



Presentation of InfoSol Unit

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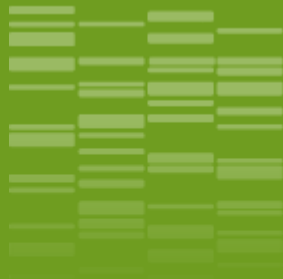
HAL Id: hal-02803309

<https://hal.inrae.fr/hal-02803309>

Submitted on 5 Jun 2020

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INRA
SCIENCE & IMPACT

InfoSol Unit

LDD – InfoSol meeting

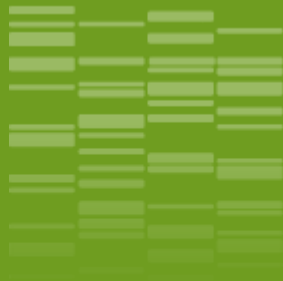


InfoSol Unit

1. Who are we?

2. What are our main activities?

- *Overview of the French soil survey and monitoring activities*
- *Focus on the Soil Test Database « BDAT »*
- *Focus on the French Soil Monitoring Network « RMQS »*



_01

InfoSol Unit: Who are we?

Inra, a public research institute



❖ INRA, a public scientific and technological establishment (EPST) under the joint authority of:

- The Minister of higher education and research
- The Minister of agriculture, agro-industries, food and forestry

❖ Goals :

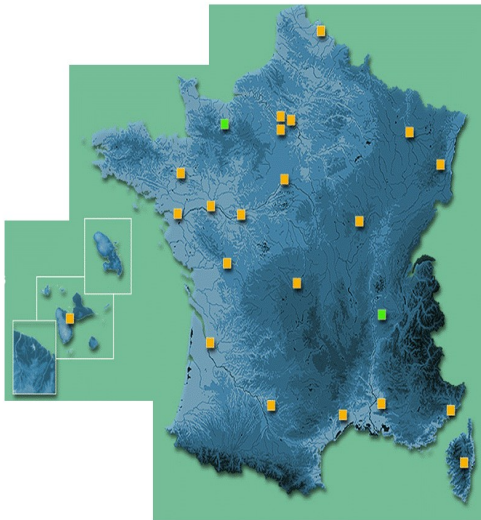
- to produce and disseminate scientific knowledge and inventions
- to contribute to education and training, to promote scientific and technical culture, and to participate in the science/society debate
- to advise decision-making by public authorities, through expertise

Inra, a public research institute

❖ Key figures:

- 8500 collaborators
- 3rd institute in the world for agricultural sciences

❖ 21 Research Centres



❖ 14 Scientific Divisions

- Human Nutrition
- Plant Biology
- Science and Process Engineering of Agricultural Products
- Forest, Grassland and Freshwater Ecology
- **Environment & Agronomy**
- Animal Genetics
- Plant Breeding and Genetics
- Applied Mathematics and Informatics
- Microbiology and the Food Chain
- Animal Physiology and Livestock Systems
- Animal Health
- Plant Health and Environment
- Science for Action and Sustainable Development
- Social Sciences, Agriculture and Food, Rural Development and Environment

❖ EA mission is to produce generic and oriented knowledges :

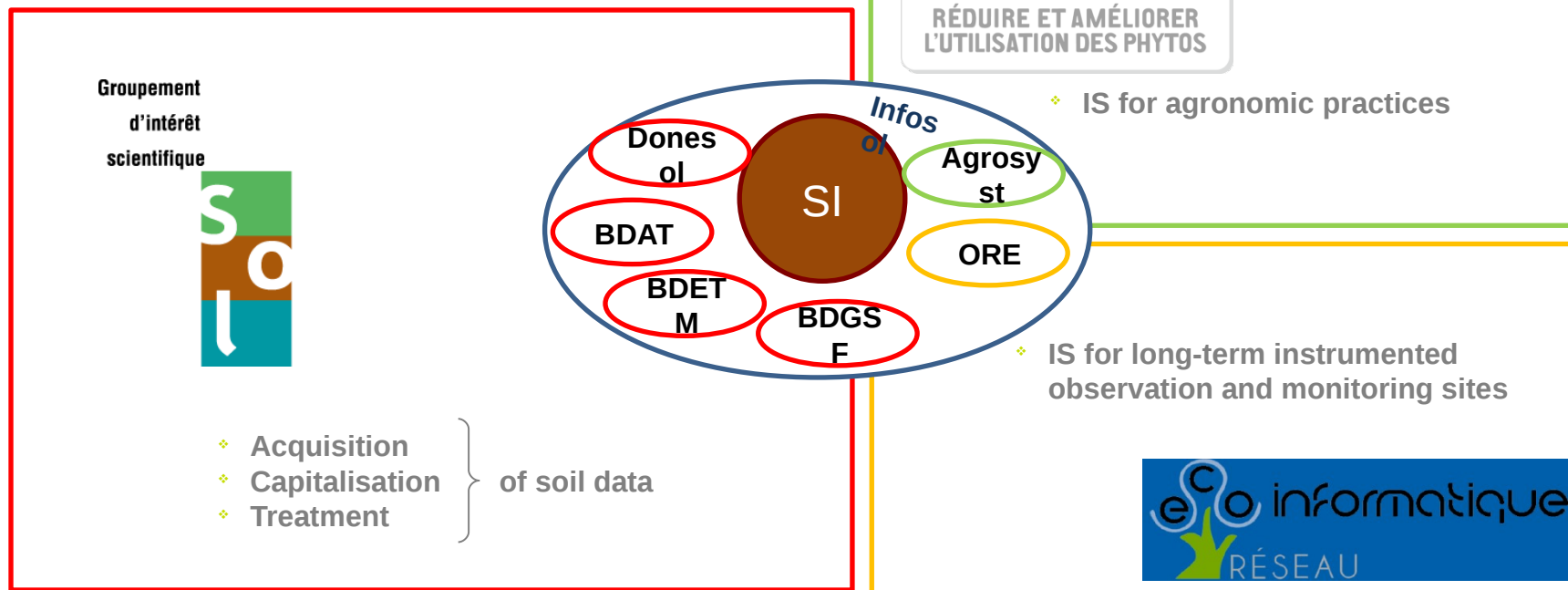
- for the sustainable management of :
 - ✓ croplands
 - ✓ biological and natural resources
 - ✓ their ecosystemic services
- to reach quantitative and qualitative objectives of agricultural production respecting the criteria of sustainable management.

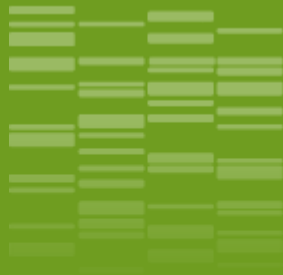


InfoSol Unit

Environnement et Agronomy Division

- ❖ 20 engineers
- ❖ 7 technicians
- ❖ Pedologists
- ❖ Computer scientists
- ❖ Statisticians (geostatistics, models, ...)





_02

What are our main activities?

The « GIS Sol »

Data on French soils

Groupement
d'intérêt
scientifique

□ Acquired since 2001 by the « Groupement d'Intérêt Scientifique Sol »



*New agreement
(2012-2016)*

□ InfoSol coordinates French soil survey and monitoring programmes

The « GIS Sol »

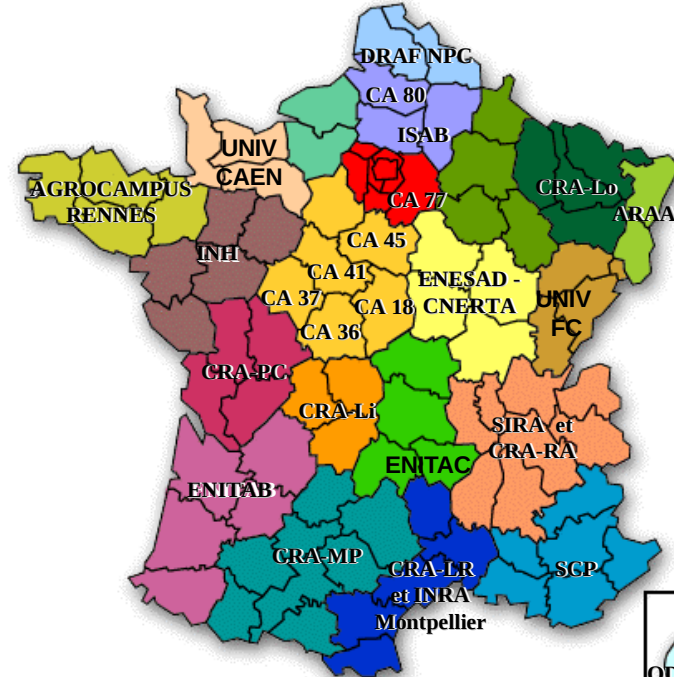
Coordination



InfoSol



Implementation



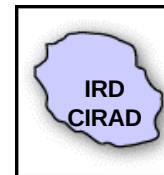
GUADELOUPE



GUYANE



MARTINIQUE



RÉUNION

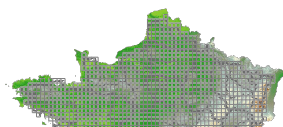


NOUVELLE CALÉDONIE

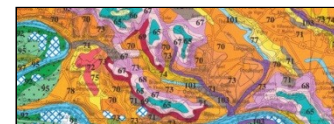
The « GIS Sol »

Four main soil survey and monitoring programmes

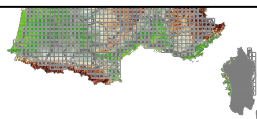
RMQS



IGCS



Improve soil knowledge and monitoring in France



BDETM



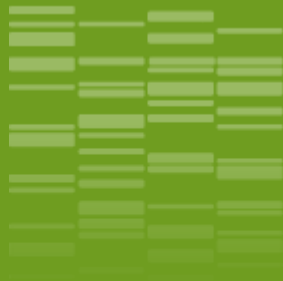
BDAT



Capitalizing soil tests requested by French farmers



14
8229
15677
- 29545
16



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The GIS Sol programmes

Soil Survey: « Inventaire Gestion et Conservation des Sols »

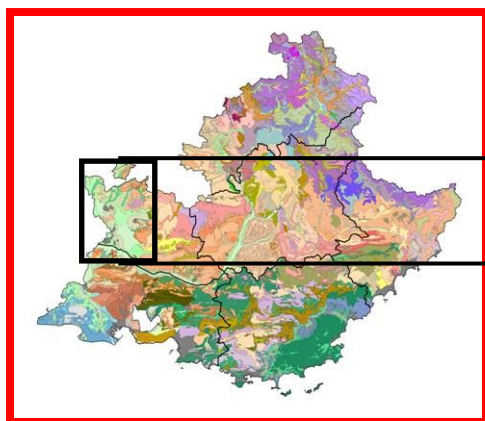
Inventaire, Gestion et Conservation des Sols (IGCS)

