Plastic Litter Projects:
exploring the detection of floating plastic debris using satellite images and UAS data

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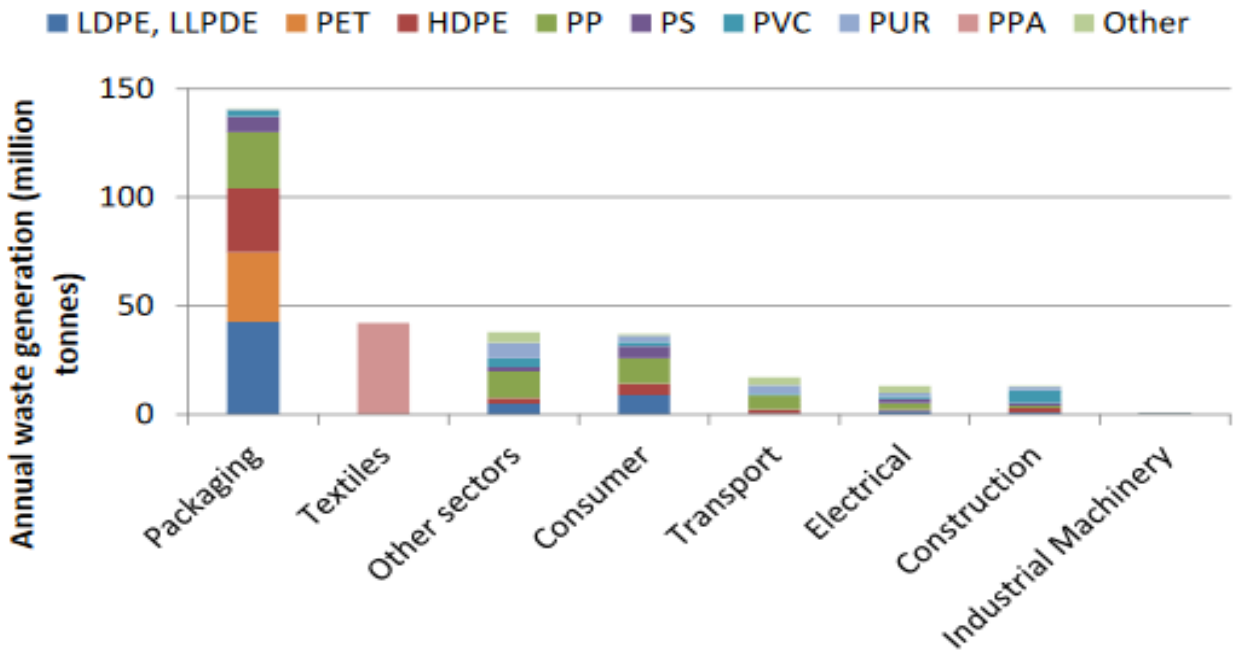
Plastic waste production

- Plastic production: 348 Mt global , 64.4 Mt in Europe for 2017
- About 302 Mt of plastic waste produced every year
- 58-62% of global waste production ends up in landfill, in Greece: about 90%
- Packaging is the biggest source of waste production



Source: OECD, 2018

Marine plastic debris

- 40% of global population lives in <100 km from the ocean, in Europe <50 km
- 8.3 Mt of plastic waste (60% floating) estimated to reach the ocean ever year, x2 in 2025
- Main sources: rivers, runoff, poor waste management, fishing industry, nautical activities
- Estimated amounts of plastic waste inputs ≠ observed concentrations
- Increasing production/inputs/concentrations + climate change induced extreme events
  ⟶ need for global monitoring of marine debris
- Integrated marine debris observing system (IMDOS; Maximenko et al, 2019) – remote sensing, in-situ observations, ocean circulation modelling

Plastic Litter Projects (PLP)

- Exploratory study into using open-access satellite and UAS imagery for the remote detection of floating marine debris targets in a realistic marine environment
- Calibration/validation campaign for marine debris detection algorithms and sensors.

Scope:

i) to explore the feasibility of detecting plastics in the aquatic environment using UAS and open access satellite missions

ii) to extract meaningful spectral measurements in near-real scenarios & collate the geospatial information ranging from moderate to very high resolution

iii) to contribute towards the development of a floating marine debris spectral library

Plastic Litter Project 2018

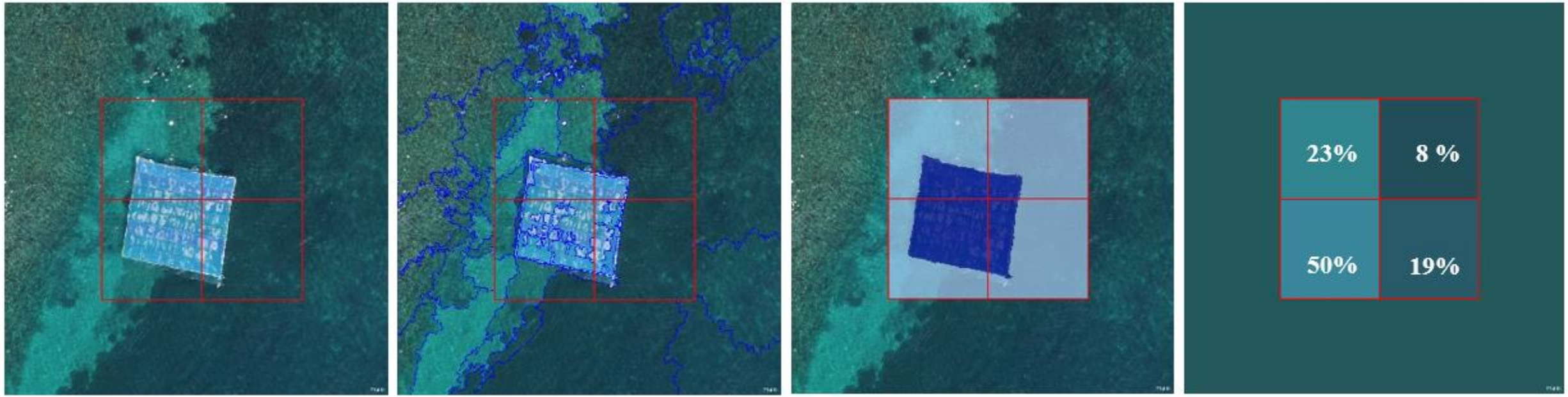
Three 10x10 m artificial targets:
1) 3600 x 1.5 L clear PET bottles,
2) 135 blue HDPE garbage bags and
3) 200 m^2 yellow nylon fishing net.

