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ARMINES

Using Sediment As a Resource

New optimization software for the formulation and the treatment of dredged sediments : valorization in civil engineering

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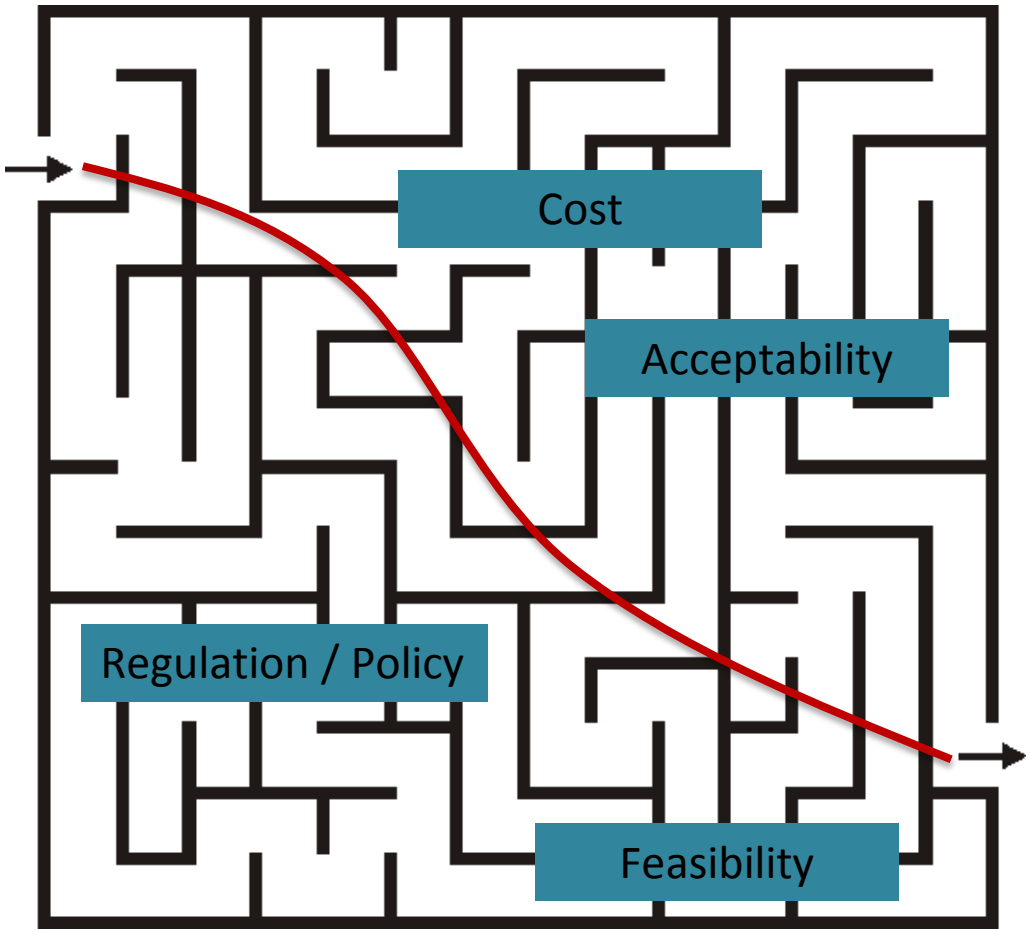
SEDNET, Dubrovnik 2-6 april 2019




