Towards a joint use of VGI and authoritative geographic information to support public policies

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AGILE Workshop: Current trends of VGI in NMCAs practices

LASTIG ID

- Research in **Science and Technologies in Geographic Information**

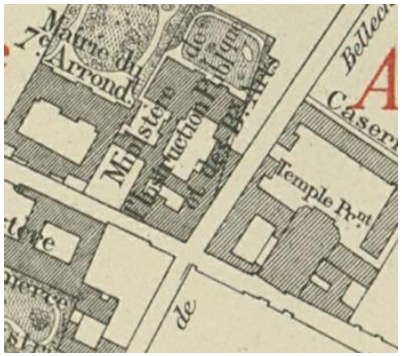
- **Objectives**:
  - Data, knowledge, methods and tools for modeling, analysis, simulation and visualizing the territories and spatio-temporal phenomena

- Four teams
  - **ACTE**: Data acquisition and processing
  - **GEOVIS**: Visualisation, Interaction, Immersion
  - **MEIG**: Mediation and semantic enhancement
  - **STRUDEL**: Spatio-temporal structures for spatial analysis

- **48 permanents (~ 75% from IGN)**
- **33 CDD: (post)doctorants, engineers**
- **Location: Paris & surroundings**

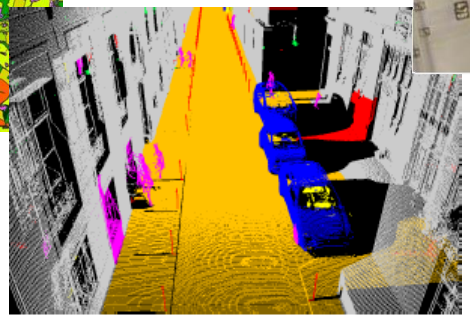
Text

Old Maps



Vector data

3D data

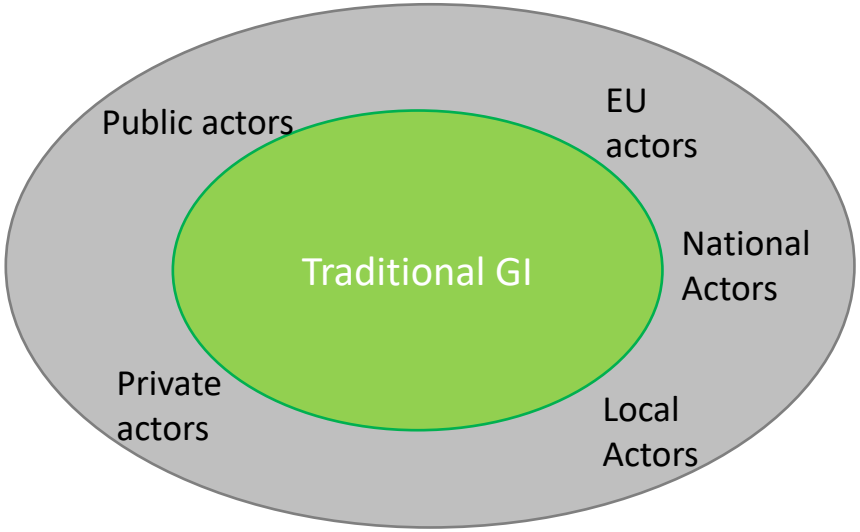


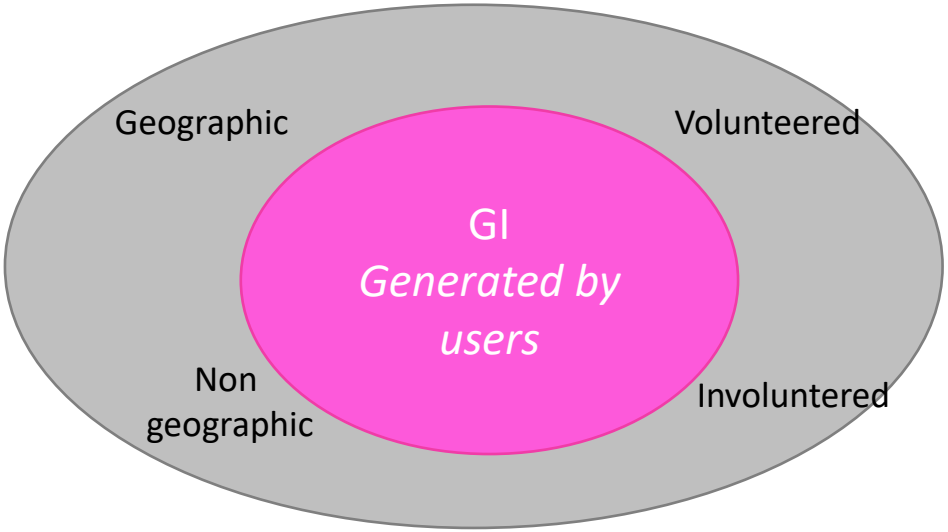
Geospatial imagery

OUTLINE

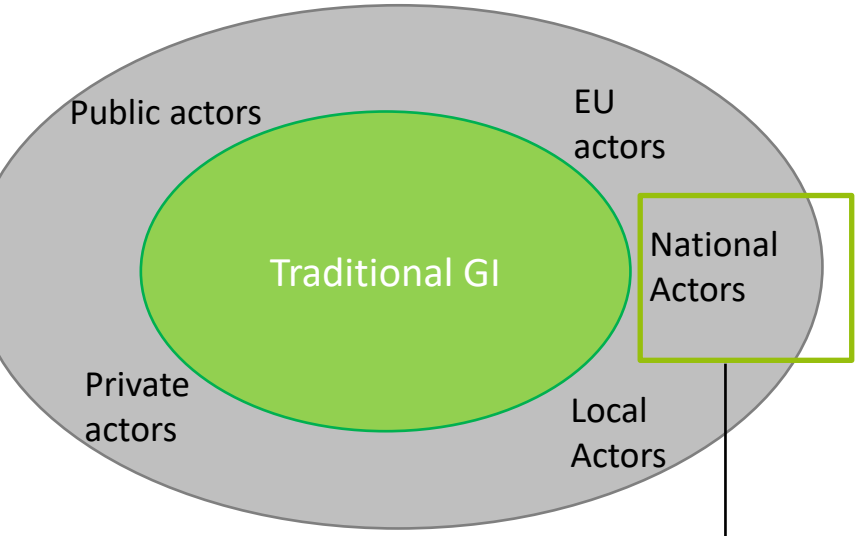
1. Context
2. Authoritative versus VGI
3. VGI to update and enrich authoritative GI
4. VGI & authoritative GI for mountain rescue
5. Conclusion

