Discriminating Seagrass From Green Macroalgae in European Intertidal areas using high resolution multispectral drone imagery

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Abstract

In September 2021, a significant jump in seismic activity on the island of La Palma (Canary Islands, Spain) signaled the start of a volcanic crisis that still continues at the time of writing. Earthquake data is continually collected and published by the Instituto Geográphico Nacional (IGN). ...

Keywords: Drone, Remote Sensing

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1. Introduction

Coastal areas are vital hotshots for marine biodiversity, with intertidal seagrass meadows playing a crucial role at the interface between land and ocean [1]. These meadows offer a myriad of ecosystem services to humanity, including limitation of coastline erosion, reducing the risk of eutrophication, carbon sequestration, and oxygen production. They serve as vital habitats for a diverse array of marine and terrestrial species, providing living, breeding, and feeding grounds [2, ; 3, ; 4]. Due to their proximity to human activities, seagrass meadows are directly exposed to and impacted by anthropogenic pressures. Global regression and fragmentation are currently observed due to diseases, disasters, coastal urbanization, sea reclamation, as well as fishing activities, dredging, sea level rise, coastal erosion, competition with alien species, and reduction in water quality [5, ; 6, ; 7, ; 8, ; 9]. While improvements in water quality have been recently reported in European sites, allowing an overall recovery of seagrass

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ecosystems at the local scale, many other coastal waters worldwide are still subjected to strong eutrophication processes [10, ; 11]. Coastal eutrophication has been associated to anomalous accumulation of green macroalgae, the so-called green tides. Green tides produce shade and suffication over seagrass individuals, thus threatening the health of seagrass ecosystems [**?** , ; 12].

The importance of seagrass meadows and the variety of ecosystem services they provide have led to the enhancement of global and regional monitoring programs for systematically surveying different Essential Oceanic Variable [13] as seagrass coverage and composition; as well as Essential Biodiversity Variable [14] such as seagrass taxonomic diversity; species distribution, population abundance, and phenology. Monitoring programs also prioritize the identification of threats to these ecosystems, particularly during early stages, to facilitate effective mitigation actions. Traditionally, these ecological parameters have been quantified through in situ measurements, although this approach faces several constraints over intertidal zones. Intertidal meadows are only partially exposed during low tide and can be situated in difficult-to-reach mudflats, potentially leading to inaccurate and limited estimations with conventional sampling techniques [15]. However, satellite data have been proven effective in complenmenting in situ surveys, allowing for the rapid and consitent retrieval of EOV's over extensive seagrass meadows. [11, ; 16, ; 17, ; 18]

Satellite remote sensing offers the advantage of acquiring large-scale data in real-time but presents its inherent challenges. Free access satellite data (e.g., Sentinel-2 and Landsat8/9) provide relatively low spatial resolution data (10 - 30 m) across a limited number of spectral bands. These characteristics can be a limitation to accurately discriminating seagrass from others co-existing macrophytes over the meadow. Chlorophyceae (Green Algae) and marine Magnoliopsida (Seagrass) share the same pigment composition [19, ; 20]. As a result, their respective spectral signatures can be considered similar by a non-expert observer [21, ; 22]. Recently, using a hyperspectral library, [21] demonstrated that the spectral resolution of Sentinel-2, might be enough for the discrimination between Magnoliopsida and Chlorophyceae. However, green tide events occur at small spatial scales that are not observable using satellite imagery [23], especially during the initial stage of the event.

Remote sensing drone acquisitions are presented as a tool that can potentially fill gaps left by satellite and in situ data. Drone can cover large expanses while recording imagery at significantly higher spatial resolutions than satellite (pixel size from cm to mm) and still capturing data at multi-spectral resolution [24, ; 25]. The versatility of drones allows for their application across a diverse thematic range , from coastal zone management [26, ; 27, ; 28] to mapping the spatial distribution of species [29, ; 30, ; 31, ; 32, ; 33]. However, when applied to coastal habitat mapping, many studies showcase their findings with study case limited to a single flight, restricting the generalizability of their application to other sites [32, ; 34, ; 35, ; 33]. This study aimed to analyze the potential of a drone equipped with a multispectral sensor for maping intertidal macrophytes, with a particular focus on discriminating Magnoliopsida and Chlorophyceae. Ten drone flights were performed over soft-bottom intertidal areas along two European countries (France and Portugal), covering a wide range of habitats, from monospecific seagrass meadows to meadows mixed with green or red algae. A deep learning algorithm was trained and validated for macrophyte discrimination, emphasizing applicability across diverse sites without a loss of accuracy in predictions.

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