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Acoustic remote sensing monitoring of morphological and sedimentological seabed evolution of small and medium-scale French estuaries

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Introduction

Recent advances in seabed habitat mapping showed that **morphology** and **seabed nature** are **fundamental parameters** (Blanchet et al., 2014), affecting **benthic habitat repartition** and **development**.

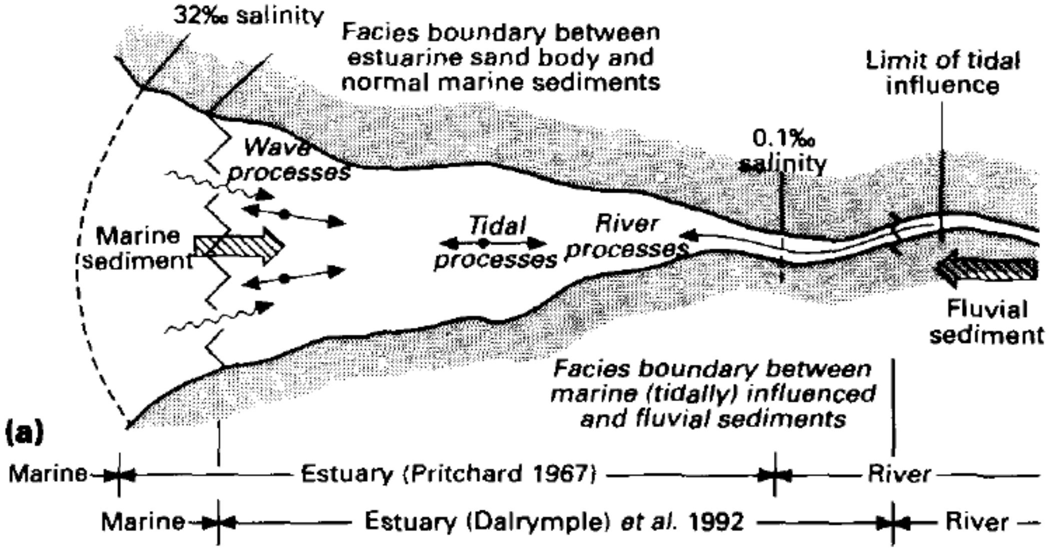
During the last decades, many studies have shown the potential of acoustic mapping methods (e.g. Brown et al., 2005) and capture innovative mapping tools and techniques (e.g. Diesing et al., 2014).

However, most of the studies cover the marine and coastal domains…

What about estuaries?

Estuaries = transitional domains

- **Complex combinations** of sedimentological, hydrodynamical and biological processes between subtidal and intertidal domains
- **Highly variables** sediment facies with **complex** sediment fraction **mixing**



Pritchard, 1967; Dalrymple et al., 1992

Then, can we apply the same mapping techniques in estuaries?

AUPASED project

Aims to test practicality of automated determination of sediment classes in subtidal estuarine environment with seabed acoustic mapping methods

General methodology

Manually produce morpho-sedimentological maps and then build training datasets for supervised classifications. In order to build training datasets, we explore the efficiency of cartographic variables to map morphologies and sediment facies.

Display content

- **Seabed acoustic mapping methods and ground truth data acquisitions**
- **Geomorphological characterisation of estuaries: example of the Belon estuary (South Britany, France)**
- **Seafloor backscatter interpretation and sedimentological maps**
- **Synthesis**

