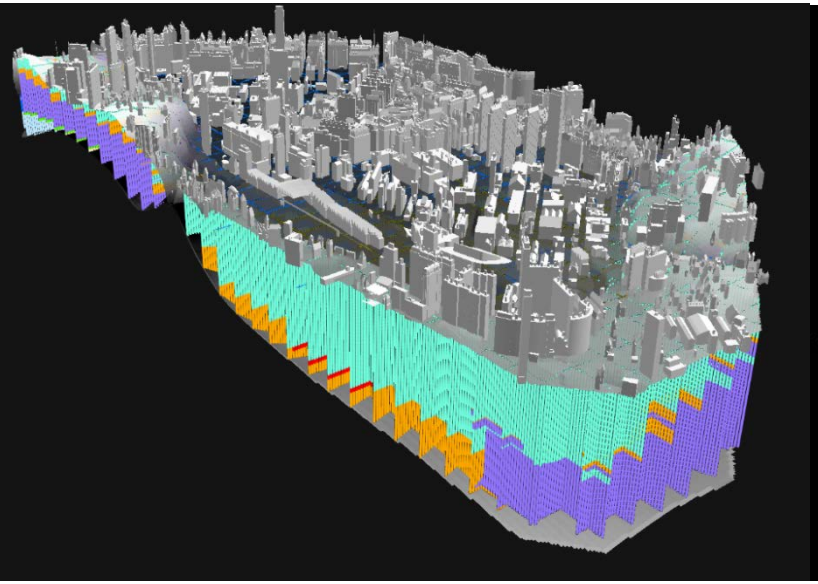
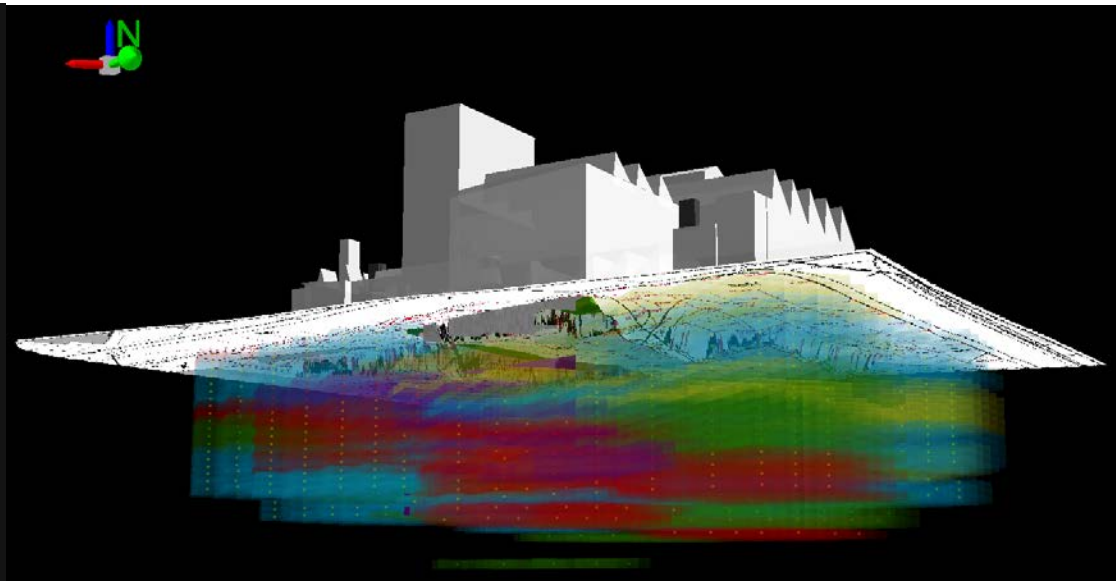
Developing a system for provisional assessments of excavation materials volumes through semi-automated tools and 2D/3D modelling interfaces in an urban context

Applications of the GeoQuat project





Development: ***Michael Gaehwiler***
Presented by: ***Nicolas Clerc,***
In collaboration with: ***Swisstopo; AlterEgo; Bricks Development West AG***

Presentation outline

Introduction: the GeoQuat project and its motivations

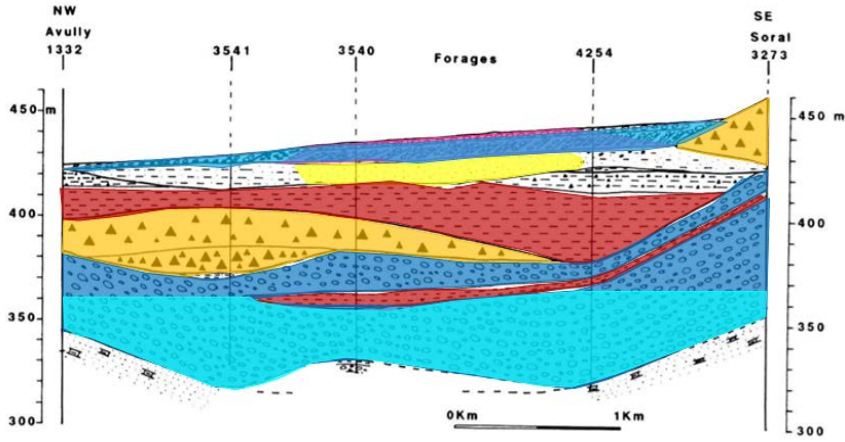
The GeoQuat Geneva pilot
- 3D Models
- Derived products and applications

Specific application case on a polluted construction site
- Environmental 3D model
- Pollution volume and associated cost assessment
- Optimization tool

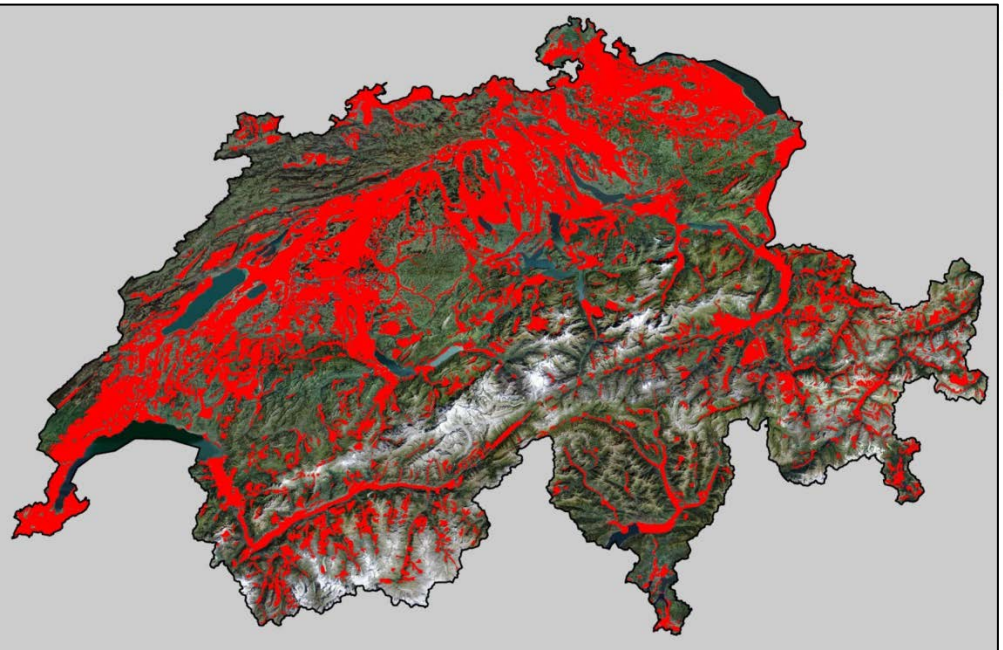
Conclusions

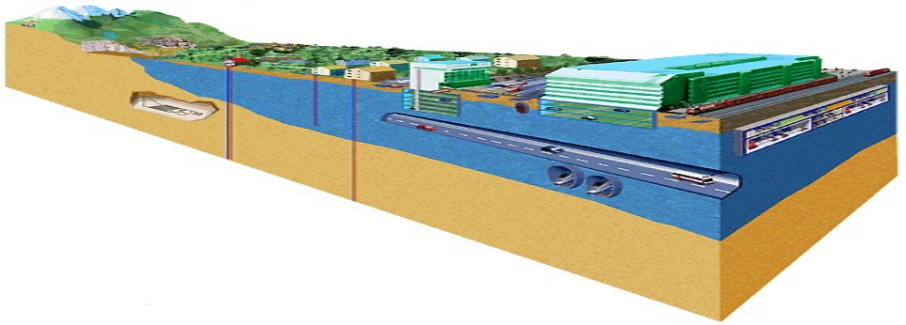
Quaternary deposits

- Mostly glacial or Interglacial origin
- Varying thicknesses
- Highly heterogeneous
- Complex geometries



In Switzerland, ~ 90% of the underground needs and infrastructures are concentrated within these unconsolidated deposits



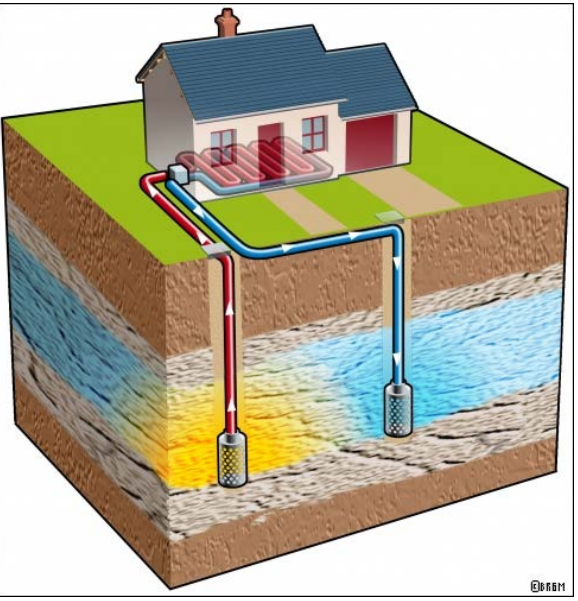


Resources, constraints and challenges

Constructions and management of excavation material

Mineral resources

Groundwater resources



Shallow geothermal systems

Etc…

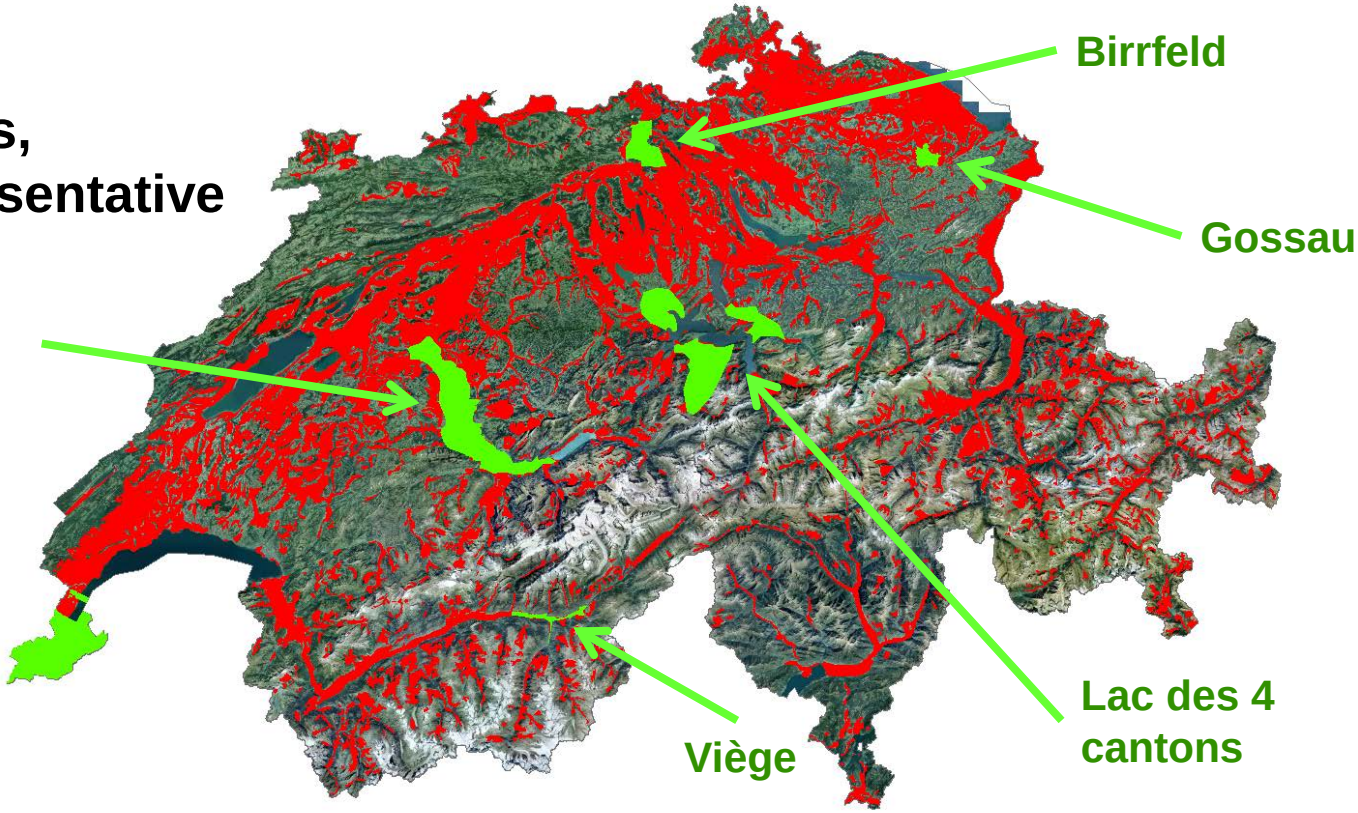
Pollution

- Large variety of use, constraints and impacts
- **Conflicts** of use are unavoidable
- Necessity of **planning and coordination**

