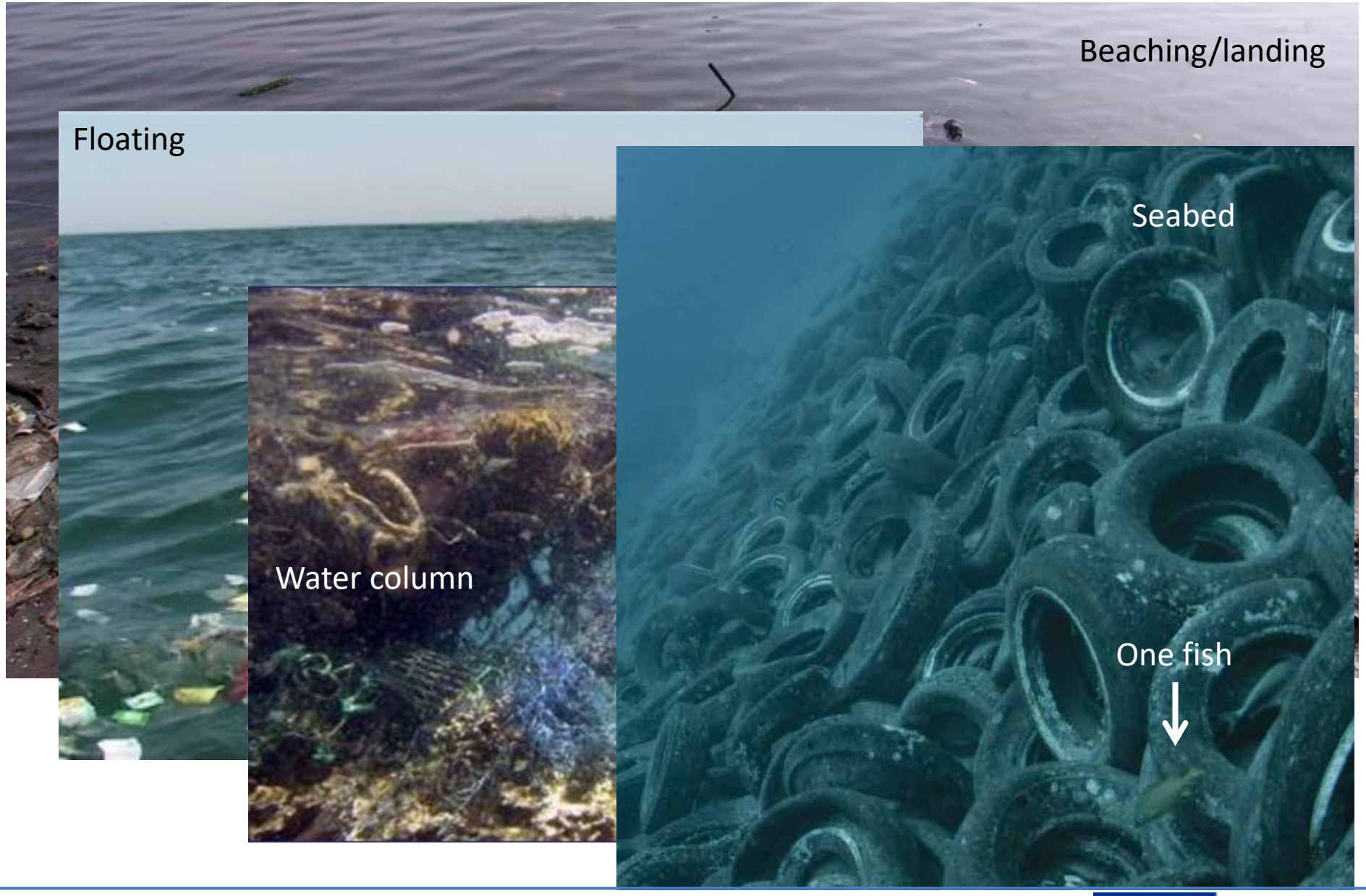
The Deployment of a Multi-source Observing System for Marine Litters at the Mediterranean Basin Scale

Antoine Mangin[1,2], Francois-Regis Martin-Lauzer[1], Manuel Arias[1] Mark Hennen[1], James Delaney[1] , Fanny Galland[2], Amine Taji[2], Odile Fanton d'Andon[2]

Outlines of this presentation

- Marine litters – the situation (focus in the Med)
- Needs for observation
- Means for observation (ARGANS perspective)
  - Earth Observation
  - Modelling
  - Citizen/participative science
- Conclusions - Next steps

Marine litters – the situation



Out of sight, out of mind

THE QUANTITATIVE DISTRIBUTION AND CHARACTERISTICS OF NEUSTON PLASTIC IN THE NORTH PACIFIC OCEAN 1985-88

Robert H. Day

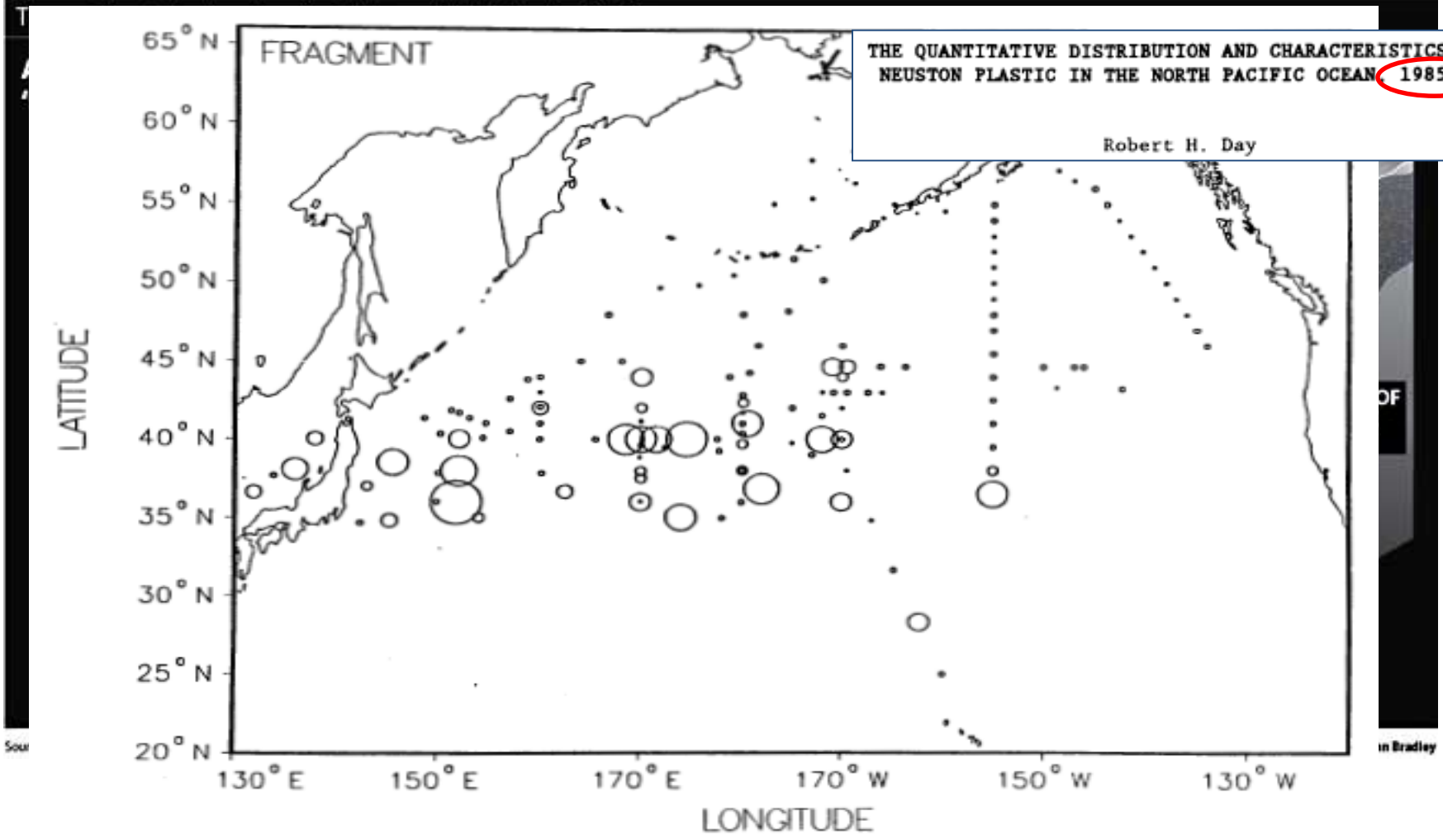
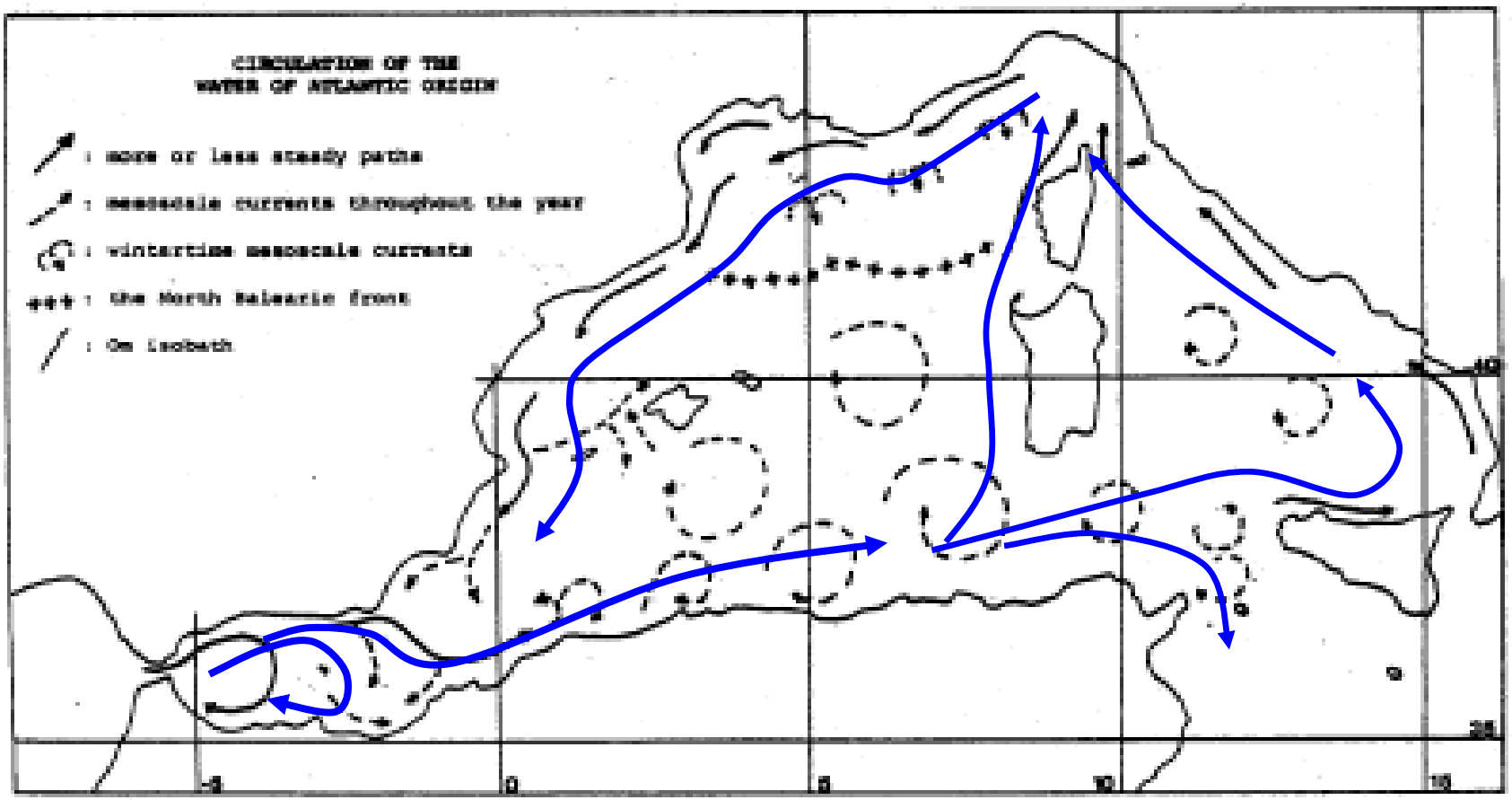


