



Ecological rehabilitation of polluted brownfields : development of an operational tool for assessing the functions of urban soils at the scale of development projects

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REGULATORY FRAMEWORK

Climate and Resilience Law, 2021

ZAN Law, 2023

Soil Monitoring Law, 2024

Zero Net Land Take policy (ZAN)
(2050) :

Artificialisation =

alteration [...] functions -

renaturation : improvement [...]
fonctionnalité



Need for
functionality
assessment
methods at
planning and
project scales, for
urban brownfield
soils




3 winning case
studies from
the 11th call for
brownfield
projects under
the 2030
recovery plan

SCIENTIFIC RESEARCH ON SOIL FUNCTIONALITY ASSESSMENT

Limits identified (ADEME, 2023)

- *Agronomic parameters ++
- *Few field experience feedbacks
- *Heterogeneous interpretation guidelines :
 - expert judgement ++
 - agricultural context ++
- *The notion of soil contamination is focused on health issues

Levers identified (ADEME, 2023)

- *  the use of biological and field soil parameters
- *Adapt interpretation guidelines to urban soils
- *1 land use = 1 adapted interpretation guideline
- * Implement operational guides
- * Working on the scale of urban planning

SCIENTIFIC RESEARCH ON SOIL FUNCTIONALITY ASSESSMENT

Project issues

1. Include operational, field-measured, biological and agronomic parameters
2. Include soil contamination as a degrading parameter
3. Create interpretation guidelines adapted to urban brownfield soils
4. Provide field feedback on rehabilitated polluted brownfields
5. Improve knowledge of urban brownfield soils
6. Provide a soil functionality assessment on a project scale

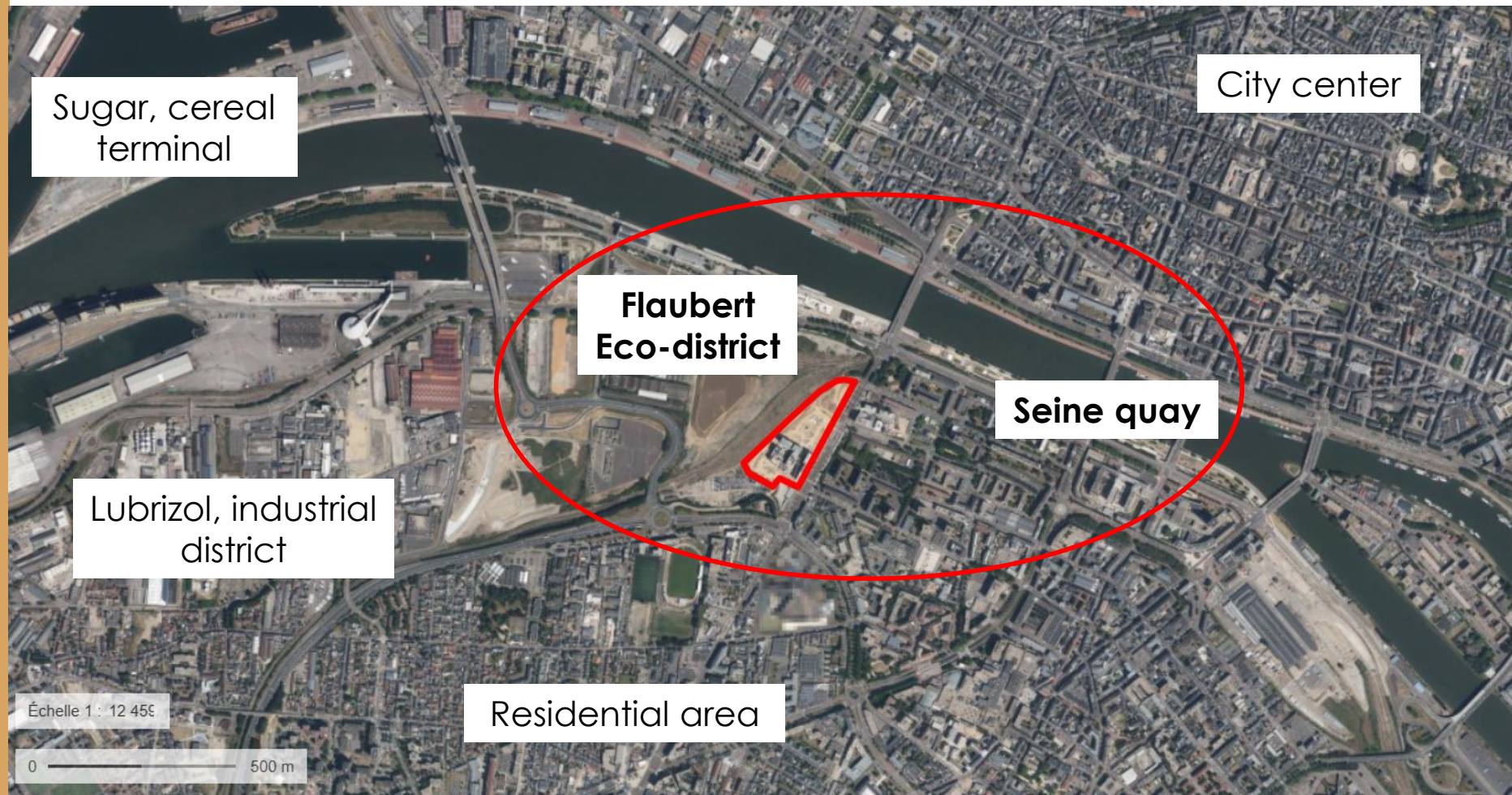
What positive or negative effects of the brownfield rehabilitation works on soil functionality ?