Brightlingsea Harbour Commissioners

ARMINES

Sediment



Materials, structure

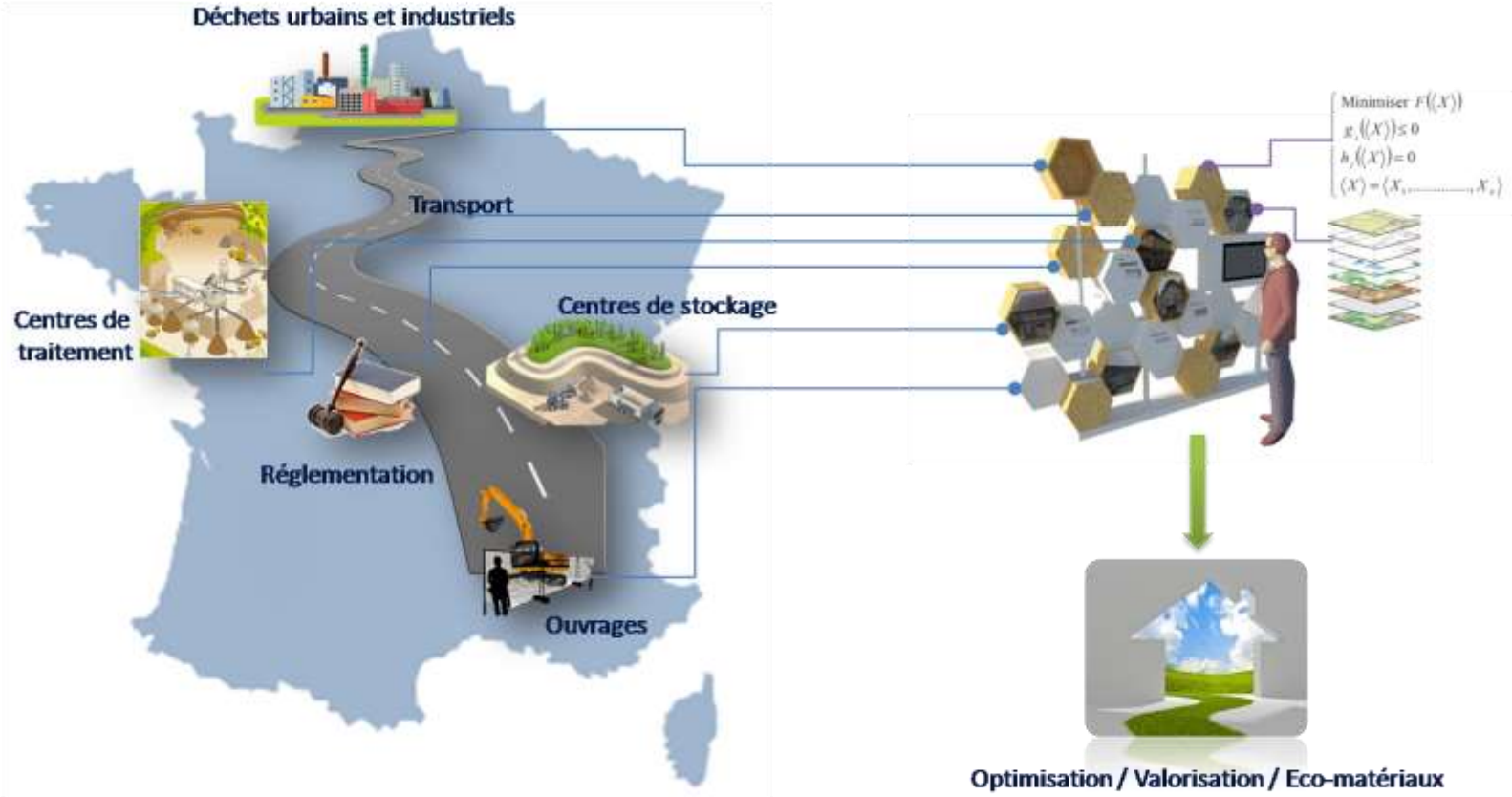
Mathematical operational approach

[Benzerzour & co 2014]

Operational Sediment Management System

Mathematical model : Objective function

$$Min\left(\sum_{i=1}^{n} C_i x_i + \sum_{j=1}^{m} C_j S_j + \sum_{i=1}^{n}\sum_{t=1}^{|T|} C_{ti} T_{ti}\right)$$



C_i : Operating cost of sediment *i* (dredging)

C_j : Purchase cost of the material *j* and transport cost (T/Km)

C_{ti} : Cost of treatment *t* applied to sediment *i* and sediment transport cost (T/Km)

Mathematical operational approach

Software : Input data

Sediment

- Name
- Type of sample
- *Characteristics*
. Chemical (as, zn, ...)
. Mechanical (GTR)
- Centre of studies
- dredging date
- dredging location
- *GPS coordinates*
- *Transport costs* T / km
- Operating costs
- Notes

Treatment center

- Unit name
-Type of treatment
- **For each type:**
. Name of treatment
. Cost € / T
. Impact on polluting element%
- Address of the center
- GPS coordinates
- Notes

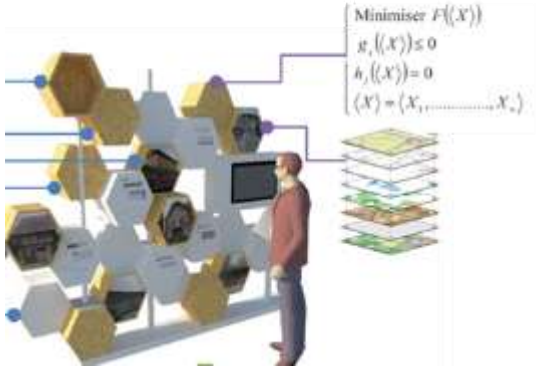
Storage center

- Zone Name
- *Type (Inert, Not dangerous, Dangerous)*
- *GPS coordinates*
- *Storage costs € / T*
-Notes

Construction Materials

- Name
- *GPS coordinates*
- *Transportation cost*
- *Operating cost (or purchase)*
- *Characteristics*
. chemical
. mechanics
-Notes