Figure 4.--Densities of fragments, 1985-88. Solid black circles indicate stations at which neuston plastic was not recorded. Sizes of hollow circles indicate relative densities. The highest density was 288,000 pieces/km^2.

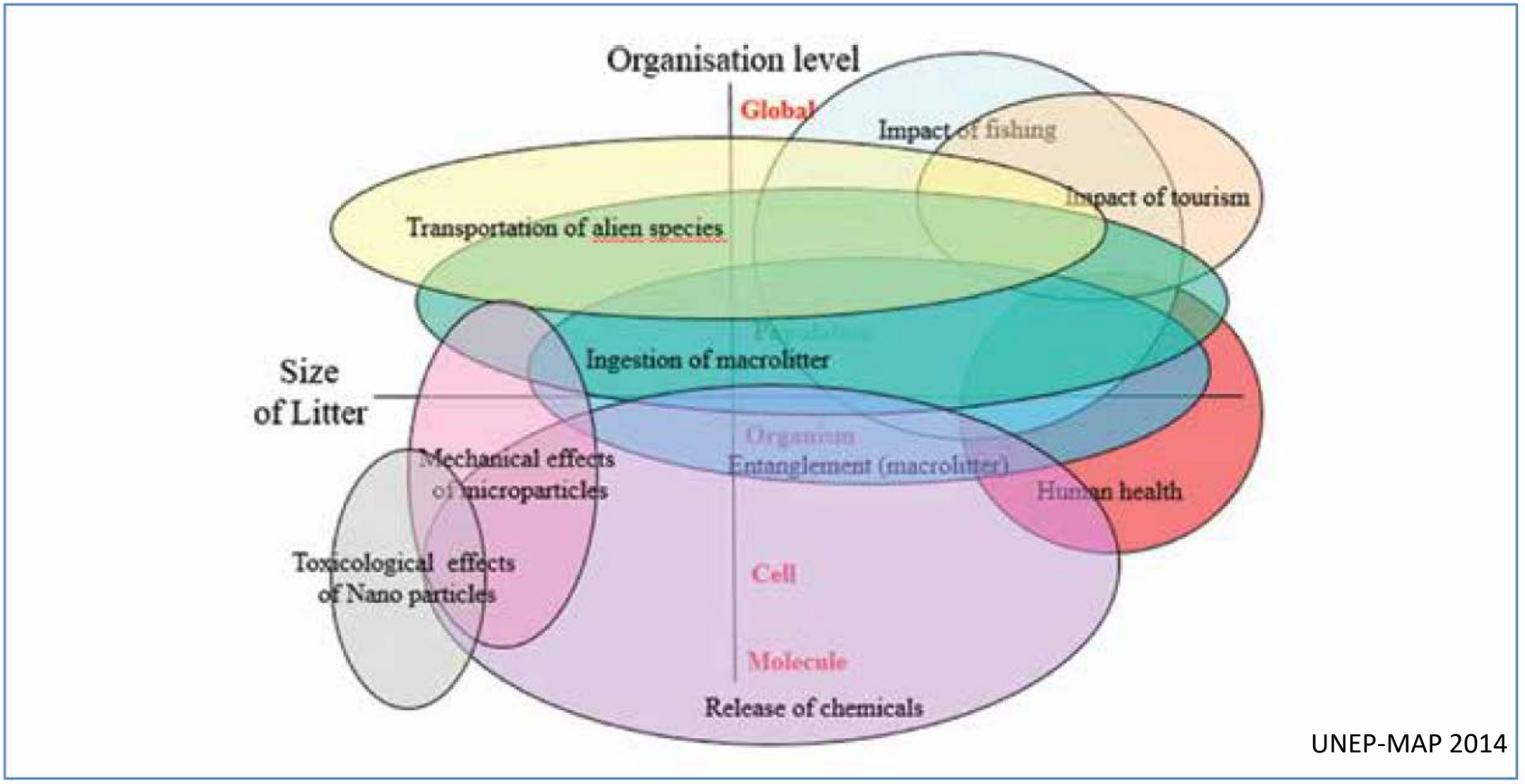
- ✓ No evidence of garbage patch in the Med – today
- ✓ Mainly plastics



- ✓ Estimates : 62 millions of macrowaste floating for the whole Med
- ✓ Everything is coming from land and sea (even through Gibraltar) – no escape.