The"GeoQuat" project

- Develop robust and structured quaternary data models.
- Demonstrate the valorization potential of structured data through:
  - The development of 3D geological and parametric models, as well as derived products
  - The use of 3D spatial requests for data consultation
- Develop "transparent" & well-documented automated workflows

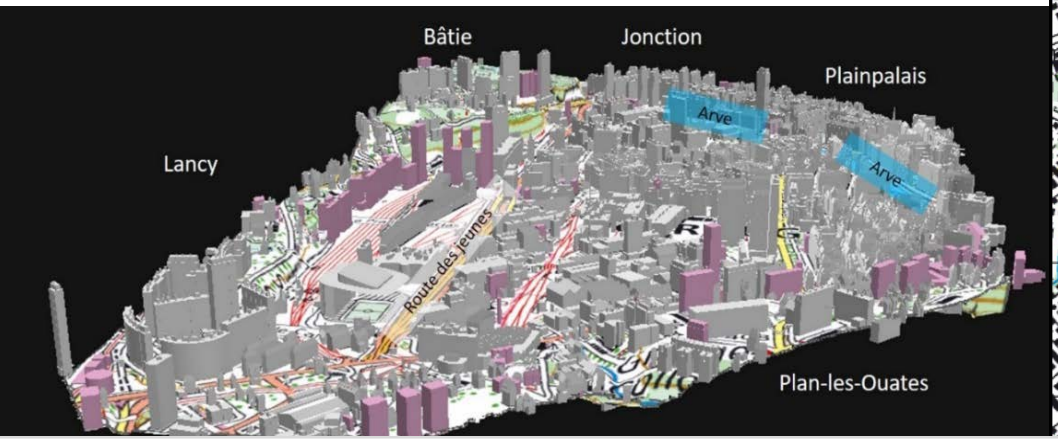
6 pilot regions, context-representative

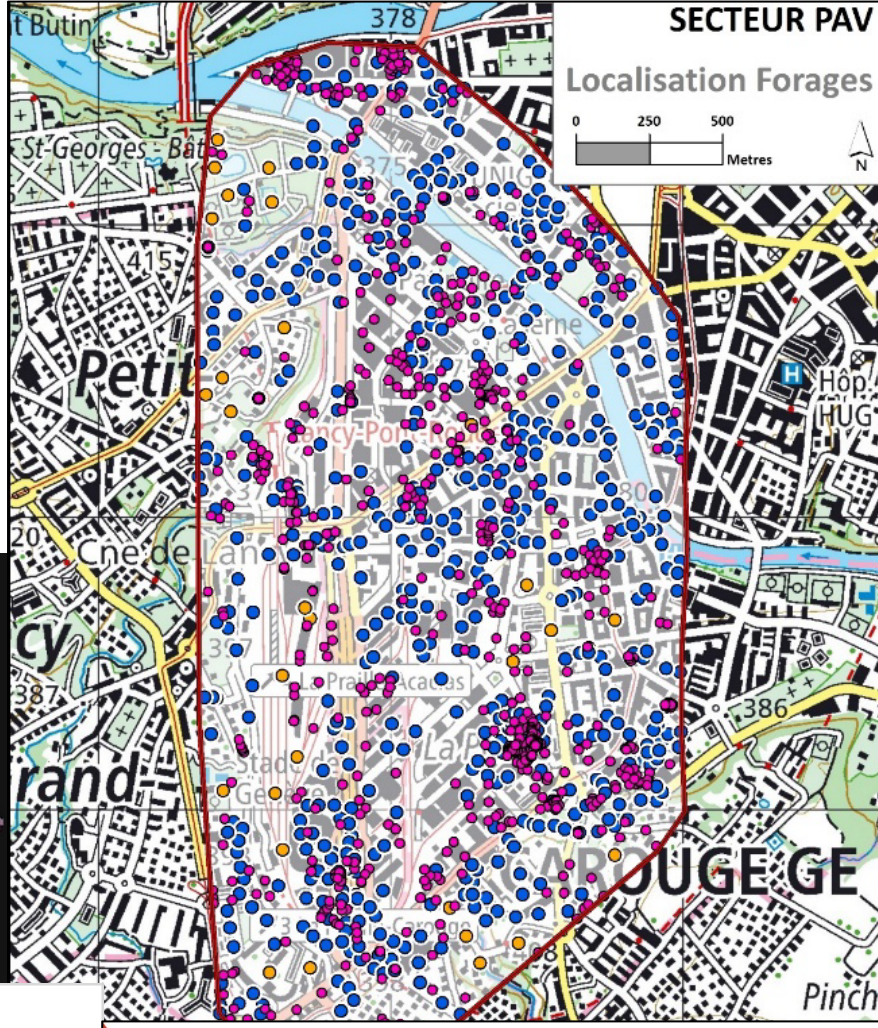


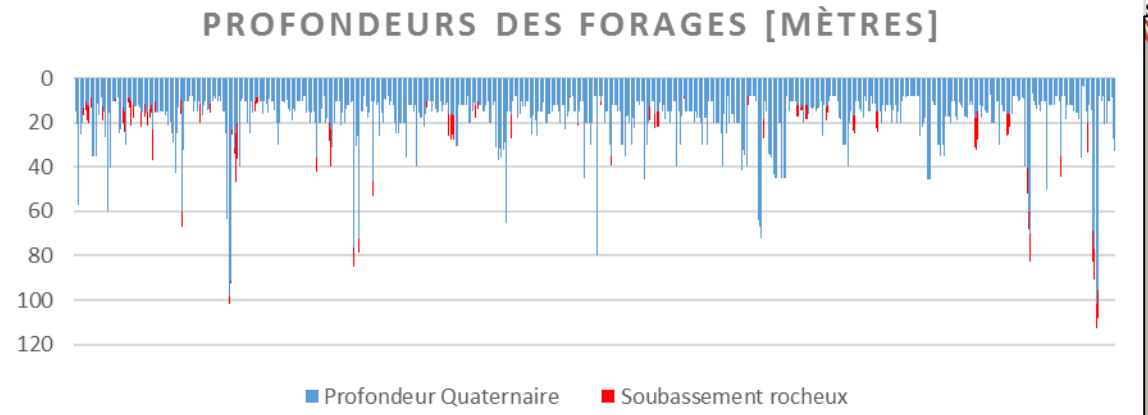
The GeoQuat Geneva pilot

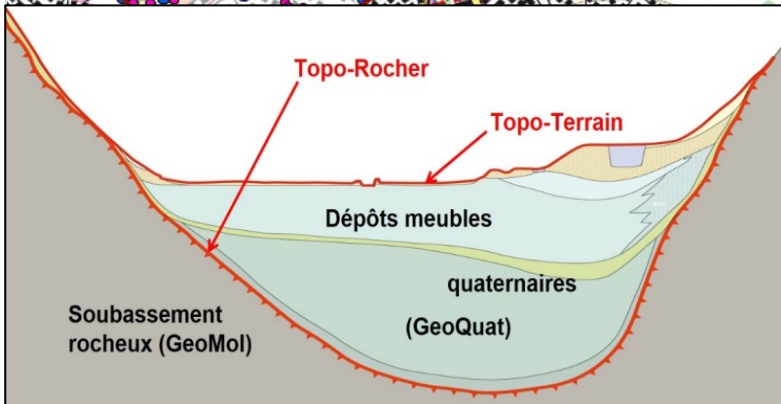
Applied in **dense urban context** with:

- Important development planned
- Urban-specific needs and problematics
- High density of data (> 600 wells used)
- Investigation area: 5km^2

