

Using high-resolution electrical resistivity maps for estimation of vulnerability within a watershed

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CONTEXT



EEC Regulation 2000/60/CE: protection of water catchments

Grenelle de l'environnement: 507 water catchments are defined as 'priority'

In the case of Ambleville water catchment (Val d'Oise), the Conseil Général has decided to do complementary studies to refine the understanding of its functioning in order to enhance our knowledge of the risks linked to human activities (agriculture, dwellings , ...) , and especially with Nitrogen increase.

The main idea is to delineate zones within the watershed (475ha) in order to locate the most vulnerable areas to agricultural diffuse pollution.



AIM and METHODOLOGY

Aim: Accurate mapping of potential risks linked to diffuse pollution : a vulnerability map with a pixel resolution of 6 x 6m and with a low price.

This implies to know such parameters such as : type of soils, depths, slopes, fissuration, etc...

Methodology:

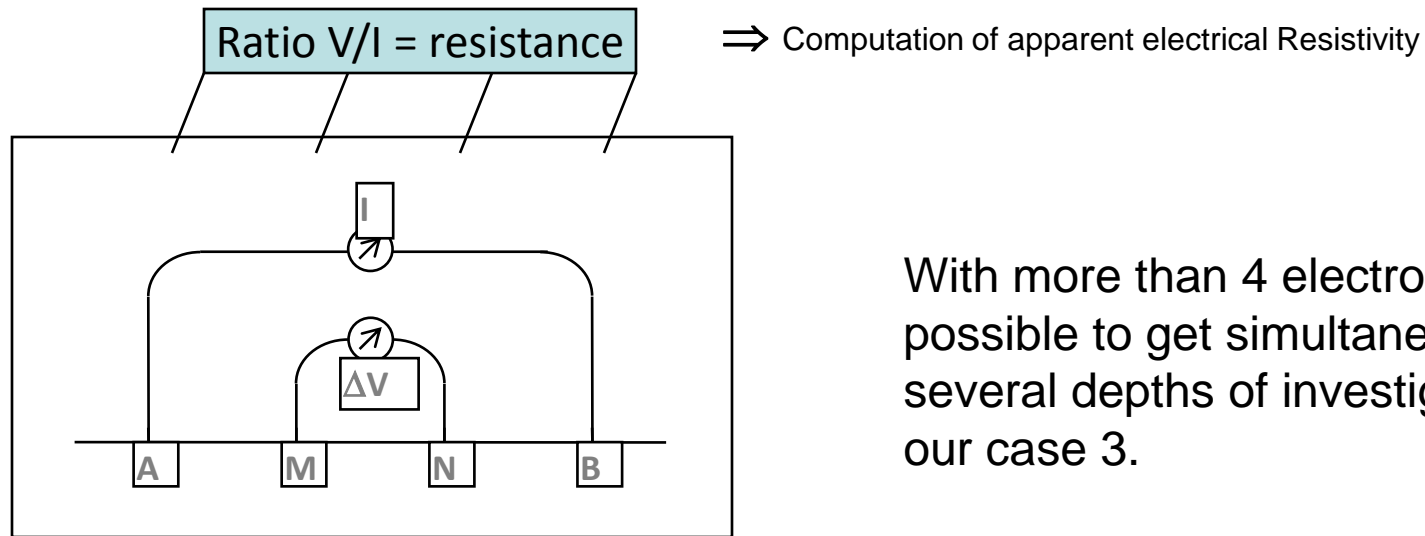
- Phase 1: Measurement of electrical resistivity (GEOCARTA); homogeneous zones within the watershed. Electrical resistivity is strongly correlated with soil texture (clay content).

- Phase 2: Interpretation of electrical maps, definition of homogeneous zones, calibration and characterization of soil units (EPIS-CENTRE)

- Phase 3: Interpretation of data coming from the geophysical survey and its interpretation in terms of soil units, in order to define the intrinsic vulnerability of the watershed: DRASTIC model BRGM, (IN VIVO AGROSOLUTIONS)

MEASUREMENT OF ELECTRICAL RESISTIVITY: PRINCIPLE

Measurement is done by inserting 4 electrodes into the soil
(2 for injecting current, 2 for potential measurement)



With more than 4 electrodes, it is possible to get simultaneously several depths of investigation, in our case 3.