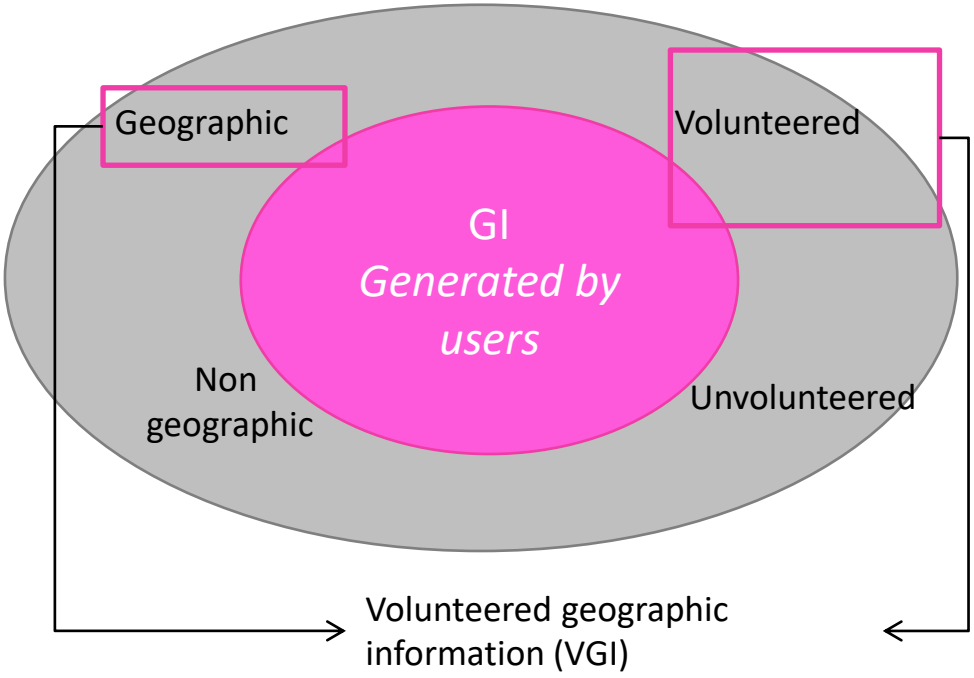
Context


Public actors
EU actors
Traditional GI
National Actors
Private actors
Local Actors


