



Detection of plastic on the sea surface



Team „More“

Our team

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- computational biology, web development, space technology

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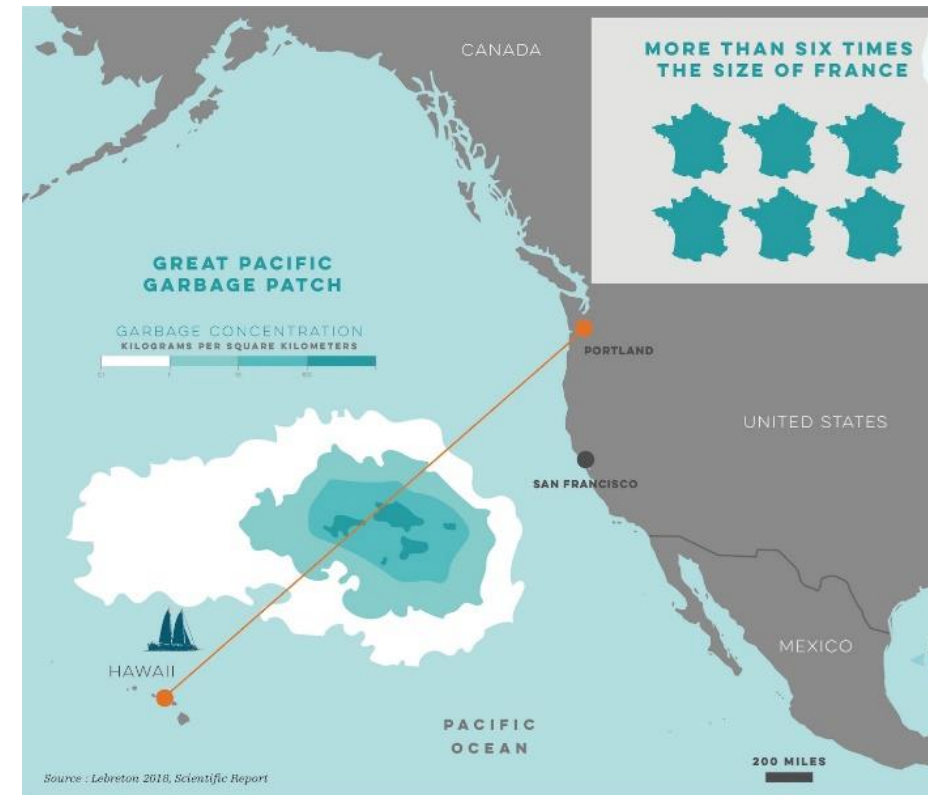
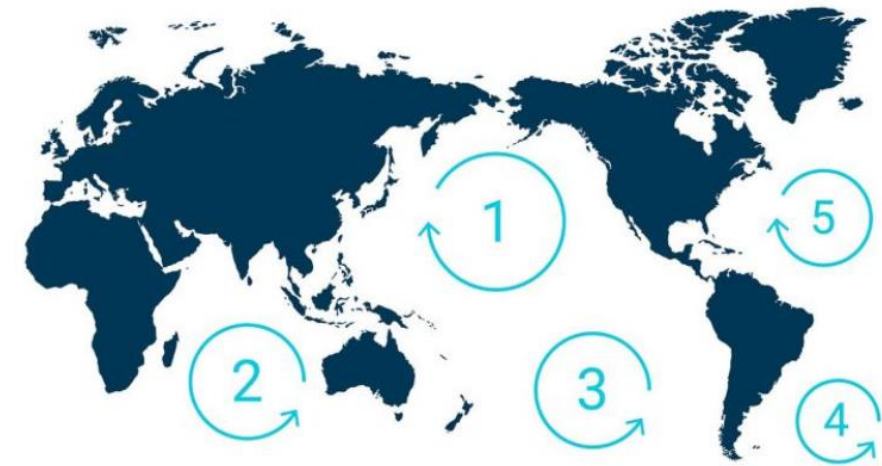


Image source: <https://www.flickr.com/photos/srcehr/>

An urgent problem

- **World oceans:**
 - **Heavily polluted** with plastic carried by gyres (right)
 - **Multiple** floating „plastic islands“
 - Largest „plastic island“ or so called Great Pacific Garbage Patch (GPGP, visible on lower map) covers **1.6 million square kilometers**
- **Croatian sea:**
 - Southern Adriatic sea and coast often polluted with mostly plastic litter **coming by sea from neighboring countries**