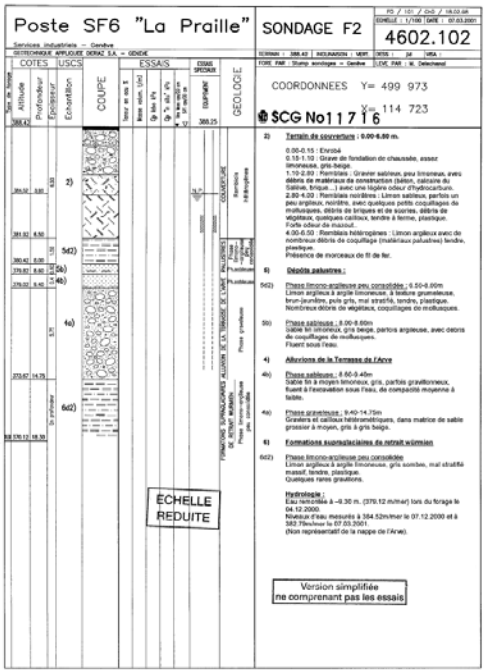






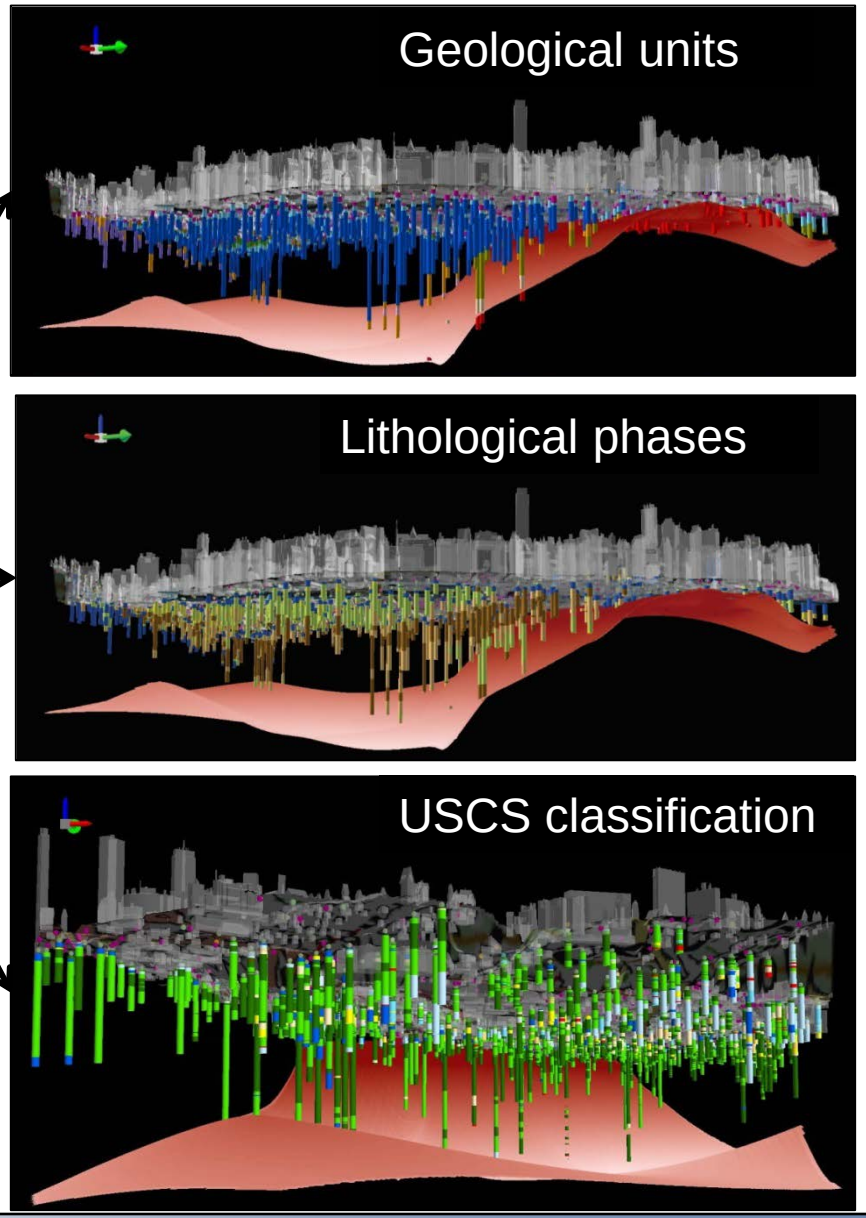


Data preparation workflow



Re-interpretation of geological and geotechnical log data

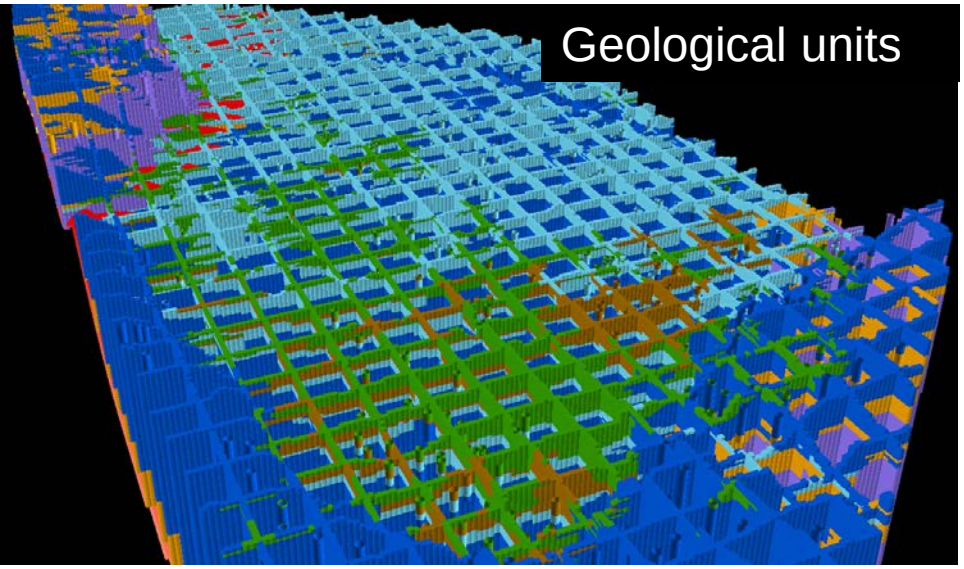
Extraction toward structured data model

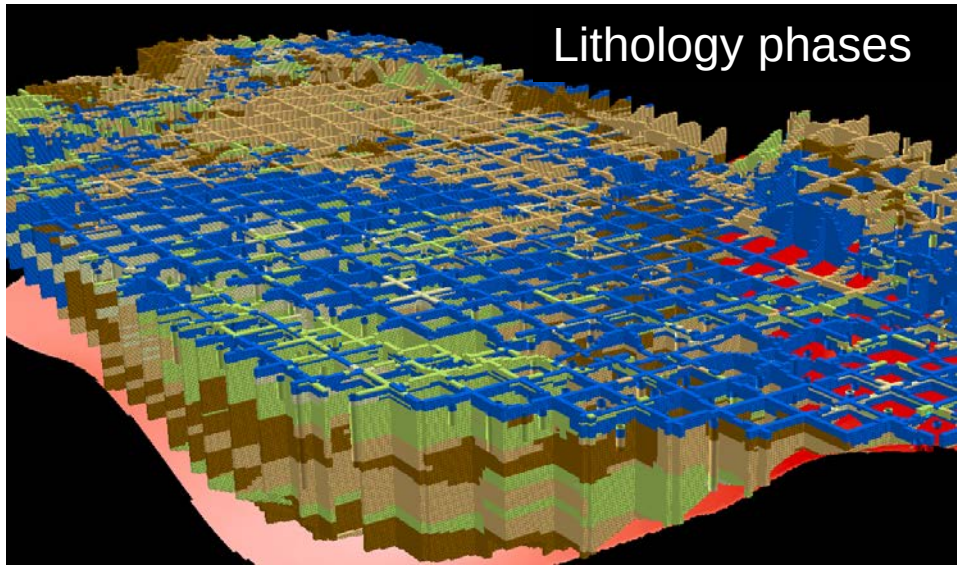


Important step, time consuming!

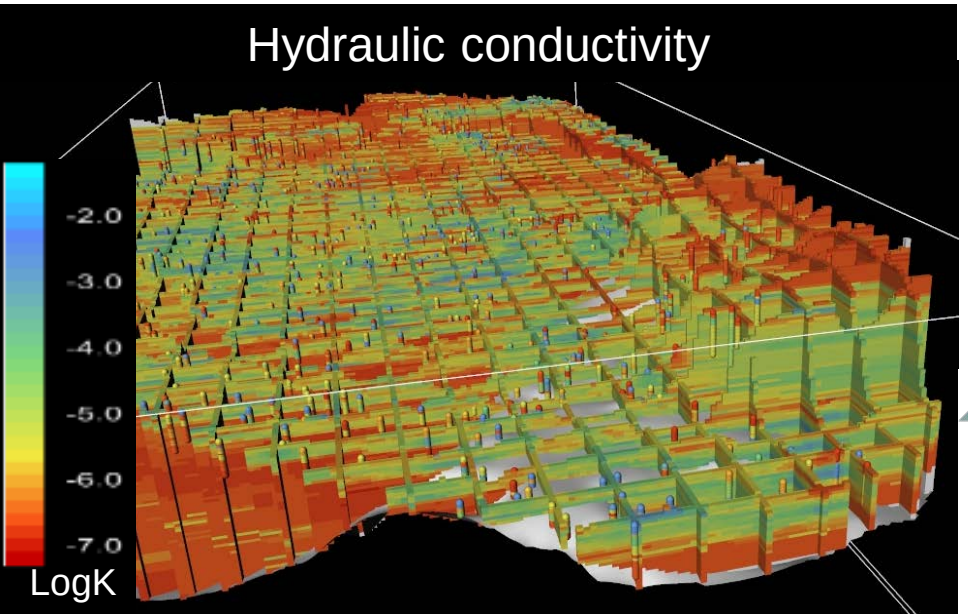
- *Grain size*
- *Grain distribution (for coarse phases)*
- *Plasticity (for fine mineral phases)*
- *OM content*

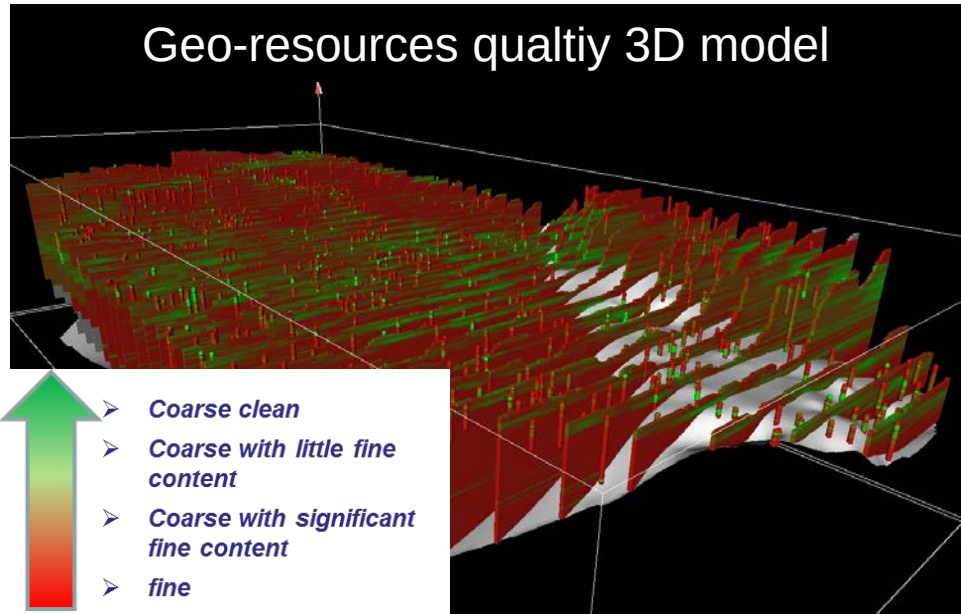
3D products





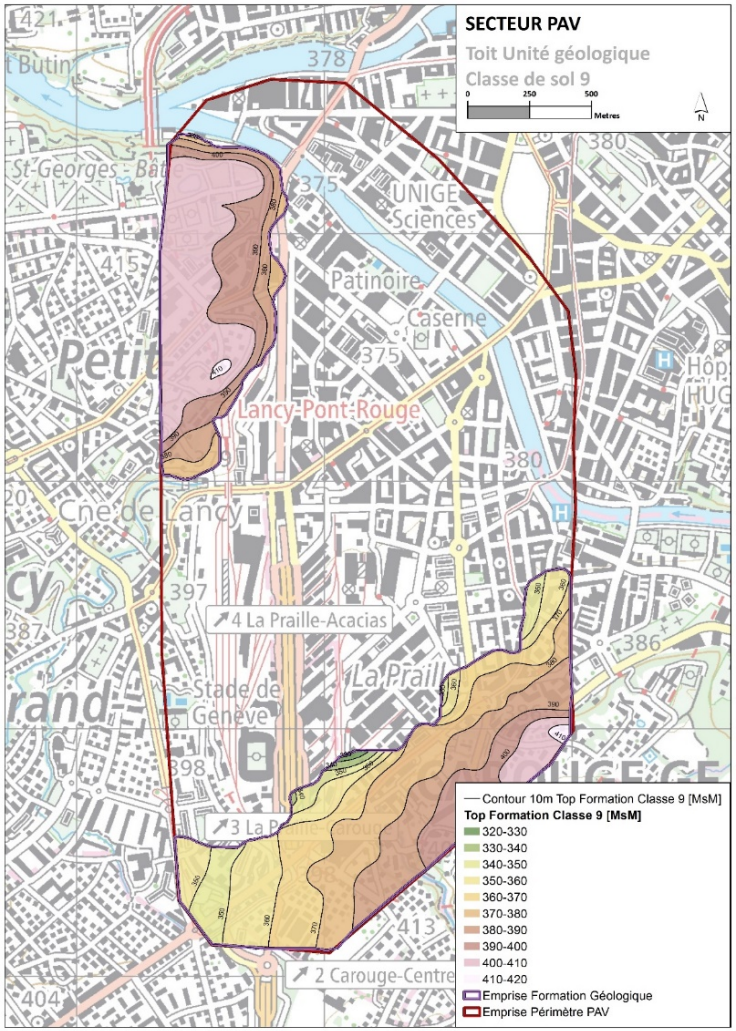
Parametric models (from USCS)