Groupe
d'intérêt
scientifique



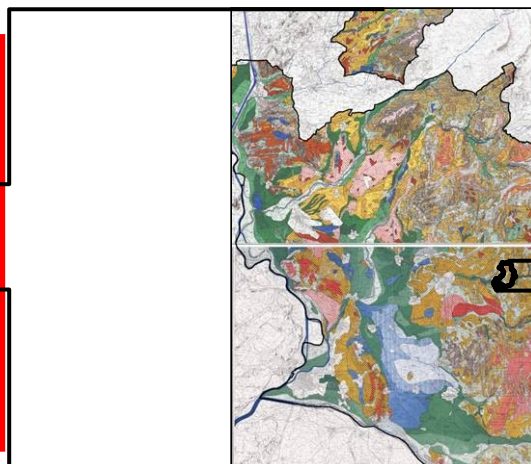
A multi-scale soil mapping framework

Regional Soil Inventories



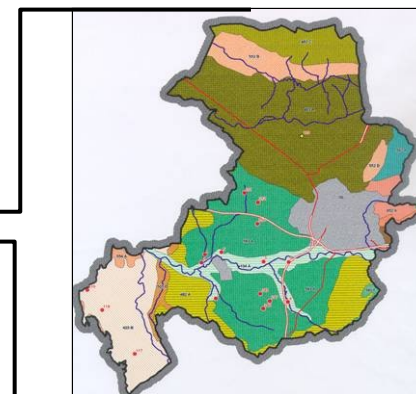
1/250 000
Regions, Départements

Mid-scale soil inventories



1/50 000 à 1/100 000
Small Régions

Reference areas



1/10 000
Field to farm

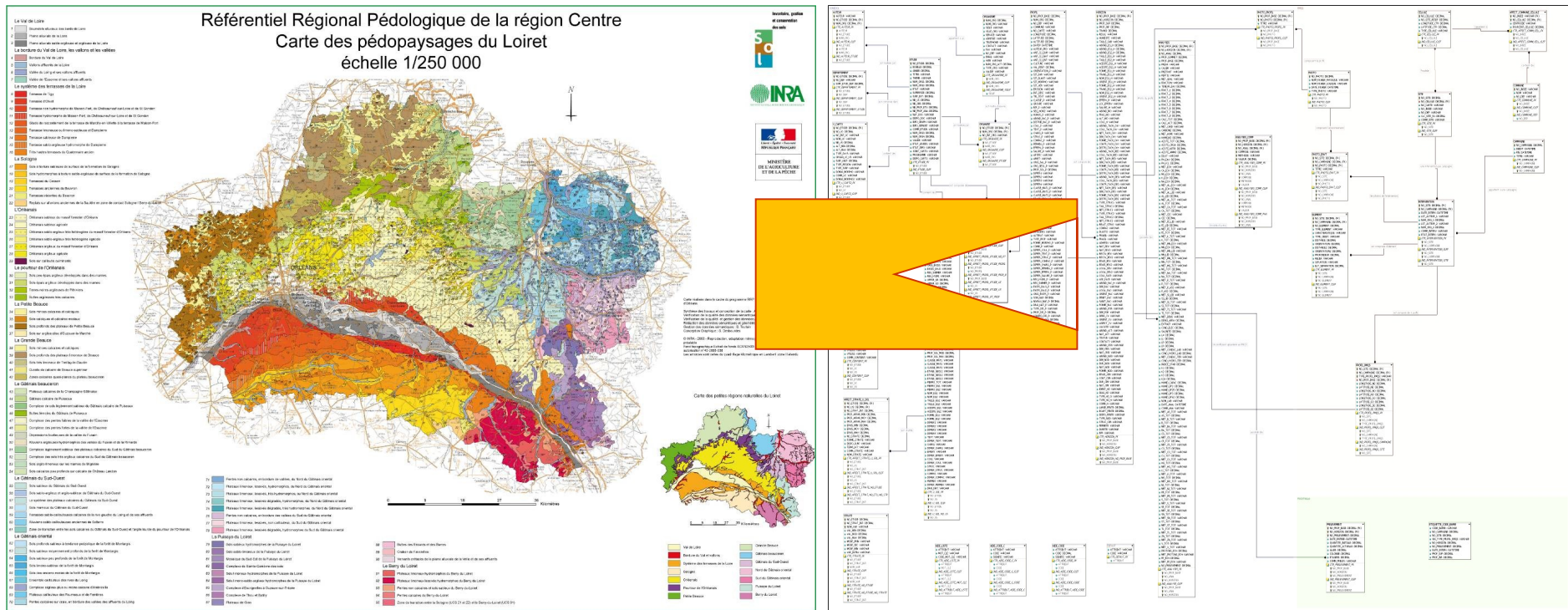
- Identify, define et locate the main soil types
- Evaluate **aptitudes of soils and risks for different uses**

Inventaire, Gestion et Conservation des Sols (IGCS)

A multi-scale soil mapping framework

What is a regional soil inventory?

A soil map and a database





DoneSolWeb 3.3.1 - Mozilla Firefox

Eichier Édition Affichage Historique Marque-pages Outils ?

DoneSolWeb 3.3.1

https://dw3.gissol.fr/login

Groupement d'intérêt scientifique

DoneSol est la base de données nationale structurant et regroupant les données ponctuelles et surfaciques des études pédologiques. Pour obtenir un compte DoneSol-web, il faut faire une [Demande de compte](#). Nous vous conseillons aussi fortement de prendre connaissance du [dictionnaire de données](#).

Bienvenue sur DoneSolWeb



Identifiant (email) *

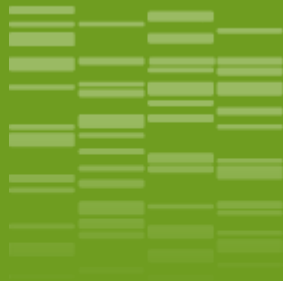
Mot de passe *

Se connecter

[Mot de passe oublié ?](#)

Version de la base de données *DoneSol* : 3.3
Version de l'application *DoneSolWeb* : 3.3.1 BL-3.3.1, journal
Maîtrise d'œuvre *DoneSolWeb* : [ici](#)
Responsable de publication : [Marion Bardy](#)
L'application *DoneSolWeb* a été développée pour Firefox.
Fiche de description d'une [fosse](#) / d'un [sondage](#)
Copyright © 2009-2013 INRA, Tous droits réservés

FR 20:32 05/06/2013



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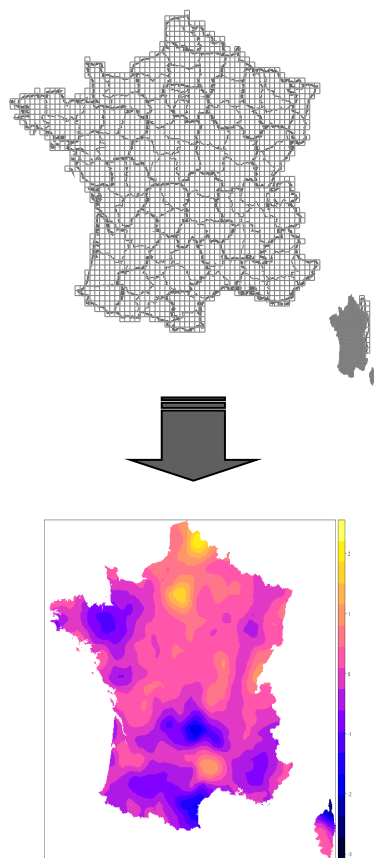
The GIS Sol programmes

Soil monitoring: « Réseau de Mesures de la Qualité des Sols »

Le Réseau de Mesures de la Qualité des Sols (RMQS)

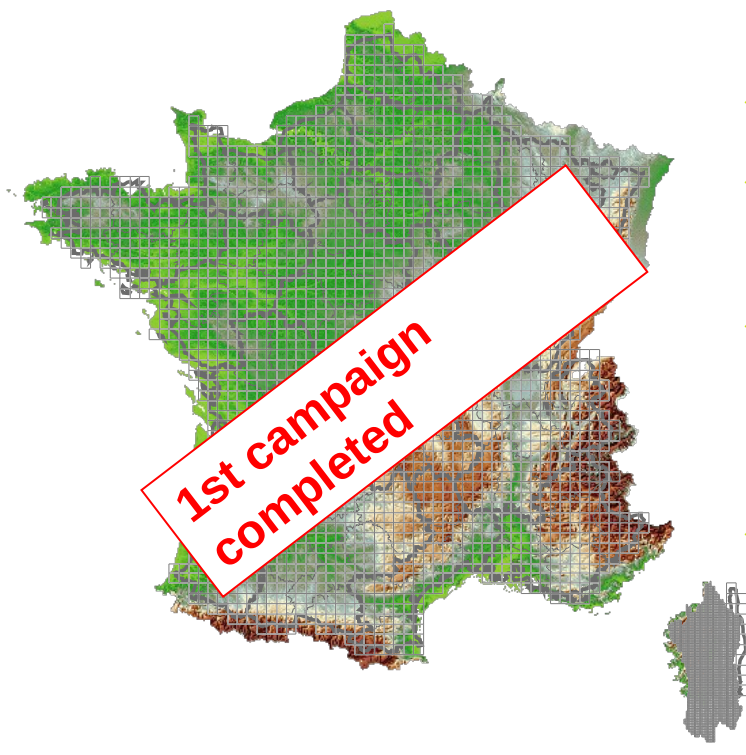
« Monitoring the soil quality of French soils »

- ❖ **National statement** (global statistic report on soil parameters evolution)
- ❖ **Mapping** (to get an instant picture of soil quality and detect gradients)
- ❖ **Warning** (early detection of unsuspected evolution)
- ❖ **Exploration** (to explore the relation between soil quality and possible controlling factors)
- ❖ **Validation** (of spatial predictions issued from external modelling procedures)
- ❖ **Archiving** (to constitute a bank of soil samples)



Le Réseau de Mesures de la Qualité des Sols (RMQS)