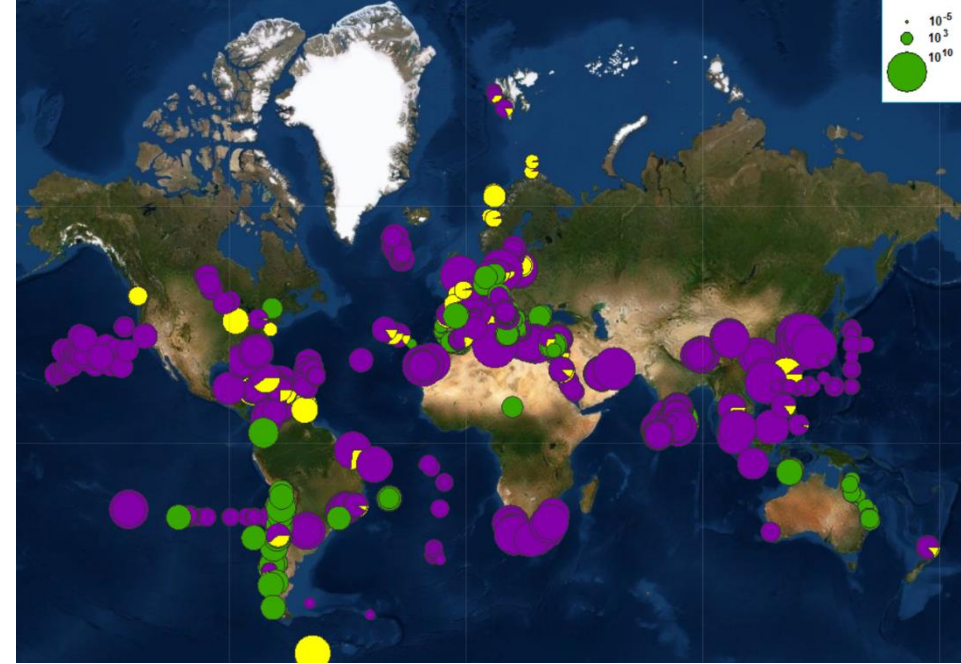
- ➡ **Health and life risk for ocean flora, fauna and human life**
- ➡ **Plastic is not bio-degradable – it will only accumulate or disperse due to sea currents**



Data source: <https://theoceancleanup.com/>

What is our goal?

- Detection of plastic using **satellite data**
 - Prediction of plastic paths, origins and **future locations** (plastic is not static in water)
 - **Wide area** of applicability
 - Since most of sea's pollution is composed of **plastic**, detecting it will also show other large pollution locations
- ↓↓↓
- **Two stages** of developing the detection algorithm:
 - 1) Detection of plastic on **open sea**
 - 2) Applying and additionally refining the algorithm for application to **coastal areas** (due to heavy interference from the coast and near coast sea area like ship and plane traffic)



Plastic pollution (items/km²) in years 2015-2019, red marking plastic. Source: <https://litterbase.awi.de/litter>

Global composition of marine litter

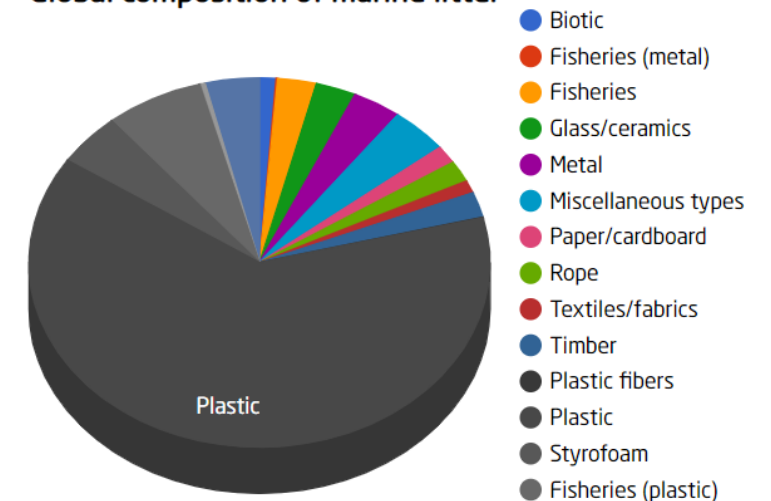


Image and data source: <https://theoceancleanup.com/>

First stage: Open sea detection

I. Temperature based detection (Sentinel 3):

PROS: - plastic heats up easily, easy marker to find

CONS: - ships also leave thermal signature
- low image resolution

II. Spectral imagery based detection (Sentinel 2 and Sentinel 3):

PROS: - easy to find differences based on individual pixel color
- high resolution data (if Sentinel 2 images are available)

