AUTOMATIC PARAMETRISATION OF BEACHED MICROPLASTICS

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Abstract

Four sandy beaches on the island of Malta were regularly sampled for Large MicroPlastic (LMP) particles having a diameter between 1mm and 5mm, at stations located at the waterline, and 10m inshore. The extracted LMPs were characterised (dimensions, surface roughness, colour) by microscopic analyses, as well as by a developed algorithm. Two-thirds of the isolated particles were smooth and the majority of these belonged to the grey-white colour category suggesting that these were preproduction pellets. Roughly six times as many particles were recorded within the inshore sampling stations as the particles recorded at the waterline stations. The automated image processing algorithm performed well when the dimension and colour parameter values it delivered were compared with those obtained by microscopic analyses.

Keywords: Plastics, Mediterranean Sea

The presence of MicroPlastics (MPs) in the marine environment is the result of two introduction pathways: as primary MPs in the form of virgin plastic pellets and powders, and as secondary MPs through the fragmention of litter (Primpke et al., 2017). Despite this consensus in recognising the importance of MP monitoring protocols, there is no universal methodology of high validity of analysing isolated MPs. The simplest MP analysis protocol involves examination with the naked eye or with a microscope, without further analyses. This results in error margins as high as 70% when the same samples were re-analysed using spectroscopic techniques (Loder et al., 2015). Human observer interpretation bias is inevitable in such visual analysis, especially when determining subjective attributes such as colour (O'Neill and Smith, 2014). For instance, the assigned colour might change according to the prevailing lighting conditions being used by the observer. Therefore, there is much scope for the formulation of an alternative MP analysis technique.

This study investigated the use of image processing techniques to automatically extract the required parameters for LMPs exceeding 1mm in diameter. Apart from making the process less time-consuming, an automated method removes the subjectivity and allows more accurate spatial and temporal comparisons to be made. The proposed algorithm was tested on a large number of LMP samples collected over several weeks from four different beaches along the Maltese coastline.

Microplastic samples were collected from popular beaches. Apart from being distributed along different swathes of the north-western and north-eastern coastline, these beaches are subjected to different wind and wave exposure conditions by virtue of differences in aspect, fetch, bathymetry, and beach profile. This allowed for an exploratory correlation of microplastic density with the meteorological conditions that prevailed on the days preceding sampling. Sampling was carried out every two weeks between August and November 2017. Each sample was collected early in the morning when no people were present and prior to beach-grooming activities by the authorities. Sampling was carried out at three replicates to the waterline (0m) and at another three replicates located 10m inshore. Sand contained within a volume of 50cm × 50cm × 10cm was sifted to collect LMP particles with a diameter that exceeded 1mm.

Digital images of the LMPs were obtained through scanning on a flatbed scanner at a high resolution. One of the preliminary steps of the algorithm developed in this study was to identify every LMP as an individual entity. In order for real length measurements of the LMPs to be obtained, a calibration coefficient to convert pixel length measurements into spatial coordinates was inferred by scanning a custom pattern at the same resolution.

Since the particles were scanned against a black background, an adaptive thresholding method was used to obtain a binary image that represented a mask. The next step involved the morphological closing of the binary image through the use of a disk template. The algorithm progressed by identifying the boundaries of objects within the processed binary mask. Here, the exterior of each object was traced to identify the coordinates of a polygon that encloses each microplastic particle. For every identified LMP, the best ellipsoid was fitted through a least squares method. The major and minor axis of the ellipse were extracted and converted to length measurements by using the calibration coefficient. The difference between the boundary and the best-fitting ellipsoid around each object was then used to obtain a measure of roughness.

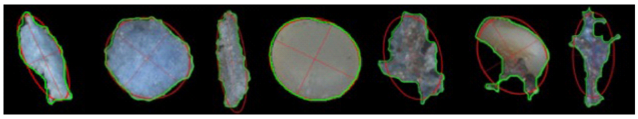

Fig. 1. Detected LMPs, their identified boundaries and the corresponding fitted ellipsoids.

The red, green, and blue components of pixels enclosed within each boundary were obtained and the mean intensities for each colour were computed from the corresponding histograms. The values were then compared to tuples in a list that stored the information of standard colours.

In order to assess the performance of the developed algorithm, individual plastic particles were also viewed under a stereomicroscope, which was used to characterise manually the LMPs through human observation and to capture micrographs of the same particles complete with a scale bar. The algorithm performed very well in determining the dimensions and colour of the LMP particles as emerging from an analysis of the correlation values for the two (algorithm-derived and human observation-derived) datasets. The contribution beyond the current state-of-the-art of marine environmental monitoring proposed by this study is along the same lines as that proposed by Deidun et al. (2018) for automated coastal litter monitoring by aerial drones in that the algorithm can be incorporated as a routine protocol within photo-capturing smart phone apps.

References

1 - Primpke, S., Lorenz, C., Rascher-Friesenhausen, R. and Gerdts, G., 2017. An automated approach for microplastics analysis using focal plane array (FPA) FTIR microscopy and image analysis. *Analytical Methods*, *9*(9), pp.1499-1511.
2 - Löder, M.G. and Gerdts, G., 2015. Methodology used for the detection and identification of microplastics—A critical appraisal. In *Marine anthropogenic litter* (pp. 201-227). Springer, Cham.
3 - O'Neill, S. J. and N. Smith (2014). 'Climate change and visual imagery'. Wiley Interdisciplinary Reviews: Climate Change 5(1): 73-87.
4 - Deidun, A., Gauci, A., Lagorio, S. and Galgani, F., 2018. Optimising beached litter monitoring protocols through aerial imagery. *Marine Pollution Bulletin*, *131*, pp.212-217.