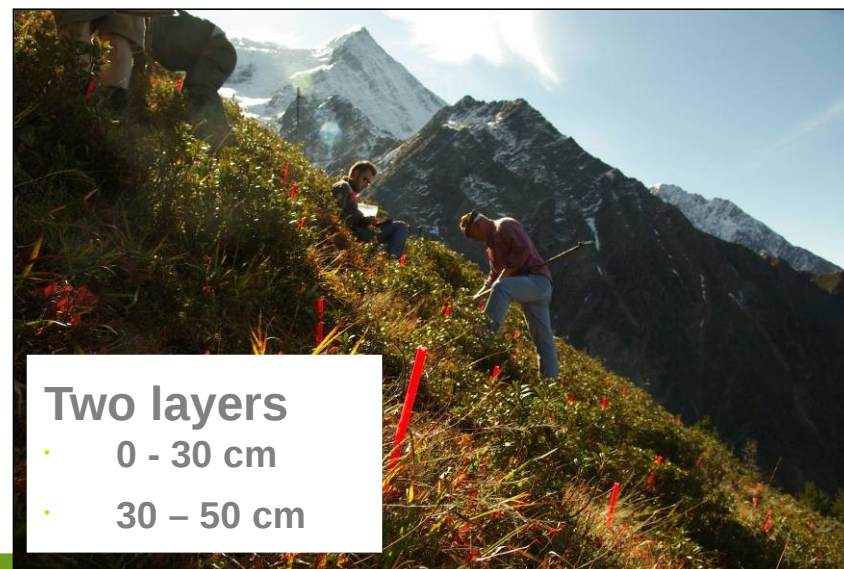
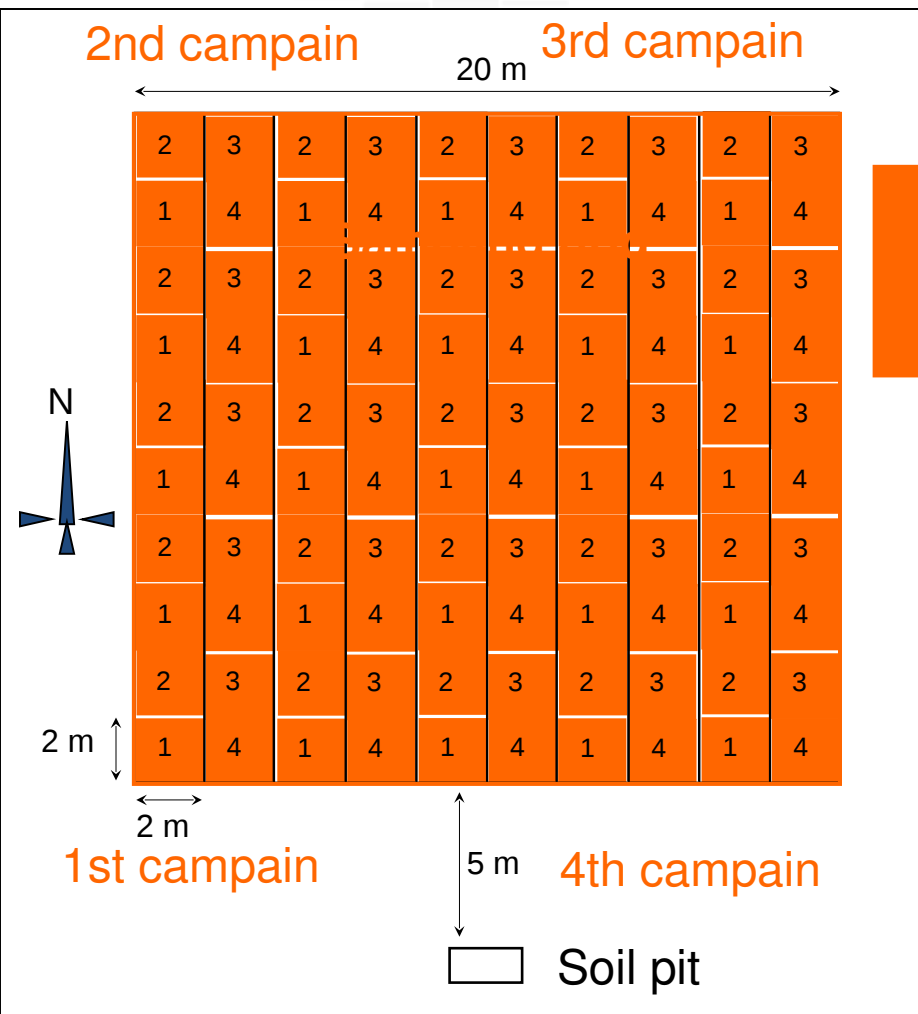
A systematic network



- ❖ 2200 sites
- ❖ located along a 16 km x 16 km grid
- ❖ representative of soil types and land uses in France
- ❖ regularly resampled

Le Réseau de Mesures de la Qualité des Sols (RMQS)

Sampling strategy



Le Réseau de Mesures de la Qualité des Sols (RMQS)

Soil analysis

- ❖ **Agronomic parameters** : pH, organic carbon, nitrogen, phosphorus, particle size distribution, CEC and exchangeable cations, major elements, boron, CaCO_3 , free iron

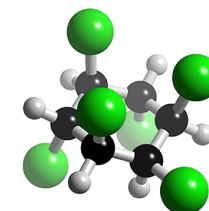
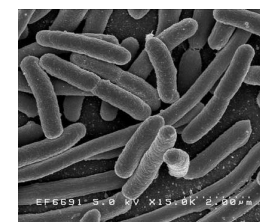


- ❖ **Contaminants** :

- trace elements (Cd, Co, Cr, Cu, Mo, Ni, Pb, Tl, Zn)
- persistent organic pollutants (PAH, OCP, Pesticides, dioxines)
- pathogen microorganisms

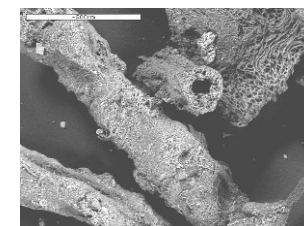
- ❖ **Biodiversity** :

- microorganisms (bacterial and fungi ADN)
- soil fauna (nematodes, collembola, earthworms...)
- flora



- ❖ **Soil organic matter quality** :

- NIRS, MIRS
- Black carbon
- Particulate organic matter





Le Réseau de Mesure de la Qualité des Sols (RMQS)

The « soil treasure »

Groupe
d'intérêt
scientifique



© Claudy Jolivet (INRA Orléans)

RMQS □ 6.7 tons of samples archived

Archiving

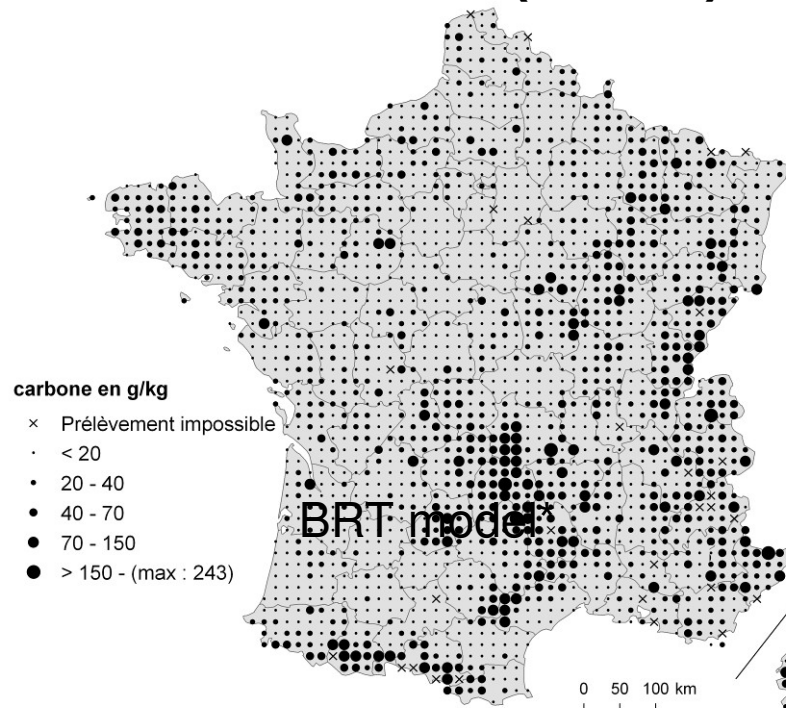


- ❖ To detect any analytical drift with time
- ❖ To « go back » in time (memory function)
- ❖ To constitute a bank of soils

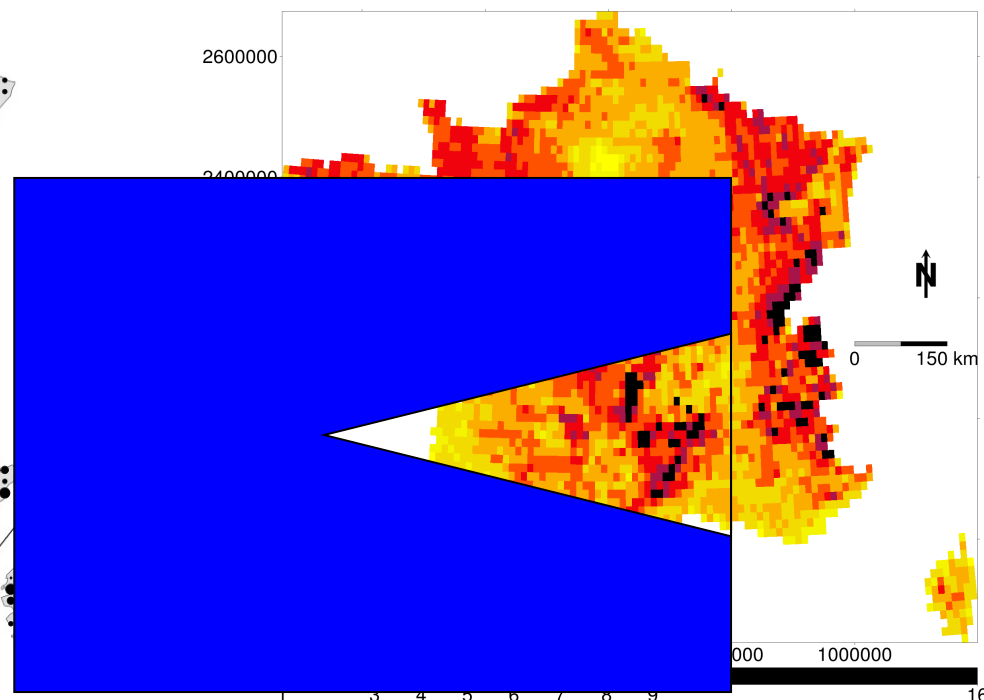
Le Réseau de Mesures de la Qualité des Sols (RMQS)

Organic carbon stocks

OC content (0-30 cm)



OC stock 0-30 cm = 3,260±0,872 Pg C



$$\text{SOCstocks}_{30\text{ cm}} = \sum_{i=1}^n p_i B D_i \text{SOC}_i (1 - r f_i)$$

*SOC stocks = f (climate, NPP, soil properties, land use)

Marion BARDY – Nicolas SABY – Claudy JOLIVET / InfoSol Unit

Source : Martin et al, 2011, Biogeoscience

Le Réseau de Mesures de la Qualité des Sols (RMQS)

Trace elements: Total and extractable Pb

Teneur en plomb total
en mg.kg^{-1}

- ★ prélèvement impossible
- < 30
- 30 - 50
- 50 - 100
- 100 - 200
- > 200 - (max : 624)

Matériaux parentaux

- Pas d'information
- Dépôts alluviaux, marins ou glaciaires
- Roches calcaires
- Matériaux argileux
- Matériaux sableux
- Matériaux limoneux
- Formations détritiques
- Roches cristallines et migmatites
- Roches volcaniques
- Autres roches

0 50 100 km

Median = 27,9
9th decile = 49,6

Teneur en plomb extractible
en mg.kg^{-1}

- ★ prélèvement impossible
- < seuil de détection
- 0,2 - 10,0
- 10,0 - 20,0
- 20,0 - 30,0
- > 30,0 - (max : 165,5)

Matériaux parentaux

- Pas d'information
- Dépôts alluviaux, marins ou glaciaires
- Roches calcaires
- Matériaux argileux
- Matériaux sableux
- Matériaux limoneux
- Formations détritiques
- Roches cristallines et migmatites
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- Autres roches

0 50 100 km

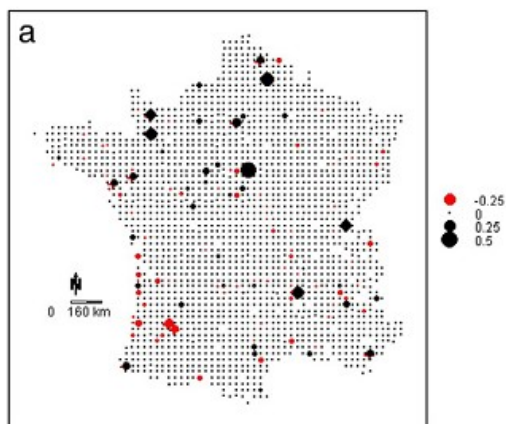
Median = 5,6
9th decile = 13,1

Source : *Gis Sol 2011, L'état des Sols de France*

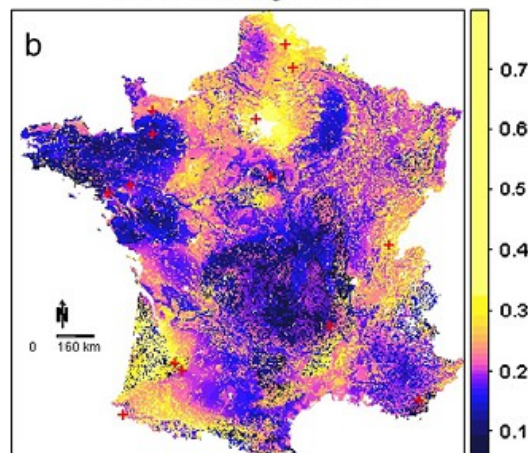
Le Réseau de Mesures de la Qualité des Sols (RMQS)

