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COMPARATIVE EVALUATION OF AERIAL AND SATELLITE IMAGES FOR MAPPING SEAGRASS MEADOWS IN THE MARINE-COASTAL ZONE NORTH OF THE PORT OF OLBIA: METHODOLOGICAL APPROACH

VALUTAZIONE COMPARATIVA DI IMMAGINI AEREE E SATELLITARI PER LA MAPPATURA DELLA PRATERIA DI FANEROGAME NELLA ZONA MARINO-COSTIERA A NORD DEL PORTO DI OLBIA: APPROCCIO METODOLOGICO

Abstract *- Seagrass meadows are protected because they are threatened by human activities and climate change. Their protection plays a fundamental role in the revision of the "Regional Strategy for Adaptation to Climate Change" carried out by the Region of Sardinia. Remote sensing is a cost-effective tool to survey large areas of coastline. In this study, seagrass meadows in the marine coastal area of Olbia were mapped in a GIS environment using aerial and satellite remote sensing for 2019. Although the satellite image is characterised by a loss of detail compared to the high-resolution orthophoto, it proves to be advantageous for the purpose of subsequent large-scale analysis due to the high mapping speed, the considerable availability of images with higher coverage and, consequently, the visibility of the lower meadow limit. The result is a methodology for producing a habitat distribution map representing a first step in the implementation of an automatic classification procedure at a regional level.*

Key-words*: seagrass, Sentinel-2, orthophoto, remote sensing, percentage cover.*

Introduction - Seagrasses form dense meadows that are widespread throughout the Mediterranean (Rigo *et al*., 2021). The endemic seagrass *Posidonia oceanica* (Linnaeus) Delile 1813 is considered dominant along the Mediterranean coasts, with a spatial distribution between 25,000 and 50,000 km^2 (Pasqualini *et al*., 1998). Specifically, it extends over about 1,700 km^2 (from the GIS Natura 2000 project of the Italian Ministry of Environment and Energy Security) along the marine coastal areas of Sardinia. The development of seagrass meadows requires stable environmental conditions and their distribution is closely linked to a complex interaction of biotic and abiotic factors (Vacchi *et al.,* 2017). They represent one of the most biodiverse and productive marine ecosystems (Boudouresque, 2004). In fact, they provide essential and numerous ecosystem services, such as carbon sequestration, maintenance of secondary production, stabilisation and production of sediment, oxygenation of water and/or habitat and shelter for a diverse and exploited community, such as fish and invertebrates (Dìaz-Almela *et al*., 2009).
Seagrass meadows are highly threatened by the presence of human activities and global climate changes: for this reason, seagrasses were chosen as the object of this study, in addition to the fact that they are widespread along all the coasts of the Sardinian region. Therefore, this topic plays a key role in the review that the Region of Sardinia is carrying out on the "Regional Strategy for Adaptation to Climate Change (SRACC)".

Materials and methods - In this study, the seagrass meadows in the marine coastal area at the north of the port of Olbia were mapped using ArcGis 10.8 software, exploiting remote sensing from airborne and satellites. We used an orthophoto of 2019 from the Sardinia Geoportal, and a Sentinel-2A image from the Copernicus programme

of the same year, on which a water column correction was made with Sen2Coral (toolbox in SNAP), with resolutions of 0.5 m and 10 m respectively. The digitised distribution from the orthophoto, taken as sea truth, and the Sentinel 2 digitised distribution were compared, overlapping the resulting polygons from the higher and lower resolution imagery. The comparison was performed on a regular grid with a cell size of 50m on the basis of the percentage of area of the cell classified by satellite-based seagrass cover estimation as in agreement to the ortophoto-based one.

Results - The digitised data from orthophotos (Fig. 1a) and Sentinel 2 (Fig. 1b) generally follow the same pattern, with the greatest differences near the coast, in particular with small patches missing from Sentinel 2. Comparison (Fig. 2) between the digitisation at high-resolution orthophotos and at the lower-resolution Sentinel-2A images allowed the effect of loss of resolution to be assessed: Sentinel-2A provided mapping with low error in cells with either high levels of vegetation cover (about greater than 80%) or low levels of vegetation cover (<20%), while it showed higher uncertainty for areas with intermediate cover (30-50%). Although the satellite image is characterised by a loss of accuracy compared to the orthophoto in transitional areas between the presence and absence of seagrass meadow (Fig. 3), it proves to be adequate in terms of describing the general patterns and more convenient for a subsequent large-scale analysis. Indeed, the main advantages reside in a higher mapping speed and in a large availability of images, allowing to choose the ones most suitable for the task, e.g. with better atmospheric visibility and water transparency.