Plastic Litter Project 2018

Sentinel-2 satellite
7 June 2018

PlanetScope satellite
7 June 2018

Combining Sentinel-2 and UAS data



Percentage plastic coverage calculation for each Sentinel-2 pixel using the othophotomap produced (Topouzelis et al, 2019).

Plastic Litter Project 2019

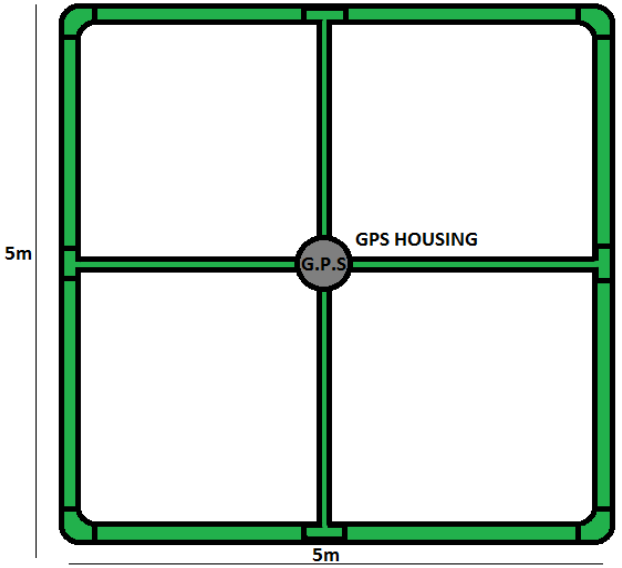
EO tracking of marine debris in the Mediterranean Sea from public satellites (ESA: EO Science for Society permanently open call for proposals)

ARGANS Argans

University of the Aegean

ISMAR CNR-ISMAR

UCA Universidad de Cádiz Universidad de Cádiz



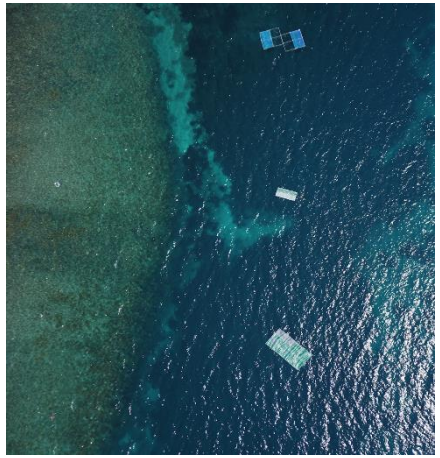
Plastic Litter Project 2019

18/4/2019
Targets in line 100% bottles, 100% bags (10x20m)

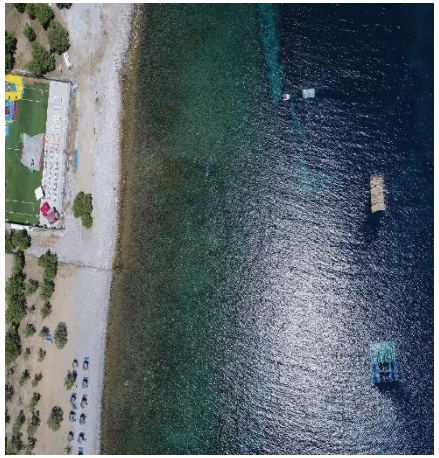
03/5/2019 Single targets 100% bottles, 100% bags & smaller mixed targets

18/5/2019 5x10m targets 75% bottles, 75% bags & smaller mixed targets

28/5/2019
5x10m targets in line 50% bottles, 50% bags & smaller mixed targets



07/6/2019
10x10m 25% bottles, 25% bags & 5x10m 100% reeds



18/4/2019
03/5/2019
08/5/2019
13/5/2019
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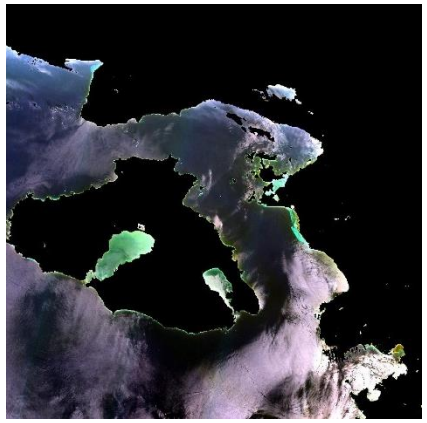
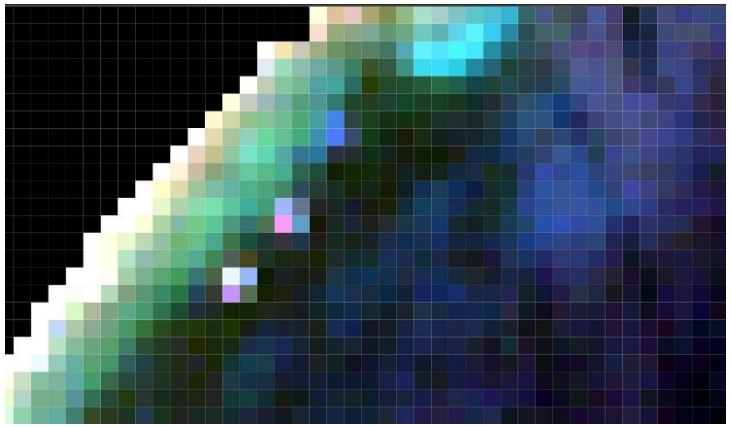
23/5/2019
28/5/2019
02/6/2019
07/6/2019
12/6/2019
17/6/2019
22/6/2019
27/6/2019

