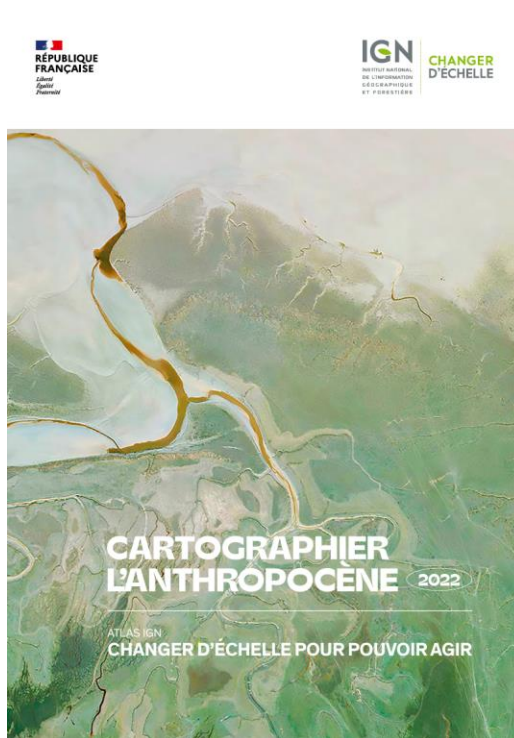


Volunteered metadata to model changes

Bénédicte BUCHER, Ana-Maria OLTEANU-RAIMOND, Constantin STOIAN, Vanessa PECH,
Univ Eiffel, Géodata Paris – IGN, LASTIG

Exploring the New Frontiers of VGI
August 31st 2026, Saint Mandé, FRANCE

Put changes on the map



Atlas « Cartographier l'anthropocène » : découvrez la collection - Portail IGN - IGN

Motivation – Investigations - Conclusion

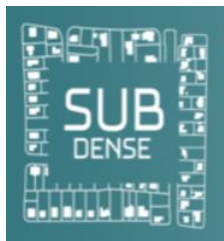
Select data
comparable in time
to **detect** changes
and **put it on the map**

Motivation – Investigations - Conclusion

Volunteered usability metadata
on the discovery and reuse of data
to map changes

To support the production of such maps

Motivation – Investigations - Conclusion



© Hartman

SUBDENSE (2023-2026)

"building changes, on city regions, over the past decades"

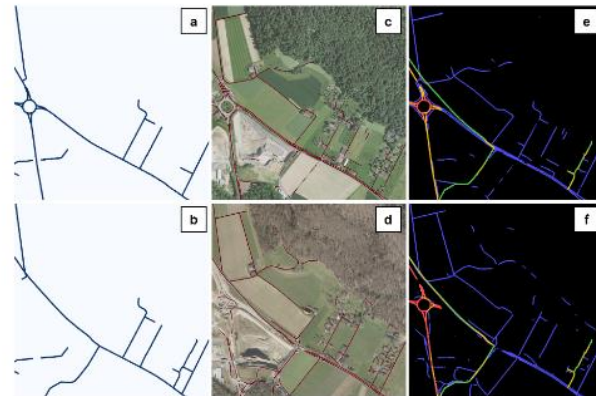
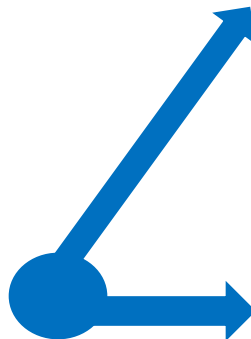
To support studies and discussions related to **densification**

Motivation – Investigations - Conclusion

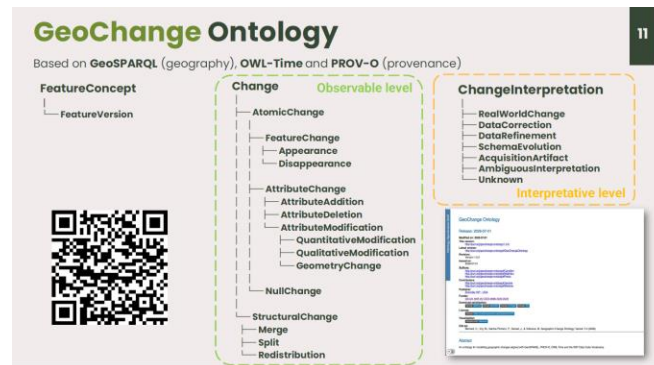


OpenStreetMap

- + homogeneous API
- + 'open' licence
- completeness when going back decades ago
- relation between data changes and real world changes



