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Towards a method for detecting macroplastics by satellite: examining Sentinel-2 earth observation data for floating debris in the coastal zone.

Lauren Biermann, Victor Martinez Vincente, Sevrine Sailley, Aser Mata, and Christopher Steele
Plymouth Marine Lab (PML), Earth Observation Satellite Applications, United Kingdom (lbi@pml.ac.uk)

To date, only a few studies have explored the potential applications of satellite remote sensing for detecting macroplastics on the ocean surface. Sentinel-2A & B are European Space Agency optical earth observation satellites launched in 2015 and 2017, respectively. The on-board multi-spectral instrument (MSI) sensors were developed for terrestrial services, but the high spatial resolution (10m, 20m and 60m bands) also allows for detection of 'small' objects in the marine environment. These objects can include boats, wind turbines, aquaculture cages, drifting Sargassum seaweed and, for our purposes, aggregations of floating debris.

At 10m spatial resolution, individual pieces of plastic are unlikely to be detectable. However, fronts, eddies and other submesoscale features are known to aggregate floating materials into patches. We propose that the spatial resolution of Sentinel-2 is sufficient to detect aggregated objects, likely a mix of macroalgae and other natural sources of debris, as well as anthropogenic sources - increasingly plastic and polystyrene. Being able to detect patches of floating material by satellite may help us to tackle some open questions about sources of macroplastics, as well as pathways, fates, and trends.

We present two examples where Sentinel-2 was used to detect aggregations likely to include floating macroplastics. First, waters around the San Juan Islands of British Columbia (BC), and second, waters off the east coast of Scotland. These two case studies were selected based on plastic pollution research published on the Alfred Wegner Institute LITTERBASE portal and on the social media platform Twitter, respectively. Level 1C sentinel-2 data were corrected using the Sen2Cor atmospheric correction, and floating aggregations were detected using algorithms that leveraged the near-infrared bands. Patches of surface debris were detected south of Gabriola Island in BC and, based on the literature, were likely to be composed of a mix of wood, jellyfish, macroalgae and macroplastics. Surface aggregations were also detected outside three rivers on the east coast of Scotland, namely: the Firth of Forth, the River Tay and the Esk. With reference to evidence from photos and reports posted to Twitter, these were likely to be composed of a mix of macroalgae and macroplastics. In both case studies, buoys, small boats, glint, foam and whitecaps were eliminated as potential sources of false detections. Outside the Firth of Forth in Scotland, however, patches detected may also include northern Gannets foraging along a front.

We have shown that sufficiently large floating patches of accumulated materials produce radiometric anomalies that can be detected by satellite. Next steps are to automate detection and classification of floating aggregations through the new Sentinel-2 processing chain of CaLimnos, using an attuned POLYMER atmospheric correction. To further develop links between debris accumulation and macroplastics abundance, access to standardised in situ data is essential.