Mathematical model : Constraints



Environmental constraints : Heavy metals

$$e_{si}\left(1-\sum_{t=1}^{|T|}\hat{e}_{sit}\,T_{ti}\right)\leq e_s+(1-x_i)M$$

Environmental constraints : Organic matter

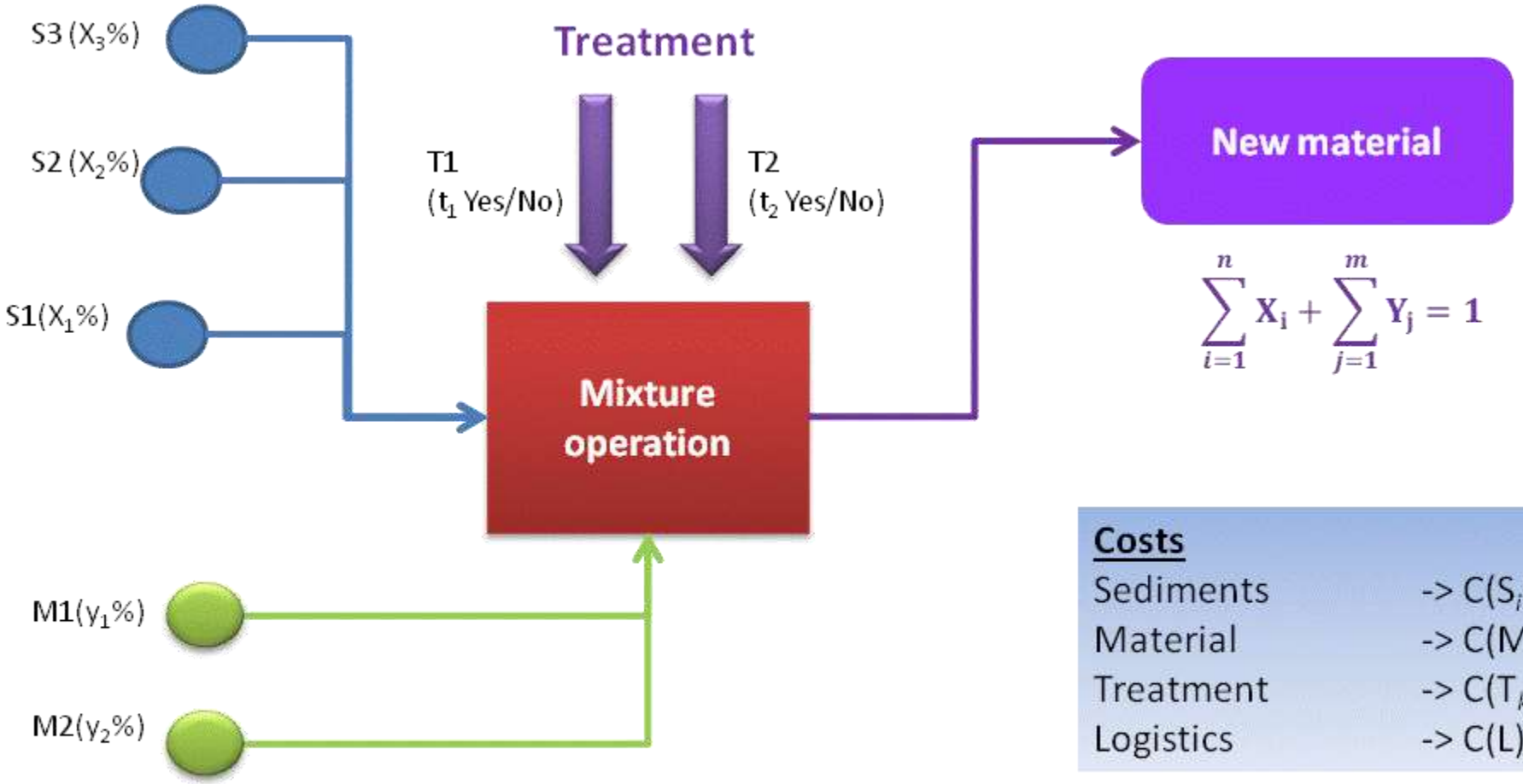
$$e_{Mi}\left(1-\sum_{t=1}^{|T|}\hat{e}_{Mit}\,T_{ti}\right)\leq e_M\left(1+\sum_{j=1}^{m}S_j\right)+(1-x_i)M$$

Mechanical constraints

$$\hat{P}_d^{0.4}\left(\sum_{i=1}^{n}x_i+\sum_{j=1}^{m}S_j\right)\leq\sum_{i=1}^{n}(P_{id}\times x_i)+\sum_{j=1}^{m}(P_{jd}\times S_j)\leq\hat{P}_d^{0.25}\left(\sum_{i=1}^{n}x_i+\sum_{j=1}^{m}S_j\right)$$

