Doctoral Thesis Title: Detection and analysis of forest degradation through the integration of satellite imagery and UAV-acquired data using artificial intelligence algorithms.

Supervisor/s: Luis Ángel Ruiz Fernández y Jorge Abel Recio Recio.

Abstract: Natural forest degradation is a significant threat to forest ecosystems globally, affecting biodiversity, carbon storage and the quality of ecosystem services (Bullock et al., 2020). Significant advances in the development of artificial intelligence algorithms on satellite imagery (Ball et al., 2017) present promising alternatives for medium- and large-scale monitoring. This research proposes to improve the detection and analysis of forest degradation in different forest ecosystems using advanced artificial intelligence techniques by integrating freely available satellite images (e.g. Landsat and Sentinel-2), high-resolution images acquired with unmanned aerial vehicles (UAVs), point clouds based on area photogrammetry (UAV-DAP) and auxiliary information acquired in the field.

In order to carry out this research, the following objectives are proposed:

i. Implement and optimise the extraction of relevant features of degraded natural forest areas from high-resolution UAV imagery using deep learning techniques and algorithms (Kattenborn et al., 2021).

ii. Design and train neural networks to efficiently integrate and fuse information derived from satellite and UAV imagery, spectral, geometric and neighbourhood features obtained from the UAV-DAP point cloud (Carbonell-Rivera et al., 2024), and auxiliary field information, taking advantage of complementarities between information sources for a better characterisation and quantification of forest degradation (Alvarez-Vanhard et al., 2021).

iii. Evaluate the possibility of extrapolating the models generated to areas where only satellite images are available.

iv. Validate the proposed methodology and assess its applicability in different forest types and degradation scenarios.

This approach is expected to improve the efficiency of forest degradation monitoring, contributing as a tool to monitor conservation and restoration actions in forest ecosystems.

Available Means: It is proposed to work in natural forest areas with open access satellite material such as Landsat and/or Sentinel-2 optical images, and UAV images and UAV-DAP point clouds obtained by the student (own surveys and management of access to data from public projects), as well as with dasometric information from National Forest Inventory (INF) plots.

References:

Alvarez-Vanhard, E., Corpetti, T., & Houet, T. (2021). UAV & satellite synergies for optical remote sensing applications: A literature review. Science of Remote Sensing, 3, 100019. Recuperado de https://doi.org/10.1016/j.srs.2021.100019

Ball, J. E., Anderson, D. T., & Chan, C. S. (2017). Comprehensive survey of deep learning in remote sensing: theories, tools, and challenges for the community. Journal of Applied Remote Sensing, 11(4), 042609. https://doi.org/10.1117/1.JRS.11.042609

Bullock, E. L., Woodcock, C. E., Souza Jr, C., & Olofsson, P. (2020). Satellite-based estimates reveal widespread forest degradation in the Amazon. Global Change Biology, 26(5), 2956-2969. https://doi.org/10.1111/gcb.15029

Carbonell-Rivera, J. P., Estornell Cremades, J., Ruiz Fernández, L. Á., Crespo-Peremarch, P., Almonacid-Caballer, J., & Torralba, J. (2024). Class3Dp: A supervised classifier of vegetation species from point clouds. Environmental Modelling & Software, 171. https://doi.org/10.1016/j.envsoft.2023.105859

Kattenborn, T., Leitloff, J., Schiefer, F., & Hinz, S. (2021). Review on Convolutional Neural Networks (CNN) in vegetation remote sensing. ISPRS Journal of Photogrammetry and Remote Sensing, 173, 24-49. https://doi.org/10.1016/j.isprsjprs.2020.12.010

LUIS ANGEL| RUIZ| FERNANDEZ

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