Trace elements: bioavailable Pb

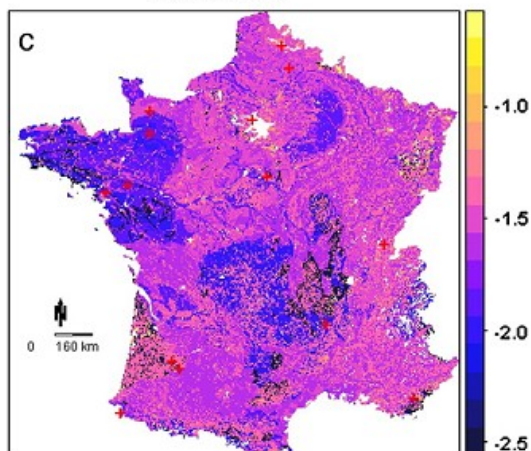
Winsorized value



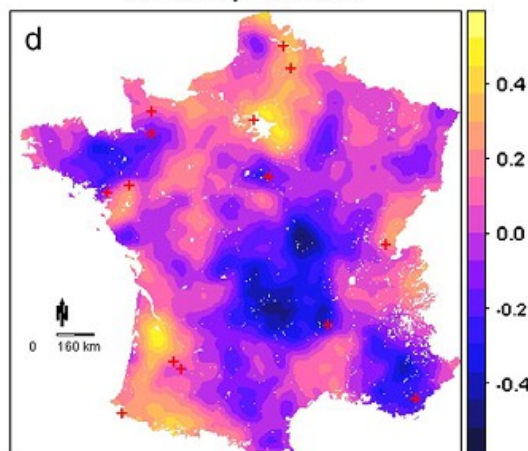
Prediction in original scale



Fixed effect



Random spatial effect



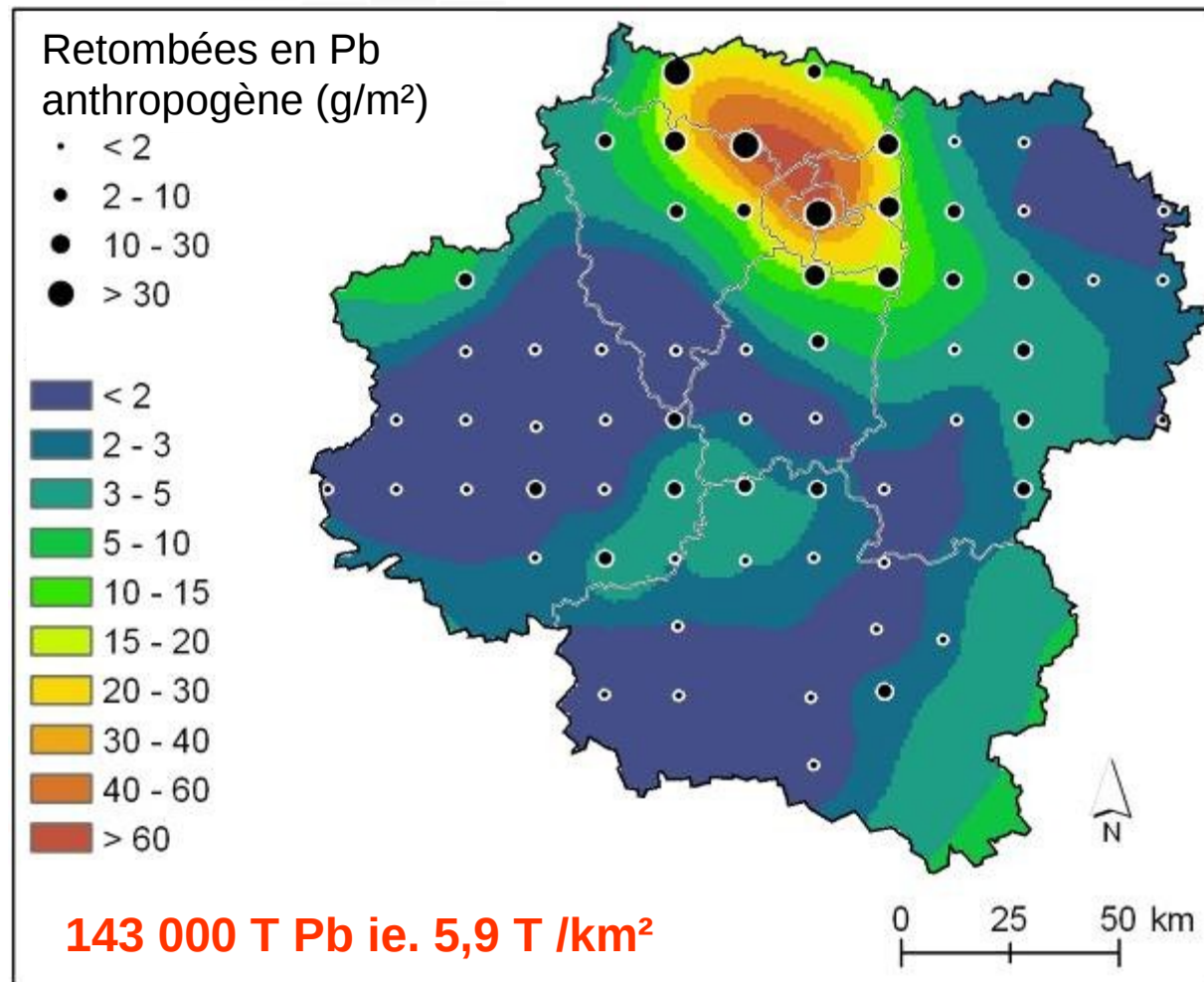
```
[ 1]root
[ 2]land use {311,312,313}
[ 3]population ≤78
[ 4]population >78
[ 5]pH ≤4.2
[ 6]pH >4.2
[ 7]land use {1,21,22,23,32}
[ 8]parent mat. {1,2,3,4,6,12}
[ 9]parent mat. {6,12}
[10]population ≤390
[11]population >390
[12]parent mat. {1,2,3,4}
[13]texture ≤1
[14]texture >1
[15]population ≤134
[16]population >134
[17]parent mat. {5,7,8,9,10,11}
[18]texture ≤1
[19]texture >1
[20]parent mat. {5,7,9}
[21]parent mat. {8,10,11}
```

$$z = M\beta + u$$

Source : Lacarce et al. 2012 *Geoderma*

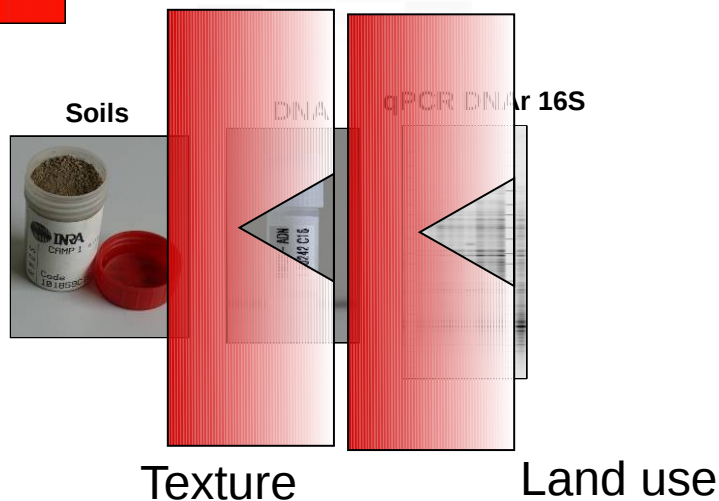
Le Réseau de Mesure de la Qualité des Sols (RMQS)

Contamination gradients

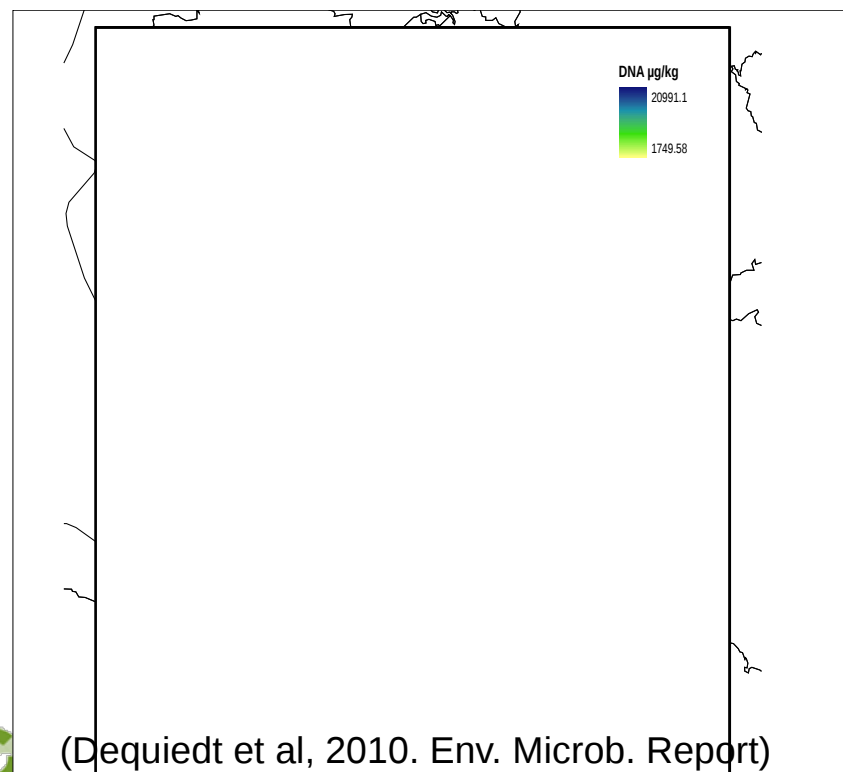


Saby et al. - Science of Total Environment, 2006

Microbio-geography (DNA)



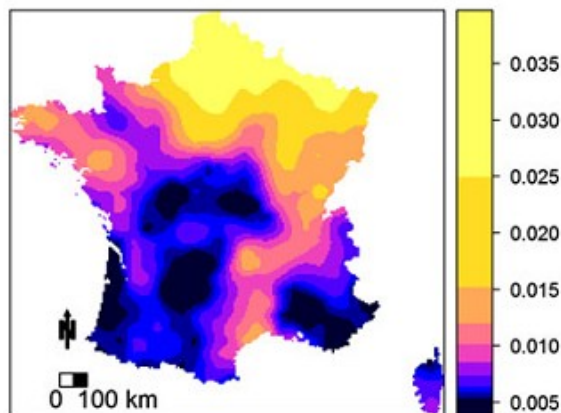
Quantities of soil DNA ($\mu\text{g/kg}$ soil)



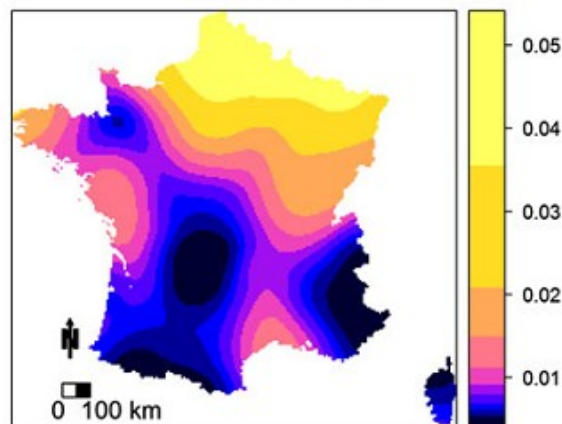
Le Réseau de Mesures de la Qualité des Sols (RMQS)