Zambianchi et al. 2014

Needs for observation



UNEP-MAP 2014

Micro-waste ⟷ Macro-waste

Biological and eco-societal impacts

Environmental regulations

- Marine Strategy Framework Directive (marine litter is descriptor #10)
- Mediterrannean Action Plan (Barcelona convention – UNEP) – Regional Plan 2014

…

→ Very good opportunity to establish North-South Cooperation

Needs to monitor locations of:

1. Emission / release of macro-waste (for reduction/ control)
2. Landing/beaching

(for pollution fight, coastal spatial zoning, moorings and navigation routes)

3. Floating filaments and patches (for cleaning)
4. Volume and location of marine litters on the sea floor

Objective is to merge efforts to demonstrate what is feasible/useful and could be operationaly deployed -> **consolidate a roadmap in addition to existing efforts.**

Monitoring

Emission / release of macro-waste

- EO (sentinel-2) – drones – fixed camera (movie)
- Modelling (emission coefficient based on land use on watershed) --
- Participative observation by professional – or citizens

Landing/beaching

- EO (sentinel-2) - drones
- Modelling (statistics)
- Participative observation by citizens and professional

Floating filaments and patches

- EO (sentinel-2 / Sentinel-1 ?)
- Participative observation by marine professional (fishermen, transportation…)

ARGANS

Environment Agency

CORNWALL COUNCIL

Space for Smarter Government Programme

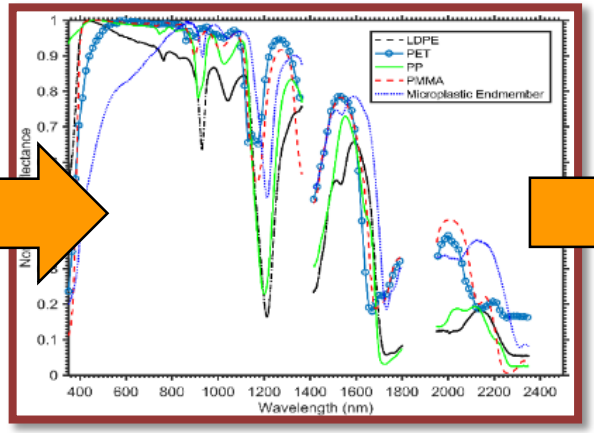
Copernicus

Marine Litter Programme

- esa — Remote Sensing for Marine Litter -RESMALI-
- UK SPACE AGENCY — GeoInt Service for Marine Litter -SSGP Project-
- esa — EO Tracking of Marine Litter in the Mediterranean Sea
- Copernicus — Copernicus Service for Marine Litter

Goals of the RESMALI project

- Characterization of physical properties and meaningful spatial and time scales for marine litter.
- Definition of remote sensing observational requirements of data acquisition for scientific and downstream applications.
- Identification of best potential technologies and instrument ensemble that could compose an EO mission for marine litter.



Characterization of marine litter

- Based on the **marine domain** under consideration


Beaches


Shallow waters


Open Ocean

- Based on the **marine litter fraction** under observation


Large Items


Small pieces and fragments


Microplastics

Characterization of marine litter

ML Characteristic	Domain			
	Open Ocean	Continental Shelf	Coastal Area	Shores & Beaches
Variability	Low (months to years)	Medium (months to weeks)	Medium to High (weeks to days)	Very high (days to hours)
Residence time	Long	Medium to short	Short	Long to short
Origin	Plastics (PP, PE)	Plastics (PP, PE, PS, PET) Organic	Plastics (PP, PE, PS, PET) Organic, Rubber, Paper	Plastics (PP, PE, PS, PET) Organic, Rubber, Paper, Metal
Accumulation factor	Global currents	Wind/currents transport, human activity	River mouths, run-offs, dumping, human activity	Tidal/storm stranding, dumping, human activity

Complexity

Characterization of marine litter

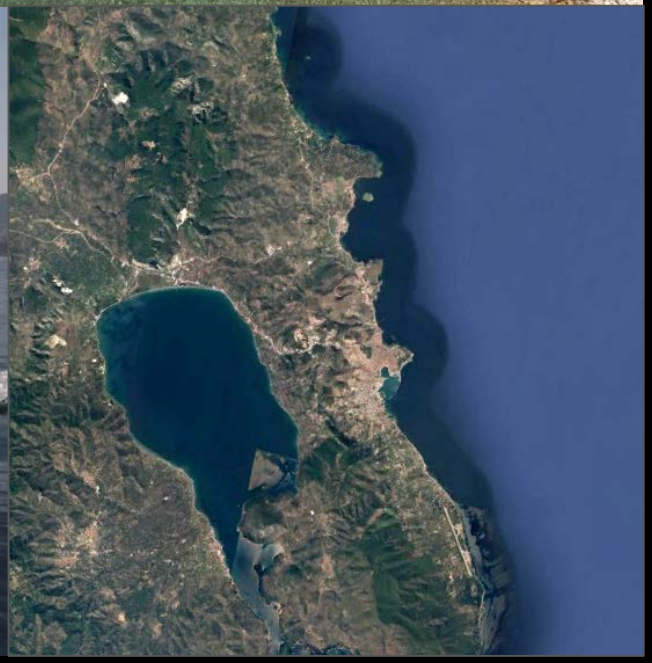
Characteristic	ML fraction			
	> 200mm	200-5mm	5-1mm	<1mm
Abundance	Very low	Low to medium	Very high	?
Total mass	Very high	High to medium	Medium to very low	?
Vertical zoning	0-5m	0-5m	0-5m	?
Main composition	PE, PP, PET, PS	PE, PP, PET, PS	PE, PP	PE, PP

Large items accumulate most of mass but are the less abundant

Smallest fractions are composed by fewer materials

Most of observable ML is found at the surface of the oceans

Advances with Sentinel-2

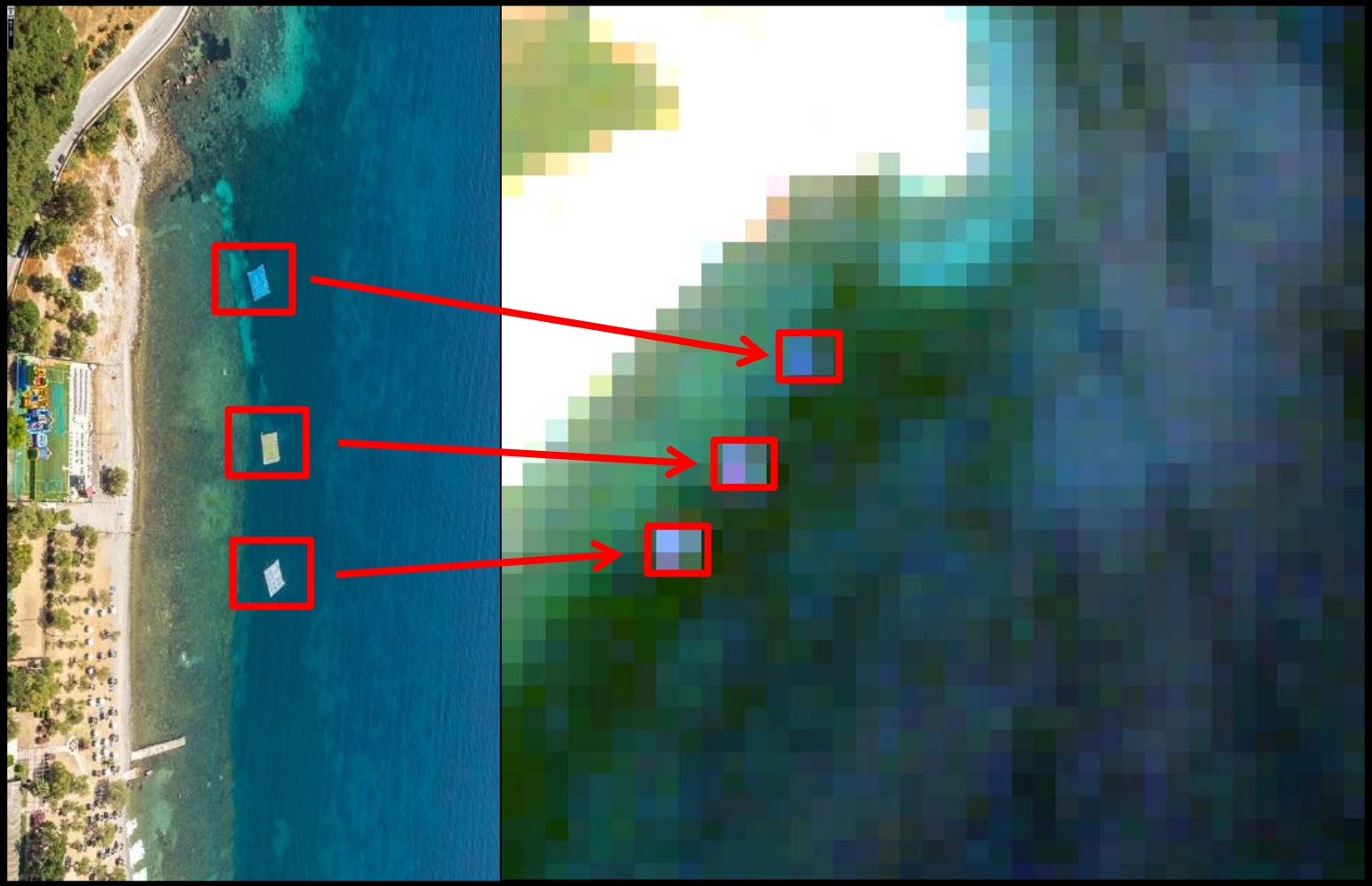


Project: EO Tracking of Marine Debris in the Mediterranean Sea

Advances with Sentinel-2

Deployment of 10x10m patches of plastic materials in Lesbos Island

Sentinel-2/MSI Image Natural colour RGB (Band 4 / 665 nm, Band 3 / 560 nm, Band 2 / 490 nm)