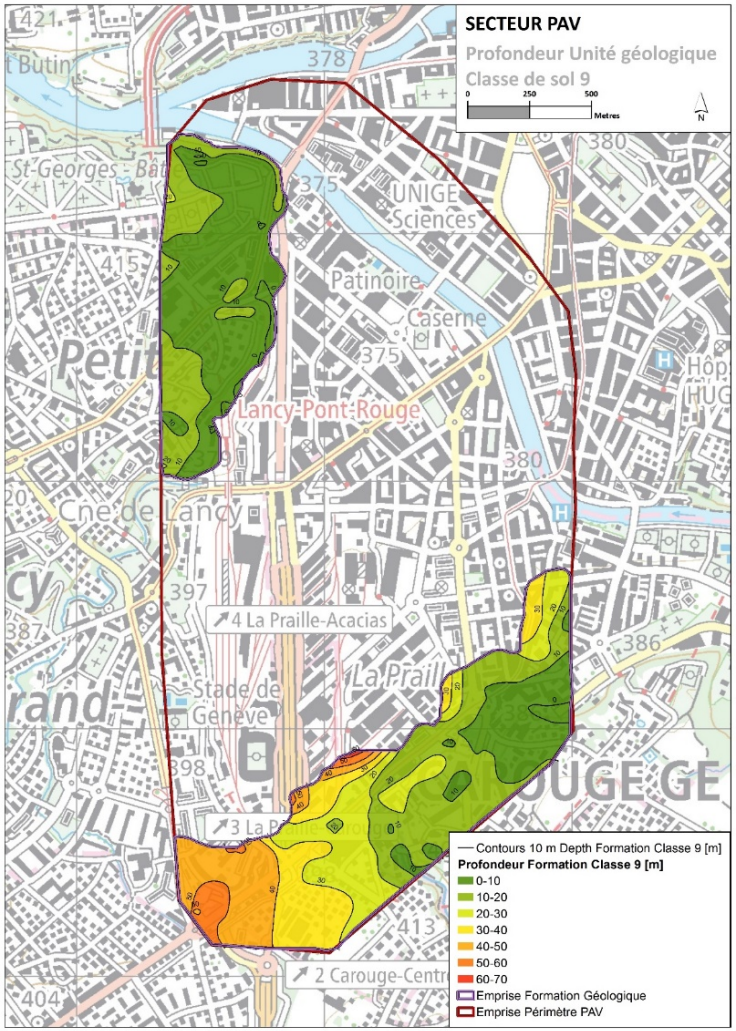




2D/3D products

- depth, elevation and thickness maps per geological units -

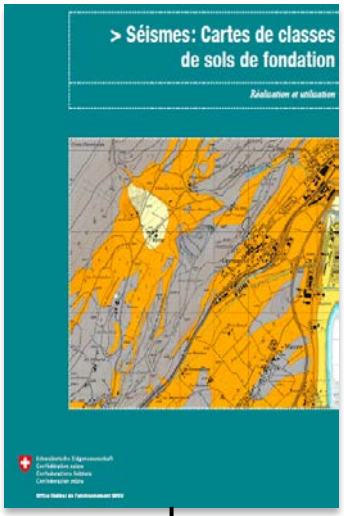




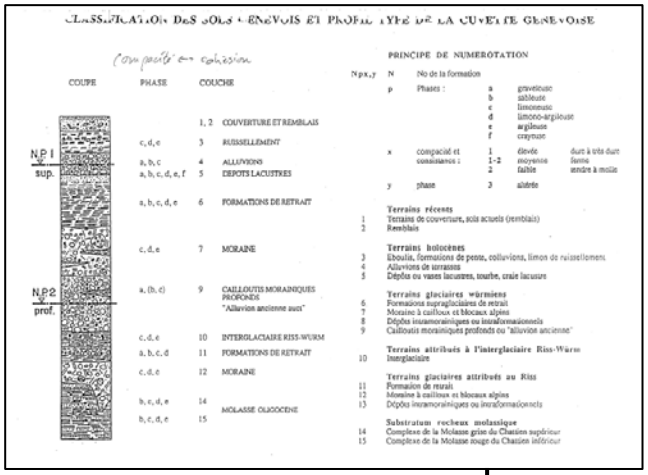
2D/3D products

- Computation of geotechnical maps ("soil fundation") maps -

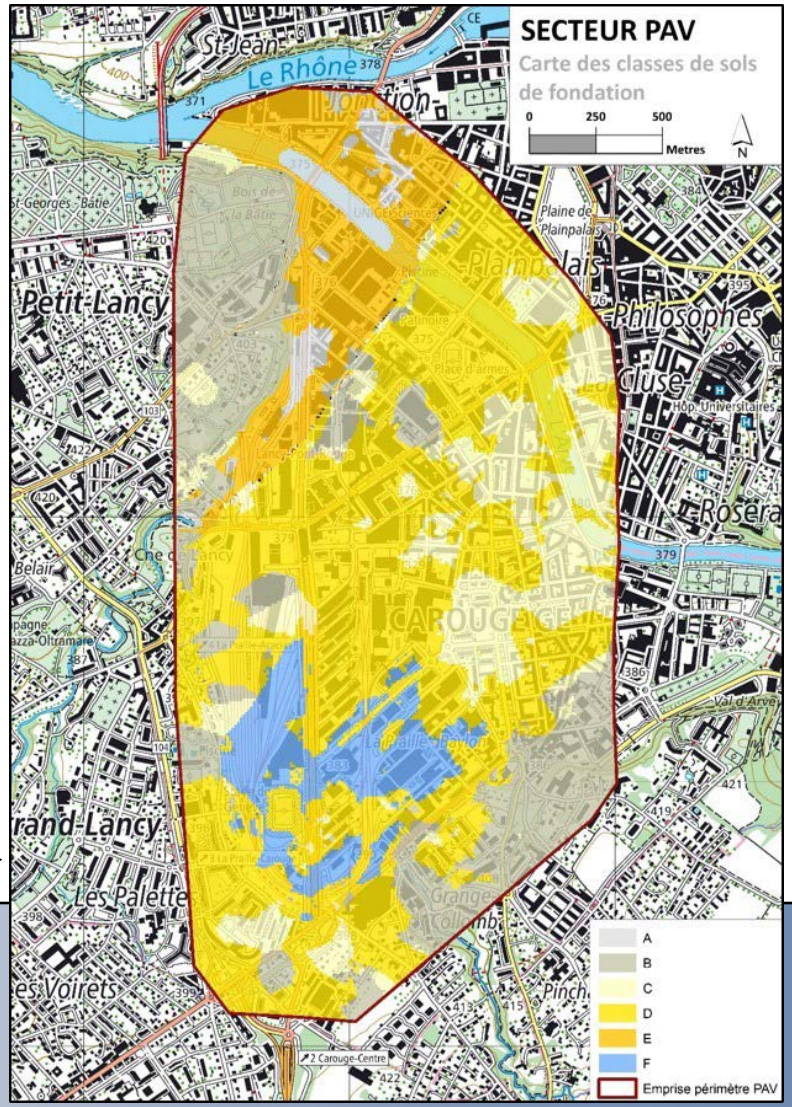
Federal recommandations



Geneva soil classification (including grain-size and degree of compaction attributes)

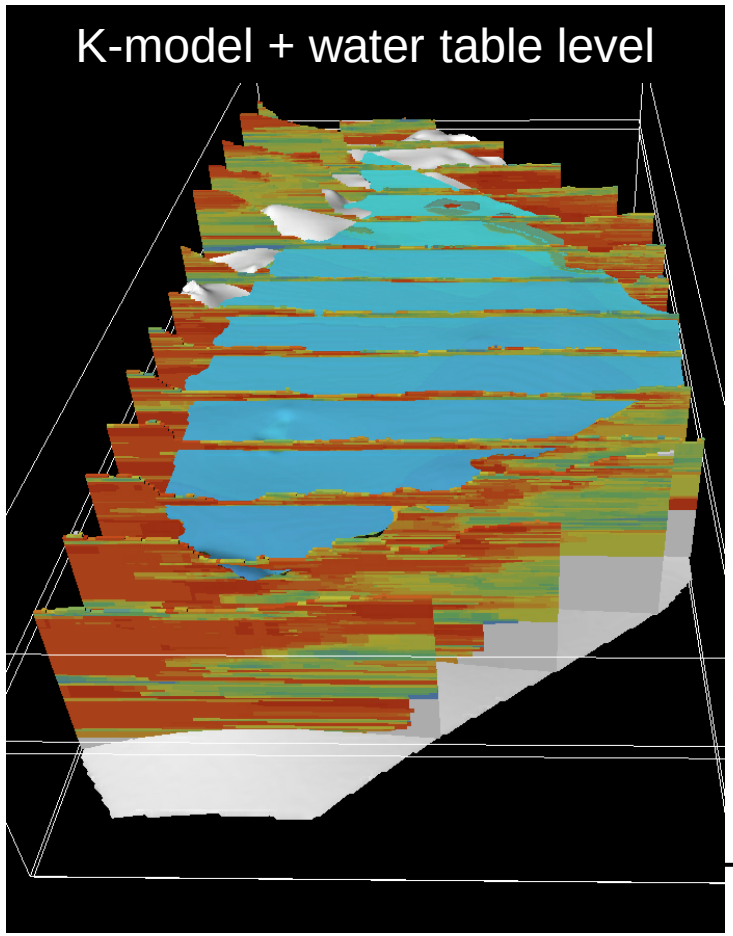


Co-interpretation

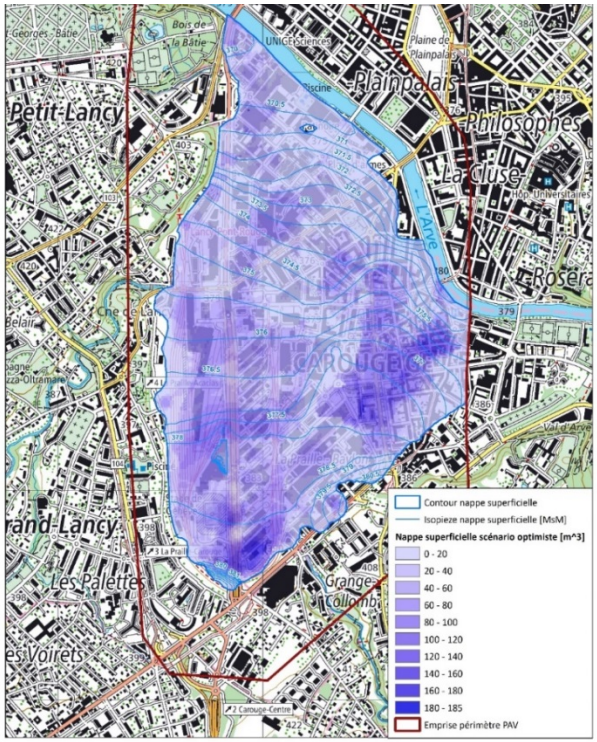


2D/3D products

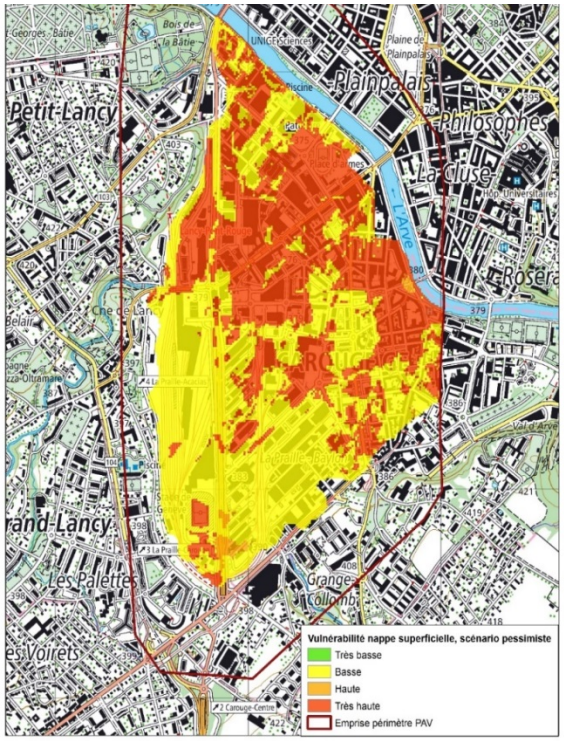
- Applications from hydraulic conductivity model -



Groundwater volumes



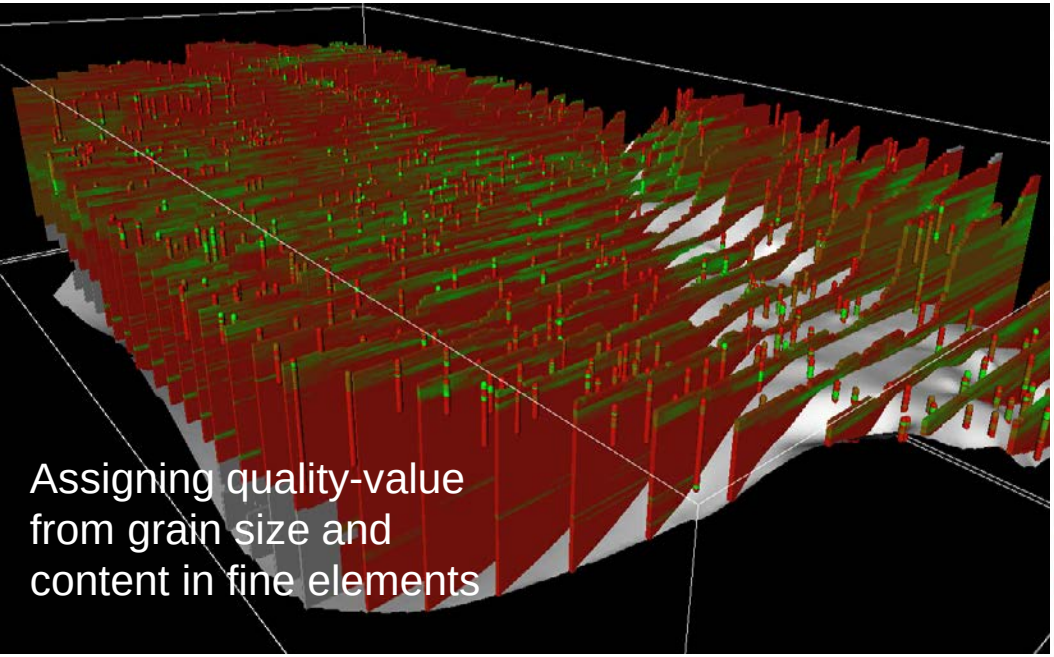
Groundwater vulnerability

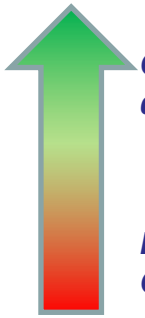


Swiss hydrogeological atlas standards and recommendations

2D/3D products

- Georesource quality -

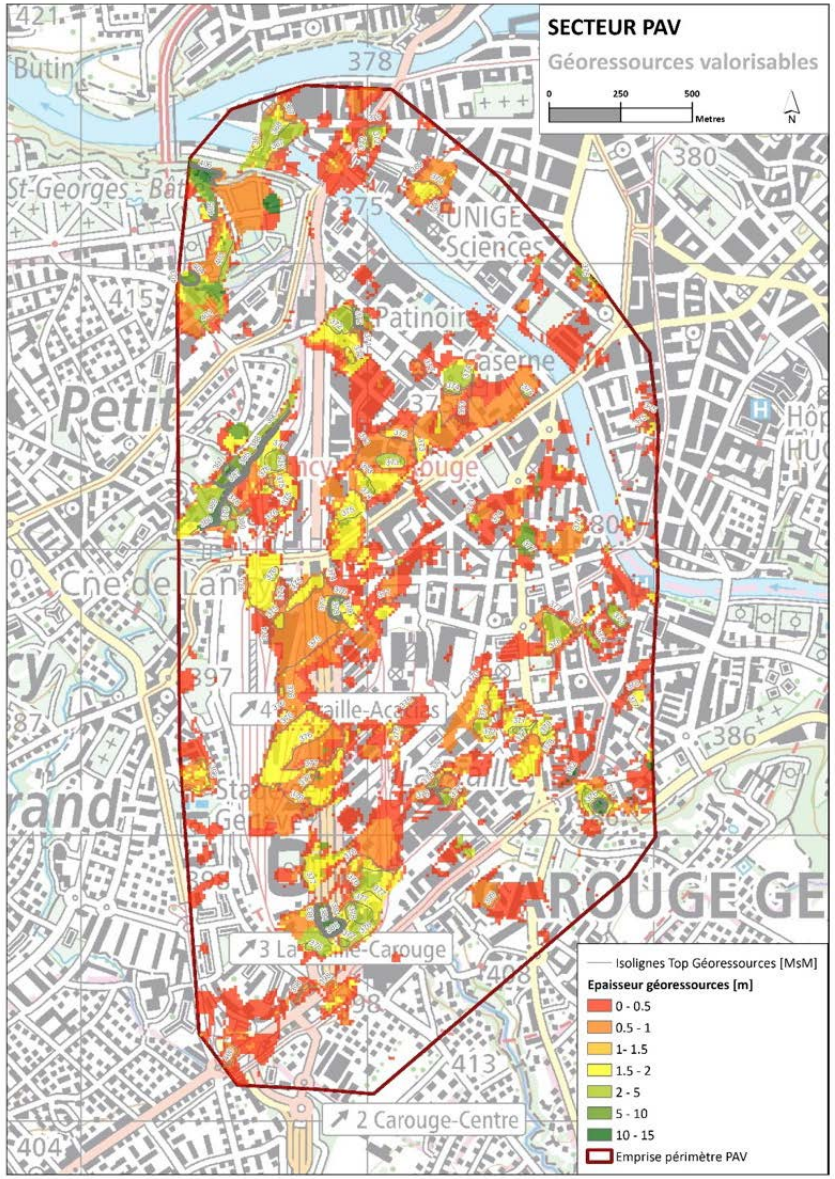




Good quality

Bad Quality

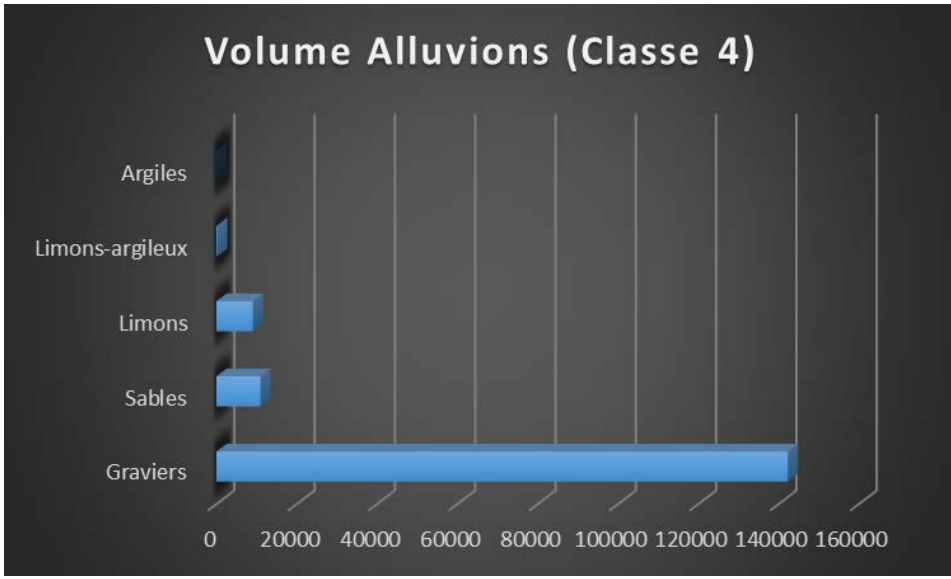
Extraction of good quality sediments thickness within the first 15m.