Organic pollutants: PAH

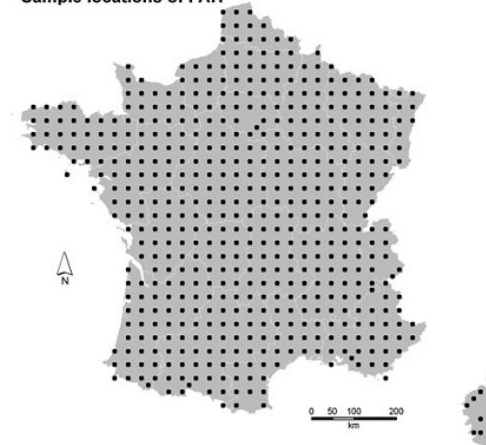
Benzo(b)fluoranthene



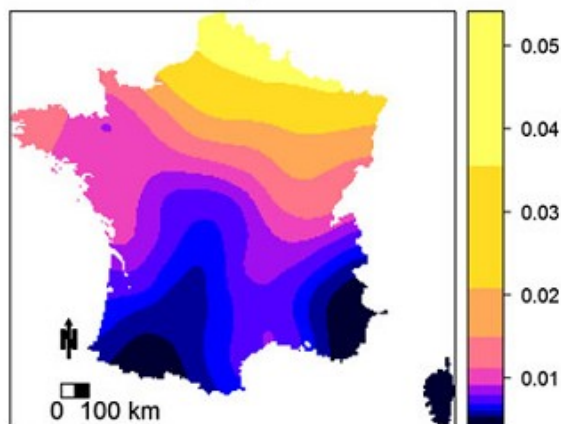
Fluorenthene



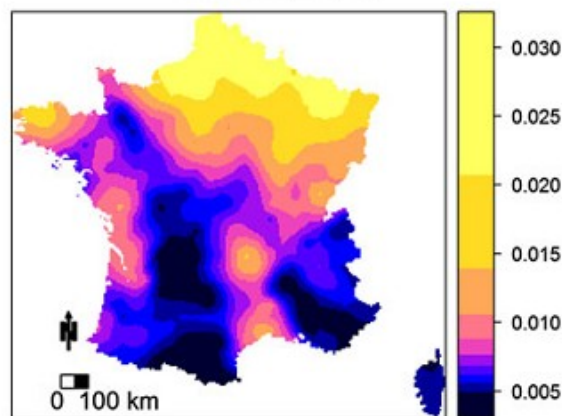
Sample locations of PAH



Pyrene

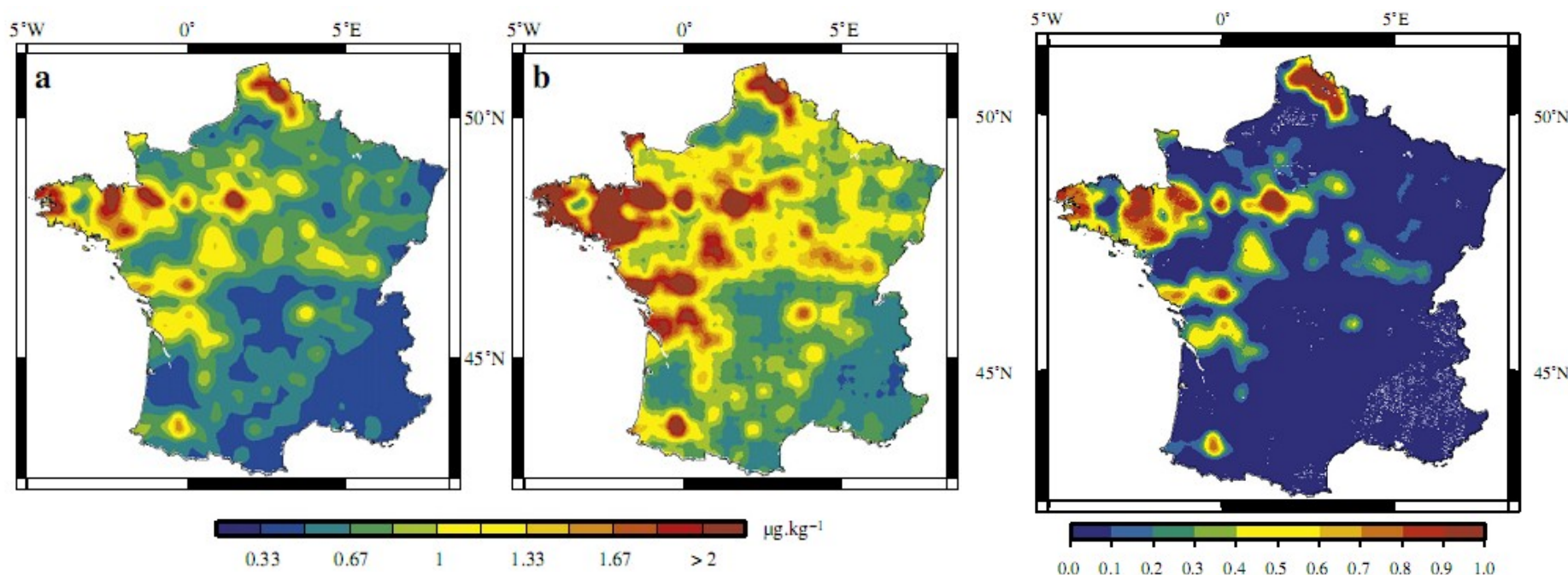


Phenanthrene



Le Réseau de Mesures de la Qualité des Sols (RMQS)

Organic micropollutants: lindane



a) Predictions

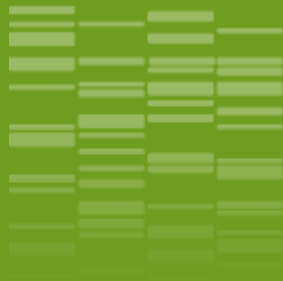
b) associated 95% confidence intervals of the Lindane concentration in soil across France (μgkg^{-1})

c) predicted probabilities of exceeding the maximum permissible concentration across France.

Source : Orton et al. 2012, *Sci.Tot.Env.*

029

06 / 06 / 2013



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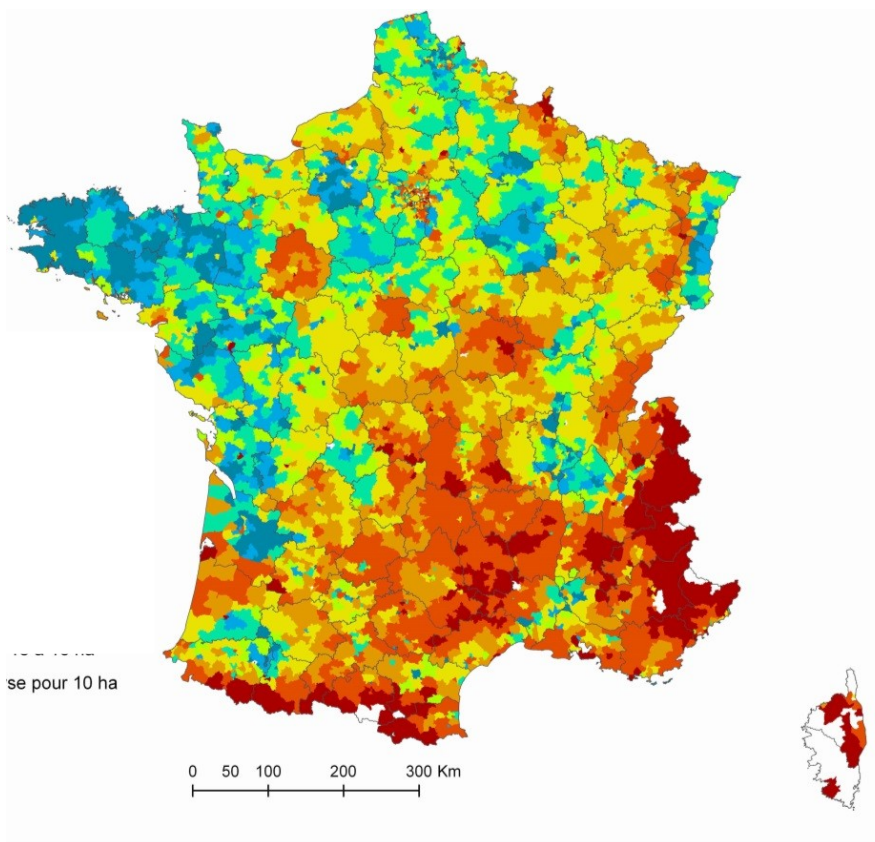
The GIS Sol programmes

Soil Test Database
Trace Element Database

La Base de Données d'Analyses de Terre (BDAT)

« Re-use soil tests not intended for monitoring »

- **Soil test requested by farmers**
(~250 000 tests each year)
- **Agronomic** soil parameters
- Collected from the laboratories approved by the ministry of agriculture
- **Collected** from 1990



densité

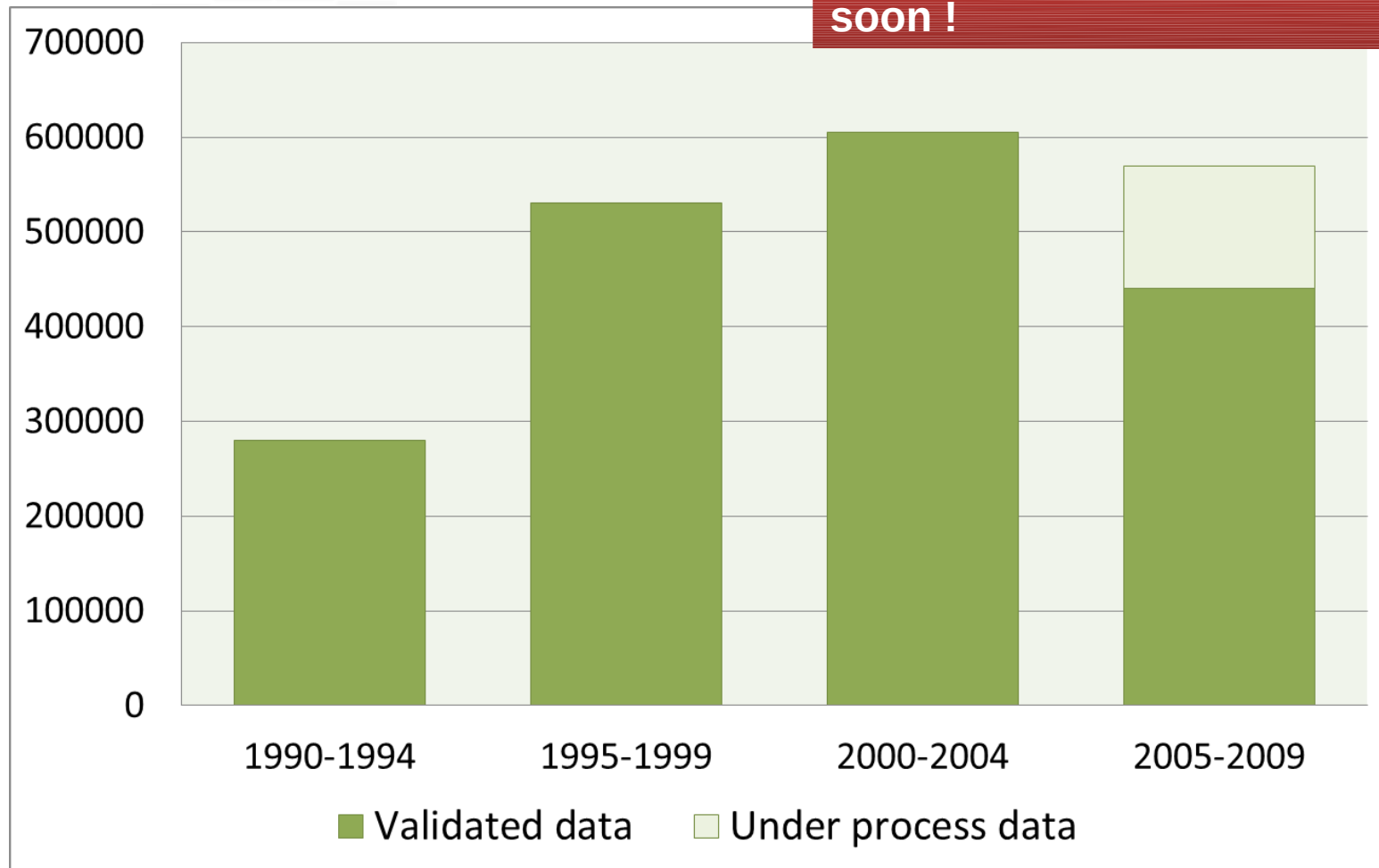
	moins de 1 analyse pour 500 ha
	1 analyse pour 500 ha à 100 ha
	1 analyse pour 100 à 50 ha
	1 analyse pour 50 à 25 ha
	1 analyse pour 25 à 20 ha
	1 analyse pour 20 à 15 ha
	1 analyse pour 15 à 10 ha
	plus de 1 analyse pour 10 ha