MEASUREMENT OF ELECTRICAL RESISTIVITY: PRINCIPLE

ARP© = Automatic
Resistivity Profiling

*Injection of
electrical current*

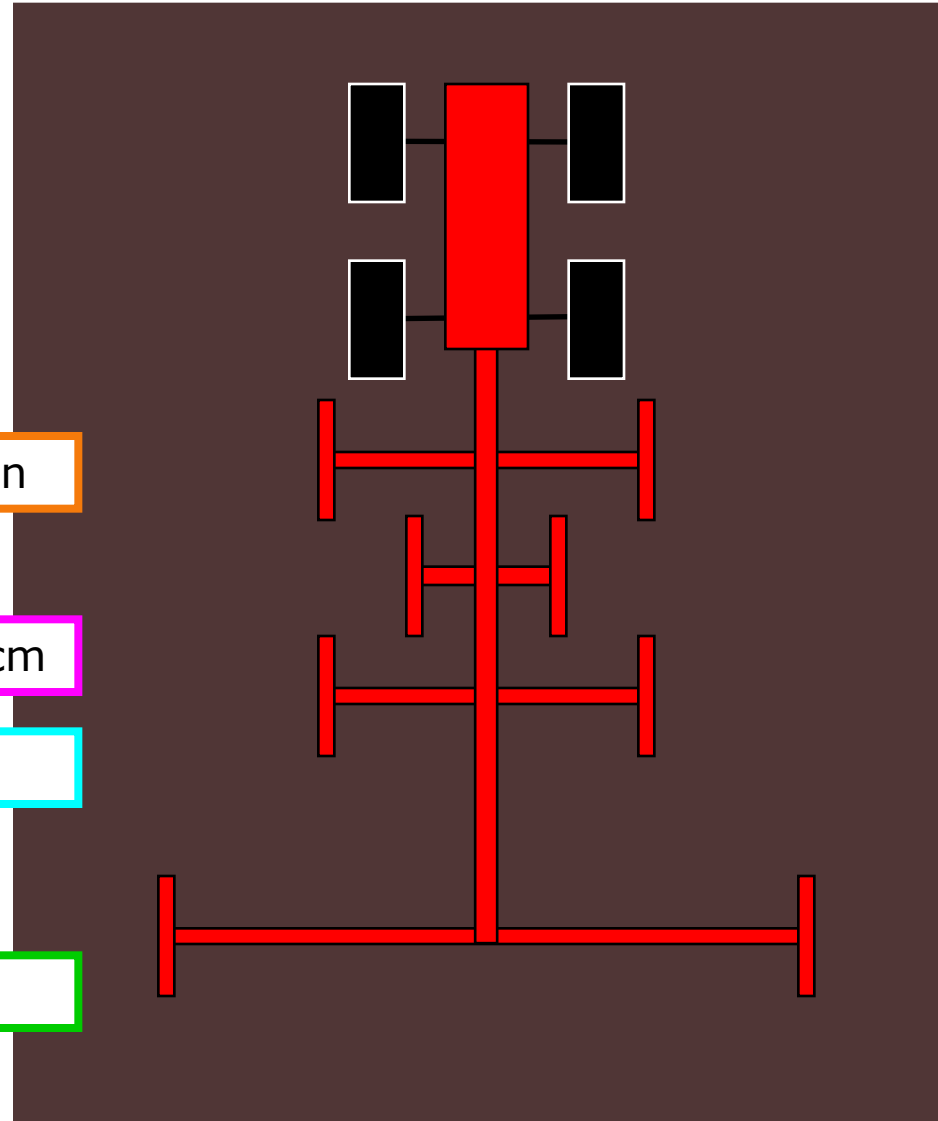
➤ Injection

➤ 50 cm

➤ 1 m

➤ 2 m

*3 depths for potential
measurement*





**Specifically
designed multi-
channel
resistivimeter**

