

55th SISV International Congress --Vegetation science and global changes: scenarios, challenges and innovation -
L'Aquila, June 16 – 17 2022



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Mapping of *Yucca gloriosa* invasion along Mediterranean coastal dunes using unmanned aerial vehicles (UAVs)

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Invasive Alien Plants (IAPs) are defined as those species whose introduction and/or spread outside their natural distribution can threaten the biological diversity of an ecosystem. They represent a severe threat to biodiversity and can severely alter the performance of crucial ecosystems such as coastal dunes. Coastal dunes are composed of specialized fauna and flora, converting them into strategic ecosystems due to their unique ecological functions.

Coastal dunes are one of the most invaded European environments, with a total flora composed of up to 7% of IAPs. One of these IAPs is *Yucca gloriosa* L. (Asparagaceae), a homoploid hybrid native plant from the United States of America introduced to Europe for ornamental purposes. For Italy, *Y. gloriosa* is a typical invasive species related to fixed dunes dominated by *Juniperus* sp. pl. (with which it competes).

Concerning biological invasions, maybe the most effective management strategy is early detection and mapping. In that sense, this work explores and tests the potential of unmanned aerial vehicles (UAVs) for detecting, mapping, and managing the *Y. gloriosa* invasion along the Mediterranean coastal dunes of a protected area located in Tuscany (Italy).

In detail, this work focuses on four aspects: i) determine the suitability of RGB images to map *Y. gloriosa*, ii) identify the best time of data acquisition, iii) detect changes affecting the occurrence and cover of *Y. gloriosa*, and iv) propose a set of management actions to preserve a coastal dune ecosystem subjected to plant invasion.

The UAV images allowed the generation of ultra-high spatial resolution maps to assess the *Y. gloriosa* invasion and distribution along the surveyed sandy dunes. The morphological characteristics of this plant – especially at the foliar level – make the invasion of *Y. gloriosa* particularly suitable for being evaluated and managed using UAV mapping, especially in coastal dunes vegetation that can be a mosaic of different plant communities hard to identify when airborne or satellite images are used. According to the obtained results, the spring season is the perfect time to collect data because light conditions are ideal, with minimal shading effects. Also, due to the peculiar morphology of *Y. gloriosa* leaves, the timing of data collection seems not crucial for mapping this IAP on coastal dune habitats.

Despite the massive eradication action funded by a LIFE project during the period 2005-2009, *Y. gloriosa* is still present in the protected area and affects the priority habitat of juniper. This might be linked to the fact that *Y. gloriosa* is a perennial rhizomatous shrub capable of switching its photosynthesis from the C3 to CAM pathway and, therefore, withstand the harsh environmental conditions of dune ecosystems.

The early detection using UAVs is the first line of defense against IAPs colonization over any ecosystem. From a conservation and management point of view, this work suggests the development of annual biomonitoring of *Y. gloriosa* to check its distribution over time and control its spread where it becomes particularly invasive. In this case, one possible strategy will be to keep the IAP in isolated nuclei of plants that are easier to remove with mechanical methods. In a broader view, the study area and the Mediterranean coast must include the ban on introducing non-native species as a strategy, adopting a short-term non-native Management Plan as urgent action.