Interreg
France-Wallonie-Vlaanderen
UNION EUROPÉENNE
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VALSE

Avec le soutien de la
Wallonie

Beneficial uses of dredged sediments from waterways: Towards a validation step of sediments as a resource

ENERO: June 2022

Avec le soutien du Fonds européen de développement régional

Context: Why VALSE?

General objectives:

- Promote the beneficial re-use of soil and dredged materials into the circular economy
- Validate cross-border materials valorisation pathways

Main addressed topics

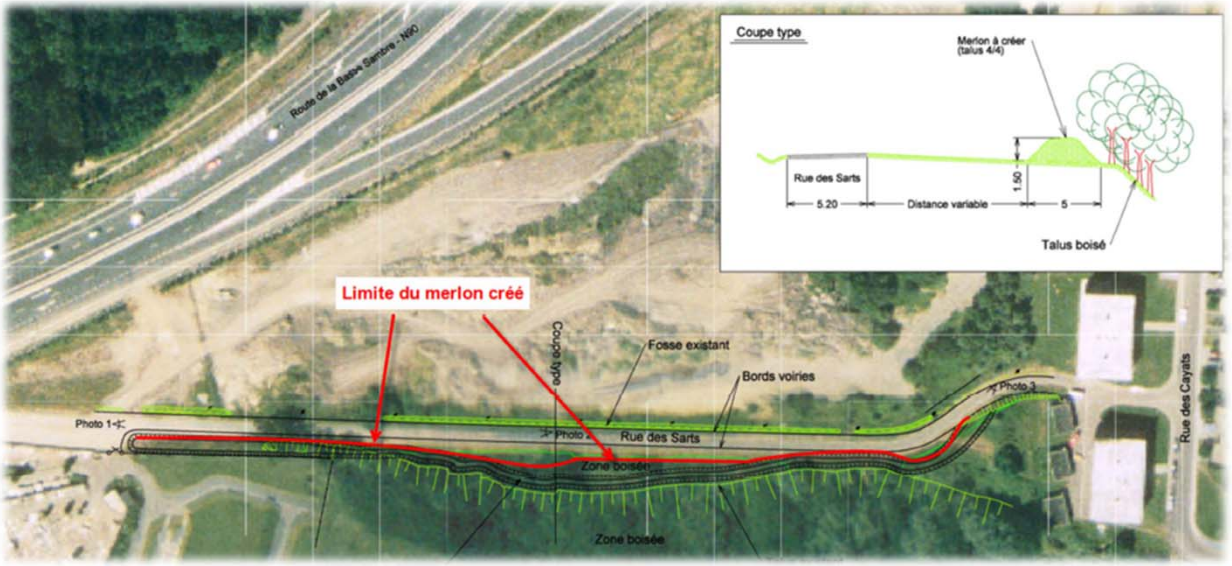
- Legislation analysis (3 regions):
  - Law comparison relative to dredged sediments and soil excavation ;
  - Identification of restrictions for re-use and valorisation;
  - Proposal strength → ease implementation pathway of valorisation.

- Tool development :
  - Analytical tools for sediments characterization in the field (pXRF, Raman, FTIR, passif samplers, electrodes,…)→ micro-pollutants
  - Decision support tools:
    - Models that allow, from the characteristics of sediments, to predict their evolution, their aging as well as potential ways of valorisation;
    - **Interactive maps which, based on the location of sediments and their physico-chemical characteristics, offer potential ways of valorisation in compliance with the principles of the circular economy.**
- Exploration of valorisation pathway :
  - « Soft » valorisation : **Landscaping pathway**: sediment mound along a roadside
  - « Hard » valorisation : Civil engineering pathway :
    - **Pouzzolan** (sediment fine fraction < 63µm);
    - **Concrete** (raw sediment fraction).

