

Providing cutting-edge graphic and modeling technology for managing, visualizing and analyzing environmental data and for assessing site and soil contaminations

J.-B. Mathieu, M. H. Garcia, V. Garcia (*KIDOVA*)

A. Rabaute (*GeoSubSight*)

*11th annual Intersol congress
Paris, France, March 27-30, 2012*



Position of the problem

• Multiple and various data

- Historical and facility data
- Surface data
 - Geological maps, aerial photos, ...
 - Topography
 - Geophysics
 - Air quality
- Borehole data
 - Lithologic and soil data
 - Contamination data on soil, water and/or air samples or in situ
 - Spatio-temporal water-table data



SONDAGE S7

Profondeur (m)	Description	Observations organoleptiques	PID (ppm)
0-0,1 m	Dalle béton		-
0,1-1,8 m	Remblais sableux		
1,8-3,2 m	Remblais s.		
3,2-6,5 m	Marnes crayeuses		
6,5-10 m	Marnes argileuses		
10-12 m	Sables fins po		
12-15 m	Argiles c		
15-18,5 m	Sables		

Call for dedicated tools

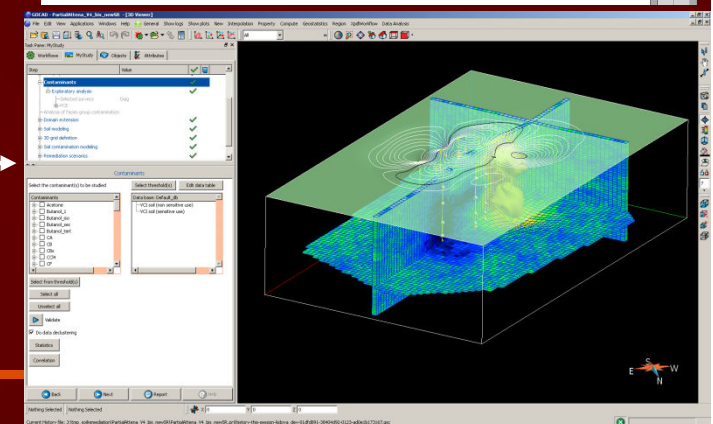
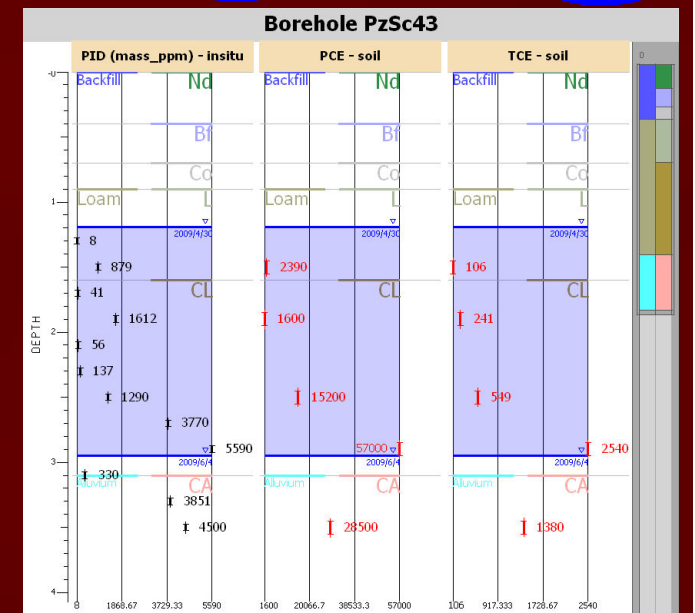
• Issues

- Managing and storing all types of data
- Analyzing the data to understand potential contaminations
- Using the data for estimation purposes: soil volumes, potential impacts, ...

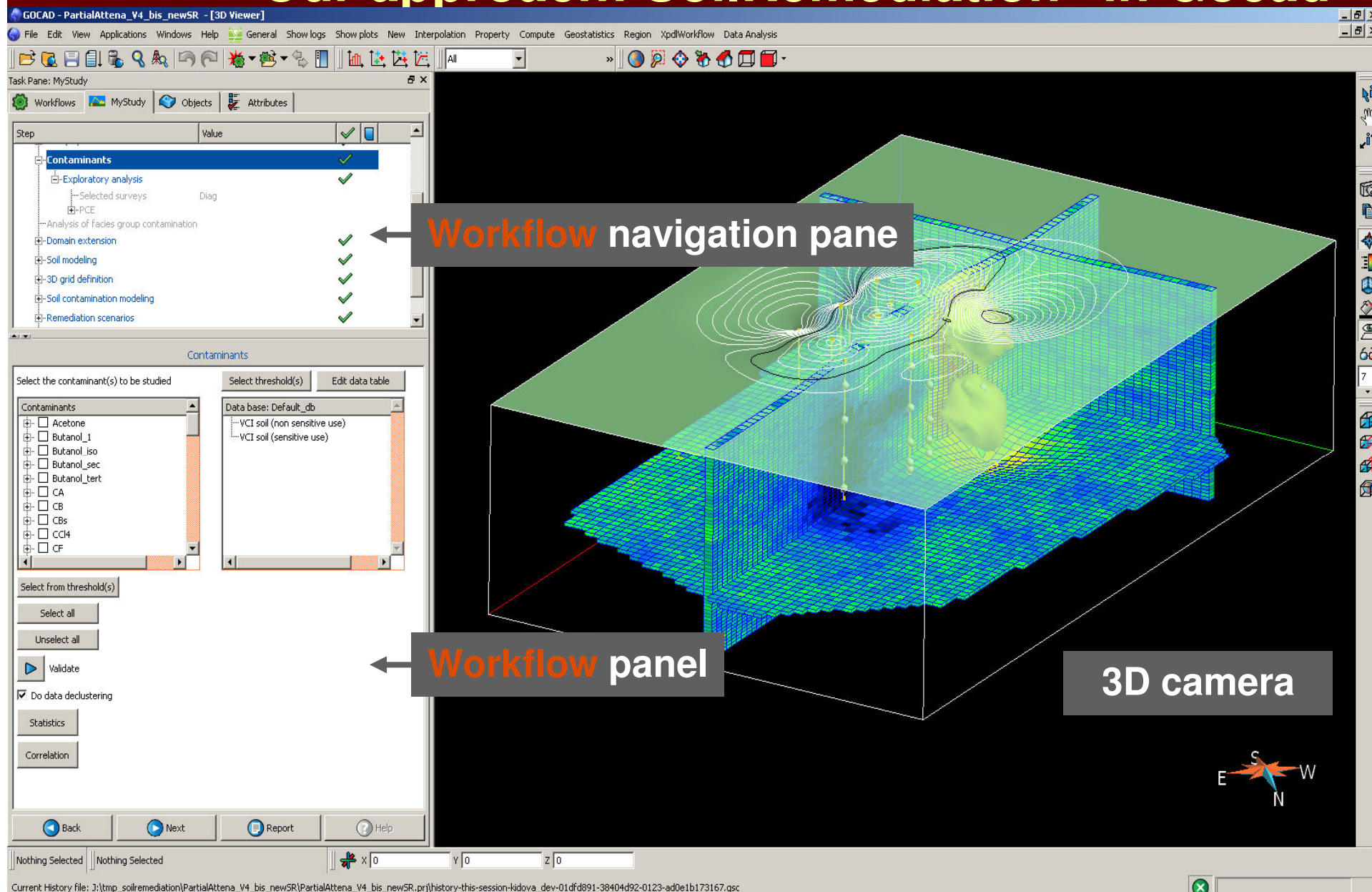
Our approach: SoilRemediation® in Gocad®

