Projet Européen SETARMS/
SETARMS European Project
(2009-2013)

Valorisation des Sédiments Marins aux travers de Techniques de Traitements Durables et Environnementales/
Sustainable, Environmental Treatment And Reuse of Marine Sediments

Nathalie DUMAY, APLM
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SETARMS partners will work jointly for the economic development of Channel Sea ports by finding modern economic and environmental solutions, based on robust scientific work.

The English Channel is acknowledged as:
- one of the busiest shipping lanes in the world
- and fishing is also a key industry.

To accommodate the ever increasing size of modern ships in European ports and waterways, and to prevent natural silting up of harbour access, significant dredging activity is constantly required to enlarge, deepen and maintain harbour access and achieve appropriate water depths along waterside facilities.

These dredging activities are:
- essential for the local economy
- generate dredging materials that are traditionally disposed at sea or stored on land.
Introduction

Today, the dredging operations, have to confront difficulties such as:

- **Regulations** (more and more detailed and strict)
- **Financial** (cost of the dredging operations and treatment if needed)
- **Environmental** (Thresholds of contamination, New Protected Marine Areas...)
- **Scientific and Technical** (treatment and means of re-use)
- **Social** (strong opposites of the fishers and the Environmental Association against the dredging operations,...)

So, the functioning of the ports could be endangered
An Ambitious project, realist and innovative, with outcomes available and transferable for all the Channel ports.

A Project which brings together most of the stakeholders concerning by the dredging operations in the Channel:

- Scientists, School of Engineers
- Local authorities
- Port authorities
- Industrials

SETARMS budget: 5.2 M €
Term: 2009-2013
The Partnership

Association des Ports Locaux de la Manche

SETARMS Lead partner

14 ports of commerce
8 Local Authorities (owners) + 11 Chambers of Commerce
Main objectives

- Have a better knowledge of the dredged sediments in the Channel
- Develop and promote the sustainable practices of the sediments management we can’t disposed at sea
- Develop and provide crossborder management tools
- Create a center of excellence and long-term relationships between all the partners.
4 Work packages

→ WP1: Overview of the dredging in the Channel
  WP leader: APLM

→ WP2: Sediment Characterisation
  WP leader: University of Brighton

→ WP3: Sediments re-used: (electro kinetic treatment, civil engineering)
  WP leader: ESITC

→ WP4: Communication, monitoring and dissemination of the results
  WP leader: APLM
WP1: Overview of the dredging in the Channel

Action 1: Overview

1.1: Report of the Dredging methods and sediment re-used opportunities
   **Objective:** Knowledge of the French and English practices

1.2 Study of the Sediment typology, characterisation of the disposal at sea site (dumping site)
   **Objective:** Define a common practice regarding the sediment disposed at sea (quality of the sediment disposing at sea, distance between sites, monitoring studies) and the knowledge of the potential volume to treat

1.3: Compare French and English regulations and study of the differences of interpretation between all organisations in charge of regulations
   **Objective:** Suggested synchronization / harmonization and improvement of the consistency of the regulations
WP1: Overview of the dredging in the Channel

Action 2: Assessment of co-operation potential

- 2.1: Identification of current and future needs
   Objective: implementation of a joint dredging programme

- 2.2: Assessment of the potential to share material and means
   Objective: check the economic feasibility and the legal possibility to
   buy material in common or to buy material through an invitation to
   tender/bid request.
Action 3: Study the environmental consequences and constraints of dredging as well as their social impact

3.1: **Current and future environmental constraints and consequences** (Water Framework Directive, Natura 2000 sites, Protected marine areas, biodiversity, bio-accumulation)

3.2: **Social impacts of dredging.**
   **Objective:** implementation of lobbying actions and concerted communication actions before, throughout and after the dredging operations.
With a better knowledge of the dredging methods, the features of disposal at sea sites and the regulation, social and environmental aspects, we wish to be able to:

- Define some good and common practices regarding the management of disposal at sea
- Suggest joint and sustainable solutions regarding the dredging operations
3- Results of the Study 1: Dredging methods and sediment re-use opportunities

Study of the frequency of the maintenance dredging in the local Channel Ports:

⇒ Most ports dredge at least one time per year

⇒ one of information to take account to develop the mutualization operations between the Channel ports
3- Results of the Study 1: Dredging methods and sediment re-use opportunities

Destination of the Dredged sediments in the Channel French local ports

- Disposed at sea: 98%
- In land: 2%

=> Representative of the national distribution
3- Results of the Study 1: Dredging methods and sediment re-use opportunities

The french needs of the career materials: 400 M T/year

Either:
- More 1 M T/day
- 7 tonnes/inhabitant/year
- 20 kg/inhabitants/days
3- Results of Study 2: Technical overview of sediments types and immersion site

Map of the disposal at sea sites in the Channel

Source: In Vivo
3- Results of the Study 2: Technical overview of sediments types and immersion site

Ex: Map of the dumping sites and environmental constraints in France

- **Context**
  - Natura 2000 (17 sites)
  - 3 Marine Parks
  - 3 Natural reserves

Source: In vivo
3- Results of the Study 2: Technical overview of sediments types and immersion site

Distance between the coast and the disposal at sea sites (nautic miles-NM)

The highest distance: 5 NM

But some of new sites will be certainly more far.

Ex. A request of permit is in progress with a suggested disposal of sea site at 15 NM from the port after 10 years of studies

6 French sites and 10 English sites analysed

So, Energetic print will increase in the same time
### 3- Results of the Study 3: Compare French and English regulations and study of the differences of interpretation between all regulatory organisations

Comparison of the French and English thresholds

<table>
<thead>
<tr>
<th>Eléments traces</th>
<th>Unité</th>
<th>Niveau N1</th>
<th>Niveau N2</th>
<th>Action level 1</th>
<th>Action level 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic (As)</td>
<td>mg/kg</td>
<td>25</td>
<td>50</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>Cadmium (Cd)</td>
<td>mg/kg</td>
<td>1,2</td>
<td>2,4</td>
<td>0,4</td>
<td>5</td>
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<tr>
<td>Chrome (Cr)</td>
<td>mg/kg</td>
<td>90</td>
<td>180</td>
<td>40</td>
<td>400</td>
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<tr>
<td>Cuivre (Cu)</td>
<td>mg/kg</td>
<td>45</td>
<td>90</td>
<td>40</td>
<td>400</td>
</tr>
<tr>
<td>Mercure (Hg)</td>
<td>mg/kg</td>
<td>0,4</td>
<td>0,8</td>
<td>0,3</td>
<td>3</td>
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<tr>
<td>Nickel (Ni)</td>
<td>mg/kg</td>
<td>37</td>
<td>74</td>
<td>20</td>
<td>200</td>
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<tr>
<td>Plomb (Pb)</td>
<td>mg/kg</td>
<td>100</td>
<td>200</td>
<td>50</td>
<td>500</td>
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<tr>
<td>Zinc (Zn)</td>
<td>mg/kg</td>
<td>276</td>
<td>552</td>
<td>130</td>
<td>800</td>
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<tr>
<td>PCB totaux</td>
<td>mg/kg</td>
<td>0,5</td>
<td>1</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>Somme des 7 PCB définis par le CIEM</td>
<td>mg/kg</td>
<td>/</td>
<td>/</td>
<td>0,01</td>
<td>/</td>
</tr>
<tr>
<td>Somme des 25 PCB</td>
<td>mg/kg</td>
<td>/</td>
<td>/</td>
<td>0,02</td>
<td>0,2</td>
</tr>
<tr>
<td>PCB 28</td>
<td>mg/kg</td>
<td>0,025</td>
<td>0,05</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>PCB 52</td>
<td>mg/kg</td>
<td>0,025</td>
<td>0,05</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>PCB 101</td>
<td>mg/kg</td>
<td>0,05</td>
<td>0,1</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>PCB 118</td>
<td>mg/kg</td>
<td>0,025</td>
<td>0,05</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>PCB 138</td>
<td>mg/kg</td>
<td>0,05</td>
<td>0,1</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>PCB 153</td>
<td>mg/kg</td>
<td>0,05</td>
<td>0,1</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>PCB 180</td>
<td>mg/kg</td>
<td>0,025</td>
<td>0,05</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>TBT</td>
<td>mg/kg</td>
<td>0,1</td>
<td>0,4</td>
<td>0,1</td>
<td>1</td>
</tr>
<tr>
<td>Dieldrin</td>
<td>mg/kg</td>
<td>/</td>
<td>/</td>
<td>/</td>
<td>/</td>
</tr>
</tbody>
</table>

