

Prioritization of valorization scenarios for sediment deposits management – VALSE project

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- Introduction
- Methodological approach
- Building of 2 indicators for the valorization scenarios prioritization
- Use of the 2 indicators in a GIS

Nord-Pas-de-Calais region has been strongly marked by an industrial and mining past:

- => soil and sediment contamination in the waterways and river basin including 186 historic onshore sediments deposits managed by VNF

Prioritization of the valorization scenarios needs to take account of **social-economic context** and **sediment quality**.

The objectives are therefore to provide a **decision-making tool** constructed **from indicators** and dealing with **valorization scenarios** of these deposits.

This study is a part of the **Interreg V France-Wallonia-Flanders VALSE project** and this part focus on historic deposits valorization. The project VALSE aims to propose and validate valorization scenarios for sediments.

The approach adopted for the prioritization for the valorization scenarios includes :

- the building of the **2 indicators**:
 - management **of VNF sediment characterization data**;
 - selection of 2 valorization scenarios with VNF;
 - assessment of **human populations exposure** for the **two major scenarios (green park, hunting area)**;
 - building of a global health risk indicator;
 - building of a **socio-economic** indicator.
- the use of the 2 indicators in a GIS.

The working steps includes:

- creation of a **sediment characterization database** of a subset (119 sites) of the 186 sediment deposits sites with chemical characterization (8 heavy metals, 7 PCBs, 16 PAHs) and location (GPS data);
- selection of **2 valorization scenarios : green park and hunting area**;
- sélection of the data concerning the first 50 centimeters of sediment deposits;
- tests of spatial correlation of the characterization data at different scales.

Parameters used for scenario exposure routes/pathways:

- « Green park » : inhalation of gaseous pollutants, ingestion of soils) ;
- « Hunting » : (inhalation of gaseous pollutants, ingestion of soils and consumption of rabbits);
- All analyzes of surface soils (8 metals, 7 PCBs, 16 PAHs).

A bioconcentration factor approach was used to account for the contamination of rabbits:

- from analysis data of caged rabbits on site transmitted by VNF;
- in the absence of measurements, by a QSAR model (dependent on the Kow of the substances).

Health risk assessment: model used

The health risk assessment calculations were carried out using the MODUL'ERS software, which is a modeling and simulation platform.

MODUL'E-RS

Moduler's - schema_conceptuel2*

Model

Information

Legumes_feuilles (Sub-system)

Id: Legumes_feuilles

Description: Ce module permet de calculer les concentrations dans les végétaux consommés liés aux dépôts atmosphériques directs, à l'absorption gazeuse (polluants organiques), aux dépôts de particules du sol remises en suspension, à l'irrigation par aspersion, au prélèvement direct à partir du sol. Pour calculer la concentration dans le végétal considéré, il est nécessaire de définir son type (grains, autres_parties_supérieures_d'une_plante : tige, feuilles, fruits ; fourrage, tubercules, parties_racinaires) et les différents transferts à prendre en compte. Un module sera défini pour chaque type de végétal à considérer. **Ce module est paramétré pour des végétaux de type "légumes-feuilles"**. Les concentrations dans les végétaux sont données au moment de la récolte et de récolte en récolte. La date de

Dose_veg_classe_age (Expression)

Id: Legumes_feuilles.Dose_veg_classe_age

Full name: Dose d'exposition par ingestion de produits végétaux

Symbol: Dose_veg_classe_age

Sub-system: Legumes_feuilles

Unit: mg kg⁻¹ d⁻¹

Dimension: Materials.Classes_d'age

Referenced by: Dose_veg_individu

Expression

$$(Age_{min_classes} < 1000000.0) * (Q_{veg} - Cp * tsp * f_{veg_dec} * f_{veg_exp} / B_w)$$

where

Symbol	Unit	Full name	Type	Sub-System
Age _{min_classes}	year	Age minimal de chaque classe d'âge	Parameter	Constantes_Replage
Q _{veg}	kg _{vegetal} d ⁻¹	Masse de ce type de produit d'origine végétale ingérée par jour par la cible humaine	Parameter	Legumes_feuilles
Cp	mg kg _{vegetal} ⁻¹	Concentration dans la plante à la récolte	Expression	Legumes_feuilles
tsp	kg _{vegetal} kg _{vegetal} ⁻¹	Teneur en matière sèche des végétaux	Parameter	Legumes_feuilles
f _{veg_dec}	unitless	Facteur de décontamination du produit d'origine végétale avant consommation	Parameter	Legumes_feuilles
f _{veg_exp}	unitless	Fraction de la quantité consommée et exposée à la contamination du site pour le végétal	Parameter	Legumes_feuilles
B _w	kg	Masse corporelle de la cible	Parameter	Legumes_feuilles




Moduler's

Health risk assessment: exposure matrice






Exposure parameters were calculated for age groups 0 to 70 years old and include:

- time spent on site and soil ingestion for the 2 scenarios;
- consumption of rabbits for the hunter scenario.