- All environmental data within the same framework
 - Dedicated import tools
 - Consistent storage (names, units)
 - Easy access and understanding of data
- Comprehensive exploratory analysis tools
 - Graphics:
 - Integrative borehole logs
 - Integrative cross-sections
 - 3D Gocad camera
 - Statistics: histograms, scatterplots, PCA, ...
- Workflow-driven approaches
 - Guiding the user through the successive steps of a (methodological) approach
 - Providing purposeful tools at each step
 - Keeping tracks of all user's choices and results (QC of the completed work)

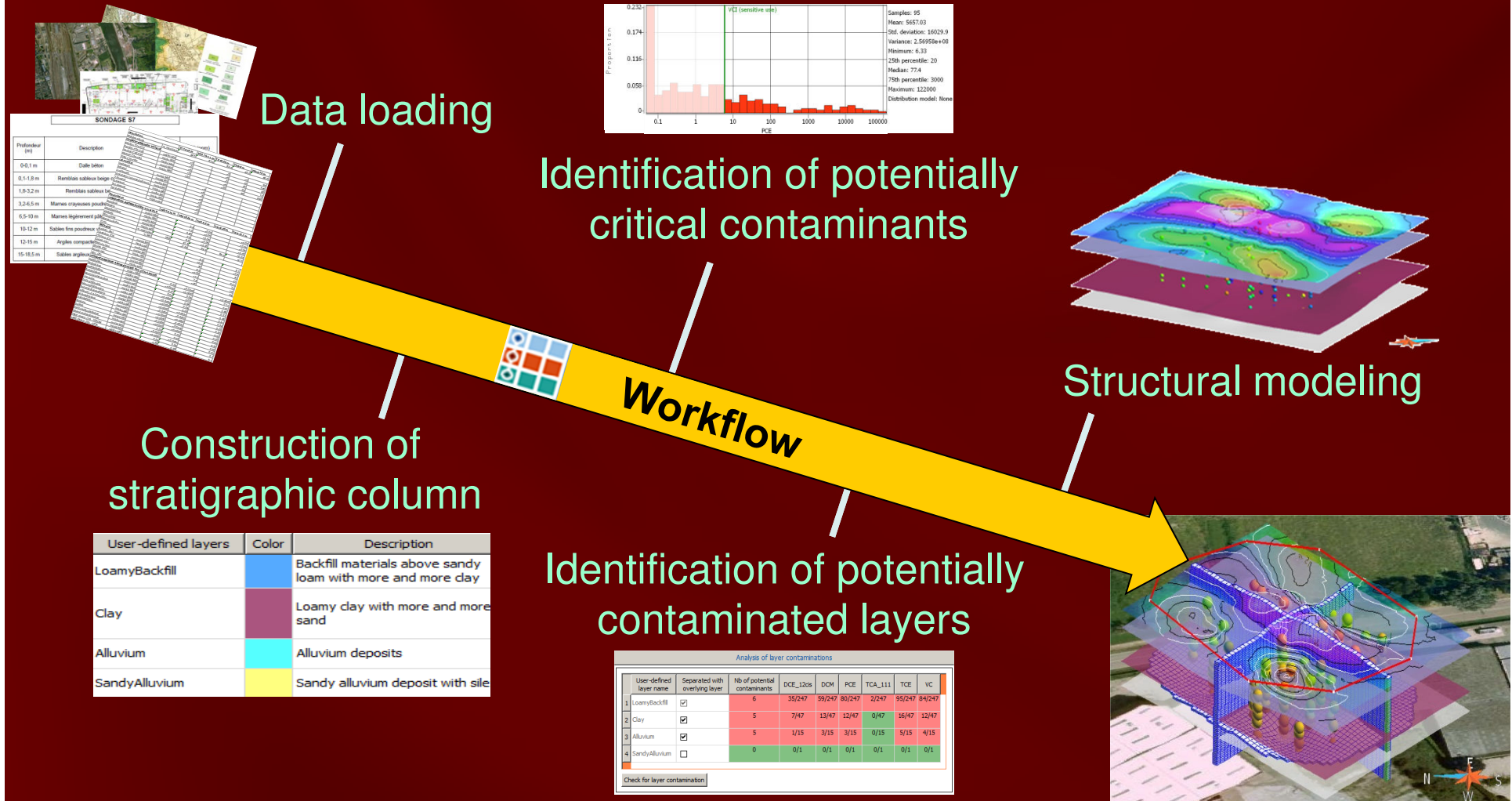
	Survey	Borehole	t	Date	Layer	Facies	Depth	Height	Source	TCA_111	TCE
1	Diag	PzSc60	3257.5	01/12/2008 12:00:00	LoamyBackfill	Bf	0.9	0.1	Labo	✓ 0.55	✓ 119
2	Diag	PzSc60	3257.5	01/12/2008 12:00:00	LoamyBackfill	CL	1.3	0.1	Labo	✓ < 0.1	✓ 2.13
3	Diag	PzSc60	3257.5	01/12/2008 12:00:00	LoamyBackfill	CL	2.1	0.1	Labo	✓ < 0.1	✓ 8.32
4	Diag	PzSc60	3257.5	01/12/2008 12:00:00	LoamyBackfill	CL	2.5	0.1	Labo	✓ < 0.1	✓ 7.34
5	Diag	PzSc60	3257.5	01/12/2008 12:00:00	Clay	C	3.1	0.1	Labo	✓ 0.12	✓ 20.8