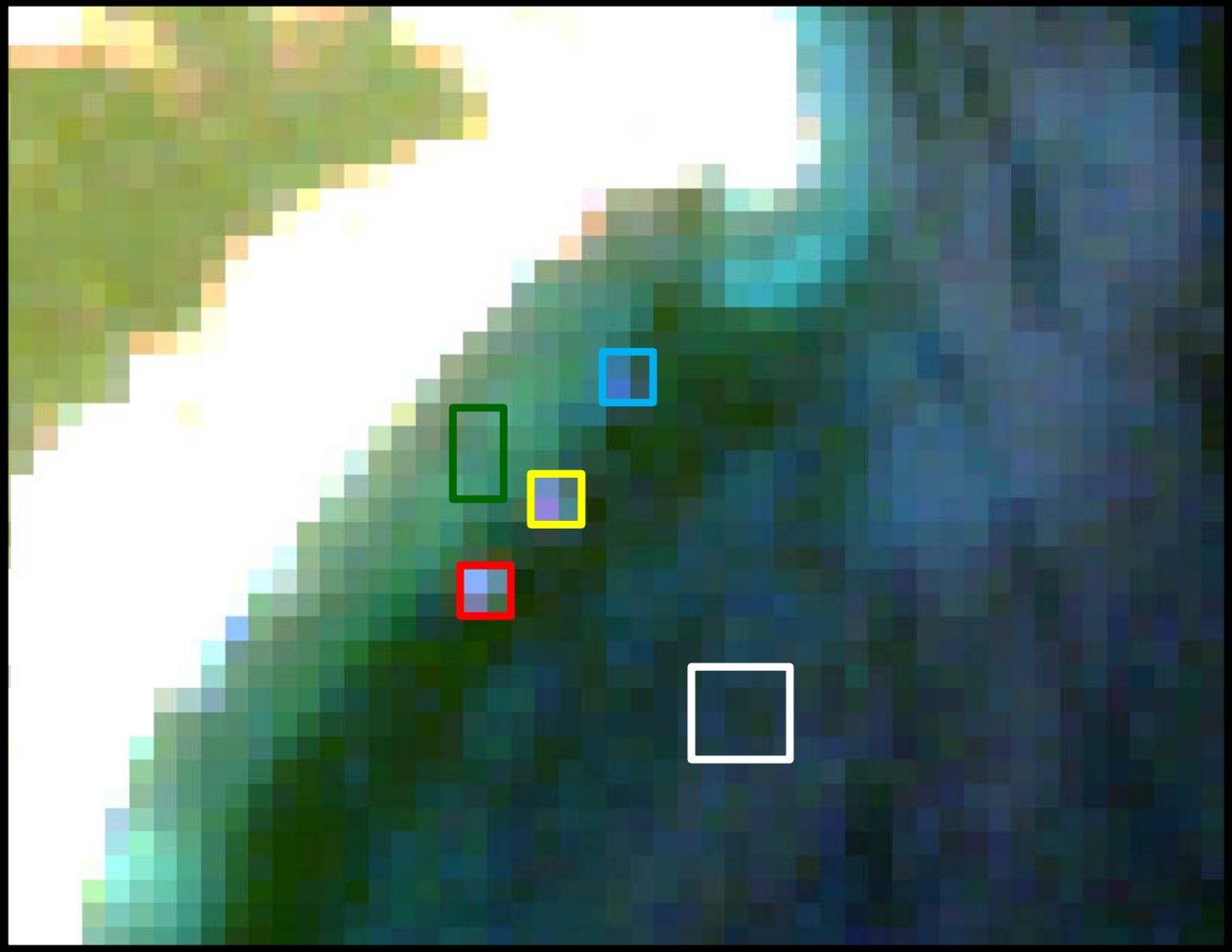


02/02/2018

Sentinel-2/MSI has capability to observe sub-pixel marine litter

Deployment of 10x10m patches of plastic materials in Lesbos Island

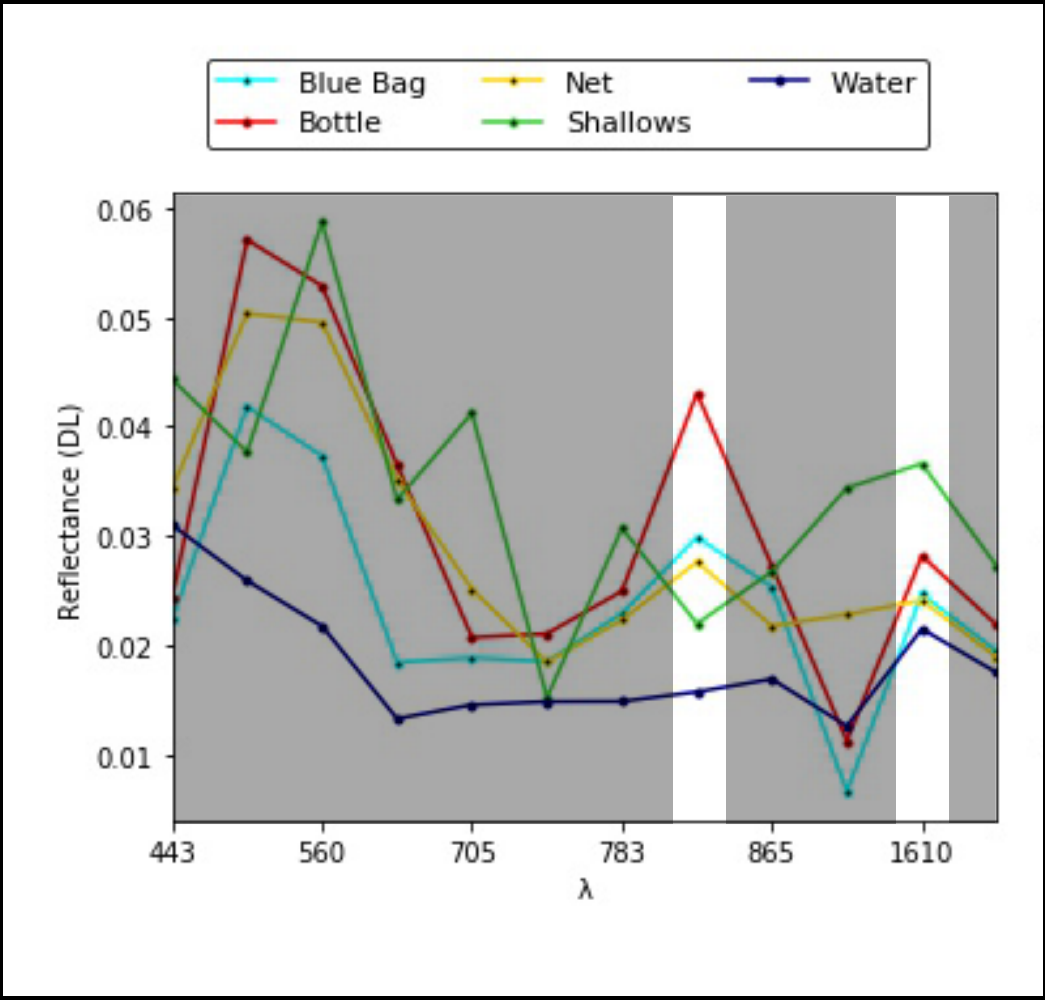
Sentinel-2/MSI Image Natural colour RGB (Band 4 / 665 nm, Band 3 / 560 nm, Band 2 / 490 nm)



Selection of areas for spectral data study

Deployment of 10x10m patches of plastic materials in Lesbos Island

Sentinel-2/MSI spectral data over selected classes

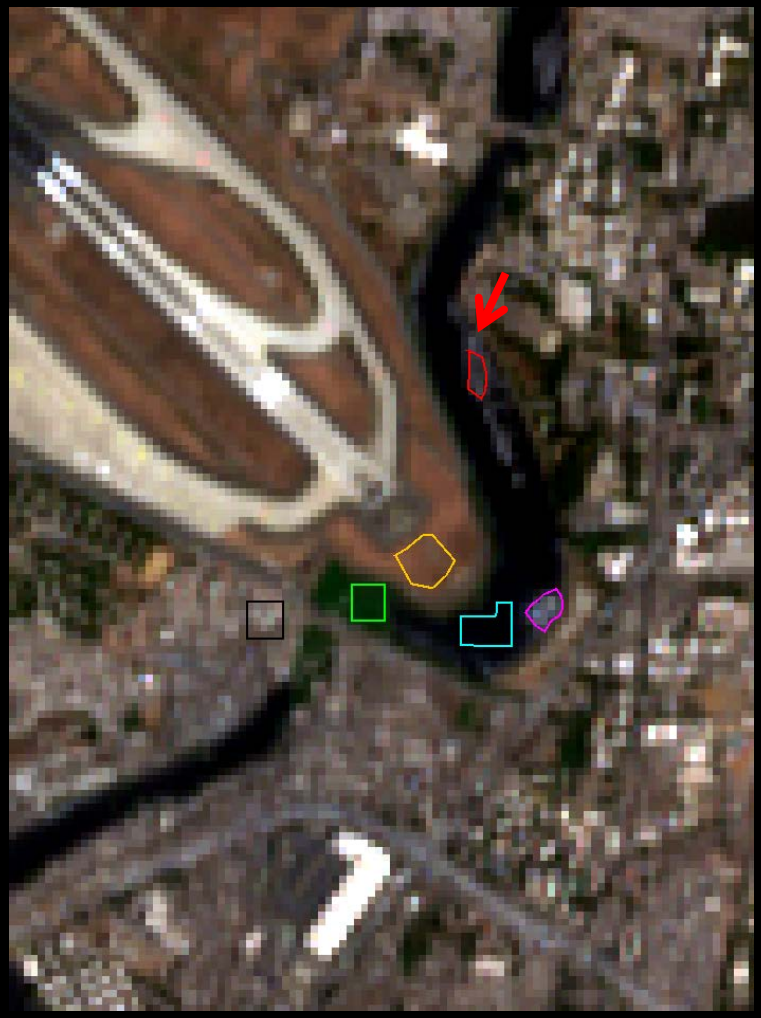


Plastic litter has identifiable pikes in NIR (Band 8 – 835 nm) and SWIR (Band 11 – 1613 nm)

