



ALIAS: A Remote Sensing Approach to Monitor *Ailanthus altissima* Invasion and its Ecohydrological Impacts

Leonardo Valerio Noto^{1,3}, **Francesco Alongi**^{1,3}, Dario De Caro¹, Emilio Badalamenti^{2,3}, Fulvio Capodici^{1,3}, Rafael Da Silveira Bueno^{2,3}, Dario Pumo^{1,3}, Tommaso La Mantia^{2,3}, and Giuseppe Ciruolo^{1,3}

¹University of Palermo, Department of Engineering, Palermo, Italy (leonardo.noto@unipa.it)

²Department of Agricultural, Food, and Forestry Sciences, University of Palermo, Palermo, Italy

³NBFC, National Biodiversity Future Center, Palermo, Italy

Biodiversity loss is a growing threat to natural ecosystems, driven by a combination of anthropogenic and natural factors (e.g., urbanization, deforestation, and, notably, climate change). Such factors can alter wildfire regimes, with the possible consequent creation of more available space for the establishment of invasive alien species. These, often highly adaptable and with rapid growth capabilities, can profoundly alter local ecosystems, disrupt hydrological processes, and reduce native biodiversity.

Among the most concerning invasive species, *Ailanthus altissima* has rapidly spread across the globe. *Ailanthus* is distinguished by its ability to adapt to a wide range of environmental conditions. It is resilient to extreme temperatures, able to grow on various soil types, and tolerant of high levels of air pollution, making it adapted also to disturbed/degraded environments. The species can regenerate even when it is cut or burned. Seed dispersal occurs through wind, but also via water, animals, and humans. *Ailanthus* demonstrated a strong dependence on water availability, employing deep root systems and efficient water uptake strategies to thrive in water-limited environments. This exacerbates competition with native species, particularly in regions under hydric stress, where *Ailanthus* can monopolize water resources and disrupt local ecohydrological balance, such in the case of Mediterranean ecosystems.

This work presents *ALIAS* (*Ailanthus Locator and Identification Algorithm Suite*), a machine learning-based classifier based on the *Support Vector Machine* (SVM) model, that uses high-resolution PlanetScope satellite imagery, designed to enable accurate remote detection of *Ailanthus* in specific areas of interest. *ALIAS* was calibrated by focusing on the presence of *Ailanthus* along transportation corridors, where species frequently establishes itself due to the wind generated by vehicles facilitating seed dispersal, and in hydrologically connected areas, such as riparian zones. Validation was conducted in an area with a confirmed invasion, i.e., the “*Vallone Piano della Corte*” Nature Reserve (Sicily, Italy). It represents a sensitive site where local biodiversity and water resources are threatened by dense clusters of *Ailanthus*. Over the past four decades, the species has progressively expanded, creating populations that competed with

native plants and disrupted the natural ecosystem balance. Particularly, four distinct clusters of *Ailanthus* were identified on the south-facing slope of the site. In contrast, the north-facing slope hosts native flora, i.e., *Quercus pubescens forest stands*. A diachronic analysis was also performed, reconstructing the invasion of *Ailanthus* from the late 1980s and performing field surveys with drone acquisitions to obtain the current distribution and the area of invasion. These historical insights were critical for validating ALIAS and demonstrating its reliability.

The results obtained highlight classifier's potential as a predictive tool for identifying regions at high risk of invasion, particularly in hydrologically sensitive areas. By enabling efficient monitoring of *Ailanthus* in both confirmed and potentially at-risk zones, ALIAS provides critical insights into the ecohydrological dynamics of invasive species. Furthermore, the classified images resulting from the use of the classifier form the basis for validating vegetation dynamics models (e.g., CATGraSS model), able to reconstruct invasion dynamics and to predict the future expansion of *Ailanthus* under different climate change and hydrological scenarios.