Our approach: SoilRemediation® in Gocad®



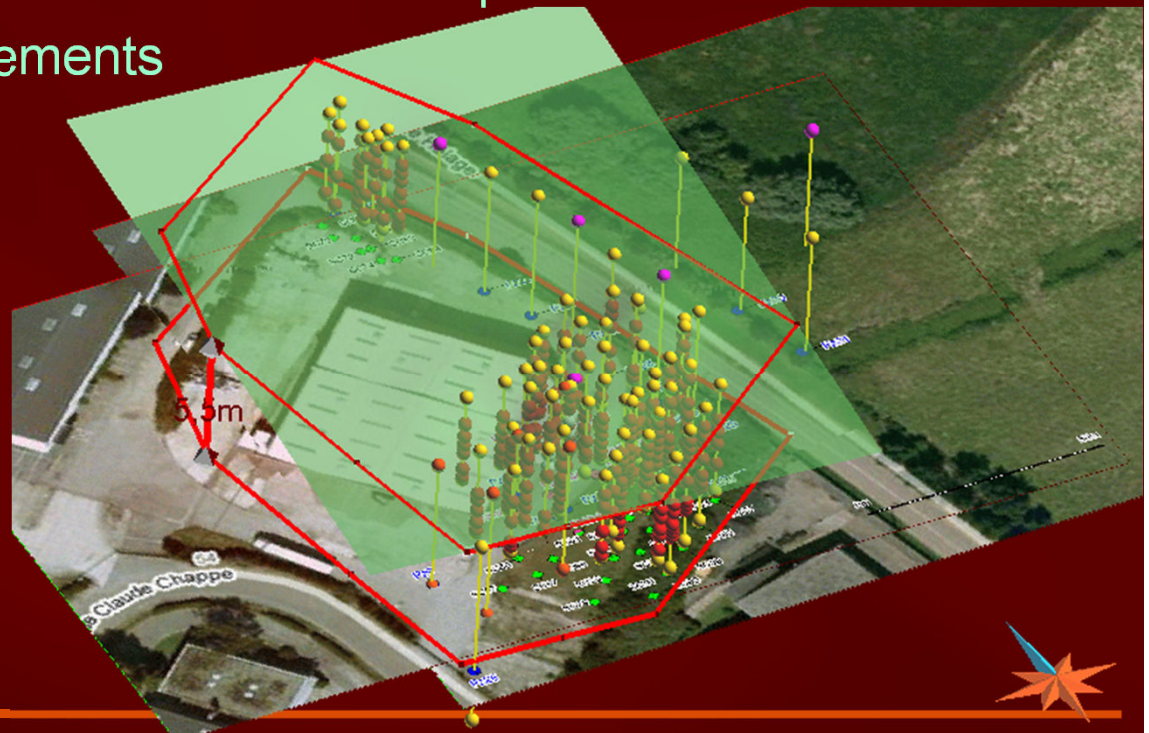
Five-step Data Analysis workflow



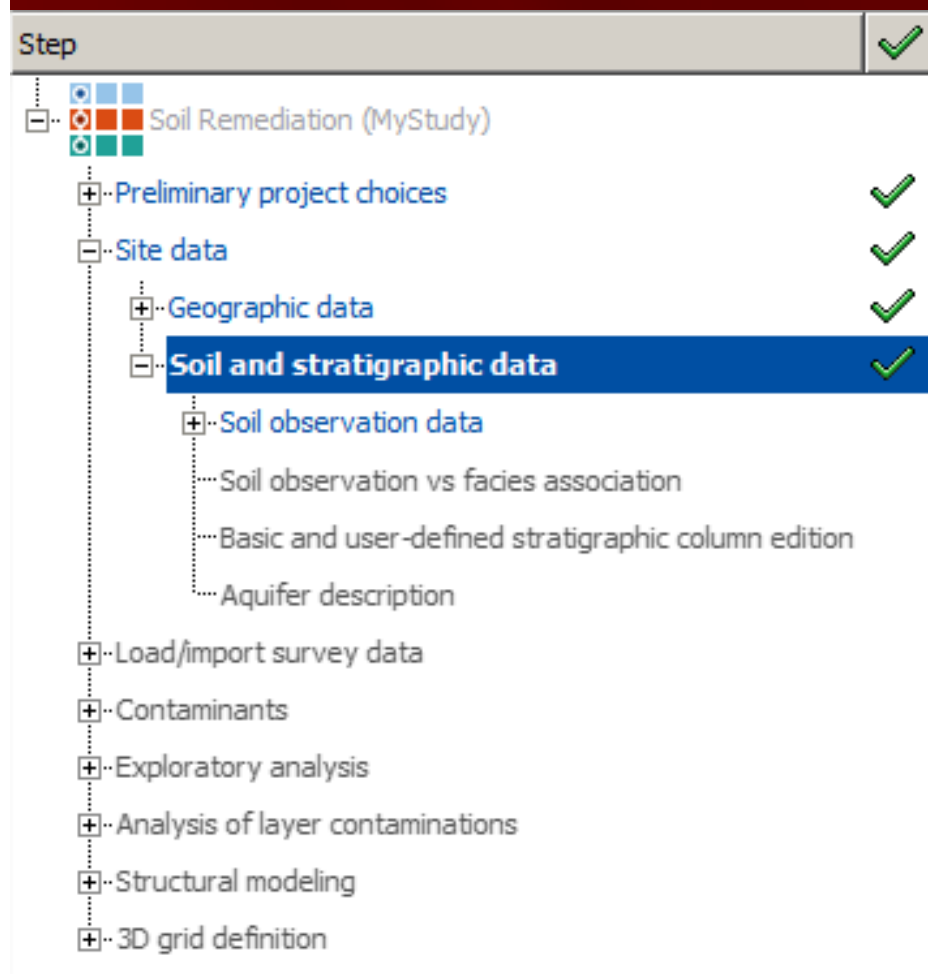
Aim: Identifying potential contaminants and contaminated layers

Application to a complex case study

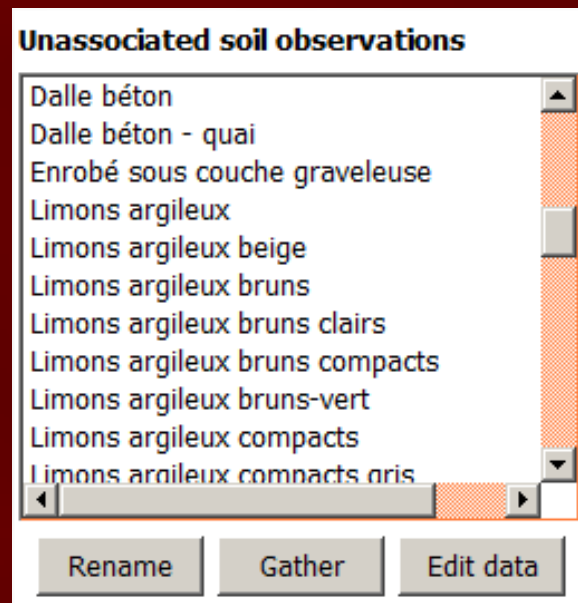
- 1 geological map
- 3 aerial photographs
- 4 successive surveys → 127 Boreholes (2004 to 2009)
 - 167 soil types identified from **387 soil marker observations**
 - 51 compounds analyzed on **319 soil samples**
 - 164 compounds analyzed on 130 water samples
 - 980 on site PID measurements
 - 727 water table data



Stratigraphic column of the site



- 167 observed soil types
- 15 interpreted facies
- 1 Stratigraphic column: 4 layers
- Time to process: < 30 mn



Stratigraphic column of the site

Step

- Soil Remediation (MyStudy)
 - Preliminary project choices
 - Site data
 - Geographic data
 - Soil and stratigraphic data**
 - Soil observation data
 - Soil observation vs facies association
 - Basic and user-defined stratigraphic column edition
 - Aquifer description

- 167 observed soil types
- 15 interpreted facies
- 1 Stratigraphic column: 4 layers
- Time to process: < 30 mn



Unassociated soil observations

Dalle béton
Dalle béton - quai
Enrobé sous couche graveleuse
Limons argileux

Site stratigraphic column definition

	User-defined layers	Color	Description	Min. thickness	Max. thickness
1	LoamyBackfill		Backfill materials above sandy loam with more and more clay	1.6	6.1
2					
3	Clay		Loamy clay with more and more sand	0	5.8
4					
5	Alluvium		Alluvium deposits	0	0.9
6					
7	SandyAlluvium		Sandy alluvium deposit with silex	Unknown	Unknown