Mithi River, Mumbai

Plastic pollution along the raised banks of the Mithi River, Mumbai. Top left: Google Earth image showing the modified section of Mithi River (Top right). Source: Hindustan Times.

Advances with Sentinel-2



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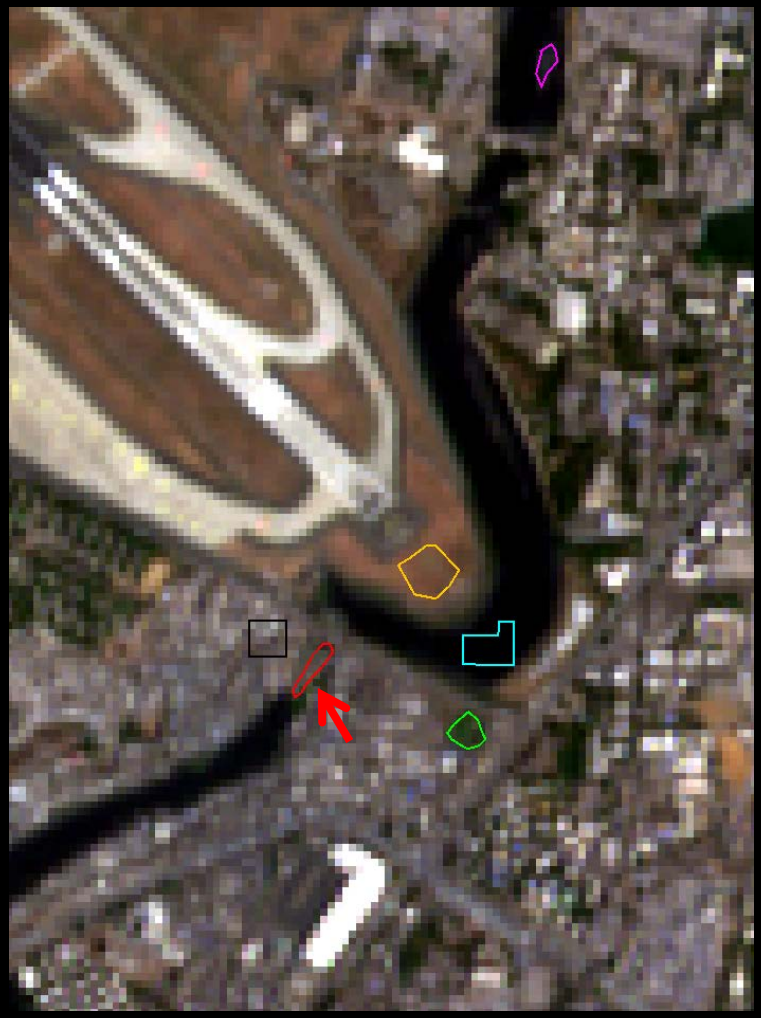
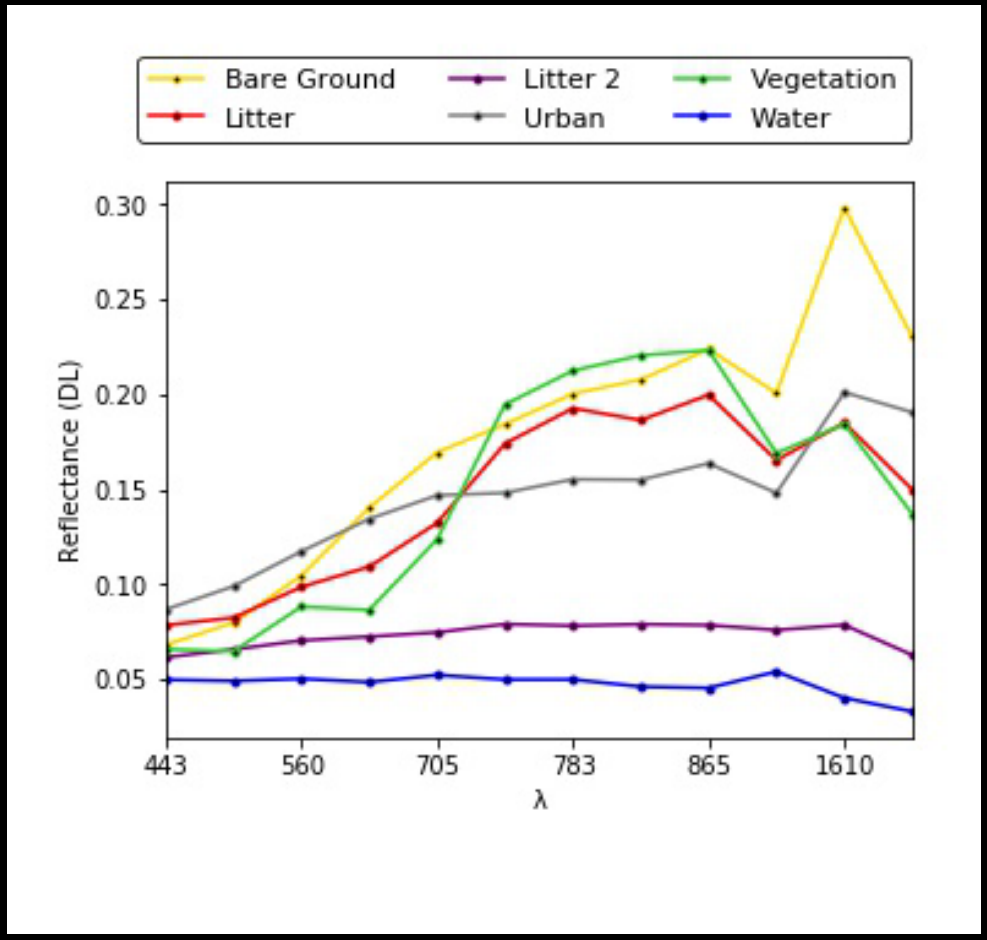


19/03/2018

Mithi River garbage patches (red polygon) as seen in Sentinel-2/MSI Natural color RGB image

