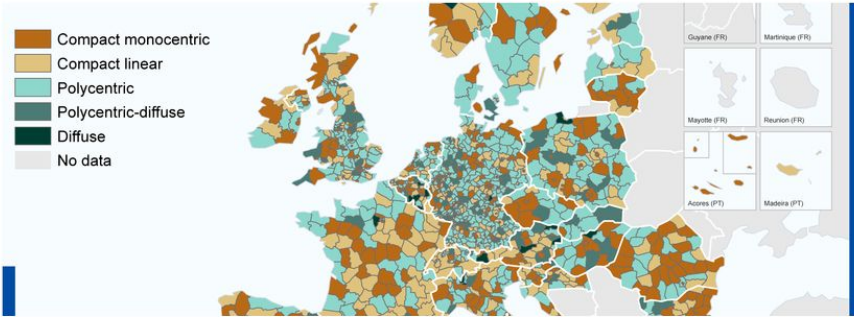




SUBDENSE : producing comparable maps of buildings evolution on city functional areas over the past decade

Bénédicte Bucher, Mouhamadou Ndim, Ana-Maria Raimond, Juste Raimbault, Julien Perret (Univ Gustave Eiffel, IGN-ENSG), Mathias Jehling (IOER), Sebastian Dembski (Univ Liverpool)





ESPON Policy Brief: Sustainable Urbanisation

POSTED ON DECEMBER 10, 2021 | BY ESPON | IN POLICY BRIEFS

Since 2000, approximately 250 football fields of land (180 ha) have been converted to urban use in Europe every day. This development far outstrips population growth; urbanisation occurs even in shrinking regions. In Europe, the conversion of land to urban use is the outcome of conscious decisions.

The purpose of this policy brief is to provide cities, regions and countries with a methodological approach to make the current urbanisation practices more efficient and sustainable, and thereby to support the implementation of the European Green Deal, the

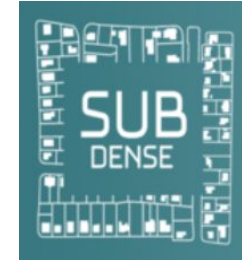
<https://www.espon.eu/Sustainable-Urbanisation>

For policymakers at the local and county levels, the study gave the following suggestions:

- adapt spatial plans;
- conduct continuous and efficient land management;
- rehabilitate neglected and illegally developed areas to create resilience;
- improve the hazard resistance of public and private buildings and spaces;
- ensure safety as a priority;
- focus on implementing plans for post-earthquake reconstruction and integrated urban revitalisation;
- implement interventions that ensure the sustainability of urbanisation and land use;
- apply good practices regarding green infrastructure and circular economy principles in the management of buildings and spaces;
- strive for densification and regeneration;
- preserve cultural heritage; and
- ensure the public participation of citizens and private stakeholders during the post-earthquake reconstruction process and integrated urban revitalisation.

SUBDENSE project, ORA7, 2023-2025

TU Dortmund, IOER Dresden, Univ Liverpool, IGN

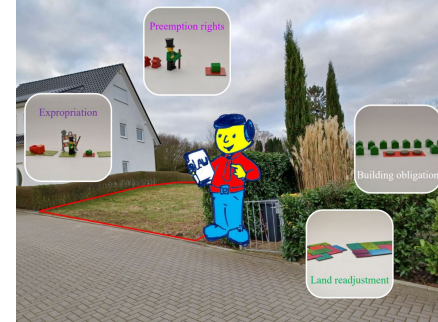


Observe densification on the ground on 6 cities
(Dortmund, Frankfurt, Strasbourg, Toulouse, Liverpool, Bristol)

Understand stakeholders interests

Support public action

with **Open Science** (incl. reproducibility to other cities)



© Hartman

Need for a model : “models act as pieces of machineries that relate theories to observation” Clark

URBAN DENSIFICATION

ambiguous concepts,
conflicting perspectives,
observed through complex sets
of indicators.

