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Eaux-SCARS

# USE OF A FREE AND OPEN ACCESS HIGH-RESOLUTION DIGITAL TERRAIN MODEL FOR THE IDENTIFICATION OF SURFACE KARST FORMS

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UNION EUROPEENNE
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RÉGION Nouvelle-Aquitaine

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# Context

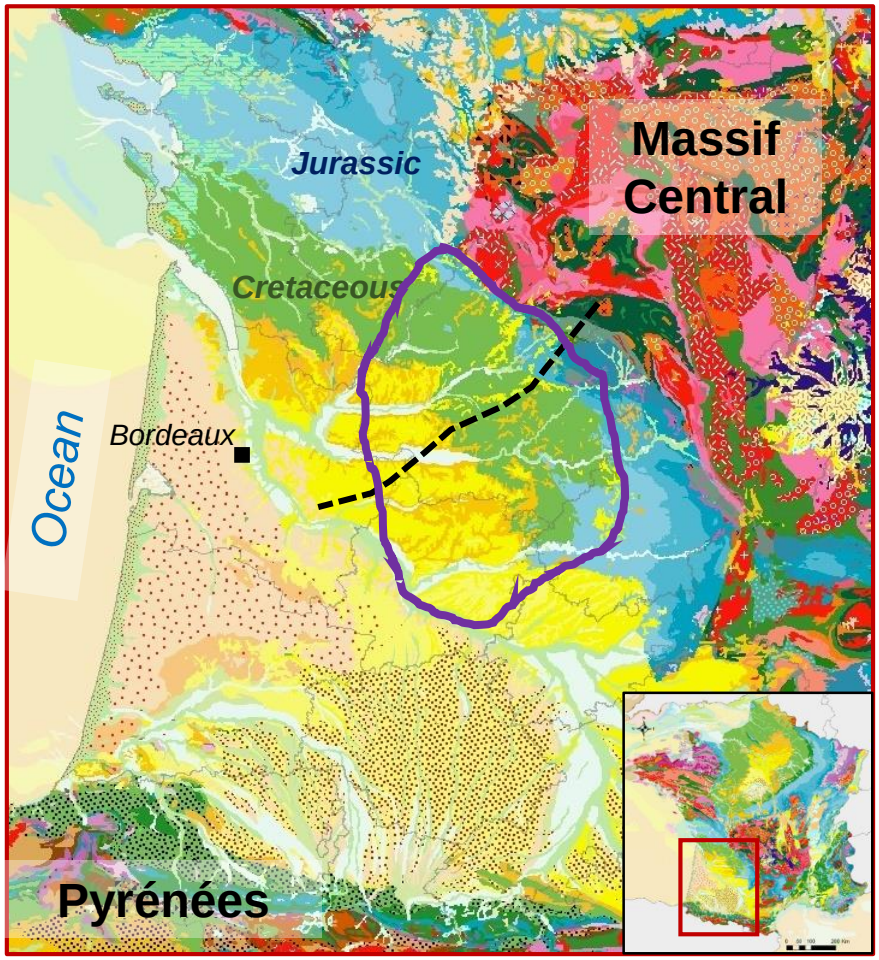
**Eaux-SCARS Project**

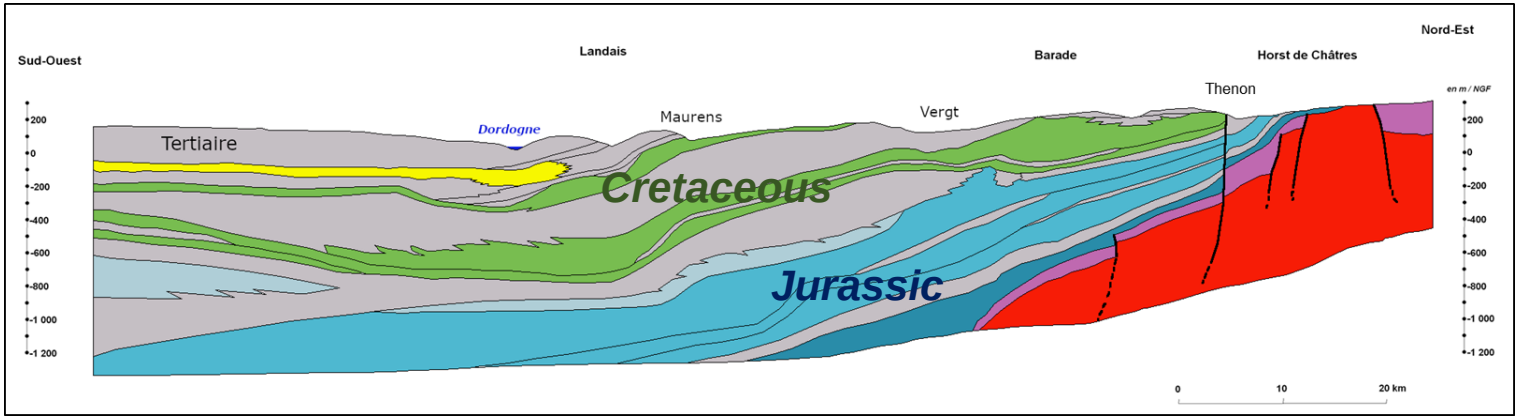