List of the facies within layer: Clay

Clay
Sandy clay
Clay alluvium
Loamy alluvium

Merge

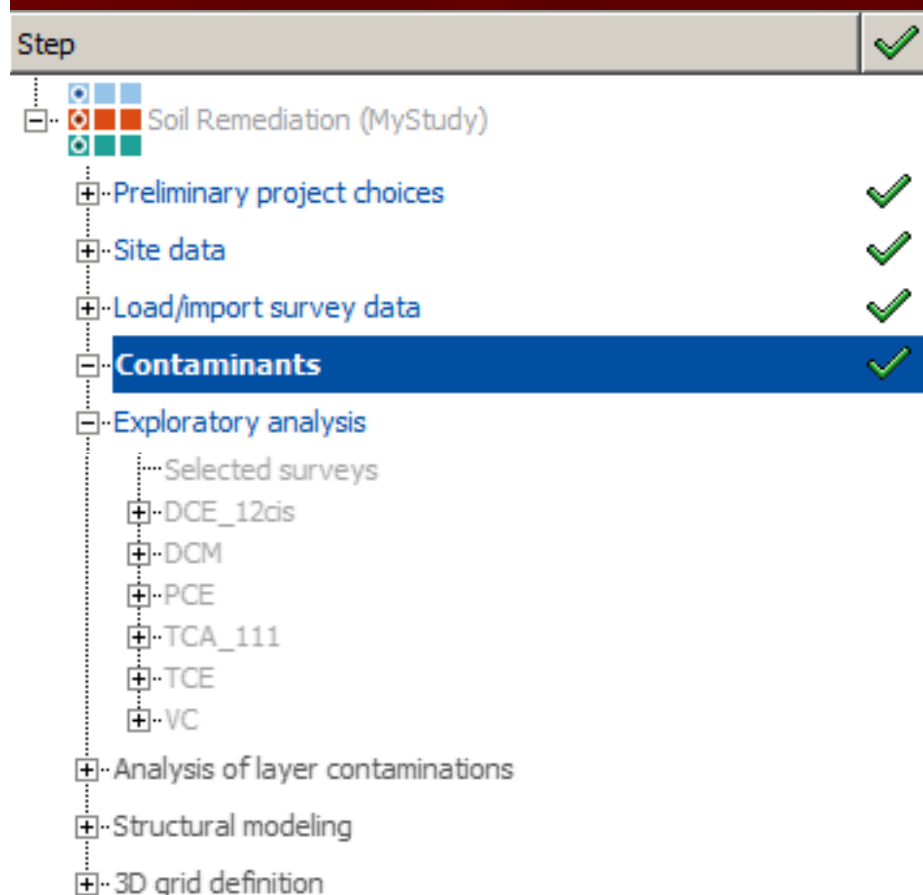
Separate

Cancel

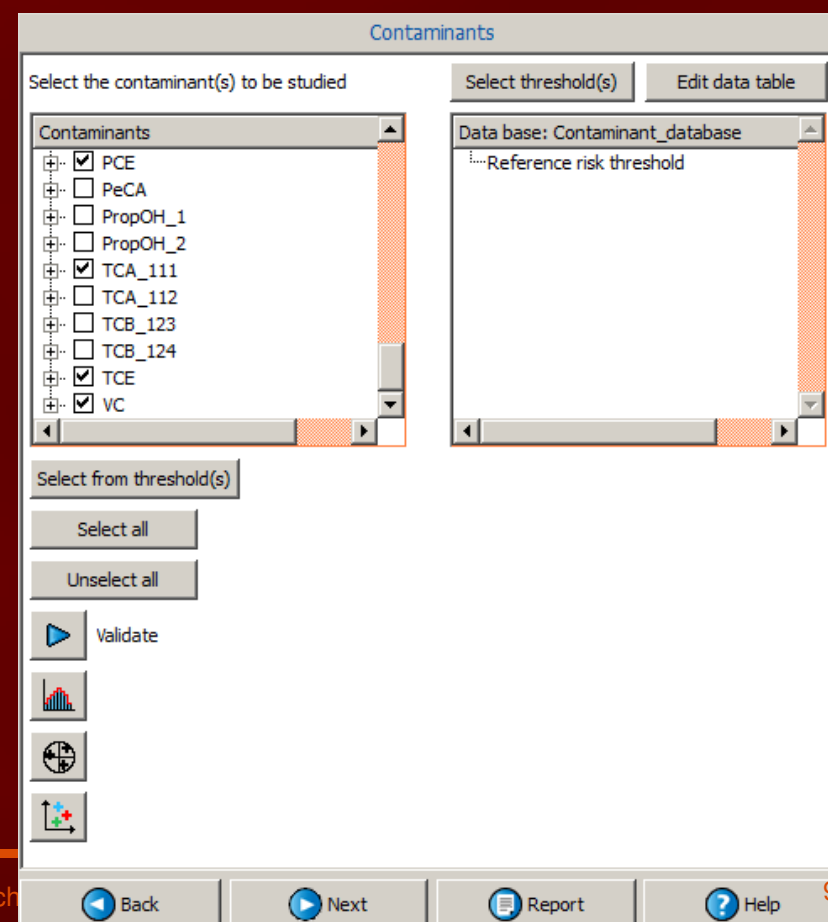
Validate

Edit markers

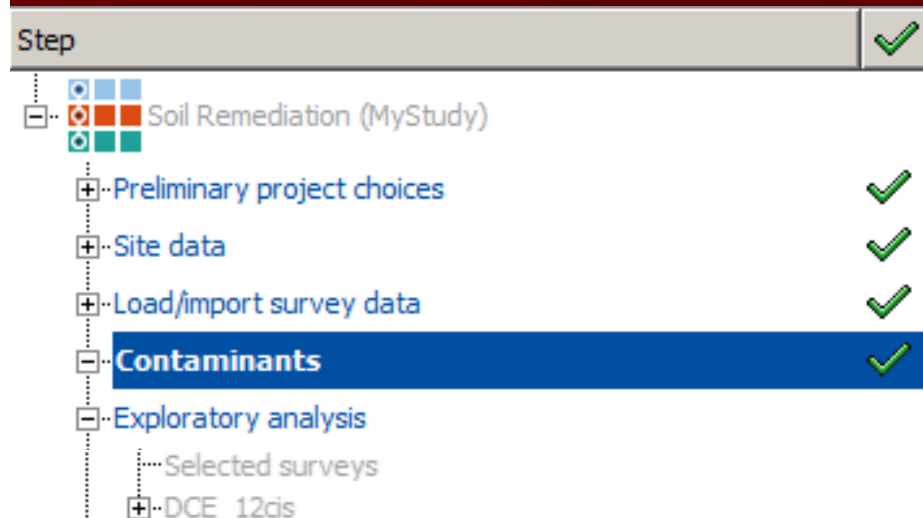
Identification of potentially critical contaminants



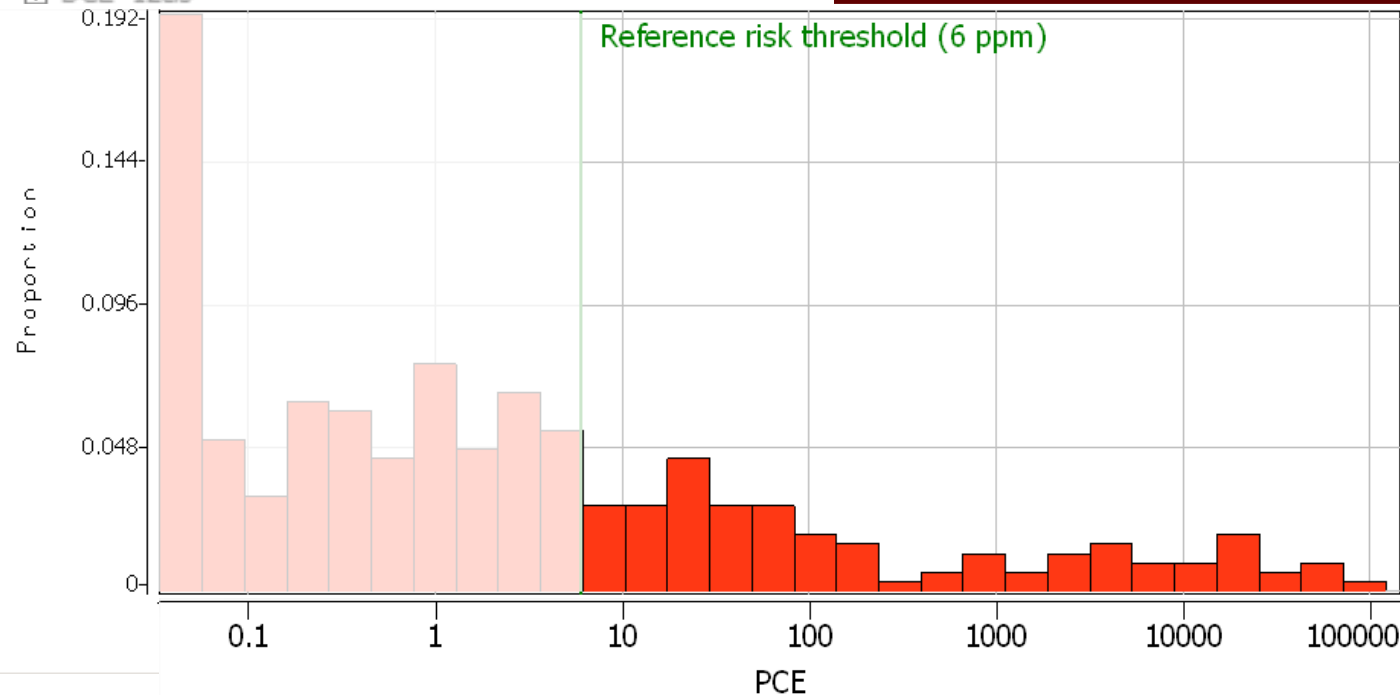
- 51 measured compounds in soils
- 6 potentially critical contaminants / reference risk thresholds
- 3 groups of correlated contaminants
- Time to process: < 5 mn