Exposure matrice of the model MODUL'ERS

 Constantes Reglages	Constantes Reglages to Sol	Constantes Reglages to Conc gaz air extérieur	
	 Sol	Sol to Conc gaz air extérieur	Sol to Niveaux Exposition Risque
		Conc gaz air extérieur	Conc gaz air extérieur to Niveaux Exposition Risque
			 Niveaux Exposition Risque

« Green park » exposure matrice

 Constantes Reglages	Constantes Reglages to Sol	Constantes Reglages to Conc gaz air extérieur	Constantes Reglages to Fourrage		
	 Sol	Sol to Conc gaz air extérieur	Sol to Fourrage Sol to Fourrage	Sol to Lapin	Sol to Niveaux Exposition Risque
		Conc gaz air extérieur	Conc gaz air extérieur to Fourrage		Conc gaz air extérieur to Niveaux Exposition Risque
			 Fourrage	Fourrage to Lapin	
				 Lapin	Lapin to Niveaux Exposition Risque
					 Niveaux Exposition Risque

« Hunting area » exposure matrice

Health risk assessment: results and selection of scenario

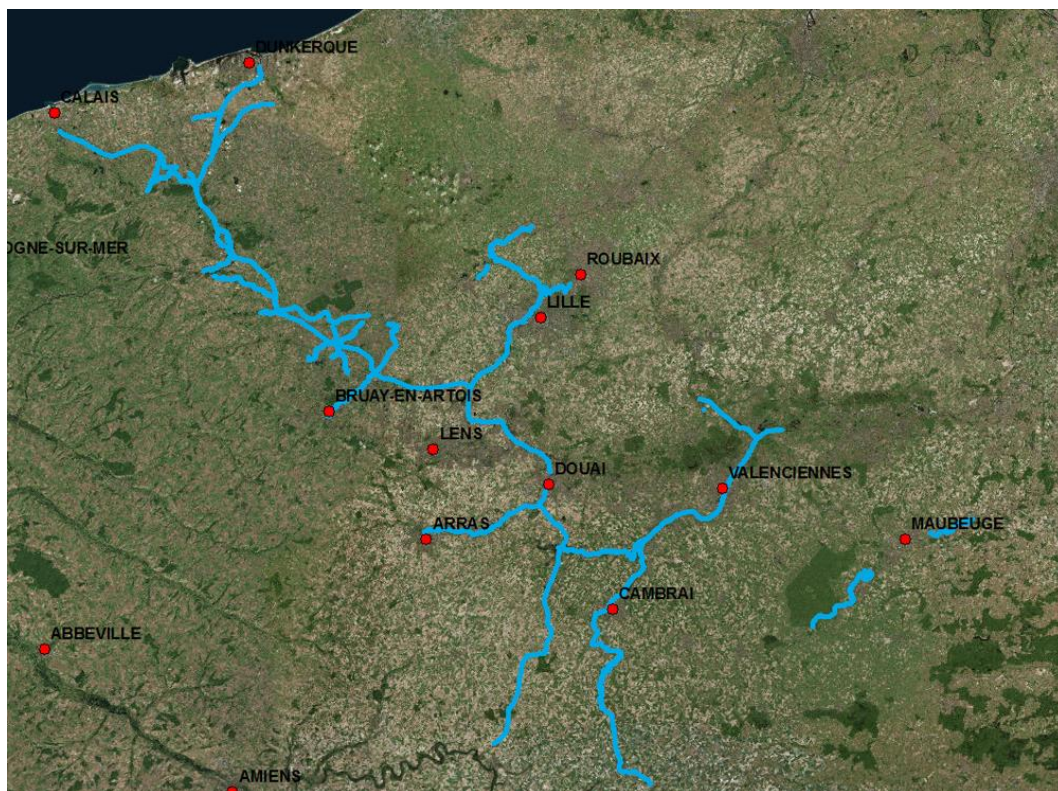
Hazard Quotients (HQs) were calculated per target organ for the two routes totaling 13 organ systems for application per route and per substance.