Groundwater resources in the Jurassic and Cretaceous carbonateous aquifers

Multilayers aquifers from the sedimentary Aquitaine Basin

Better understanding of the aquifers' functionning

- Recharge
- River-aquifer exchanges
- Role of karstification
- Behaviour with regard to climate change

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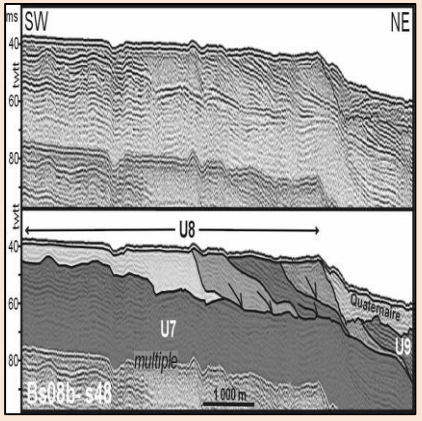
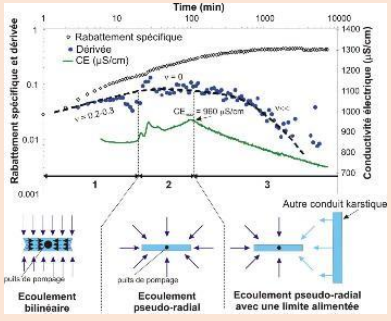
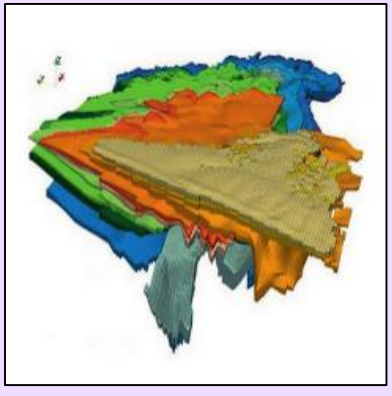
# Context