Seabed acoustic mapping methods and ground truth data acquisitions

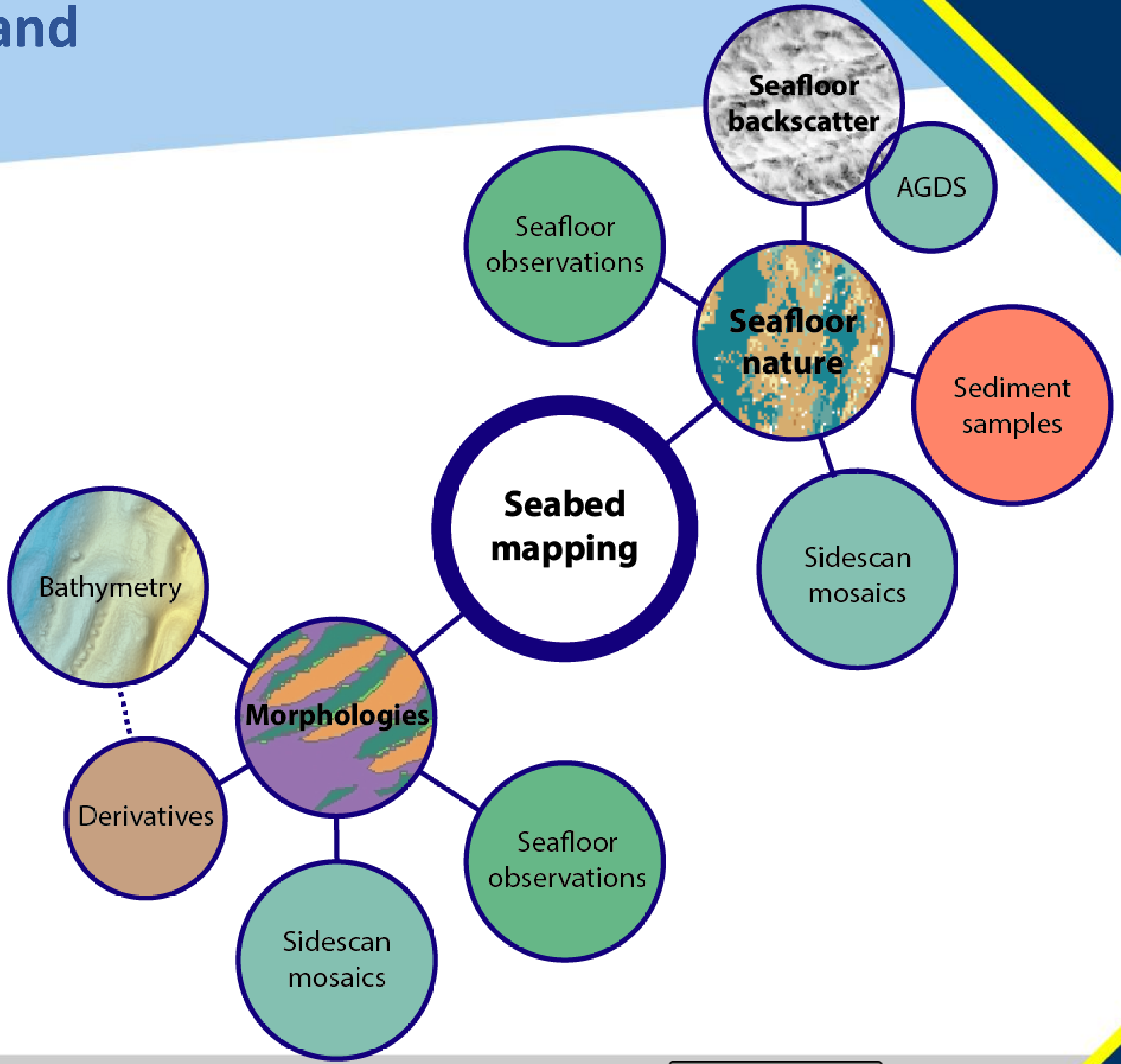
Data acquired;

Acoustic data:

- Interferometric sonar, Geoswath Geoacoustics, 250 kHz
- Monobeam Kongsberg ER60, 120 kHz, coupled with a RoxAnn system (AGDS)
- Side-scan sonar, CMAX-CM2, 325 kHz

Ground truth data:

- Van Veen and Shipek grab samples
- Seafloor videos with a weighted GoPro



Seabed acoustic mapping methods

Mapping methodology,

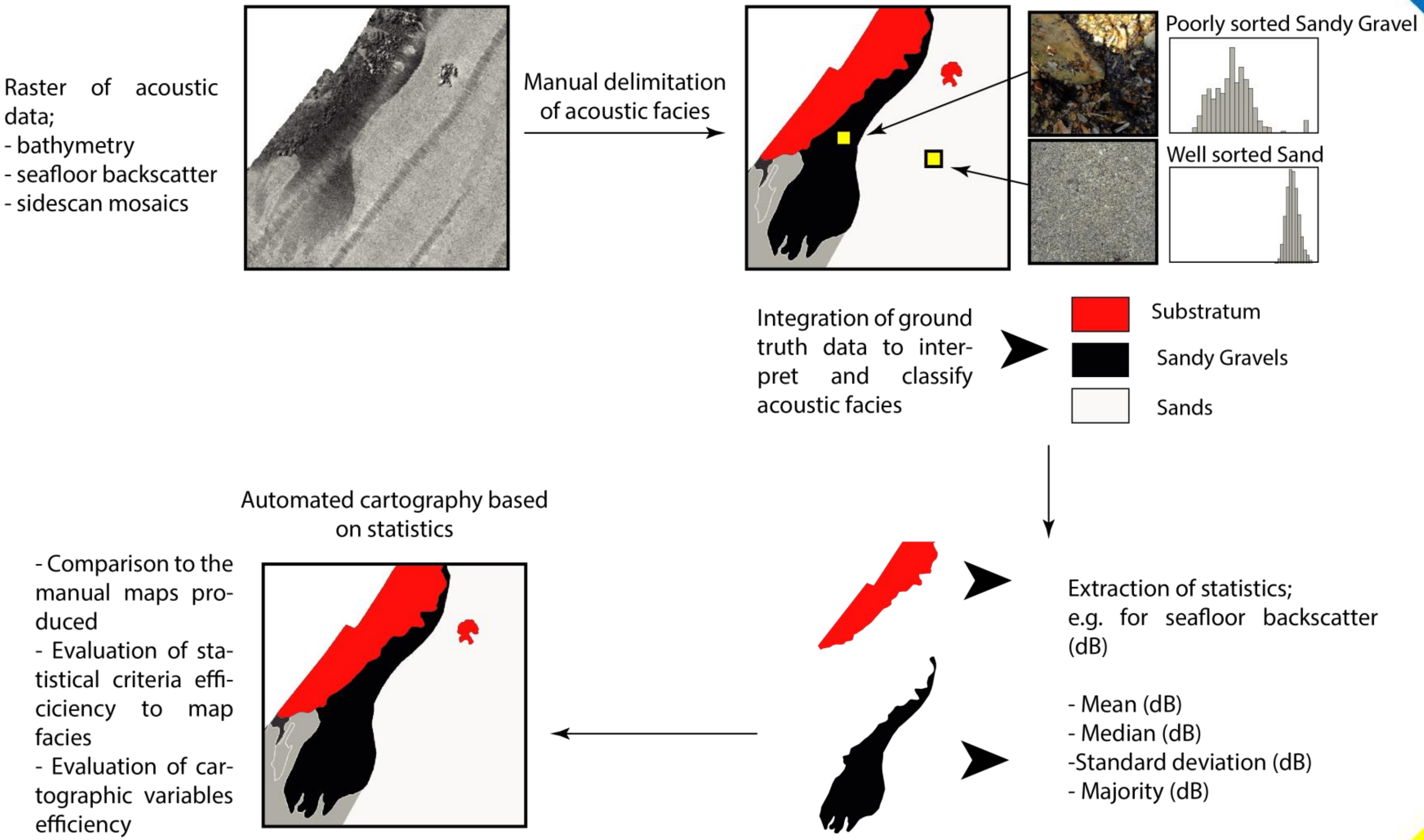
This methodology has been applied to map both seabed morphologies and seabed nature.

Raster data for morphologies:

- Bathymetry
- Derived variables (slope, curvature, ruggedness)
- Specific variables (e.g. Bathymetric Position Index)

