PhD2: Backcasting anthropogenic infrastructures over a century of historical EO data and maps

Context

This doctoral position is offered under the Collaborative Doctoral Partnership (CDP) Programme, a joint initiative of the European Commission's Joint Research Centre (JRC) and European universities. The programme is designed to train a new generation of researchers at the science-policy interface, strengthening collaboration between academia and EU institutions to support evidence-based policymaking and address pressing societal challenges. More specifically, Université Bretagne Sud has been selected by the JRC among the key international academic partners on the topic Artificial Intelligence for Earth Observation (AI4EO).

The PhD will be jointly hosted by the Global Human Settlement Layer (GHSL) project within the Disaster Risk Management (DRM) Unit at the JRC (Ispra, Italy) and the OBELIX group within IRISA research institute at Université Bretagne Sud (Vannes, France). This collaboration combines advanced AI and remote sensing techniques to address complex issues in mapping and characterising human settlements and the built environment.

The JRC's Global Human Settlement Layer project not only plays a central role in supporting EU policies related to disaster risk management by providing exposure estimates of buildings and population but also supports the monitoring of sustainable development goals by providing baseline data for quantifying settlement expansion and characterising urbanisation at a global scale. The JRC is a research centre located in an attractive setting at Lake Maggiore, in commutable distance to Milan (1h by car, 1.5h by public transport), offering a modern and flexible work environment.

The OBELIX group is an internationally recognized team in AI4EO, with strong expertise in machine and deep-learning-driven analysis and processing of complex, multidimensional geospatial data, and privileged access to cutting-edge high-performance computing resources at the local and national level. It belongs to IRISA, one of the largest French research laboratories (more than 850 people) in the field of computer science and information technology, and it is hosted at Université Bretagne Sud (UBS), a multidisciplinary university located in Vannes, a beautiful medieval city of medium size close to the sea, and easily accessible by high-speed train from Paris (2h30). Together, JRC and UBS/IRISA provide a unique interdisciplinary setting where technical innovation is directly connected to policy application.

Scientific challenges and objectives

Understanding the long-term evolution of anthropogenic infrastructures is essential for modelling urbanization dynamics. However, monitoring the built environment over extended time spans remains highly challenging. Currently, global geospatial data available measure the distribution of built-up area and human population from 1975 onwards, such as the European Commission's Global Human Settlement Layer (GHSL).

The GHSL project produces global, consistent geospatial data on the distribution of built-up areas, building height and volume, from 1975 onwards, using Earth observation (EO) data from the Landsat and Sentinel sensors. These datasets are key input to produce high-resolution, multi-temporal gridded population data by integrating them with globally harmonised census-based population counts. GHSL data support efforts for globally harmonised monitoring of the Sustainable Development Goals (e.g., the Degree of Urbanisation method endorsed by the UN statistical commission or the UN World Urbanization Prospects). While such data are key for disaster risk management and the monitoring of sustainable urban development in recent decades, they currently do not reflect long-term urbanization trajectories extending before 1975, and they do not fully exploit the synergies between modern, detailed building footprint data and the historical information contained in long-term EO data archives.

Hence, the scarcity of consistent spatiotemporal datasets over long time periods limits our ability to reconstruct historical urban trajectories. Although open-access satellite archives such as Landsat and Sentinel now provide multi-decadal imagery, their varying spatial and spectral resolutions demand innovative methods capable of harmonizing heterogeneous data sources. Indeed, their relatively coarse spatial resolution (10 m for Sentinel-2, 30 m for Landsat) constrains the detection of individual building changes, calling for strategies that aggregate information at appropriate spatial units, such as building footprints or street blocks. Furthermore, urbanization trajectories often encompass multiple centuries, and modern EO data constrains us to a limited observational window. However, there is an increasing availability of digital historical records such as scanned and georeferenced historical maps that can help reconstructing long-term settlement patterns using modern computer vision methods. Finally, the absence of temporally consistent labelled data makes it necessary to employ unsupervised or weakly supervised learning techniques that can leverage both modern and historical EO data for long-term inference.

Within this context, this PhD project aims to develop a novel framework for long-term backcasting of urban infrastructure evolution using Earth Observation (EO) time series and multi-modal learning approaches. The main objective is to infer the historical states of anthropogenic infrastructures, such as building age, by combining Sentinel-1, Sentinel-2, and Landsat satellite imagery with historical maps and aerial photography. The central methodological innovation lies in representing urban environments as dynamic graphs (GNNs) constructed from spatial tessellations, for example derived from modern building footprint and road network data, enabling the model to capture relationships between neighbouring buildings or other morphology-derived units over time. The first objective is to train GNNs using available labelled datasets (e.g., building footprint data attributed with building age or construction dates) to model evolution over time: which could be regularly or irregularly sampled. The second objective is to integrate historical maps and imagery to extend temporal coverage over a century and demonstrate model generalization across time periods. A key component of this work

involves extracting robust and transferable features from diverse EO and other data sources. To ensure consistency and scalability, the project will leverage remote sensing foundation models (such as AlphaEarth or TESSERA) to compute multi-sensor embeddings, thus providing harmonized, information-rich representations suitable for dynamic spatiotemporal graph learning.
The methods developed in this research project are intended to be scaled up to a global or quasi-global extent for operational production of multi-temporal building footprint data, ultimately contributing to an improved modelling of the (long-term) settlement evolution in the scope of the Global Human Settlement Layer project.