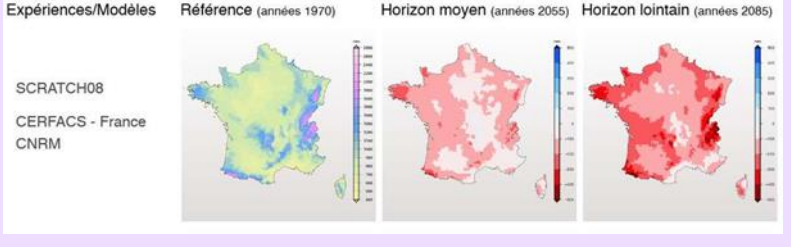


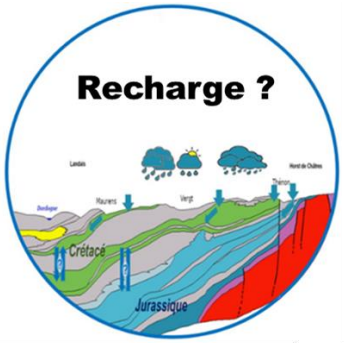

**Eaux-SCARS**

***Examples of acquisition and work***





# Objectives



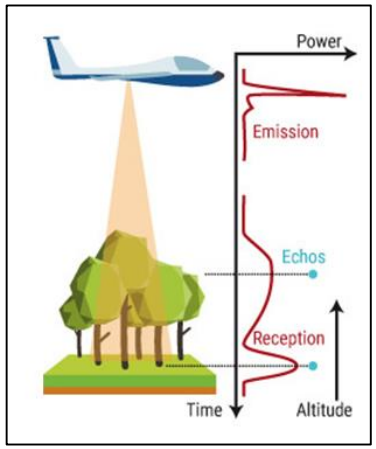

**Assessment of geomorphological features such as sinkholes**

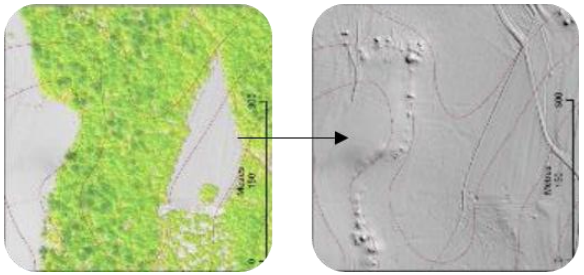
- preferential infiltration points of rainwater directly towards groundwater
- Aquifers vulnerability

Fieldwork : delicate identification and characterisation

- depends on soil conditions (presence of vegetation or outcrops),
- long,
- rarely exhaustive

**LiDAR « Li**ght **D**etection **A**nd **R**anging"
(high-resolution digital terrain models)
⇒ semi-automatic detection,
⇒ rapid detection
⇒ large area.



Methodology to **highlight circular surface karst shapes** with a depression (sinkholes)

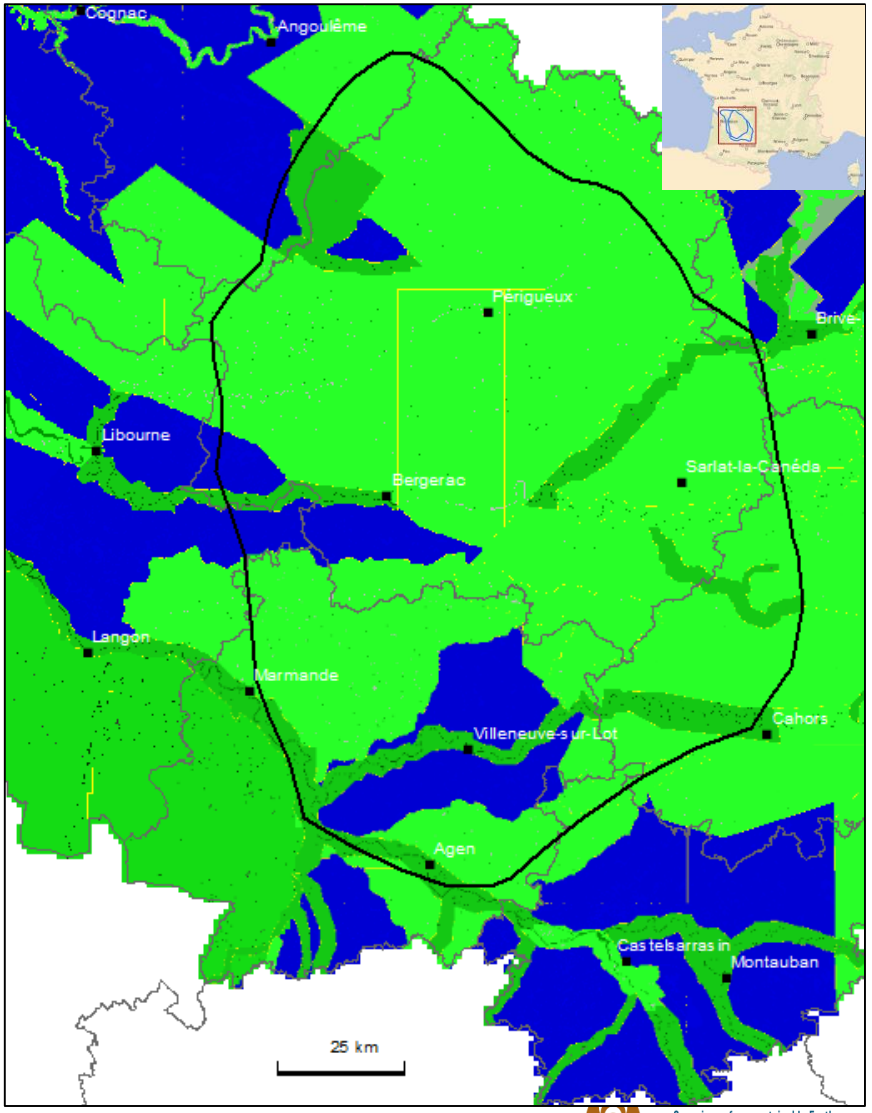
**Large scale** methodology : 22 000 km² (Eaux-SCARS territory)