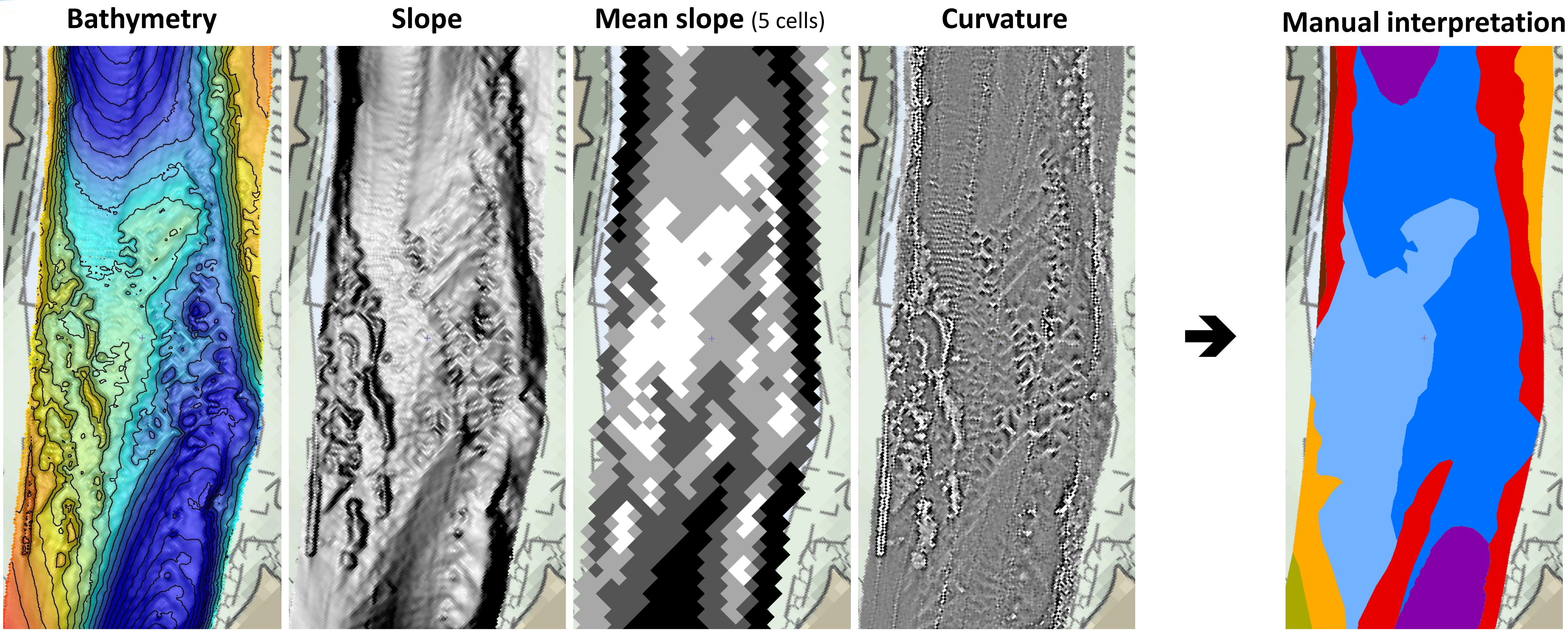
Raster data for seabed nature:

- Seafloor backscatter
- Side-scan sonar mosaics



Geomorphological characterisation of estuaries: seabed morphologies

Seabed morphologies have been manually map by using the following cartographic variables.



Geomorphological characterisation of estuaries: **seabed morphologies**

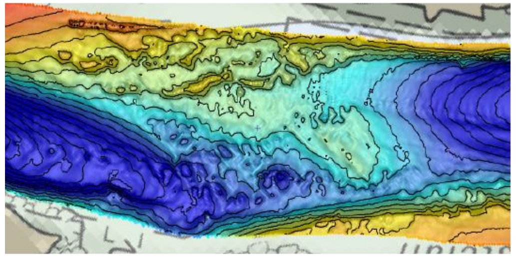
Cartographic variables classification has been explored to produce a geomorphological map.

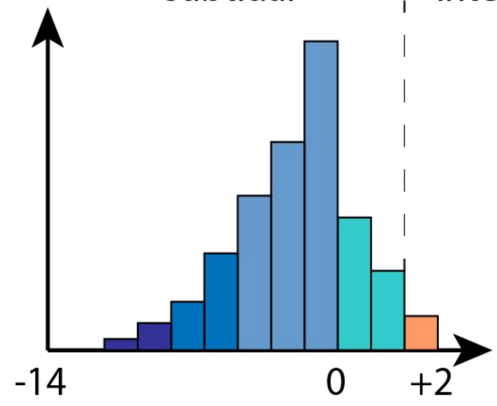
The classification of the bathymetric and slope data is a straightforward process. The results are:

- The differentiation of morphologies related to tidal zones.
- Differentiation of flat areas and complex areas with variables slope angles.