Geographic
Volunteered
GI
Generated by users
Non geographic
Involuntered

Context

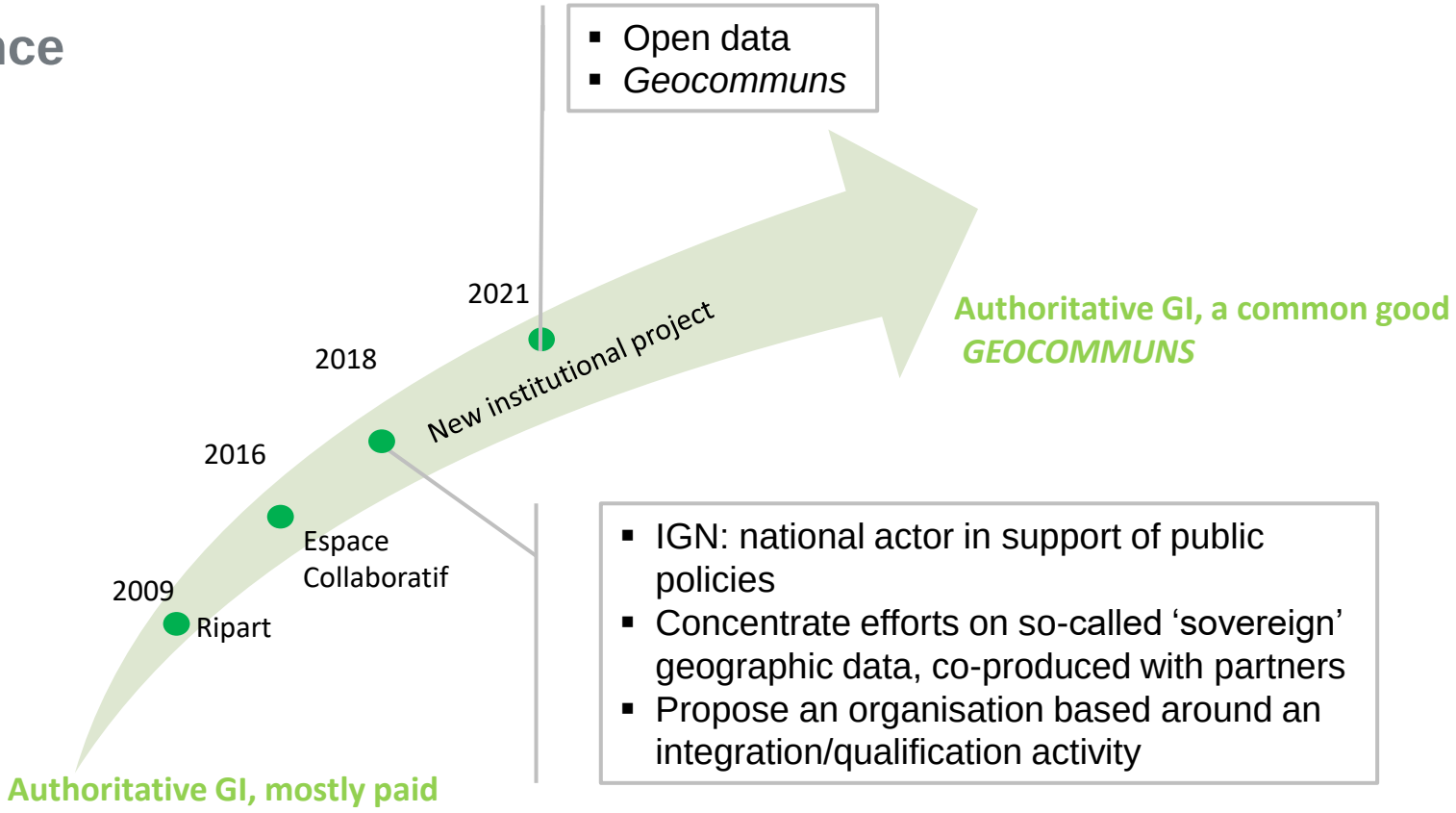




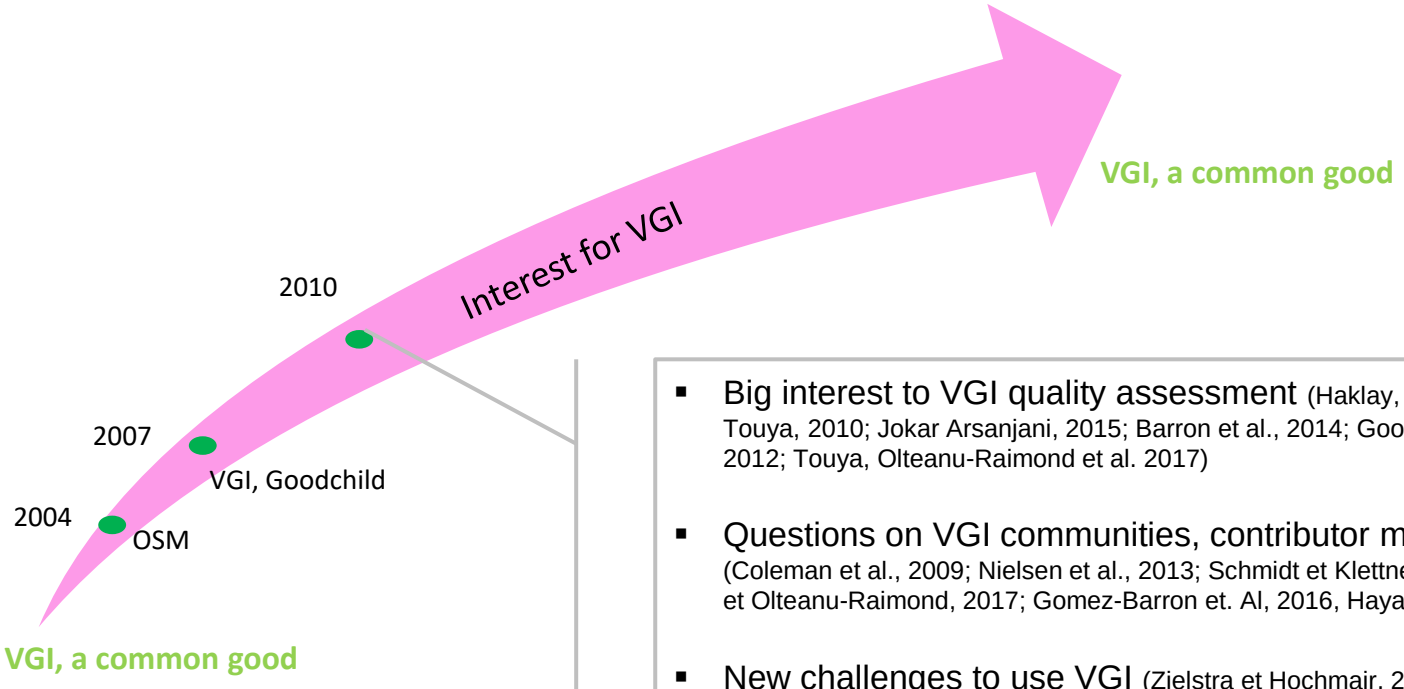
Two opposing world with a crisp frontier

Institutional context in evolution

- IGN France



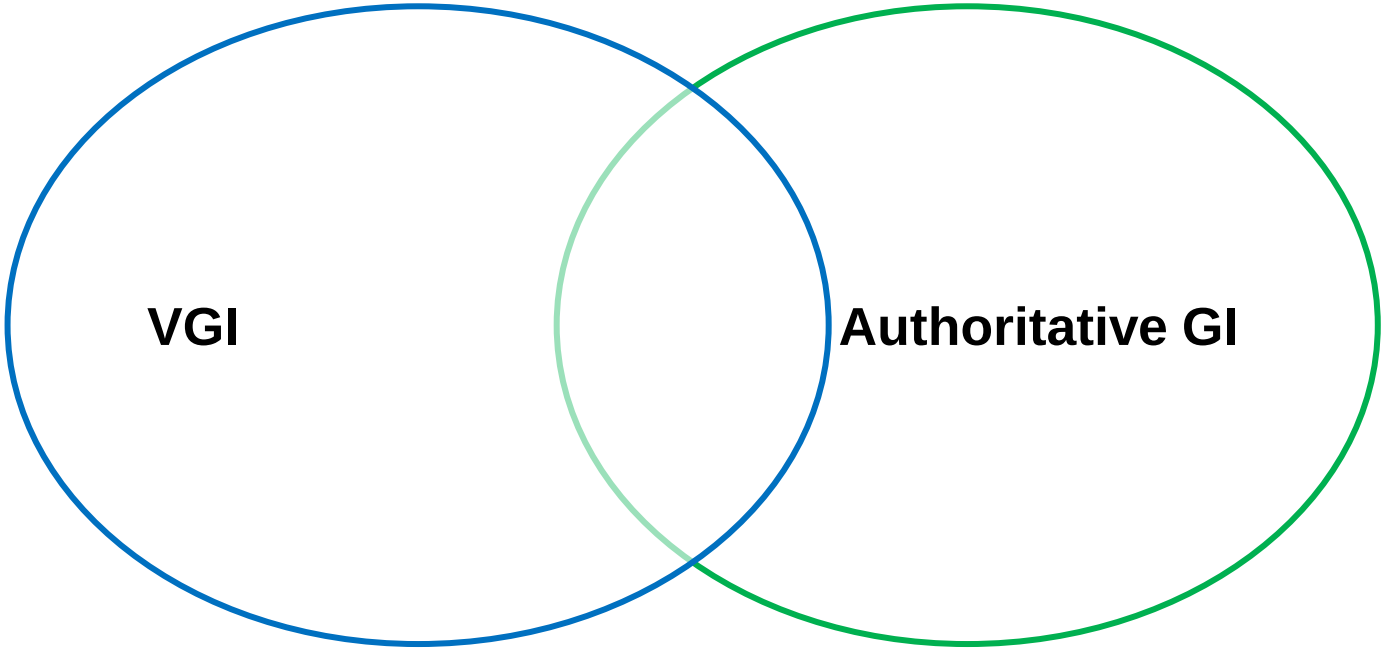
Rapidly changing scientific context



- Big interest to VGI quality assessment (Haklay, 2010; Girres et Touya, 2010; Jokar Arsanjani, 2015; Barron et al., 2014; Goodchild and Li, 2012; Touya, Olteanu-Raimond et al. 2017)
- Questions on VGI communities, contributor motivation (Coleman et al., 2009; Nielsen et al., 2013; Schmidt et Klettner, 2013; Jolivet et Olteanu-Raimond, 2017; Gomez-Barron et. Al, 2016, Hayat, 2019)
- New challenges to use VGI (Zielstra et Hochmair, 2011, Liu et al., 2015; Van Winden et al., 2016; Hayat, 2019; Liu et al., 2020)
- VGI & IA

Research hypothesis

Two pieces of information that enrich each other…



… and generate new applications

OUTLINE

1. Context
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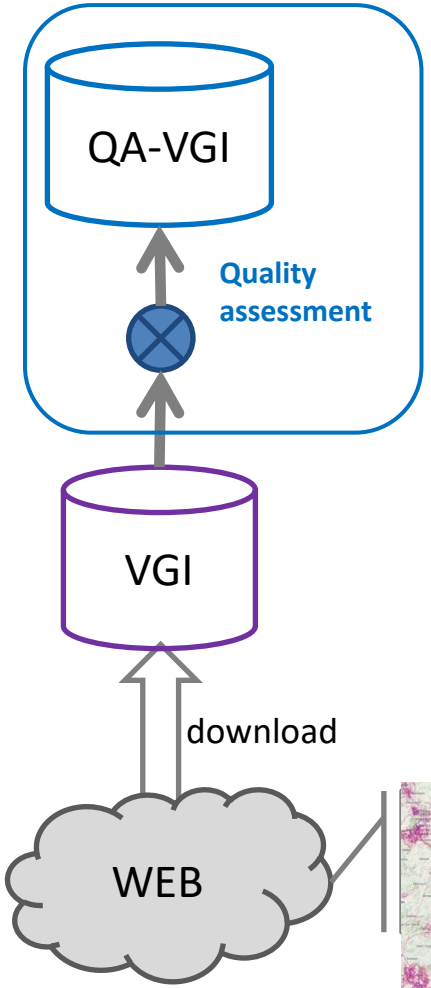
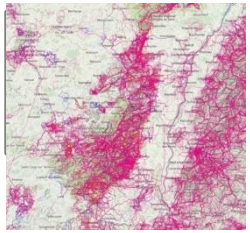
1. UPDATE AUTHORITATIVE TOPOGRAPHIC DATA