# Available data

- **National Institute of Geographic and Forest Information (IGN)**
  - French public establishment
  - Produce and update large scale reference geographic and environmental data

- Altimetry : RGE Alti V2 ® **Open data** since 01/01/2021 (licence Etalab 2.0)
  - ⇒ Digital Terrain Model with a 1m step compiling the best available sources from IGN.

- > 80 % Eaux-SCARS territory covered by LiDAR (green)




**Sources RGE Alti V2 - IGN**

- Corrélation automatique PVA HR 30 cm >= pixel => 20 cm Zone Rurale
- LiDAR Topo IGN densité d'acquisition théorique 2 points au m²
- LiDAR Topo IGN en forêt densité d'acquisition théorique 2 points au m²
- LiDAR Topo externe densité d'acquisition théorique 2 points au m²
- LiDAR Topo IGN sans corrections interactives



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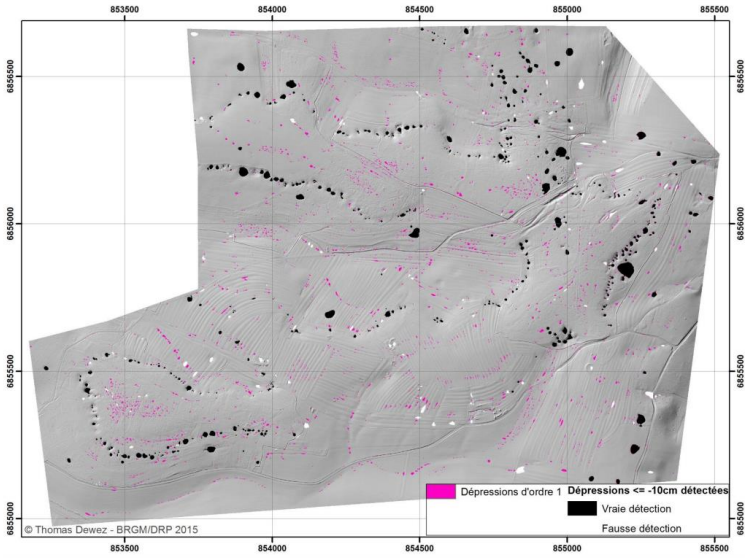
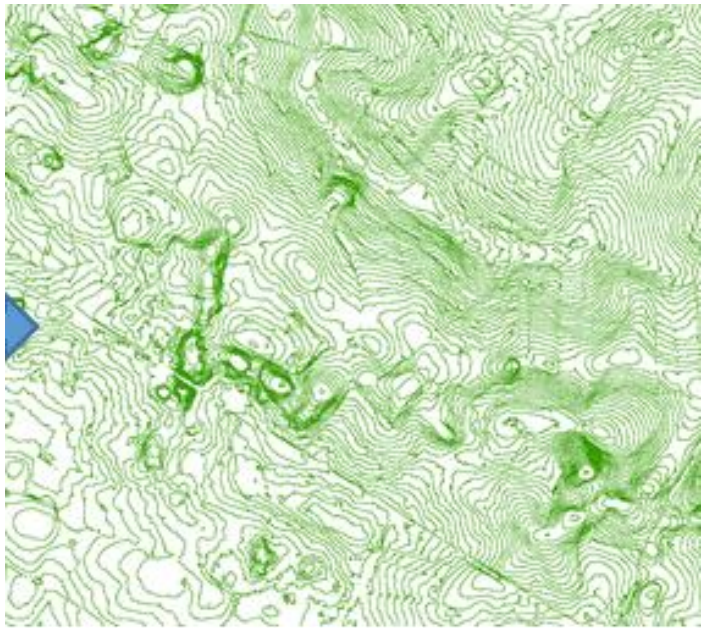
# Methodology (1/2)

