Label-scarce VHR Disaster Mapping in the Era of Geospatial Foundation Models

PhD proposal within UBS-IRISA/CNES

Expected starting: September/October 2026
Application deadline: **March 13, 2026**
(Please carefully read the application process)

Context

Very-high-resolution (VHR) satellite imagery plays a central role in disaster response, allowing the identification of collapsed buildings, inundated roads, and fire-affected areas at the scale of individual structures. Such fine-grained detail is essential for rapid humanitarian action and recovery planning. In recent years, deep learning (DL) has emerged as the dominant approach for analyzing VHR imagery, offering state-of-the-art performance in various Earth observation (EO) tasks. However, automatic VHR disaster mapping remains constrained by label scarcity, sensor heterogeneity, and model inefficiency [1]. First, label scarcity is the primary bottleneck. In disaster mapping, obtaining accurate labels is nearly impossible due to the infrequent and unique nature of catastrophic events. The available labels primarily rely on expert knowledge derived from past events, while expert annotation is very time-consuming and costly. Second, domain shift is a crucial challenge in the deployment of DL models. VHR data coming from multiple satellites (e.g., SPOT, Pléiades, WorldView, PlanetScope) often differ in spatial resolutions, spectral bands, and acquisition zones. Models trained on one dataset often fail when applied to another, which limits its generalization ability across disasters and regions. Finally, computational sustainability has emerged as a pressing concern. State-of-the-art DL architectures are growing in size, demanding massive resources for training and inference. Recent advances in geospatial foundation models (FMs) offer a huge opportunity to address these challenges [2, 6]. Models such as SkySense, AnySat, TerraMind, pretrained on massive geospatial datasets via self-supervised or multimodal learning, exhibit strong transfer capabilities with limited labels. In parallel, more generic FMs such as Grounding-DINO or SAM enable prompt-based detection or segmentation in few-shot/zero-shot settings, allowing us to train them with minimal or no labels.

Objectives

This PhD proposal aims to develop cutting-edge research in VHR disaster mapping by bridging the gaps between the challenge of label scarcity and sensor heterogeneity, and the demand for robust, reliable and scalable mapping solutions in the era of geospatial FMs. The main goal is to design and evaluate efficient pipelines for label-scarce disaster mapping from any type of VHR data at inference. The research will advance methods that combine self-supervised representations, parameter-efficient fine-tuning, few-shot learning, open-vocabulary modelling to approach label-free disaster mapping. The main objectives are the three-folds:

- Benchmarking generic and geospatial FMs on label-scarce VHR disaster mapping tasks. This involves evaluating state-of-the-art FMs such as SkySense, AnySat, TerraMind, as well as generic FMs like Grounding-DINO or SAM, on widely used disaster datasets including xBD, xView2, and BRIGHT. The benchmarking will follow the well-established protocols in Geo-Bench [3] and Pangaea [4] and focus on assessing zero-shot/few-shot performance in key tasks such as segmentation of affected areas and change detection to identify building damage levels.

- Developing effective strategies for few-shot adaptation under label scarcity. Building on pretrained FMs, we will explore parameter-efficient tuning techniques such as LoRA, adapters [5], and prefix-tuning to achieve rapid adaptation with very few training samples (1/5/10-shot). In addition, meta-learning and prototype-based approaches will be investigated to enable fast transfer to new types of disasters. Prompt-tuning will also be explored to leverage textual descriptors (e.g., "collapsed building," "flooded road") and temporal information ("pre-event," "post-event") to enhance the adaptability of models to diverse disaster contexts.

- Advancing the transition from few-shot to label-free mapping. The project will investigate open-world and open-vocabulary approaches, enabling models to recognize and segment novel or rare disaster-related categories that were unseen during training. By aligning VHR imagery with language embeddings, the system can flexibly respond to new hazards described in text modality, pushing toward more practical disaster mapping in real-world scenarios.

The proposed topic is expected to provide cutting-edge solutions for large-scale EO applications using multi-source VHR satellite images in the context of disaster mapping. All datasets, codes and pretrained models will be published for reproducibility and reuse purposes.

Required background and skills

- MSc or Engineering degree with excellent academic track and proven research experience in one of the following fields: computer science, applied maths, signal and image processing;

- Experience with machine learning, in particular deep learning;

- Interests for environment and earth observation applications;

- Skills and interest in programming (Python and frameworks such as Pytorch/Tensorflow will be appreciated);

- Excellent communication skills (spoken/written English) is required ;

Supervision and Funding

The expected PhD candidate will join the OBELIX research group[1] from IRISA (UMR 6074) is located in the UBS (Université Bretagne Sud) campus in Vannes 56000, France. He/She will be jointly supervised by **Minh-Tan Pham**[2] (Associate Professor, MCF-HDR at UBS), **Marc Chaumont**[3] (Associate Professor, MCF-HDR at UBS) and **Derksen Dawa** (Researcher at CNES). This PhD track will co-funded by the ANR JCJC DREAMS project and the CNES (The National Centre for Space Studies).

[1] http://www-obelix.irisa.fr/

[2] https://sites.google.com/site/mtanpham89

[3] https://www.lirmm.fr/~chaumont/index.html

Application

Position to be filled as soon as possible. To apply, please prepare your **Detailed CV + Master transcripts + Reference letter from your Master supervisor/ engineering school director** (in English or French) and **do both**:

- submit their application to the CNES website **HERE**[4]
- send their application to **minh-tan.pham@irisa.fr** and **marc.chaumont@irisa.fr**

Deadline for application: **March 13, 2026**. Potential candidates will be contacted for interview.

References

[1] Akhyar, A., Zulkifley, M. A., Lee, J., Song, T., Han, J., Cho, C., ... & Hong, B. W. (2024). Deep artificial intelligence applications for natural disaster management systems: A methodological review. Ecological Indicators, 163, 112067.

[2] Lu, S., Guo, J., Zimmer-Dauphinee, J. R., Nieusma, J. M., Wang, X., Wernke, S. A., & Huo, Y. (2025). Vision foundation models in remote sensing: A survey. IEEE Geoscience and Remote Sensing Magazine.

[3] Lacoste, A., Lehmann, N., Rodriguez, P., Sherwin, E., Kerner, H., Lütjens, B., ... & Zhu, X. (2023). Geo-bench: Toward foundation models for earth monitoring. Advances in Neural Information Processing Systems, 36, 51080-51093.

[4] Marsocci, V., Jia, Y., Le Bellier, G., Kerekes, D., Zeng, L., Hafner, S., ... & Nascetti, A. (2025). PANGAEA: Assessing Geospatial Foundation Models Capabilities through a Global and Inclusive Benchmark. IEEE geoscience and remote sensing magazine.

[5] Thoreau, R., Marsocci, V., Derksen, D. (2025). Parameter-efficient adaptation of geospatial foundation models through embedding deflection. ICCV 2025.

[6] Adorni, P., Pham, M. T., May, S., & Lefèvre, S. (2025). Towards Efficient Benchmarking of Foundation Models in Remote Sensing: A Capabilities Encoding Approach. In Proceedings of the Computer Vision and Pattern Recognition Conference (pp. 3096-3106).

[7] Adorni, P., Pham, M. T., May, S., & Lefèvre, S. (2025). EoS-FM: Can an Ensemble of Specialist Models act as a Generalist Feature Extractor?. arXiv preprint arXiv:2511.21523.

[4] https://recrutement.cnes.fr/en/annonce/4122251-26-103-label-scarce-vhr-disaster-mapping-in-the-era-of-founda