**dGPS (absolute
positioning)**



**Ruggerized
computer**

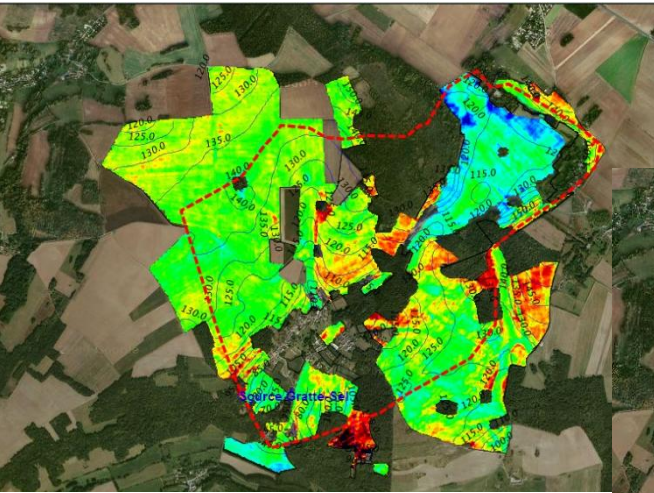


**Radar (20cm
sampling distance)**

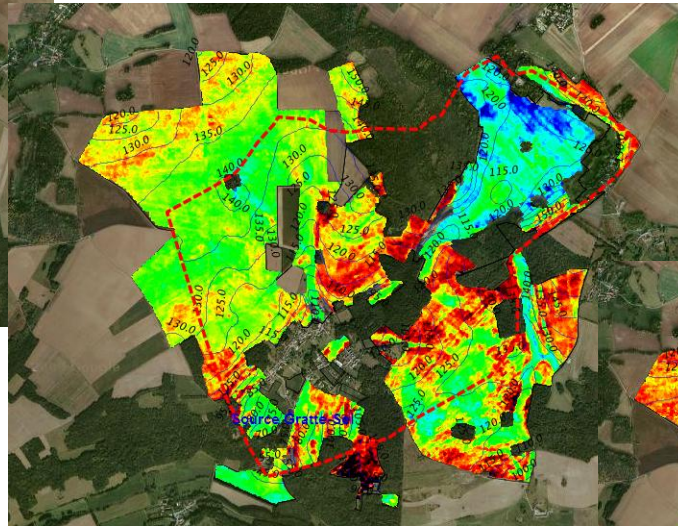


Electrodes

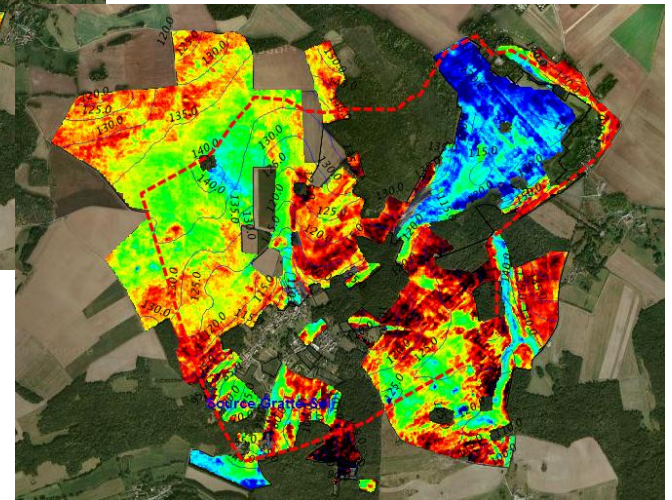
Electrical Resistivity Measurements : Results



Channel1 (0 - 0.5 m)