Zollner, J. M., Werner, M., Luo, X., Rieger, C., & Herfort, B. (2026, July 25). Towards a Real-Time Monitoring System for the Road Network Based on OpenStreetMap and Remote Sensing Data: OSM Road Monitor. OSM Science 2026 at State of the Map 2026 (OSMScience2026), Paris, France. <https://doi.org/10.5281/zenodo.21563625>



Bernard, C., Pinheiro, P., & Viry, M. (2026, July 23). Detection and Semantic Annotation of Changes in OpenStreetMap Data. OSM Science 2026 at State of the Map 2026 (OSMScience2026), Paris, France. <https://doi.org/10.5281/zenodo.21509277>

Motivation – Investigations - Conclusion



La modélisation 2D et 3D du territoire
et de ses infrastructures sur l'ensemble
du territoire français

Producteur



- heterogeneous API
- not always 'open'
- + completeness when going back decades ago
- + relation between changes in data and in real world is partly documented

Motivation – Investigations - Conclusion

Digitale Geodaten ▶ Digitale Landschaftsmodelle

Digitale Landschaftsmodelle

Digitale Landschaftsmodelle (DLM) beschreiben die topographischen Objekte der Landschaft und das Relief der Erdoberfläche im Vektorformat. Die Objekte werden durch ihre räumliche Lage, beschreibende Attribute und Beziehungen zu anderen Objekten definiert. Jedes Objekt ist einer Objektart zugeordnet und besitzt deutschlandweit eine eindeutige Identifikationsnummer.

Der Inhalt der Digitalen Landschaftsmodelle wird durch die ATKIS-Objektartenkataloge beschrieben. Weitere Dokumente erläutern Regeln zur Erfassung und Objektbildung.

Die Bundesländer erstellen das ATKIS Basis-DLM, durch das BKG werden das DLM250 und DLM1000 gepflegt.

Darstellung als Sortierung Reihenfolge ▼

Digitales Basis-Landschaftsmodell (Ebenen) (Basis-DLM)



Das Basis-DLM beschreibt die topographischen Objekte der Landschaft im Vektorformat (Ebenenstruktur).

Preis: ab 50,00 € zzgl. USt.

[Produktdetails](#)

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The OS MasterMap Topography layer is presented seamlessly with more than 500 Million world objects – all uniquely identified – including roads, buildings, parks and waterways all and maintained by Ordnance Survey within one of the world's largest spatial databases.

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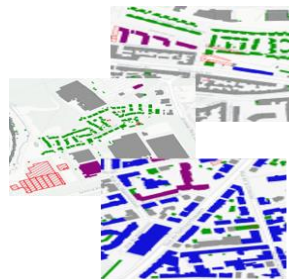
France : BDTopo

Allemagne : ATKIS GeoBASIS

UK : OS MasterMap

Reproducible change detection procedure

applied to *local* sources (vector data, and aerial imagery for quality control)

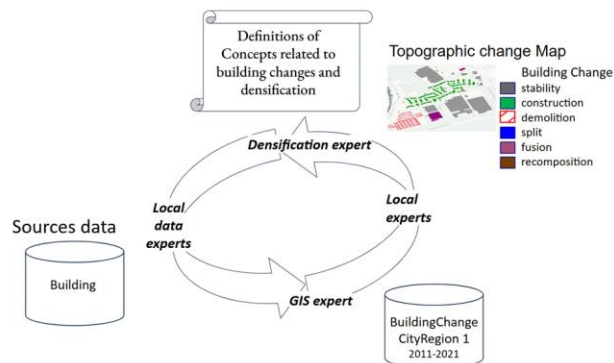


Maps of building-changes

- Stability
- Construction
- Demolition
- Split
- Fusion
- Recomposition

Motivation – Investigations – Conclusion

<https://doi.org/10.3390/ijgi14040155>



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Article

A Model of Building Changes to Support Comparative Studies and Open Discussions on Densification

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Abstract: Densification is a widely used concept, but there is a lack of terminology and tools to facilitate discussions among data scientists, policy makers and citizens. This paper proposes a model of building changes based on building surveys undertaken in past decades to connect discussions about densification with shared evidence. A specific challenge is to process buildings in city regions and areas in a replicable way across different building data sources. Another challenge is to manage the quality of the representation, i.e., how well the maps represent changes to buildings and how well they can support discussions of densification. Building data and real buildings are different things that sometimes change in an independent way. Addressing these factors requires different forms of expertise, i.e., expertise about the realities depicted in the areas studied, about local data sources, and about advanced matching tools and state-of-the-art densification concepts. We present a collaborative dashboard through which to engage corresponding experts in the production of building change maps and the clarification of related concepts.