Ivanovic et al. 2019

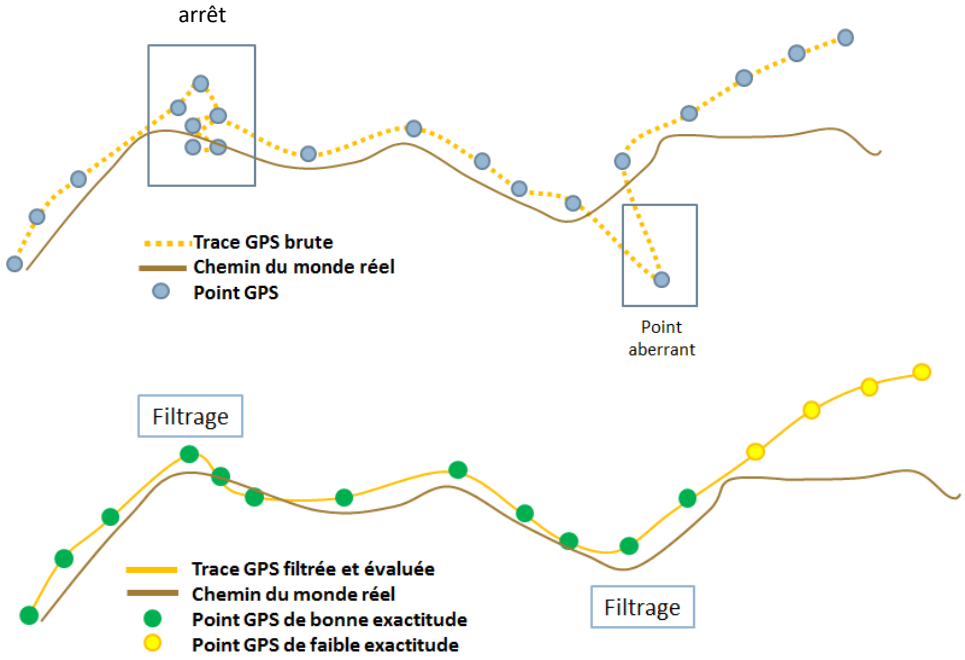
Three steps approach:

1. Quality assessment : **spatial analysis** and **supervised machine learning techniques** to improve track geometry and assess the GPS points accuracy



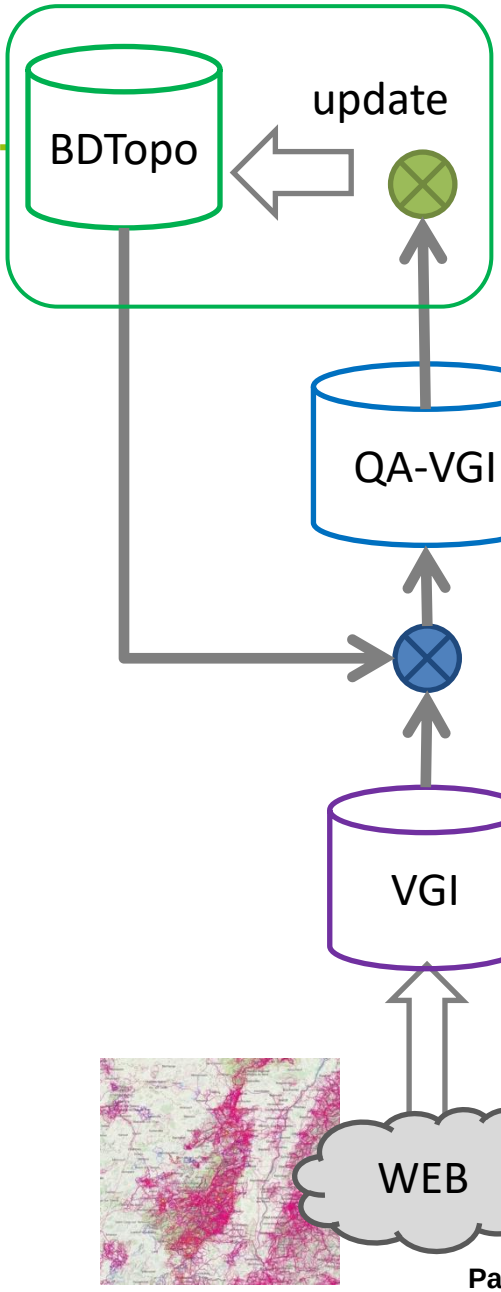


VGI: GPS tracks



Outliers detection

Ivanovic et al. 2019

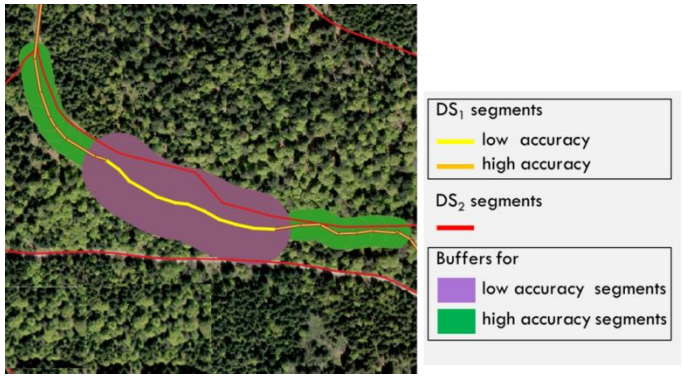


VGI: GPS tracks

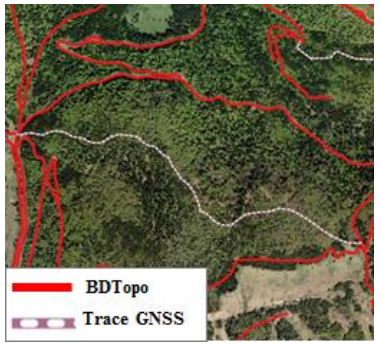
Three steps approach:

2. **Data matching** to identify homologous features and potential candidates for update
3. **Multi-criteria decision** method to identify features to be updated

Buffer according to segment accuracy



Missing paths detected from GPS data



High potential of VGI for updating road data: 9.5% of the GPS tracks length are alerts representing real roads