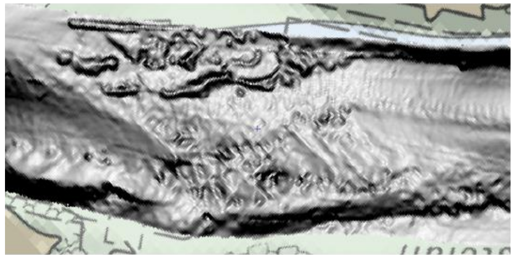
A more detailed automatic classification of the estuarine morphologies relies on more specific criteria associated to others cartographic variables (e.g. curvature, ruggedness). However, several estuarine morphologies share common characteristics.

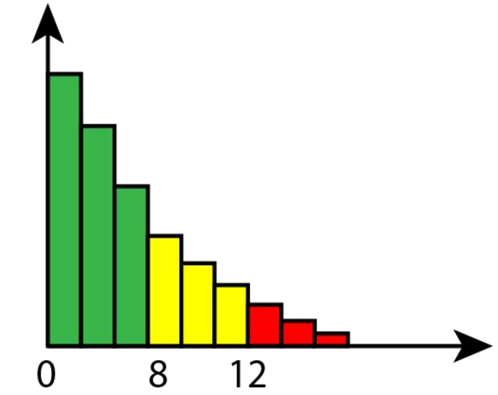
Bathymetry





Slope





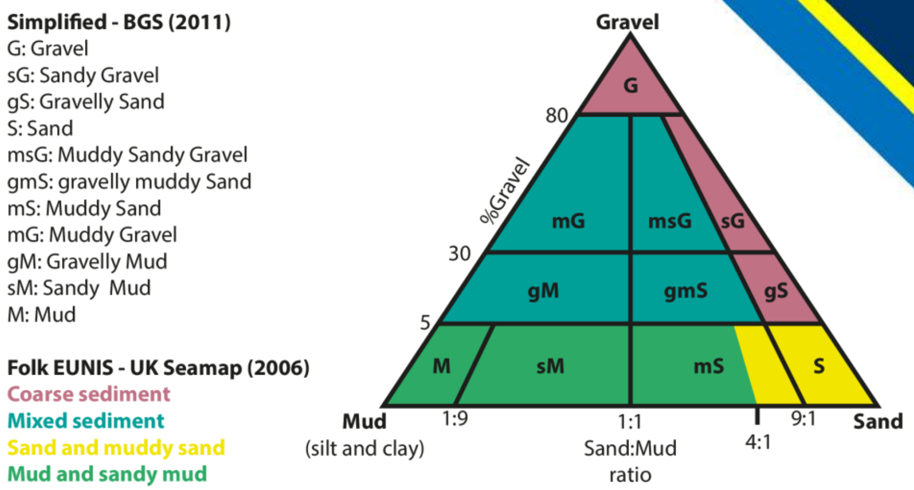
Currently, the classification of data is a useful tool to help the manual interpretation and then implement a semi-automated classification. However a fully automated classification of estuarine morphologies requires more criteria. Presently we are exploring several criteria based on shape characterization (e.g. area, complexity) and neighborhood relationship.

