Conceptualising a co-operative building evolution dashboard on city regions over the past decades for densification studies

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Abstract. This contribution presents the principles of a co-operative dashboard dedicated to comparative densification studies on city areas in France, Germany and UK, over the past decade. It uses national building data together with their detailed documentation and extends upon Geospatial User Feedback to engage geodata experts and local densification experts in the production and quality management and documentation of the produced data.

Keywords. Building, change detection, quality, densification, collaboration

1 Introduction

The sustainability of urban systems involves multiple contradictory dimensions on which trade-offs or synergies must be found. Urban densification has a positive potential on different aspects, including the limitation of urban sprawl and land uptake, an increased accessibility to amenities, and a higher equity in housing affordability (Jehling et al., 2020). Suburban areas with low density are ideal candidates for such densification, which are furthermore less prone to negative impacts of densification such as the Urban Heat Island effect or a decrease in urban green spaces. However, implementing densification policies is not straightforward, facing local resistance of landowners for example (Dembski et al., 2021). A good understanding of suburban densification dynamics, the role of multiple stakeholders, the impact of various policies, and the exploration of possible scenarios to foster suburban densification, are objectives of the SUBDENSE European project[1], within which context this contribution is proposed.

[1]https://bbv.raumplanung.tu-dortmund.de/research/projects/subdense/

There are several resolutions at which urban dynamics can be quantified, from the street level to the system of cities scale, but also multiple aspects as witnesses the specific case of urban morphology (Zhang et al., 2023). Using building evolutions to approach densification concepts, to contribute to observing it on the field, is a good compromise that (i) ensures a higher enough resolution and precision to capture different perspectives on densification; but (ii) is also generic enough to be available and comparable across countries and data products, on the contrary to census micro data for example.

However, the use of building data products require an expert knowledge for a proper application to change detection, including specification details and changes in these specifications. Furthermore, experts from different countries must be able to share this knowledge and their interpretation. They also should be able to share and reproduce quantitative analysis. Finally, concepts with multiple definitions, such as suburbia or densification itself, should be discussed between experts to reach a consensus on what is studied. We extend upon Spatial Data Infrastructures and data integration litterature to propose a collaborative dashboard ensuring the collaborative specification, production and revision of comparable maps of building evolutions on city regions based on topographic building sources. It is applied, in a comparative manner, to data and contexts from the three countries involved in the project, namely France, Germany, and the UK.

2 Collaborative dashboard

2.1 Dashboard principles

Our proposed contribution is a platform to engage different relevant experts in the specification, production and documentation of comparable maps of buildings evolution : experts that can scan datasources documentations in search for evolutions in the product specifications during the past decade, experts that can prepare datasets, run change detection algorithms, apply styles, experts that can have a critical reading of maps with local knowledge.

The scope and functionalities of the dashboard are defined through an iterative a co-operative process, by considering "User Stories" that detail the expected contributions and motivation of different dashboard contributors and users. For example, qualitative researchers in urban policy act more as map readers and need to communicate their interpretations with local stakeholders, while a quantitative urban analyst will seek to run algorithms for change detection on multiple data sources, to finally produce maps used by the former. We show in Fig. 1 the current state of dashboard functionalities and usage, which can always evolve in the future.

The core components of the dashboard are: (i) a registry for concepts, maps, datasources, datasets, processes ; (ii) shared models for describing these items ; (iii) shared libraries and software for computing building evolution and producing maps ; (iv) different clients to interact with the previous components (including a web application displaying maps, which corresponds to the more classical view of a "dashboard").

2.2 Implementation

Our dashboard implementation aims for genericity, reproducibility, and minimisation of deployment constraints. Therefore, the `git` software was chosen, ensuring also full transparency and tractability of the process. The dashboard itself is a git repository available at https://github.com/subdense/dashboard.

The repository includes different registry files, as plain text markdown files, which list and provide unique identifiers for objects. These include registries for concepts, maps, datasources, datasets, and processes. Comments and feedback on objects are also stored in these files.

At this stage, three types of clients are proposed to interact with the dashboard: (i) the git client itself, by directly committing changes to the repository; (ii) a website, deployed automatically through github pages at https://subdense.github.io/dashboard/, for which user feedback is collected using a Javascript git library (currently under implementation); (iii) the open software QGIS for processing data, map reading and enrichment (python plugins for QGIS which run processes from the dashboard are also currently being implemented, and map style sheets are provided).

2.3 Building change detection and Geospatial User Feedback

Processes in the dashboard include step-by-step descriptions of how a user retrieved data, processed it, produce maps, etc., but furthermore automated processes to run algorithms analysing data. One key process is change detection in building data, for which we use vector data matching algorithms (Olteanu-Raimond et al., 2015). Building features between two dates are matched using the Geometric Matching of Areas algorithm (Harvey et al., 1998), are then automatically interpreted as changes following a `BuildingFeatureEvolution` model following Claramunt et al. (1997), and finally filtered to distinguish specific cases of evolutions due to changes in data sources (for example, for France IGN BDTOPO changed between 2011 and 2021 the minimum threshold to include buildings and the way to compute building boundaries).