Filtering and estimating the quality of GPS data facilitate the detection of updates

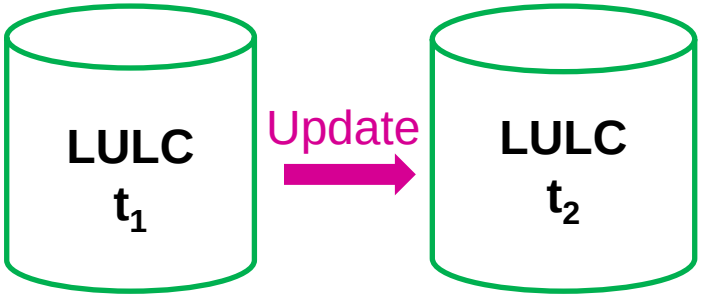
Paper: Ivanovic .S., Olteanu-Raimond, A.-M., Mustière, S., Devogele, T. (2019). Potential of Crowdsourced Traces for Detecting Updates in Authoritative Geographic Data, in: Kyriakidis, P.et al. (Eds.), Geospatial Technologies for Local and Regional Development. pp. 205–221. https://doi.org/10.1007/978-3-030-14745-7_12

2. ENRICH AND UPDATE AUTHORITATIVE LULC DATA

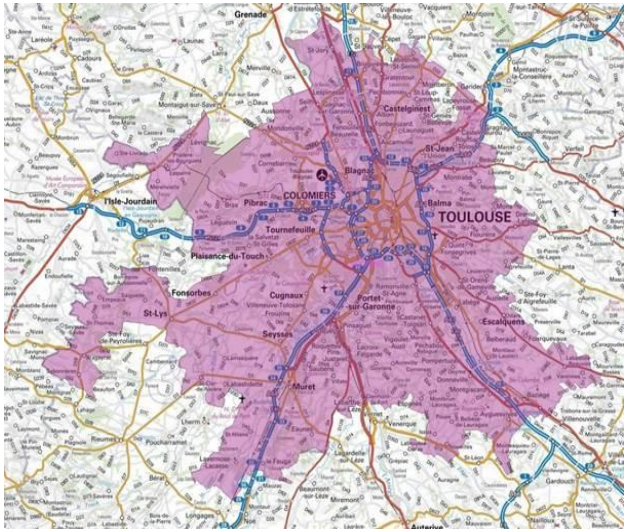
LandSense
A Citizen Observatory and Innovation Marketplace for Land Use and Land Cover Monitoring

H2020 project (2016-2020)

IGN PILOT GOAL



What is the potential of VGI for updating and enriching authoritative LULC data?



- Pilot : Toulouse and its surrounding areas
- Campaigns : 2018 -2019

PAYSAGES PLATFORM

- Three tools to contribute

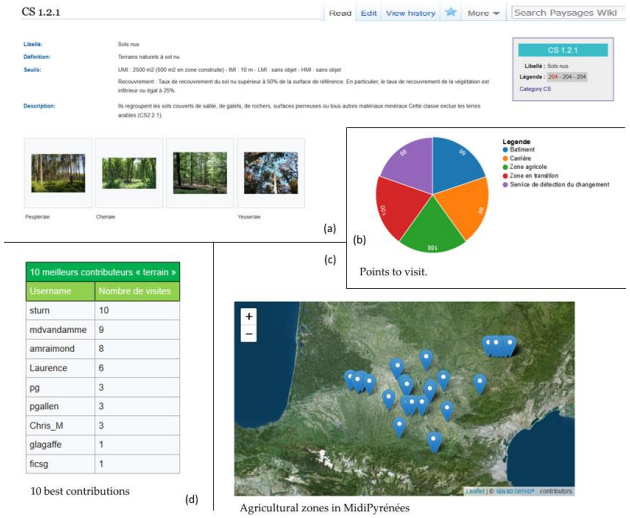
1 PAYSAGES web: https://paysages.ign.fr/

- Collaborative mapping and validation: thematic and geometry information

2 PAYSAGES mobile: (Android and Apple store)

- Collaborative validation: thematic information
- *In-situ*, guided campaign

3 PAYSAGES semantic wiki

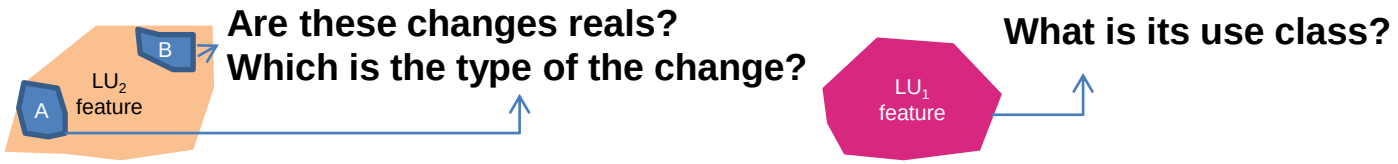


- Inform and help contributors
- Describe metadata
- For citizens and local authorities

Paper: **An Experimental Framework for Integrating Citizen and Community Science into Land Cover, Land Use, and Land Change Detection Processes in a NMA (Olteanu-Raimond et al., 2017)**
DOI : **10.3390/land7030103**

CAMPAIGN DESIGN AND SETUP

1. Define target/feature for classification and validation
   - LULC classification : LU 2 (Industrial), LU3 (Commercial), LU5 (Residential) and OCS-GE nomenclature
   - Change validation : changes detected by the **change detection service proposed in Landsense** from 2016-2019



2. Configure the campaign (e.g. data), distribute to participants
   - Organize mapthons: *in situ* and *in front of the desk*

3. Provide instructions and guidance, ensure participants are motivated

Paper: Use of Automated Change Detection and VGI Sources for Identifying and Validating Urban Land Use Change (Olteanu-Raimond et al., 2020)
DOI : **10.3390/rs12071186**