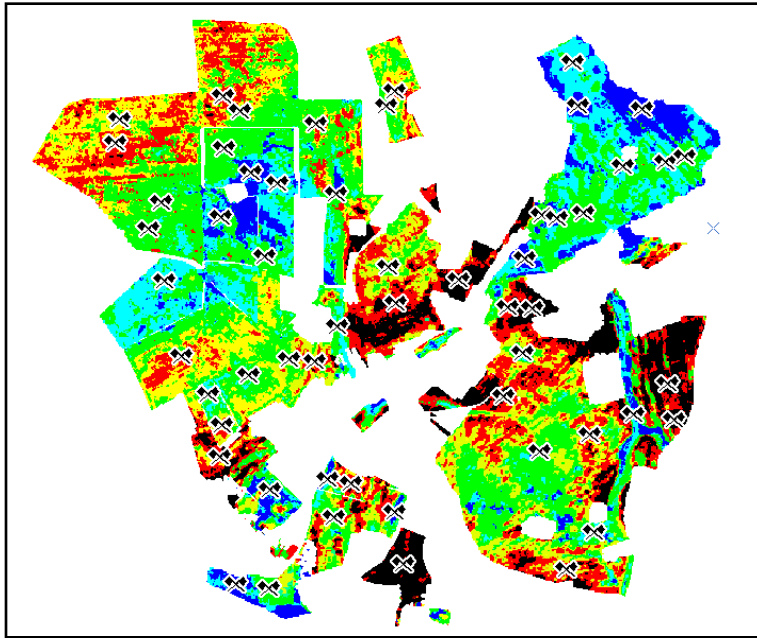


Channel 2 (0 - 1 m)

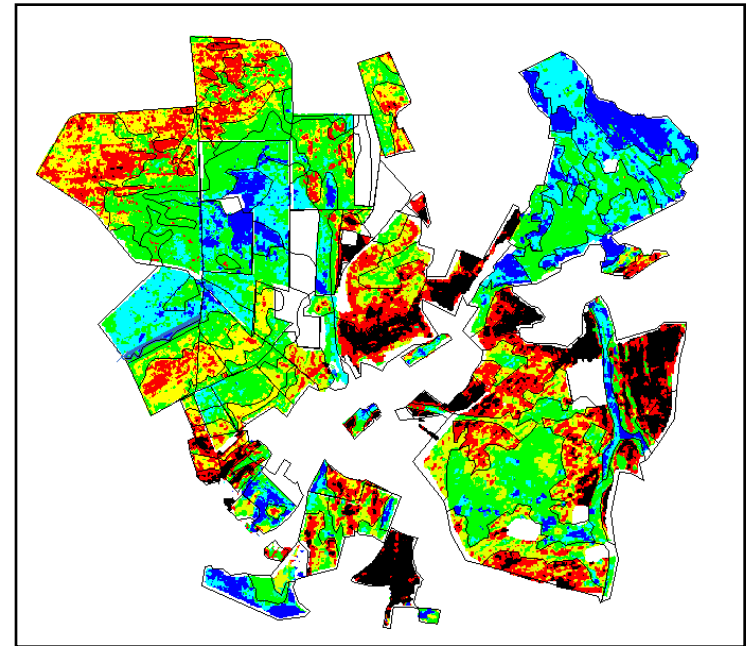


Channel 3 (0 - 1.7 m)

FIELD VALIDATION : from AUGER Observations to INTERPRETATION



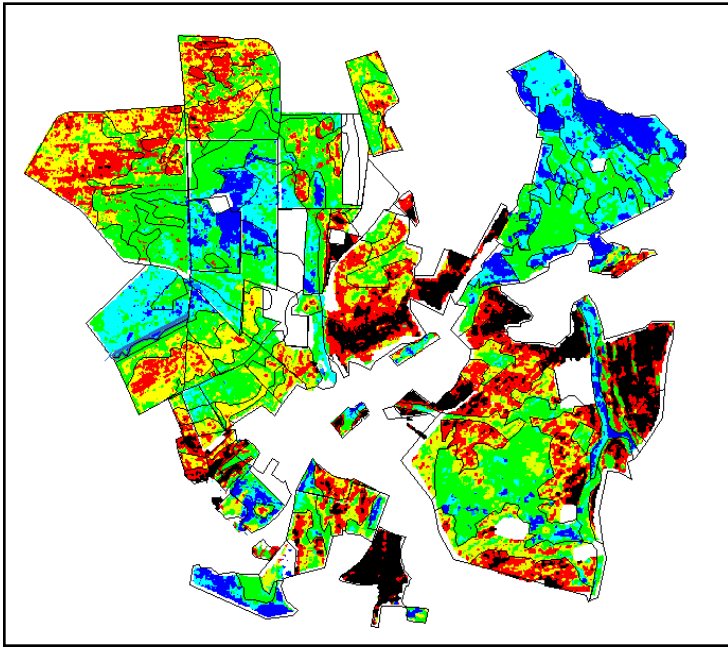
Map of sorted resistivities
(same vertical profile) and
positioning of auger holes