- N2 more restrictive in France (10 times)
- N1 less strict in France
- PCB controlled variously

(Source: IN VIVO/CETMEF)

To relativize due to different uses of these thresholds in each country

APLM, 04 April 2011
3- Results of the Study 3: Compare French and English regulations and study of the differences of interpretation between all regulatory organisations

**Ex.: Evolution of the French regulations**

<table>
<thead>
<tr>
<th>Réglementation internationale</th>
<th>Réglementation européenne</th>
<th>Droit français</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immersion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Convention OSPAR, 1992</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Convention de Londres, 1975</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DCE 2000/60/CE</td>
<td>Loi sur l’eau n°92-3</td>
<td></td>
</tr>
<tr>
<td>DCSMM 2008/56/CE</td>
<td>Non repris en droit français</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Loi n°76-599 du 7 juillet 1976 relative à la prévention et à la répression de la pollution marine par les opérations d’immersion effectuées par les navires et aéronefs, et à la lutte contre la pollution marine accidentelle</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ordonnance n°2005-805 portant simplification, harmonisation et adaptation des politiques de l’eau et des milieux aquatiques, de la pêche et de l’immersion des déchets</td>
<td></td>
</tr>
<tr>
<td>Dépôt à terre</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DCD 2008/98/CE</td>
<td>Non repris en droit français</td>
<td></td>
</tr>
<tr>
<td>Catalogue européen des déchets, 2002</td>
<td>Décret n°2002-540 relatif à la classification des déchets</td>
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<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Directive 1999/31/CE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>concernant la mise en décharge des déchets</td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>

More and more regulations since the last decade and new regulations are still in progress (due to European Directive implementations at national level)

**One of benefits**

→ **Environmental aspects better taken into account**

Nevertheless:

→ **Still lack of consistency between all the regulations**
4- WP 2 and 3: Characterisation and re-use of the sediments

13 Sampled ports
WP2: Sediment characterisation

Coordinator: University of Brighton

Several analysis will be lead to obtain:

- Geochemistry and mineralogy measures
- Bioavailability
- Geotechnics measures
- Answers to Electrokinetic tests
# WP2: Sediment characterisation

## Geochemical analysis

<table>
<thead>
<tr>
<th>METAUX/METALS (mg/kg MS)</th>
<th>HAP/PAHs (mg/kg MS)</th>
<th>PCB/PCBs (mg/kg MS)</th>
<th>Pesticides concentrations (mg/kg MS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al</td>
<td>A cénaphènène</td>
<td>PCB 28</td>
<td>Aldrin</td>
</tr>
<tr>
<td>As</td>
<td>Anthracène</td>
<td>PCB 31</td>
<td>Heptachlor exo</td>
</tr>
<tr>
<td>Fe</td>
<td>Benzo(a)anthracène</td>
<td>PCB 52</td>
<td>Heptachlor endo</td>
</tr>
<tr>
<td>Mg</td>
<td>Benzo(a)pyrène</td>
<td>PCB 101</td>
<td>-HCH</td>
</tr>
<tr>
<td>Mn</td>
<td>Benzo(b)fluoranthène</td>
<td>PCB 118</td>
<td>-HCH (lindane)</td>
</tr>
<tr>
<td>Ti</td>
<td>Benzo(ghi)pérylène</td>
<td>PCB 138</td>
<td>Hexachlorobenzène</td>
</tr>
<tr>
<td>Cd</td>
<td>Benzo(k)fluoranthène</td>
<td>PCB 153</td>
<td>Fenthion</td>
</tr>
<tr>
<td>Cr</td>
<td>Chrysène</td>
<td>PCB 180</td>
<td>Diazinon</td>
</tr>
<tr>
<td>Cu</td>
<td>Dibenzo(ah)anthracène</td>
<td></td>
<td>Ethion</td>
</tr>
<tr>
<td>Hg</td>
<td>Fluoranthène</td>
<td></td>
<td>Malathion</td>
</tr>
<tr>
<td>Ni</td>
<td>Fluorènne</td>
<td></td>
<td>Parathion-éthyl</td>
</tr>
<tr>
<td>Pb</td>
<td>Indéno(1,2,3,cd)pyrène</td>
<td></td>
<td>Parathion-méthyl</td>
</tr>
<tr>
<td>Zn</td>
<td>Méthyl(2)fluoranthène</td>
<td></td>
<td>Azynphos-éthyl</td>
</tr>
<tr>
<td></td>
<td>Méthyl(2)naphthalène</td>
<td></td>
<td>Triazophos</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bioavailability</th>
<th>Radioactivité/ Radioactivity Bq/Kg de M.S</th>
</tr>
</thead>
<tbody>
<tr>
<td>CACO₃ (%)</td>
<td>40K (natural)</td>
</tr>
<tr>
<td>SO₄²⁻</td>
<td>235 U</td>
</tr>
<tr>
<td>Cl¹</td>
<td>65 Zn</td>
</tr>
<tr>
<td>NO₃³</td>
<td>60Co</td>
</tr>
<tr>
<td>N (g/kg)</td>
<td>137Cs</td>
</tr>
<tr>
<td>P (g/kg)</td>
<td>241Am</td>
</tr>
<tr>
<td>COT/TOC (% de M.S)</td>
<td></td>
</tr>
<tr>
<td>HCT/TPH (mg/kg MS)</td>
<td></td>
</tr>
</tbody>
</table>

