

MONITORING SUBMERGED CULTURAL HERITAGE SITES WITH DESIS

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1. ABSTRACT

The submerged harbors of Amathus in Cyprus and Hipponion in the South of Italy are examples of sensitive cultural heritage requiring special attention in the frame of Marine Spatial Planning. This paper introduces the use of the DESIS sensor, an imaging spectrometer mounted on the International Space Station, for the monitoring of cultural heritage sites of this kind, located in shallow waters. On the one hand, monitoring eutrophication and pollution can timely raise awareness on critical conditions of the surrounding waters; on the other hand, the monitoring of water depth can indicate effects, such as shoreline erosion, which could lead to a deterioration of the relics.

2. DATA AND CASES OF STUDY

The ruins of the external ports of the archaeological sites of Amathus (Cyprus) and Hipponion (Italy), are today preserved under the sea in the proximities of the cities of Limassol and Vibo Valentia, respectively. The DESIS sensor has been successfully tasked to acquire images on these two sites, dated 9th of June 2020 (Amathus) and 29th of December 2020 (Hipponion). The images are cloud-free and have undergone several pre-processing steps (such as radiometric, geometric, rolling shutter, and smile correction) and converted to bottom-of-atmosphere reflectance, corresponding to Level 2A among the available DESIS products. The original data contain 235 spectral bands spanning the range 400-1000 nm, with a spectral resolution of 2.35 nm.

3. WATER PARAMETERS

On both sites, bathymetrical maps are derived by applying the 2D module of the WATER color SIMulator WASI (Gege, 2014) to the DESIS data. The depth values in the Amathus harbour area are favourably compared to products derived from Sentinel-2, and assessed with LiDAR measurements acquired in situ, in our previous study (Cerra et al., 2020).

As an imaging spectrometer, DESIS is able to derive additional water quality parameters. The concentration of Coloured Dissolved Organic Matter (CDOM, also known as gelbstoff), chlorophyll-a, and total suspended matter, are important to assess eutrophication and pollution in sensitive areas. These quantities have been estimated around the harbour of Hipponion.

As an additional aspect, the image containing the Hipponion harbour includes the estuary of the Mesima river into the Tyrrhenian sea, where local authorities verified the frequent

illegal discharge of toxic materials in the past months. It results interesting to verify the water quality in this area, in order to understand if similar phenomena could pose a threat to submerged cultural heritage. The image in Fig. 1 illustrates an RGB combination using narrow bands centered around 703 nm (R, band 60), 700 nm (G, band 59) and 675 nm (B, band 54). Bright areas indicate a high concentration of inorganic compounds in the water.

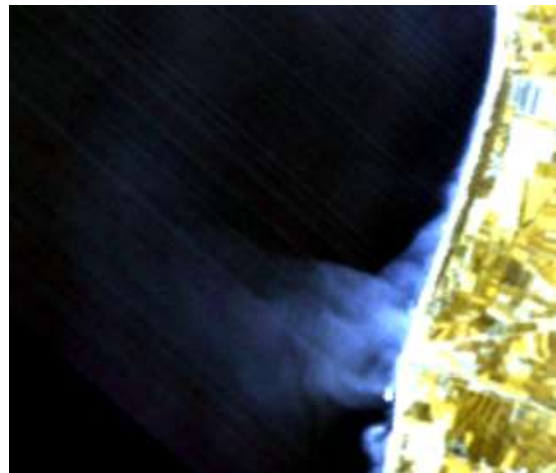


Figure 1. Highlighted water with high inorganic content discharged into the Tyrrhenian sea from the Mesima river as observed by DESIS.

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