Landscaping mound (1)

Aim:

- Monitoring of the ecological quality (faunistic and floristic inventories) and the ecotoxicity of materials



Volume of unpolluted dredging material: 1500 m^3

Landscaping mound (2)


Landscaping mound and control site (Farciennes, Belgium)

Floristic inventory


Origanum vulgare
(June 2020)

Faunistic inventory


Macro-invertebrate sampling
(June 2020)


Eisenia fetida

Conclusions:

- The use of non-contaminated sediments in a landscaping mount does not have any significant toxic effect on the flora and fauna of Eutrophic sites
- Biodiversity index is similar compared to the roadside of the surrounding area with some difference in the fauna species and flora from seeds trapped in the sediments

Pozzolan pathway

Aim: To assess the potential for valorisation of a river sediment: contribution of the fine fraction (< 63µm) to the pozzolanic cement composition

Pozzolanic reactivity:

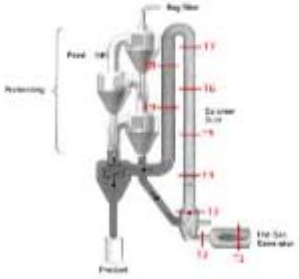
- All calcinated products are considered reactive
- Faster contribution than reference fly ash

Process

Fraction < 63 µm

Drying (70-140°C)

Calcination (750-850°C)



Grinding (Clinker)

Pozzolan

Pozzolan pathway

- **Cement**
  - 30% substitution of Portland clinker by calcined sediments
- **Performance properties**
  - Mechanical resistance slightly higher than CEM II/B-V (containing fly ash)
  - No setting delay problems, nor affected resistance (combustion of the OM)
  - Easily adjustable workability using commercial superplasticizers (PCE type) – Durability (on concrete) has been demonstrated to be equivalent to CEM II/B-V composite cement
- **Environnemental compatibility**
  - Leaching (lixiviation) tests on hardened (28 days) and crushed mortars
  - No exceeding of the standards observed, heavy metals (if present) are frozen by the cement matrix

Conclusion: The equivalent performance and the environmental compatibility demonstrated in the VALSE project present a favorable balance for the pozzolan pathway

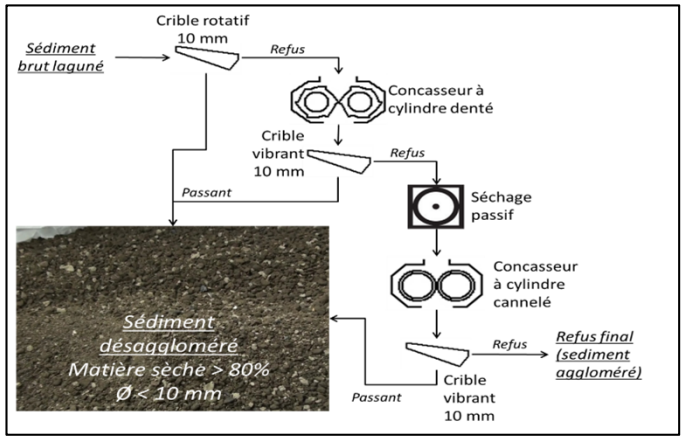
Concrete pathway

Aim: To assess the potential of waterways sediments as a substitute for the sandy fraction in the cement concrete for the construction of a cycle path

Sediment typology of Hauts-de-France (France) and walloon (Belgium):

- Very high fines (silt) content (70 – 90%) → very small grain fraction
- High content of organic matter and heavy metals (mainly: Zn, Pb, Cu) due to a fairly similar industrial history → Contaminated sediments