Working plan
The doctoral project will start in Spring 2026 and be implemented through 2 working periods in JRC, Italy and UBS, France:
1) 18 to 24 months in JRC, Ispra, Italy (2026, 2027);
1) 12 to 18 months in UBS, Vannes, Vannes (2028, extension to 2029 if needed).

At the JRC, the candidate will be employed by a Grantholder contract (category 20, indicative gross annual salary, 40.966,56 €, see working conditions and salary simulations under contract staff, and JRC grantholder rules under research fellows) in accordance with Grantholder rules and the applicable Vademecum (GH Rules).
At UBS, the candidate will be employed by a temporary contract aligned with the recommended level of remuneration and protection that is offered by the doctoral contract as defined by national regulations (indicative gross annual salary, 27.600,00 €). The salary may be supplemented by teaching duties (64 hours annually, accounting for an extra 3.200,00 €).

The work programme will include the following steps:

1) Familiarizing with graph neural networks applied to remote sensing and spatial modelling applications, gaining conceptual understanding of remote sensing in an urban / settlement context, as well as assimilating existing data, the GHSL mission, data ecosystem and data processing pipelines, and getting acquainted with temporal processing and remote sensing foundation models dedicated to spatio-temporal data;
2) Gaining an overview and gathering potentially usable data for training and evaluating models (e.g., building footprint data with construction year information, demolition data, historical settlement data, historical maps and aerial imagery);
3) Constructing spatial tessellations for selected study areas, based on available training data, and integrating with historical EO data from the Sentinel and Landsat archives;

4) Implementing and testing graph neural networks for reconstructing historical states of settlements and building distributions based on historical EO data by considering the distribution shift between past and present data;
5) Incorporating information from scanned and georeferenced historical maps and/or pre-Landsat EO data (e.g. Hexagon/Keyhole imagery) for selected study areas;
6) Possibly, operationalising the developed method in the context of large-scale GHSL data production.

Candidate profile

The offer is restricted to candidates having the nationality of a Member State of the EU or a country associated to the EU Research Framework Programme in force or being resident in an EU Member State since at least five years.

We are seeking an enthusiastic researcher willing to conduct a doctoral project in an international context with mobilities between France and Italy. A MSc degree in remote sensing, computer science, geoinformatics, data science, or a related field is required. The ideal candidate will have a solid foundation in computer vision and machine learning, and a strong interest in processing large-scale geospatial data. The candidate should be proficient in Python programming and familiar with at least one deep learning framework (preferably PyTorch). Multidisciplinary collaboration skills are highly desirable. Excellent analytical and communication skills in English, as well as the ability to work across disciplines, are essential. Curiosity or previous experience working with historical maps or long-term urbanization assessments would be a plus.

Supervision team

The candidate will be enrolled in a PhD programme in computer science at Université Bretagne Sud and MathSTIC - Bretagne Océane doctoral school.

At UBS, the PhD will be co-supervised by Prof. Sébastien Lefèvre, Assoc. Prof. Marc Chaumont, and Assoc. Prof. Charlotte Pelletier. All are researchers in artificial intelligence for Earth observation within the OBELIX group of IRISA. At JRC, co-supervision will be ensured by Dr. Johannes Uhl (Geographic Information Scientist in the GHSL team) in collaboration with other members of the GHSL team (e.g., Dr. Thomas Kemper and Dr. Martino Pesaresi).

In the context of the CDP between JRC and UBS/IRISA, a team of 3 PhD candidates will be hired at the very same period, with the same mobility plan. It is thus expected that the candidate will interact regularly with 2 other PhD students working on related topics.

Besides, the project will be implemented within the experienced AI chair PANORAMIX held by Prof. Sébastien Lefèvre within SequoIA (a 20 M€ centre of excellence in AI research and training in Brittany), offering additional networking opportunities, including with the ESA Φ-lab at which Prof. Lefèvre is Visiting Professor.

How to apply?

Interested candidates holding, at least, a BSc degree and a MSc degree, should submit their application (CV + cover letter + academic transcripts + any relevant supplementary material, e.g. github account or master's thesis) before January 15, 2026 (but the sooner the better) through the AMETHIS platform: https://amethis.doctorat.org.

Applications will be processed along the way, and preselected candidates will be offered interviews with UBS supervisors between January 12 and 30, 2026. Shortlisted candidates will then be invited for a second interview by the JRC CDP committee between February 2 and February 10, 2026. Final notification will be given end of February 2026, for a tentative start in April 2026.

The JRC reserves the right to request additional documents to ensure the compliance with all requirements and specific rules applicable to JRC sites. The selected candidate must also be recognized as medically fit to carry out the work activities foreseen. To this end, the candidate must undergo, in advance and independently, the medical checks specified by the JRC.

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