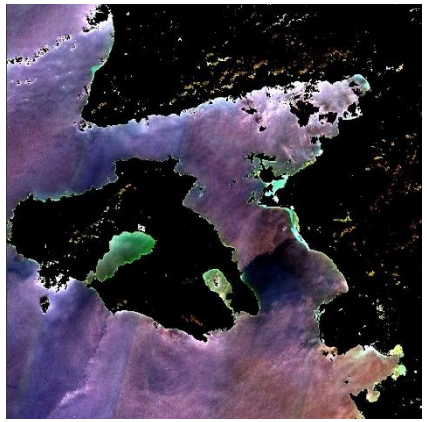
Sentinel 2 Data – PLP 2018 & 2019

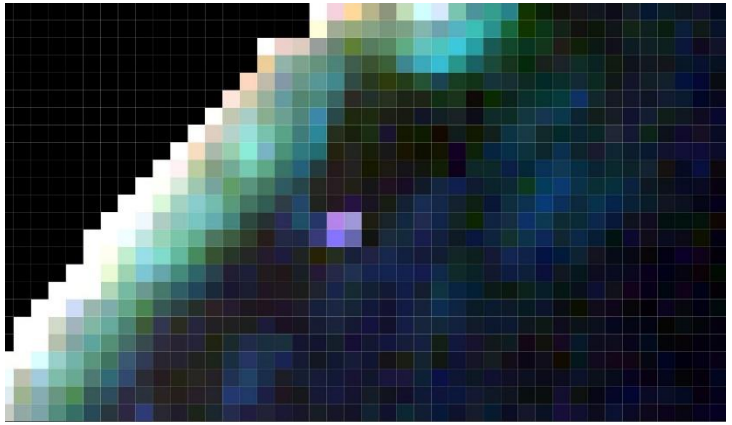
- 20180607

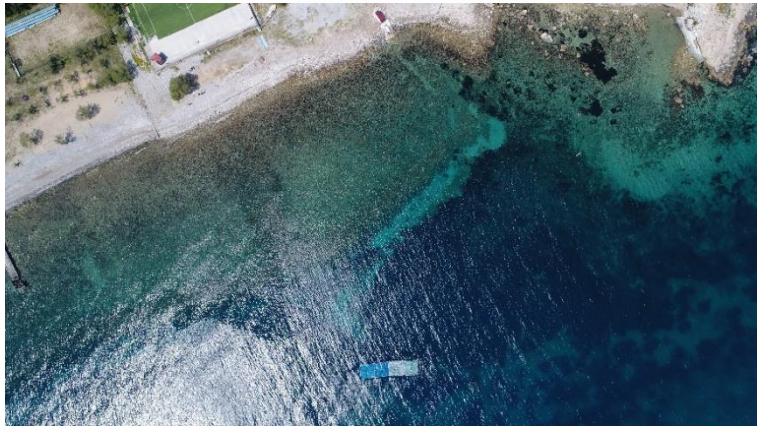




- 20190418







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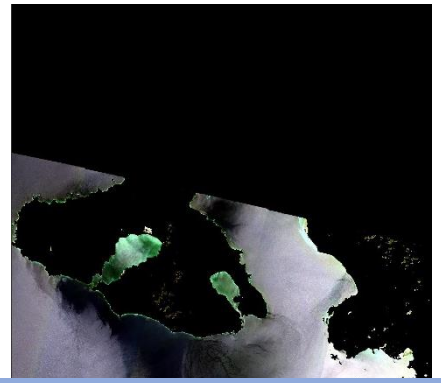
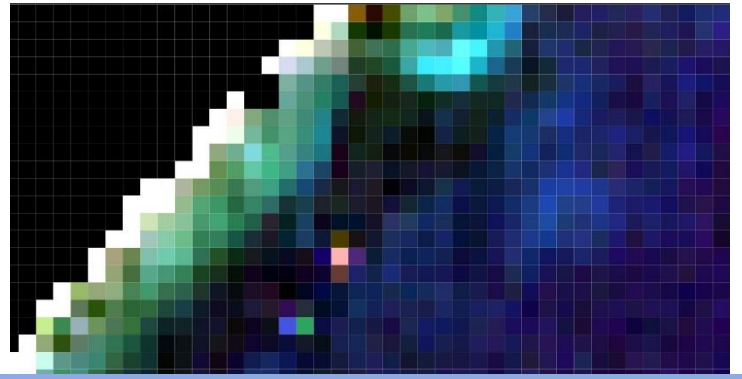
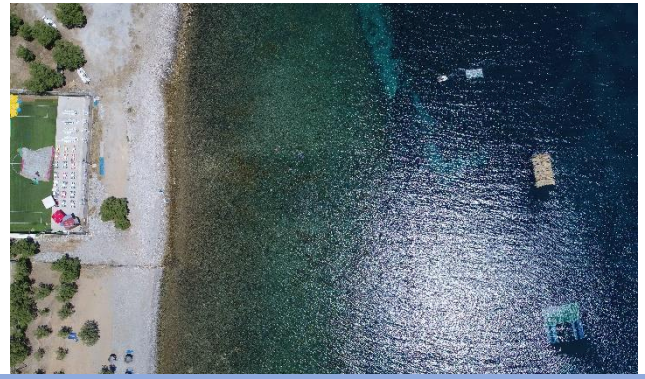




