Doctoral Thesis Title: Prediction models and mapping for wildfire prevention in the Valencian region using remote sensing tools and artificial intelligence.

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Abstract:

Wildfire risk management in the Mediterranean requires understanding where fires are likely to start and spread, as well as the potential damage they may cause to vegetation and soil. Fire severity determines the ecosystem's capacity for regeneration and the risk of subsequent erosion (see [3]). However, severity is typically mapped only after a fire has occurred, limiting its utility for prevention. In this context, the landscape's predisposition to wildfire damage—defined as the territory's tendency to sustain damage based on its pre-ignition state—is a key parameter that has not yet been sufficiently characterized. Maps indicating the probability of wildfire occurrence are also essential.

The objective of this doctoral thesis is to model and map—in raster format—the predisposition of the Valencian Community to wildfire damage, utilizing remote sensing data (Sentinel-1, Sentinel-2, PNOA LiDAR) alongside machine learning and deep learning methods (Random Forest, gradient boosting, convolutional neural networks). Models will be trained using a wildfire dataset covering the 2017–2025 period and validated through spatial block cross-validation schemes to distinguish spatial autocorrelation from true predictive capability.

Spectral variables, vegetation structural metrics derived from LiDAR (see [4]), and topographic, thematic, and meteorological variables (see [5])—including live fuel moisture content (LFMC) (see [1] and [2])—will be incorporated, and the impact of their spatial and temporal resolution will be assessed. Using explainable artificial intelligence techniques (permutation importance, SHAP, accumulated local effects), the contribution of each environmental factor will be quantified, and it will be analyzed whether this contribution varies according to vegetation type and bioclimatic zone. Based on the results, thematic maps will be produced for integration into a viewer within the Generalitat Valenciana's Integrated Forest Fire Prevention System. The feasibility of updating these maps at shorter intervals using dynamic predictors will also be assessed.

Available Means:

- Imagery: Sentinel-1/2 via Google Earth Engine and PNOA LiDAR data.
- Catalog of fires (2017–2025) and LFMC values, owned by the Generalitat Valenciana and obtained from the public company VAERSA.
- Meteorological data from AEMET and AVAMET.
- Open-source software: Python, R, and QGIS.
- The research will be conducted as part of the project titled: "Prediction of areas susceptible to forest fires in the Valencian Community using Live Fuel Moisture models and meteorological data" (September 1, 2026 – August 30, 2029), funded by the Generalitat Valenciana.

References:

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