The simulations for the “Green park” scenario show exceedances of the risk threshold value for 7 sites out of 119. These exceedances are mainly linked to arsenic for the carcinogenic risk (CR) and lead for the non-carcinogenic risks (HQ). This scenario was confirmed as the reference scenario.

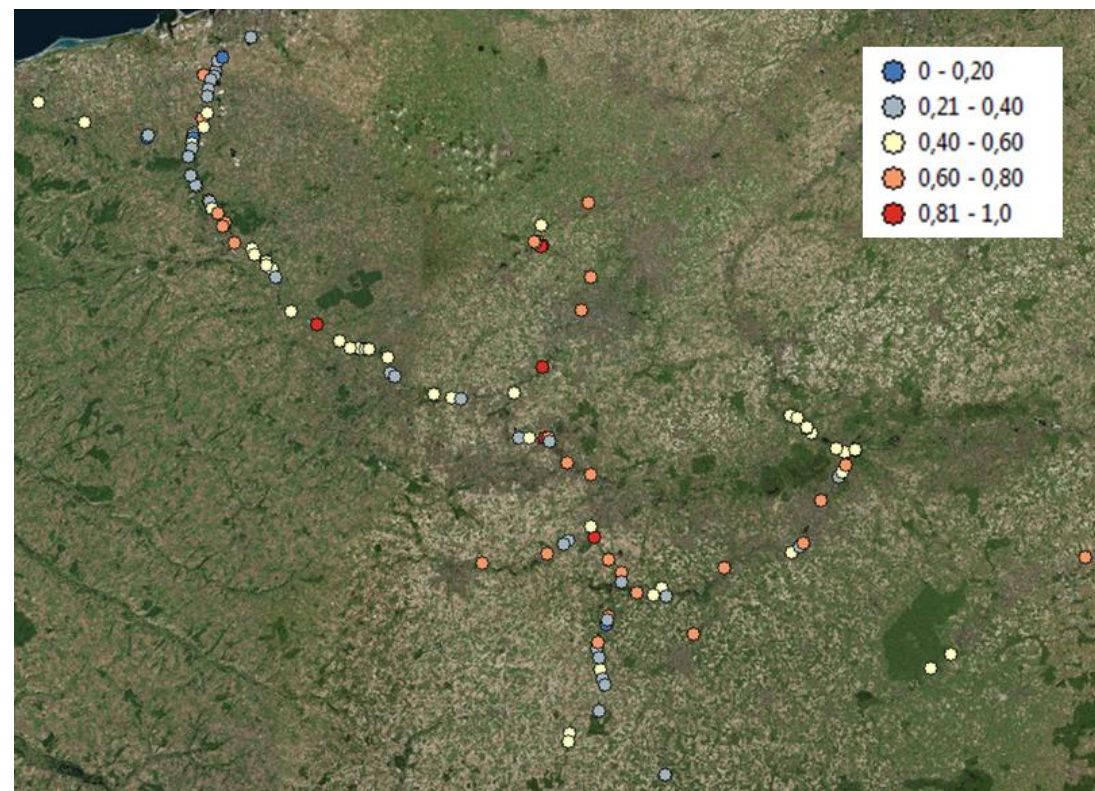
In the case of the “Hunting area” scenario, almost systematic exceedances of risk threshold value are linked to exposure to lead through the consumption of rabbits. The presence of potentially pre-existing lead linked to hunting activity does not, however, allow a conclusion for this parameter. At a few sites, the CR for arsenic also exceeds the risk threshold value.

Building of a global health risk indicator

The raw values of HQs and CRs are normalized, reduced to $[0 - 0.5]$ and summed to produce the global health indicator “ENV” at the 119 sites. This indicator must be only used for comparison purpose.