✓ **1 800 000** soil samples
✓ **19 000 000** soil test values

La Base de Données d'Analyses de Terre (BDAT)

Amount of soil tests

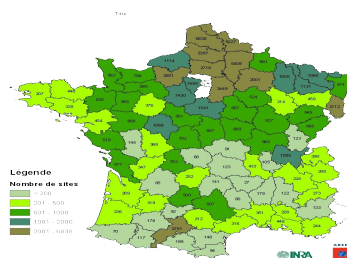
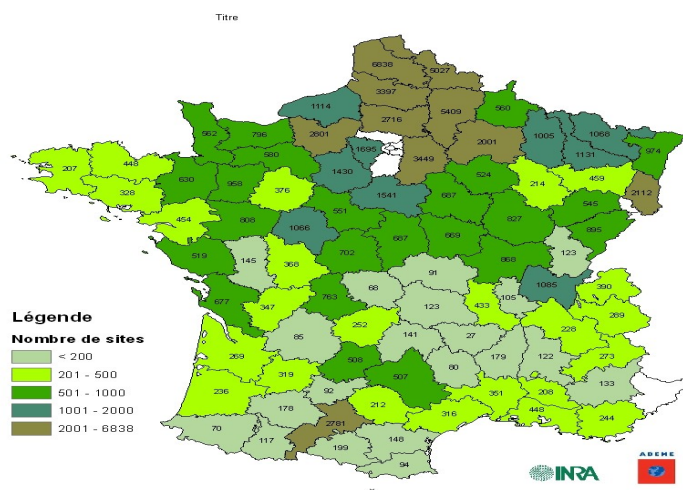
2 millions samples coming soon !



La Base de Données des Elements Traces Métalliques (BDETM)

« Re-use soil tests not intended for monitoring »

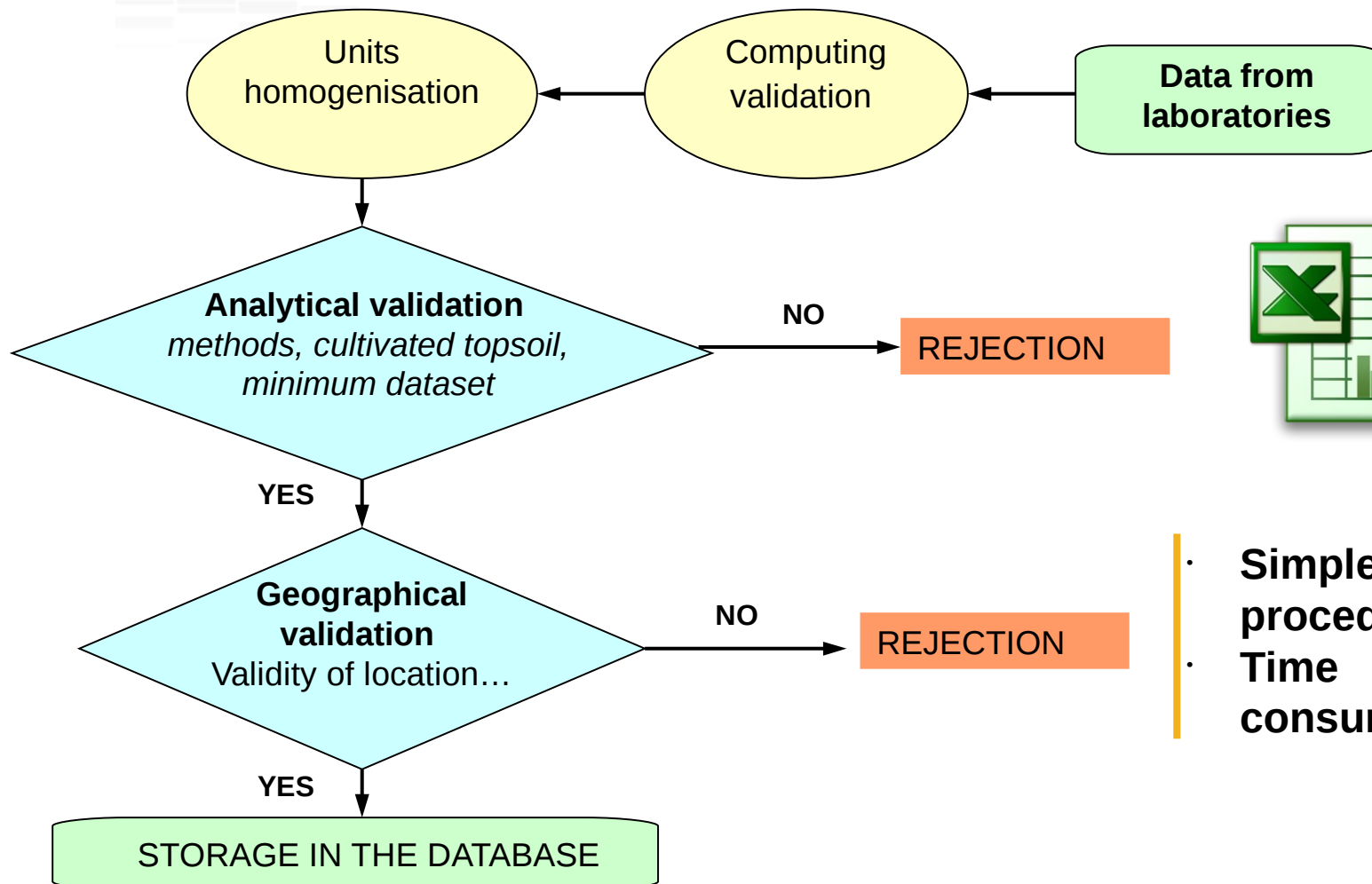
- Analyses **prescribed** previous to sewage sludge application
- **2 campaigns** (1998, 2008)



- ✓ **74 000** soil samples
- ✓ **520 000** soil test values

La Base de Données d'Analyses de Terre (BDAT)

Data assimilation procedure



- Simple procedure
- Time consuming

La Base de Données d'Analyses de Terre (BDAT)

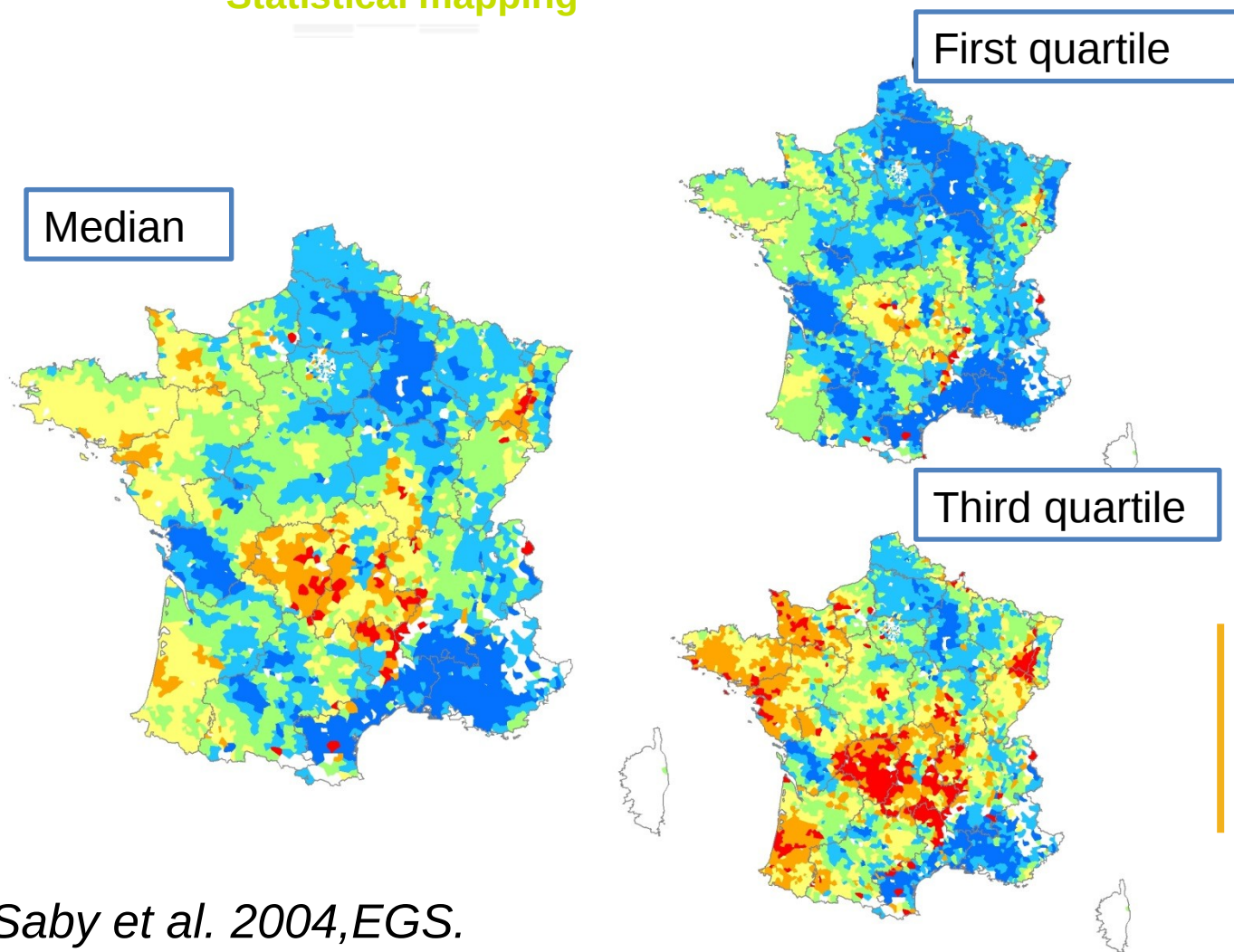


Statistical issues

- ❖ **Statistical mapping of soil properties**
- ❖ **Harmonisation**
- ❖ **Detecting temporal trend**
- ❖ **Correlative analysis of soil properties**

La Base de Données d'Analyses de Terre (BDAT)

Statistical mapping



**pH in water of
topsoil horizons
for the 1995-2000
period:**

- Detecting spatial trend
- Characterize spatial variability

Saby et al. 2004, EGS.