$P_{id}\,(P_{jd})$: associated percentage to the diameter *d* in sediment *i* (material *j*)

Mathematical model : Constraints



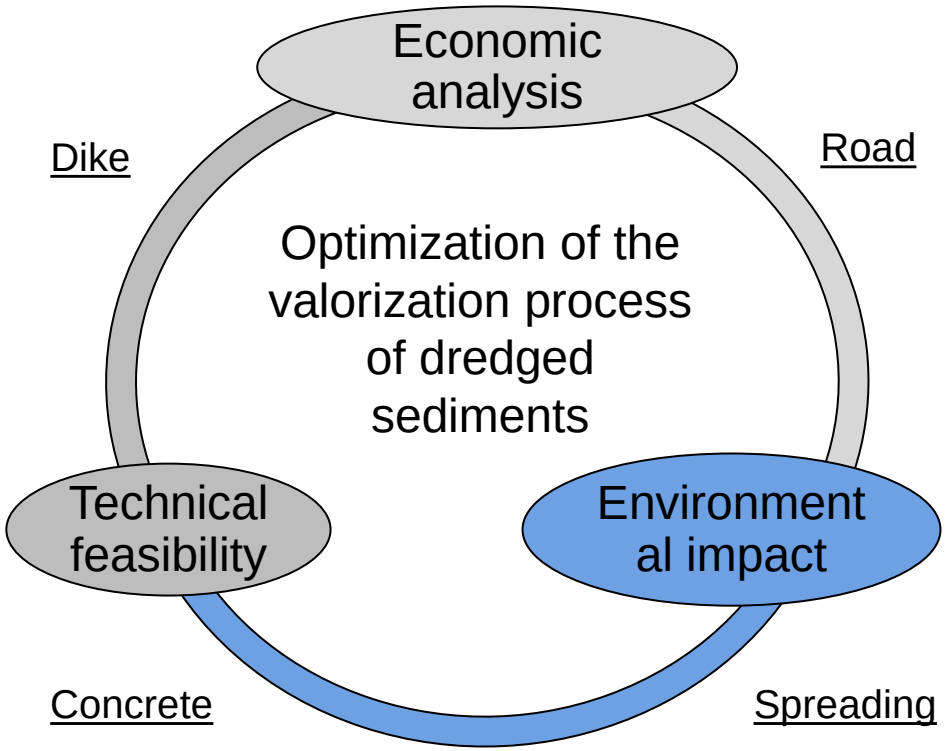
$$\sum_{i=1}^{n} X_i + \sum_{j=1}^{m} Y_j = 1$$

Costs

Sediments	-> $C(S_i)$
Material	-> $C(M_j)$
Treatment	-> $C(T_k)$
Logistics	-> $C(L)$

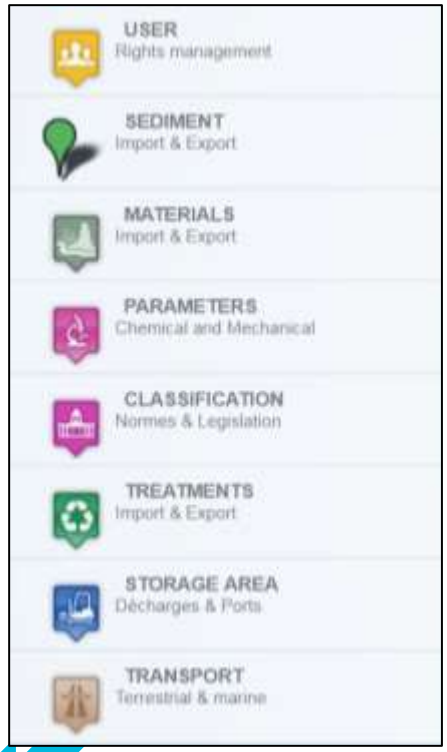
$$\sum_{i=1}^{n} X_i\, C(S_i) + \sum_{j=1}^{m} Y_j C(M_i) + \sum_{k=1}^{K} T_k C(T_k) + C(L) \rightarrow \mathbf{Min}$$

OSMS Optimization process



The purpose of the OSMS is to propose an optimal solution that meets the different technical and environmental requirements at a lower cost.

