1400 years of man-environment interactions and soil evolution in the Saint-Mont mountain (Remiremont, Vosges)

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Context of the study

The Saint-Mont site

A relatively inhospitable mountain:
- hard climate, steep slopes,
- on acid soils developed from a granitic rock,
- nowadays covered by forests.

Remains suggest human presence for at least 1400 years:
- At the top, the monastery Habendum (from the 7th century to the French Revolution) and a late antique occupation (Chenal 2016).
- Monumental enclosure dry-stones walls of unknown age (Grzesznik, 2019).
- The « Point des Fées »: An enigmatic structure.

Objectives

To investigate traces of ancient anthropic activities in soils and landscapes, on areas where archaeological structures have not yet been detected.

Material and methods

Joint work involving soil scientists, archaeologists, geographers, and computer scientists

Approaches from the landscape to the microscopic scales.

Archaeological data

Software tools to extract and analyze geometric structures in LiDAR data

Field prospectuses / rocks and soils descriptions and sampling, floristic surveys.

Studies along gradients from highly to poorly human impacted areas.

Results

Interactive extraction of linear structures from LiDAR raw data

Development of new algorithms based on digital geometry tools to directly process 3D ground points and get rid of digital terrain model approximations in forested areas (Even and Ngo, 2020).

Immediate visualization of extracted structure, cross and longitudinal profiles and of geometric estimations (height or depth, width, volume, ...).

Time and precision performance evaluated on well controlled structures: forest roads (Even and Ngo, 2021).

Usability assessed on archaeomorphological enclosure walls and old holloways (Even et al., 2021).

ILSD: Open source software for direct exploitation by soil scientists or future integration in geographical information systems (https://github.com/egrea/ILSD)

Landscape and geological materials

A tectonic and glacial heritage

- 3 axes of fracturing highlighted from rock outcrops and preferential feldspar orientations in thin-sections measurements.

- Tectonic fracturing guided the action of the Quaternary. Both factors structure the massif and control its triangular shape.

Geological heritage

The rock descriptions (macroskopically and in thin sections) confirm that most of the Saint-Mont is composed of Remiremont granite (Vincent, 1976).

- New informations, not noted on the geological map:
  * Larger vein of aplite (supposed by the presence of aplite fragments in our studied profiles).
  * At the bottom of sand 6, a lamprophyre vein (rock more basic than granite).

Soil covers

1. Soils not clearly disturbed

- Far from any known archaeological remains, two main types of soils develop on granite:
  * Humic alocrisols (RP) → acidic vegetation.
  * Rankoels (RP) → Strict acidophilic vegetation.

- Reference soils not affected by ancient activities:

2. Highly anthropised soils on platform P

- Undisturbed soils associated to ancient walls:
  * Physical-chemical characteristics close to those of reference soils → low human activity?

- Black unit (1m thick) very rich in organic matter.

- Chemical (pH) in the organo-mineral horizon and saturated soils 5 (T/0.95%)

- Acidcline to neutroline vegetation → Clues of long term tillage and regular manure inputs

3. Other evidence of ancient human influence on soils?

Detection of same anomalies:
- When pH is between 4 and 5
- More significant when pH is > 5
- Easily related to the long-lasting human occupation on the summit.
- More surprising on some western or southern platforms: → Leads for future archaeological studies?

Conclusion and perspectives

Our results confirm:
- A very strong imprint of historical human activities on soils close to the summit part of the massif.
- An heritage on the western slope mainly from natural glacial and pedogenic processes.
- Possible other human activities on some western or southern platforms.

We hypothesize that the weak anomalies are due to older and/or different human activities than those that took place at the top of Saint-Mont (like breeding).

Other analyses are being acquired and interpreted on soils, rocks and LiDAR images.

Bartier, F. and Ngo, T. 2020, The extraction of confounding structures from LiDAR raw data. RHYSI seminar of the LDMG (Laboratoire de Modélisation Géomorphologique). 29-31 October, Rhône-Alpes, France.
Bartier, F. and Ngo, T. 2021, The extraction of confounding structures from LiDAR raw data. 10th International Conference on European Glaciology and Palaeohydrology (EGH2021), online conference.
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