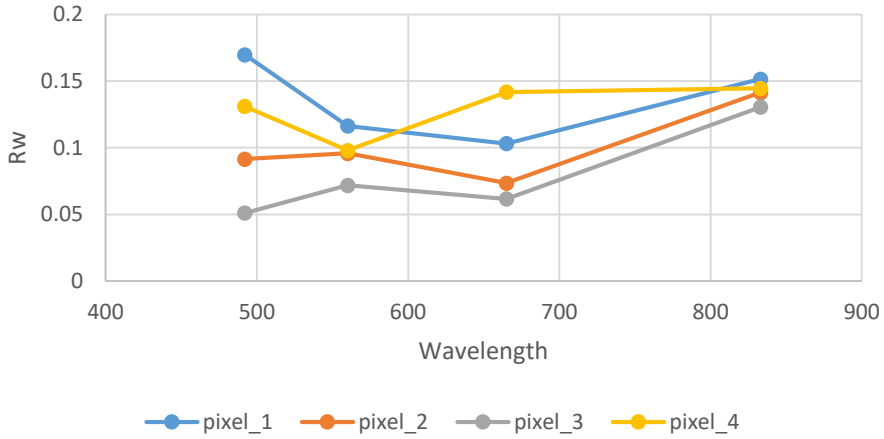


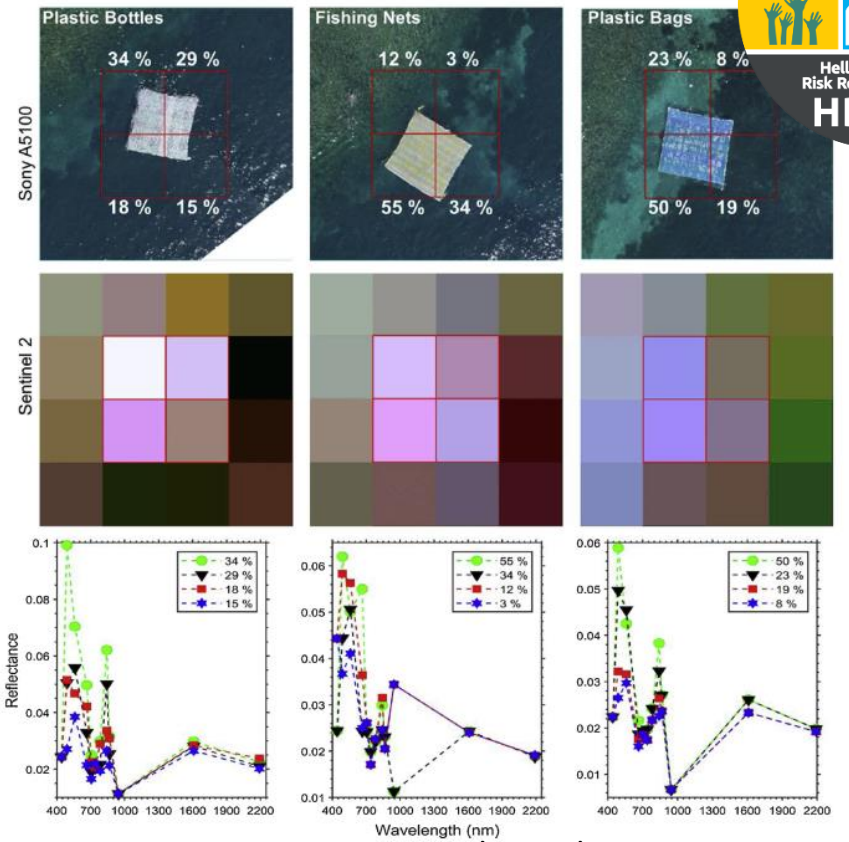
Data Analysis

- Linear Spectral Unmixing:

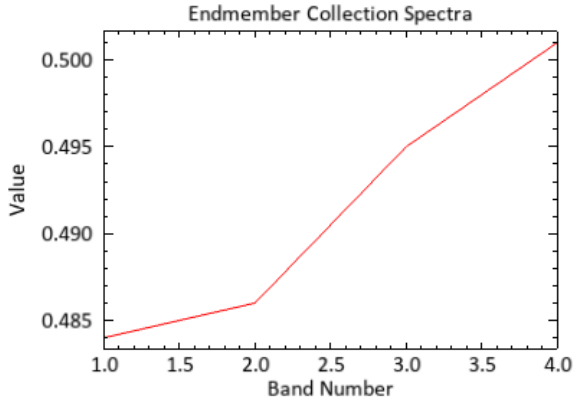
$$Rt = f_w \times R_w + f_p \times R_p \Rightarrow R_p = \frac{R_t - (f_w \times R_w)}{f_p}$$