CASE STUDY : ROUEN FLAUBERT ECO-DISTRICT



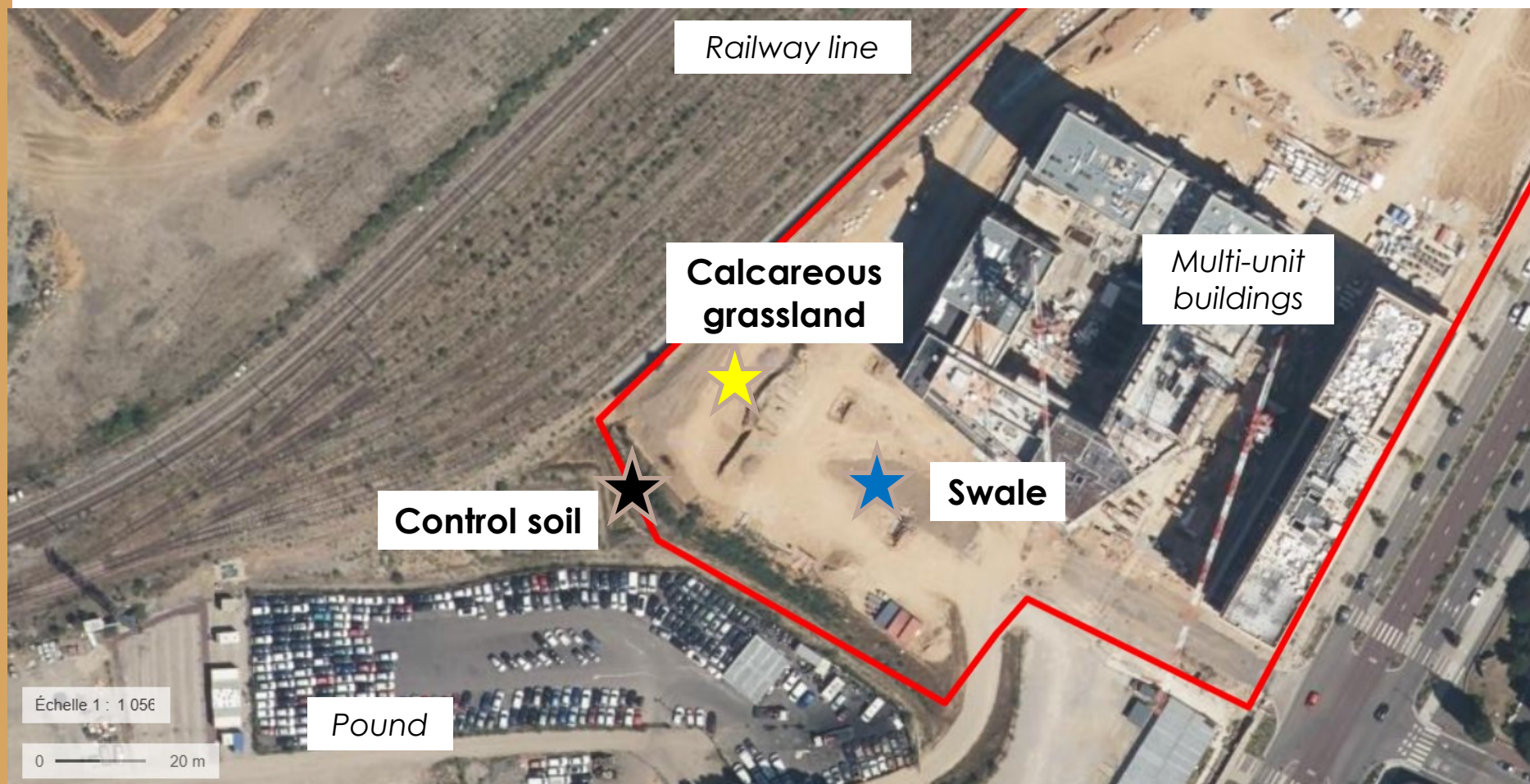
Geoportail©

CASE STUDY : ROUEN FLAUBERT ECO-DISTRICT



Geoportail©

CASE STUDY : ROUEN FLAUBERT ECO-DISTRICT



MATERIAL AND METHODS

EXPERIMENTAL SOIL MODALITIES

Local functional
reference soil

REF22_QS



< ?

Control soil / TEM3_ECO _22

Initial state : control soil



> ?

2022



2024

Soil Restoration work

< ?

Final state

Control soil / TEM3_ECO_24



< ?

Calcareous grassland : T24_PC



< ?

Swale : T24_NO



Legend :

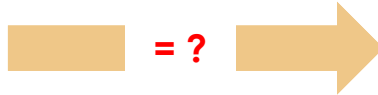
>> Far superior functionality > Superior functionality = Equivalent functionality