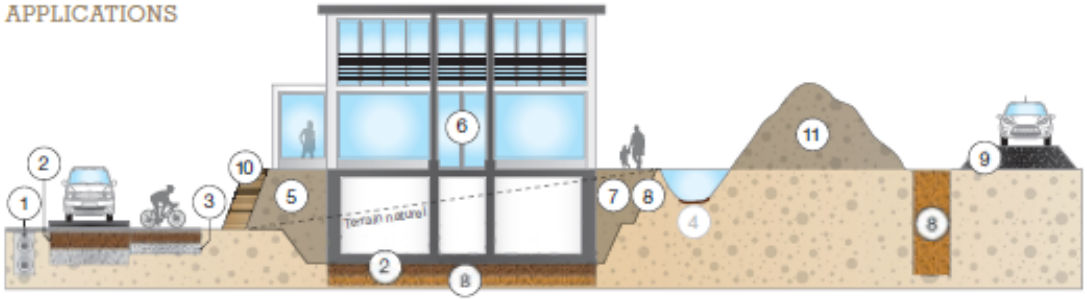
2D/3D products

- Volume prediction for valorization of excavation materials -

Following cantonal guidelines

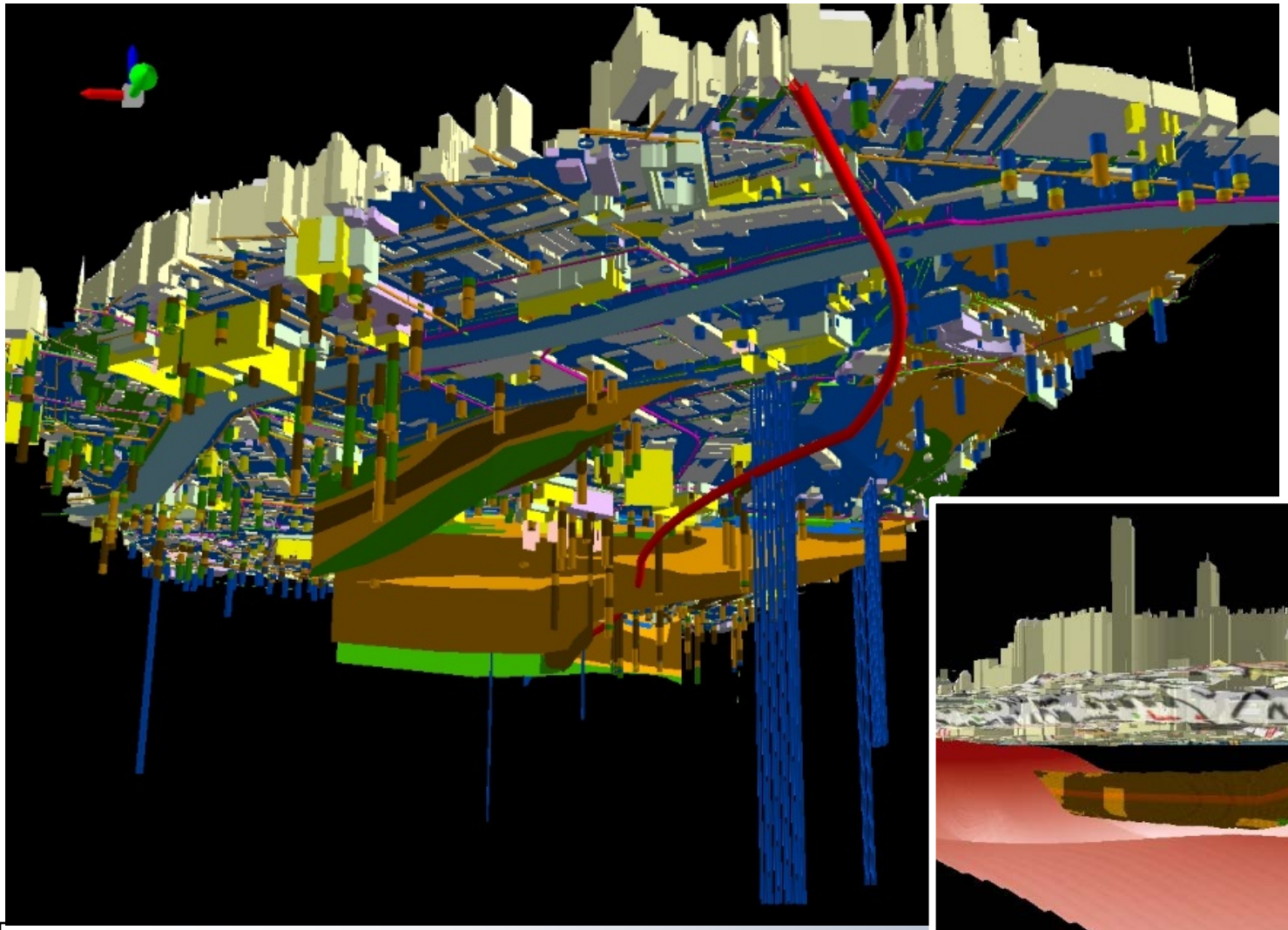


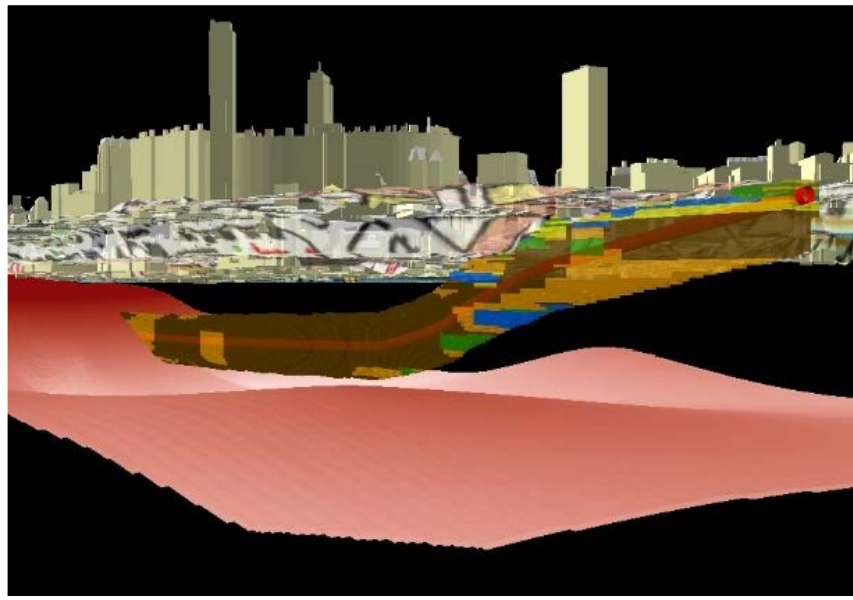
APPLICATIONS



1	Remblayage tranchées de collecteurs	utilisation brute
2	Couche de fondation	utilisation brute, éventuellement criblage
3	Couche de forme infrastructure routière	utilisation brute, éventuellement criblage
4	Etanchement	inadaptée
5	Surélévation terrain	utilisation brute
6	Matériaux de construction	utilisation après criblage, éventuellement brute
7	Remblayage contre ouvrages	utilisation brute
8	Drainage	utilisation après criblage, éventuellement brute
9	Digue ou remblais pour infrastructure routière	utilisation brute
10	Modelage paysager avec renforcement	utilisation brute
11	Modelage paysager sans renforcement	utilisation brute

Interraction Geology - BIM



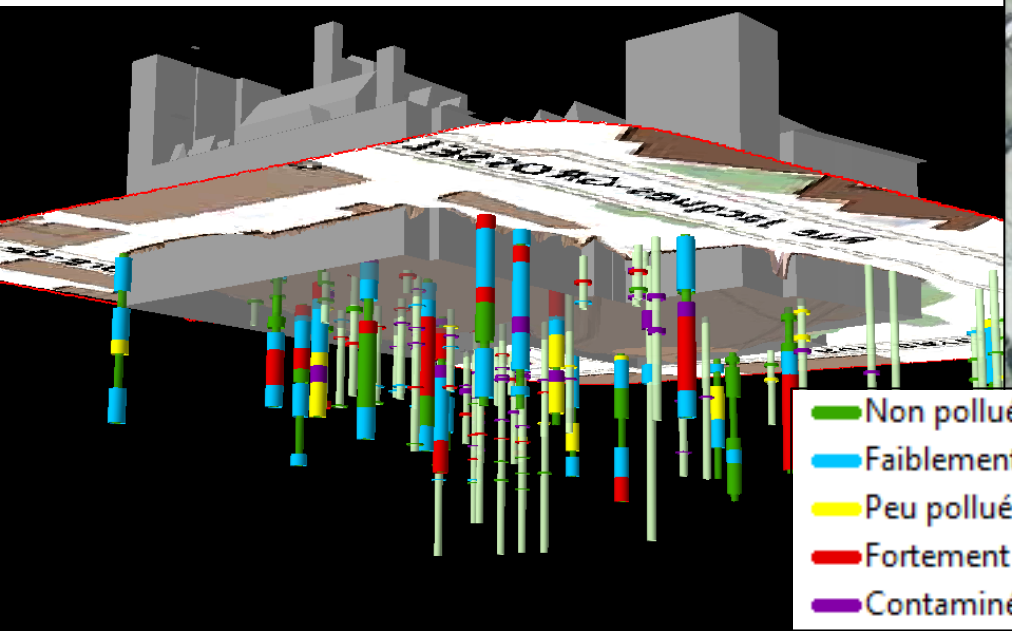


Application case on polluted site

- Diagnostic and cost-optimization tool for a construction project -

- Pollution: ***heavy metals; HCV; PCB; BTEX; HPT; HAP***
- Former industrial activity
- Size of the plot ~15'000m^2

- Realization of a higher-resolution environmental model
- Nb of wells 79
- Nb of samples 281
- 5 pollution status defined



Workflow

Field data & measurements

Sampling surveys (1998-2010) & (2018)

Laboratory sample analysis

Determination of pollution status

Elimination / treatement channels

Costs estimation

2D / 3D products

Environemental 3D models (status / costs)

diagnostic products

optimization tool

Federal regulations

Ordonnance
sur la limitation et l'élimination des déchets
(Ordonnance sur les déchets, OLED)

814.600

du 4 décembre 2015 (Etat le 1er janvier 2018)

