CEAMaS
Civil Engineering Applications for Marine Sediments

Proposals for a European methodology for ports operators

Management and reuse of dredged marine sediments

Possible management scenarios

Investing in Opportunities

This project has received European Regional Development Funding through INTERREG IV B.

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Scope for sediment reuse

The present document consolidates the project's outcome and findings on sediment reuse issues and opportunities, based on stakeholder consultations, documentary research, site visits, laboratory experimentation and partner expertise.

- Current practice
- Developing reuse
- Technical and regulatory barriers
- Economic framework and system boundaries
- Reuse opportunities

This presentation document and the WP4 decision support tool are supporting our proposal for a European methodology for sediment reuse.

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Current practice

Port dredging obeys to operational requirements (removal of large quantities of sediments to meet increasing navigational needs) and financial constraints (dredge only what is needed to reduce dredging and management costs, under a fixed budget).

It complies also with environmental requirements on each option for sediment disposal.

Dredged sediment is mostly considered as a burden, seldom as a potential resource. Developing sediment reuse is at least a change of paradigm.

- Current practice
- Technical and regulatory barriers
- Economic framework and system boundaries
- Reuse opportunities

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Current practice

Everywhere in the NWE area, the most economy efficient sediment disposal option is disposal at sea. More than 90% of dredged sediments are managed this way, and this proportion may increase as a result of reduced pollution.

Sediment disposal or reuse options on land are more expensive.

Disposal at sea is based on national permitting criteria – mitigating the possible milieu impacts of disposal.

The n° 1 key on reuse vs. disposal is therefore based on environmental compliance. Most "clean" sediments are earmarked for disposal at sea.

Beneficial reuse of "clean" sediments is possible, but must be based on their sole economic value for civil engineering.

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Current practice

Disposal at sea is not necessarily opposed to reuse.

It may fulfil sustainable objectives, such as beach nourishment[1] or coastal defence[2] .

In several EU countries, dredged sediments are considered as waste rather than part of the natural environment. This may seem odd but reflects the background of national regulations.

Waste is classified as "inert", "hazardous" or "NINH",

Disposal at sea is easiest for sediments classified as "inert" and forbidden for sediments classified as "hazardous"..

1 www.tudelft.nl/en/current/university-magazines/delft-outlook/former-editions/2012/2012-1/delft-outlook-2012-1/science/sand-engine-quells-the-coasts-hunger-for-sand/

2 www.sussex.ac.uk%2Fgeography%2Fresearchprojects%2Fcoastview%2Fdredging%2Fcoastal-defencne-and-marine-ag-dredg-off-UK.pdf

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Current practice

Disposal at sea is the preferred option for non-contaminated sediments, unless they have positive economic value.

Highly contaminated sediment has to be managed everywhere according to hazardous waste rules.

The scope of sediment reuse is therefore:

- coarse or sandy non-contaminated sediment, with valuable civil engineering properties, or
- mildly contaminated sediment, compatible with reuse specifications, but not classified as hazardous

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Developing reuse

Sediment reuse has to meet several challenges in order to switch from desirable to operational:

- demonstrate it is at least technically feasible and economically acceptable, if not beneficial,
- demonstrate it involves no significant impact or risk,
- meet public and stakeholders acceptance through careful dialogue and overcome the Nimby effect,
- be attractive enough, and provide sufficient indirect benefits, in order to be an alternative to the "business as usual" rule governing tendering processes and permitting

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Developing reuse

The roadmap to successful sediment reuse projects includes

- an extensive phase of public information and consultation, regardless of the reuse option chosen,
- a thorough knowledge of the characteristics of the sediment volume to be dredged, in order to identify the most suitable reuse option and the possible impacts of the whole operation, both positive and negative,
- a thorough and careful laboratory and pilot experimentation of the considered option, including testing of the reuse products, their safety and their possible impacts
- extensive communication on the reuse products, in order to let the public appropriate them, on the local economy development and on the improvement of living places

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Developing reuse

The technical part of this road map is the backbone of the "Sédimatériaux" strategy

1. full characterisation of the sediment properties (physical, geotechnical, mineralogical, mechanical, chemical and environmental) and its deposit, in order to identify the monitoring and treatment needs,
2. full laboratory experimentation of the formulation, performance demonstration, product feasibility and testing
3. pilot scale experimentation on site including site monitoring, verification of the performance of the product for civil engineering and environmental criteria

This strategy, developed by the Nord Pas de Calais Region of France led to numerous successful reuse projects.