CONS: - harder detection if only Sentinel 3 images are available

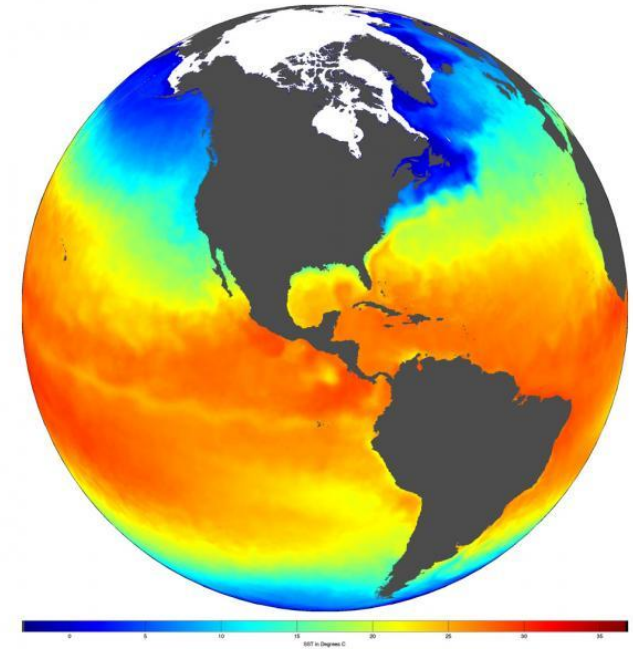
III. Reflection (Sentinel 3):

PROS: - plastic has a different reflectance value than water and is easier to detect

CONS: - plastic is often see-through
- plastic patches may not be dense enough due to sea currents

IV. Other confirmation possibilities:

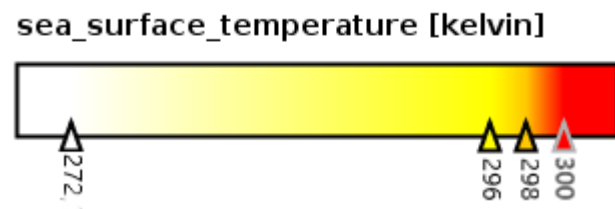
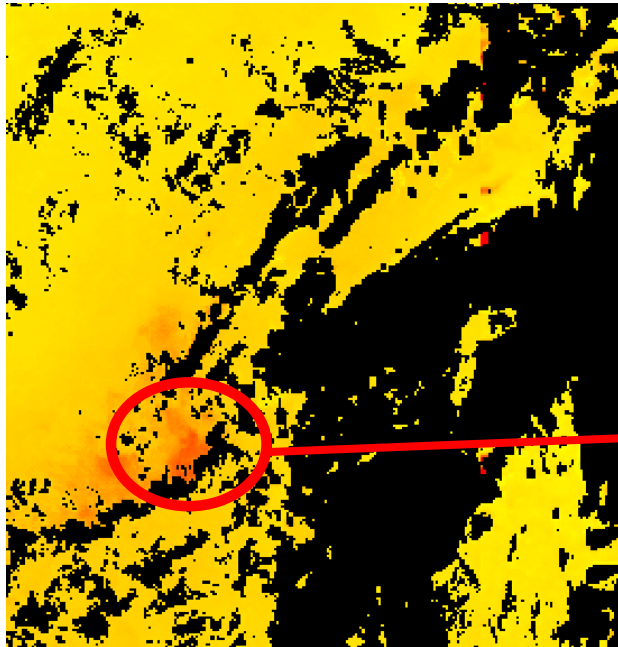
- **UV radiation** (Sentinel 5) – yielded mixed results
- **Microbiota** based detection (Sentinel 1 SAR) – only in controlled environments, currently unavailable as open source