REFERENCE SITUATIONS : NO CHANGE OF LAND USE

Control soil / TEM3_ECO_22



2022



Control soil / TEM3_ECO_24



2024

REF22_QS



Seine quay



REF22_QS



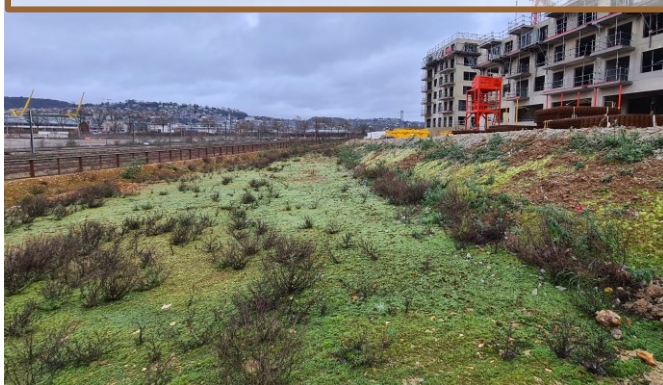
PROJECT SITUATIONS : CHANGE OF LAND USE

Control soil / TEM22_ECO



2022

Control soil / TEM22_ECO



Swale : T24_NO



2024

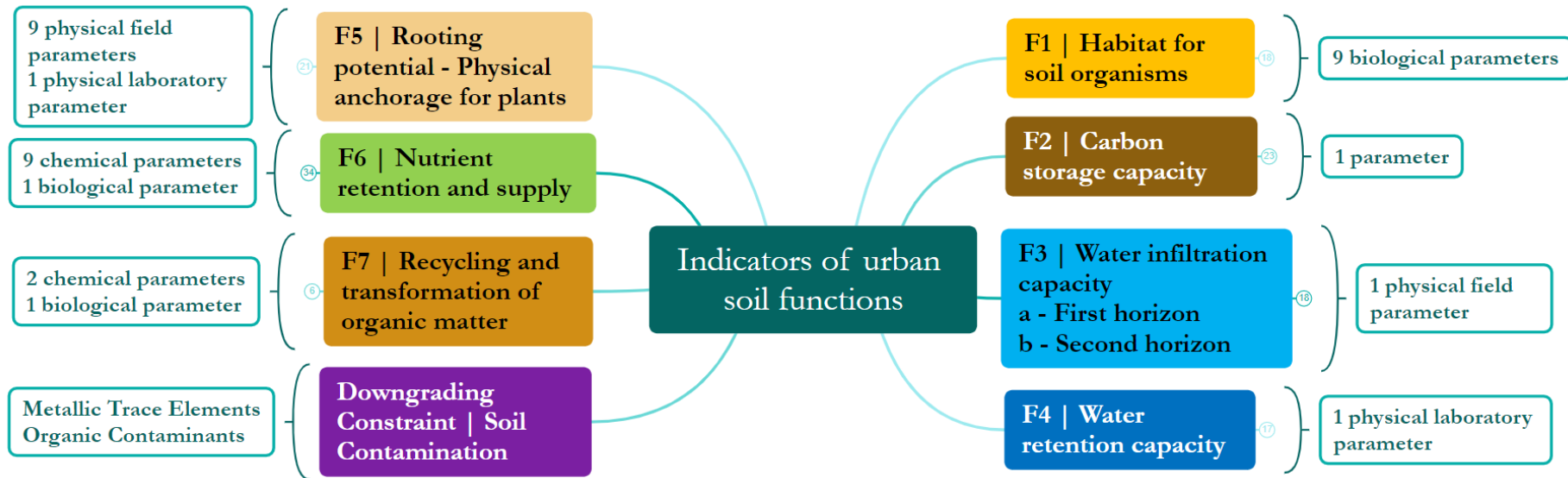
Calcareous grassland : T24_PC



SOIL FUNCTION ASSESSMENT METHODOLOGY

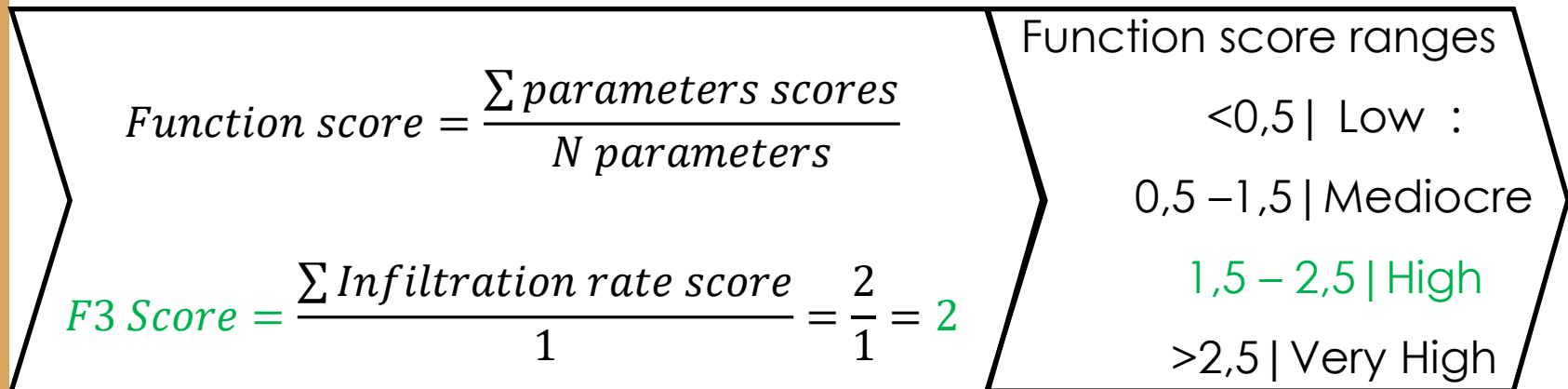
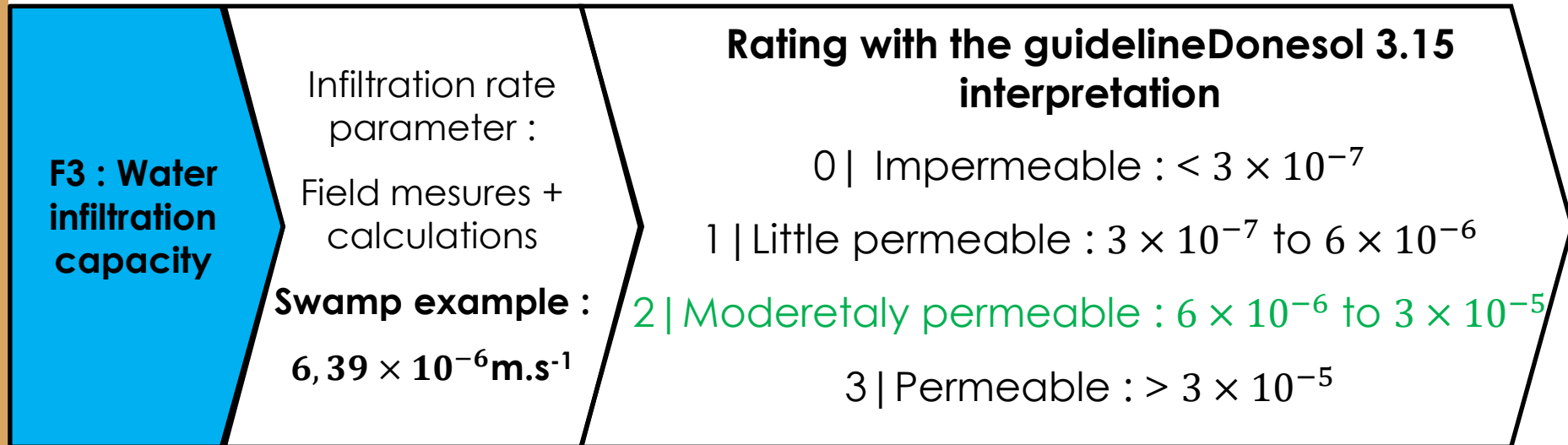
Review of scientific and grey literature (functions and contamination) :