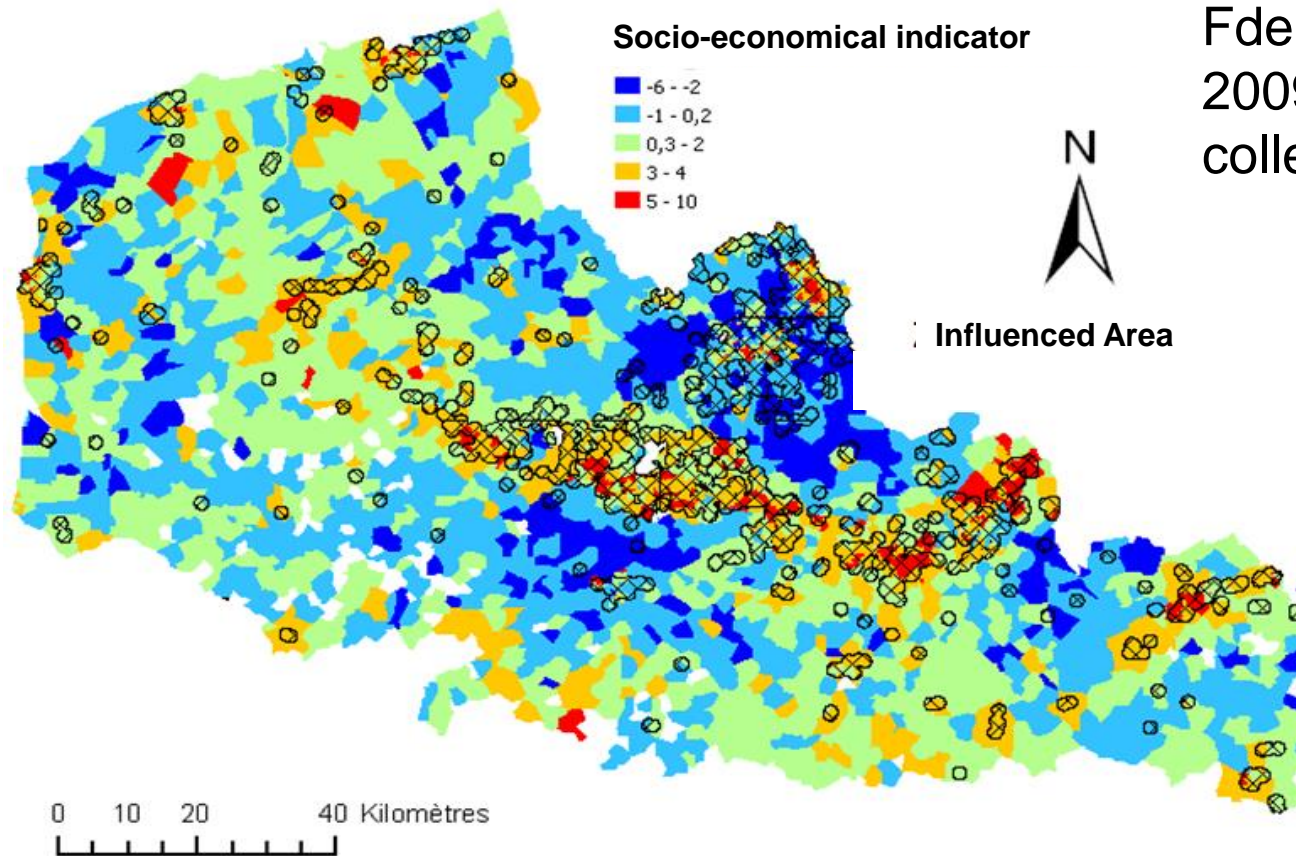


River basin



ENV indicator

Building of a social economic factor: use of a social deprivation index



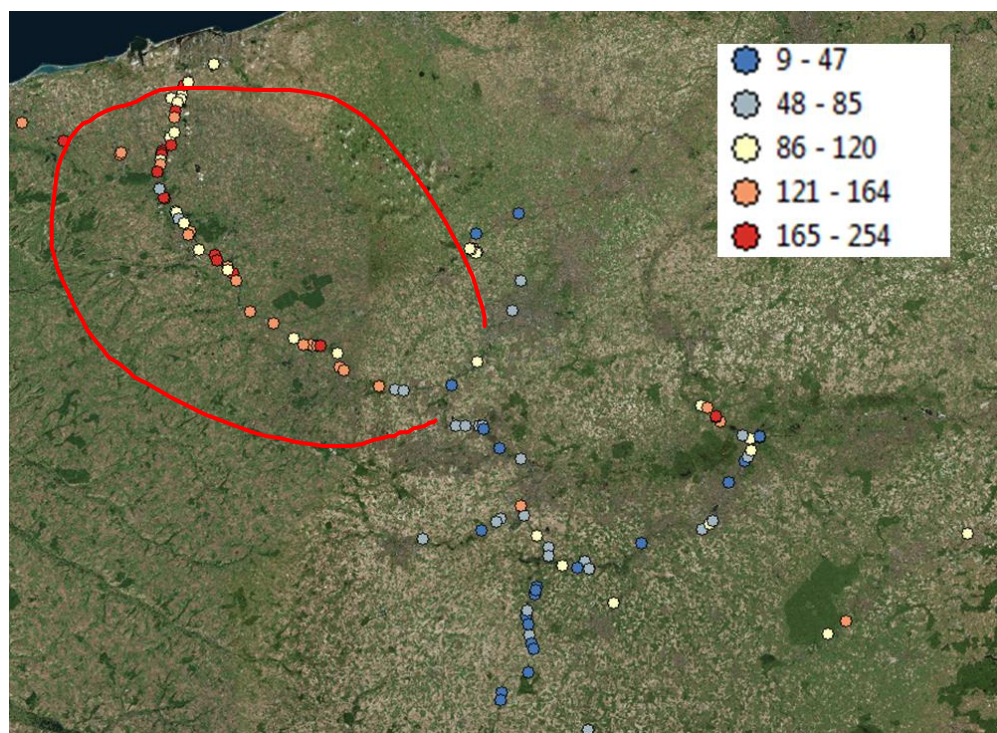
Fdep : social deprivation index (Rey et al., 2009) based on 4 socio-economic variables collected in the 2008 INSEE census:

- 4 variables (INSEE): unemployment, income, diploma, worker
- sum of the 4 reduced, weighted and stratified centered variables

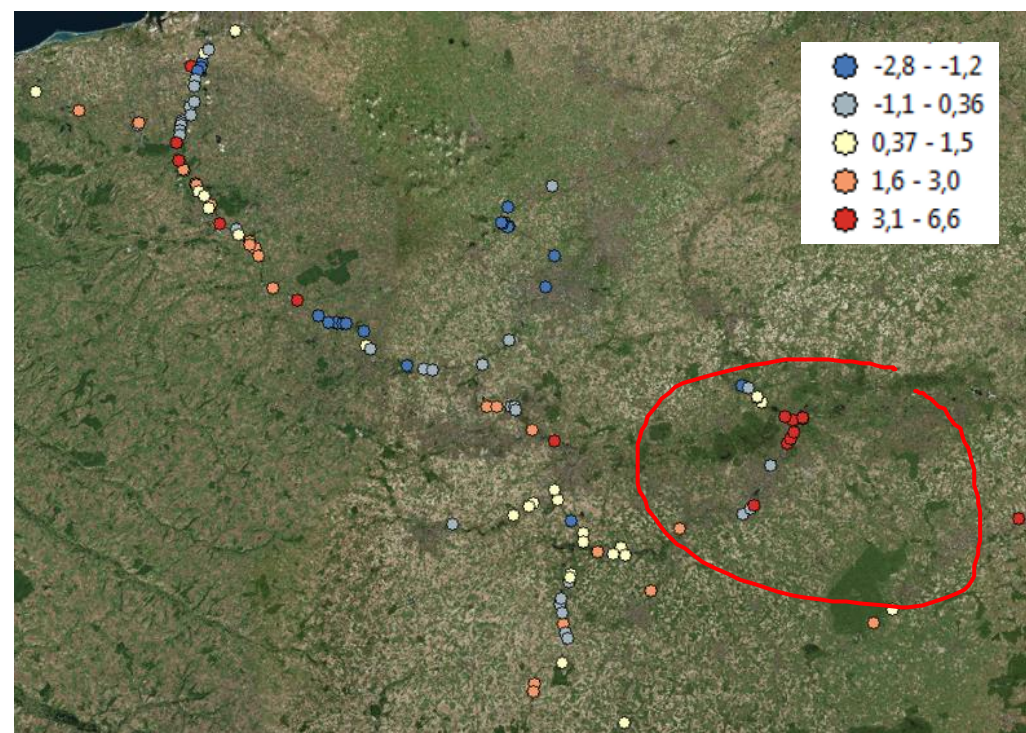
Methodological approach : building spatial composite indicators to analyze environmental health inequalities on a regional scale (Caudeville et Rican, 2016).

Building of a social economic factor: use of Nord Pas-de-Calais population and social deprivation index

Combination of the population living within a radius of one km (POP parameter) and the social deprivation index (FDEp).