Mechanical treatment



Final granulometry

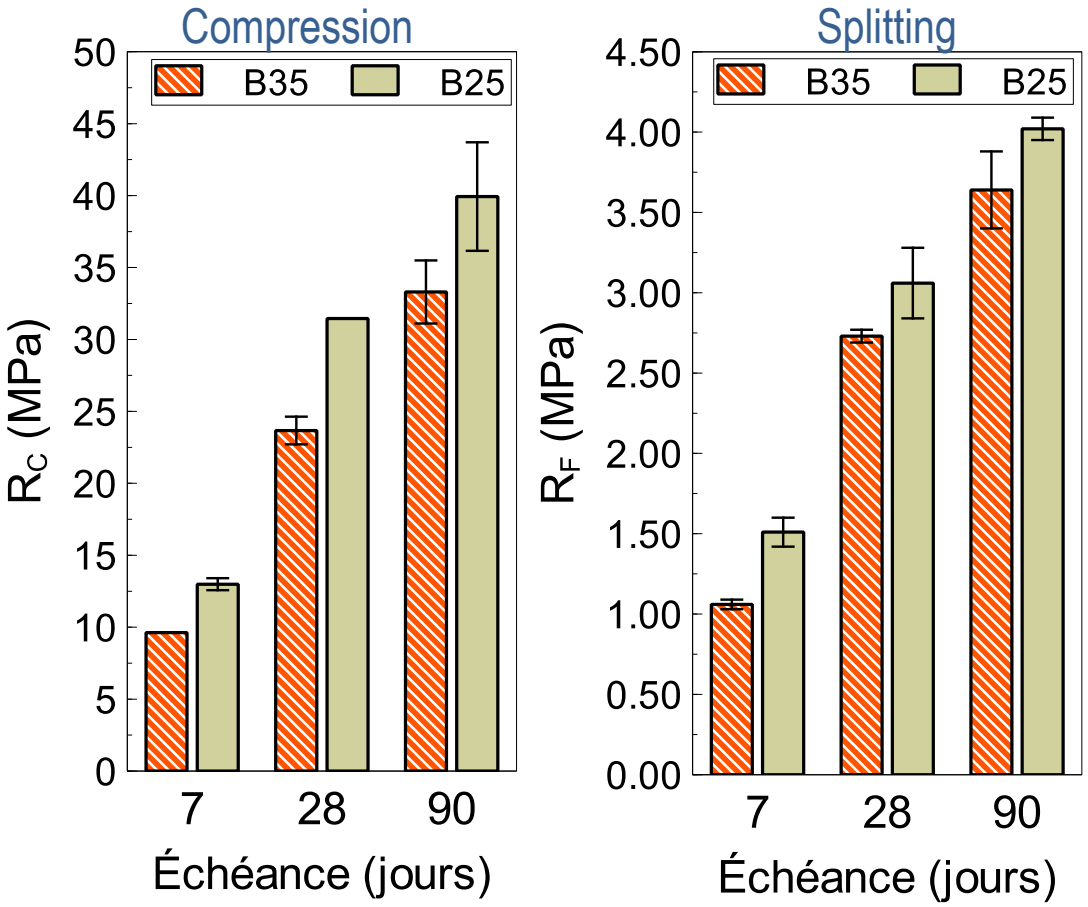
<63µm	**75%**
$LOI_{550°C}$ (≈MO)	**13%**
Fluorine >TS : Catégory **B** (AGW95)	

Heavy metal concentrations

	Solid ($mg.kg^{-1}$)	Eluate ($mg.kg^{-1}$)
Zn	1115	<1
Pb	194	<0,5
Cu	81	<1

Concrete pathway

Mechanical performance in test tubes (Φ11*22cm³)



Applicable and current standards:

- NF EN 206
- NF P 98-170 (road cement concrete)

B35 - 28 days :

$R_C = 23,67 \pm 0,96$ MPa → C25

$R_S = 2,73 \pm 0,04$ MPa → **S2,7**

→ **Concrete of class 5** : sufficient "resistance" for a cycle path

B35 : Sed 220 kg.m^{-3}

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Concrete pathway

From « laboratory » scale to « field» scale : mechanical monitoring of the cyle path

			Compression			Splitting	
		E/C	$R_{c\text{-}7}$ (MPa)	$R_{c\text{-}28}$ (MPa)		$R_{s\text{-}7}$ (MPa)	$R_{s\text{-}28}$ (MPa)
Concrete plant	BC[1]	0,53	24,83	40,11		2,57	3,87
	BE[2]	0,75	14,00	26,21		1,54	2,61
Core (cycle path)	BC	0,53	21,54	35,06		–	2,01
	BE	0,75	13,70	22,50		–	1,83

[1]BC = Control concrete; [2]BE = B35 = Experimental concrete (35% sand)

B35 : Sed 220 kg.m^{-3}

Conclusions:

- « Drying delay » effect on BE (concrete with sediment) → sediments affect the rise in resistance due to the negative effect of organic matter on the cement setting;
- Labo/Field (Core worksite) → simillar and consistent results.