Soil units

31 Auger holes : 1 every 15ha was sufficient

Field Test, Validation and Results

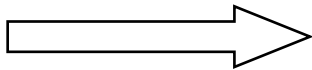


-Blue: deep clayey soils (low resistivity all over the vertical profile)

-Green: silty loam soils (average resistivities), bedrock<80cm

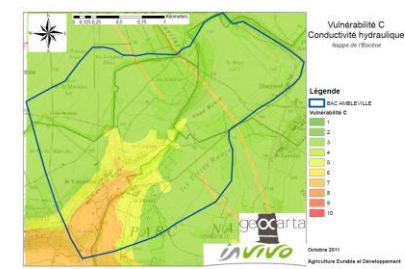
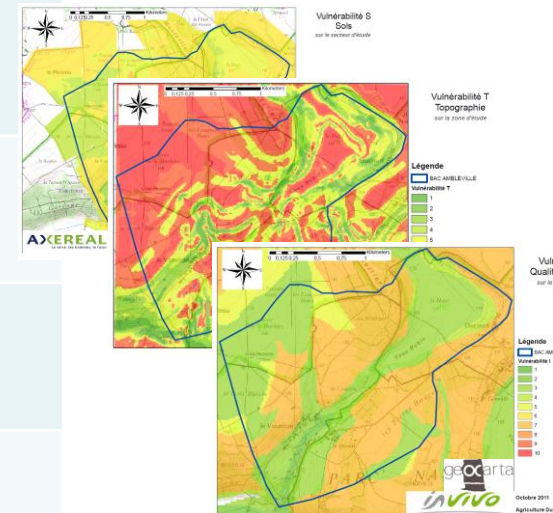
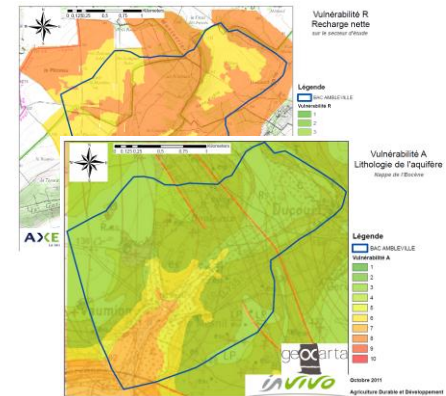
-Light blue: silty clayey soils (average superficial resistivity but lower when deeper)

