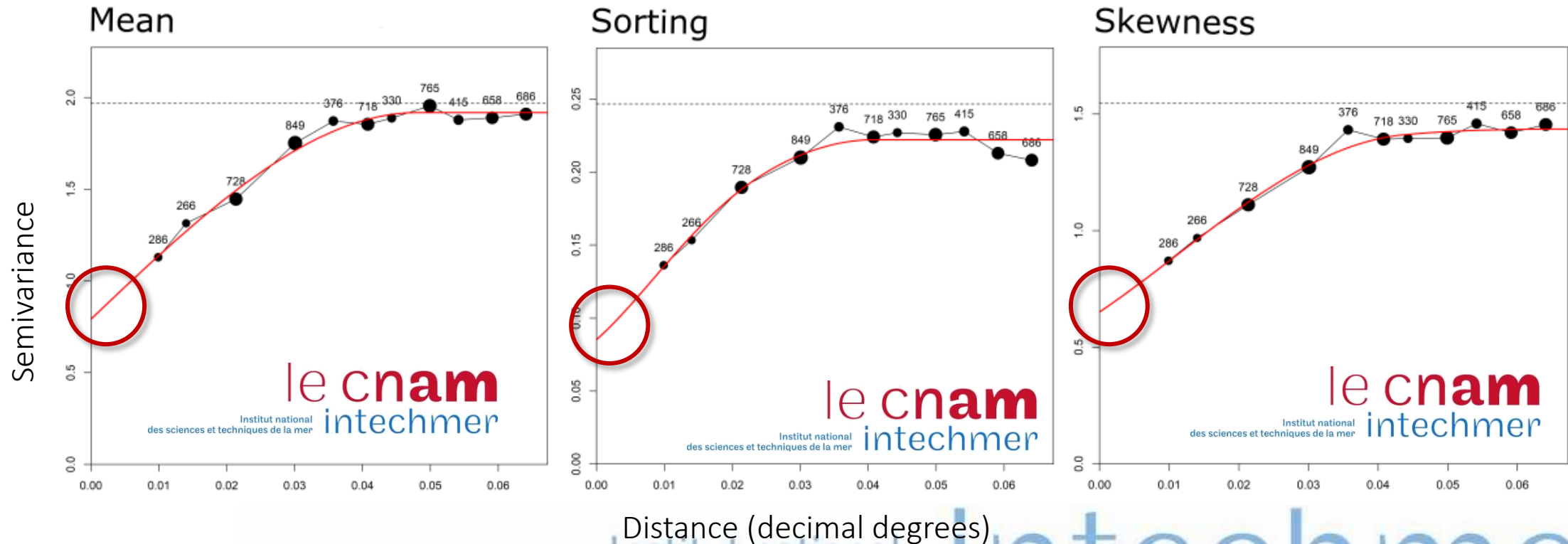
Based on the differences between spatial
distributions of the 3 granulometric
parameters (geostatistical analysis)



1st step: semivariogram analyses

Spatial structuration of variables

Variographic model



Baux et al. (2022)