Concrete pathway

Pilot test site in Chatelet (Belgium) for the cycle track

Conclusions:

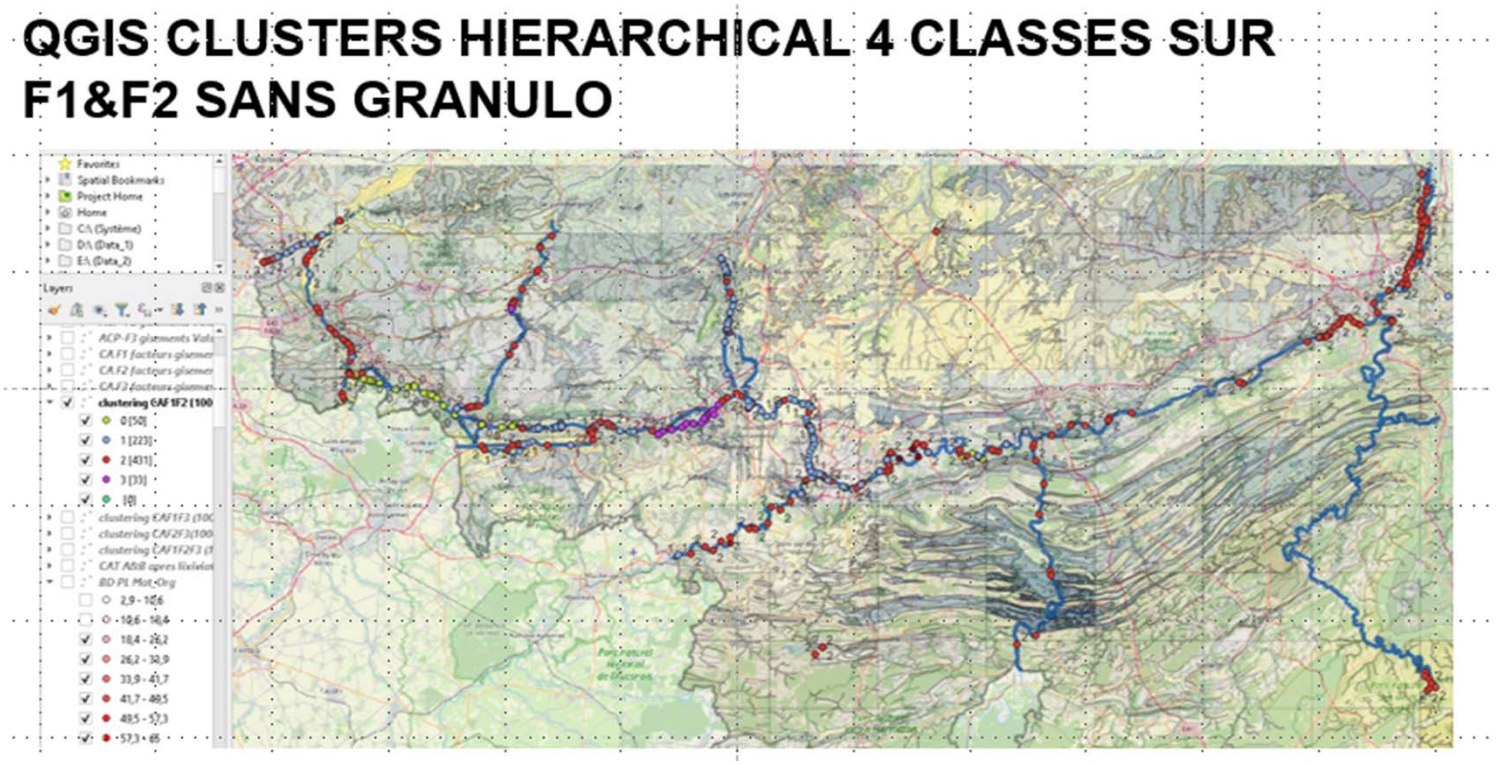
- 1st Educational cycle path with sandy fraction substituted at 35% by mass by contaminated river sediment
- Experimental formulation allows the use of 220 kg of dry sediment per m3 of fresh concrete.
- “Freezing/defreezing” resistance on BE/BC results show no significant difference
- The environmental analysis (lixiviation test) on the concrete leachates comply with the legislation

