Seasonal sediment dynamics of the Marennes Oléron Bay: Characterisation of superficial sediment textural properties and rheophysic.

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Introduction

Marennes Oléron Bay is a semi-enclosed bay (150 km²) (fig. 1), with large intertidal mud and sandy-mud flats (60 %) (Sauriau *et al.*, 1989). The shellfish intertidal culture area represents approximately 32 km². The Marennes Oléron Bay is the first oyster farming area in Europe with an annual production of 40 000 tons (Goulletquer and Le Moine, 2002). This activity highly affects the sedimentary dynamics of the bay, locally inducing silting (Ottman et Sornin, 1982). Due to the re-organization of the shellfish zones over the past decades, previous sedimentary data became inadequate (Pouliquen, 1975 ; Gouleau, 1975 ; Hily, 1977). Furthermore, the mechanical behaviour of superficial sediments was not determined in previous studies, so it remains an important issue for the validation of numerical model on the sedimentary cohesive transport. Sediment transport depends on water velocity, texture and structure of the sediment. In the present study, the mechanical behaviour of the superficial sediment (thickness of the layer: 2 cm) was examined for two seasons (summer 2006 and winter 2007) (Fig. 1) from particle size distribution and rheological measurements in coastal environment (Fig. 2).

Figure 1 : Sediment samples sites (Summer 2006 and winter 2007)

Aims :

- Development of adapted rheological protocol for the sandy-muddy sediments.
- Use of the mechanical behaviour of the sediments to identify their facies.
- Creation of seasonal maps of superficial sediments.

Materials and methods :

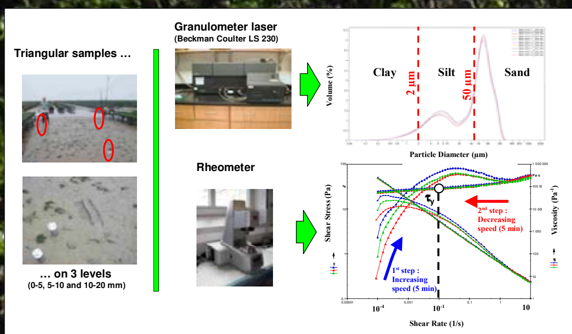

Figure 2 : Methods of analyses of the surface sediments

The flow curves (shear stress versus strain rate) of muddy sediments show a viscoplastic behaviour with an yield stress.

We define the deformation yield stress τ_y , the stress value at strain rate value equal to 0,1.s^{-1} on the down curve of the rheogram, when the shear rate decreases (Fig. 2)

This value varies according to the composition of the sediment (clays, sands, etc…) and the water content.

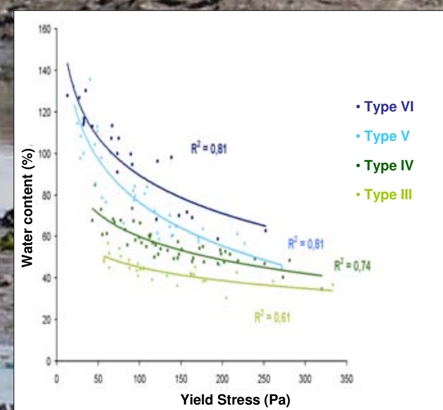

Figure 3: Relationship between the yield stress (τ_y,Pa) and the water content (W, %) according to the sediment type (summer 2006 and winter 2007 samples).