Unmixed 2018 PET target signatures

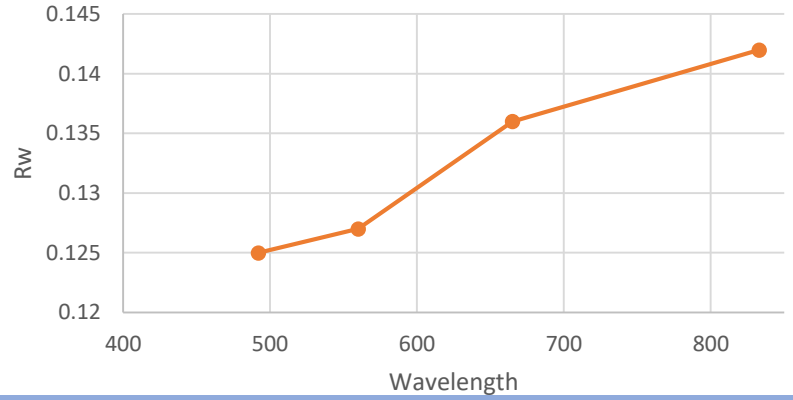


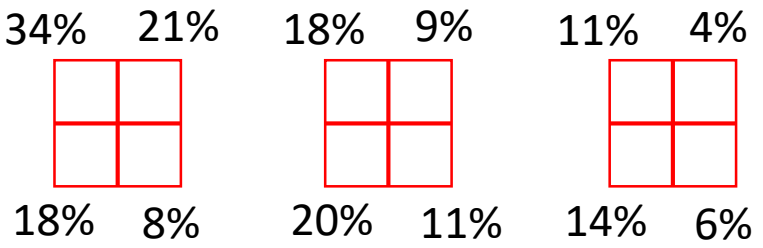


Source: Topouzelis et al, 2019



Adjusted USGS PET signature





Initial Results

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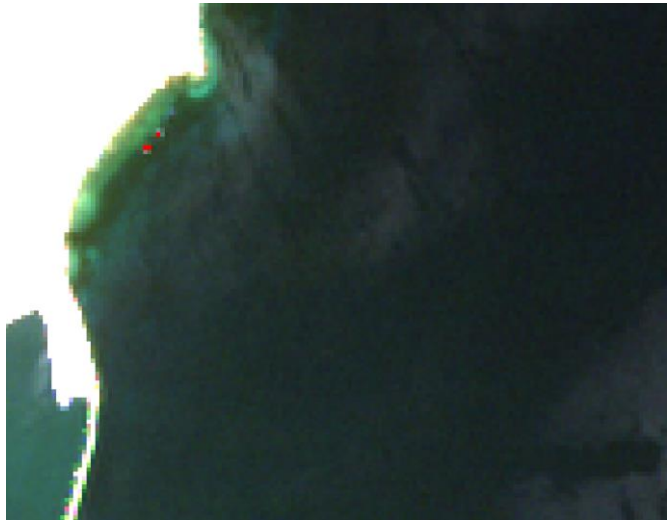

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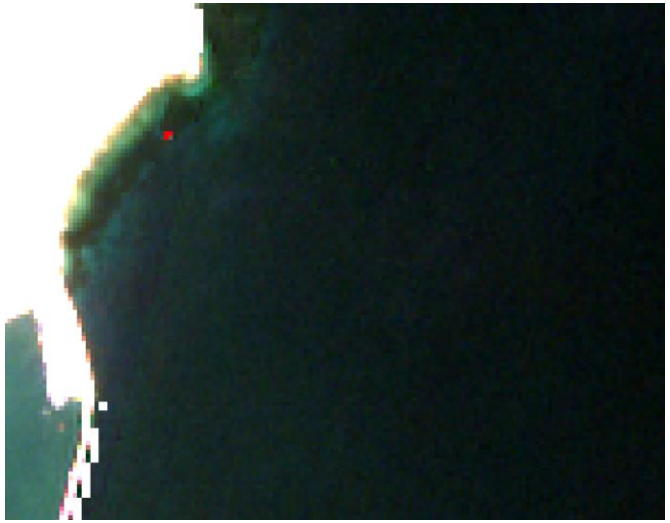

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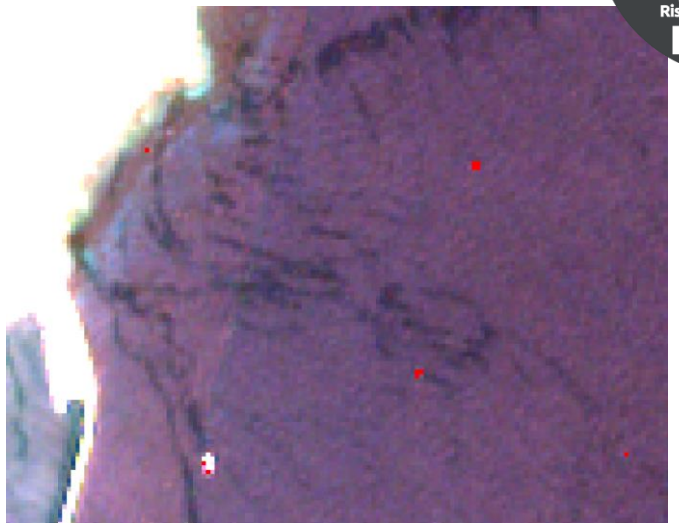

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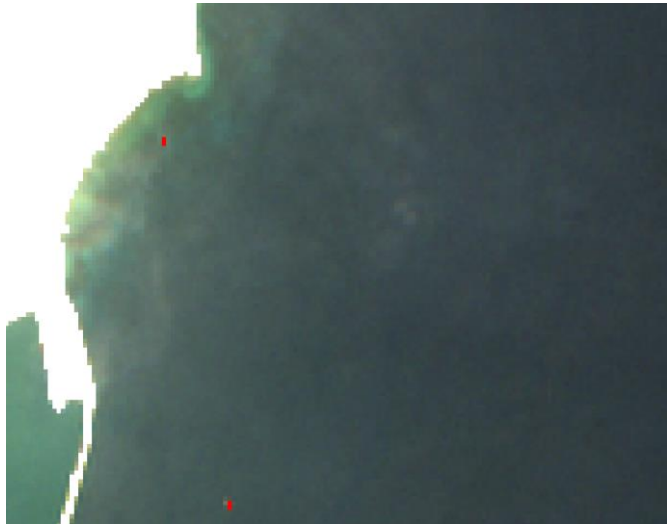

