POS2IDON: A TOOL FOR MONITORING MARINE DEBRIS BASED ON SENTINEL-2 SATELLITE IMAGERY AND MACHINE LEARNING

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SCAN THE QR code to access the source-code.

POS2IDON is an open-source data pipeline designed for long-term analyses and monitoring of suspected marine debris accumulations (>10 m) and other ocean features, such as vessels and floating *Sargassum*. Applications for a plastic-affected region of the Honduras Gulf are here demonstrated, such as **post-disaster management** and a **long-term seasonal analysis** to inform stakeholders on patterns and trends of plastic pollution.

Scope and context

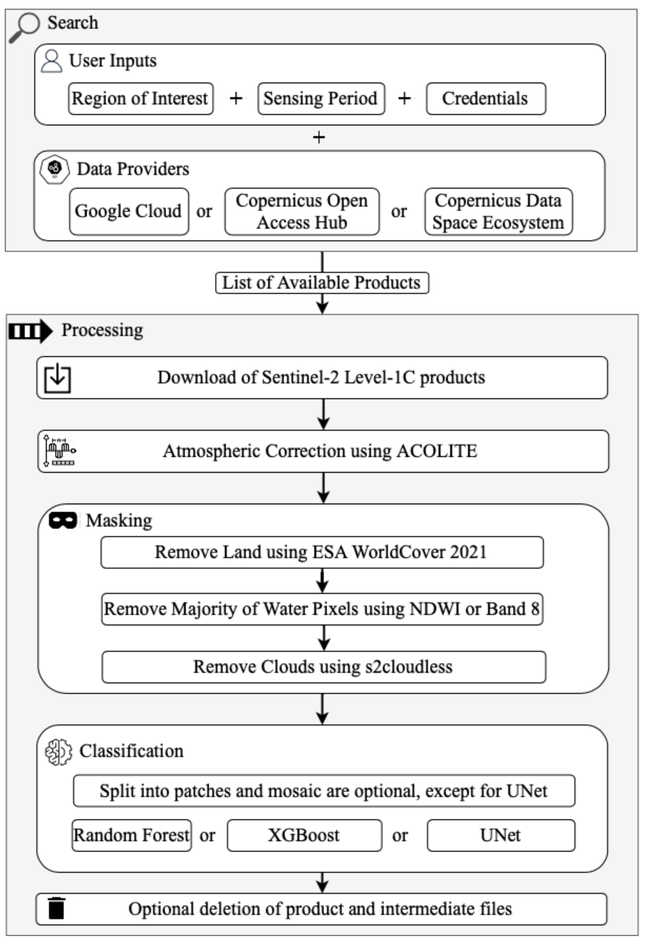
- Previous studies showed that Copernicus Sentinel-2 can detect artificial plastic targets and large accumulations of marine debris.
- However, automatic data pipelines are still rare in literature, which hinders scientific advances and monitoring efforts.
- We developed an open-source data pipeline, POS2IDON, to foster the development of a tool for monitoring plastic in the ocean.
- POS2IDON uses Sentinel-2 and Machine Learning (ML), and provides users several customizable options to detect suspected marine debris and perform different monitoring analyses.

POS2IDON architecture

- POS2IDON downloads (Sentinel-2 L1C through three different data providers), pre-processes (atmospheric correction, and masking for land, cloud, NDWI and/or Band 8), and classifies (using a chosen ML model) all available imagery for the region of interest and period specified by the user.
- Supported classification models include Random Forest (RF) and XGBoost. An improved U-NET option is under testing.
- RF and XGBoost models were trained with an extended version of the MARIDA spectral library, totalizing 14 classes, including Marine Debris, Floating Macroalgae, Ships, Foam, Clear and Turbid Water and Phytoplankton Blooms. Satisfactory performances provide confidence in using these models within POS2IDON.

	XGBoost		
	IoU	Recall	F1
Marine Debris	0.73	0.84	0.84
Macro Average	0.89	0.93	0.94

	Random Forest		
	IoU	Recall	F1
Marine Debris	0.68	0.83	0.81
Macro Average	0.86	0.91	0.92



