PhD1: Global multi-task learning for mapping and characterizing human settlements from EO data

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 (2h30 in train from Paris). Together, JRC and UBS/IRISA provide a unique interdisciplinary setting where technical innovation is directly connected to policy application.

Scientific challenges and objectives

With a steadily increasing share of human population living in urban areas, and in the light of increasing threats related to climate change, social and ecological issues, detailed knowledge of where people live and where they build their homes and infrastructure is a key factor for risk management and sustainable development. The GHSL project supports this need by producing 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 global, 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).

For these efforts, accurate and temporally consistent EO-based measurement of both the horizontal and vertical components of buildings, and the characterisation of their spatial context is crucial. These measurements enable the detailed characterisation of the built environment and improved population modelling. While technological advances of recent years allow for improved EO-based detection of buildings, built-up areas and infrastructure in general, their satellite-based characterisation in terms of height, volume, age, function, material and their changes over time remains an open field of scientific research.

This research project aims to explore the capabilities of cutting-edge multi-task deep-learning based regression methods (e.g., geospatial foundation models) for joint estimation of settlement characteristics such as built-up area, building height and volume, impervious surface, but also contextual variables such as canopy height, greenness, and non-built spaces using Earth observation from Sentinel-1, Sentinel-2 and/or other sensors. This information extraction step will be incorporated into a data processing pipeline for context-based settlement characterization using existing or novel settlement taxonomies (e.g., Local Climate Zones). Finally, the developed method should be applied over time for an improved modelling of changes in settlement typology, with respect to changes in building height and volume.

This research project constitutes a unique opportunity to push the frontiers in global human settlement modelling and to contribute actively to future datasets produced in the scope of the Global Human Settlement Layer.

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, France (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) Gaining conceptual understanding of remote sensing in an urban / settlement context, familiarising with existing settlement typologies, available data, and familiarising with the GHSL mission, data ecosystem and data processing pipelines;
2) Establishing training and evaluation datasets by aggregating relevant data sources (e.g., multitemporal building footprint data with height attributes) in an ever-changing data landscape, and assessing existing building height and volume datasets, their accuracy and their temporal reference;
3) Developing and evaluating a multi-task deep learning pipeline for extracting settlement-related characteristics such as building height descriptors, canopy height, greenness, non-building area and volume, impervious area and built-up area. This process involves the integration of different input data (e.g., Sentinel-1, Sentinel-2), existing EO embeddings, and geospatial foundation models;
4) Generating and assessing settlement typologies (e.g., Local Climate Zones) from the extracted settlement-related characteristics;
5) Applying the developed pipeline over time and assessing changes, especially with respect to the vertical component of the built environment.

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. Knowledge of human settlement modelling or urban remote sensing 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 and Assoc. Prof. Minh-Tan Pham. Both are researchers in artificial intelligence for Earth observation within the OBELIX group of IRISA. Both are senior researchers 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, 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.

Bibliography (*****: from the supervisors)
Castillo-Navarro et al. Semi-Supervised Semantic Segmentation in Earth Observation: The MiniFrance suite, dataset analysis and multi-task network study. *Machine Learning*, 111(9):3125-3160. doi: 10.1007/s10994-020-05943-y, 2022 *
Pesaresi et al. Advances on the Global Human Settlement Layer by joint assessment of Earth Observation and population survey data. *International Journal of Digital Earth,* 17(1):2390454. doi: 10.1080/17538947.2024.2390454, 2024 *
Pesaresi et al. Generalized Vertical Components of built-up areas from global Digital Elevation Models by multi-scale linear regression modelling. *PLoS One*, 16(2), e0244478. doi: 10.1371/journal.pone.0244478, 2021 *

Lê et al. Box for Mask and Mask for Box: weak losses for multi-task partially supervised learning. In *British Machine Vision Conference (BMVC)*. doi: 10.48550/arXiv.2411.17536, 2024 *

Tuia et al. Artificial Intelligence to Advance Earth Observation: A review of models, recent trends, and pathways forward. *IEEE Geoscience and Remote Sensing Magazine*. doi: 10.1109/MGRS.2024.3425961, 2024

Xiao et al. Foundation models for remote sensing and earth observation: A survey. *IEEE Geoscience and Remote Sensing Magazine*. doi: 10.1109/MGRS.2025.3576766, 2025

Xue & Zhu, Regression in Earth Observation: Are vision–language models up to the challenge? *IEEE Geoscience and Remote Sensing Magazine*. doi: 10.1109/MGRS.2025.3596243,

Zhu et al. GlobalBuildingAtlas: An Open Global and Complete Dataset of Building Polygons, Heights and LoD1 3D Models. *Earth System Science Data*. doi: 10.5194/essd-2025-327, 2025.