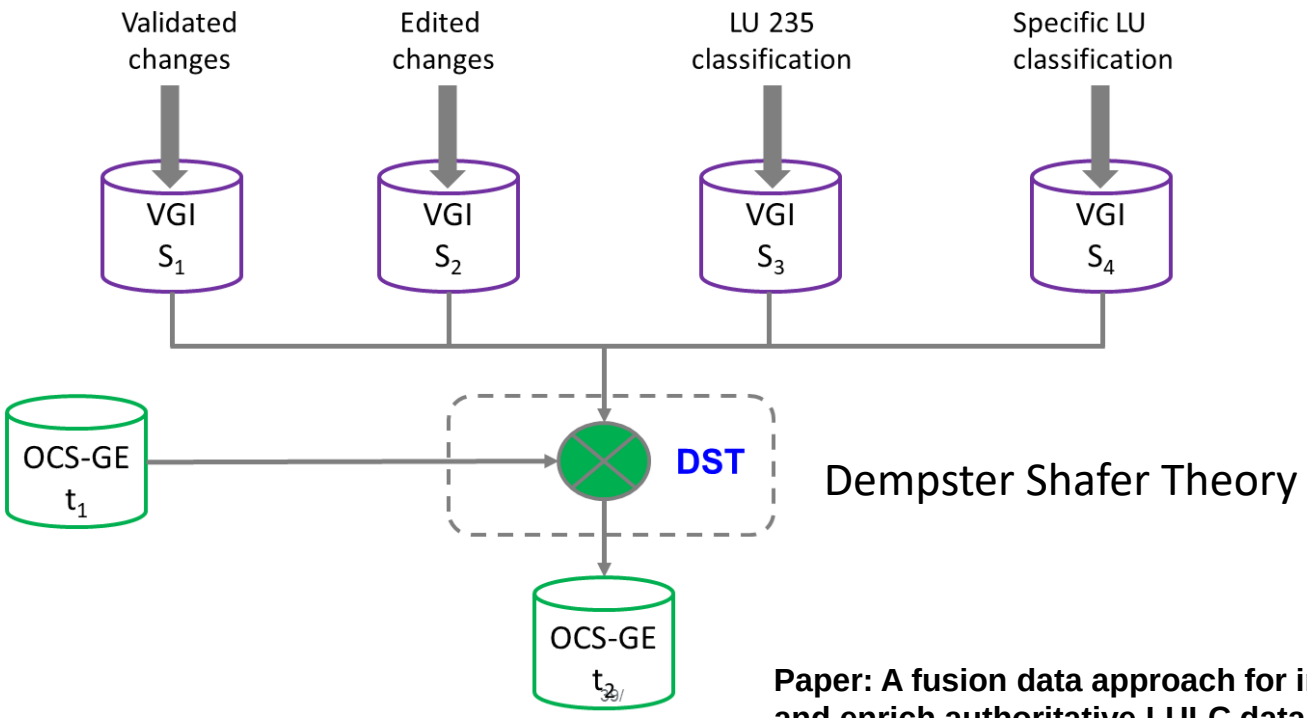
LU UPDATE

- Approach based on data fusion (Dempster-Shafer Theory - DST)

130+ participants

7500+ observations

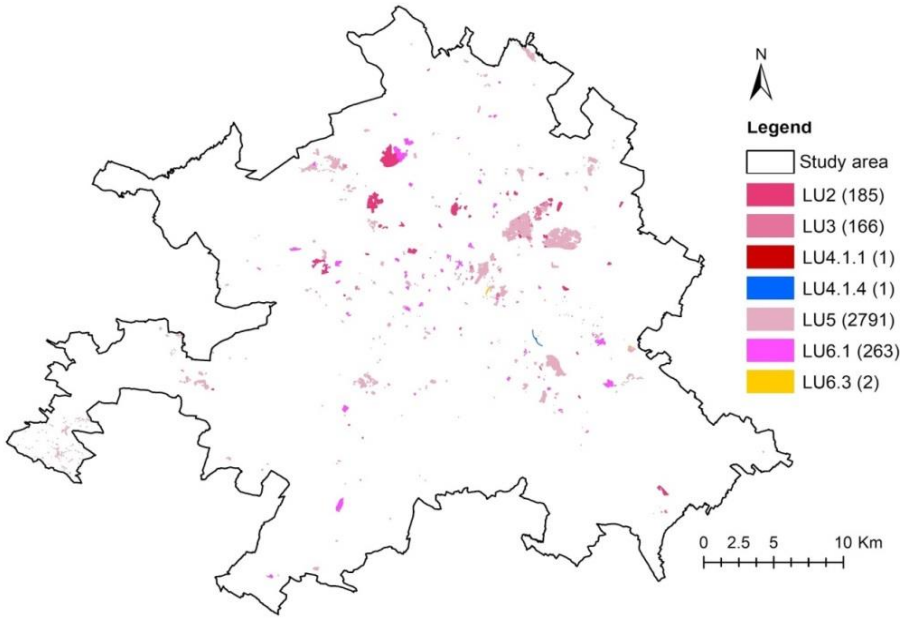
4 sources of information: S_j



Paper: A fusion data approach for integrating VGI to update and enrich authoritative LULC data (Liu et al. 2020)
https://doi.org/10.1080/17538947.2020.1842524

LU UPDATE

Approach based on data fusion (Dempster-Shafer Theory)



- Among the alerts, 97% generated an LU update
- Only 15 % of changes are detected
- Global accuracy: 85.6

Paper: A fusion data approach for integrating VGI to update and enrich authoritative LULC data (Liu et al. 2020)
https://doi.org/10.1080/17538947.2020.1842524

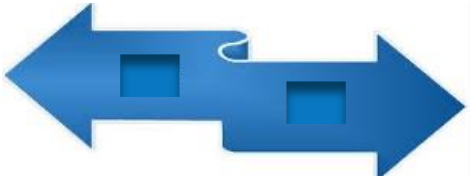
Datasets available here

https://doi.org/10.5281/zenodo.3691827

BUILD A LANDMARK GRAPH DATABASE FOR MOUNTAIN RESCUE APPLICATION

CONTEXT AND GOALS

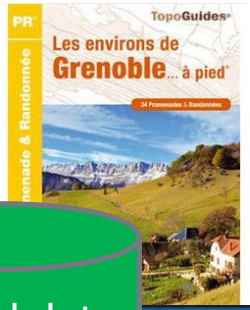
Caller (victim or third party)



Rescue operator

- **Imprecise location and low reliability**
  - Poor mountain knowledge
  - Inaccurate description of route and spatial environment
  - Fear and stress

- **Multi-source and multi-format data**



GPS

Spatial data

Where is the victim located?