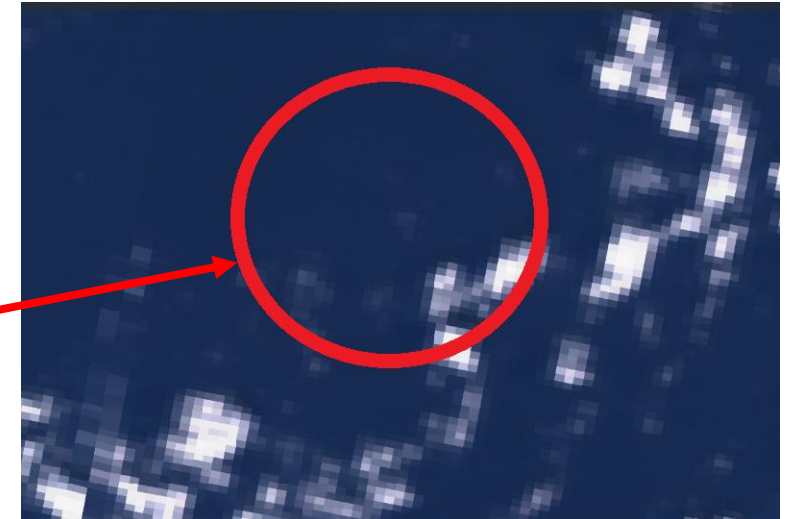
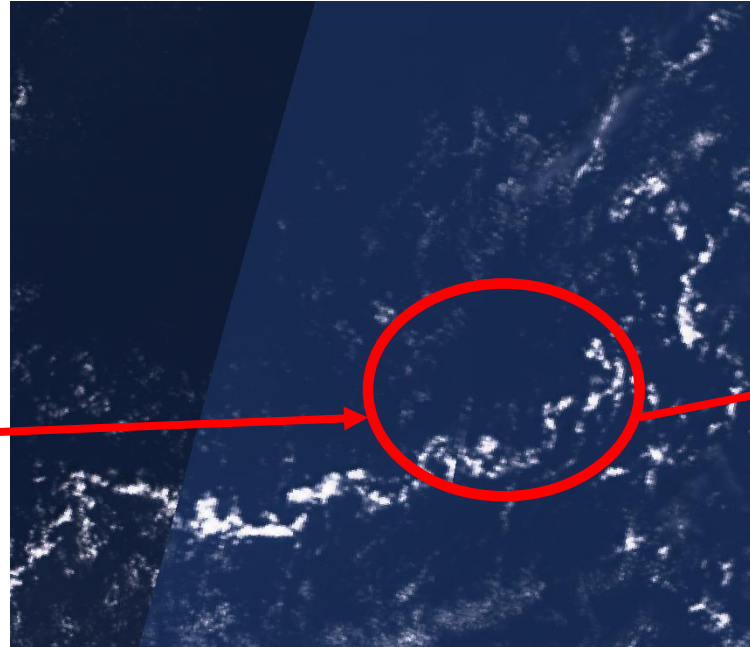
Example of open sea detection

Date: 10.9.2019., Great Pacific Garbage Patch – Coordinates: Longitude: 140°09'26" W degree, Latitude: 31°34' N degree

Sentinel S3B SLSTR
(Sea Land Surface Temperature)



Sentinel S3B OLCI
(Ocean and Land Colour Instrument)



Sentinel thermal sensors (left image) show elevated temperature while optical sensors (right) show no noticeable visible changes or sources of heat of that size. Plastic is often transparent or hard to see in water and is only available explanation

Second stage – coastal area detection

- Algorithm used for open sea detection needs to be **refined and adjusted**
- Coast and near coast area more challenging:
 - Prominent **ship traffic**
 - **Airplane traffic**
 - River and exhaust **water inflow** into the sea
 - Various **sources of reflection**
 - Coastal **sources of heat**
 - More visible **flora and fauna**
 - A lot of **small, more mobile pieces of plastic** due to sea currents
 - Inflow of **mixed debris** from surrounding countries