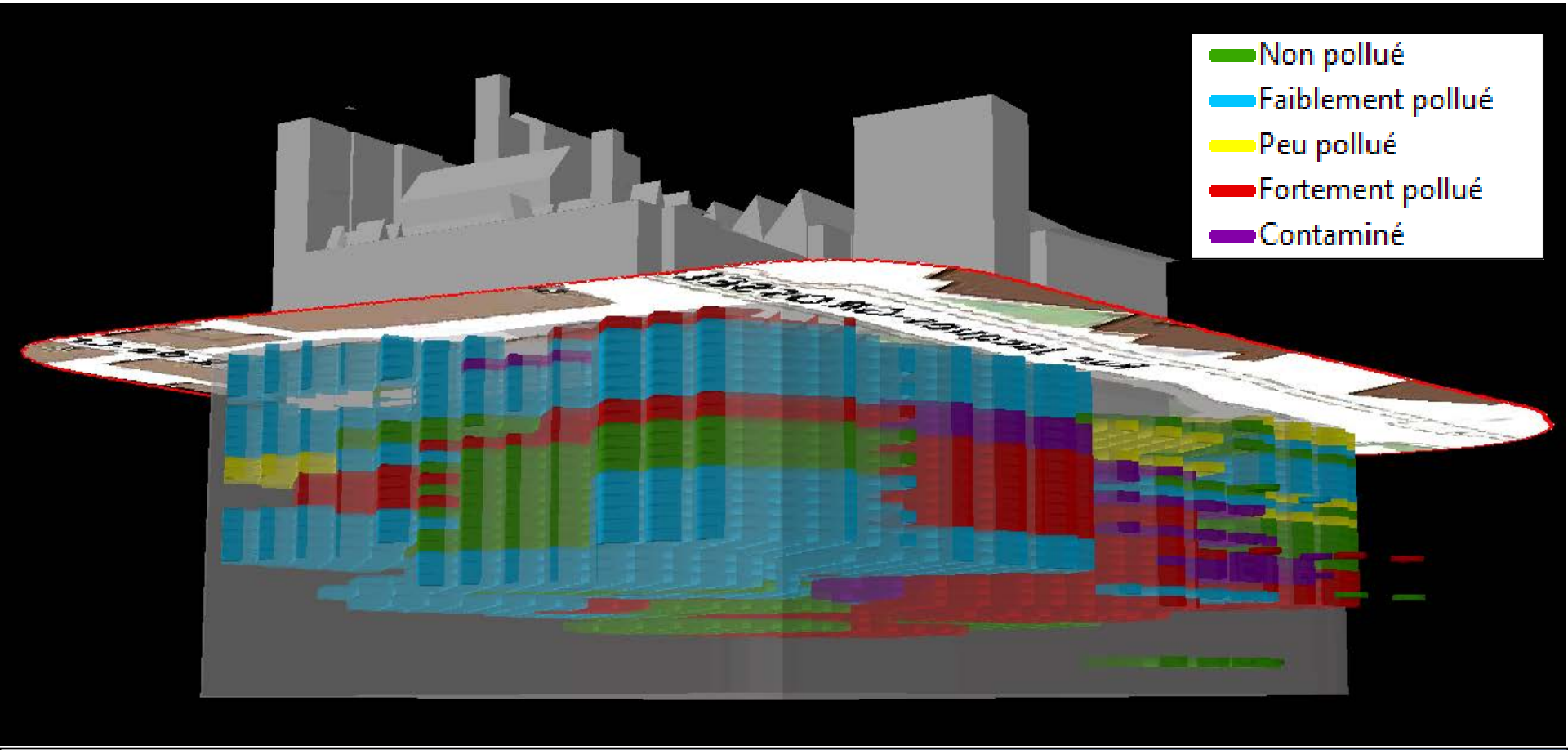
Cantonal regulations

VALEURS LIMITES DE RÉFÉRENCE ET FILIÈRES D'ÉLIMINATION

	NON POLLUÉ	FAIBLEMENT POLLUÉ	PEU POLLUÉ	FORTEMENT POLLUÉ	CONTAMINÉ
STATUT	OLED – Annexe 3, ch. 1	OLED – Annexe 3, ch. 2	OLED – Annexe 5, ch. 2.3	OLED – Annexe 5, ch. 5.2	OLED – Annexe 5, ch. 5.3
CODE OMOD	17 05 06	17 05 94	17 05 97 (sc)	17 05 91 (scd)	15 05 05 (ds)
EXIGENCES D'ÉLIMINATION	OLED – Art 19, al. 1 & Annexe 5, ch 1	OLED – Art 19, al. 2 & Annexe 5, ch 2	OLED – Art 19, al. 3 & Annexe 5, ch. 2.3	OLED – Annexe 5, ch. 5.2	OLED – Annexe 5, ch. 5.3
VALORISATION	- matériaux de construction sur des chantiers ou dans des décharges; - matières premières pour la fabrication de matériaux de construction; - comblement de sites de prélèvement de matériaux; - modifications de terrain autorisées.	- matières premières pour la fabrication de matériaux de construction aux liants hydrauliques ou bitumineux - matériaux de construction dans les décharges de type B à E - matières premières de substitution pour la fabrication de clinker de ciment	- matériaux de construction dans les décharges de type C à E - Réutilisation dans le cadre des travaux d'assainissement d'un site contaminé; si un traitement des matériaux est nécessaire, il aura lieu sur le site même ou à proximité	-	-

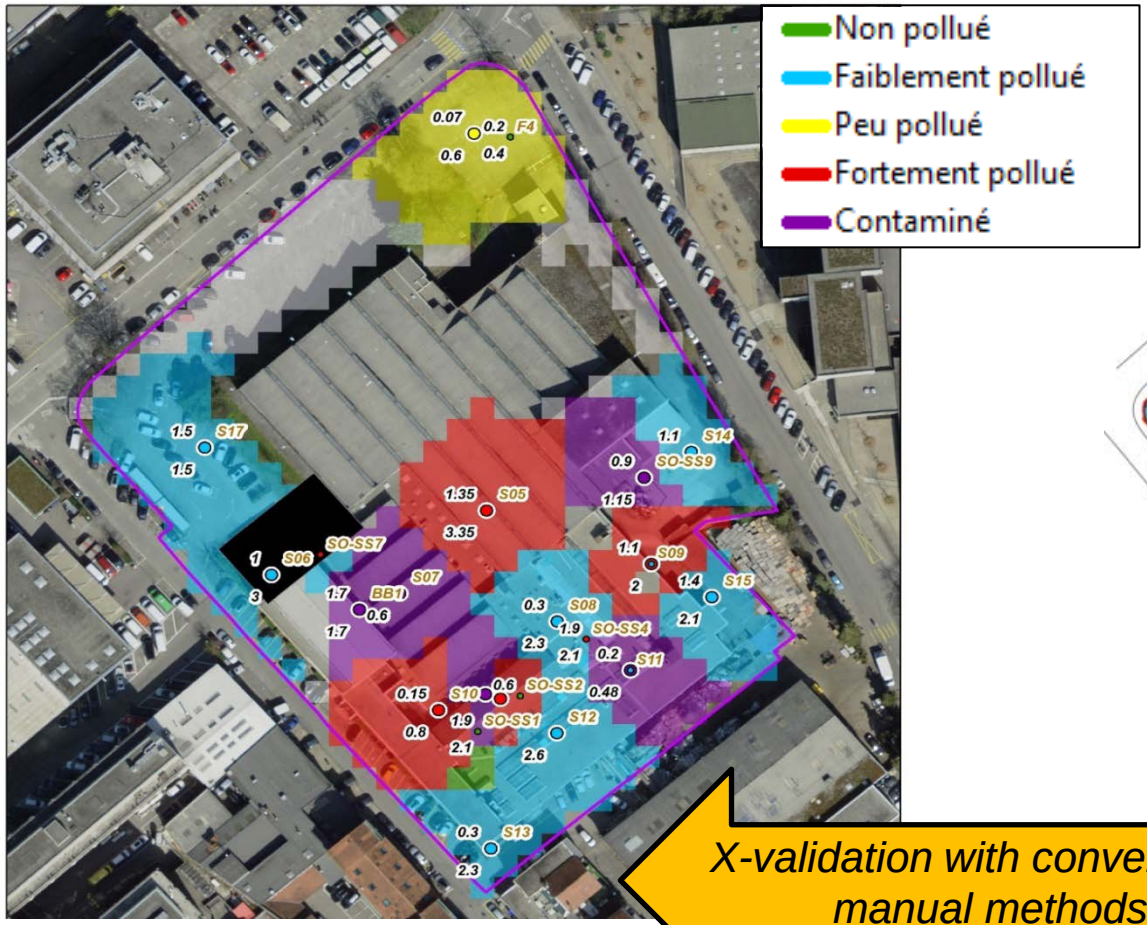
Environmental 3D model

- Pollution status -



Environmental 3D model

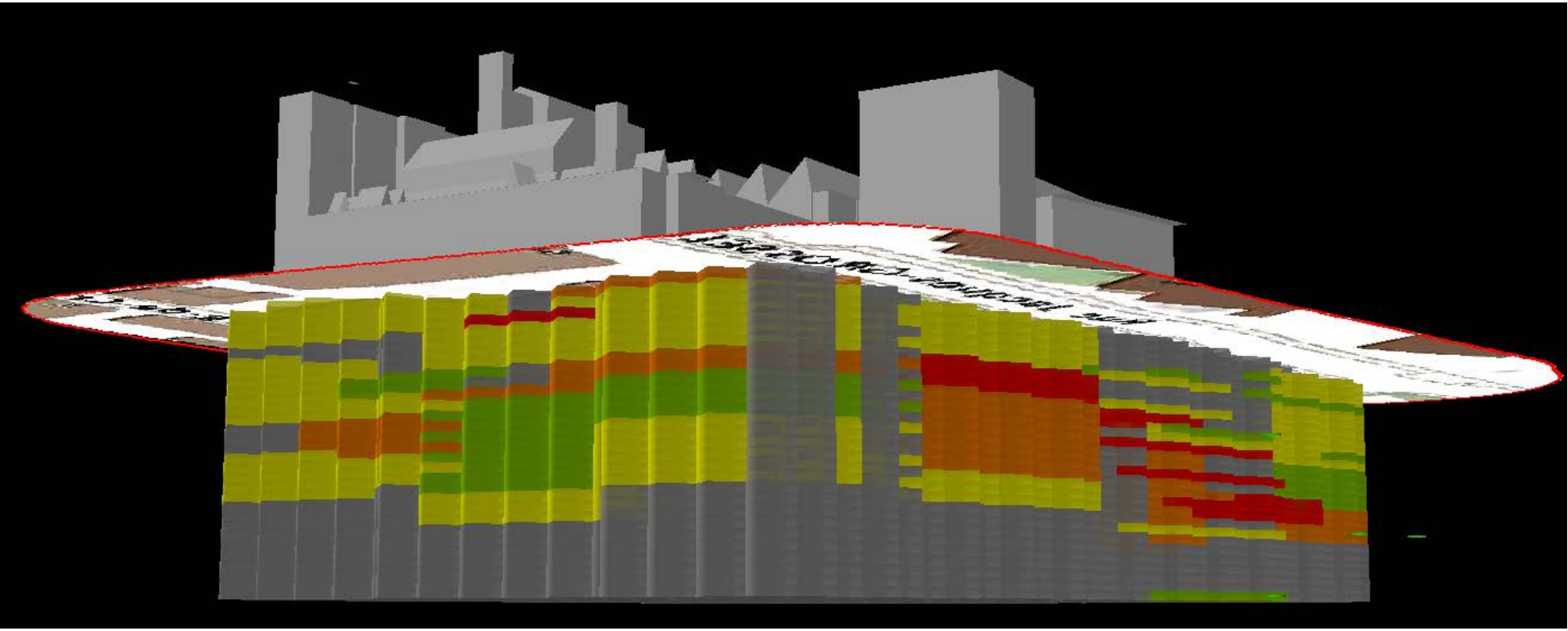
- Extraction of pollution status maps per depth-intervals (0.5m) -



X-validation with conventional manual methods

Environmental 3D model

- Unitary excavation costs 3D model -



Minimal cost — Maximal cost

Environmental 3D model

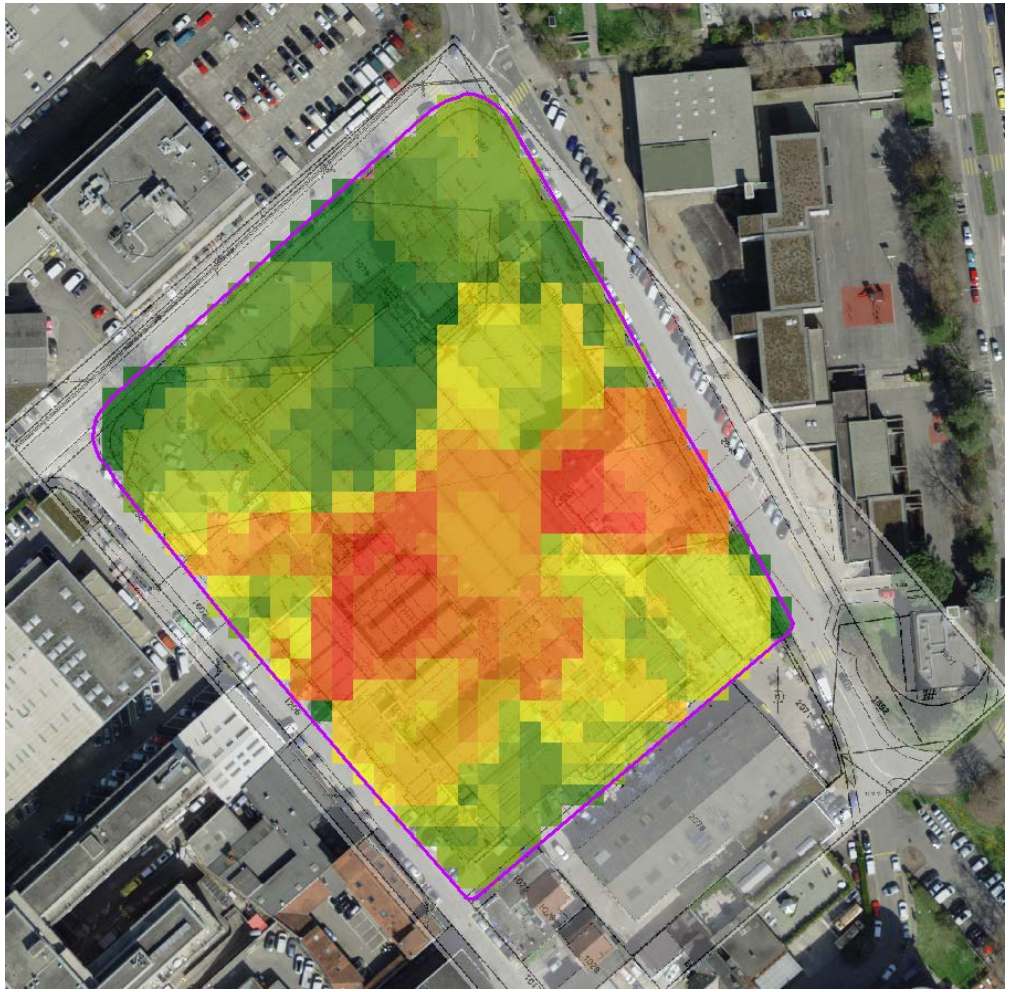
- Unitary cost estimation per excavation depth -