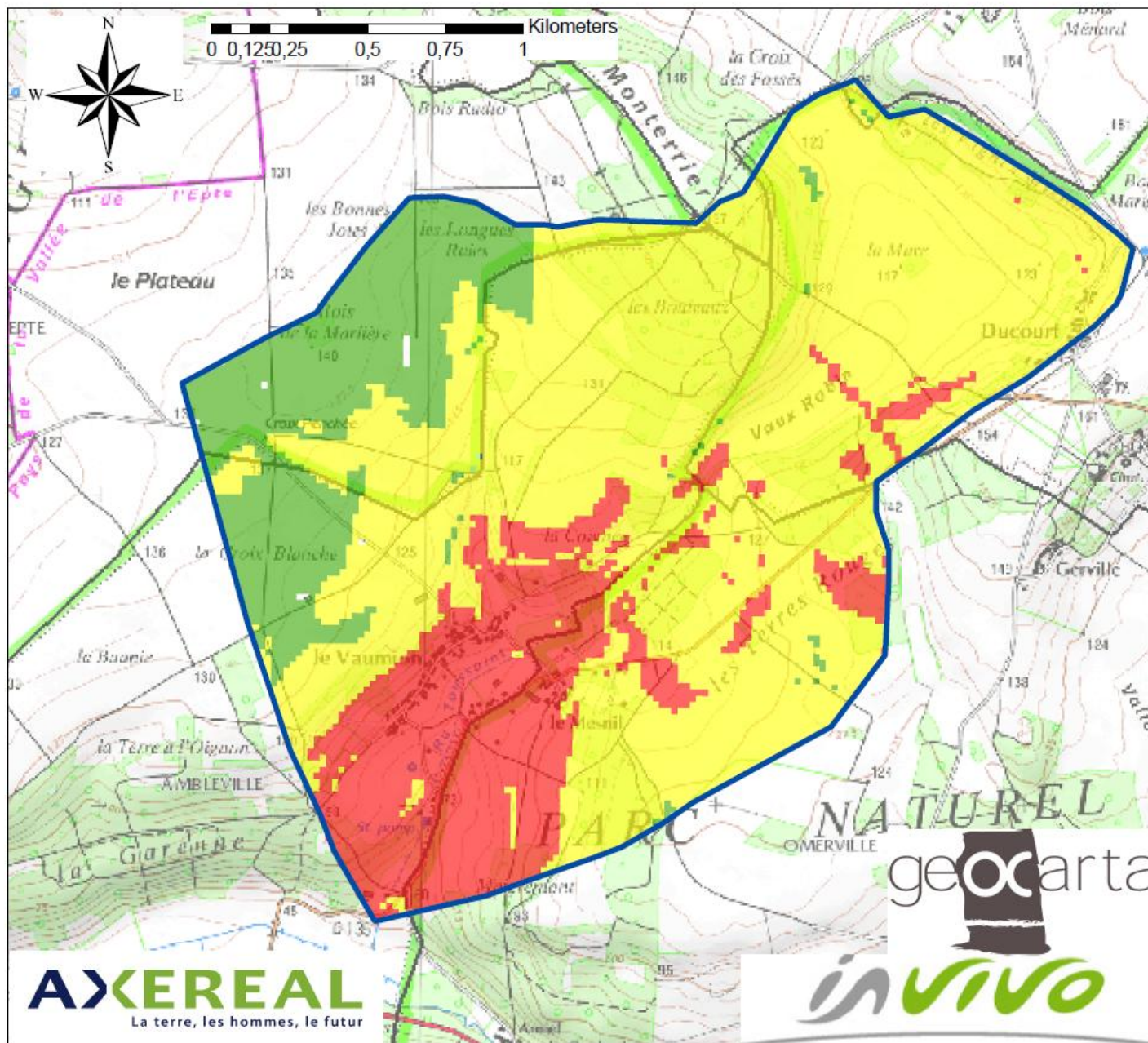
- Yellow, red and black: shallow depth calcareous soils (high resistivity to very high resistivity). The stone content was derived for this soil unit.



=> Knowledge of data to feed the model from which we will derive the vulnerability maps

	DRASTIC model:	Factors	Weight
D	Depth to water	Represents the depth from the ground surface to the water table, deeper water table levels imply lesser chance for contamination to occur.	5
R	Net Recharge	Represents the amount of water which penetrates the ground surface and reaches the water table, recharge ater represents the vehicle for transporting pollutants.	4
A	Aquifer media	Refers to the saturated zone material properties, which controls the pollutant attenuation processes.	3
S	Soil media	Represents the uppermost weathered portion of the unsaturated zone and controls the amount of recharge that can infiltrate downward.	2
T	Topography	Refers to the slope of the land surface, it dictates whether the runoff will remain on the surface to allow contaminant percolation to the saturated zone.	1
I	Impact of vadose zone	Is defined as the unsaturated zone material, it controls the passage and attenuation of the contaminated material to the saturated zone.	5
C	Hydraulic Conductivity	Indicates the ability of the aquifer to transmit water, hence determines the rate of flow of contaminant material within the groundwater system.	3





Vulnérabilité DRASTIC

Faible, Moyenne et Forte

Légende

 BAC AMBLEVILLE
DRASTIC sur l'AAC

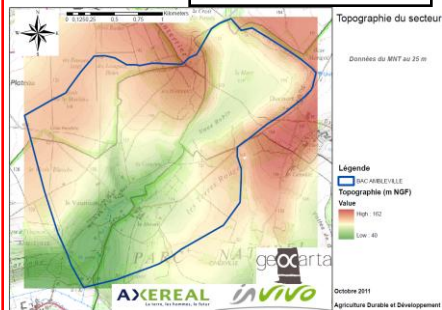
3,2 - 4
 4,1 - 6
 6,1 - 7,8

Octobre 2011

Agriculture Durable et Développement

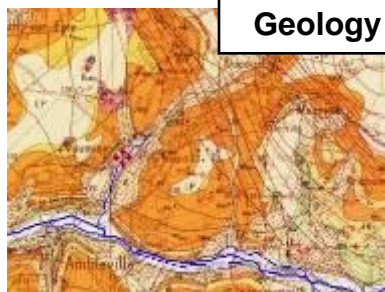
Available data before the geophysical surveys