Identification of the sedimentary facies according to their mechanical behaviours :

The composition of clays is similar for all sediments of the bay (Pouliquen, 1975). Sediment behaviour depends on sand, clay and water content. Six types of sediments could be identified by particle size and rheological analysis (Fig. 3) and have highly distinct mechanical behaviours:

- Sands *(100% > Sand > 90%) : Type I*
- Slightly silty sand *(90% > Sand > 73%) : Type II*
- Very silty sand *(73% > Sand > 60%, and Clay < 9%) : Type III*
- Sandy mud *(60% > Sand > 45%, and Clay < 9%) : Type IV*
- Silty sandy mud *(45% > Sand > 29%, and Clay < 9%) : Type V*
- Very silty mud *(Sand < 29% and Clay > 9%) : Type VI*

Seasonal intertidal sediment maps of Marennes Oléron Bay :

The mechanical behaviour of the superficial sediments, the *in-situ* measurements coupled with field morphology observations on the intertidal areas have allowed to establish detailed maps of the superficial sediments (Fig. 4). This study of the flats of MO Bay shows:

- ➢ A high spatial and temporal sedimentary diversity
- ➢ Important changes in the sediments composition between summer and winter.
- ➢ A trapping (approximately 1 cm in summer) of fine sediments (Type V) by seagrass meadows.
- ➢ The resuspension of ~ 6500 m³ of fine sediments (Type V), when the seagrass meadows disappeared in winter.

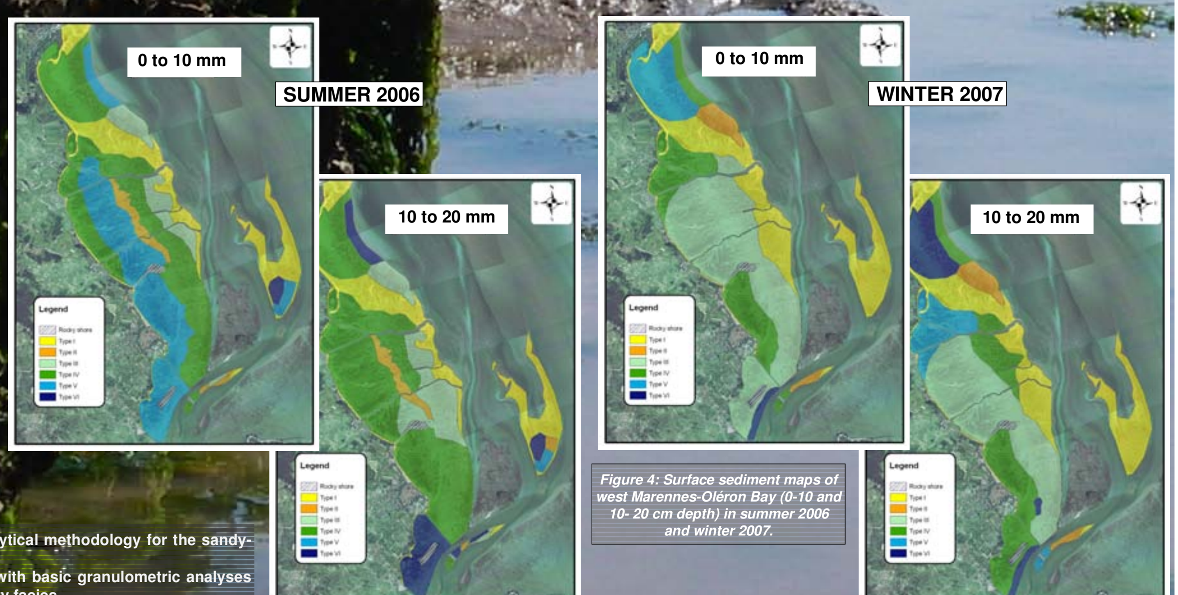

Figure 4: Surface sediment maps of west Marennes-Oléron Bay (0-10 and 10- 20 cm depth) in summer 2006 and winter 2007.

Conclusion :

We have developed an observational and analytical methodology for the sandy-muddy sediments .

The shear strength measurements combined with basic granulometric analyses allowed to characterize six types of sedimentary facies.

A seasonal influence on surface sediment was underlined. Superficial sediment maps of intertidal areas, useful in sedimentary dynamics, have been elaborated with an innovating approach. The superficial sediments were also characterized by a mechanical parameter. Knowledge of the mechanical behaviour is essential to validate numerical model on sedimentary cohesive transport, useful to improve the management and the development of the MO Bay .

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