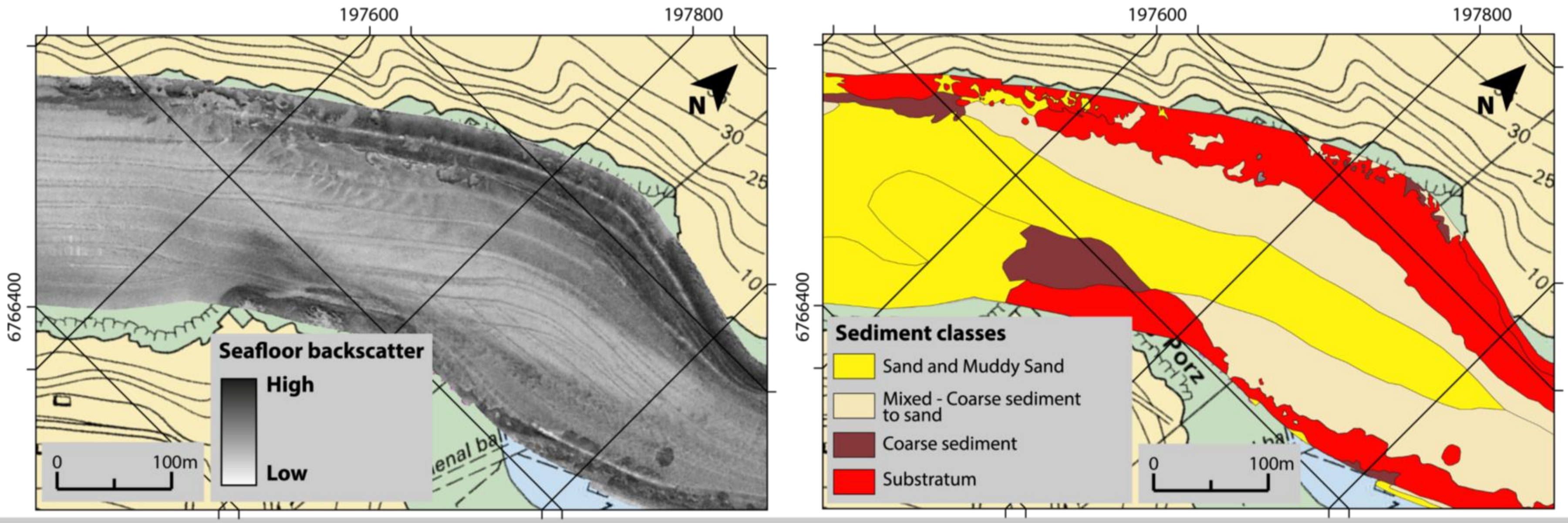
Seafloor backscatter interpretation and sedimentological maps

Seabed nature has been defined by manually mapping acoustic facies and by using ground truth information.

The sediment classification used to classify seafloor backscatter facies is the Folk classification adapted by the EUNIS program (Long, 2006; Dolan et al., 2011).

Because of sediment variations complexity and seafloor backscatter values spatial evolution, we have choose to use the Folk EUNIS more general classes to minimize classification uncertainties.