→ High spatial variance due to the sum of all uncertainties

→ Coupling different methods for interpretation

Spatial distribution of each element concentration

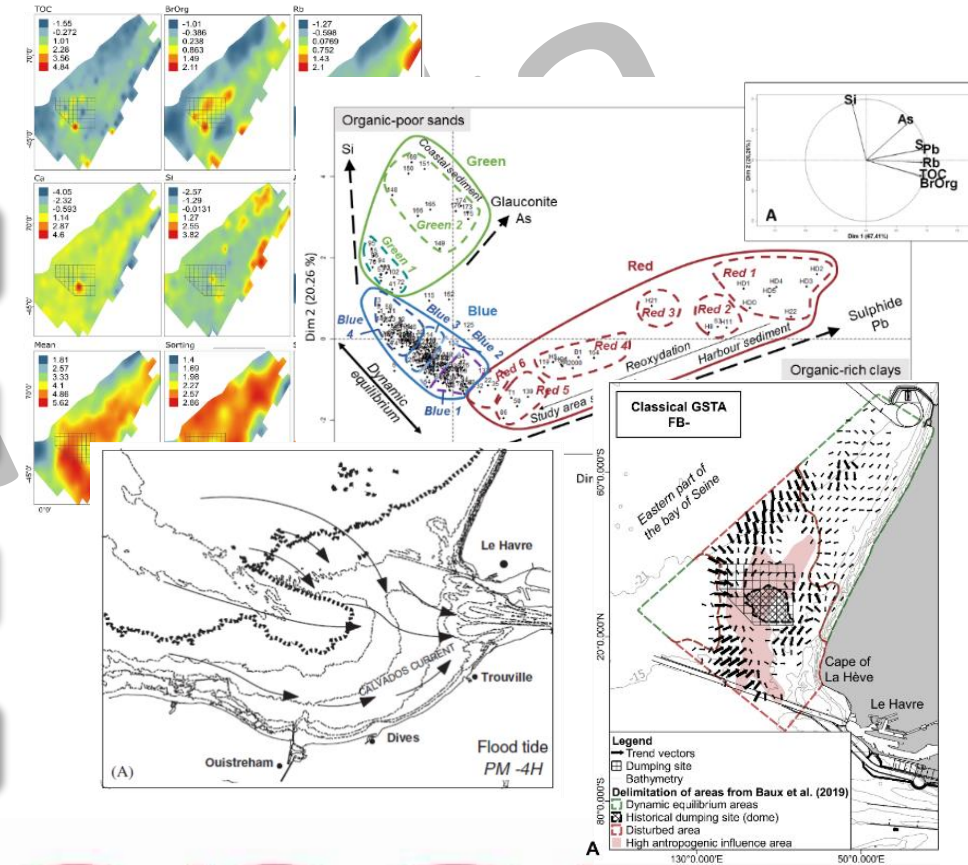
Multivariate analyses: PCA, CA, PMF, etc.