- Select operational parameters (x 35).
- For each indicator, select and adapt interpretation guidelines to the context of urban brownfield soils.
- Define the most suitable scoring method for indicators and functions.



SCORING METHODOLOGY

Example with function 3 : water infiltration capacity



SCORING METHODOLOGY

Example with function 1 : habitat for soil organisms

F3 : Habitat for soil organisms

8 parameters

- Soil cover
- Traces of biological activity
- Nematofaunal abundance (nb/g soil)
- Nematofaunal diversity index (Shannon)
- Nematofaunal structure index
- Microbial biomass (%OC)
- Earthworm abundance (nb/m²)
- Taxonomic richness of earthworms (n taxons)

Swamp example : 158 earthworms / m²

Rating with expert opinion, SUPRA, OPVT and Elisol interpretation guidelines

Earthworm abundance (nb/m²) : rating with the SUPRA/OPVT interpretation guideline

0 | Very low : < 25

1 | Low : 25 - 150

2 | Mediocre : 150 - 300

3 | High to very high : > 300

$$\text{Function score} = \frac{\sum 8 \text{ parameters scores}}{8 \text{ parameters}}$$

$$\text{F1 Score} = \frac{\sum (3, 1, 3, 3, 1, 1, 2, 2)}{8} = \frac{16}{8} = 2$$

Function score ranges

<0,5 | Low :

0,5 – 1,5 | Mediocre

1,5 – 2,5 | High

>2,5 | Very High

SCORING METHODOLOGY

Example with downgrading constraint : soil contamination (First horizon).

Selected threshold values selected from scientific literature :

« A criteria » from Coussy and coll. (2020) : mixing thresholds of ISDI and National pedogeochemical background.