Sentinel 2 L1C, True color



Moving ships have thermal footprint but also leave a wave „tail“

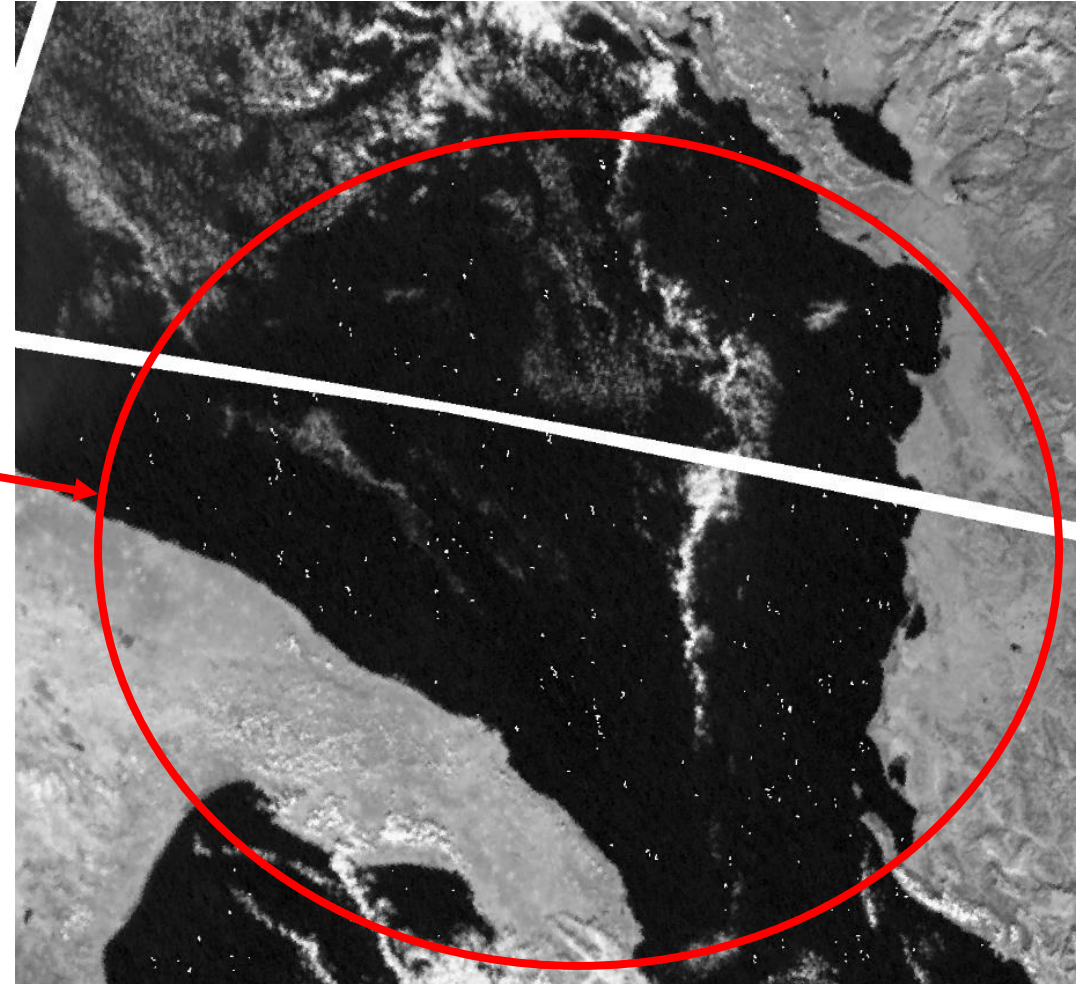
Example of coastal detection problems

Date: 19.10.2019. Southern Adriatic Sea

Sentinel 3 OLCI



Sentinel 3 SLSTR



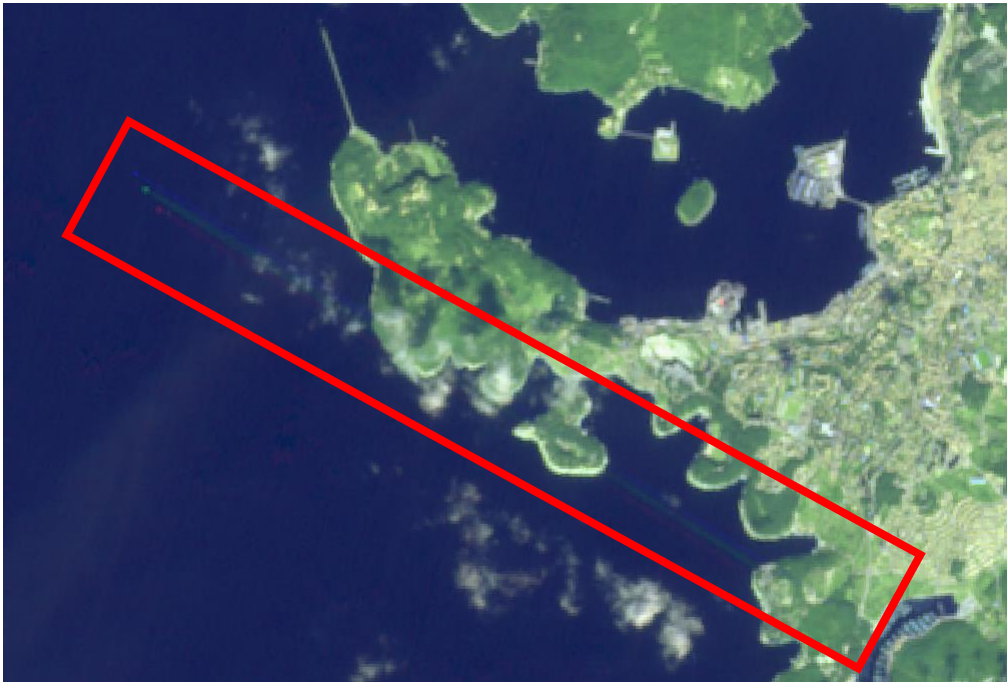
Optical sensors show no change,
while Southern Adriatic sea is filled with highly
reflective objects of unknown origin