Sediments classification

***Objectives**: Characterize the sediments into categories towards the different valoraisation pathways*

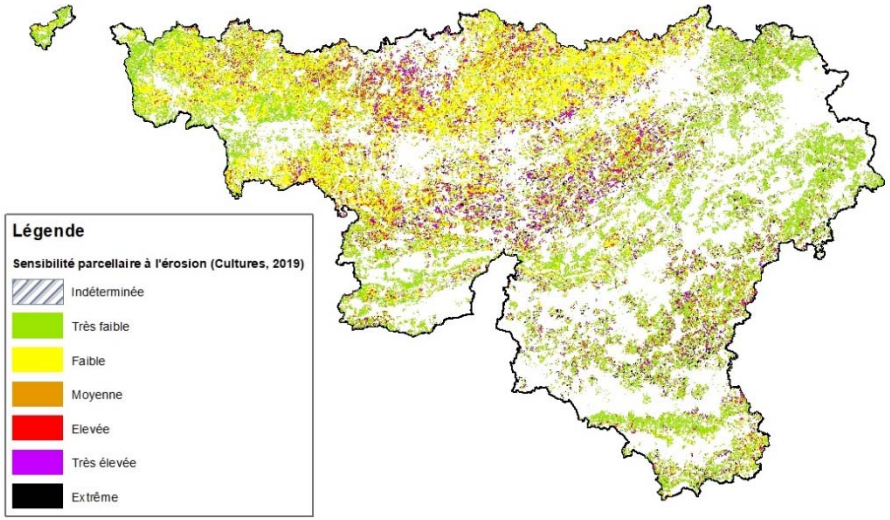
***Approach**: Statistical analysis (cluster analysis) of the Walloon (SPW) and French (VNF) databases, mapping of associations*

***Data**: inorganic/ organic contaminants, particle size, mineral composition*



Interactive map

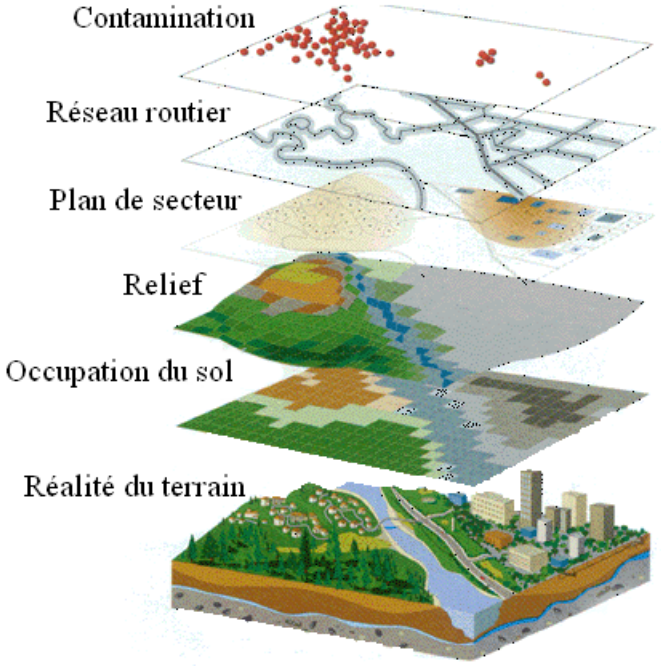
Strategy proposal : cartographic and GIS tool



Sensitivity to erosion of agricultural plots on bare soil in Wallonia. Source: Giser