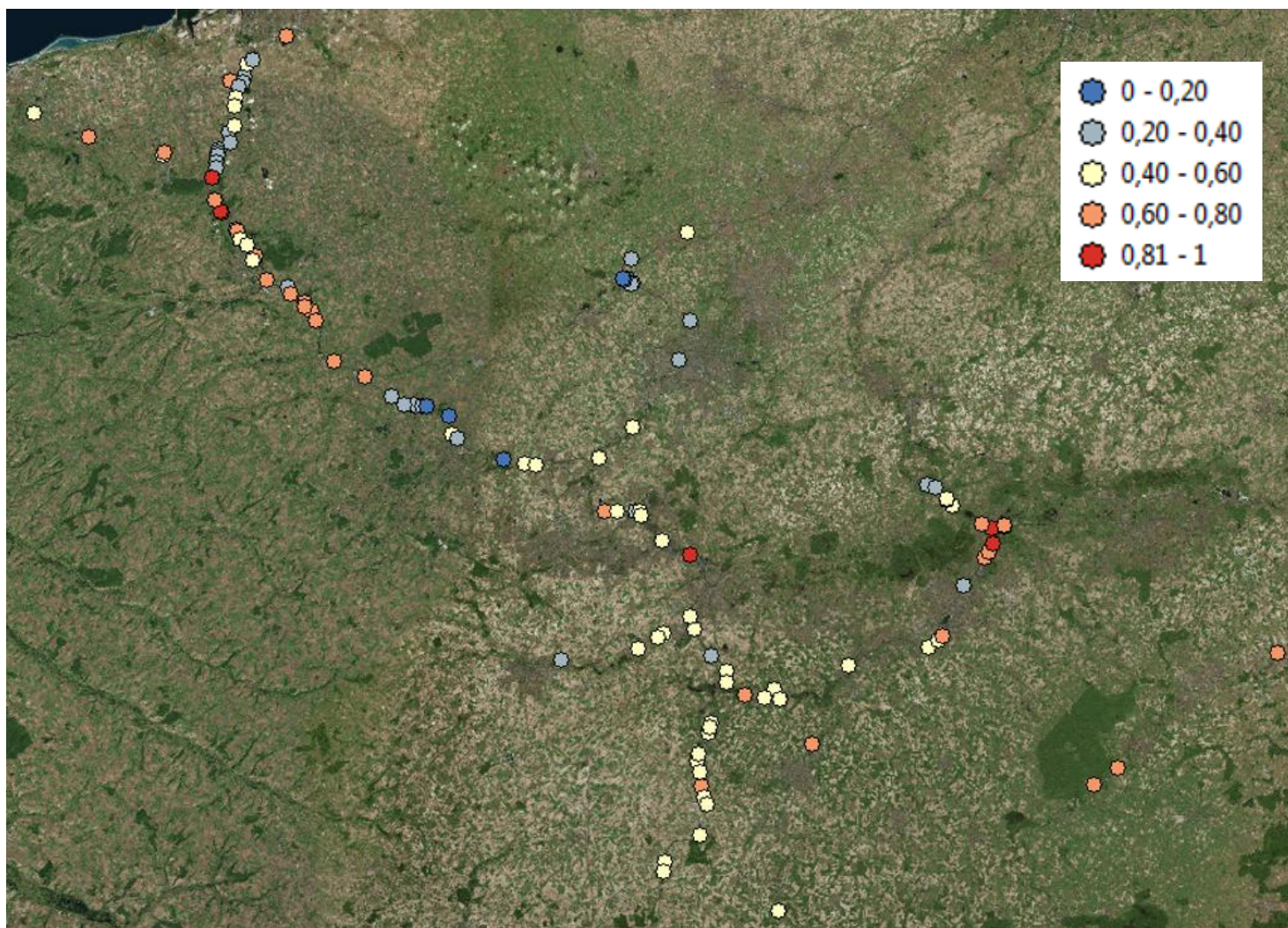


POP : Population for radius = 1km



FDep index

Building of a social economic factor: (POP Fdep) indicator

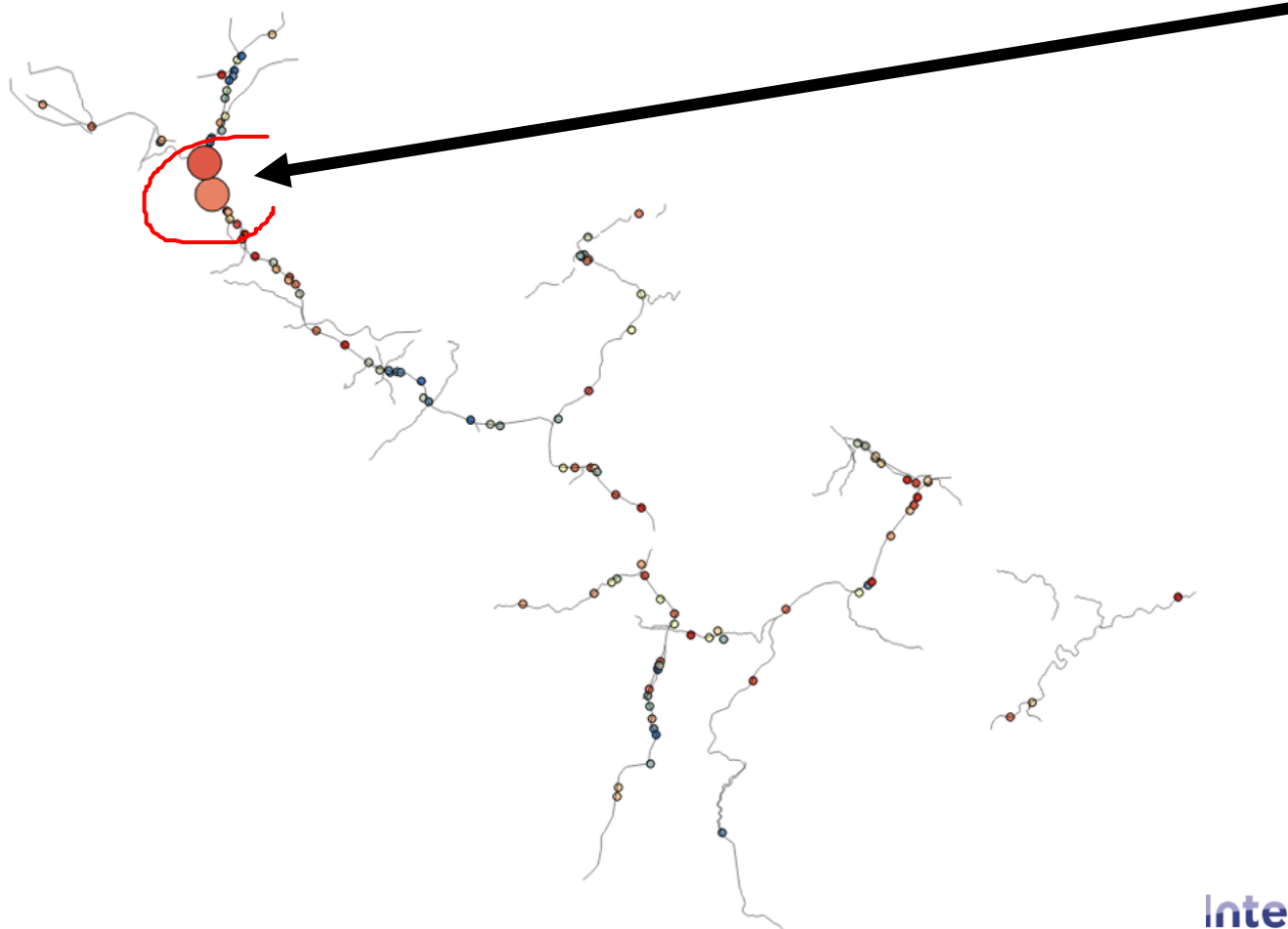