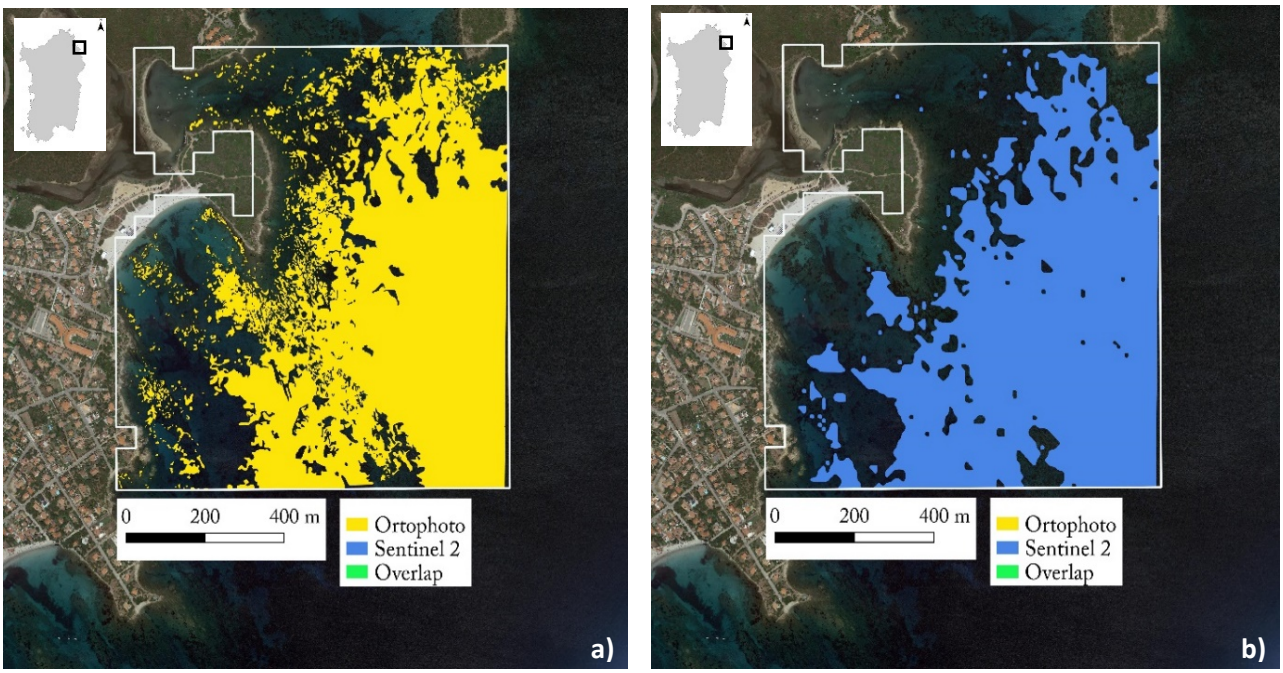

Fig. 1 - Seagrass coverage digitised from orthophotos (a) and Sentinel 2(b).
Copertura di fanerogame digitalizzata da ortofoto (a) e Sentinel 2 (b).