Data tab & admin



→ GPS coordinates, characteristics and cost

→ Sand, gravel, lime, fly ash etc., location, characteristics and cost

→ Physical, mechanical and chemical parameters

→ Classification of the sediment

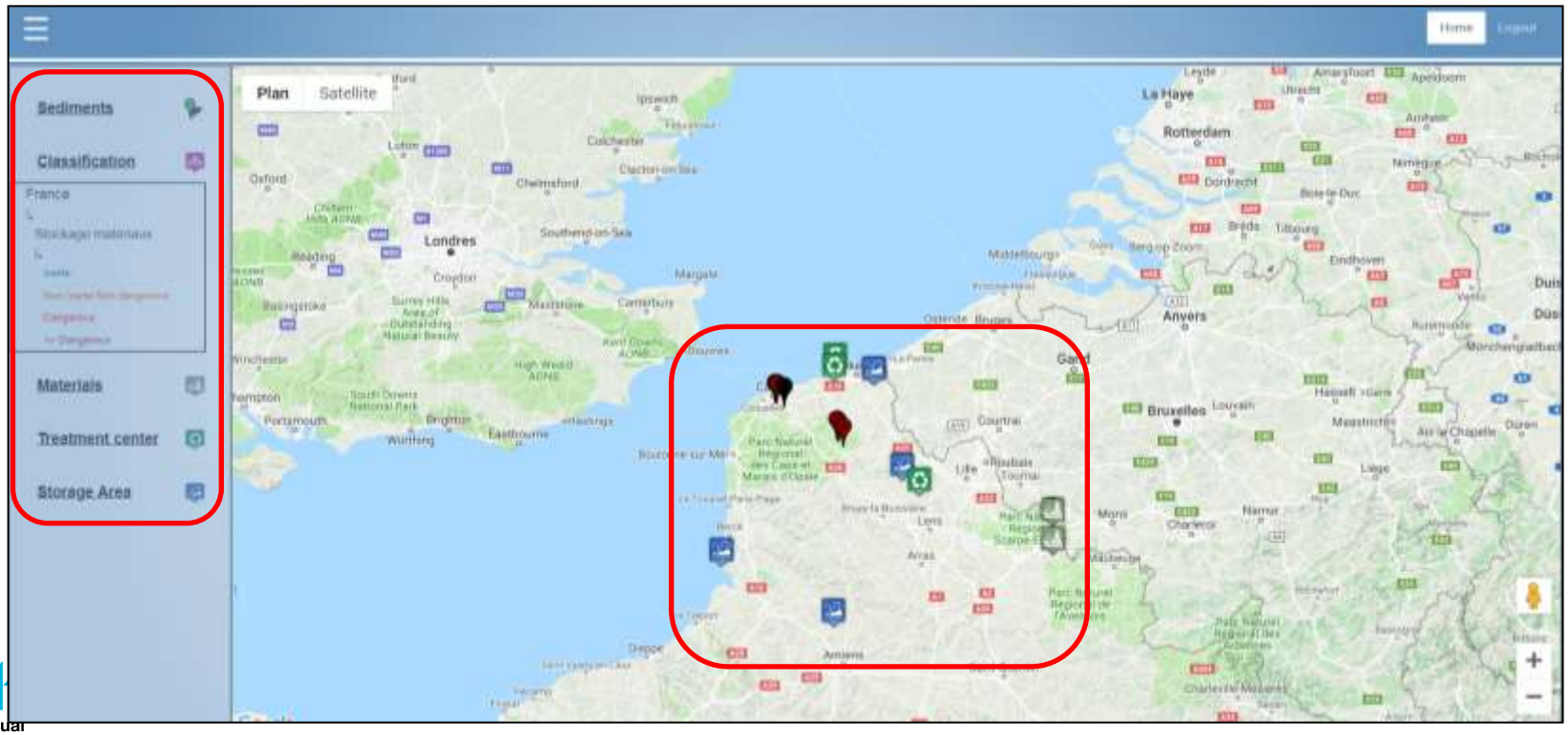
→ Add a treatment center, location and cost of each treatment