Keywords: building change conceptual model; metadata; data matching; collaborative platform; densification; quality metadata

1. Introduction

As the demand for housing in European metropolitan areas continues to increase, densification, defined as a net increase in the dwellings within pre-existing built-up areas [1], is expected to mitigate urban sprawl and promote sustainable transport [2]. Empirical evidence on densification processes implies that there is immense densification potential in relatively low-density suburban areas across Europe. Examples from Germany show that densification happens to a high extent in core cities [3], while the potential in suburban areas remains unused, leading to concerns about the environmental implications in already dense urban contexts, as well as ongoing land take in the suburban realm. Research on the social effects of densification also reveals that it can provide housing for various socio-economic groups through more affordable housing and fostering socially mixed neighbourhoods [4,5]. However, land policies targeting urban densification can have undesirable side effects, such as insecure neighbourhoods and low social mixing [4] or a loss of urban green space [6], and there is potential resistance to such densification. Against this backdrop, a deeper



Research Paper

Densification in European city-regions: From observed patterns to actors and policy constellations

Mathias Jehling^{a,*}, Vera Götze^b, Juste Raimbault^{c,f}, Julien Perret^{c,f},
Ana-Maria Olteanu-Raimond^{c,f}, Sebastian Dembski^d, Thomas Hartmann^e, Denise Ehrhardt^a

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^b University of California Los Angeles, United States

^c Ecole Nationale des Sciences Géographiques, University Gustave Eiffel, Champs sur Marne, France

^d Department of Geography and Planning, University of Liverpool, United Kingdom

^e Department of Spatial Planning, TU Dortmund University, Germany

^f LASTIG, Institut National de l'Information Géographique et Forestière, Saint-Mandé, France

HIGHLIGHTS

- Reproducible geospatial approach reveals densification across three countries.
- Multi-temporal building data enables cross-national densification analysis.
- Densification on project level links urban form to actor and policy constellations.
- Results show region-specific actor constellations and land policies.
- Approach supports actor-targeted policies for sustainable densification.

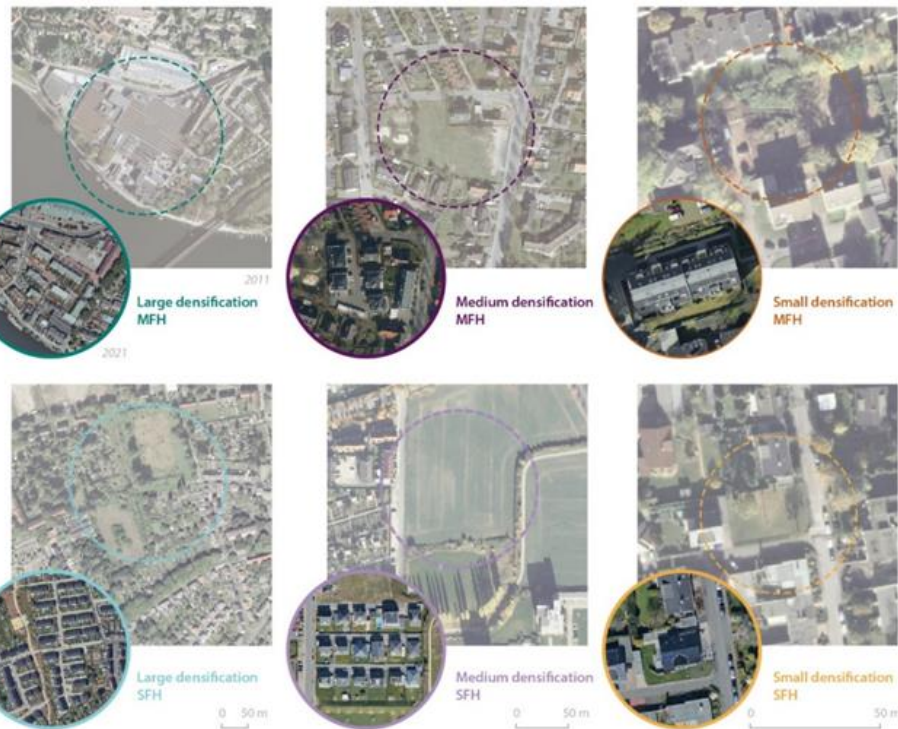
ARTICLE INFO

Keywords:

Geospatial analysis
Urban densification
Actors
Land policy

ABSTRACT

Urban densification is widely promoted as a strategy to limit land-take and provide housing, yet its sustainability and effectiveness remain debated. The impacts of densification depend heavily on the form of densification, but systematic knowledge about these forms and the policies and actors shaping them is still limited. To better understand this relationship, we present an approach to measure densification on the level of urban form through multi-temporal building data, which overcomes limitations for comparative research. We derive information on building change, housing form and project size which allows us to identify densification patterns. Through aggregation and visualisation, the observed patterns are discussed against the backdrop of actor constellations and institutions of land policy. To test the approach, we apply it to three city-regions in Germany, France and England. The interpretation of the spatial results reveals distinct patterns, which are found to be in line with knowledge on actors and policy across the regions, which we retrieve from existing literature on land policies in the context of densification. Predominantly large-sized development of detached housing in the Liverpool region are found, compared to large- to medium-sized apartment projects in Strasbourg and incremental densification in Dortmund. The analysis and interpretation of the study indicates for a multi-layered disciplinary approach to urban



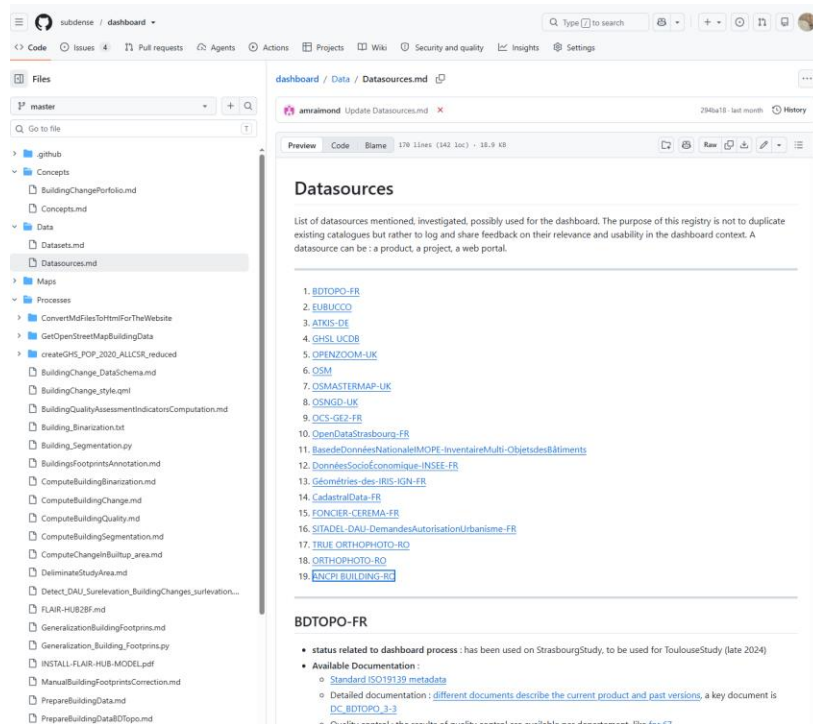
Motivation – Investigations – Conclusion

Usability metadata fragments =
text edited through md files on a git

To describe data, its relevance, how to use it, derived building changes maps

To clarify concepts (*density, densification, urban area, built up area, vacant plot, roof-stacking, ...*)

Collaboration : improve and reproduce



Motivation – Investigations - Conclusion



- 94 km² total area
- Population: 610k inhab. in 2023

Reproducibility in another EU country

Motivation: Rapid urban densification in Iași, Romania, driven by residential and functional changes

New challenges:

- Existing building footprint datasets are **outdated or incomplete**
- **Limited availability** of reliable **historical building footprint data** for densification analysis