- **Bibliography : 2 data treatments generally applied to localised studies** with acquisition of specific HR DTMs + fieldwork

**1. Remote sensing :**
detection of holes in the high resolution DTM




**2. Geomatics** :
use of contour lines



- Use of Geomatics



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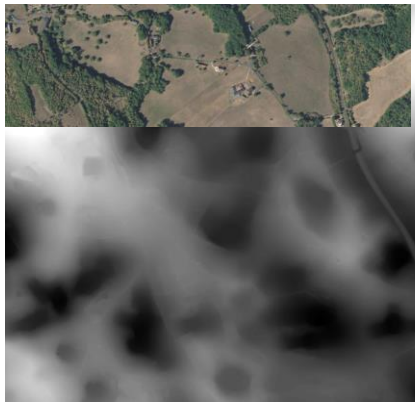
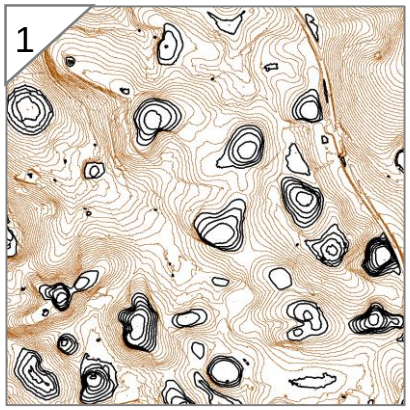
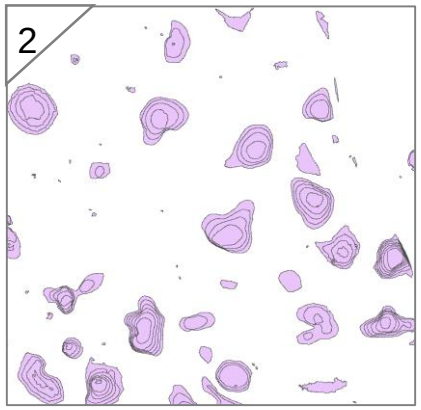
# Methodology (2/2)



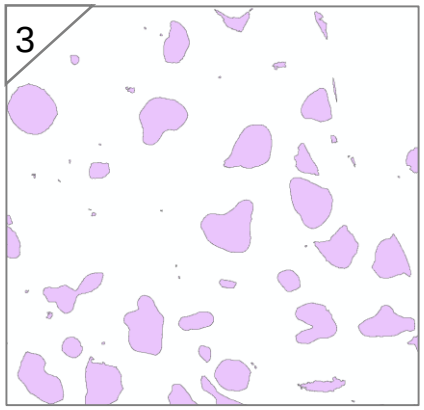
RGE Alti V2 (1m)



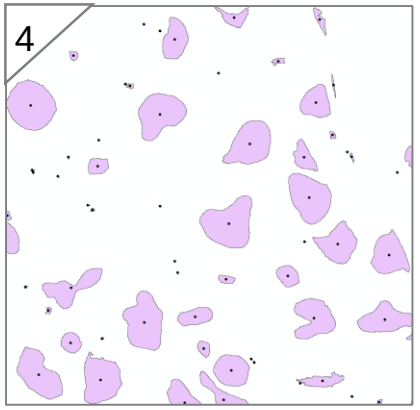

Contour lines at 1m intervals
(lengths between 15 and 500 m )