0 | $x < A \text{ criteria}$

-1 | $A \text{ criteria} < x < 3x A \text{ criteria}$

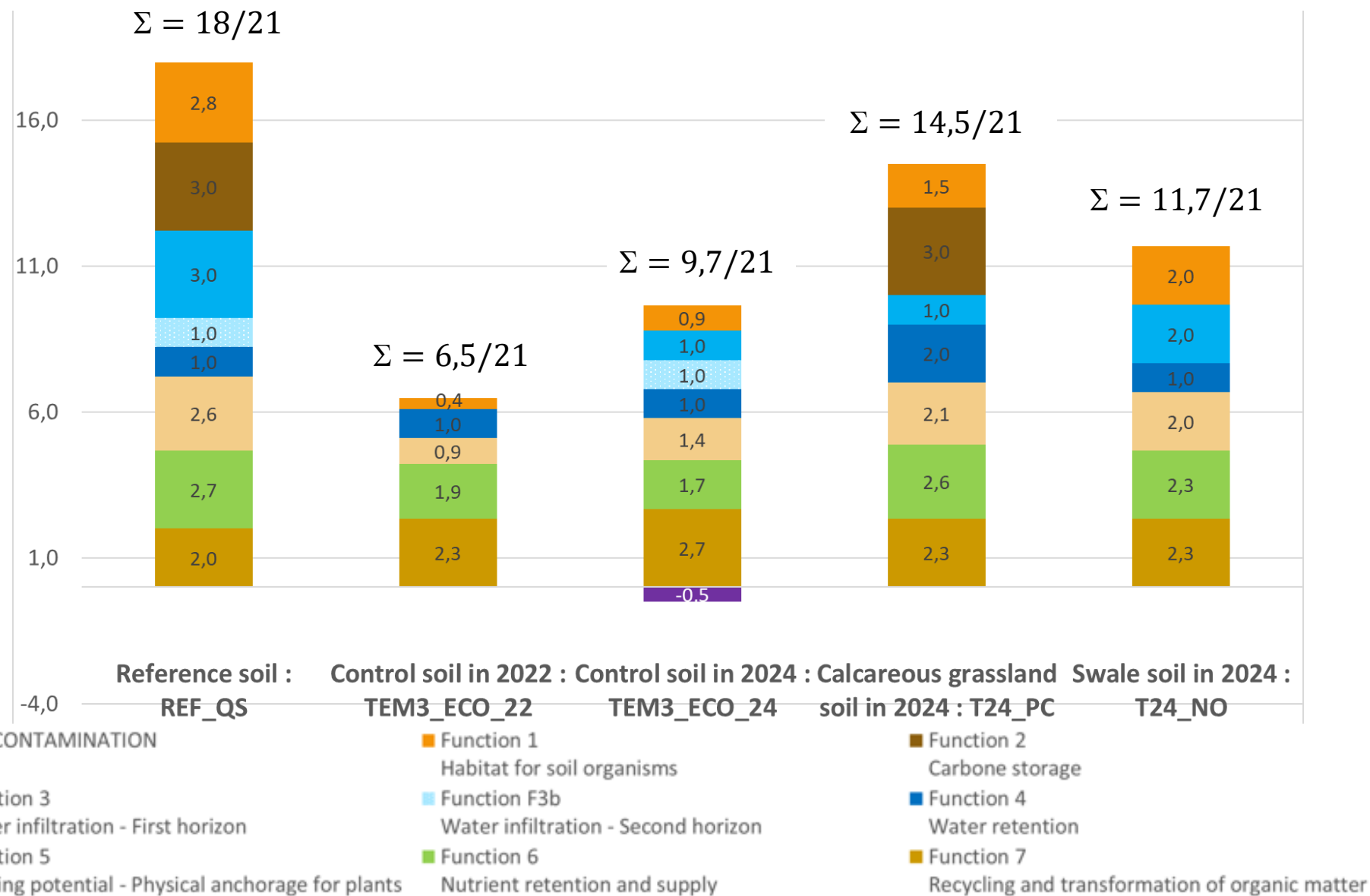
-2 | $3x A \text{ criteria} < x < 5x A \text{ criteria}$