2011



2024



New residential buildings

Motivation – Investigations – Conclusion

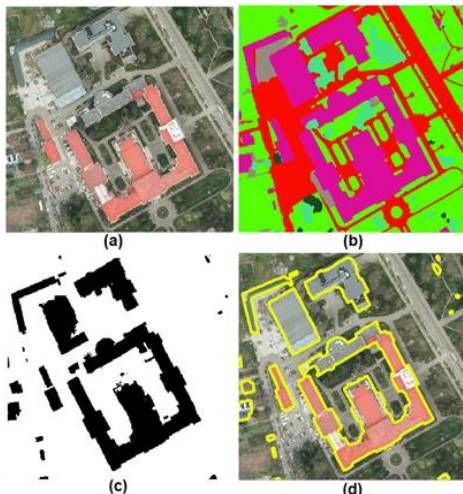


- 94 km² total area
- Population: 610k inhab. in 2023

Processes for generating buildings footprints datasets

2024: FLAIR-HUB2BF process

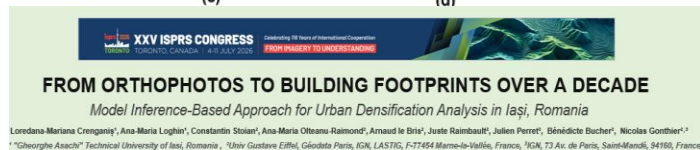
2011: Collaborative **Annotator** and **Edits**



Collaborative validation with students from Faculty of Hydrotechnical, Geodesy and Environmental Engineering

Classification: no change, **modification**, construction, demolition

- 5 Ground Datasets:** Automatic Generation, Collaborative Annotation, and Manual Correction
- Metadata** description for data and processes



Motivation – Investigations – Conclusion



- 94 km² total area
- Population: 610k inhab. in 2023

Processes for generating buildings footprints datasets

The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XLIX-B4-2026
XXV ISPRS Congress 2026 "From Imagery to Understanding", Commission IV, 4–11 July 2026, Toronto, Canada

From Orthophotos to Building Footprints over a decade: Model Inference-Based Approach for Urban Densification Analysis in Iasi, Romania

Loredana-Mariana Crenganis¹, Ana-Maria Loghin¹, Constantin Stoian², Ana-Maria Olteanu-Raimond²,
Arnaud le Bris², Juste Raimbault², Julien Perret², Bénédicte Bucher², Nicolas Gonthier²

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Keywords: semantic segmentation, transferability, building footprints extraction, data matching, urban densification

Abstract

Urban densification in post-socialist cities involves fine-scale spatial transformations that are difficult to quantify in data-scarce environments. This study proposes FLAIR-HUB2BF, a model inference-based workflow for automated building footprint extraction and multi-temporal change analysis, applied to the city of Iasi, Romania. The methodology extends the SUBDENSE conceptual framework by integrating the FLAIR-HUB deep learning model for semantic segmentation of very high resolution aerial orthophotos from 2011 and 2024, followed by binary mask extraction, instance segmentation, and Douglas-Peucker polygon generalization. The approach demonstrates good spatial transferability of the FLAIRHUB model which was trained on France to generate buildings (for 2024) and less good temporal transferability (for 2011) due to the quality of orthophotos in 2011. To support rigorous evaluation, the first open benchmark building footprint datasets for Romania in 2024 were produced through manual photo-interpretation correction across four morphologically distinct urban neighborhoods of Iasi, and assessed against ISO 19157 spatial data quality standards, achieving commission and omission rates of 1.95% and 2.39% respectively. Quantitative evaluation using complementary GMA (Geometric Matching of areas) and MCA (Multi-Criteria Algorithm) data matching algorithms confirms moderate-to-high spatial accuracy for 2024, with MCA surface agreement rates reaching 91%. The proposed workflow establishes a transferable, reproducible, and open methodology for building-level urban monitoring applicable to other Romanian and European cities facing similar data constraints.

[isprs-archives-XLIX-B4-2026-25-2026.pdf](#)

Motivation – Investigations - Conclusion



- 94 km² total area
- Population: 610k inhab. in 2023

Identifying patterns in building changes maps

2011-2024: Densification



Change pattern:
residential to
commercial



Change pattern:
industrial to
residential

Work in progress...