Sentinel-2 can capture variability of litter in targeted and confined areas

Advances with Sentinel-2

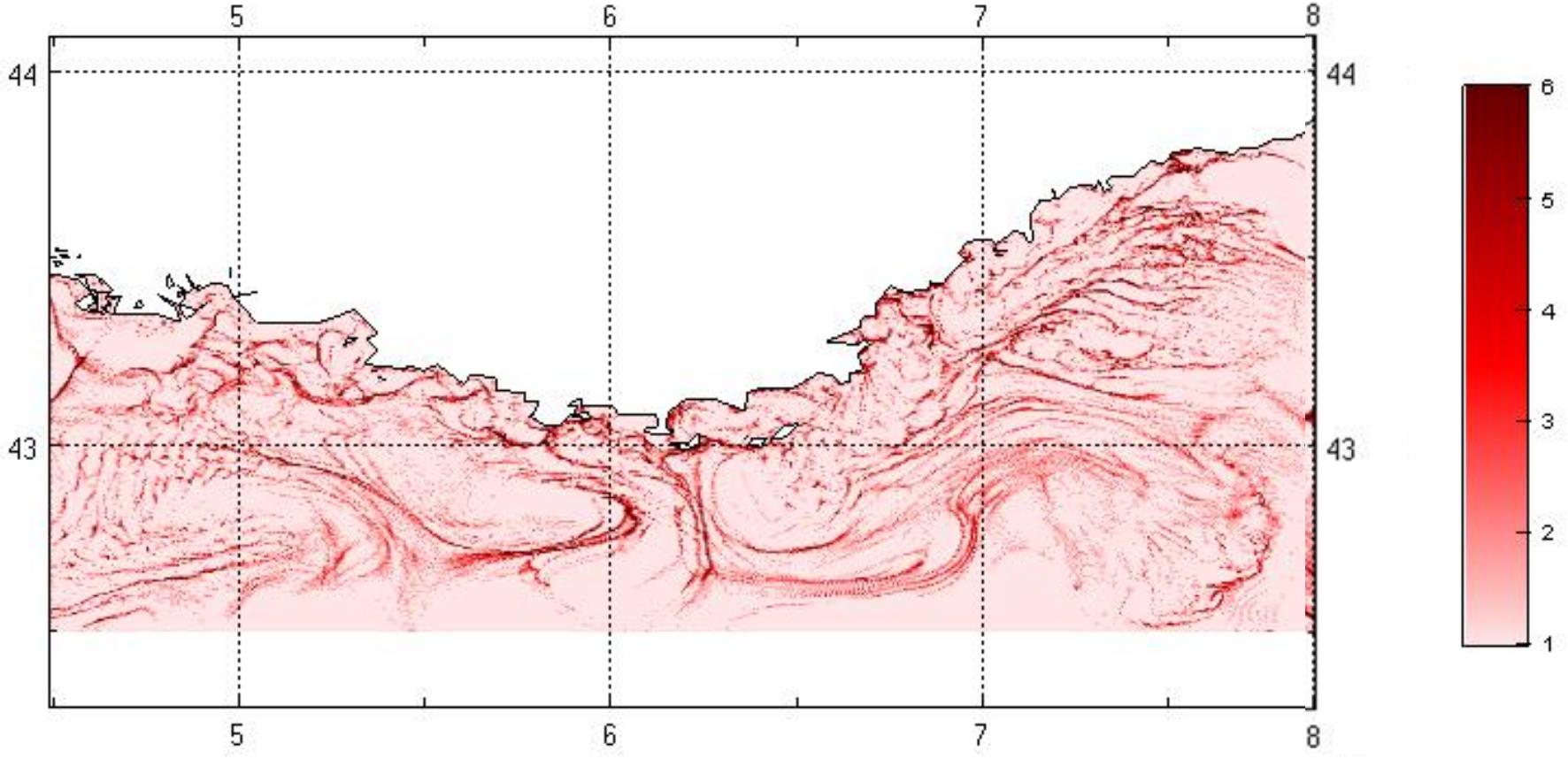


S-2/MSI Spectral profiles for Mithi River

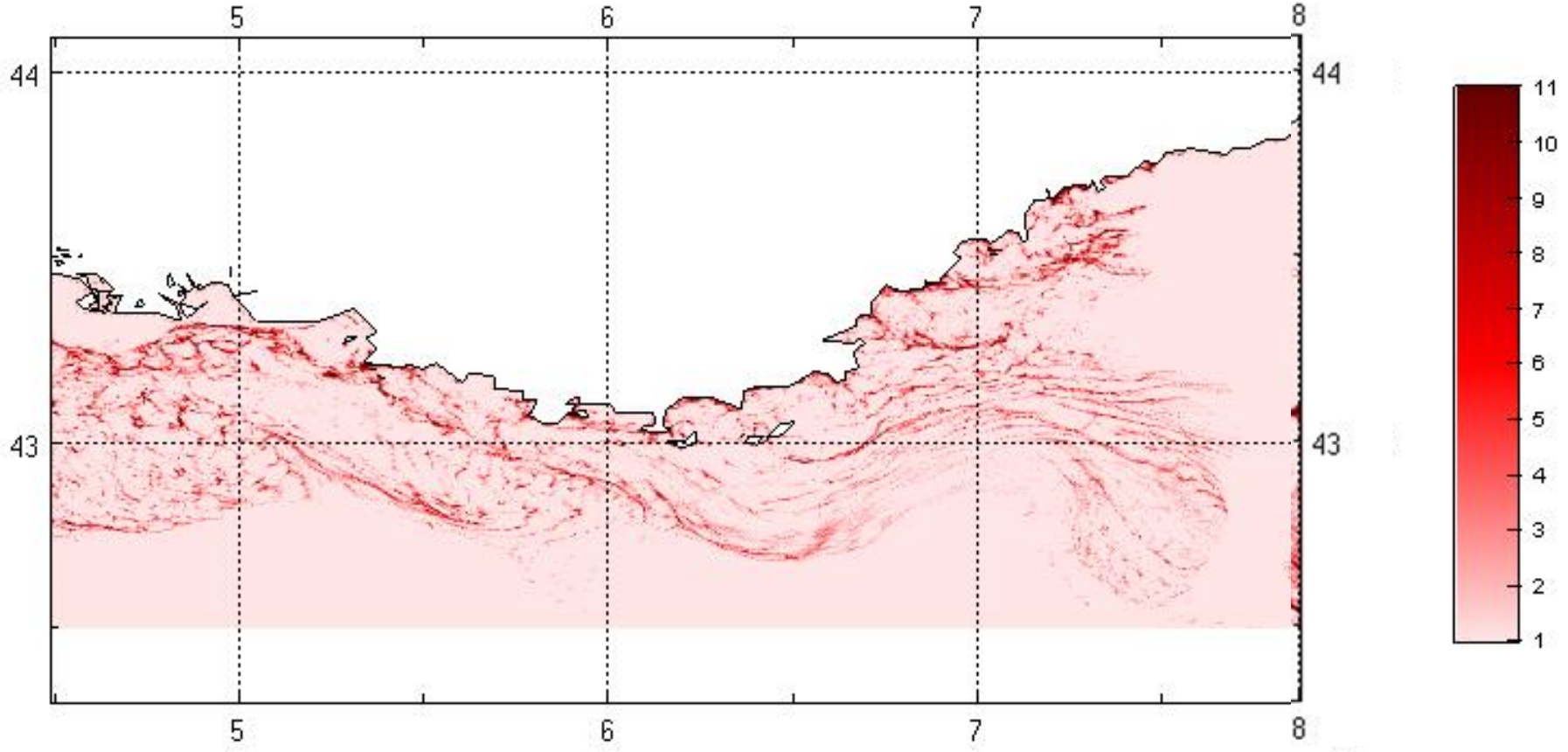
However, low concentrations of litter are much more difficult to detect, whereas scattered in water (purple line) or mixed with vegetation (red line)

