Submerged vegetation and bathymetry mapping using EnMAP image of the Gulf of Oristano (Italy)

EnMAP Workshop 2025
Abstract
Corresponding Author: [bresciani.m@irea.cnr.it]

Mariano Bresciani[1], Monica Pinardi[1], Salvatore Mangano[1], Claudia Giardino[1], Nicole Pinnel[2], Andrea Pellegrino[1,3], Andrea Taramellli[4]

[1] CNR - IREA Institute for Electromagnetic Sensing of the Environment, National Research Council, Milan, Italy
[2] German Aerospace Center (DLR), Earth Observation Center (EOC), Wessling, Germany
[3] University of Sapienza, Department of Engineering, Rome, Italy
[4] IUSS, Institute for Advanced Study of Pavia, Pavia, Italy,

Keywords: EnMAP, Hyperspectral, substrate bottom cover, bathymetry

Challenge

Shallow water hosts some of the most important and productive ecosystems on the planet. Seagrasses typically grow on safe, gently sloping beaches in brackish and salty waters. Remote sensing has been used to map some of the dense underwater meadows that seagrasses can form. Most seagrass conservation initiatives focus on maintaining the biodiversity of the environment. The study of seagrass cover and its evolution over time can help control and manage the spread of seagrass. For the management of these ecosystems, satellite-derived products of substrate and plant cover at different spatio-temporal resolutions provide crucial information. This study has the main objective of testing and applying algorithms to obtain bottom substrate, canopy cover, bathymetry mapping from ENMAP hyperspectral satellite data. The study is part of the PRISMA SCIENZA OVERSEE project funded by the Italian Space Agency (ASI) and focuses on the coastal areas of the Gulf of Oristano, and to the habitat colonised by *Posidonia oceanica* (Sardinia, Italy).

Materials & Methods

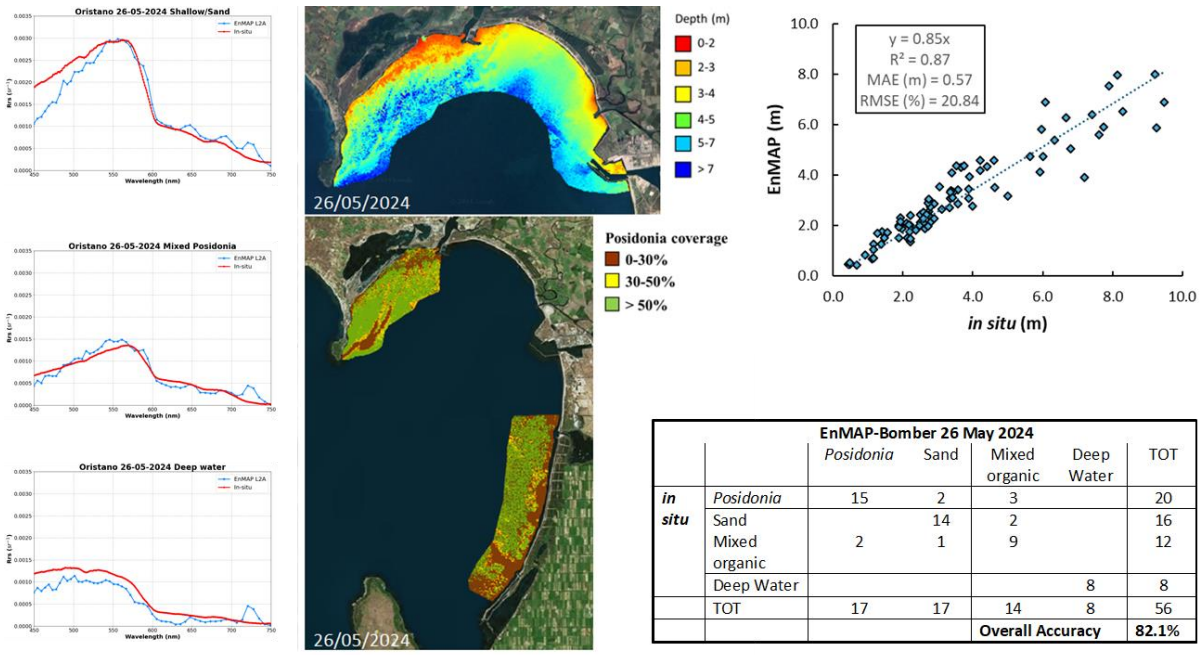
The suitability of the EnMAP radiance and reflectance products has been demonstrated in several papers by comparison with reference data. The Remote Sensing Reflectance images (directly downloaded as Level 2), validated with spectral ground truth, were converted into maps of marine substrate and bathymetry maps using bio-optical modelling (BOMBER) parameterised with specific inherent optical properties collected in situ. Validation of the substrate and bathymetry products was performed by comparison with in-situ data. In May 2024 there were three EnMAP overpasses on the Gulf of Oristano (25-26-29/05/2024). The 25 May image was not used due to clouds noise and the 29 May image was not used as it was completely affected by sunglint. For the image of 26 May, comparisons were made between the EnMAP L2A reflectance products and the in-situ synchronous measurements. 56 ground true substrate and sonar depth information were collected in different sites of the Gulf and two different radiometers (WISP-3 and Spectral Evolution rs-3500) were used to collect Remote Sensing Reflectance (Rrs).

Results

The comparison between EnMAP and in-situ Rrs measurements shown a good accuracy in the image acquired on 26 May (cloud-free), in particular in the green-red spectral region. Bathymetry of the upper part of the seabed surface (intended as the depth in meters of the path of the radiation signal leaving the water surface due to reflection from the bare bottom and the canopy of phanerogams). Classes of bottom coverage divided in bare sediment with phanerogams (*Posidonia oceanica*) <30%; mixed substrate with sand and phanerogams (*Posidonia oceanica* e *Cymodocea* spp.) between 30% and 50%; substrate with sand phanerogams (*Posidonia oceanica*) >50% were obtained. When compared to in situ measurements, the results for bathymetry and substrate and vegetation distribution data were accurate as shown in Figure 1. The depth map obtained with BOMBER showed an R^2 of 0.87, with a Mean Absolute Error (MAE) of 0.57 m. The confusion matrix of the bottom coverage product obtained for the EnMAP image acquired on 26/05/2024 showed a good overall accuracy of the outputs corresponding to 82.1%.

Outlook

As the hyperspectral missions progresses and the number of matchups increases, it will be possible to expand the spatio-temporal assessment and evolution of the *P. oceanica* meadows in the marine protected area of the Gulf of Oristano. Additionally, the quality monitoring of the EnMAP water products could be extended by cross comparing the products to other satellite missions as DESIS, PRISMA, and Sentinel2-MSI. This work demonstrates that the bio-optical modelling can be successfully applied to different temporal acquisitions when specific optical characteristics of the study area are well defined, with the possibility of minimising in situ measurements.



EnMAP-Bomber 26 May 2024						
		Posidonia	Sand	Mixed organic	Deep Water	TOT
in situ	*Posidonia*	15	2	3		20
	Sand		14	2		16
	Mixed organic	2	1	9		12
	Deep Water				8	8
	TOT	17	17	14	8	56
				Overall Accuracy		**82.1%**

Figure 1. On the left, spectral signature comparison between in situ and EnMAP Rrs for different sites (shallow bottom with sand, shallow bottom with *P. oceanica* and deep water). On the center, bathymetry (top) and *P. oceanica* coverage (bottom) maps from the EnMAP image acquired on 26/05/2024. On the right, validation of EnMAP bottom depth products (top) and confusion matrix for EnMAP bottom coverage (bottom).