Topography

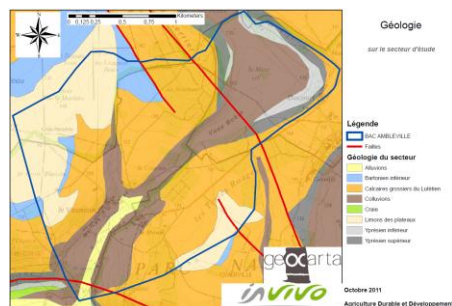
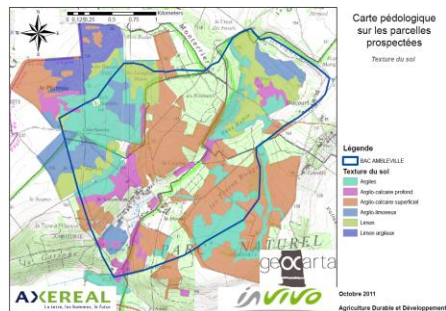
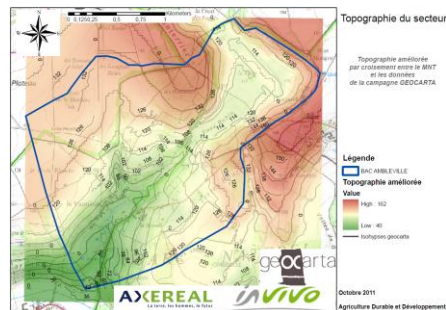


Pedology

No pedological map available

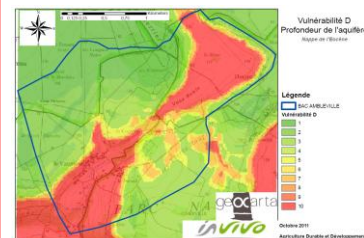


Improvement of data due to the geophysical surveys

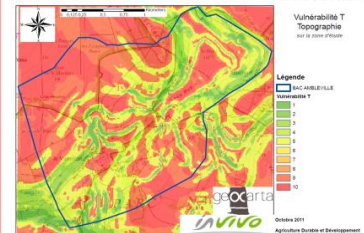


Confirmation of fault positioning and geological boundaries noticed in BRGM geological

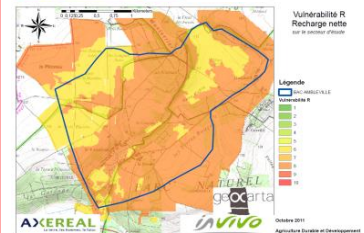
Significant improvement of vulnerability thanks to geophysical



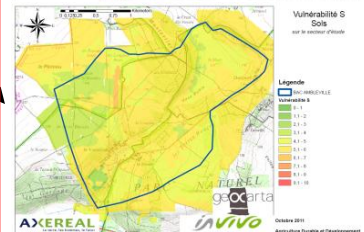
← D



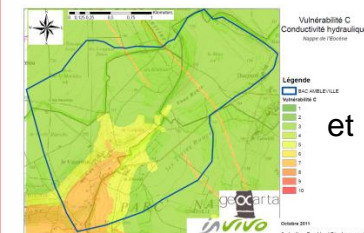
← T



← R

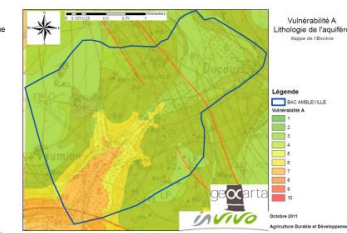


← S



← A

← C



et

Thanks for your attention!

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This study was conducted for Conseil général du Val d'Oise
and partially funded by Agence de l'Eau Seine Normandie.