Maps are then produced using QGIS, and experts can provide Geospatial User Feedback (GUF) (Zabala et al., 2021), either to rework the data model, to refine the automatic interpretation process, or more generally to gain knowledge on data quality or the process itself. Such an example of GUF is shown in fig. 2, with the example of a specific area in Liverpool for which a local spatial planning expert went on the field and checked planning documents, to invalidate a building evolution produced by the algorithm. This feedback will then be used to reconsider the algorithm parametrisation or its internal mechanisms.

2.4 Data and software availability

Software, metadata, data, maps, and results produced in this project are openly available on the git dashboard repository. Building data is available under an Open Licence for France (compatible with CC-By) from the data product BD TOPO, while for the UK and Germany, data can be accessed and used freely for research purposes after signing agreements with local mapping agencies. Our data on building evolution derived from these will be made available under the same terms. We plan to also compute building evolution data for UK and Germany using OpenStreetMap (for years having sufficient coverage), to ensure that produced evolution dataset are available under an Open Licence for all countries.

3 Perspectives

Future work include the definition of quality control methods to document quality criteria for the building evolution data, and the extraction of a knowledge graph based on the different metadata fragments to depict the dashboard content and automate some tasks like generation of web pages with relevant quality information aside maps: scope, provenance, usage.

We also plan to enrich the process with evolutions of other features and to engage with local stakeholders to clarify the evolutions concepts.

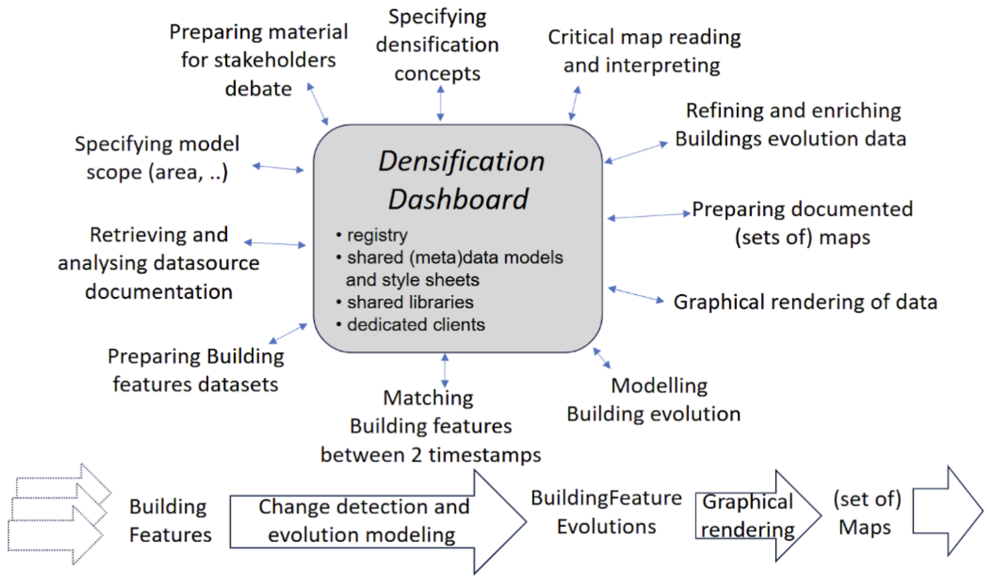

Figure 1. Components and usages of the co-operative dashboard. An example of a workflow within the dashboard, from building data to thematic maps is also detailed.

Figure 2. Example of Geospatial User Feedback on the building evolution model, with change detection on OSMasterMap 2011 and 2021 data for Liverpool.

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References

Claramunt, C., Thériault, M., and Parent, C.: A qualitative representation of evolving spatial entities in two-dimensional topological spaces, 1997.

Dembski, S., Sykes, O., Couch, C., Desjardins, X., Evers, D., Osterhage, F., Siedentop, S., and Zimmermann, K.: Reurbanisation and suburbia in Northwest Europe: A comparative perspective on spatial trends and policy approaches, Progress in Planning, 150, 100 462, 2021.

Harvey, F., Vauglin, F., and Bel Hadj Ali, A.: Geometric matching of areas, comparison measures and association links, in: Proceedings of the 8th International Symposium On Spatial Data Handling, pp. 557–568, 1998.

Jehling, M., Schorcht, M., and Hartmann, T.: Densification in suburban Germany: approaching policy and space through concepts of justice., TPR: Town Planning Review, 91, 2020.

Olteanu-Raimond, A.-M., Mustiere, S., and Ruas, A.: Knowledge formalization for vector data matching using belief theory, Journal of Spatial Information Science, pp. 21–46, 2015.

Zabala, A., Masó, J., Bastin, L., Giuliani, G., and Pons, X.: Geospatial User Feedback: How to Raise Users' Voices and Collectively Build Knowledge at the Same Time, ISPRS international journal of geo-information, 10, 141, 2021.

Zhang, P., Ghosh, D., and Park, S.: Spatial measures and methods in sustainable urban morphology: A systematic review, Landscape and Urban Planning, 237, 104 776, 2023.