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Developing reuse

Besides this technical strategy, the communication and societal strategy around a sediment reuse option must include

- a full information of the public and stakeholders on the project, from the impact of dredging to the improvement of the living frame. This may help to avoid Nimby effects and facilitate the acceptance of a project
- a comparative assessment of the various possible reuse options, beyond the usual direct costs approach
- a multi-disciplinary and multi-criteria analysis (MCA) approach to project evaluation, taking into consideration indirect benefits within larger system boundaries
- publication of monitoring results on the ongoing works and on the final product

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Technical and regulatory barriers

Technical barriers to sediment reuse include:

- poor geotechnical properties of fine grained sediment. Additives may be required to allow it to meet geotechnical use properties, and compete with natural aggregate or sand;
- chemical composition. Sediment may be included, for instance, in cement feed, but it may contain unwanted components such as organic matter,
- distance and transport. Harbour dredging sediments may travel easily and cost-effectively in the harbour area and upstream, but will not compete with quarry material where significant road transport is required (both on economic and emissions criteria)

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Technical and regulatory barriers

Regulatory barriers to sediment reuse include:

- management of dredged sediments only as waste, paying no attention to its possible beneficial application for water protection. This is the case in several EU countries but not all, leading to major differences in reuse acceptability;
- placing excessive precautionary principle constraints on reuse, based on emissions prevention rather than on circular economy benefits. It may be associated with expensive risk analysis procedures in reuse permitting. This blocks most reuse initiatives in some countries,
- restricting "end of waste" status options, maintaining therefore the initial owner's responsibility on the reuse products.

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Economic framework and system boundaries

Port dredging is based everywhere on public tendering procedures. This means that total cost is considered first, with navigation efficiency and compliance as the second criteria.

Most of the external benefits of sediment reuse, such as

- community quality of life and environment
- natural resource preservation and land use
- requirements in fossil fuel and GHG emissions
- local economic development and employment

will be overlooked. The external costs of the cheapest options will be borne by other public budgets.

In MCA terms, the system boundaries need to be enlarged beyond the tendering terms of reference.

MCA: Multi Criteria Analysis

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Economic framework and system boundaries

Several tools are involved in sustainability assessment, depending upon stakeholder's objectives and constraints.

Among such tools, the most commonly used are:

- LCA (Life Cycle Assessment)
- MCA (Multi Criteria Analysis)

LCA was used during CEAMaS to evaluate scenarios. This method is supported by ISO standards (14040, 14044) and therefore easily implemented in real-world projects.

MCA is more flexible and reflects better stakeholders' and public's preoccupations.

Both were used in CEAMaS for scenario assessment.

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Reuse opportunities

In the CEAMaS project countries, a wide range of reuse opportunities was identified, according to national needs and constraints including regulatory:

- Cement raw material, concrete component,
- Civil engineering, including road base and waterworks,
- Sediment-based products, from coastal defence acropods to urban furniture and sediment brick construction,
- Landscaping, dikes, soundproofing, landfill cover,
- Soil improvement, soil upheaval,
- Derelict soil restoration and brownfield management,
- Soil revitalisation through energy crop development or recreational areas

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Scenario development

Beyond the "business as usual" approach, we propose to evaluate alternative management options as scenarios. Many scenarios are actually country- or site-specific, according to heterogeneous regulation systems and standards at the NWE countries scale, and according to large variations in geographic and socio-economic constraints.

The starting point for scenario identification was the only universally shared situation:

- Sediment quality: Uncontaminated / Mild contamination / Contaminated
- Possible reuse on land: Yes but more expensive / Depending on application and on prior treatment / Safe disposal (i.e. Slufter) or treatment
- Disposal at sea: Always the cheapest option / Possible in some cases and (/or) after treatment or separation / Not allowed
- Criteria for reuse: Indirect benefits from reuse / Cost of treatment and of safe disposal / Economic activity, but acceptability & safety ?

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Scenario development

Identified scenarios comprise (the following list is not limitative, these are examples):

- agricultural use and improvement. Advantages: uplift of land, input of organic matter. Detriment: salt contents;
- civil engineering in contact with water (flood protection, embankment)
- civil engineering in port management (new surfaces, new roads, landscaping buttes),
- coastal defence (concrete blocks, sand refill)
- civil engineering at brownfields and contaminated sites (replacement of excavated soil) in combination with other materials (demolition waste),
- reuse in construction material (road sub base, filling)
- reuse as minerals (cement or brick industry)

For all these scenarios, it must be taken into account:

- the actual extra cost of reuse (reuse is almost never cheaper than disposal),
- the indirect benefits on mineral resources (avoided mineral extraction)
- the benefits on land use (disposal and extraction sites)
- the benefits on the quality of life (improved living area, improved employment)
- the benefits for safety (flooding, subsidence, coastal defence),
- the environmental benefits (reduced emissions and historic contamination backlog)

Scenario refining and evaluation can be carried out with the CEAMaS decision tool

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Reuse as cement raw material or concrete component

Cement and concrete applications are very large scale ones, compatible with dredged sediment volumes.

Cement reuse constraints include:

- a raw composition compatible with kiln needs,
- acceptable levels of pollutants and penalty elements,
- a negative (subsidised) economic value.