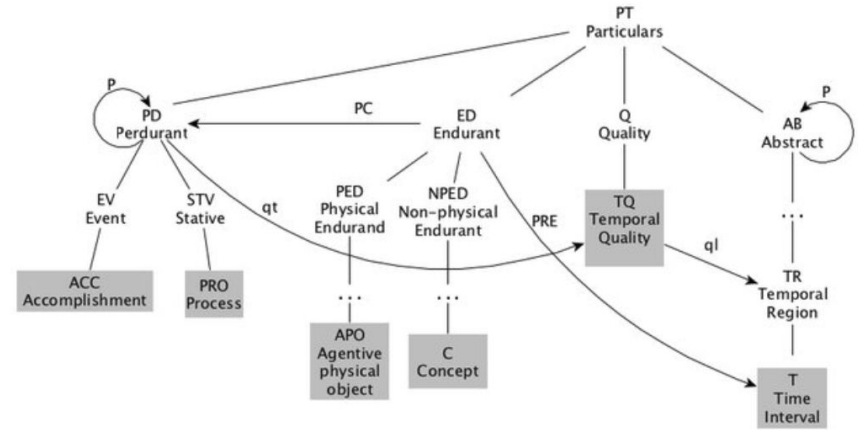


©AvenirBois

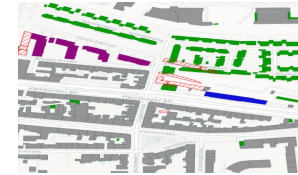
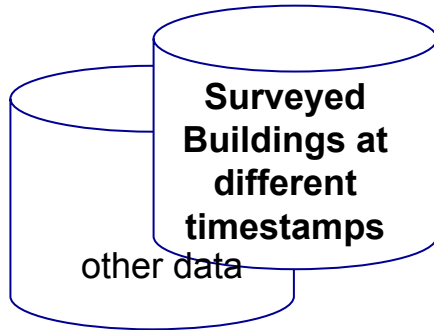


©AFP

Change and time is a complex reality to grasp and relate to observations



DOLCE, (Gangemi et al. 2002)
(Borgo et al. 2023)



**Shared maps of
buildings evolutions
on cities region areas
over past decades**

**OBSERVATIONS
AND DATA**

**THEORIES AND
DISCUSSIONS**

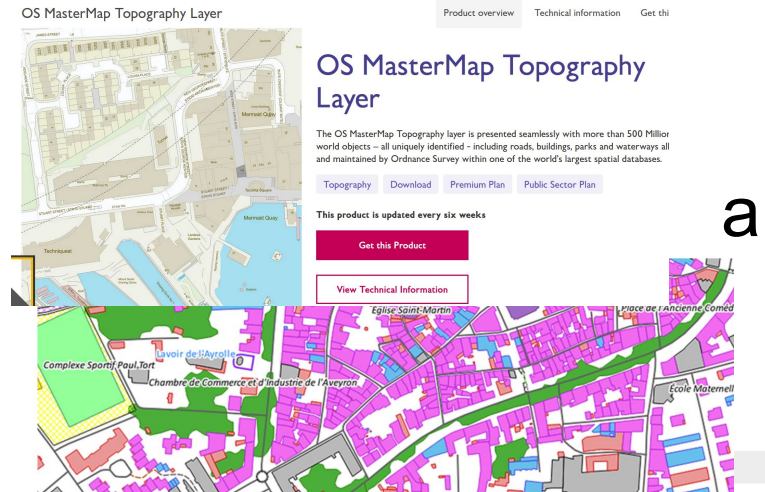
Which building data source to use? on cities in Uk, Fr, De, and past decades



OpenStreetMap

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

No unique source, select best source to derive building evolution on decades, reproducible way, and then harmonise building evolution



BD TOPO®



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

Producteur



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)



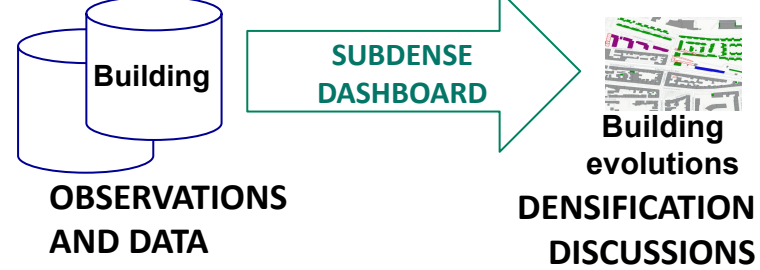
Das Basis-DLM beschreibt die topographischen Objekte der Landschaft im Vektorformat (Ebenenstruktur).

Preis: ab 50,00 € zzgl. USt.