## Mineralogy

- Laser granulometry
WP2: Sediment characterisation

Bioavailability Methods

Sédiment

Kinetic Extraction
- metals fastly removable

Simple Extraction

Sequentiel Extraction
- Metals slowly removable
WP2: Sediment characterisation

Geotechnical Characterisation of pre and post treated dredged marine sediment
And assessment of re-use applications.

- A complete appraisal of the strength and deformation characteristics will be obtained from a series of laboratory tests.
- Characterisation will aid in the development of
  - Process options
  - Storage options
  - Deposit management
Electrokinetic remediation and stabilization is an emerging technology that has received attention as a practical in-situ and ex-situ remediation technique for clay-rich soils. In its most basic form: apply electrical current between electrodes that have been implanted in the ground on each side of a contaminated soil mass. Less advanced is its use on dredged marine sediments, although its use as a mechanism to accelerate dewatering of slurries is well established.
Expected results regarding the WP2 and 3

- **Pre-treatment**
  - Deshydratation: methodology
  - Depollution?

- **Treatment**
  - Cimentation and électrokinetic
  - Geotechnical and environmental
  - Characterisation

- **Samplings**

- **Re-used**

Depending on the final use: civil engineering, others…
Expected results regarding the WP2 and 3

**Typology**

<table>
<thead>
<tr>
<th>ECHANTILLONS</th>
<th>CARACTER. SEDIMENTS NON TRAITES</th>
<th>PRETRAITEMENT</th>
<th>TRAITEMENT</th>
<th>CARACT. SEDIMENTS TRAITES</th>
<th>COUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Geochimique, biodisponibilité, geotechnique, modélisation</td>
<td>déshydratation</td>
<td>(cimentation, etc.)</td>
<td>Geochimique, biodisponibilité, geotechnique</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>D</td>
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<tr>
<td>E</td>
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<td>F</td>
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<td>...</td>
<td></td>
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</tr>
</tbody>
</table>

6 samples selected

Creation of trial roads (5m x 20 m) in situ and test

APLM, 04 April 2011
WP3: Sediment re-used

Experimental tests on 6 samplings in 2012-2013

By an industrial: Eurovia
WP4: Communication, monitoring and dissemination

**Audience:** Ports authorities, state services, European institutions, Association, economic stakeholder

**Organisation of 2 scientific seminars**: next one in September 2011

**Organisation of 2 public seminars:** next one in June 2013

**Links with another national and European projects:** SEDIMATERIAUX, SEDIGEST, SuPorts, ...

**A website:** [www.setarms.org](http://www.setarms.org)
Thank you for your attention

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