Tool: **G**eographic **I**nformation **S**ystem as a management tool

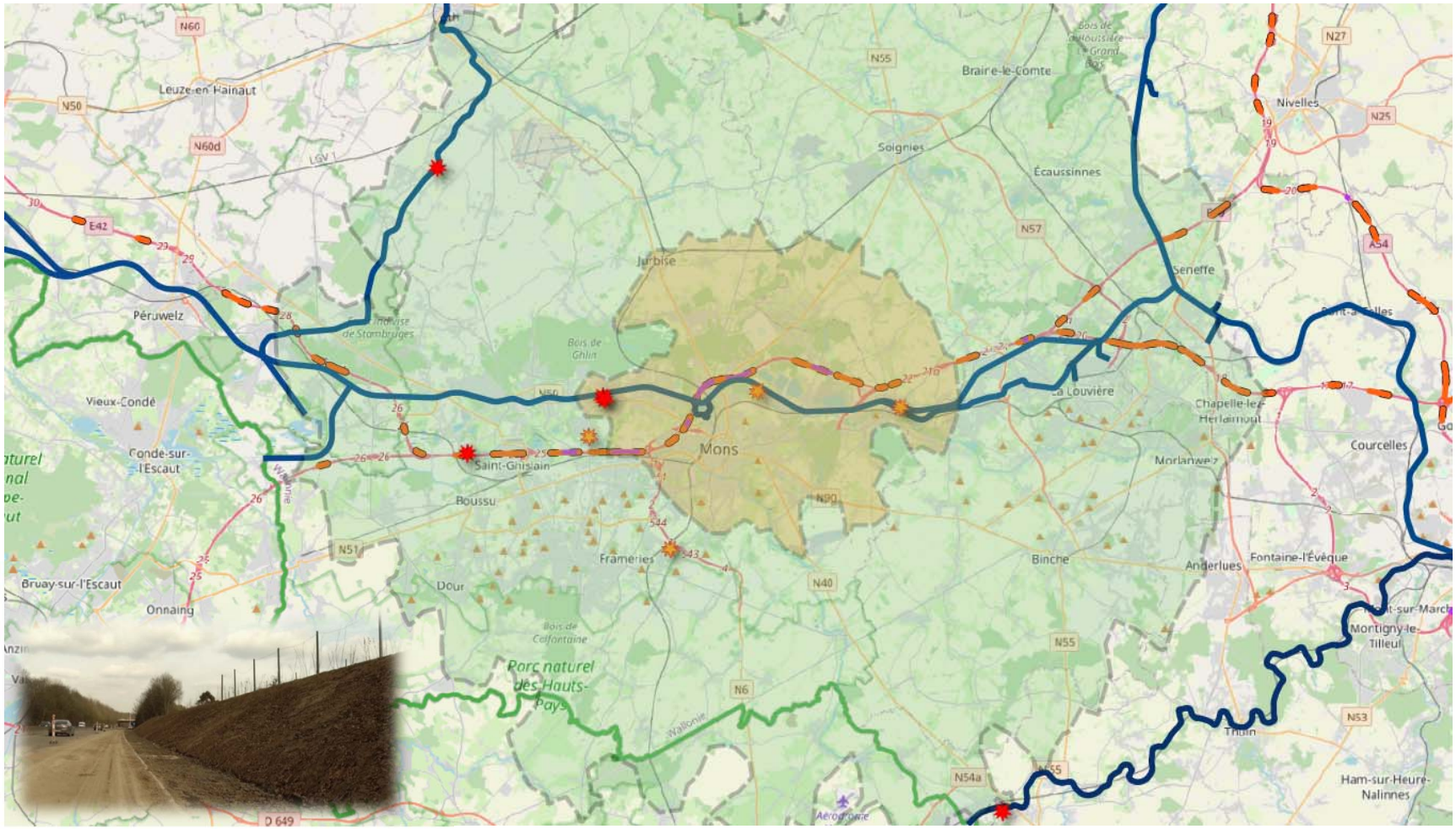
GIS?



Objective: Interconnection of dredged sediments disposal sites and sites for valorisation pathways

Interactive map (1)