Produktdetails

- heterogeneous API
- not always 'open'

- + completeness when going back decades ago
- + relation between data evolutions and real world evolutions is documented at the level of product



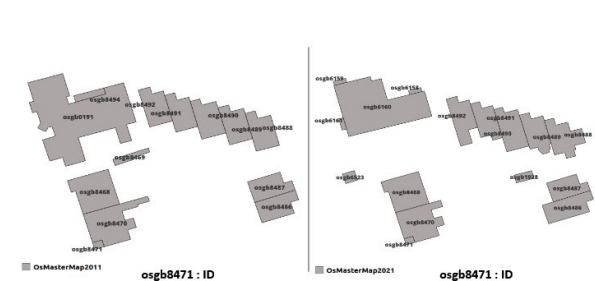
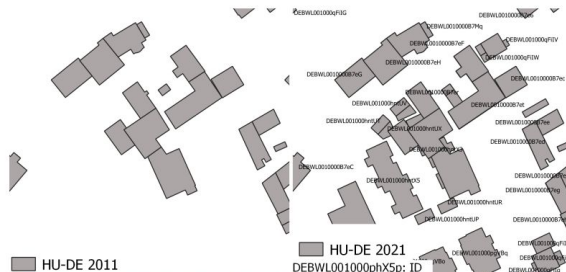
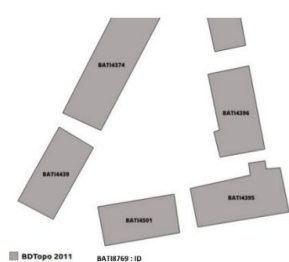
Engage
DIFFERENT EXPERTS
in the production of
BUILDING EVOLUTION
MAPS

Expert of
local/national data :
analyse
documentation

Expert on (local)
densification :
critical reading,
scope new map
(what changes)

GIS Expert :
produce Building Evolution Data
using advanced GIS tools

- Building data not natively adapted to diachronic analysis
- Many objects to process on city region areas, need to model changes
- Need to identify product evolutions and heterogeneities that bias the analysis



FR : BDTopo

DE : ATKIS

UK : OS MasterMap

• [BD TOPO® - Descriptif de contenu](#)

Ce document décrit en termes de contenu, de caractéristiques générales, de précision géométrique et de qualité sémantique, le produit BD TOPO®.

• [BD TOPO® édition 2008 - Descriptif de contenu](#)

Ce document décrit en termes de contenu, de caractéristiques générales, de précision géométrique et de qualité sémantique, le produit BD TOPO® édition 2008.

• [BD TOPO® Suivi des évolutions depuis la v3.0](#)

Ce document présente les évolutions du produit et de la documentation à partir de la version 3.0 (mars 2011) à la v1.0 (septembre 1994).

• [BD TOPO® Suivi des évolutions de la v1.0 à la v3.0](#)

Ce document présente les évolutions du produit et de la documentation de la version 3.0 (mars 2019) à la v1.0 (septembre 1994).

• [BD TOPO® - Métadonnées au format .xml](#)

Ce document présente les métadonnées produit de format .xml.

• [BD TOPO® - Métadonnées simplifiées au format SQL et Shapefile.](#)

Ce document présente les métadonnées simplifiées SQL et Shapefile.

• [BD TOPO® - Métadonnées complémentaires - MD_COMMUNE/MD_DEPARTEMENT](#)

Les métadonnées complémentaires fournissent des données supplémentaires à la commune (concernant le bâti) et au département (concernant le réseau routier, les adresses, etc.).

```
<gmd:abstract>
```

```
<gco:CharacterString> [...] Depuis la version 3.0, tous les objets possèdent un identifiant unique et stable dans le temps.</gco:CharacterString>
```

```
</gmd:abstract>
```

Sélection : *Initialement*, les seuils de sélection des bâtiments étaient les suivants :

- Tous les bâtiments de plus de 50 m² sont inclus.
- Les bâtiments faisant entre 20 et 50 m² sont sélectionnés en fonction de leur environnement et de leur aspect.
- Les bâtiments de moins de 20 m² sont représentés par un objet de classe *Construction ponctuelle* s'ils sont très hauts, ou s'ils sont spécifiquement désignés sur la carte au 1 : 25 000 en cours (ex: antenne, transformateur...).

Après unification de la BD TOPO® avec la BD PARCELLAIRE®

Tous les bâtiments présents dans la dernière édition de la BD PARCELLAIRE® vecteur sont inclus, sauf éventuellement des bâtiments manifestement détruits depuis la date de validité de la BD PARCELLAIRE®. Les petits bâtiments de la BD PARCELLAIRE® qui représentent des constructions ponctuelles (exemple des transformateurs) ou des constructions linéaires (exemple des murs de remparts) sont saisis avec leur modélisation initiale respective en BD TOPO®.