Other example of coastal detection problems and possible solution

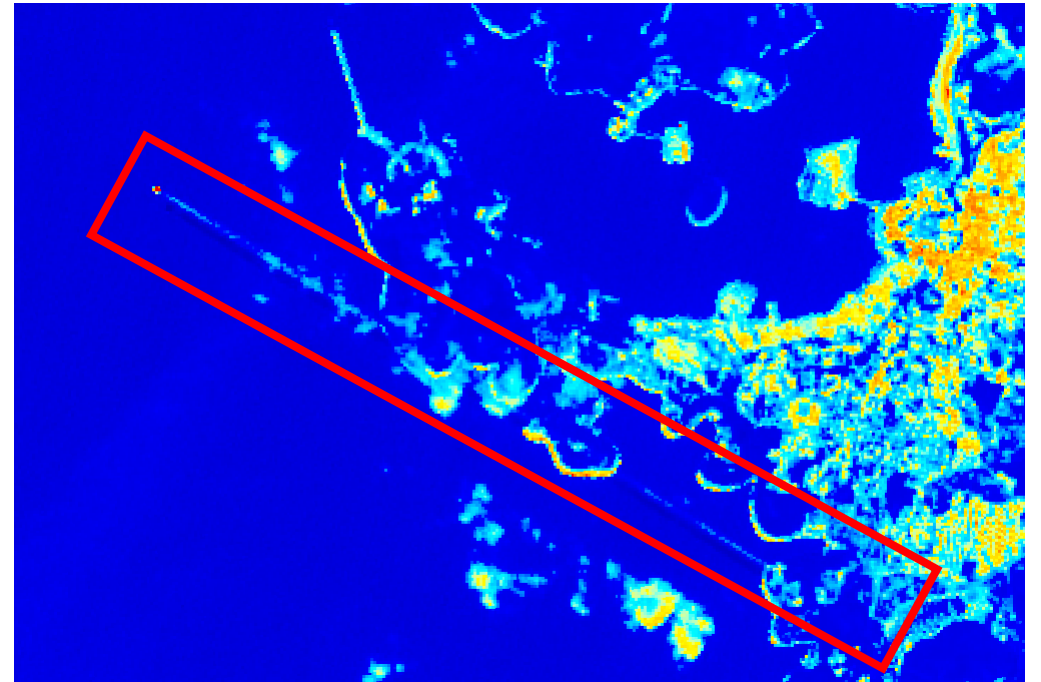
Airplanes (shown here) and ships leave thermal footprint and are highly reflective, but can be distinguished by Moisture sensor (Sentinel 2) which will show their trail:

Date: 23.10.2019., near Istria

Sentinel-2B L1C, False color (urban)



Sentinel-2B L1C, Moisture index



Future work and goals

- Further **improvement of detection algorithms** on sea and on coastal areas (UV, SAR?)
- Get more **experts** on board from marine and biology fields
- Possibility of cooperation with microbiology science field by **using microbiota** (laboratory grown bacteria which feeds on plastic) as marker which would include Sentinel 1
- **Machine learning** for big data processing and necessary exclusions on coastal areas
- Development of **web** and **mobile** apps for users to access data (marine protection agencies, policy makers, private organizations, etc.)



Sentinel 2. Image © ESA

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