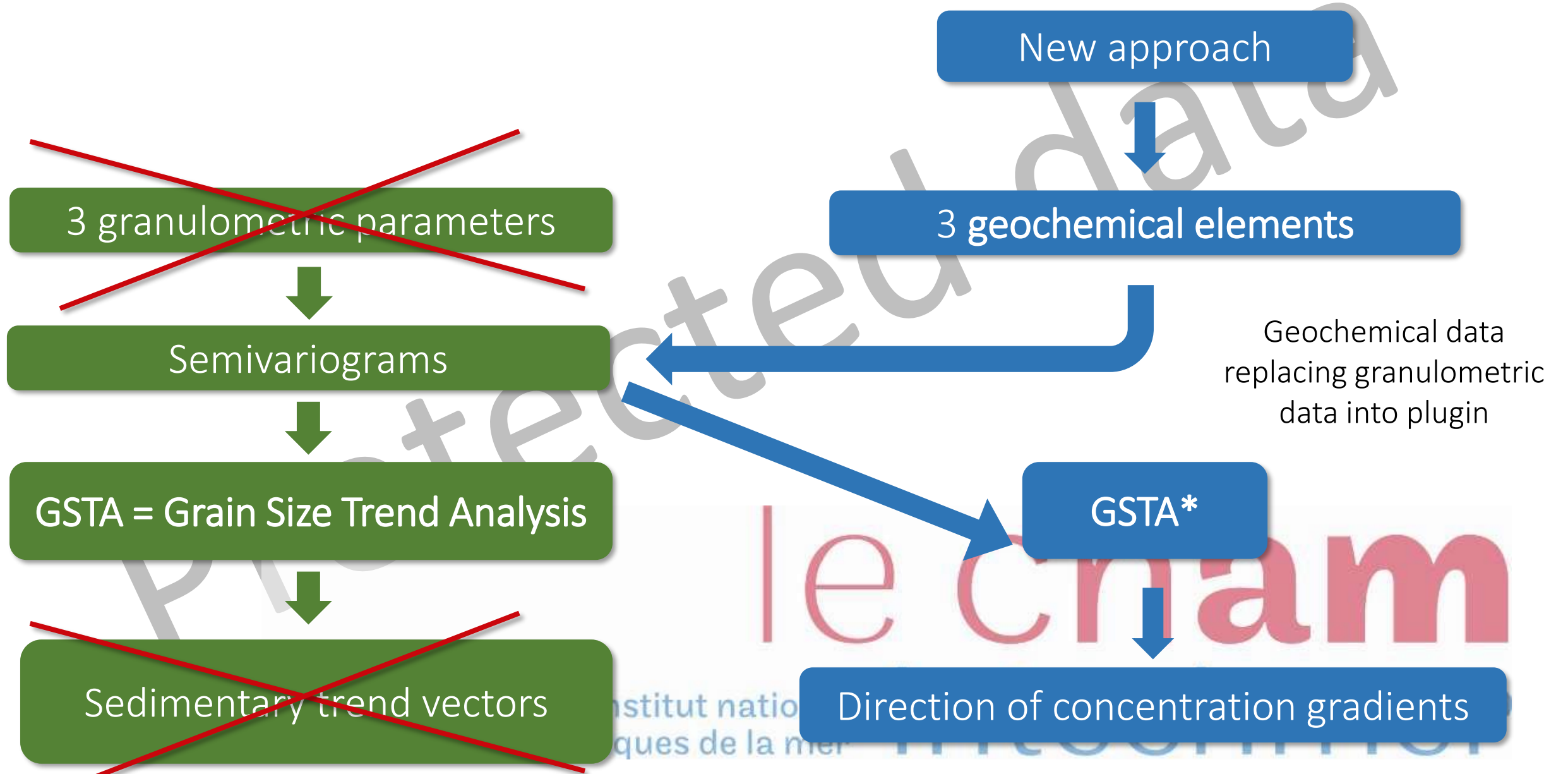
GSTA = Grain Size Trend Analysis

+ Flow directions

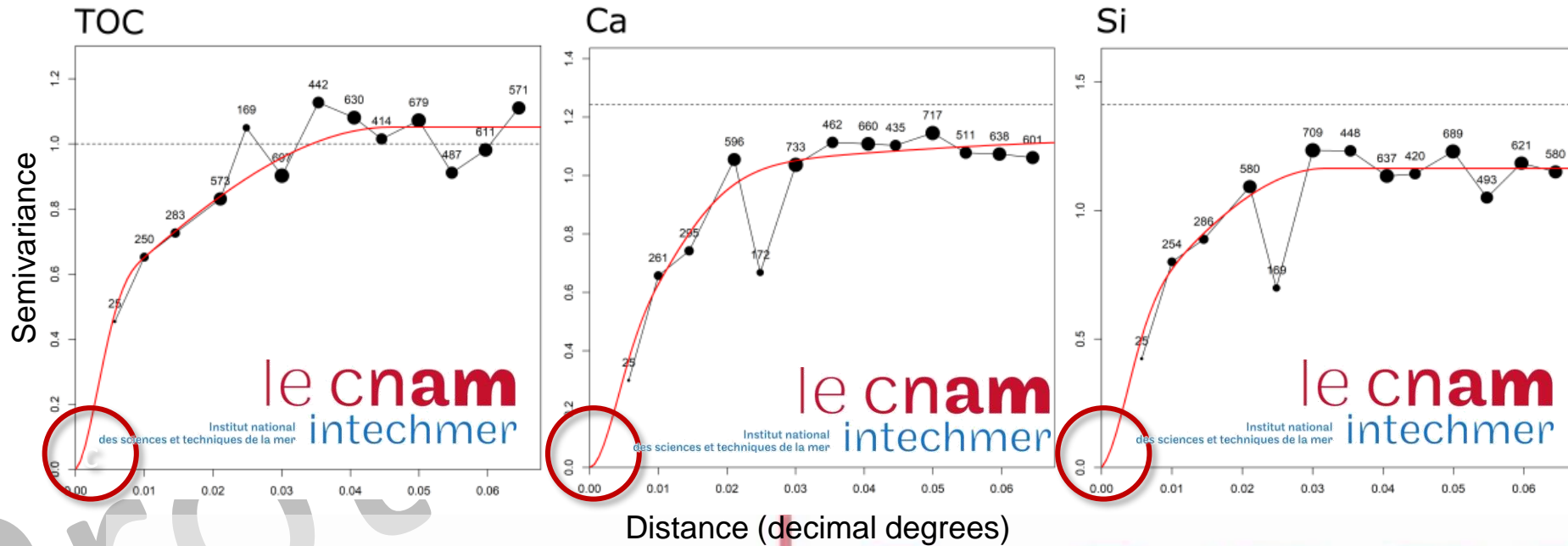
→ It constraints the authors to “manually” link the parameters together, making the interpretation more complex and relatively subjective