Identification of potentially critical contaminants

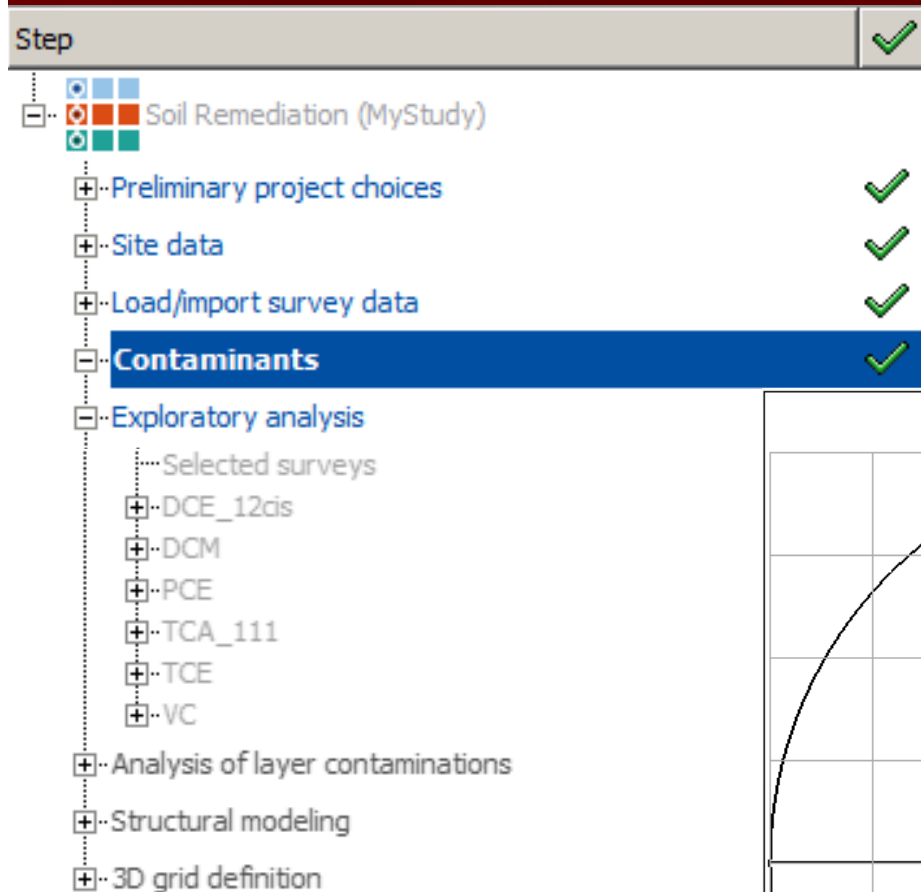


- 51 measured compounds in soils
- 6 potentially critical contaminants / reference risk thresholds
- 3 groups of correlated contaminants
- Time to process: < 5 mn

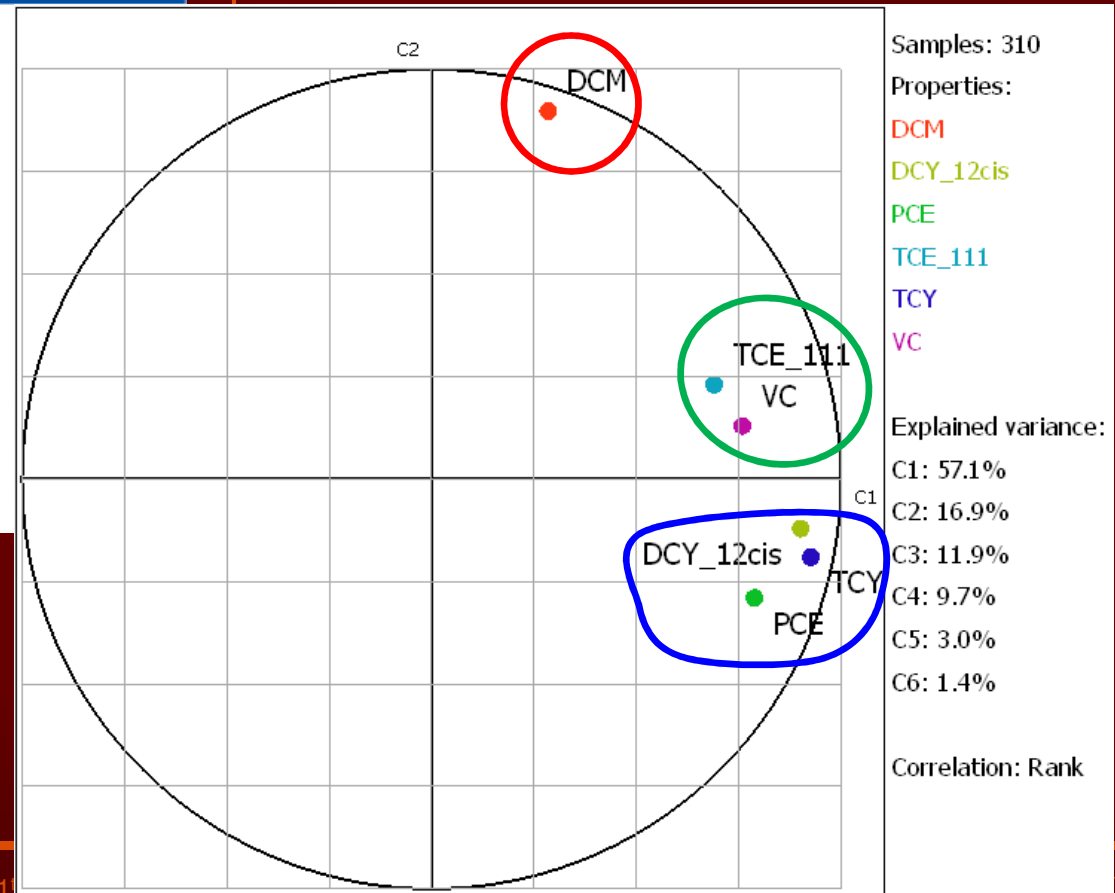


Samples: 97
Mean: 5584.62
Std. deviation: 15873.9
Variance: 2.5198e+08
Minimum: 6.33
25th percentile: 20.35
Median: 80.2
75th percentile: 3015
Maximum: 122000
Distribution model: None