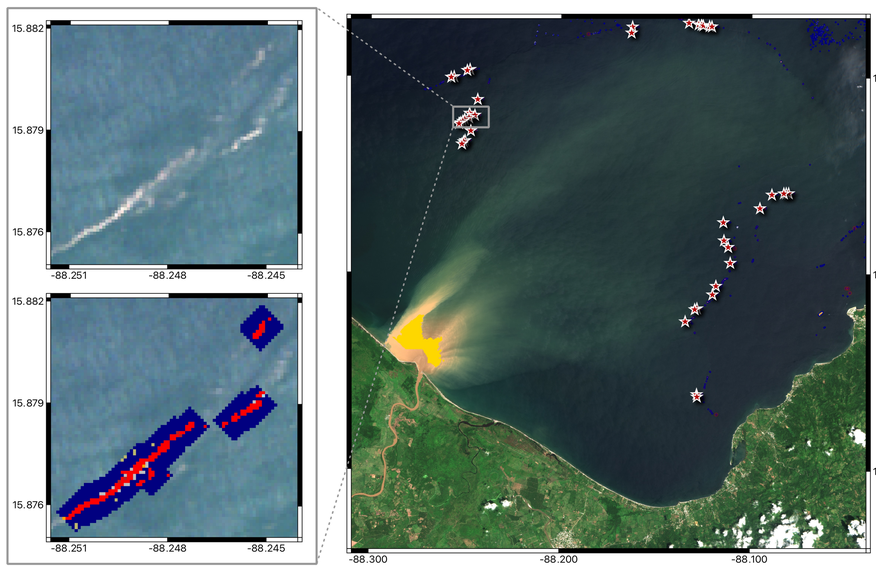
POS2IDON architecture

- POS2IDON is developed mostly in Python, with some options in Julia to speed up processing and take advantage of dedicated GPU.
- The input parameters used in this study include a land buffer of 50, an NDWI threshold of 0.01, an NDWI dilation of 6, a cloud mask threshold of 0.05, a cloud mask average of 10 and a cloud mask dilation of 50.
- Post processing steps and human visualization are critical to deal with false positives.

Applications and potential services

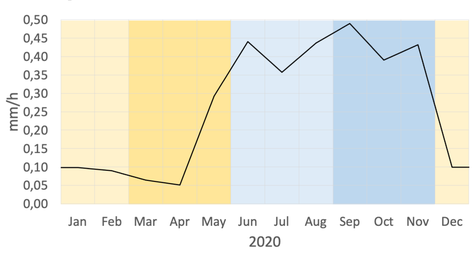
- Post-disaster management after flooding events in heavily polluted regions to direct cleanup activities and assess the input of debris into the ocean. Next figure shows POS2IDON applied to a major plastic debris event in Honduras Gulf in 2020/09/18.

Likely presence of MD (red pixels and dots) detected along the river front. Red stars with white borders are clusters of at least 10 MD pixels at 100 meters distance.

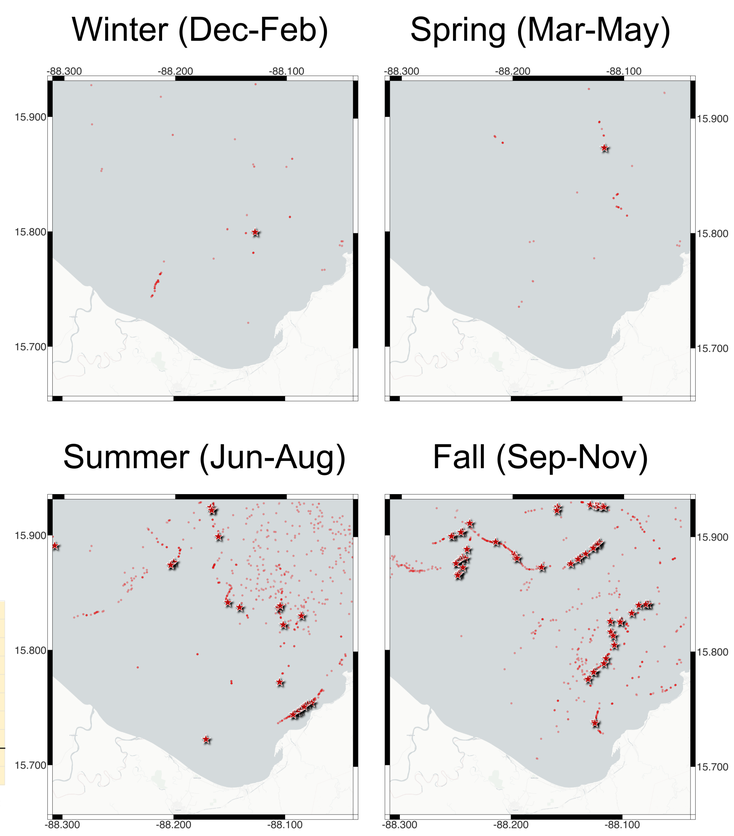


- Long-term seasonal analysis taking advantage of regular Sentinel-2 imagery (5 days) since 2018, useful to better understand patterns and trends in marine debris. POS2IDON is used to analyse Honduras Gulf for all 2020 (72 images).

Each of the classified images with suspected MD were human verified. Those with artifacts and false positives were removed. Dryer seasons (winter and spring) have less debris detection, in agreement with rivers being the major source of pollution.



Monthly precipitation in Honduras



Challenges and future work

- Reach out to stakeholders and test POS2IDON unique tool.
- False detections due to foam, sun glint and thin clouds need more sophisticated processing modules (e.g. leveraging meteo-oceanographic data), as well as human validation of the results.
- More in-situ data for validation of plastic-debris events using community-driven geo-referenced photographic databases, to enhance spectral libraries and improve classification models.

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