→ On our studied site → sedimentary processes not clearly highlighted with granulometric parameters





Semivariograms



→ Measurement errors are insignificant

→ better than the granulometric semi-variograms

→ The short-distance processes can be interpreted with high confidence level

GSTA* with 3 chemical elements



TOC: tracer of OM

Ca

actual marine biologic sources, coarse
sediments and fine carbonates

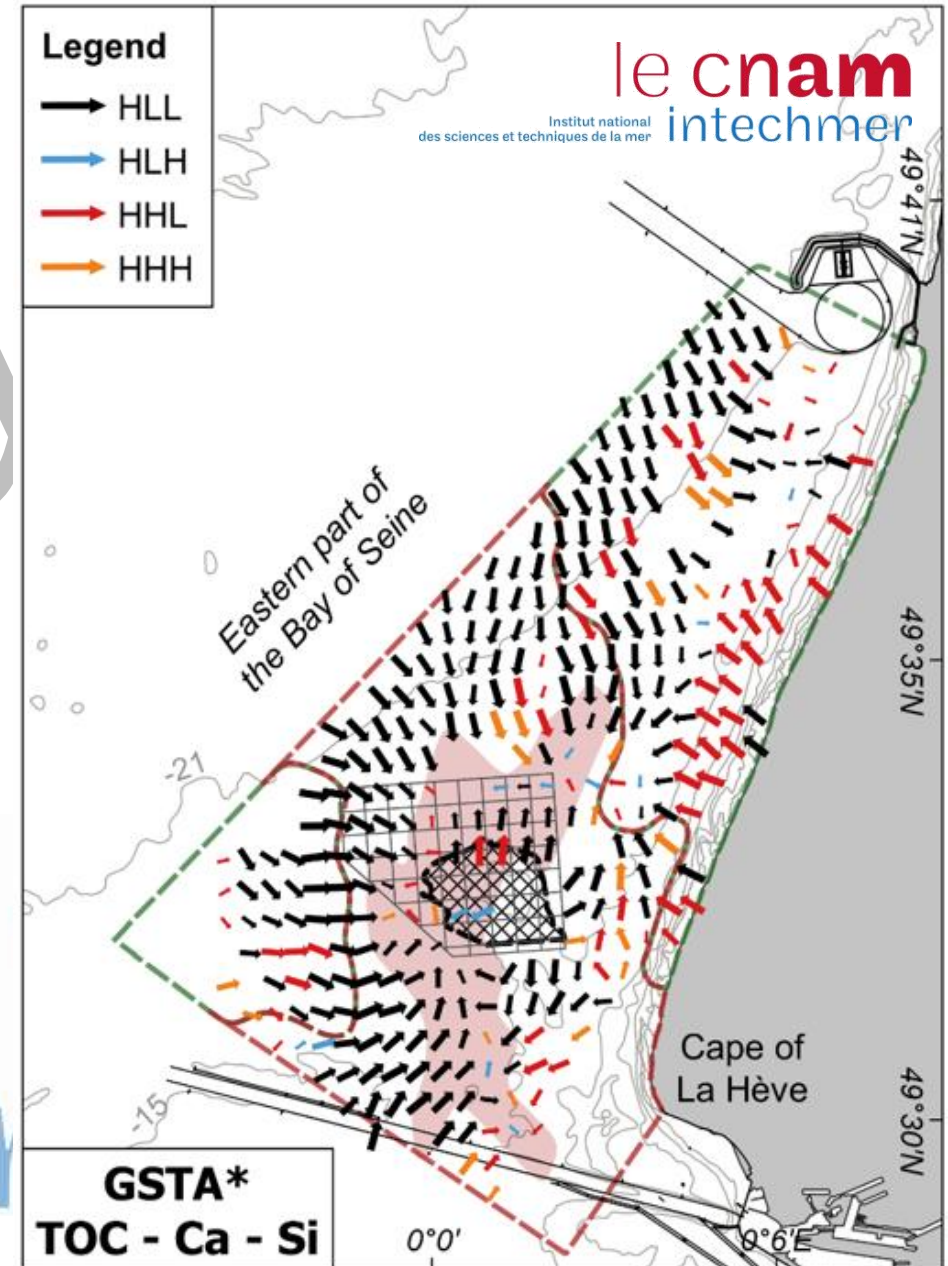
Si

coarse detrital fraction

4 defined cases

	Direction of concentration		
	TOC	Ca	Si
HHH	+	+	+
HHL	+	+	-
HLH	+	-	+
HLL	+	-	-

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HLL (229 vectors): gradient of refinement

HLH (13 vectors): can be considered negligible

HHL (74 vectors):

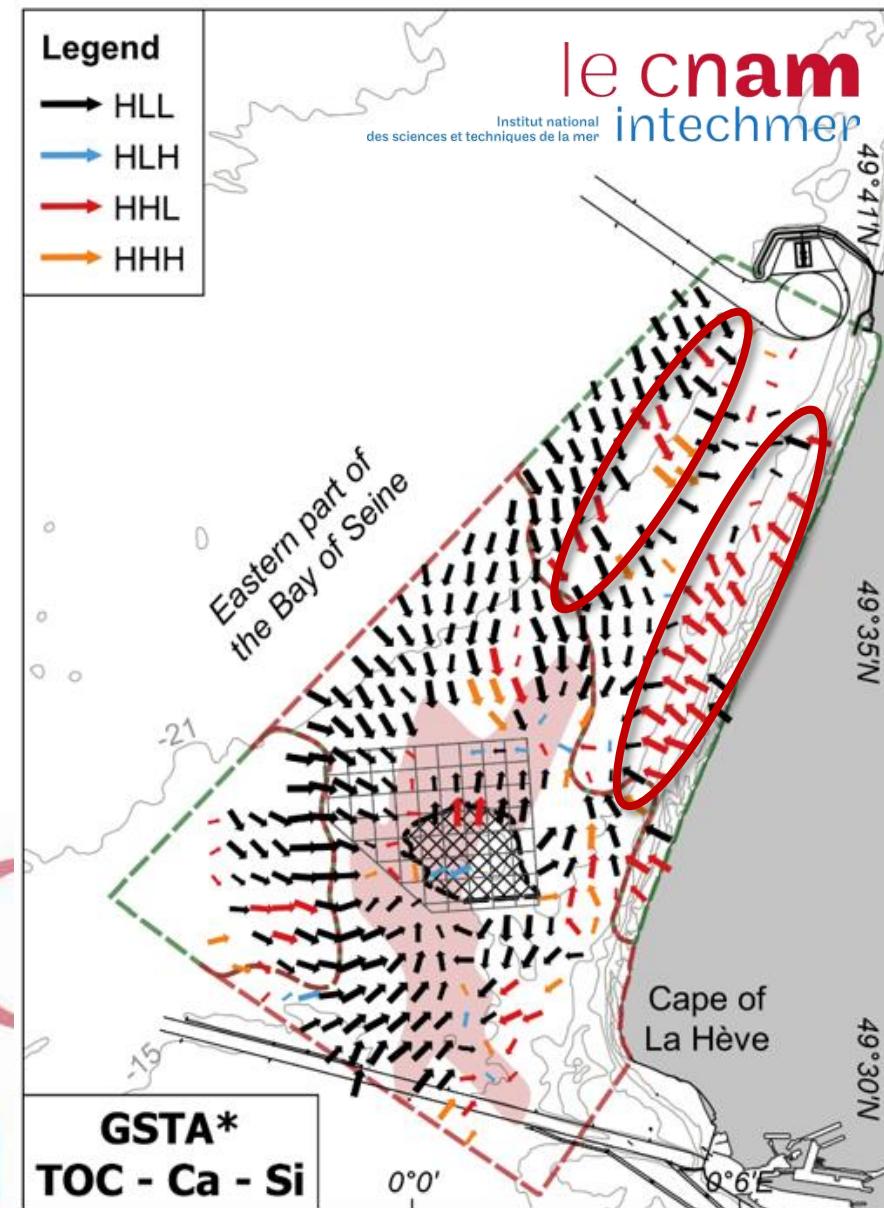
1) gradient from siliceous to carbonate sands