-3 | $x > 5x A \text{ criteria}$

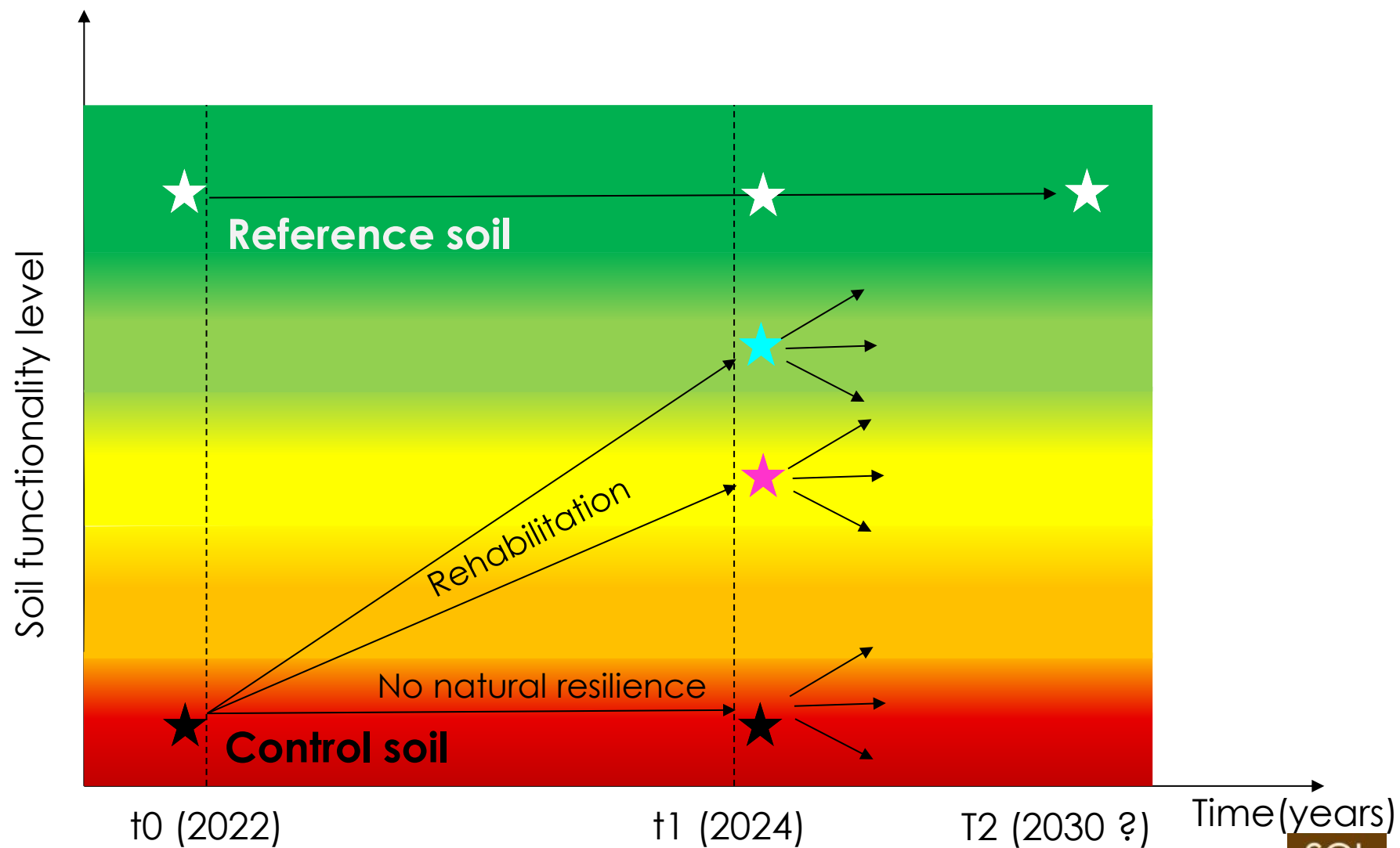
Realistic approach :

Global soil contamination score = Average of the scores of each contaminant compound (each score is rounded up)

SOIL FUNCTION ASSESSMENT RESULTS



SOIL FUNCTIONALITY RESULTS



LIMITS AND PROSPECTS

- ❑ The methodology is useful and well suited to assess soil health rehabilitation
- ❑ There is a lack of soil interpretation guidelines for assessing the functionality of urban soils
- ❑ The function « Filter and Degradation of pollutants » remains unexplored to assess soil degradation states
- ❑ Expert judgement is necessary at every stage of the project
- ❑ Consider results as a trend rather than a fixed, stable state