→ GPS coordinates, criteria for storage and cost

→ Terrestrial or marine transport, cost

Data & Analysis

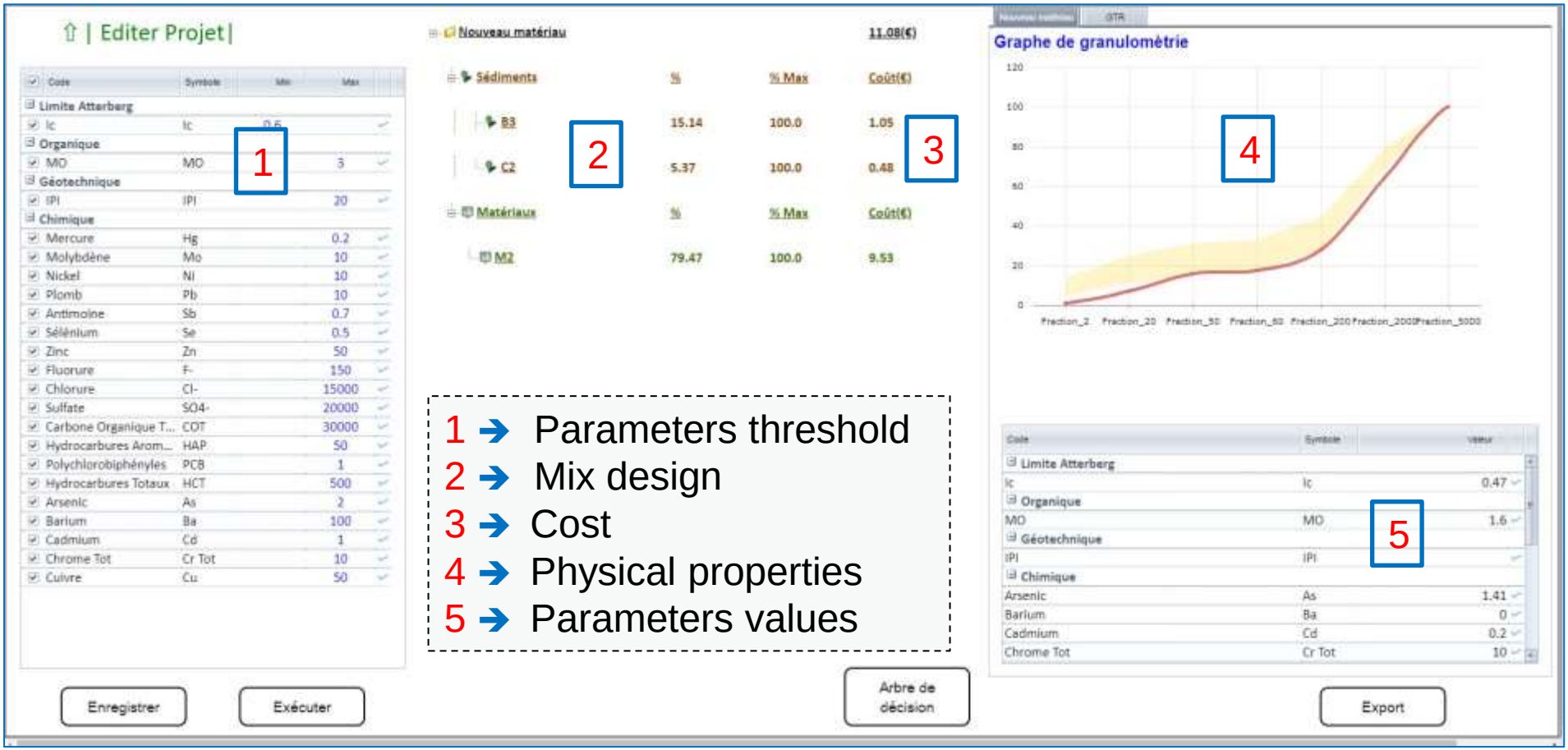
This tab allows to display the location of the sediments, added materials, treatment centers and storage centers on the map and make analysis.



