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Detecting and Identifying Floating Plastic Debris in Coastal Waters using Sentinel-2 Earth Observation Data

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Satellite remote sensing is an invaluable tool for observing our earth systems. However, few studies have succeeded in applying this for detection of floating litter in the marine environment. We demonstrate that plastic debris aggregated on the ocean surface is detectable in optical data acquired by the European Space Agency (ESA) Sentinel-2 satellites. Furthermore, using an automated classification approach, we show that floating macroplastics are distinguishable from seawater, seaweed, sea foam, pumice, and driftwood.

Sentinel-2 was used to detect floating aggregations likely to include macroplastics across four study sites, namely: coastal waters of Accra (Ghana), Da Nang (Vietnam), the east coast of Scotland (UK), and the San Juan Islands (BC, Canada). Aggregations were detectable on sub-pixel scales using a Floating Debris Index (FDI), and were composed of a mix of materials including sea foam and seaweed. A probabilistic machine learning approach was then applied to assess if detected plastics could be discriminated from the natural sources of marine debris. Our automated Naïve Bayes classifier was trained using a library of pumice, seaweed, timber, sea foam and seawater detections, as well as validated macroplastics from Durban Harbour (South Africa). Across the four study sites, suspected marine plastics were classified as such with an accuracy approaching 90%. The 'misclassified' plastics were mostly identified as seawater, suggesting an insufficient amount of pixel was filled with materials.

Results from this study show that plastic debris aggregated on the ocean surface can be detected in optical data collected by Sentinel-2, and identified. With the aim of generating global 'hotspot' maps of floating plastics in coastal waters, automating this two-stage process across the Sentinel-2 archive is being progressed; however, the method would also be applicable to drones and other remote sensing platforms with similar band characteristics. To extend remote detection methods to river systems and optically complex and/or tidal coastal waters, in situ data collection across optical water types is the next key step.