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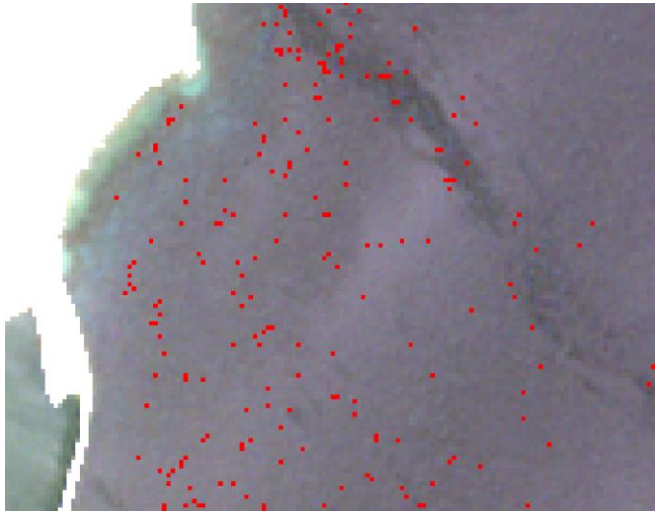

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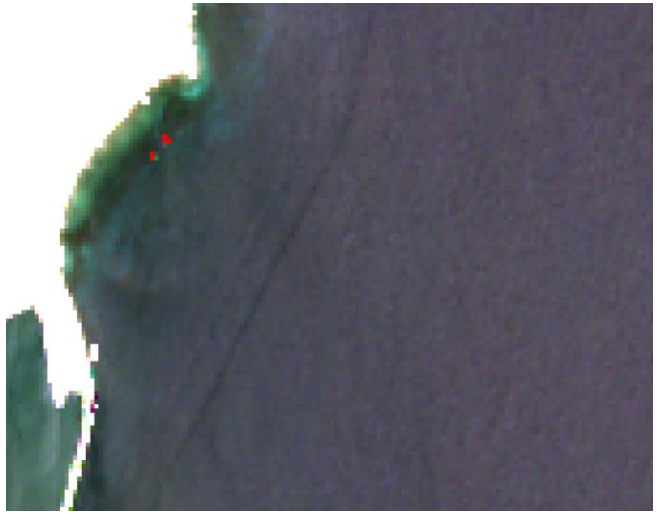
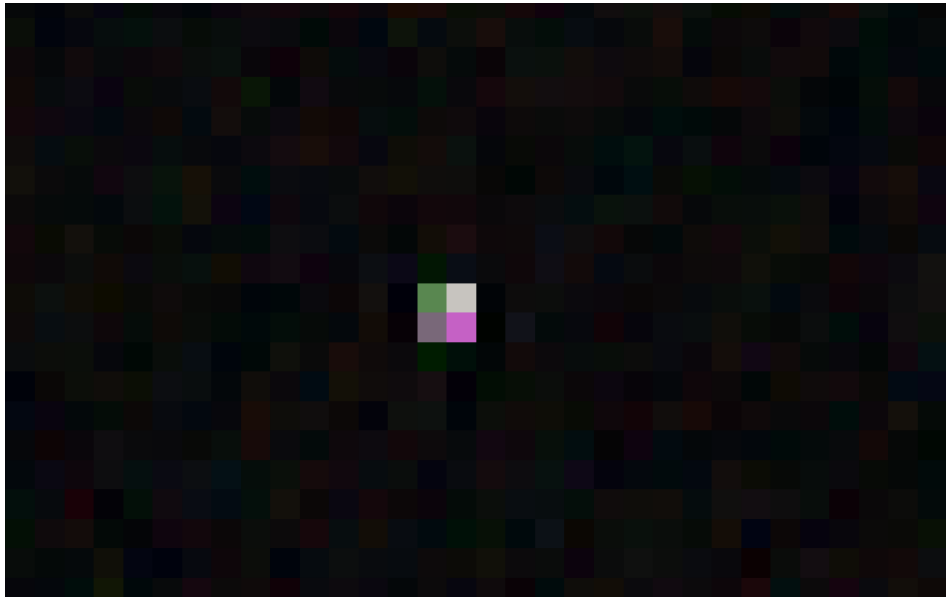
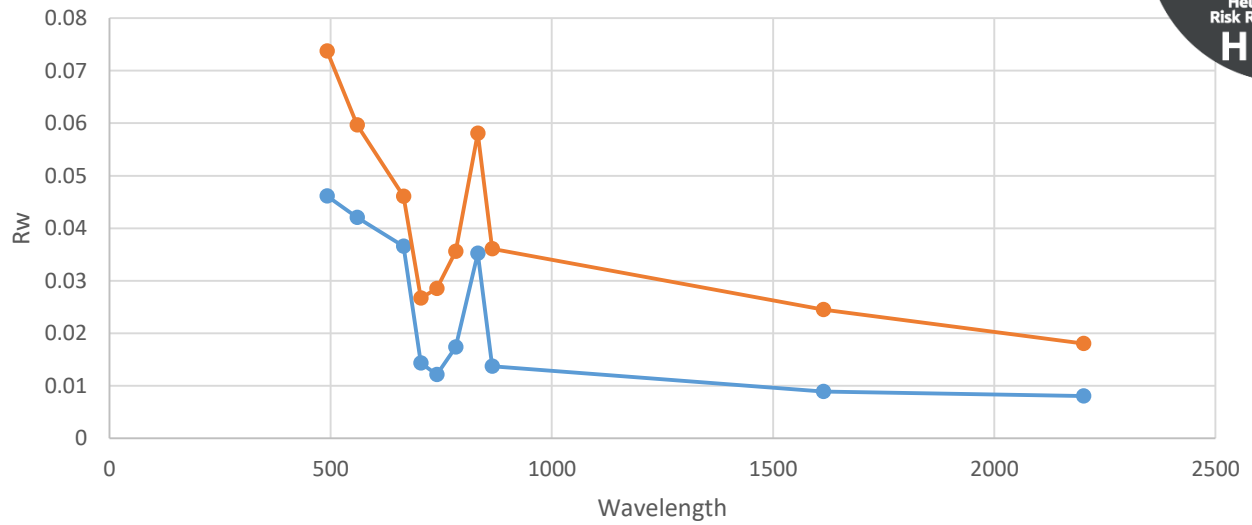
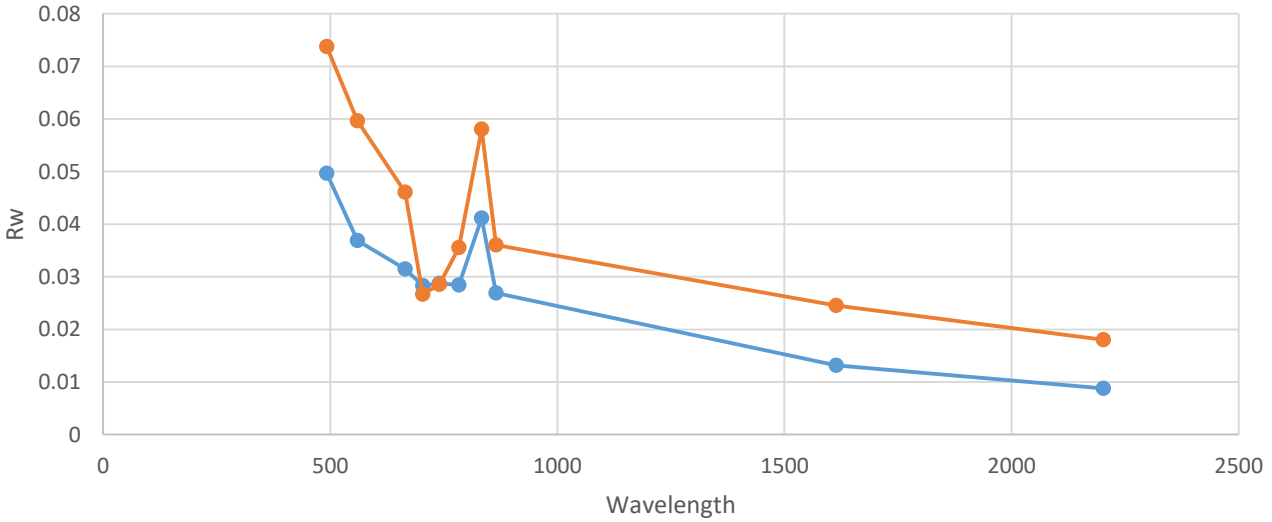