2) transition areas between terrigenous littoral sand and sediment rich-in OM

➔ information of particles sources (continental or marine)

HHH (26 vectors) = punctually high concentration values ➔ vector direction anomalies.

	Direction of concentration		
	TOC	Ca	Si
HHH	+	+	+
HHL	+	+	-
HLH	+	-	+
HLL	+	-	-



→ Successful to defined sources and sinks in a complex environment with GSTA*

→ Generalizing this new approach

le cnam
intechmer

→ Development in progress of the MSTA : Multi Sediment Trend Analysis

→ More than 3 variables : quantitative and qualitative variables

→ Combination between chemical and granulometric parameters in the same analyses

→ Implementation of intra-statistical tests to consider the quantitative aspect and precision of variables

→ Choice of variables most representative of the environment studied

MSTA

Ongoing creation of a new Qgis plugin : « Multi Sediment Trend analysis »

Classical methods

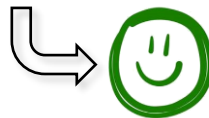
- Study of constituents one by one



Static approaches

GSTA

- Granulometric parameters



Dynamic approach



Difficult to applied in complex environment

MSTA

- Choice of type and numbers of variables



Dynamic approach



Geochemical data = very discriminants



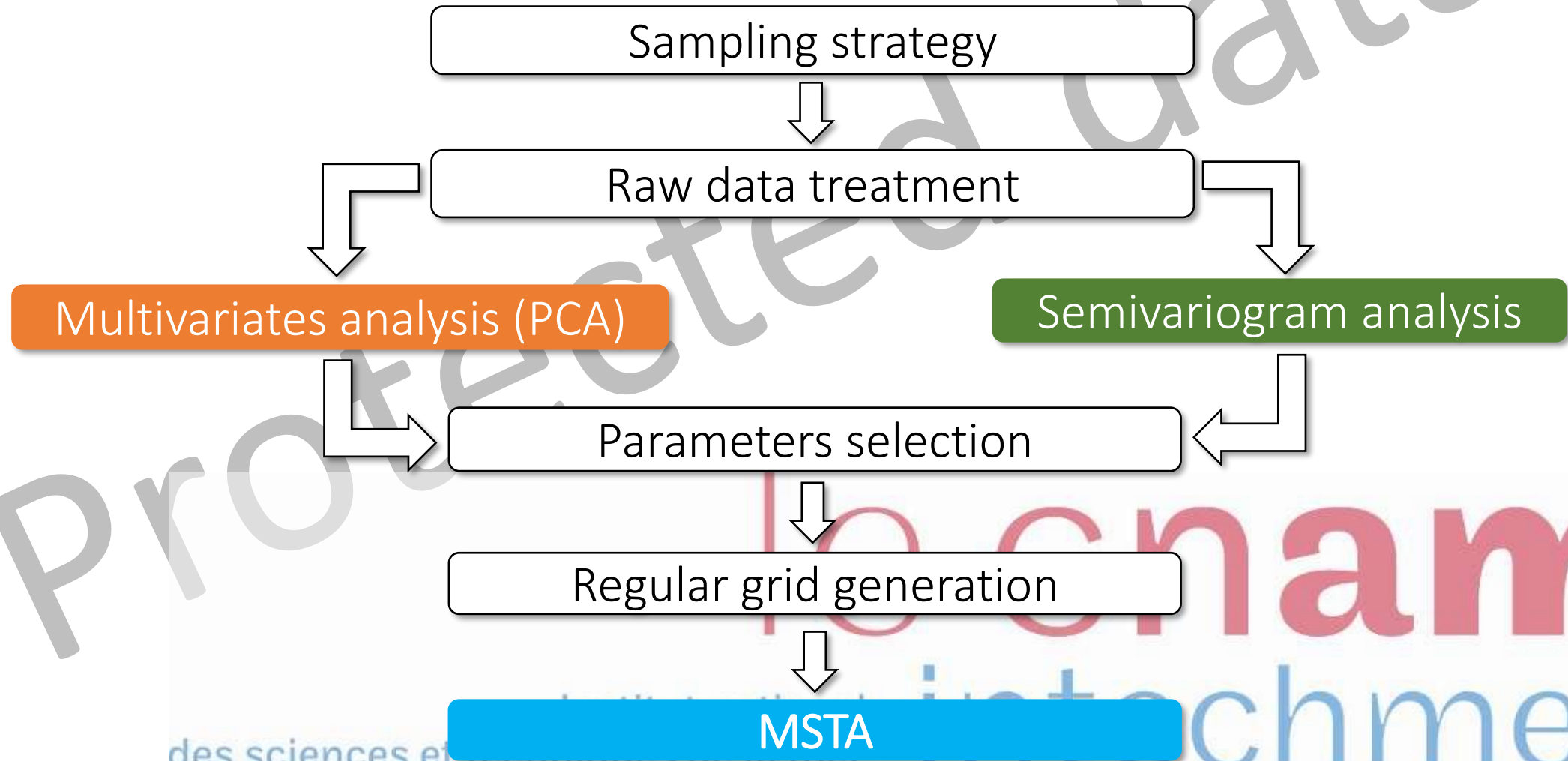
Better integration of variability at fine distance



Fine scale description of the processes



Proposed workflow :



ありがとう

Thank you!

Poizot, E., Murat, A., Baux, N., Frigola, C., Gregoire, G., Méar, Y. (2023)
MSTA : a new framework for sediment transport analysis. *SSRN*.

Baux N., Murat A., Poizot E., Méar Y., Lesourd S., Gregoire G., Dauvin J.C. (2022)
An innovative Geostatistical Sediment Trend Analysis using geochemical data to highlight sediment sources and transport.
Computational Geosciences. 26. 263–278.

Baux N., Murat A., Faivre Q., Lesourd S., Poizot E., Méar Y., Brasselet S., Dauvin J.C. (2019)
Sediment dynamic equilibrium, a key for assessing a coastal anthropogenic disturbance using geochemical tracers: Application to the eastern part of the Bay of Seine. *Continental Shelf Research*. 175. 87-98