Il n'existe plus de seuil minimal pour la superficie des bâtiments.

Cependant, si une nouvelle saisie photogrammétrique a lieu après les phases d'unification du bâti, les nouveaux bâtiments ne posséderont pas la granularité de la BD PARCELLAIRE®. Pour la restitution, les seuils de sélection initiaux sont alors appliqués (bâtiments de plus de 50 m² et bâtiments de 20 à 50 m² en fonction de leur environnement et de leur aspect).

Modélisation géométrique : Bâtiments issus de la BD PARCELLAIRE®

Ils sont différenciés par le champ 'Origine du bâtiment' = "Cadastré"

Le contour extérieur du bâtiment repris de la BD PARCELLAIRE® est éventuellement translaté sur le bâtiment BD TOPO® lors du processus d'unification. L'orientation initiale de la BD PARCELLAIRE® est généralement conservée, sauf en cas de rotation trop marquée par rapport aux données BD TOPO® initiales.

La forme du contour est prise au sol. Le polygone est aplati c'est-à-dire que l'on affecte à chaque point du bâtiment unifié la même altitude toit (comme une « boîte à chaussures »).

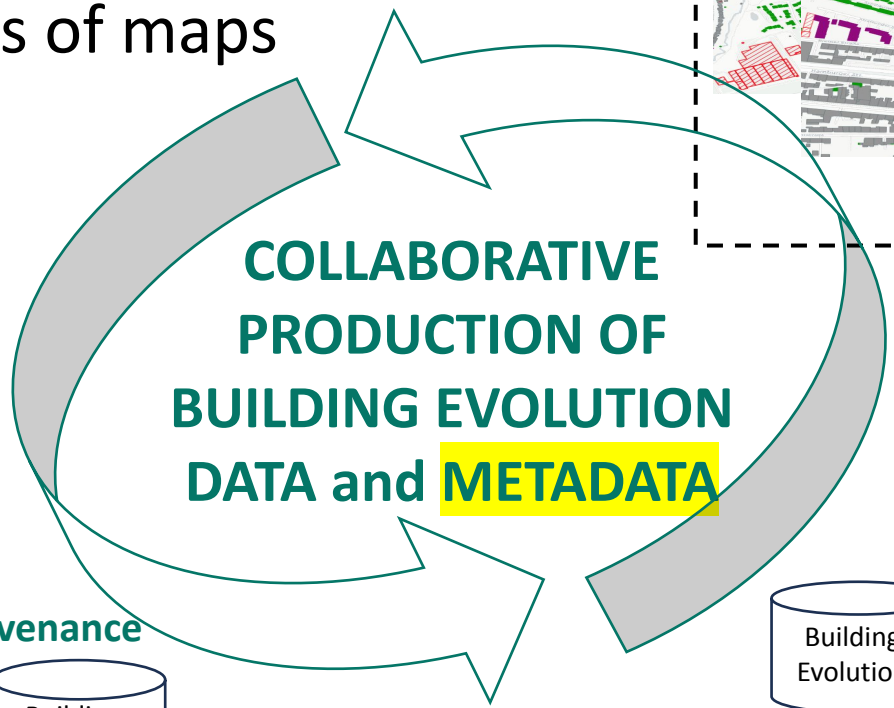
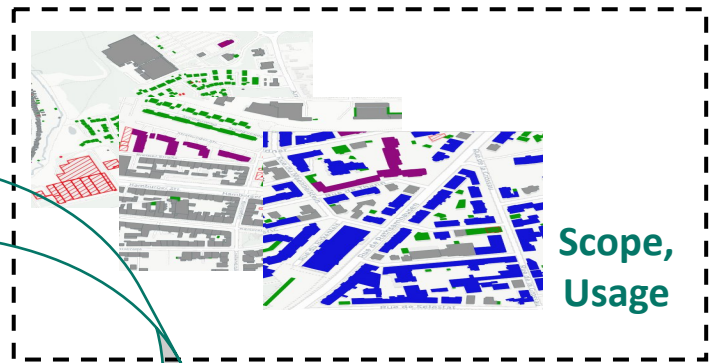
Les bâtiments BD PARCELLAIRE® ont une granularité plus fine que les bâtiments issus de BD TOPO® (découpage aux parcelles, aux extensions de bâtiment, etc.).