Initial Results

Flagged Pixels





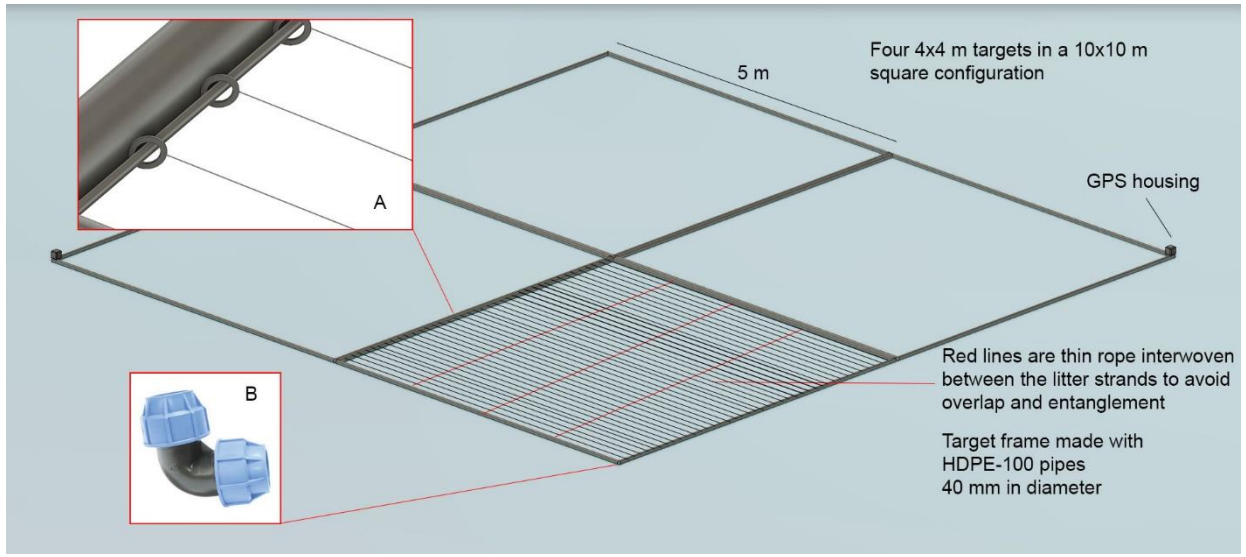


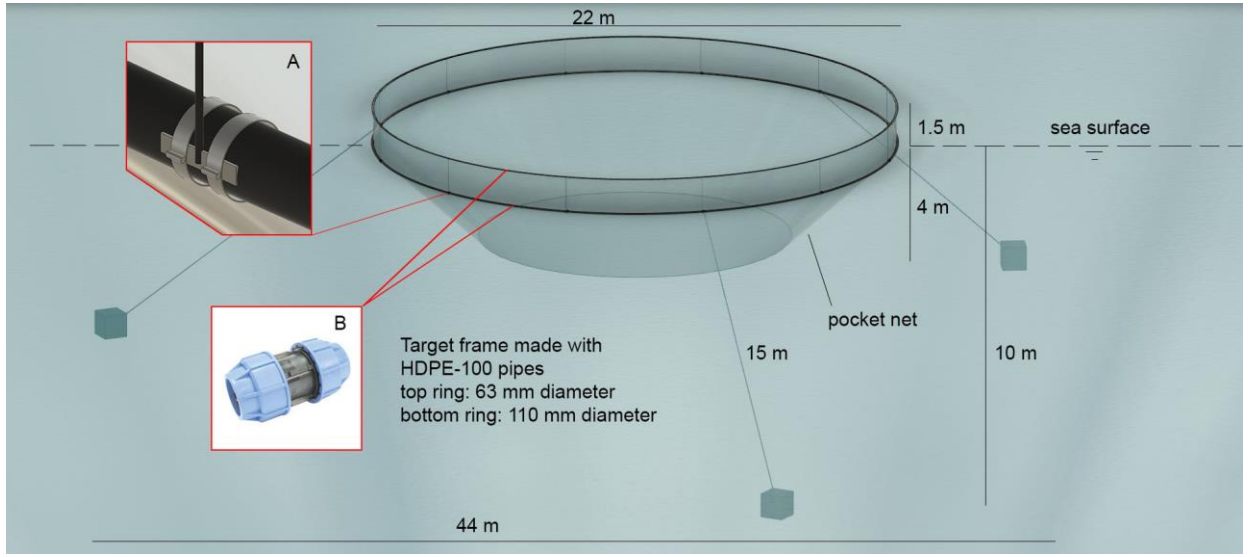
Main scientific inquiries

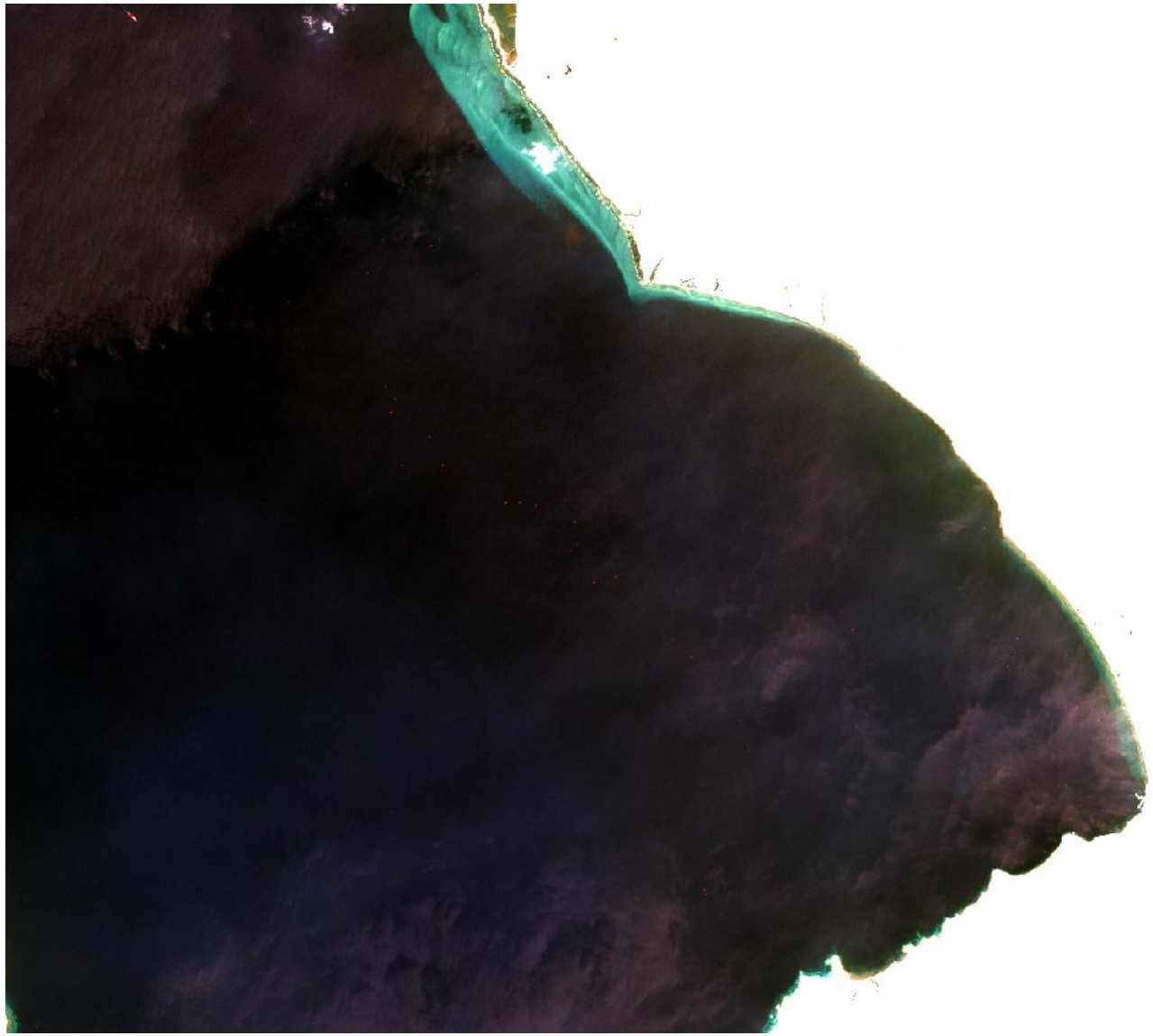
- Min. detectable sub-pixel abundance of plastic debris
- Parameters affecting detection capabilities (e.g. sunglint, bottom reflectance, floating/suspended matter, SNR)
- Optimal atmospheric and sunglint correction methodologies
- Spectral unmixing for quantification purposes
- Relationship between degree of submersion and reflectance properties of plastics
- Floating marine debris polymer identification
- Future mission requirements (e.g. SNR, radiometric/spectral/spatial resolutions)

Planned Further Work – PLP2020

- Development and construction of semi-permanent at-sea infrastructure and re-deployable targets for calibration and validation of marine debris detection methodologies
- Marine debris image database/spectral library of characteristic polymers in realistic conditions (satellite, UAS VHR multi- and hyperspectral imagery, field spectrometry)
- Multi-sensor/platform detection methodologies







Thank you for your attention!

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