Dispersion of a generalised, uniform and unitary pollution of floating objects

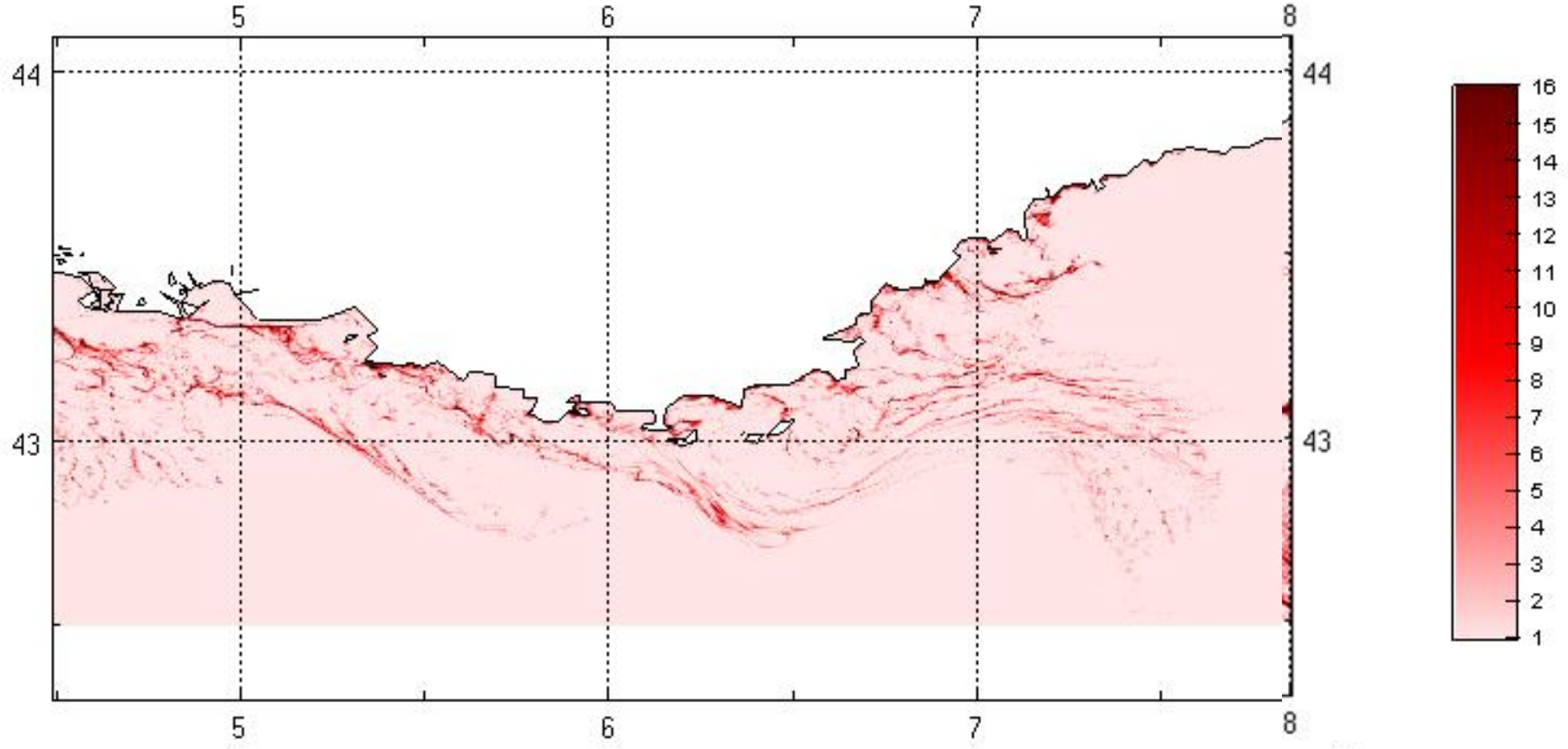
After 12 hours of drift



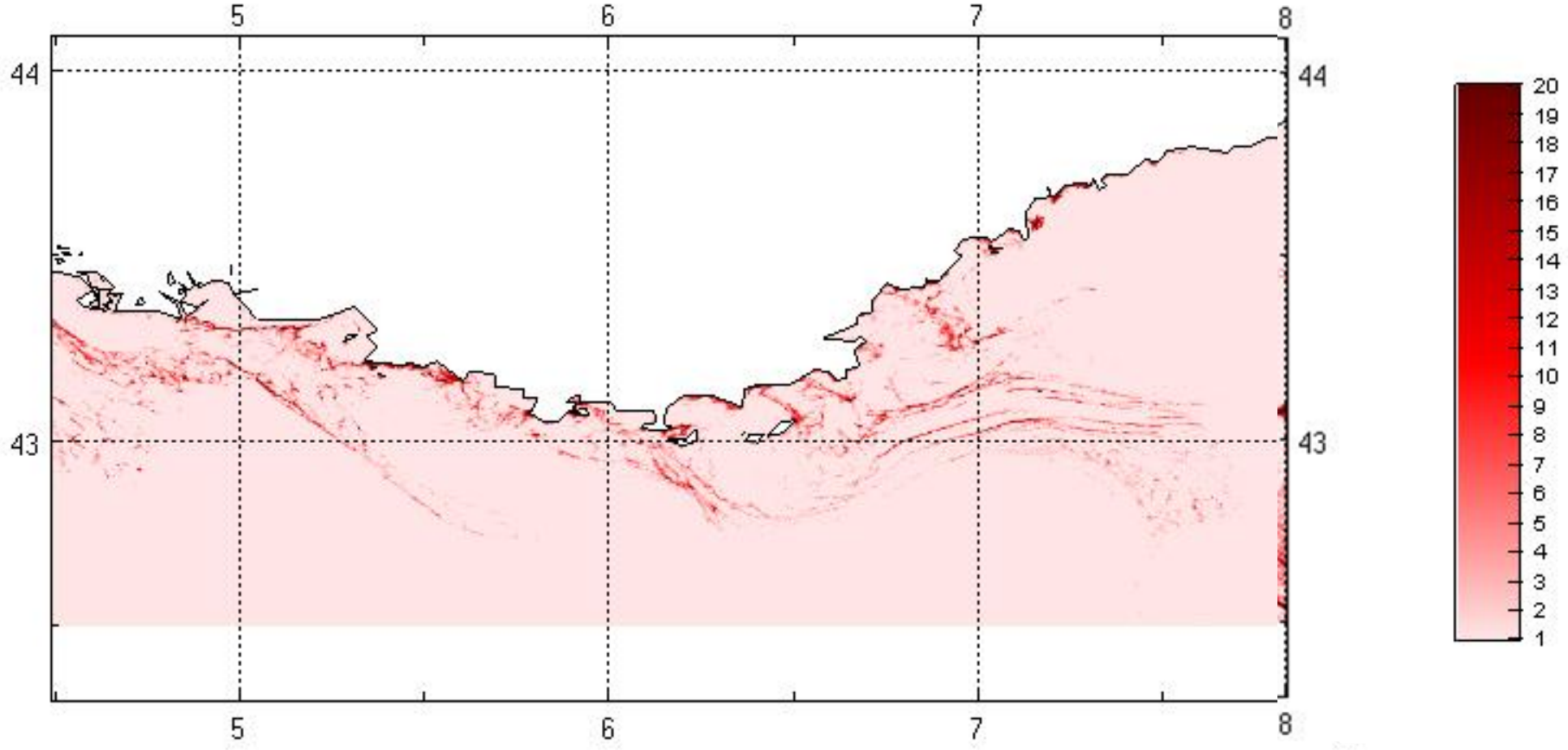
After 24 hours



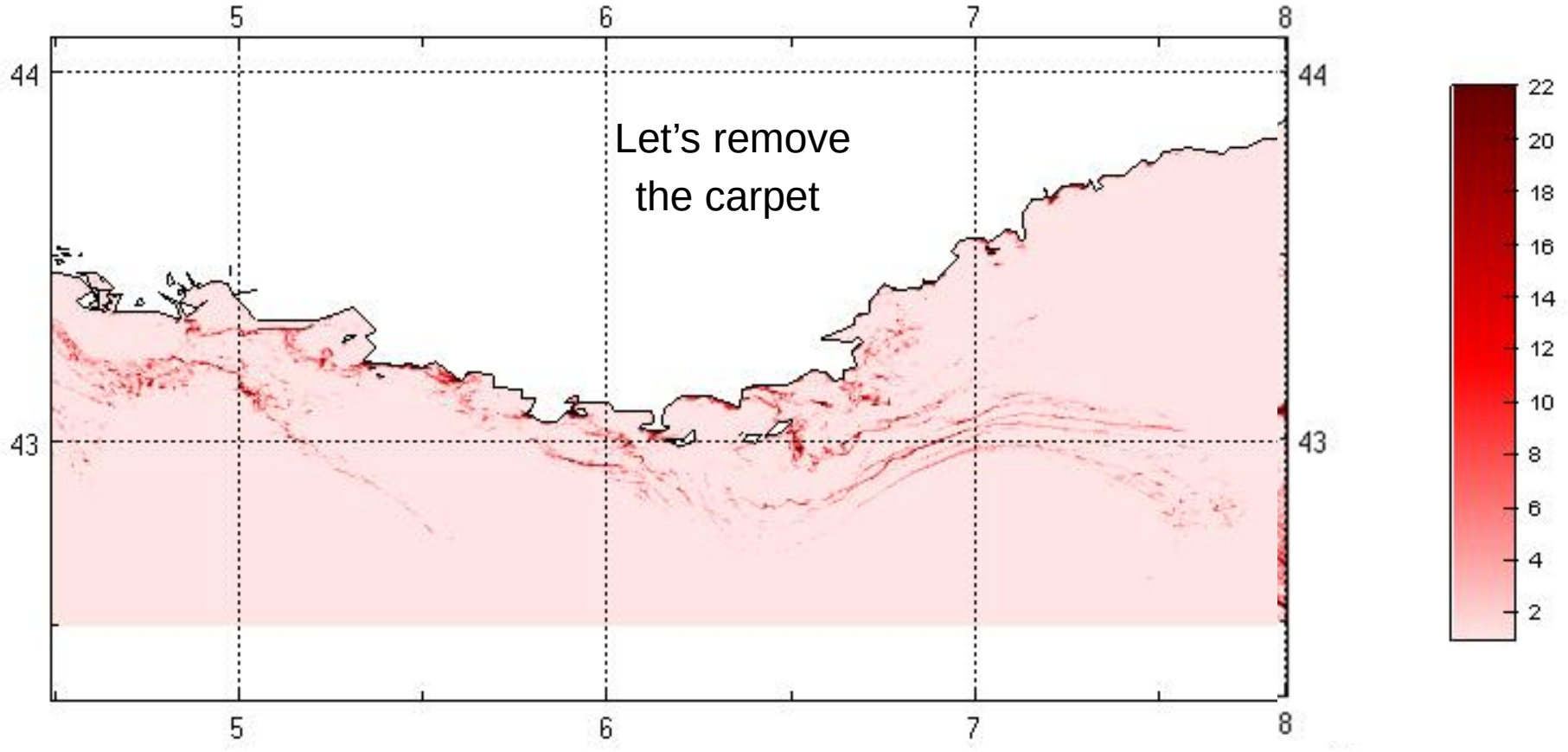
After 36 hours

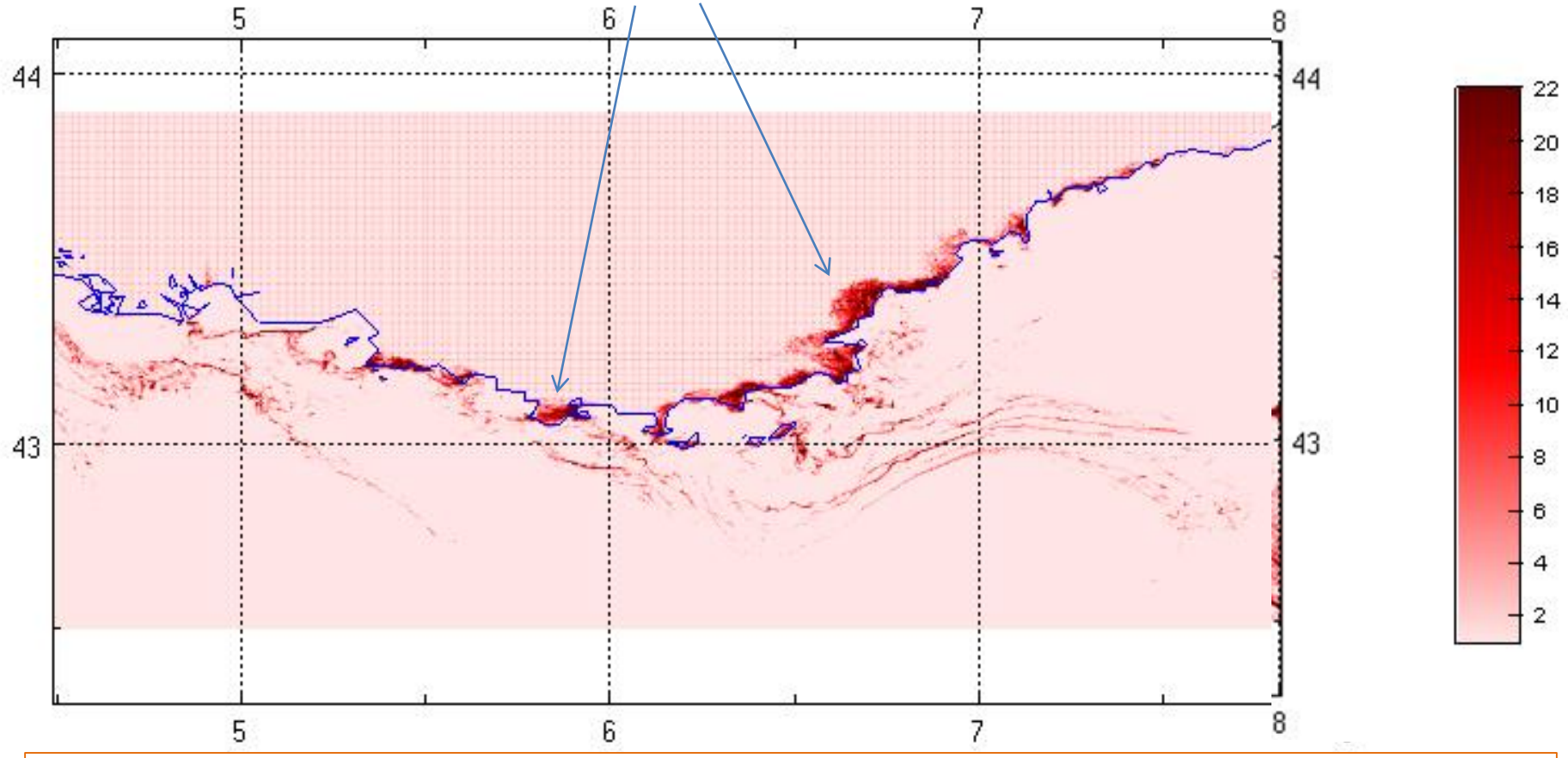