NOM_DEP	INSEE_DEP	ROUTE_CL	ROU_KM	ROU_KM_3M	ROU_KM_EV	BATI	BAT_NB	BAT_NB_3M	BAT_NB_EV	BAT_SUR	BAT_SUR_3M	BAT_SUR_EV	PVA_MAJ	BDP_VECT
BAS-RHIN	67	13/06/2023	296530	296395	0,05	03/09/2021	820430	820214	0,03	8968	8966	0,02	03/09/2021	100

NOM_COM	INSEE_COM	UNI_BATI	BDP_BATI	MAJIC	ERP
Strasbourg	67482	Oui	06/11/2020	16/11/2021	01/04/2019

A quality management framework dedicated to the maps and sets of maps

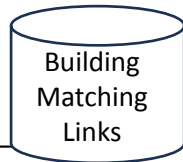
MapsPatchwork **Scope, Usage, Inconsistencies**



Scope, Provenance



Provenance



Scope, Provenance, Quality criteria



← → ↻ https://github.com/subdense/dashboard

subdense / dashboard 🔍 Type ↵ to search

<> Code Issues 2 Pull requests Actions Projects Wiki Security Insights Settings

dashboard Public Edit Pins Watch 2

master 1 Branch 0 Tags 🔍 Go to file Add file Code

benedictebucher Delete Processes/ComputeBuildingEvolution/BuildingFeatureE... 0ba3f0a · 3 days ago 405 Commits

Concepts	Update Concepts.md	last week
Data	Update Datasets.md	4 days ago
Maps	updating maps	4 days ago
Processes	Delete Processes/ComputeBuildingEvolution/BuildingFeatur...	3 days ago
Website	update website	4 months ago
img	updating schema model	4 days ago
.gitignore	osm:test	last year
.nojekyll	adding .nojekyll file	8 months ago
README.md	Update README.md	5 months ago

Preview Code Blame 55 Lines (44 loc) · 5.94 KB Raw Download Edit

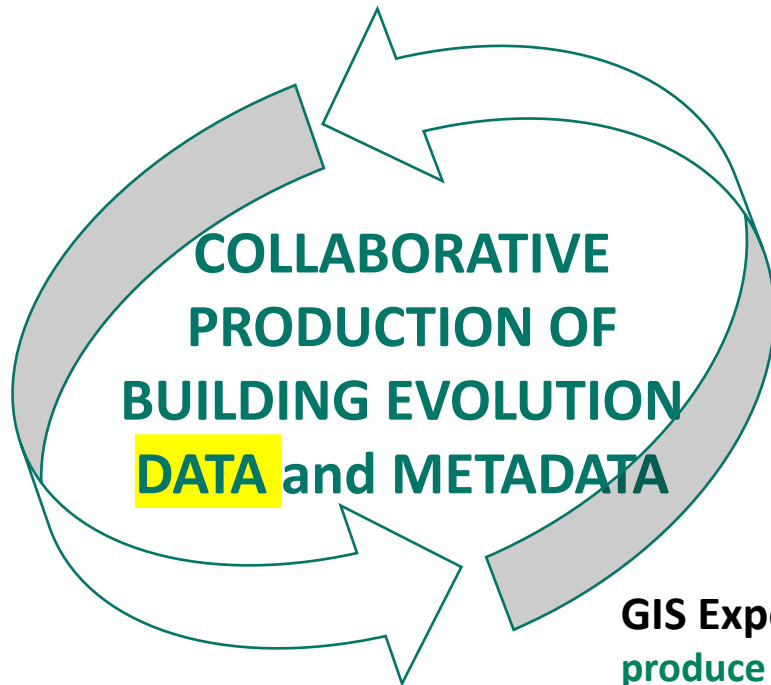
Concepts

List of concepts which are useful to study suburban densification and for which 1) it is relevant to go beyond commonsense knowledge and possibly to highlight elements to have in mind when comparing situations across times and cities 2) it is useful to specify how the concept can be observed through data.

A concept is registered on this file and can also be described here, or a dedicated file can be created for describing and discussing the concept., in which case the file shall be put in the same git folder as this registry Concepts.md, and it should be called by the concept label, e.g. Suburb.md.