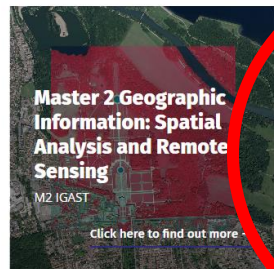
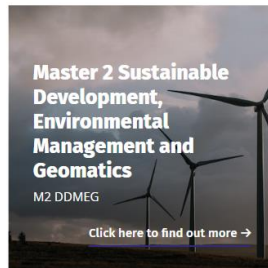
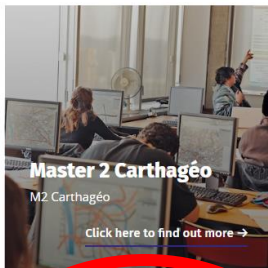
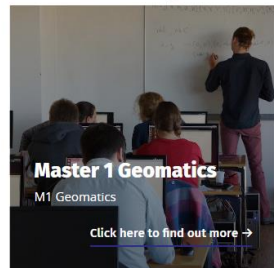
Motivation – **Investigations** – Conclusion

First finding : it is feasible to engage experts in the **co-production of usability metadata** to detect and put changes on maps

Second investigation : **a pedagogic exercise** in a SDI curriculum

Motivation – Investigations - **Conclusion**

Master's degrees



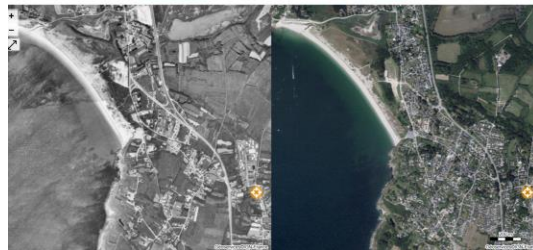
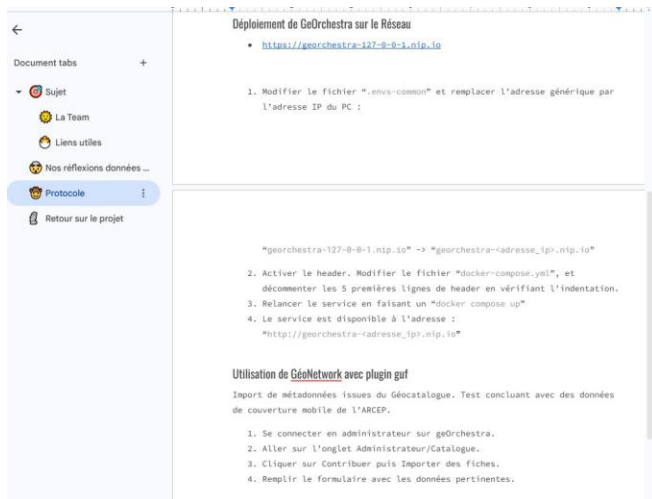
Motivation – Investigations - Conclusion

1 day work with our master students
to understand "next generation SDI" :

Produce usability metadata to
help scientists (urbanists, ecologists, ...)
who study changes

Motivation – **Investigations** - Conclusion

Use interoperability standards – GeospatialUserFeedback- and software (Geonetwork).



GUFnumero1 {

Auteur : <https://orcid.org/0000-0002-5797-5170>

Comment : [..]

Target 1 : Aerial pictures 1950-1960 on Commune 56730,

Target 2 : Aerial pictures on Commune 56730, consultées le 11/03/26,

Target 3 : ModeledChanges.shp,
}

Motivation – Investigations - Conclusion

```
GUF_TSI {  
  Author: TSI_GéodataParis2025,  
  Target 1: Aerial pictures 1965 on PNR des Bauges from  
  BDOrthoHistorique,  
  Target 2: Aerial pictures 2024 on PNR des Bauges from  
  BDOrthoHistorique,  
  Target 3: field_boundary_between_1965-2024,  
  Coment: We observed a shift in the boundary between  
  forested areas and cultivated areas (primarily vineyards)  
  around Montmélian (the Bauges Regional Nature Park)  
  based on historical aerial pictures from the IGN (1950 to  
  2024).  
}
```



Motivation – **Investigations** - Conclusion

First finding : it is feasible to engage experts in the **co-production of usability metadata** to detect and put changes on maps

Second finding : it is **a good pedagogic exercise** for master students, to understand the stake of interoperability, discover different data products, understand how their competences are useful for sustainability

Motivation – Investigations - **Conclusion**

Perspective :

- Continue working with our master students on preparing GeospatialUserFeedback related to comparable data, detected changes
- Extend to the 1945-2025 time period

Work with EuroSDR community !

Motivation – Investigations - **Conclusion**