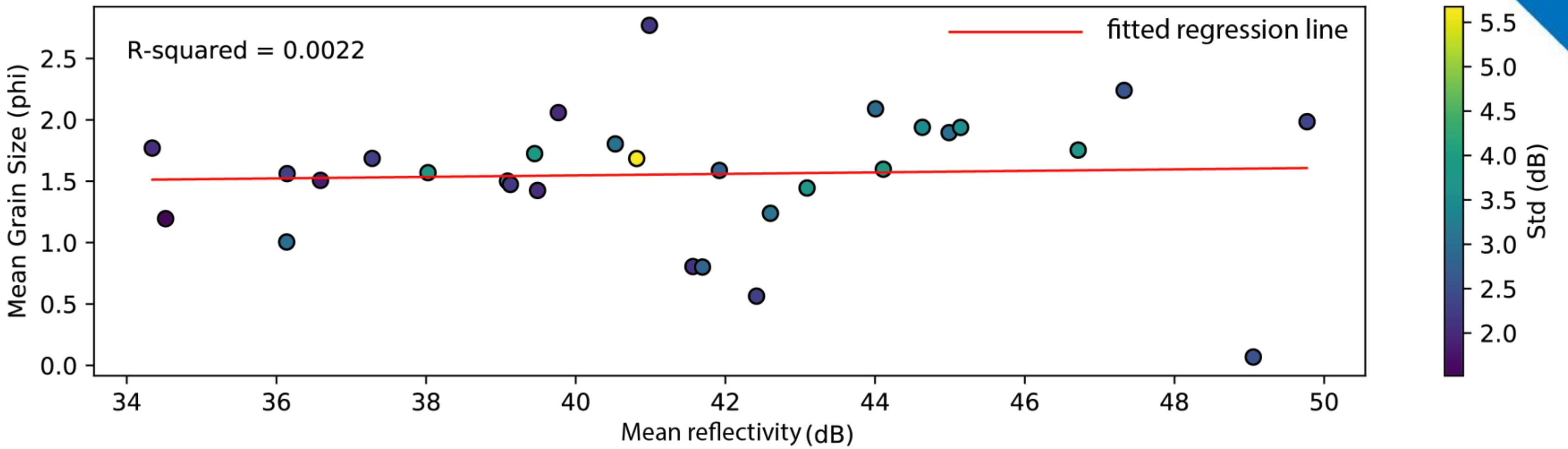


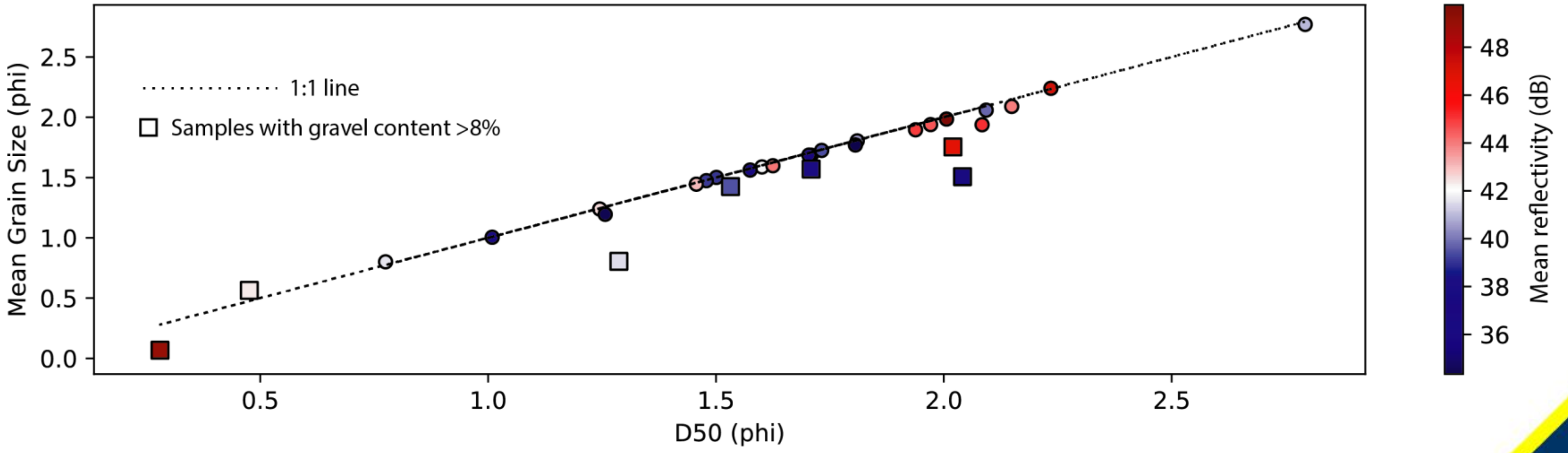
Seafloor backscatter interpretation and sedimentological maps

Without clear relations between seafloor backscatter and information from ground truth data, it is difficult to predict seabed nature more precisely.

- Manual interpretation has showed that there are identical acoustic responses for different sediment types and vice versa.
- Theorical relations between seafloor backscatter values and granulometric information are not verified in the studied estuaries.

Currently, we are exploring multivariate statistics analyses to look after relationships between seafloor backscatter statistics and one or several granulometric parameters.