0-3 [m]

0-6 [m]

0-9 [m]

0-12 [m]

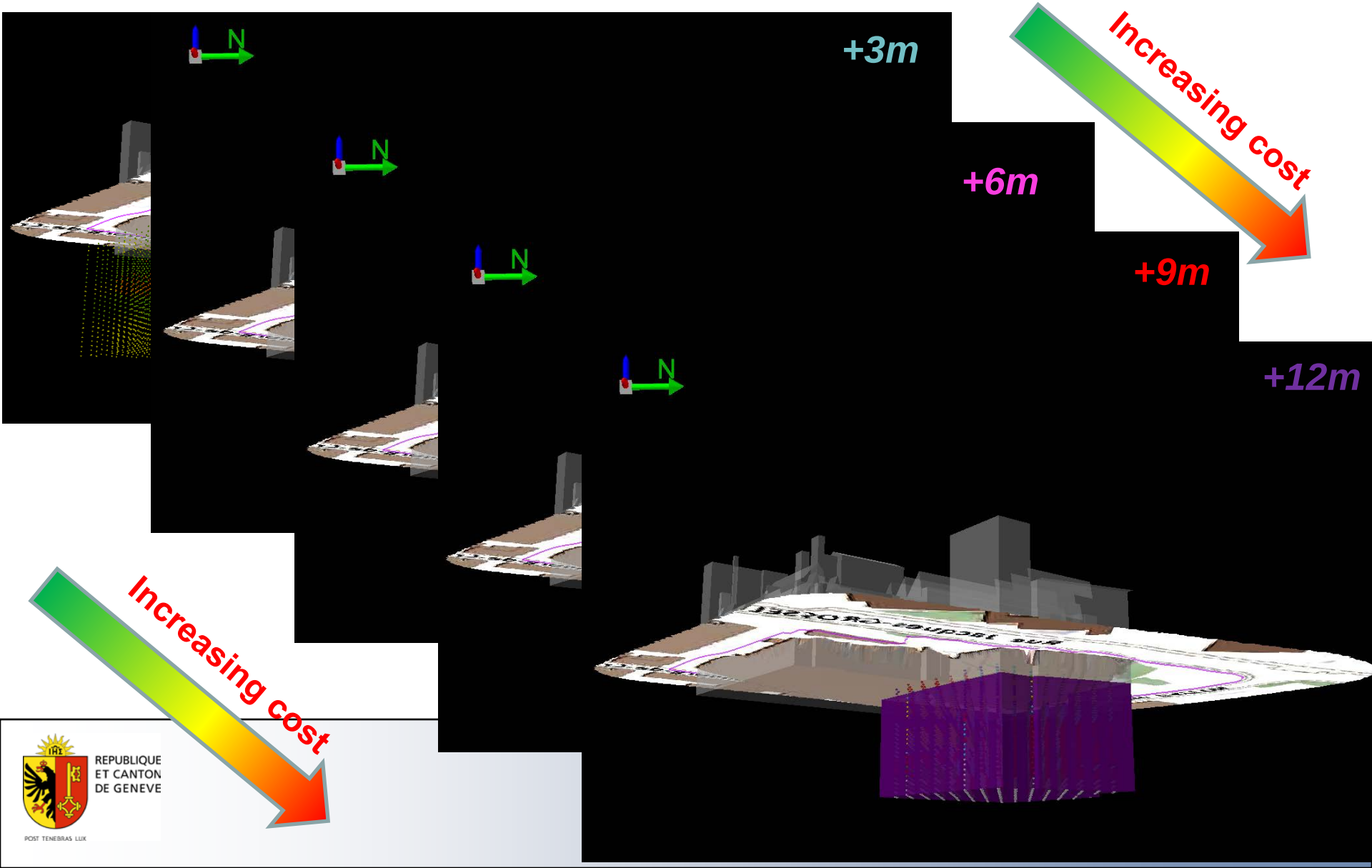


Maximal cost

Minimal cost

Environmental 3D model

- Total cost estimation per excavation depth -

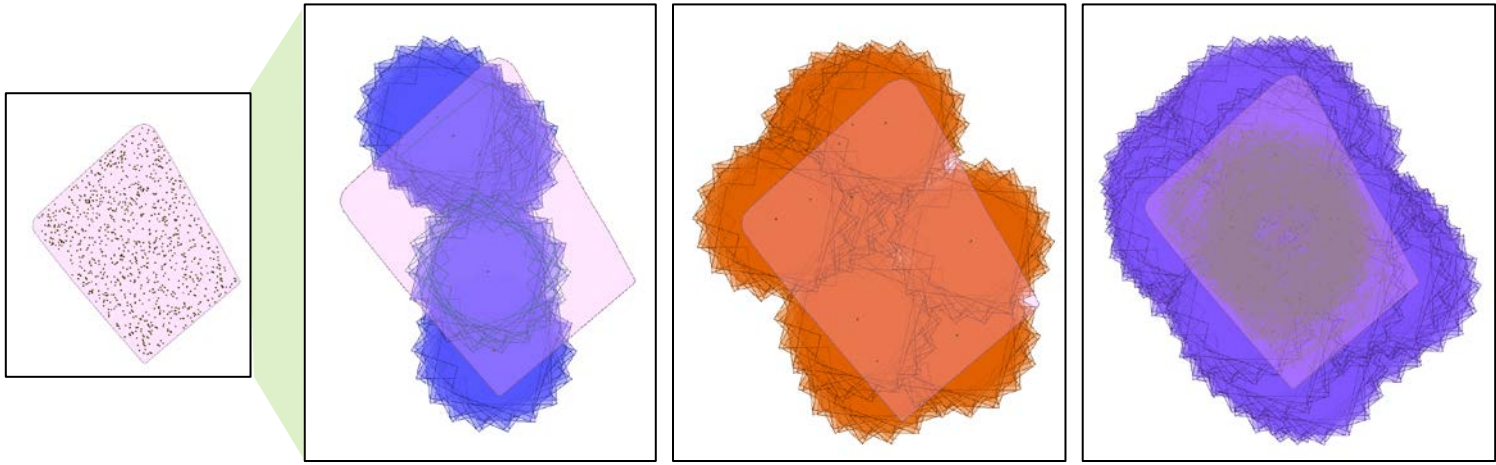


REPUBLIQUE
ET CANTON
DE GENEVE

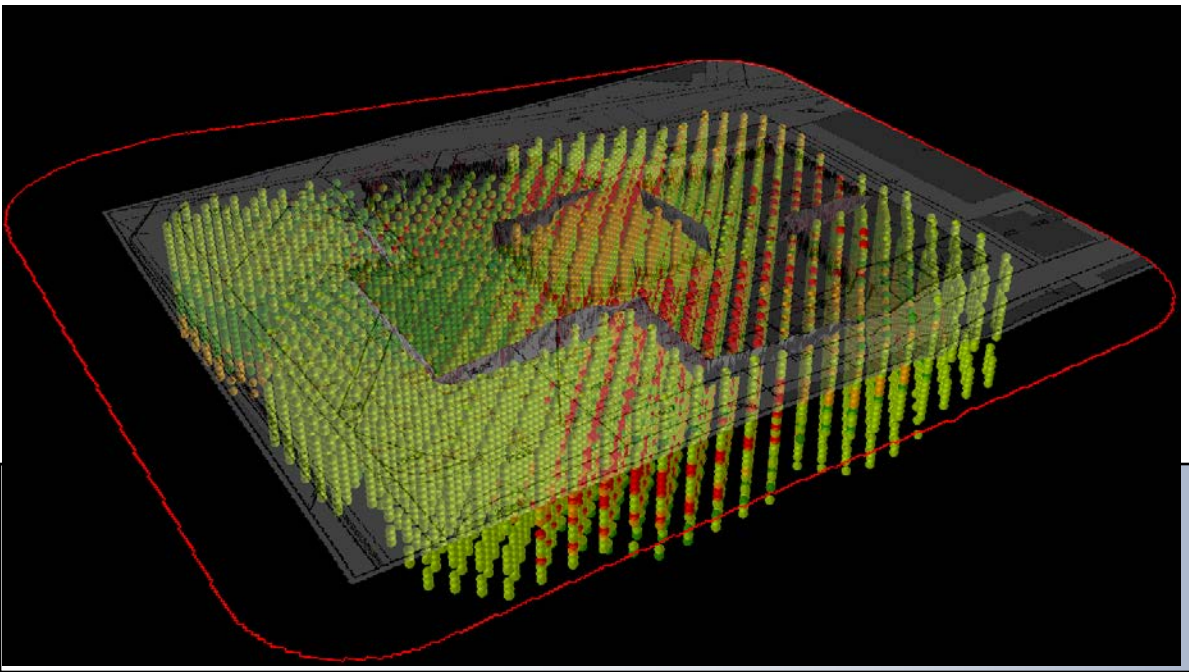
POST TENEBRAS LUX

2D/3D products

- Geographical optimization -

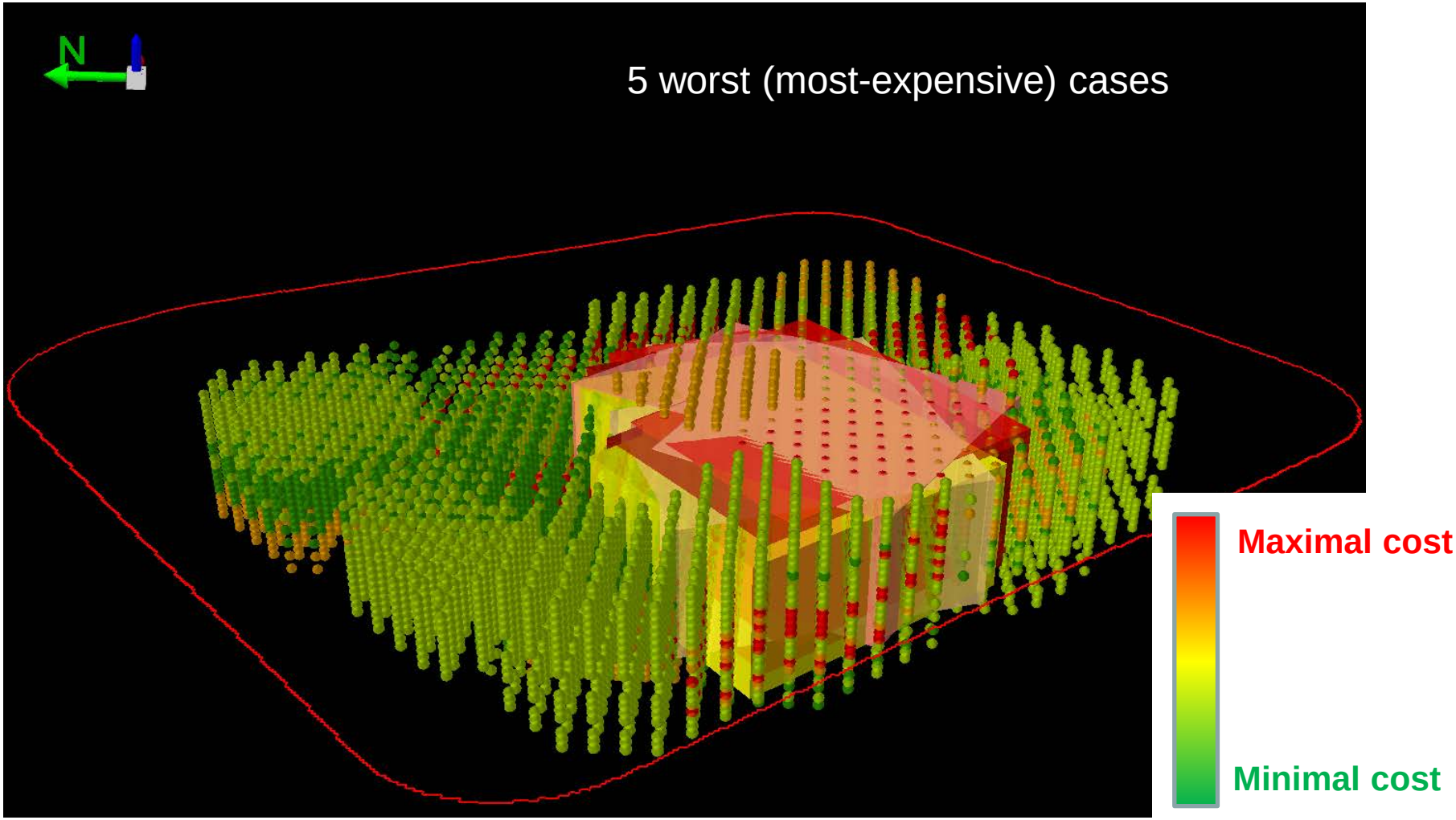


n=5 *n=10* *n=100*



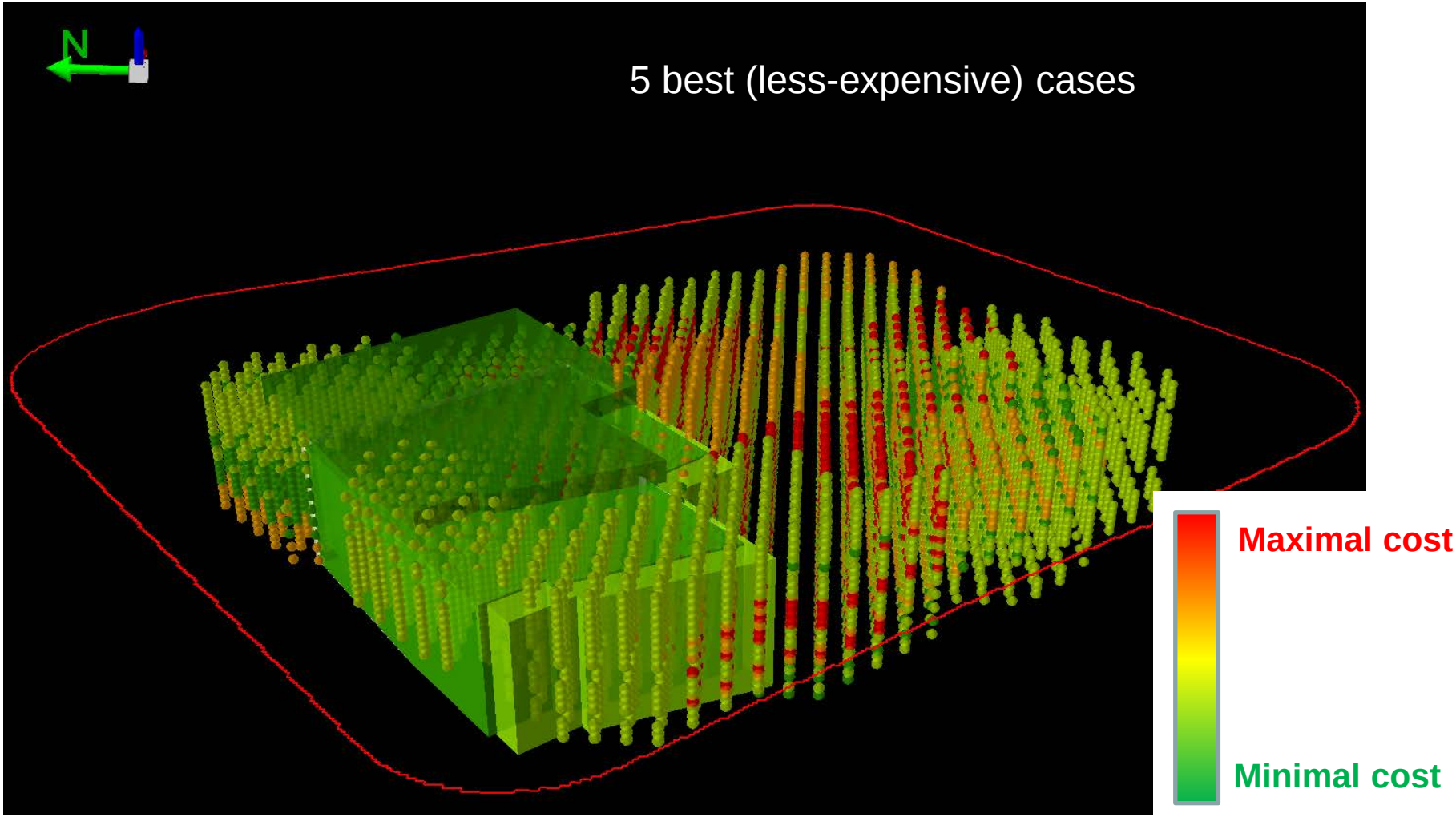
Environmental 3D model

- Geographical optimization -



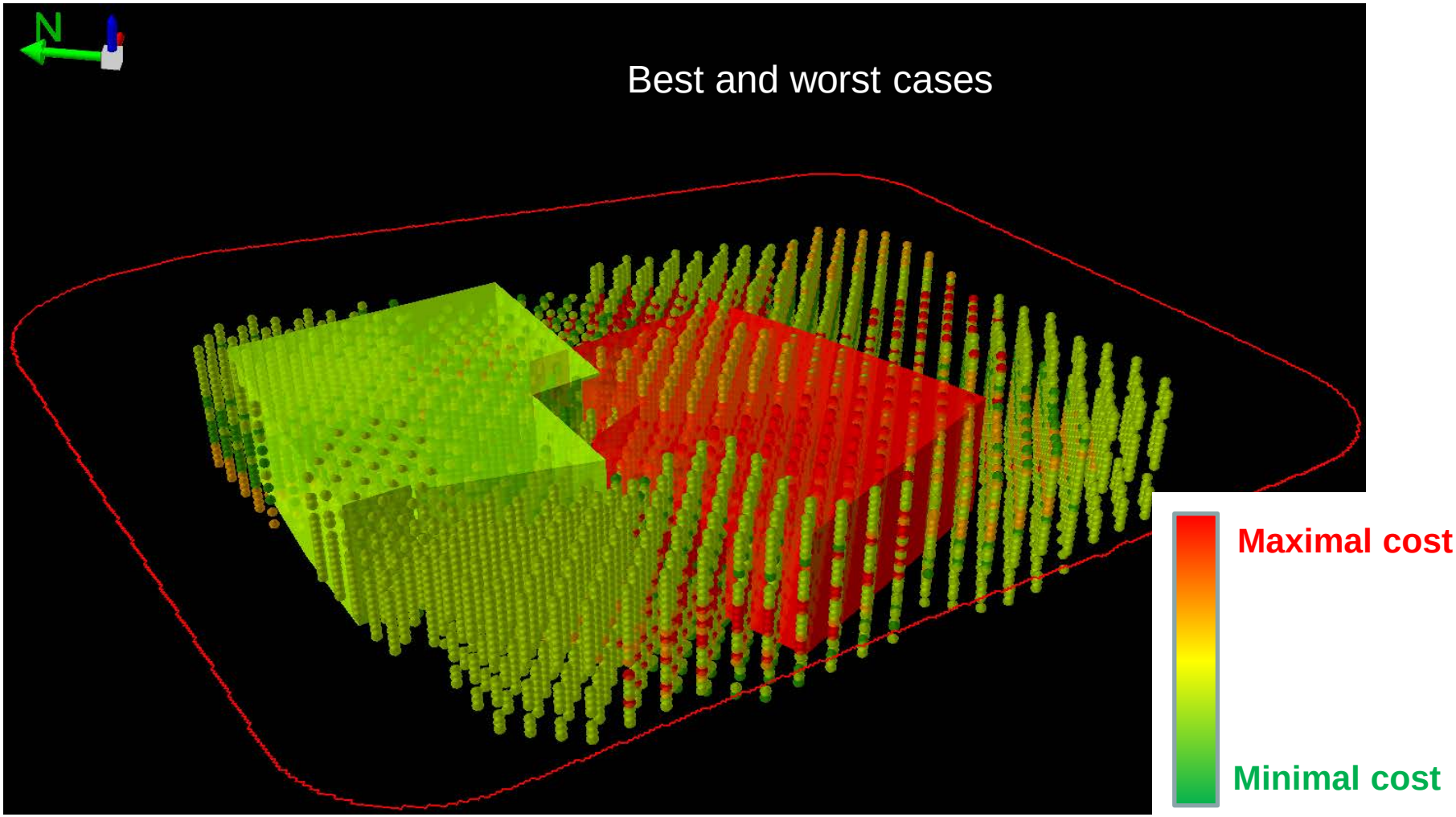
Environmental 3D model

- Geographical optimization -



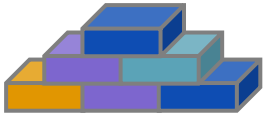
Environmental 3D model

- Geographical optimization -



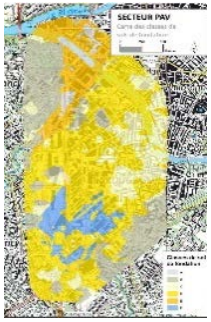
2D/3D products summary

Geological and lithological units (Geneva soil classification)

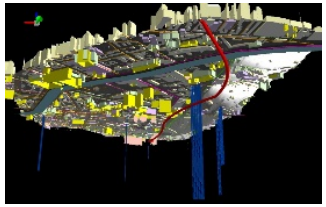


Geology

Lithology

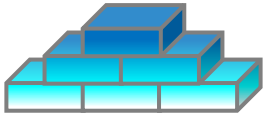


Soil fundation map

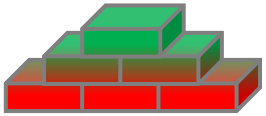


Interactions Géologie-BIM

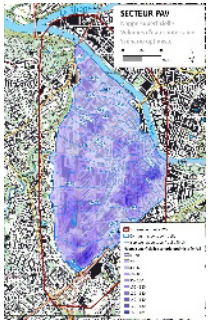
USCS classification

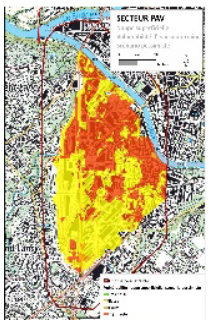


Permeability



Georessources

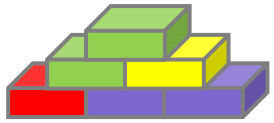




Groundwater Volume & Vulnerbility

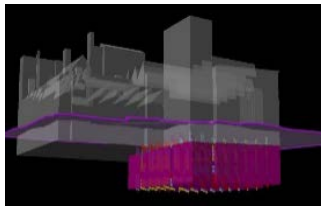
Quality of Georessources