- [Suburb](#)
- [Urban Density](#)
- [Urban Densification](#)
- [Building](#)
- [BuidingEvolution](#)
- [Functional Urban Area](#)
- [Concept labelling policy](#)
- [Concept description template](#)

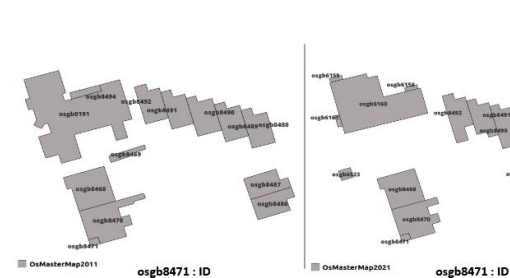
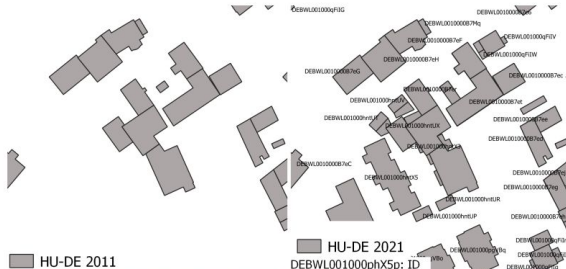
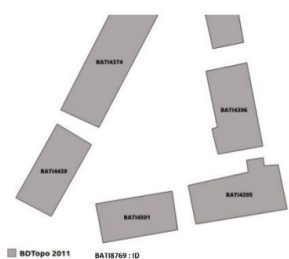
**Expert of
local/national data :**
analyse
documentation



**Expert on (local)
densification :**
annotate Building
Evolution Map, scope
new map

GIS Expert :
produce Building Evolution
Data using advanced GIS tools

- Many objects to process on city region areas
- Need to identify product evolutions and heterogeneities that bias the analysis



FR : BDTopo

DE : ATKIS

UK : OS MasterMap

Functional Urban Areas

Toulouse

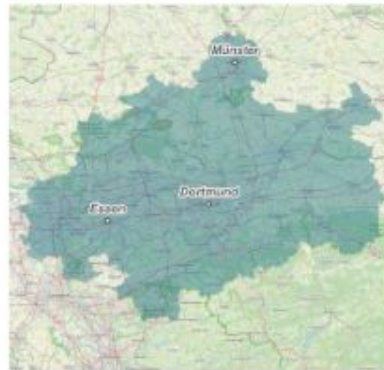
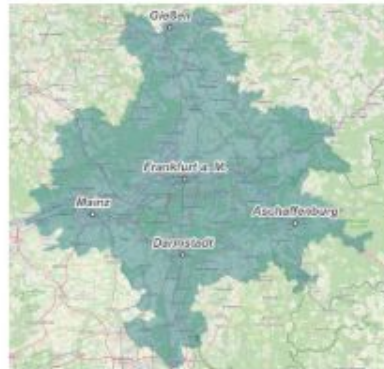
Strasbourg

Liverpool

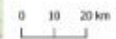
Frankfurt

Dortmund

Bristol

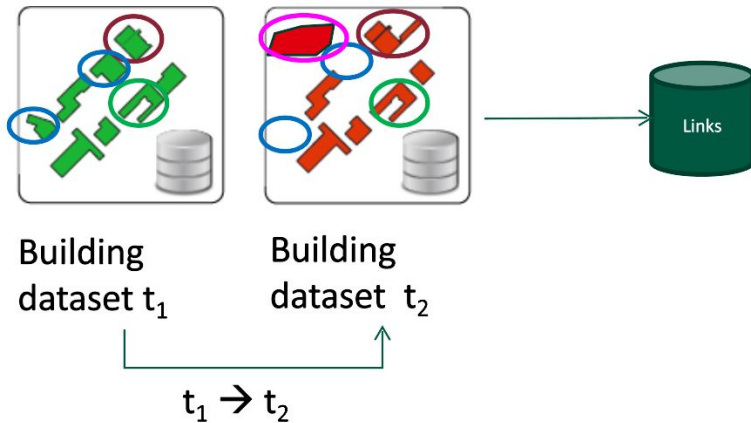


■ Case study region



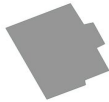

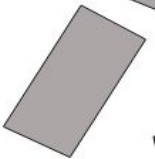
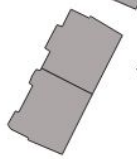
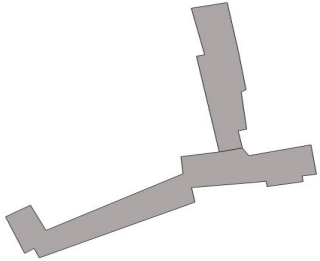
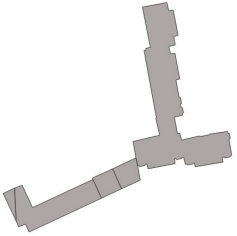


