

Hyperspectral imaging applied to monitoring microplastics collected from sediments of Mar Piccolo basin (Taranto, Southern Italy)

G. Capobianco¹, P. Cucuzza¹, E. Gorga¹, S. Serranti¹, A. Rizzo^{2,3}, I. Lapietra², G. Mastronuzzi^{2,3}, D. Mele², G. Bonifazi¹

¹Department of Chemical Engineering, Materials and Environment, Sapienza University of Rome, Via Eudossiana 18, 00184 Rome, Italy

²Department of Earth and Geo-environmental Sciences, University of Bari Aldo Moro, Bari, 70125, Italy

³Interdepartmental Research Centre for Coastal Dynamics, University of Bari Aldo Moro, Bari, 70125, Italy

Keywords: Hyperspectral imaging, microplastic pollution, marine environment, machine learning

Presenting author email: eleonora.gorga@uniroma1.it

The Mar Piccolo basin, located in Taranto (Apulia region, Southern Italy), is about 20 km² wide and it is divided in two bays, the First and the Second bay, with a maximum depth of 12 m and 8 m, respectively. It is a semi-enclosed sheltered sea with a very low water circulation and characterized by the presence of several submarine springs that recharge the basins with freshwater. Such peculiar hydrogeological characteristics have determined typical transitional and lagoonal environmental features, which have favored the development of wide mussel farms. Despite its remarkable geo-environmental value, the area has been strongly affected by the urbanization and industrialization processes that have taken place since the second half of the XIX century, leading to the contamination of the different environmental matrices (Cardellicchio *et al.*, 2009 and 2016; Rizzo *et al.*, 2022; Marsico *et al.*, 2023). Up to now, no studies have evaluated the microplastics (MPs) content in marine sediments of the Mar Piccolo bays. In order to fill this gap, this study proposes a first attempt for the MPs analysis. To this aim, sediment samples have been collected by means of a grab sampler in both bays of Mar Piccolo (Figure 1).

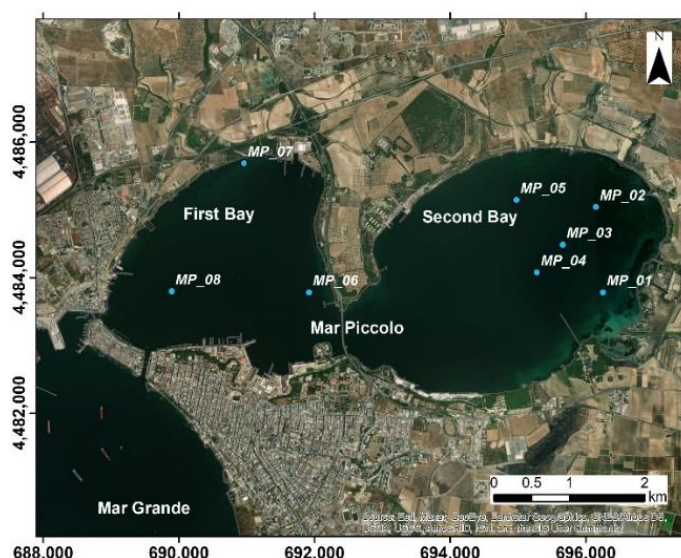


Figure 1. Sampling sites in the Mar Piccolo basin.

Grain-size analyses were carried out by following international standard procedures. For the sieving, a set of ASTM sieves with meshes of $\frac{1}{2}$ phi from 4 mm to the minimum granulometric fraction was used. In the laboratory, samples were dried in the oven at a temperature of 80°C for 24 h and each individual sample was quartered and set in a sieve column. The sand sediments from 2.0 mm to 0.063 mm were sieved with the vibrating screen for a duration of 20 min (Lapietra *et al.*, 2023). Subsequently, each retained fraction was weighed and the results were processed with a specific application for Microsoft Excel (Gradistat© v8), which yield distribution cumulative curves, histograms, and statistically evaluate the main textural parameters. Grain-size analyses of the fraction < 63 μ m were conducted by the use of Coulter counter that works on dispersing samples. The results of this analytical phase were then integrated in the analysis software. According to the obtained results, the sediments of the Mar Piccolo are mainly composed by silt (ranging from very coarse to medium silt) and sand (from very fine to coarse sand).

Once sediment samples are categorized based on their textural parameters, effective methods for identifying microplastics are needed. In recent years, hyperspectral imaging (HSI) has started to be applied for automated recognition of microplastics from marine environment with reference to both sediments and seawater (Serranti *et*

al., 2018 and 2019). In fact, identification of polymers is particularly effective in the short-wave infrared (SWIR) range, based on their typical spectral signatures (Bonifazi *et al.*, 2022, 2023a, 2023b). Therefore, HSI working in the SWIR range (1000-2500 nm) combined with machine learning approaches was applied to develop a procedure for identifying microplastics in marine sediments collected from Mar Piccolo. Sediment samples were first investigated by stereomicroscopy to evaluate the presence of microplastics in the different size classes. Selected microplastic particles were handpicked to build the HSI classification model based on the different identified polymers, in order to directly recognize them on the sediment surface. Spectral preprocessing and principal component analysis (PCA) were applied to emphasize the spectral differences of the examined polymer classes and to explore the spectral data, respectively. Classification models based on HSI data were tested, in which several microplastic classes, constituted by different polymers, were identified in the marine matrices applying a hierarchical approach.

The obtained results demonstrated how the proposed strategy based on HSI, in combination with machine learning, can represent an efficient approach to perform a rapid, non-invasive, and automatic recognition of microplastics in marine sediments, allowing to reduce analysis times.

Acknowledgements

The research was carried out in the framework of the Enlarged Partnerships supported under the National Recovery and Resilience Plan (NRRP), Mission 4, Component 2, Investment 1.3 funded by the European Union—NextGenerationEU (RETURN project “Multi-risk science for resilient communities under a changing climate”, no. PE00000005, CUP B53C22004020002).

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