Concrete reuse constraints include:

- acceptable levels of pollutants for secondary emissions,
- acceptable levels of penalty substances (salt, organic,...),
- mechanical properties (raw or after additive additions)
- very low value of material.

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Reuse in Civil engineering, road base and waterworks

Civil engineering, including road base and waterworks are large scale ones, compatible with dredged sediment volumes, and often local.

Road base constraints include (national specs):

- civil engineering properties compatible with road base use,
- acceptable levels of pollutants in leaching tests,
- short reuse distances.

Waterworks reuse constraints include:

- acceptable levels of pollutants for secondary emissions,
- acceptable engineering properties, compatible with local use,
- good hydraulic properties,
- water transportation without road transfer.

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Sediment-based products

Products based on sediments - and in most cases, upon a part of sediments in their composition, are almost limitless. They comprise medium-scale (sea defence acropods) to small-size (urban furniture) applications:

- having a high social visibility, they play a significant role on the acceptability of sediment-based products,
- they save primary mineral resources through their alternative origin,
- their performance requirements are not high, except for health and emissions constraints

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Landscaping, dikes, soundproofing, landfill cover

Landscaping and cover applications are very large scale ones, compatible with dredged sediment volumes.

- they mainly need to be fertile in order to allow a quick integration in landscape, and conversion to soil,
- their pollutant constraints are defined by local regulations on soil application. When these regulations take risks into consideration, such applications belong to the lowest use classes,
- salt contents is therefore the main constraint for marine sediments.

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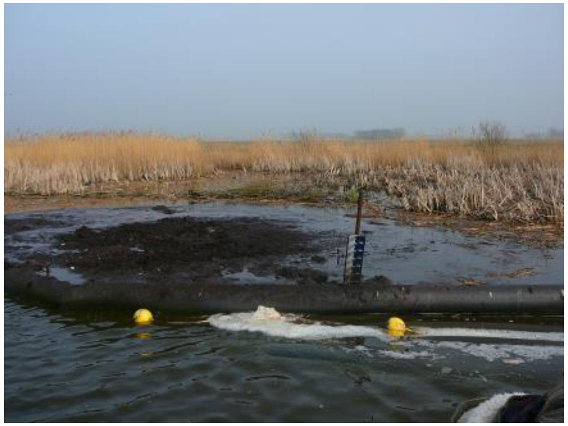
Soil improvement, soil upheaval

Soil rebuilding, cover and upheaval applications are also very large scale ones, compatible with dredged sediment volumes. They address two major issues of the EU policy:

- preservation of soil organic matter and fertility,
- mitigation of the sea level effects of climate change.

Agricultural applications need to be fertile in order to allow a quick recovery and conversion to soil, without adding contamination.

Soil upheaval applications need to be compatible with agricultural use



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Derelict soil restoration and brownfield management

Soil backfill, excavation cover and rebuild applications are large scale ones, compatible with dredged sediment volumes, and often with waterways transportation. They address a major issue of EU policy:

- recovery of derelict land, mainly from brownfields, and
- mitigation of pollutant migration towards surface and groundwater.

Brownfield applications need to be fertile in order to allow a quick recovery to soil, without adding to pre-existing contamination.

Their feasibility is subject to local and national regulations.

photo Actu-environnement

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Energy crops and recreational areas

Beyond derelict soil restoration, an additional benefit of fertility of sediments may be applied through use of recovered land as:

- Energy crop development on formerly waste land and brownfields, or on dredged sediment disposal sites. Such land use for energy crops, does not compete with the use of valuable agricultural land for food crops,
- Development of recreational areas on derelict land or on sediment disposal sites, in former industrial settlings, starved of such areas.

< photo Farmers Weekly
photo USACE >

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KEY SUCCESSES OR PROBLEMS TO SOLVE

A few examples of beneficial sediment reuse case studies are already documented. They can be used as guidelines for developing new options:

- Lift Up Lowlands (NL),
- Aquatic disposal sites (IJsseloog , NL),
- Soil generation and land reclamation after sediment washing (Waterford and Bantry, IE),
- Dunkerque harbour road and Le Havre reclaimed areas (FR),
- Cycle paths (Sedicycle, FR),
- Urban furniture and environmental engineering from recycled sediment (examples : C'Urban project, FR; non-structural concrete components for road base, FR)

Other more hypothetical reuse scenarios were also considered

- Donges oil refinery railway track safety cover (FR)

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KEY SUCCESSES OR PROBLEMS TO SOLVE

According to general stakeholder perception, the n° 1 barrier against sustainable sediment reuse options is regulation.

- lack of End-of-Waste scenarios, precluding the development of economic activities based on reuse material,
- lengthy permitting procedures based on desk studies and unrealistic hazardousness criteria
- precautionary principle application to sediment management, which may ultimately lead to choking maritime transport in the EU, port competitiveness and loss of economic activities in relation with ports,
-