La Base de Données d'Analyses de Terre (BDAT)

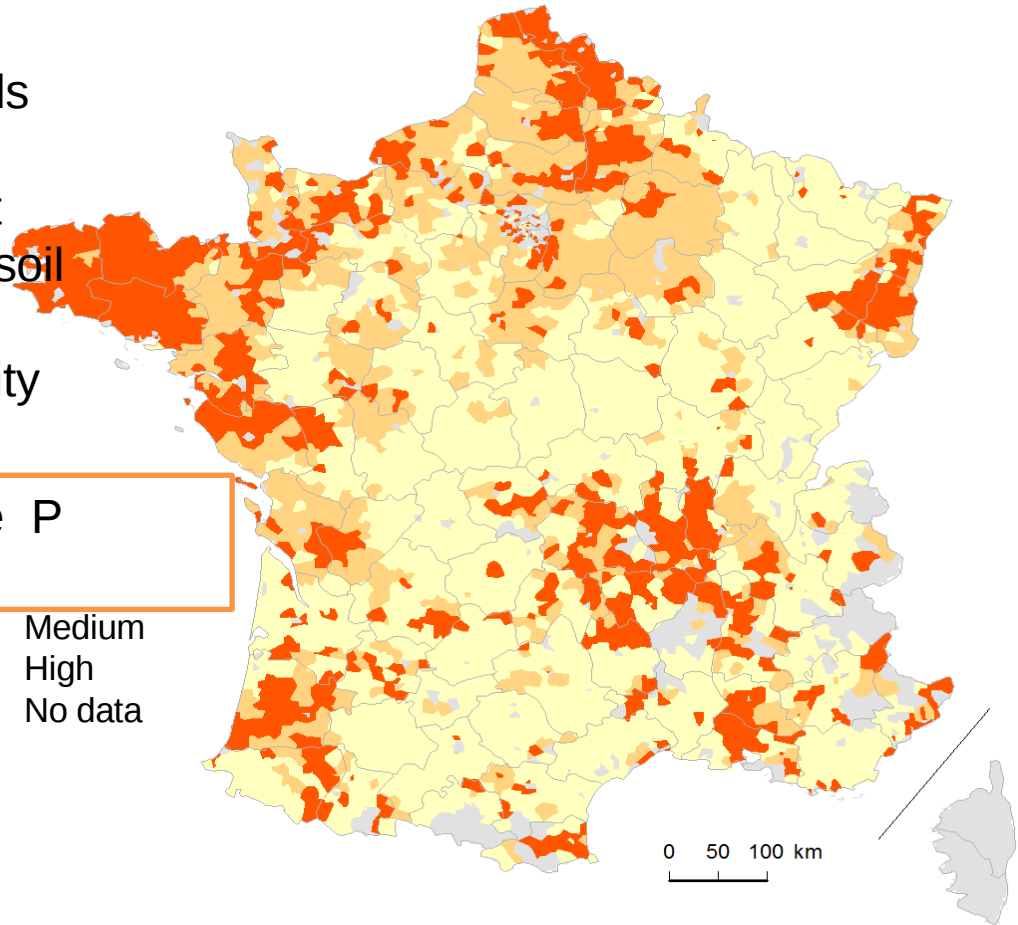
Harmonisation issue

- assessing the phosphorus bioavailability in arable topsoils on France's national scale
- Evaluation using the RegiFert software, which incorporates soil characteristics and crop sensitivity to nutrient availability

Interpreted available P content

- Harmonizing 3 methods
- Unbiased evaluation

Medium
High
No data

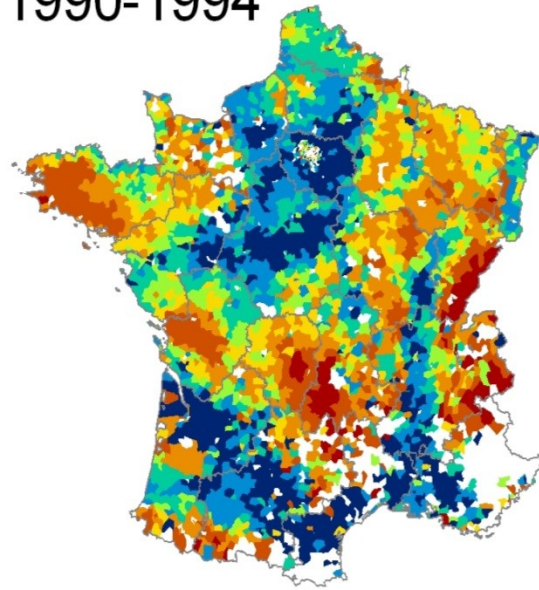


(Follain et al., Agr. Sust. Dev. 2009)

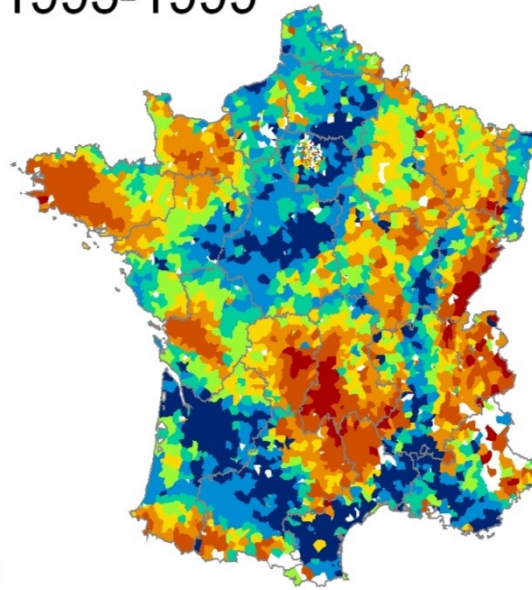
La Base de Données d'Analyses de Terre (BDAT)

Detecting temporal trend issue

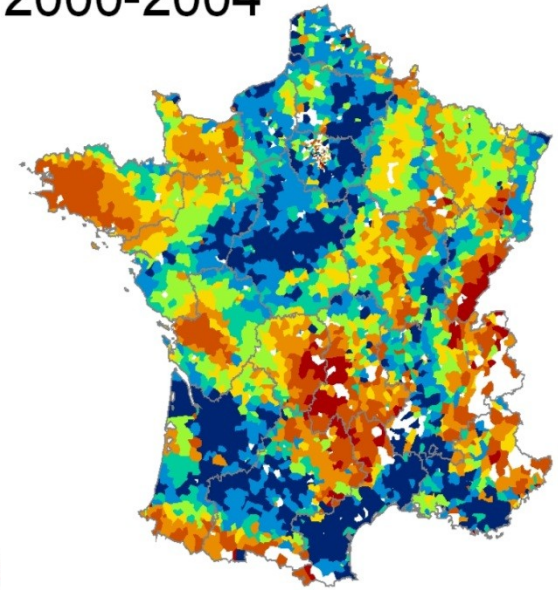
1990-1994



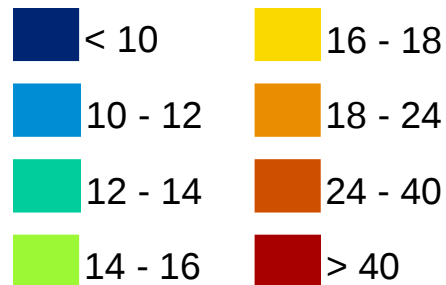
1995-1999



2000-2004



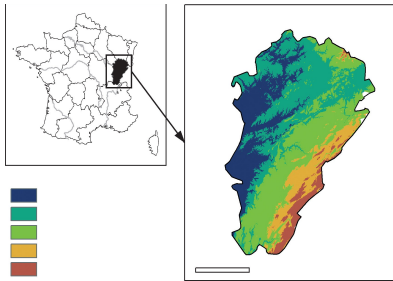
Organic C content (‰)



(Source : BDAT, 2006)

La Base de Données d'Analyses de Terre (BDAT)

« Detecting temporal trend issue »

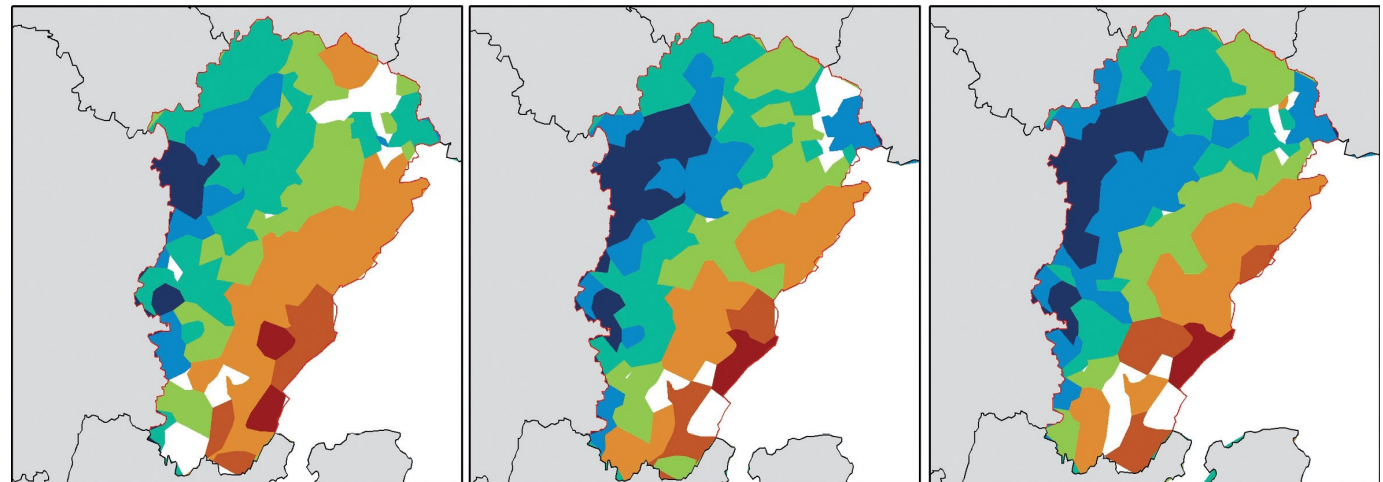


Altitude

Carbon content



Regional study to find the main controlling factor for the spatial and temporal trend