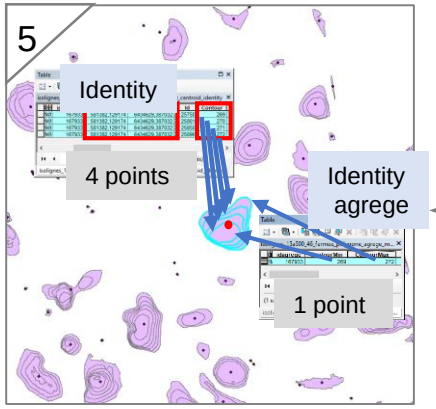

Convert to polygons



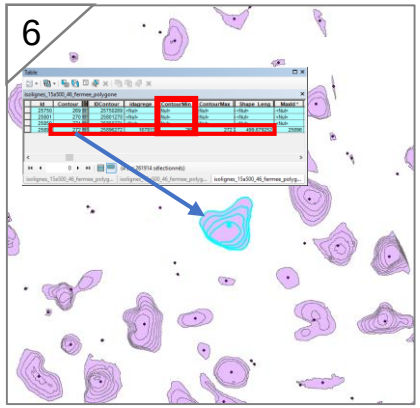

Merge



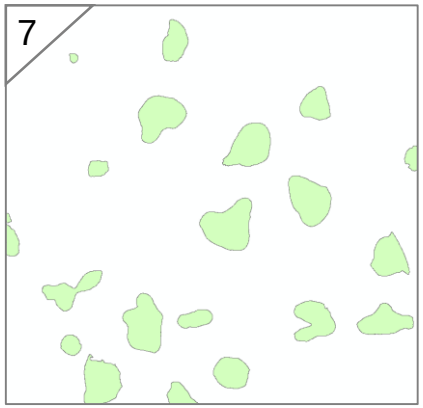

centroid extraction




Identity




Identification of depressions

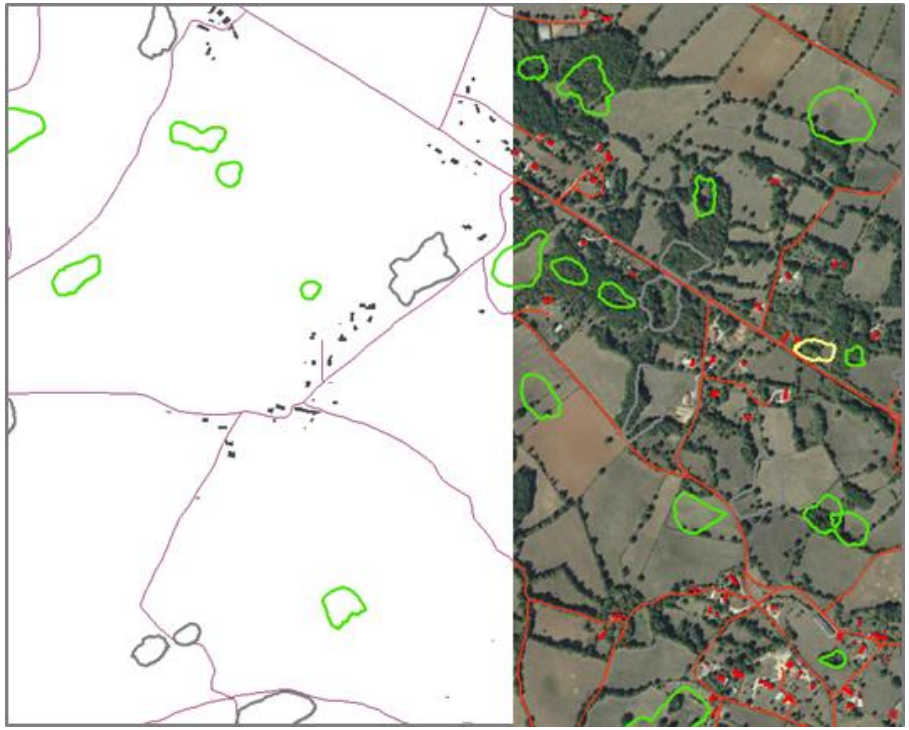



Depressions
⇒ False positives ?

# Qualification of depressions

- Milller circularity index: $$I_{\text{Miller}} = \frac{4\pi \times \textbf{Area}}{\textbf{Perimeter}^{2}}$$