Location clues

(1) I am **between Grand Veymont** and **Pas de la Ville**

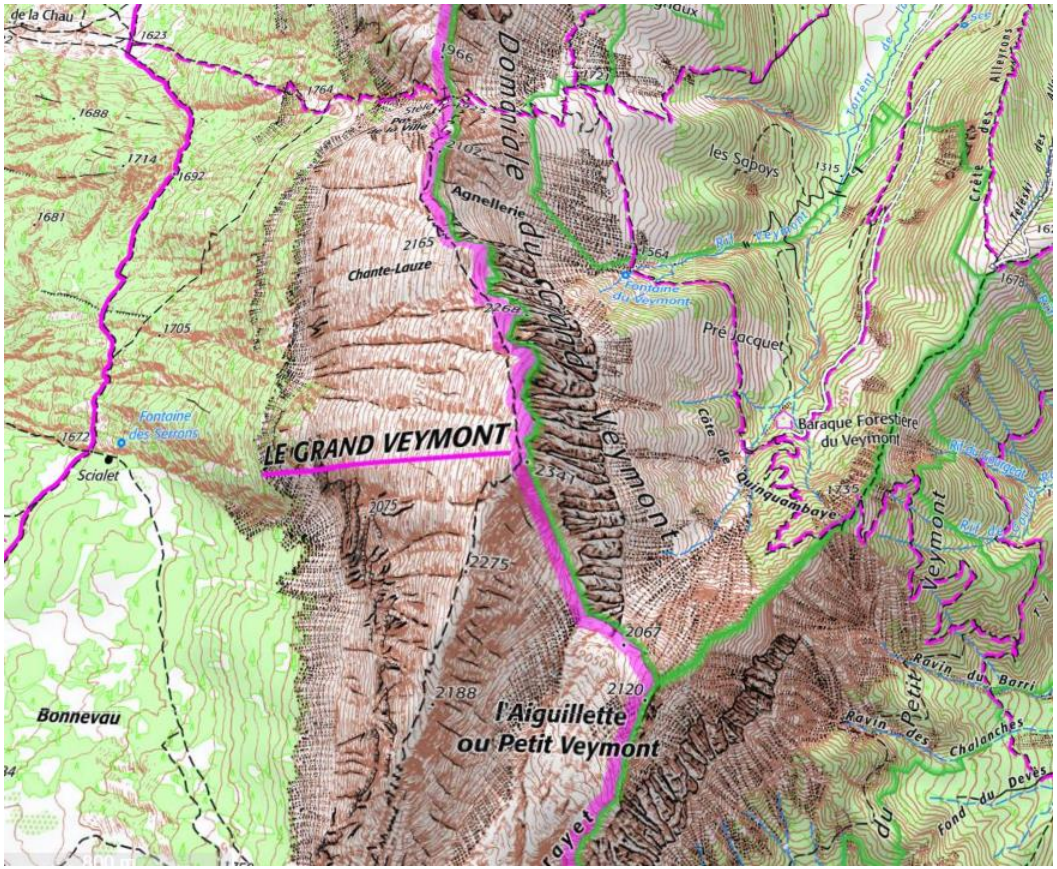
(2) I am **between Pas de la Ville** and **Pierre Blanche**

(3) I am **not in the forest**

(4) I am **at 800m from Pas de la Ville**

- I: *subject* to be localised
- **between**, **in**, **at 800m from**: prepositions describing location relationships
- **Grand Veymond**, **Pas de la Ville**, **Pierre Blanche**: named landmarks
- **Forêt**: non named landmarks

Indirect georeferencing (Hill et Zheng, 1999)



Direct georeferencing

Area described by geographic coordinates, that corresponds to a "probable location zone" (Viry et al., 2019)

3. SEMANTIC INTEGRATION

Five heterogenous datasets

Controlled vocabulary : ***Ontology of landmarks***

paper: Olteanu-Raimond, A.-M., et al. : A lightweight ontology for landmarks to assist rescue in mountainous areas, Adv. Cartogr. GIScience Int. Cartogr. Assoc., 4, 15, https://doi.org/10.5194/ica-adv-4-15-2023, 2023

Automatic processing

Manual processing

Semantic Mapping (1)

Feature type alignment of landmarks

Instantiate data (2)

Instantiated data source

Instantiated reference data source: BDTOPO

Data matching (3)

Matching links between landmarks

Quality assessment (4)

</> XML

Metadata records

Landmarks graph DB

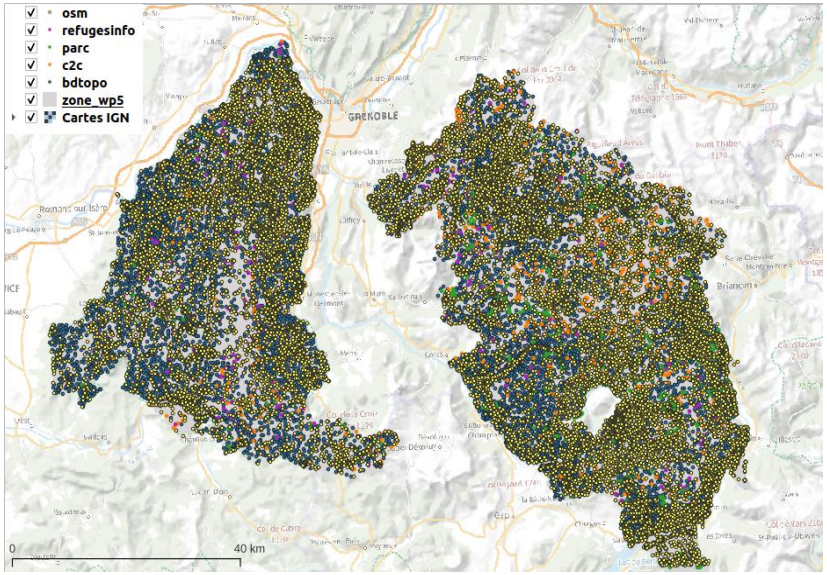
(Van Damme et al., 2019)

Paper: A method to produce metadata describing and assessing the quality of spatial landmark datasets in mountain area (Van Damme, M.-D. and Olteanu-Raimond, A.-M, 2022)
DOI: https://doi.org/10.5194/agile-giss-3-17-2022

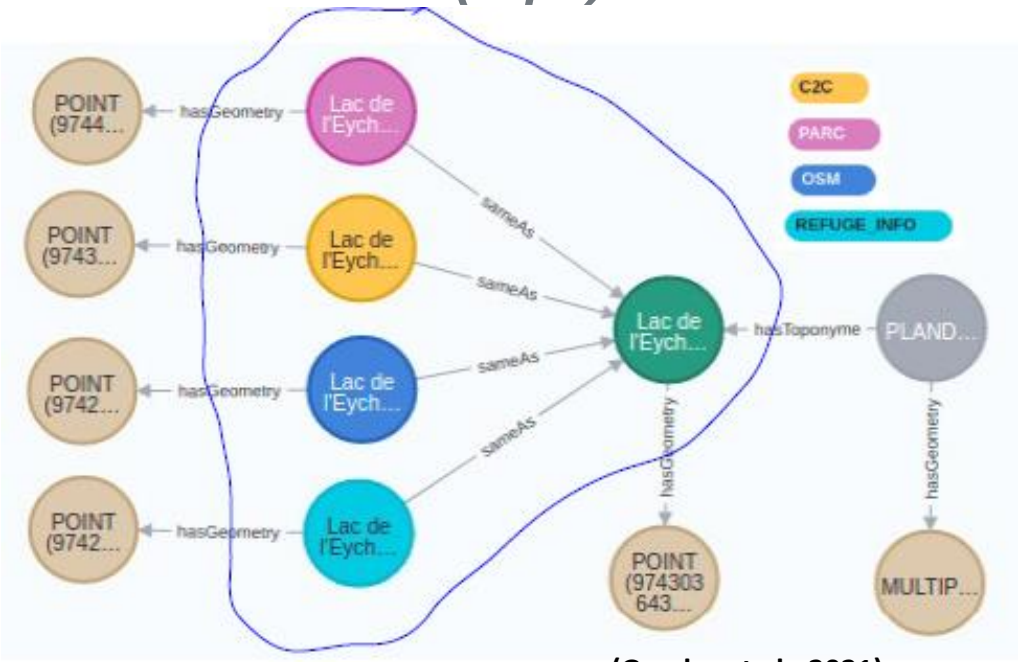
AGILE reproducible

3. SEMANTIC INTEGRATION

Landmark graph DB by using authoritative and VGI → 64 070 landmarks on *Ecrins and Parc du Vercors Massifs (Alps)*