Identification of potentially critical contaminants



- 51 measured compounds in soils
- 6 potentially critical contaminants / reference risk thresholds
- 3 groups of correlated contaminants
- Time to process: < 5 mn



Analysis of layer contaminations

Step

- Soil Remediation (MyStudy)
 - Preliminary project choices
 - Site data
 - Load/import survey data
 - Contaminants
 - Exploratory analysis
 - Analysis of layer contaminations**
 - Structural modeling
 - 3D grid definition

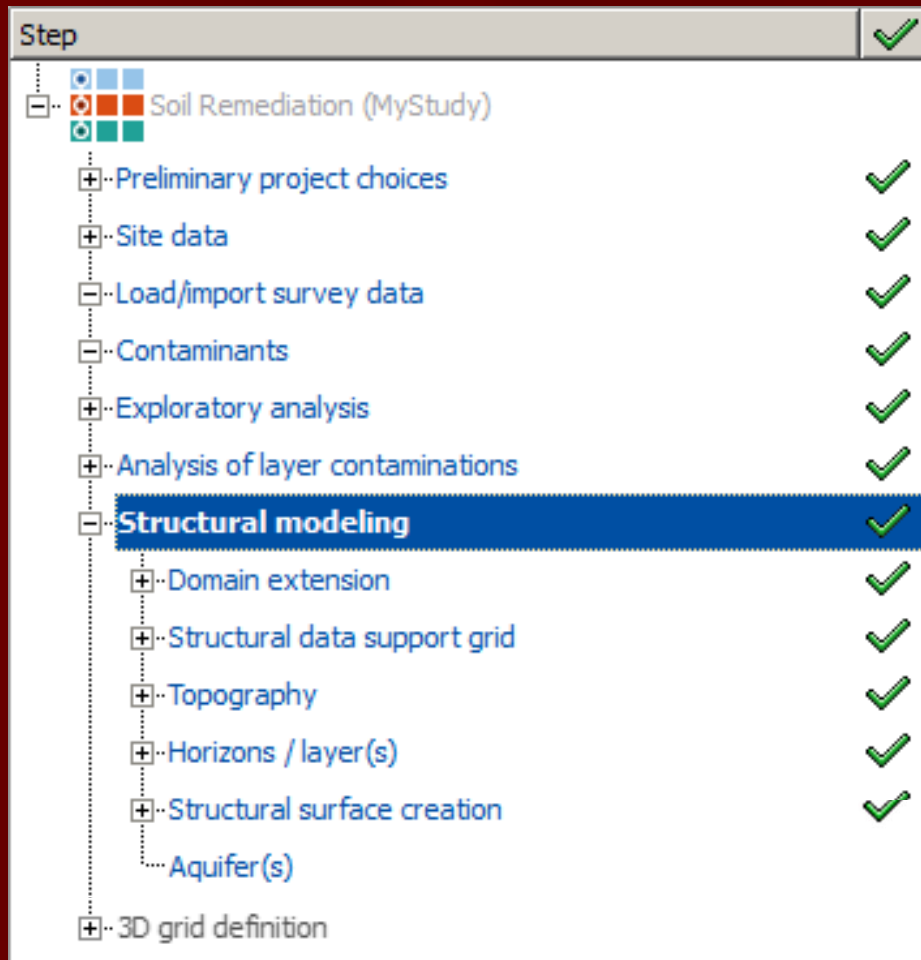
- 319 soils samples in 4 layers
- Which contaminant in which layer ?
- Nb of contaminated samples vs. nb of analyzed samples
- Time to process: 1 click + a few mn

Analysis of layer contaminations

	User-defined layer name	Separated with overlying layer	Nb of potential contaminants	DCE_12cis	DCM	PCE	TCA_111	TCE	VC
1	LoamyBackfill	<input checked="" type="checkbox"/>	6	35/247	59/247	80/247	2/247	95/247	84/247
2	Clay	<input checked="" type="checkbox"/>	5	7/47	13/47	12/47	0/47	16/47	12/47
3	Alluvium	<input checked="" type="checkbox"/>	5	1/15	3/15	3/15	0/15	5/15	4/15
4	SandyAlluvium	<input type="checkbox"/>	0	0/1	0/1	0/1	0/1	0/1	0/1

Check for layer contamination

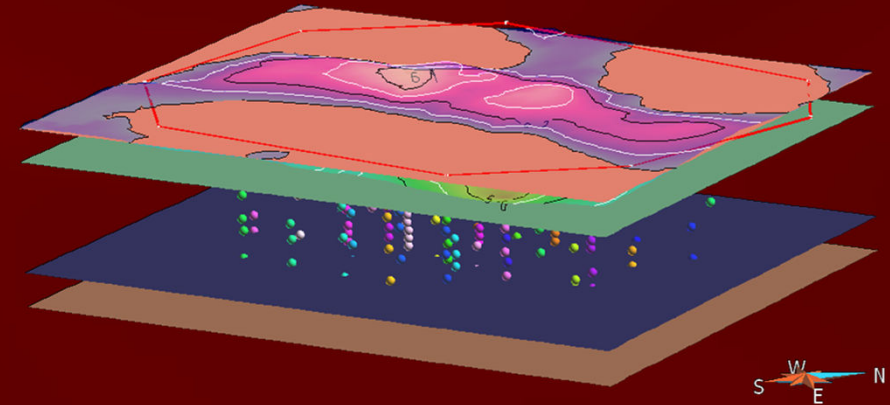
Structural modeling



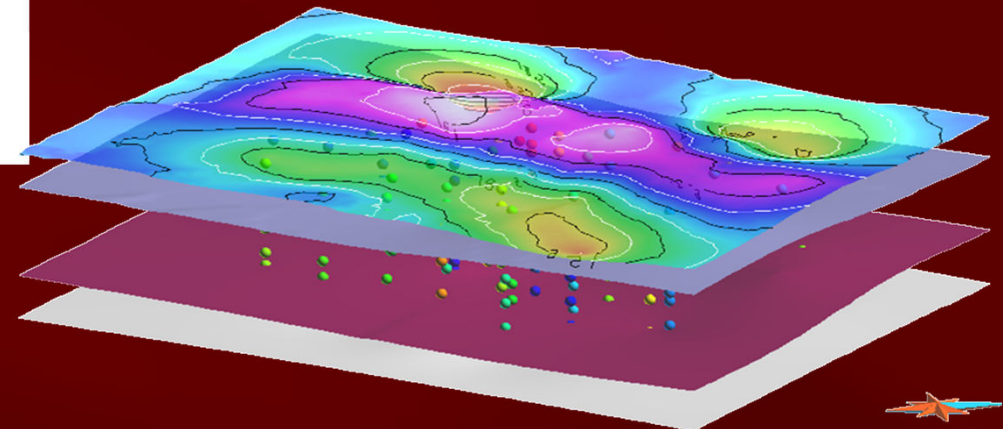
- Topography and 3 layers

- Time to process:

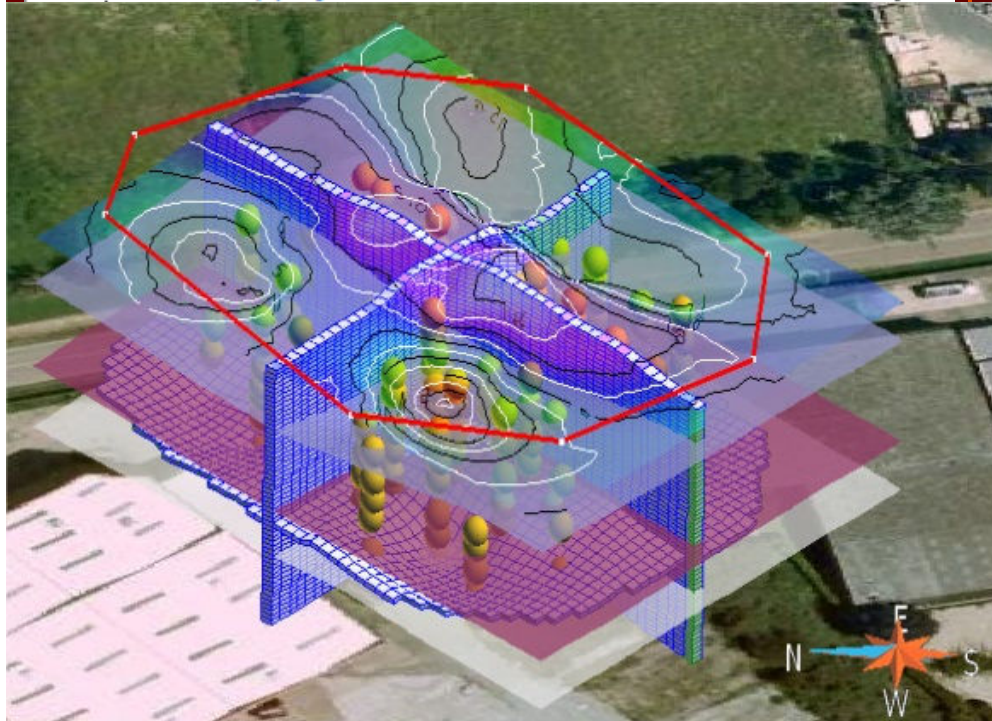
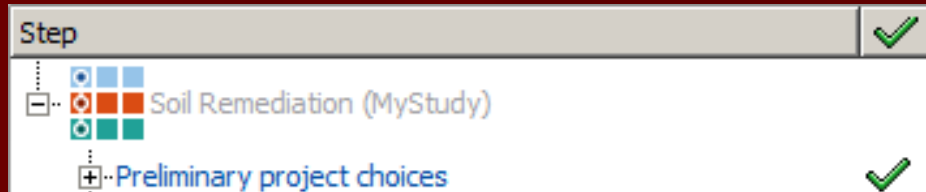
➤ < 5 mn for **constant** thicknesses



➤ 3 hours for **estimated** thicknesses



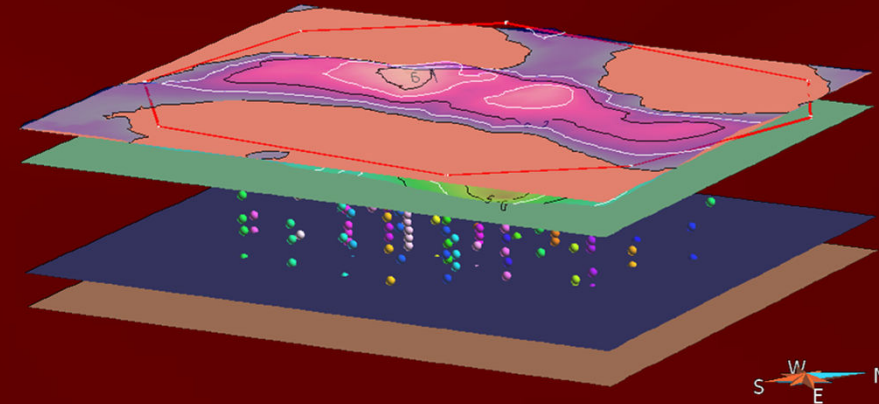
Structural modeling



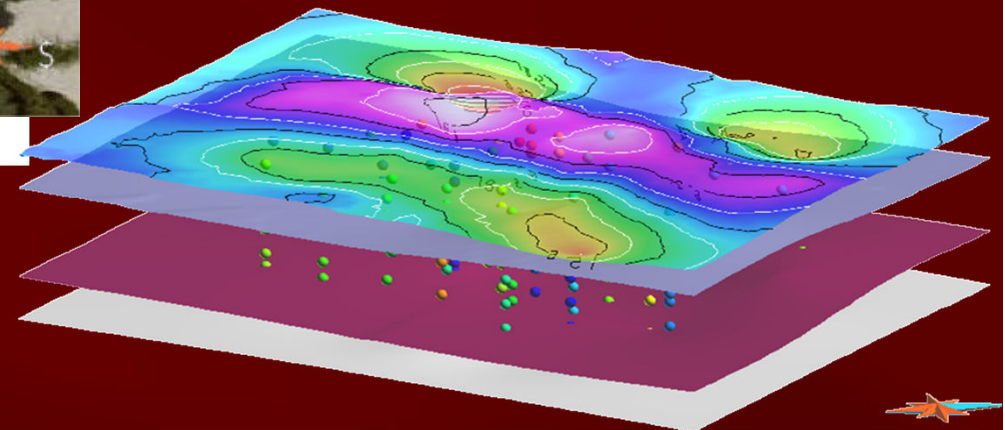
- Topography and 3 layers

- Time to process:

➤ < 5 mn for **constant** thicknesses

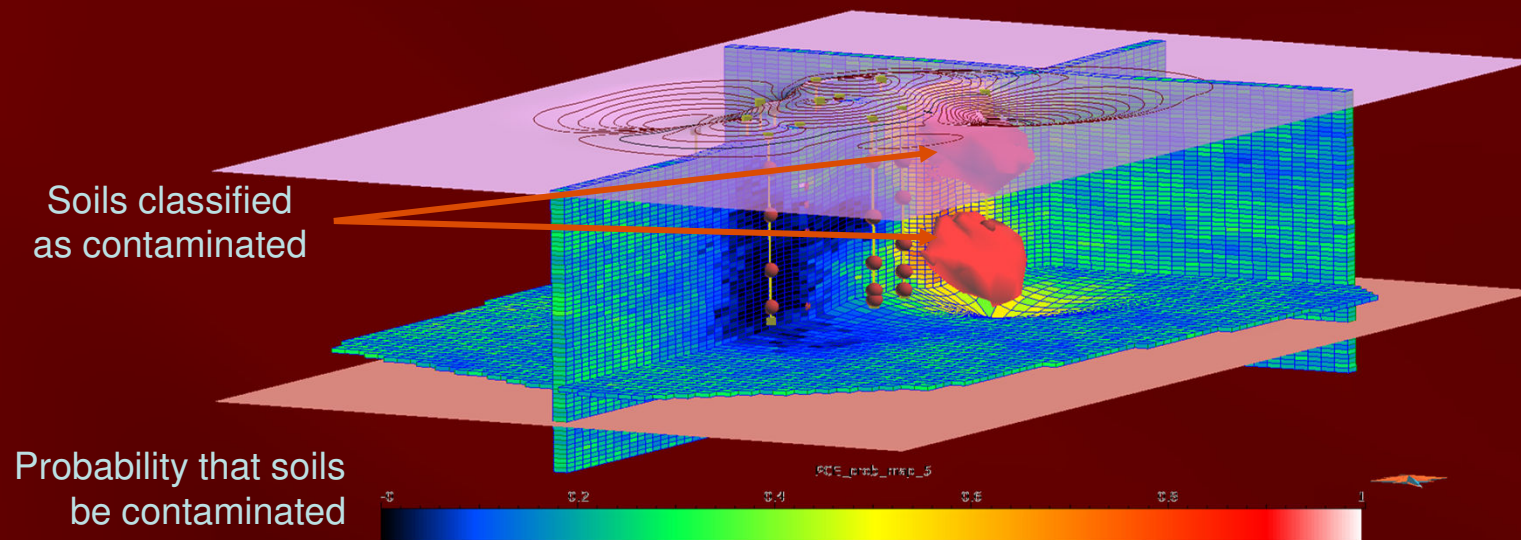


➤ 3 hours for **estimated** thicknesses



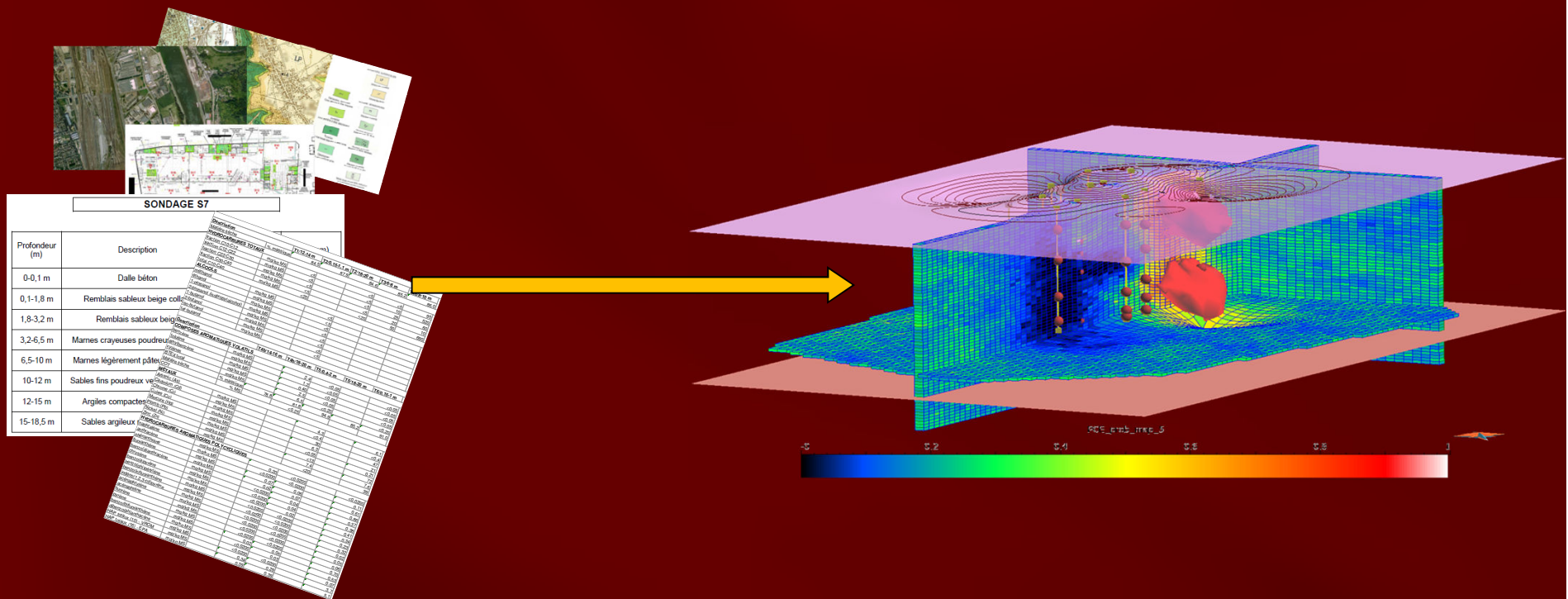
Next step... SoilRemediation Modeling Workflow

1. Geostatistical modeling of soil contamination
2. Uncertainty and risk analysis
3. Decision making

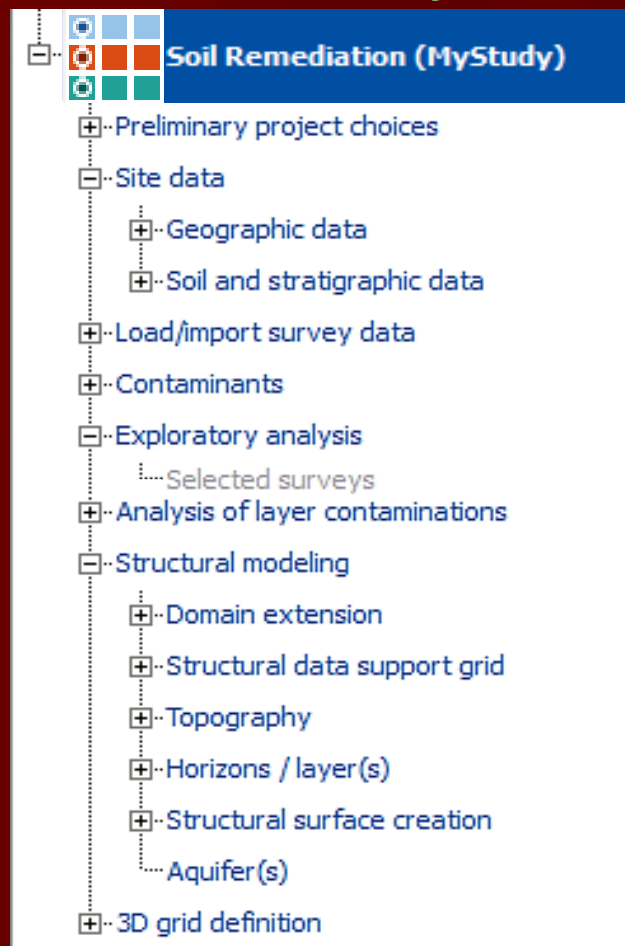


Conclusions about SoilRemediation

- **Fully dedicated** to contaminated sites and soils
- **Making easier, better and faster** all analysis & modeling steps

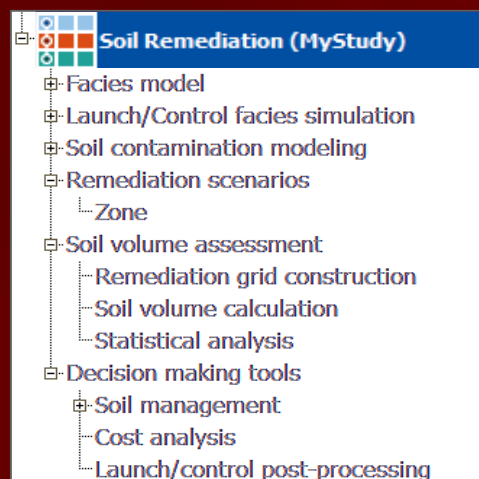


SoilRemediation Data Analysis Mandatory



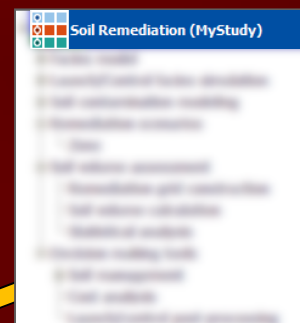
Mid 2012

SoilRemediation Modeling Optional



End 2012

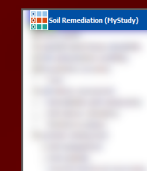
Site sampling optimization Optional



> 2012

Future work...

Health risk assessment Optional



> 2013

Groundwater Analysis/Modeling Optional