- Location



Probable presence

Incertainty due to building

Incertainty due to road

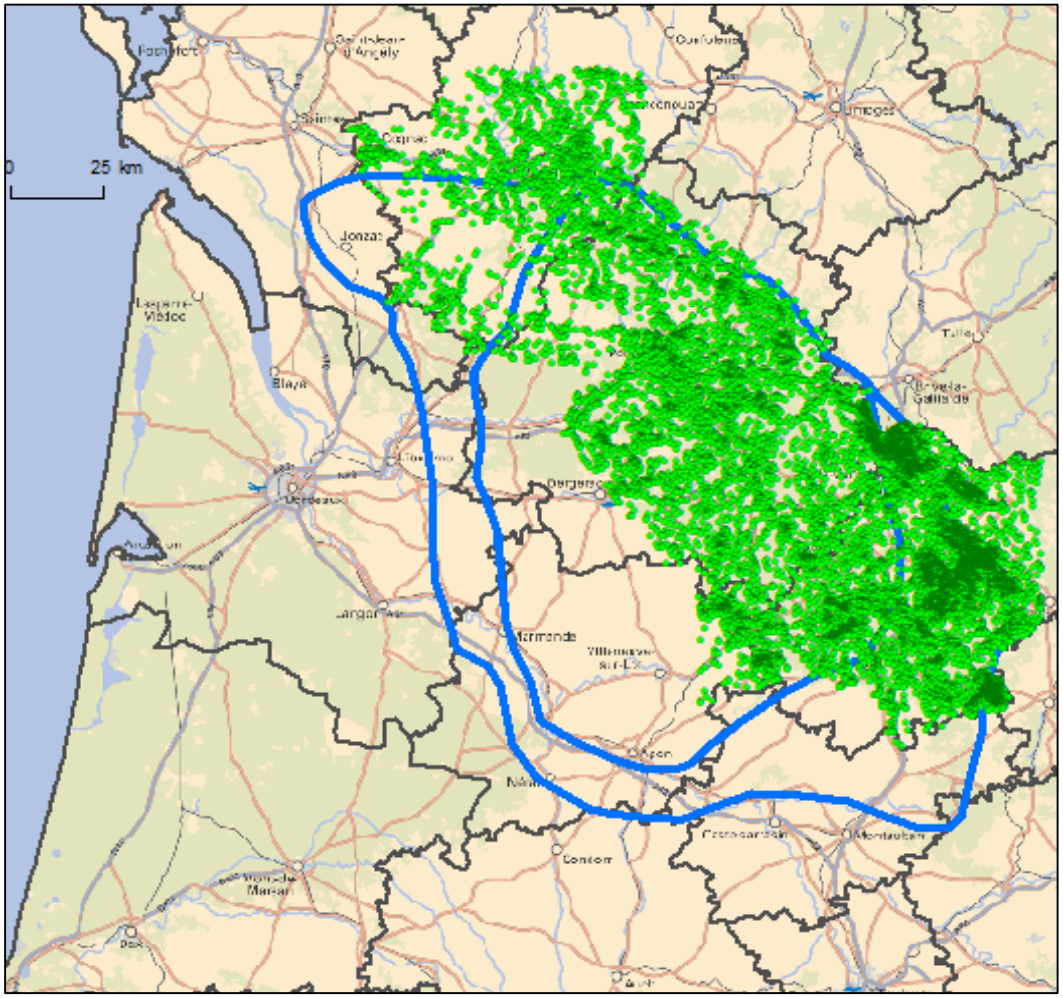
Incertainty due to urban areas

Roads

- Shape / Geometry : slope, orientation, size, depth, …

# Results

**Approximately 9 000 depressions detected in the EauxScars study area, 7 000 with a circularity index > 0.6**




| | |
|---|---|
| Late Cretaceous | 16,53 % |
| Late Jurassic | 25,69 % |
| Middle Jurassic | 36,48 % |
| Early Jurassic | 2,53 % |
| Other | 18,77 % |