(POP FDep) indicator in the Nord-Pas-de-Calais river basin

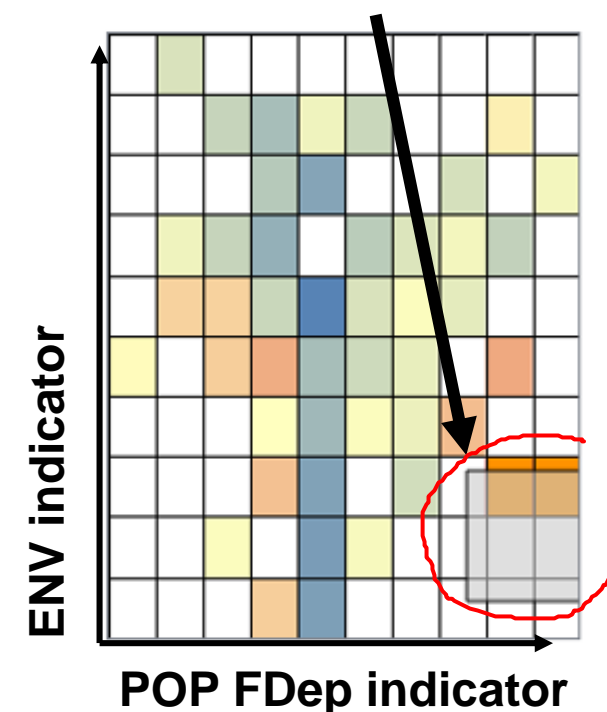
Prioritization for sediments deposits management: case 1