A matching algorithm adapted to polygon geometries, implemented in GEOXYGENE (LASTIG platform)

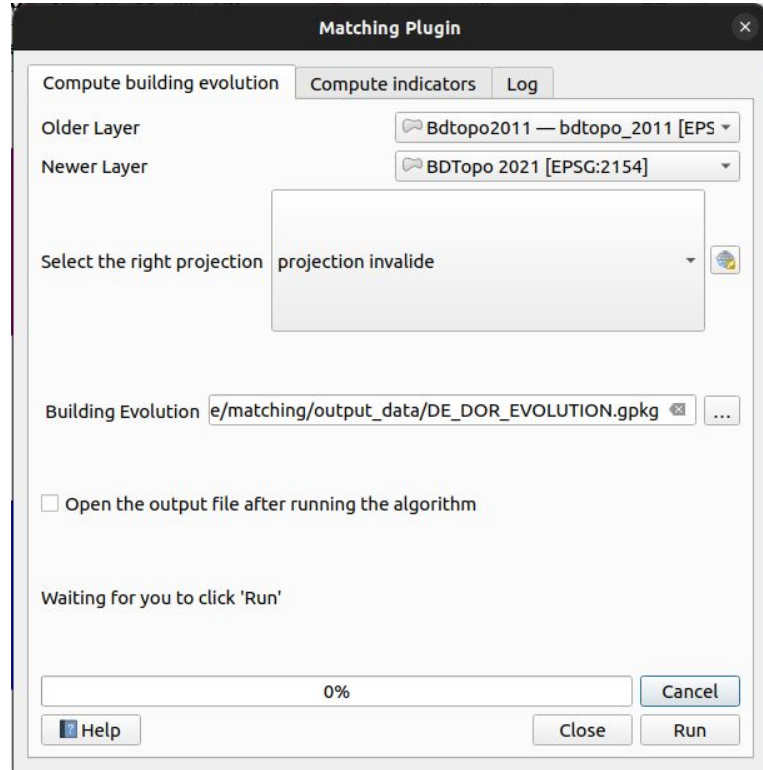
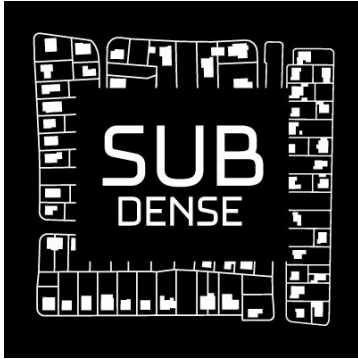
- Implemented in the geoxygene java library, called from a python script
- Link determinacy computed with surface intersection (several parameters)



```
# Parameters of the matching algorithm
param = ParametresAppSurfaces()
param.surface_min_intersection = 1
param.pourcentage_min_intersection = 0.2
param.pourcentage_intersection_sur = 0.8
param.minimiseDistanceSurfacique = True
param.distSurfMaxFinal = 0.6
param.completudeExactitudeMinFinal = 0.3
param.regroupementOptimal = True
param.filtrageFinal = True
param.ajoutPetitesSurfaces = True
param.seuilPourcentageTaillePetitesSurfaces = 0.1
param.persistant = False
param.resolutionMin = 1
param.resolutionMax = 11
```

2011	2021	Links and typology of changes	Explanation
 		1-1 Stability	No change, but geometric modification
		0-1 Apparition	New building appeared
		1-m Split	If area < 50m ² then causedByProductEvolution
		n-m Recomposition	Change specification of the data but not real evolution

The matching algorithm is implemented in a QGIS plugin for replicability



BuildingEvolution

+ typeOfEvolution : EvolutionCode
+ qualityControl : Yes/No/Unknown
+ evolutionProduct : Yes/No/Unknown
+ entitiesEvolution : Yes/No/Unknown



1 - Computing Building Evolution

2 - Interpreting matching links :

1 : 1 Stable
0 : 1 Appeared
1 : 0 Disappeared
1 : m Split
n : 1 Merged
n : m Recomposed