Depressions mainly located on Jurassic formations

Spatial repartition of 9 000 depressions

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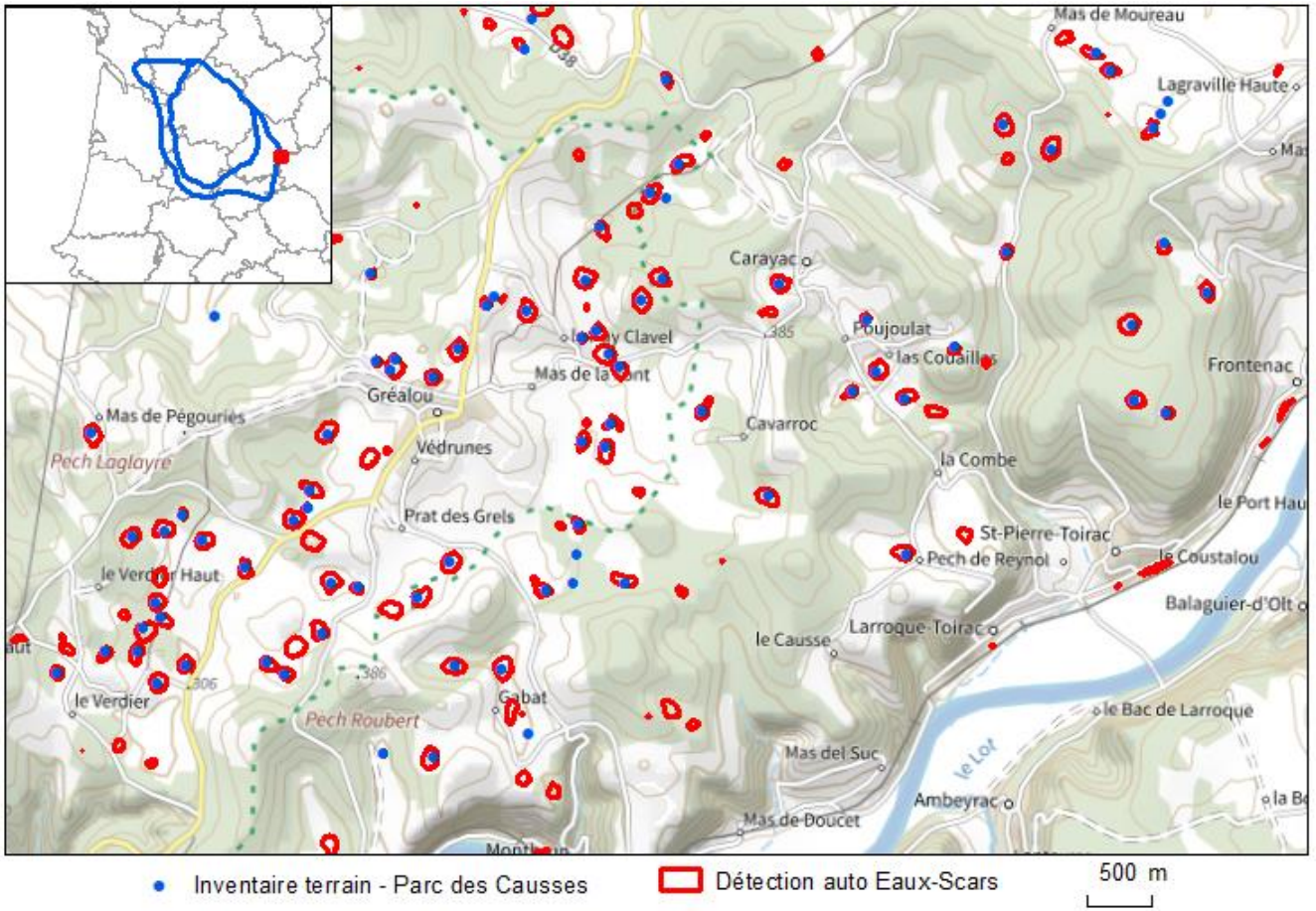
# Validation of the method

➢ Comparison with different inventories

- Inventory obtained from geological and geographical maps at a county scale (study report BRGM RP-62902-FR, 2014)
  ⇒ **Result ++**

- Fieldwork on two municipalities
  ⇒ **Result +** (80 % identified but only 30 depressions) : adjustment of the method and qualification of depressions

- Confrontation with inventory of the « Causses du Quercy » Regional Natural Park (fieldwork)
  ⇒ **Result ++**
  ⇒ 129 of 173 (75 %) of sinkholes detected by the method
  ⇒ > 80 sinkholes identified by the method but not in the inventory



# Conclusion / Perspective

- Method applied at a **large scale** : 22 000 km²
- Use of a **free and high resolution DTM** from IGN (French national institute)

- Improvement of the knowledge concerning aquifer recharge and vulnerability

- Need of data consolidation :
  - Other comparisons with field data in the future
  - Free download of the results : SIGES website

SIGES Aquitaine
Système d'information pour la gestion des eaux souterraines en Aquitaine

  - Use of the method on other territories : data share ?

- A new LiDAR HR DTM (10 pts/m²) obtained from IGN (opendata) within 5 years (2 years for Eaux-SCARS territory)



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