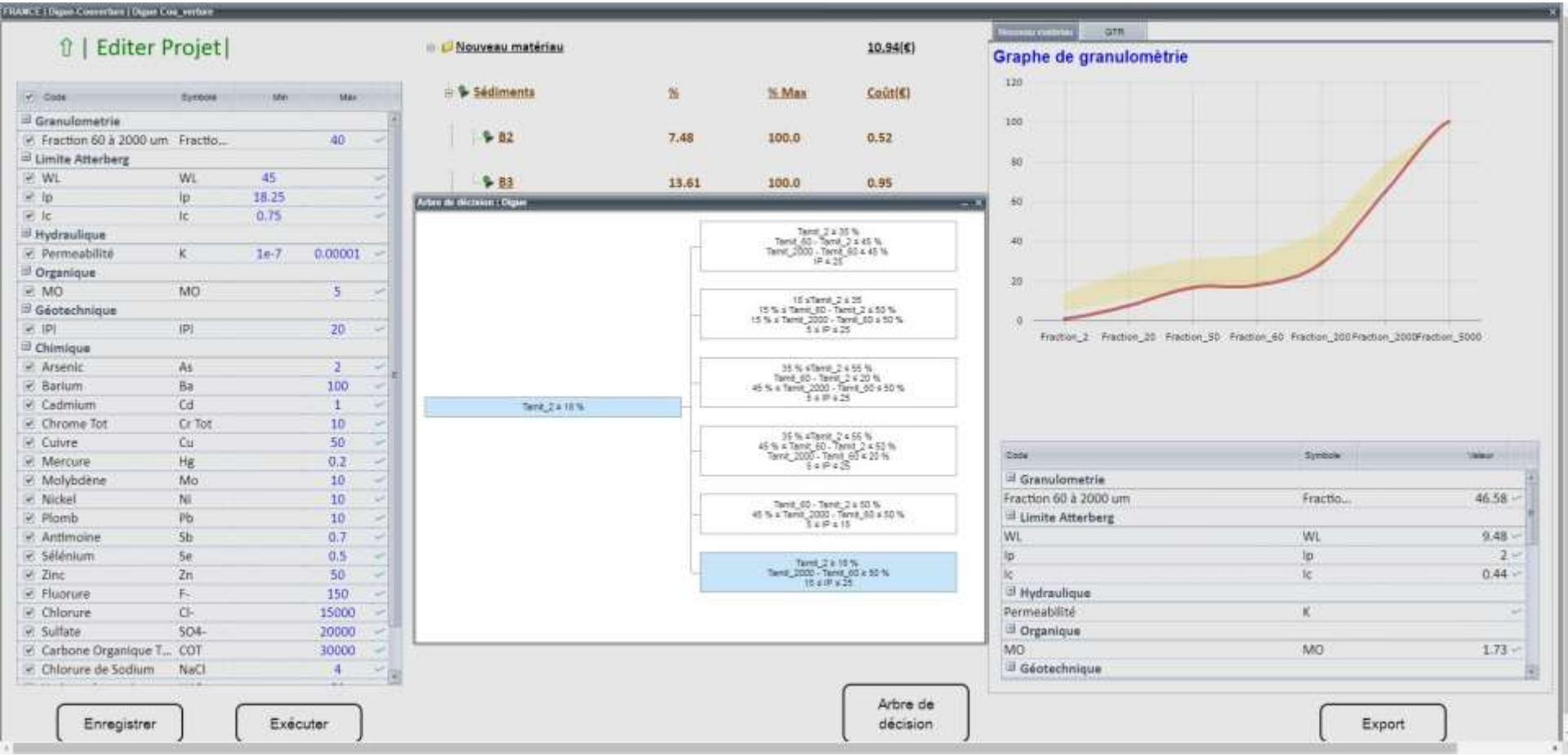
Simulation tab

In this tab we can create a new project, choose the characteristics of the project: Application, sediment used, quarry, treatment centers, storage areas…