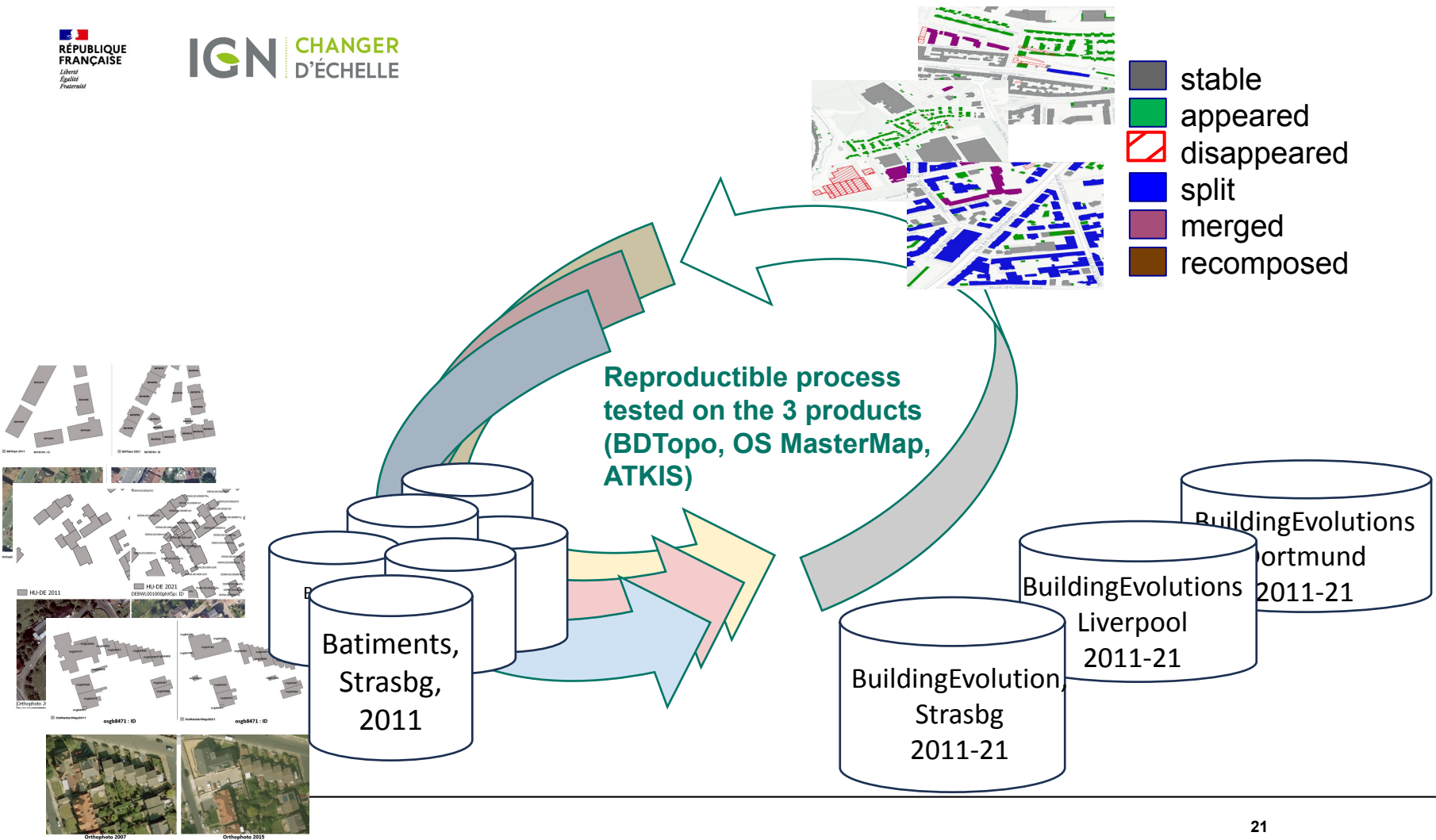
3 - Apply refinement rules:

If the area is less than 50m² and it is in an urban context,
THEN set causedByProductEvolution to Yes

4 - Stylesheet application



- The map, obtained through matching for building change detection, allows identifying quickly areas of significant change between 2011 and 2021.
- Hypothesis can be drawn from exploring the map, such as change in land use or zoning, which will be later investigated through qualitative fieldwork.



Ensure a full reproducibility, tractability and collaboration of the process

Evolutions of buildings features in OsMasterMap between 2011 and 2021



Source : Building data from OS MasterMap
 Crown copyright and database rights 2023 Ordnance Survey
 (100025252)

SUBDENSE (2023-2025). Some perspectives :

- Get back to stakeholders : use maps, clarify concepts, revise maps' scope (possibly introducing evolutions of other entities)
- Evaluate quality criteria of building evolution data
- Integrate simulation of possible building evolutions



Thank you for your attention!