Use of indicators for decision support:

- case 1: choice of strong socio-economic issues and low environmental risks
(willingness to reduce only socio-economic inequalities)



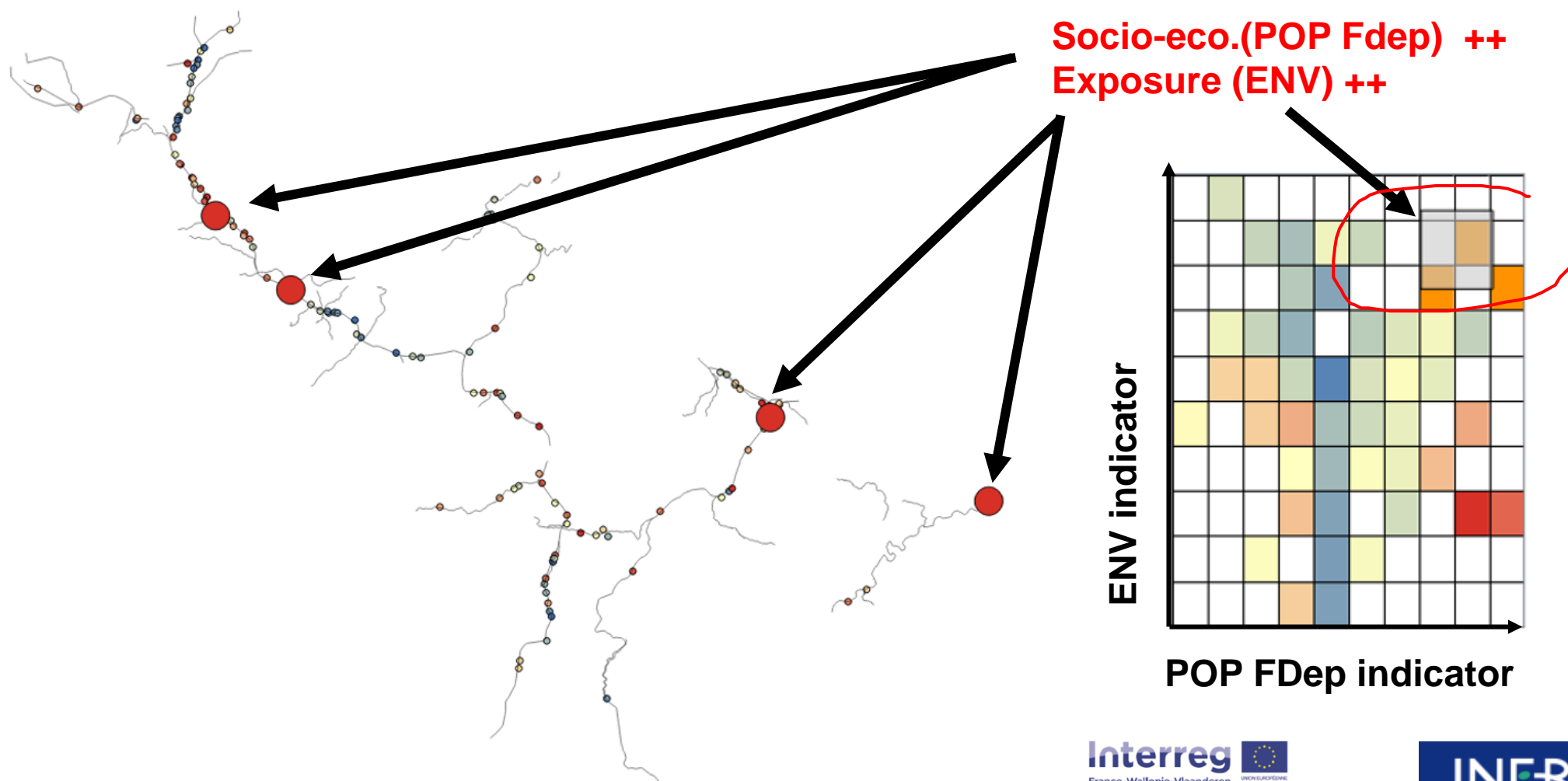
Socio-eco. (POP FDep) ++
Exposure (ENV) --



Prioritization for sediments deposits management: case 2

Use of indicators for decision support:

- case 2 : choice of strong socio-economical and health risk issues (willingness to reduce socio-economical and environmental inequalities)



Thanks for your attention !

More info on VALSE projet: <https://valse.info/>

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