Example of result for road application -1-



Example of results for dike application



Reusd possibility : Projects SETARMS, PRISMA, ECOSED, GPMD, SEDIMATERIAUX

Road

Dyke

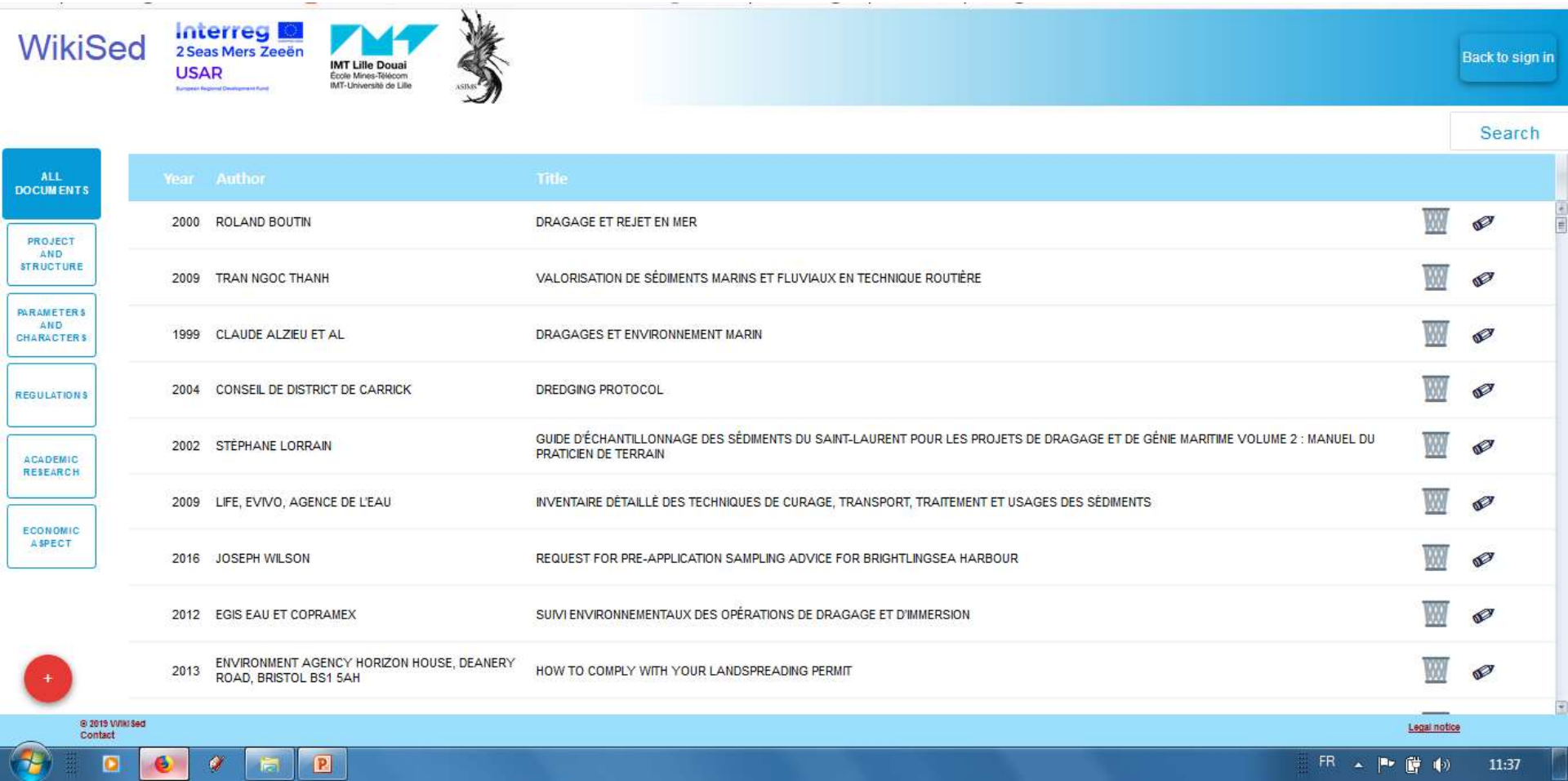
self-compacting concrete

Urban furniture

Reservoir concrete pavement

Aggregates

http://wikised.phenixmat.com/



Pour plus d'infos: Publications 2017-2018
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ORIGINAL ARTICLE

Formulation of mortars based on thermally treated sediments

Mahfoud Benzerzour[1] · Walid Maherzi[1] · Mouhamadou. A. A. Amar[1] · Nor-Edine Abriak[1] · Denis Damidot[1]

ORIGINAL ARTICLE

Environmental impact and mechanical behavior study of experimental road made with river sediments: recycling of river sediments in road construction

Abdelhafid Kasmi[1] · Nor-Edine Abriak[1] · Mahfoud Benzerzour[1] · Bassam Azrar[1]

ORIGINAL PAPER

Effect of Dewatering by the Addition of Flocculation Aid on Treated River Sediments for Valorization in Road Construction

Abdelhafid Kasmi[1] · Nor-Edine Abriak[1] · Mahfoud Benzerzour[1] · Bassam Azrar[1]

Construction and Building Materials

New experimental approach of the reuse of dredged sediments in a cement matrix by physical and heat treatment

Mahfoud Benzerzour, Mouhamadou Amar, Nor-Edine Abriak

Cement and Concrete Research

Role of porosity on the stiffness and stability of (001) surface of the nanogranular C–S–H gel

W. Sekkal, A. Zaoui, M. Benzerzour, N. Abriak

Construction and Building Materials

A bibliography on the analytical model of the mechanical behaviour in uniaxial tension of fibre concrete: Application to concrete reinforced with fibres and powders from recycling of thermoset composite materials

Mahfoud Benzerzour, Nassim Sebaibi, Walid Maherzi, Nor Edine Abriak, Yahya Sebaibi

Powder Technology

Study of the pozzolanic activity of a dredged sediment from Dunkirk harbour

Mouhamadou Amar, Mahfoud Benzerzour, Nor-Edine Abriak, Yannick Mamindy-Pajany

Journal of Building Engineering

Towards the establishment of formulation laws for sediment-based mortars

Mouhamadou Amar, Mahfoud Benzerzour, Nor-Edine Abriak

Construction and Building Materials

A laboratory-scale experimental investigation on the reuse of a modified red mud in ceramic materials production

Cyril Scribot, Walid Maherzi, Mahfoud Benzerzour, Yannick Mamindy-Pajany, Nor-Edine Abriak

Waste Management

Review

Mechanical behavior of municipal solid waste incinerator bottom ash: Results from triaxial tests

Ngoc Hung Le, Nor Edine Abriak, Christophe Binetruy, Mahfoud Benzerzour, Sy-Tuan Nguyen

Case Studies in Construction Materials

Case study

Durability of a cementitious matrix based on treated sediments

Mouhamadou Amar, Mahfoud Benzerzour, Amine El Mahdi Safhi, Nor-Edine Abriak

Environmental Technology

Beneficial reuse of Brest-Harbor (France)-dredged sediment as alternative material in road building: laboratory investigations

Walid Maherzi, Mahfoud Benzerzour, Yannick Mamindy-Pajany, Eleanor van Veen, Mohamed Boutouil & Nor Edine Abriak

PUBLICATIONS

2017-2018