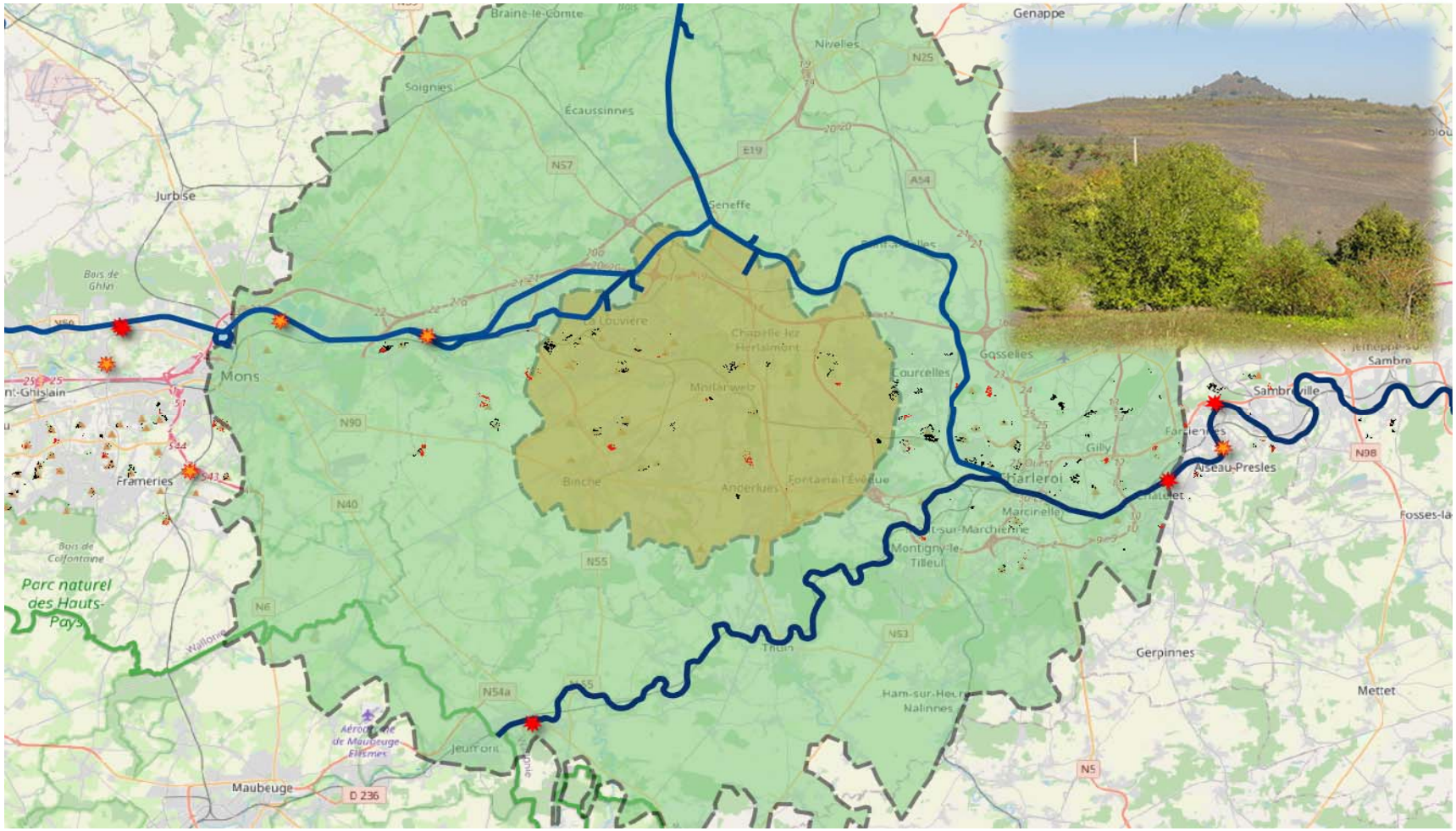
Relationship between the demand and the offer : From the "disposal sites" towards the "valorisation pathways"
A civil engineer perspective of noise-reducing embankments on motorways



Region of Mons-Charleroi: location of noise-reducing embakments available (Orange dots) along the speeedways on a maximal distance by truck of 10 Km (yellow color area) and of 25Km from a disposal site located at *Obourg (green color area). Orange /red stars: disposal sites*

Interactive map (2)

Relationship between the demand and the offer: From the "valorisation pathways" towards the "disposal sites"
An agronomic perspective of valorisation based on flat mining heap



Région Mons-Charleroi: location 25Km from a disposal site available on a maximal distance by road (Yellow color) and of 25Km by truck from a mine heap located in *Morlanwelz. Red spots : Contaminated or potentially contaminated soil; Black color: uncontaminated soil; Orange /red stars: disposal sites*

General conclusions

- Promising valorisation pathways of dredged sediments within the circular economy framework with industrial interest for concrete and pozzolan tracks;
- 1st Walloon educational cycle path based on waterway sediments;
- Landscaping mound opportunities (with noise reduction effect);
- GIS tool to assist sediment management.

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Thank you for your attention

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