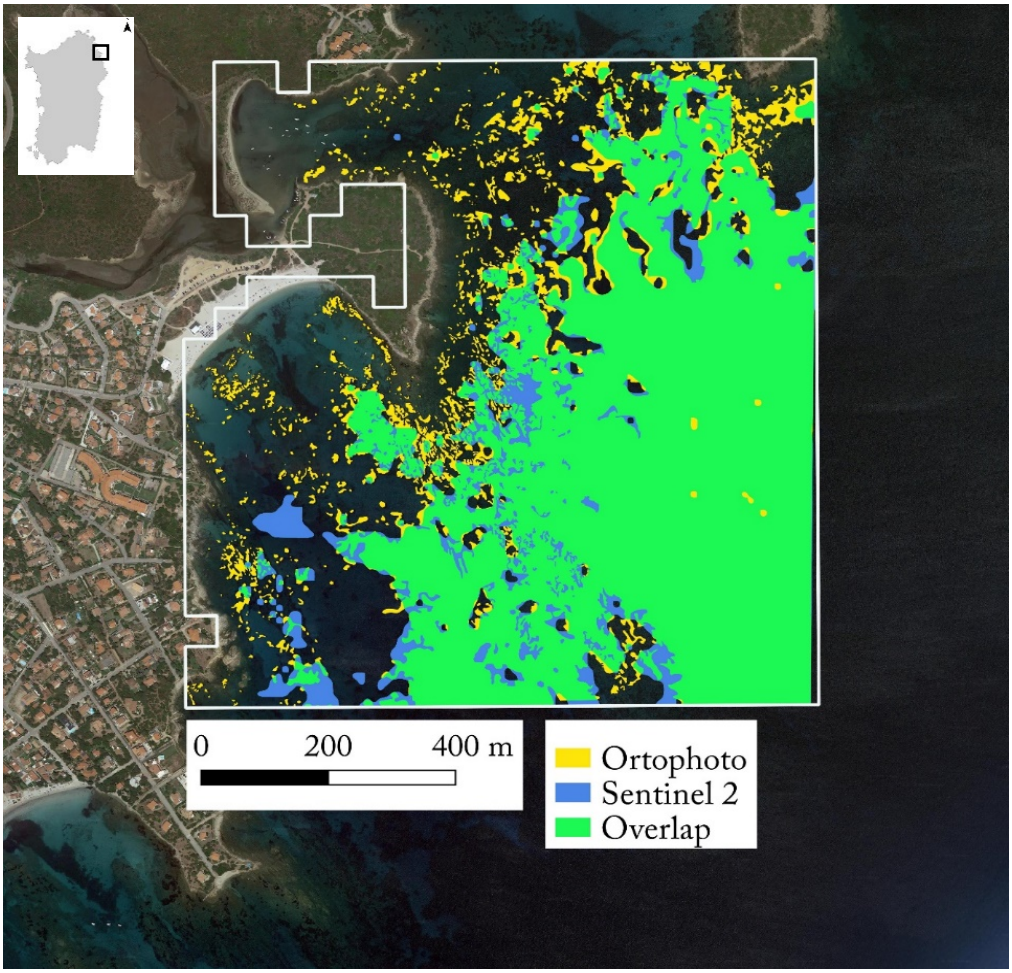

Fig. 2 - Representation of the superposition of the two mappings.
Rappresentazione della sovrapposizione delle due mappature.

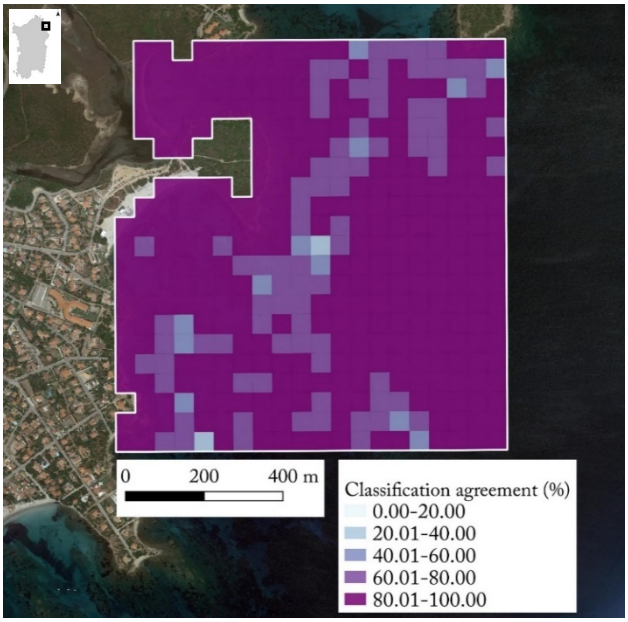

Fig. 3 - Classification agreement of seagrass mapping from orthophotos and satellite on the 50x50 m grid.
Accordo di classificazione della mappatura di fanerogame da ortofoto e da satellite su un grigliato di 50x50 m.

Conclusions - This work aims to provide the Region of Sardinia with a methodological tool that is easy to find, cheap to use and can be widely applied for the assessment of marine coastal ecosystems, such as seagrass meadows, related to climate change, but also to human activities use. The use of aerial and satellite imagery is a cost-effective tool for surveying large areas of coastline (Smith *et al*., 2021). Indeed, the resulting maps demonstrated the ability of remote sensing to produce more or less extensive mapping and allowed quantitative estimation of seagrass coverage. The result is a methodology for producing a habitat distribution map suitable for the implementation of an automatic classification procedure at regional level, which is functional for comparisons at large spatial and temporal scales, also thanks to the use of mathematical models that will allow the assessment of the impact of climate change on the possible future distribution. In conclusion, the local analyses carried out in this study provide a concrete tool for assessing the vulnerability of marine coastal ecosystems, in this case seagrass meadow, functional for future governance frameworks on climate change mitigation in the region of Sardinia.

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