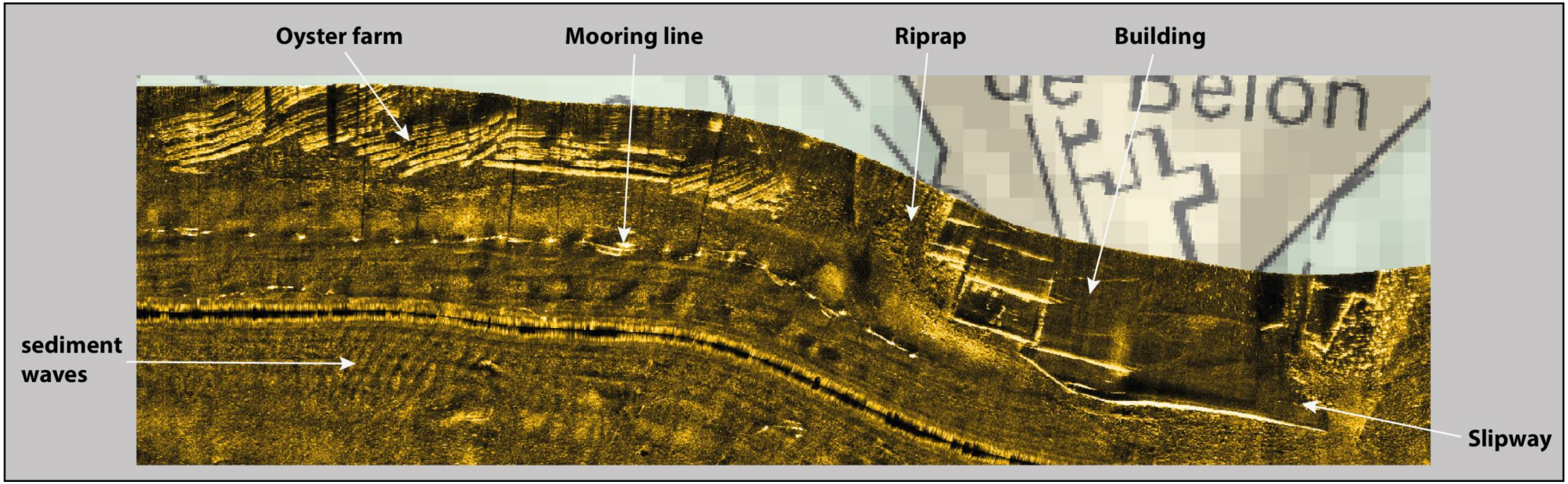




Particular attention to: side-scan sonar mosaics

In our study, side-scan mosaics have been used to manually map hydrodynamic structures and anthropic features.

Because of the predominant influence of seabed morphologies in side-scan sonar acoustic response, and highly variable morphologies within the estuaries, these data could not have been used to map sediment facies.



Currently, within estuaries, side-scan sonar is a powerful tool to map specific features, but hardly exploitable in sediment facies mapping and in automated mapping because of incidence angles (shading/illumination of seabed features).

Synthesis

Estuarine system are complex in terms of morphologies and sediment facies mixing and spatial variability.

Main conclusions

- **Theorical relations** between seafloor acoustic backscatter and granulometric parameters are **not verified within estuaries.**
- The **definition of a training set** representative of estuarine system complexity (both geomorphology and sediment facies) requires a **complex mixing of criteria.**
- Presently, **manual mapping**, with classification of few variables produce the **most detailed map.**

Perspectives

Currently, we are exploring:

- The **efficiency of cartographic variable** to represent all the estuarine morphologies.
- **Complex relations** between seafloor backscatter and multiple variables (granulometry, apparent ruggedness, etc.).
- The generation of **less detailed training set** to produce morpho-sedimentological maps by using **supervised classifications**.

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References

Blanchet, H., Gouillieux, B., Alizier, S., Amouroux, J.M., Bachelet, G., Barillé, A.L., Dauvin, J.C., de Montaudouin, X., Derolez, V., Desroy, N., Grall, J., Grémare, A., Hacquebart, P., Jourde, J.Ô., Labrune, C., Lavesque, N., Meirland, A., Nebout, T., Olivier, F., Pelaprat, C., Ruellet, T., Sauriau, P.G., Thorin, S., 2014. Multiscale patterns in the diversity and organization of benthic intertidal fauna among French Atlantic estuaries. J. Sea Res. https://doi.org/10.1016/j.seares.2014.02.014

Brown, C.J., Mitchell, A., Limpenny, D.S., Robertson, M.R., Service, M., Golding, N., 2005. Mapping seabed habitats in the Firth of Lorn off the west coast of Scotland: Evaluation and comparison of habitat maps produced using the acoustic ground-discrimination system, RoxAnn, and sidescan sonar. ICES J. Mar. Sci. https://doi.org/10.1016/j.icesjms.2004.10.008

Diesing, M., Green, S.L., Stephens, D., Dove, D., Lark, R.M., Stewart, H.A., 2014. Mapping seabed sediments: Comparison of manual, geostatistical, object-based image analysis and machine learning approaches. Cont. Shelf Res. 84, 107–119. https://doi.org/10.1016/j.csr.2014.05.004

Dolan, M., Thorsnes, T., Leth, J., Guinan, J.C., Alhamdani, Z., Van Lancker, V., 2011. Deliverable 10.5: Standards for seabed habitat mapping (Part B: Terrain), Geo-Seas.

Long, D., 2006. Seabed sediment classification, MESH Project Document.

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