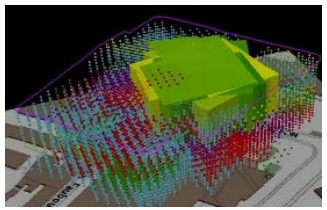
Environnemental



Pollution Status

Diagnostic of excavation costs





Conclusions

- This method offers a large pannel of applications, derived products and decision tool in support of both:
  - The authorities in their role of sustainable planning and management of the subsurface and its resources.
  - The construction project managers and architects in the planning of treatment or valorization of excavation material.
- Robust data model and transparent, semi-automated, workflows allow repeatable results, as well as controlled and relativey fast update of the models.
- Data collection and re-interpretation, although most important, remains a laborious and time consuming task and must be realized by experienced people.
- Models remain predictive and carry a certain amount of uncertainty related to:
  - The data quality and spatial distribution
  - The construction of the model (choice of interpolation methods)
- This "demo" tool can be further developped and refined (and should be, step by step, extended to the rest of the territory, toward a complete 3D management persepctive of the subsurface, which is of particular interest in densly urbanized regions.

Thank you

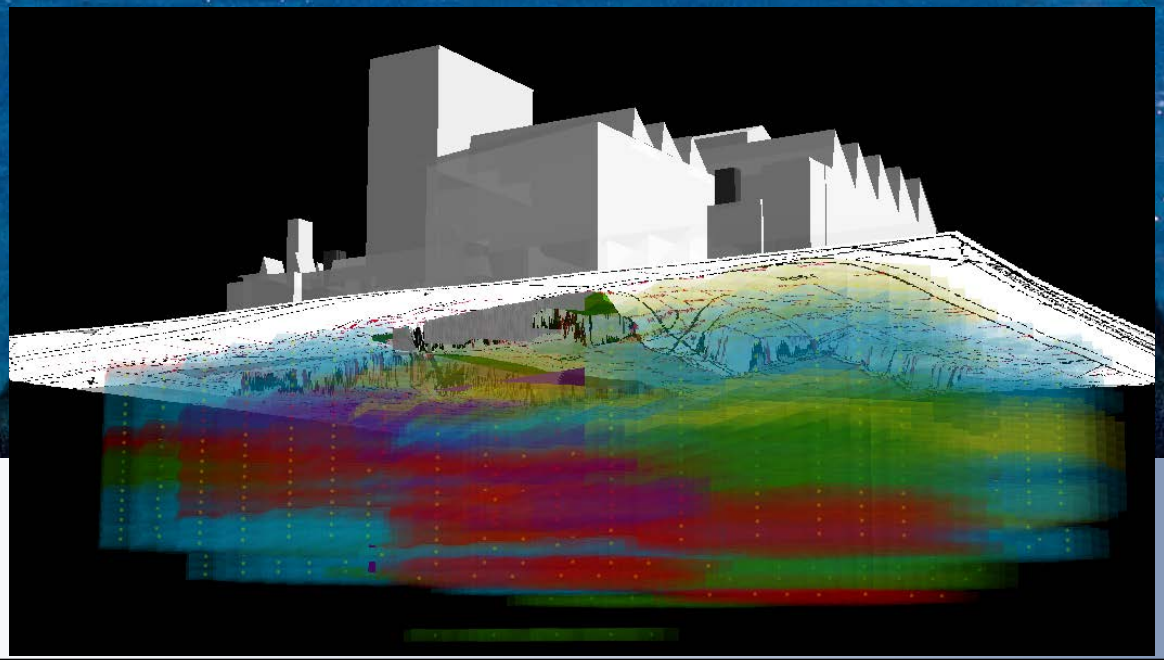


Photo C. Chelle-Michou

REPUBLIQUE
ET CANTON
DE GENEVE

POST TENEBRAS LUX