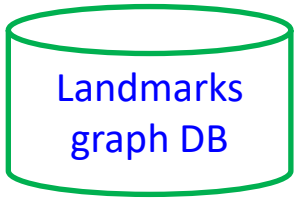
(Van Damme and Olteanu-Raimond, 2022)



(Gender et al., 2021)

Number of landmarks: ~64k

Sources	POI	Licences
Refuges.info	659	CC-By-Sa 2.0
Camptocamp.org	2 289	CC-by-nc-nd
rando.ecrins-parcnational.fr rando.parc-du-vercors.fr	1 906	Etalab 2.0
OpenStreetMap.org	41 454	Open Data Commons Open Database License (ODbL)
BD TOPO®	17 769	Etalab 2.0



(***Van Damme et al. , 2023***)

CONCLUSION AND CURRENT WORK

- **Combine VGI & authoritative GI for LU mapping by using IA (*Cubaud et al., 2024*)**

- **Combine VGI & authoritative GI to define a cycling network enriched with bikeability* information (*Bres et al, 2024*)**

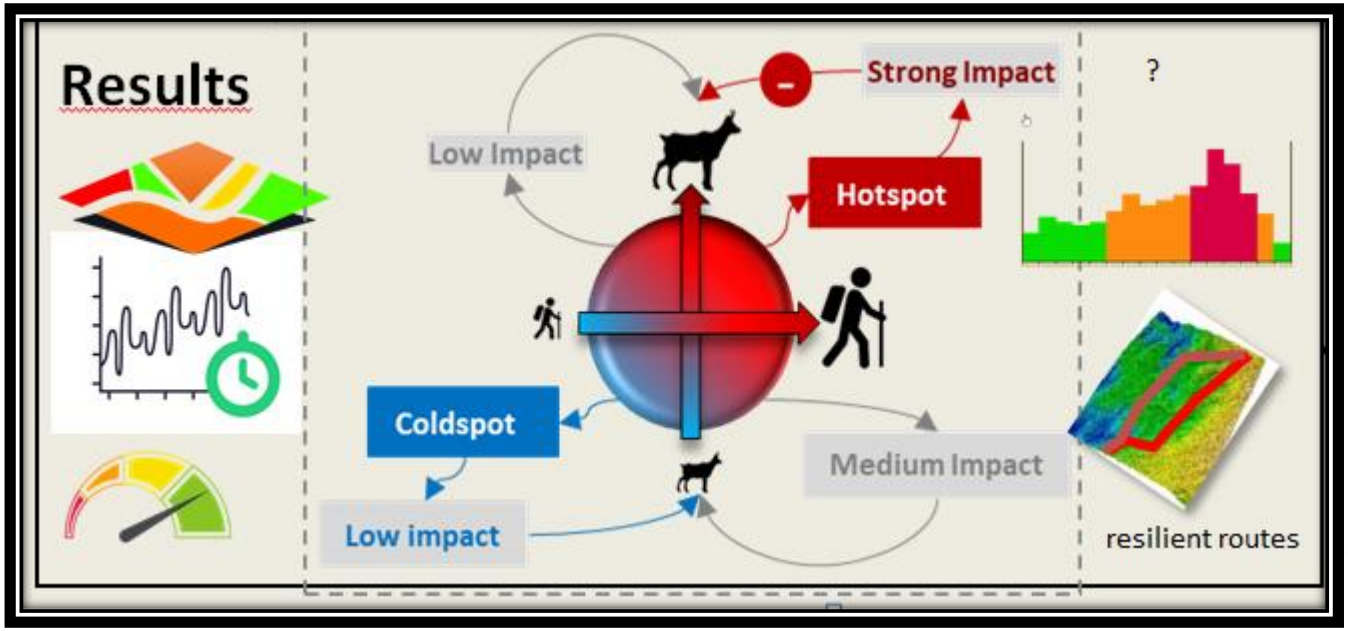
- **Semantic integration**
  - Identify new landmarks from VGI (e.g. signs) and surveys in non-urban areas (*Nuhn et al., 2024*)
  - Define a network of routes (human and animals) and derive relationships between the networks, landmarks, and environmental data to measure **pressure of outdoor recreation**

Flick'r photo

Bikeability: define how friendly is a road for cycling practise

CONCLUSION AND CURRENT WORK

IntForOut ANR Project (2024-2027)



Multisource spatial data INTegration FOR the Monitoring of Ecosystems under the pressure of OUTdoor recreation

Citizens and communities for outdoor activities


Thank you!
Any questions?

REFERENCES

- Hill, L., Zheng, Q., 1999. Indirect Geospatial Referencing through Place Names in the Digital Library: Alexandria Digital Library Experience with Developing and Implementing Gazetteers, in: Proceedings of the 62nd Annual Meeting of the American Society for Information Science. Washington, DC, pp. 57–69.
- Mustière, S., Abadie, N., Aussenac-Gilles, N., Bessagnet, M.-N., Kamiel, M., Kergosien, E., Reynaud, C., Safar, B., Sallaberry, C., 2011. Analyses linguistiques et techniques d'alignement pour créer et enrichir une ontologie topographique. Revue internationale de géomatique 21, 155–179. https://doi.org/10.3166/rig.21.155-179
- Peroni, S., 2016. A Simplified Agile Methodology for Ontology Development. Presented at the OWL: Experiences and Directions – Reasoner Evaluation,Bologna, Italy.
- Sinha, G., Arundel, S.T., Hahmann, T., Usery, E.L., Stewart, K., Mark, D.M., 2018. The Landform Reference Ontology (LFRO): A Foundation for Exploring Linguistic and Geospatial Conceptualization of Landforms (Short Paper). Schloss Dagstuhl - Leibniz-Zentrum fuer Informatik GmbH, Wadern/Saarbruecken, Germany. https://doi.org/10.4230/lipics.giscience.2018.59
- Van Damme, M.-D., Olteanu-Raimond, A.-M., 2022. A method to produce metadata describing and assessing the quality of spatial landmark datasets in mountain area. AGILE GIScience Ser. 3, 1–11. https://doi.org/10.5194/agile-giss-3-17-2022
- Viry, M., 2022. GASPAR —Geoviz Application for Searching And Rescuing People. *Mappemonde* [Online], 134 | 2022, Online since 27 October 2022, connection on 05 January 2023. DOI: https://doi.org/10.4000/mappemonde.8063
- Viry M., Bunel M., Villanova M., Olteanu-Raimond A-M., Duchêne C., Davoine P-A. 2023 Prise en compte de l'incertitude dans un processus de localisation de victime en montagne. Une approche méthodologique, logicielle et cognitive. *L'imperfection des données géographiques Tome 2 Applications*. A paraître