1990-94

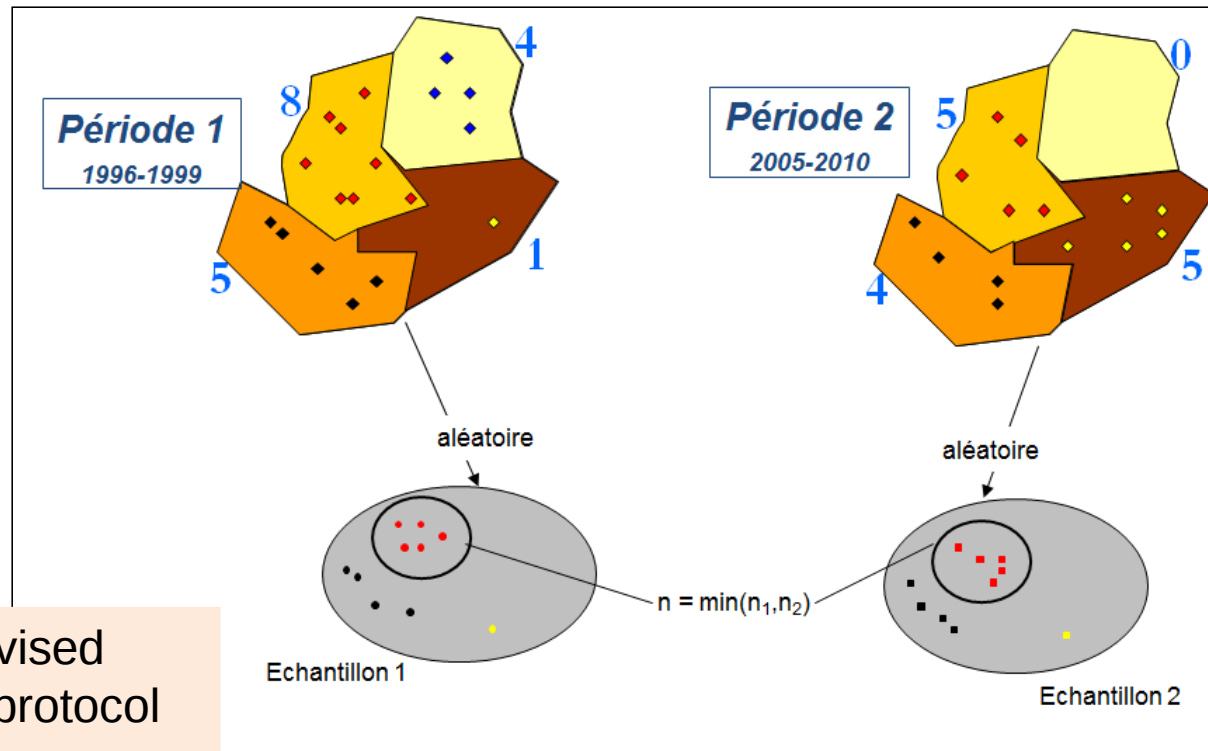
1995-99

2000-04

*Saby et al. 2008,
Soil Use Manag.*

La Base de Données d'Analyses de Terre (BDAT)

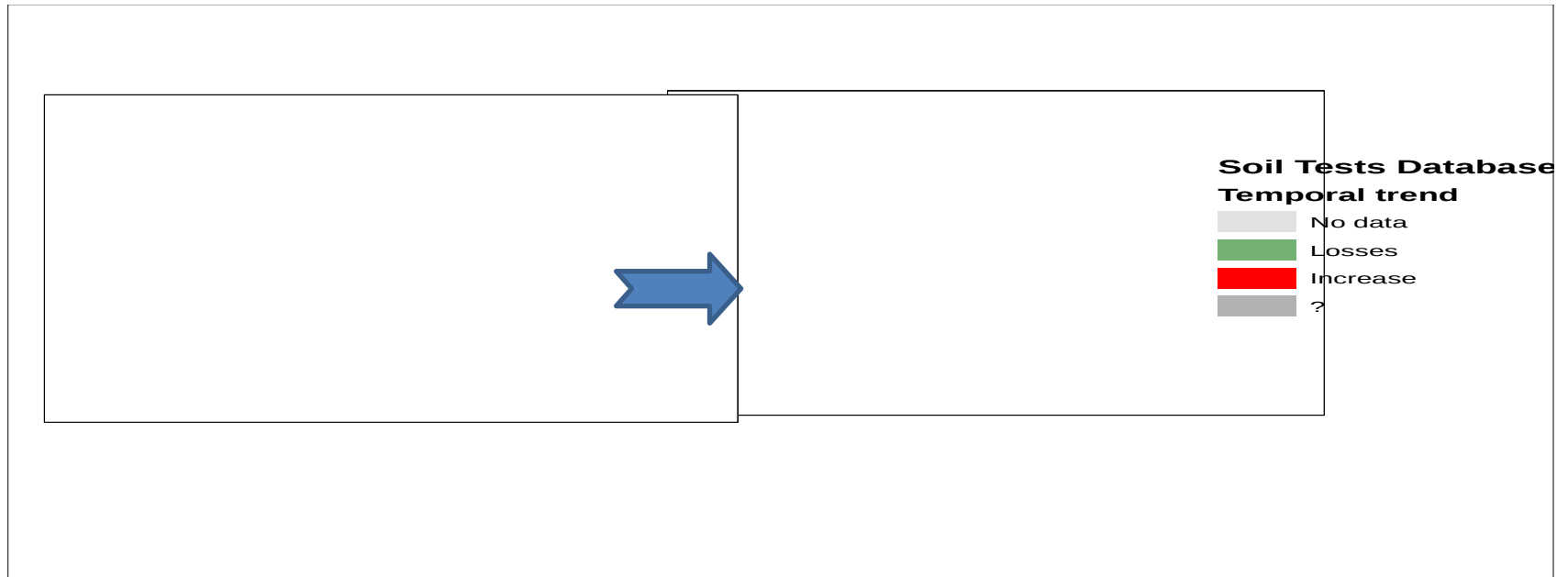
Detecting temporal trend



- Undersupervised sampling protocol
- Try to remove spatial trend

La Base de Données d'Analyses de Terre (BDAT)

Removing spatial trend



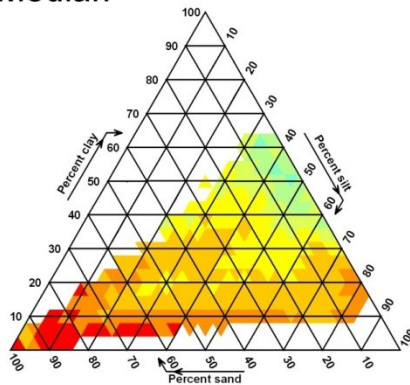
Raw comparisons

Detrending

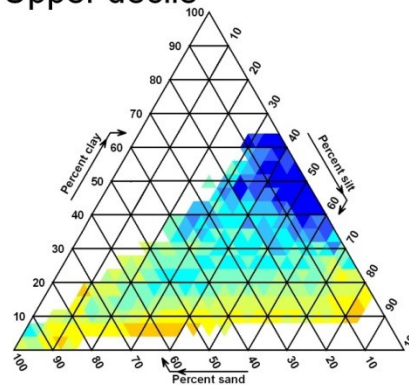
La Base de Données d'Analyses de Terre (BDAT)

Correlating pedological properties

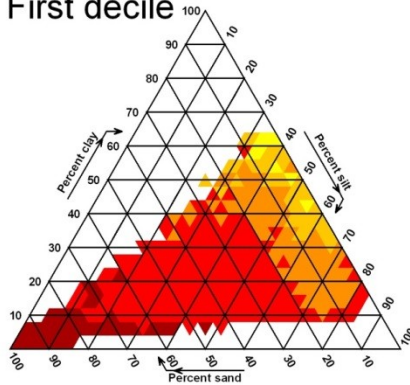
Median



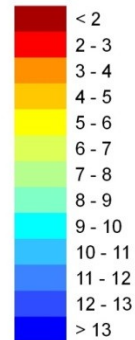
Upper decile



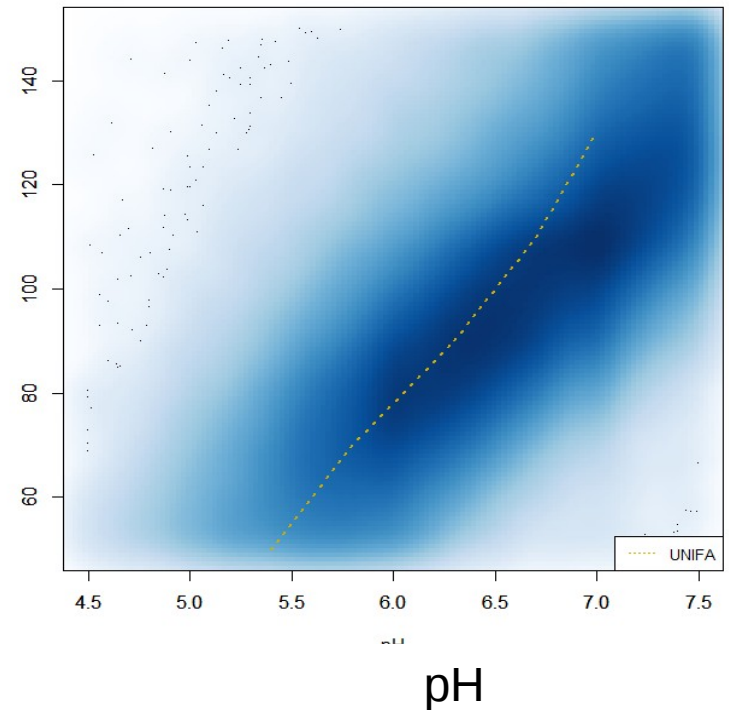
First decile



C stocks kg m⁻²



S/T



(Arrouays et al, 2006)

La Base de Données d'Analyses de Terre (BDAT)

The soil test database

<http://bdat.gissol.fr>

Tools for
downloading

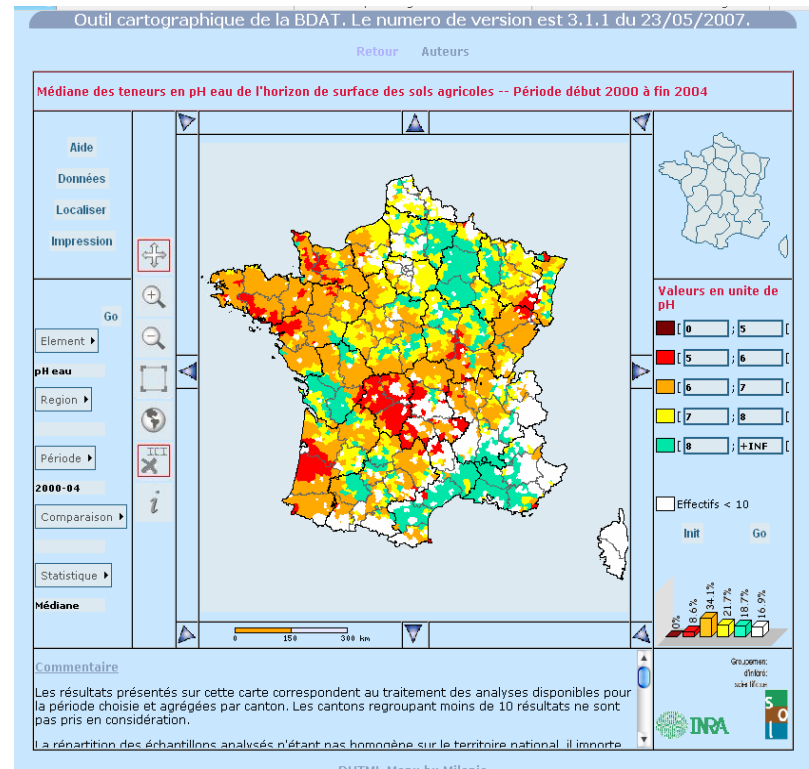
Spatial navigation
tools

Tools for
exploring the
data

title

Editable
Legend

Comments



Conclusion

❖ Synthesis of results :

Groupement
d'intérêt
scientifique



<http://www.gissol.fr>

infosol@orleans.inra.fr



Vient de paraître :
Groupement d'Intérêt Scientifique
Sol, 2011. L'état des sols de
France. Gis Sol, 188 p.

✓ **available online:**
<http://www.gissol.fr/RESF>

➤ Thanks for your attention !