After 48 hours



After 60 hours

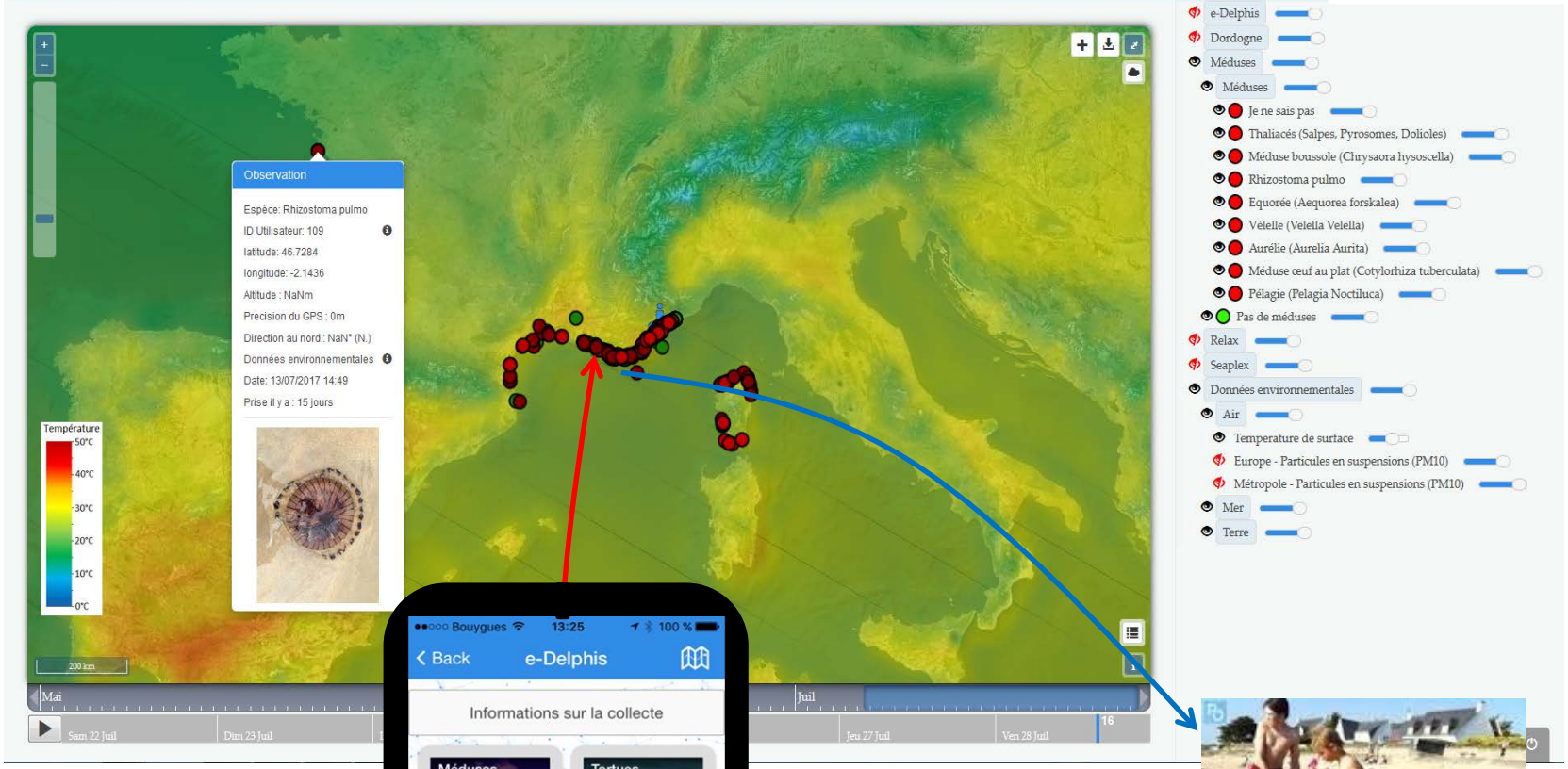


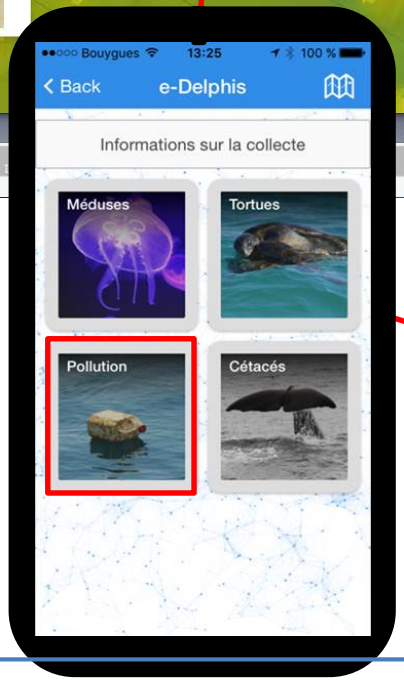


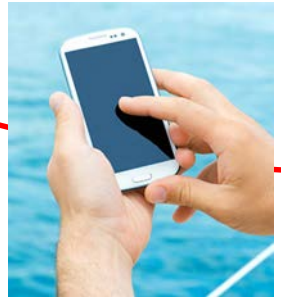
Landing is following a rather complex process
(**currents – availability of ML** / waves + tides for landing ML / high hysteresis in beaching)

Simplex

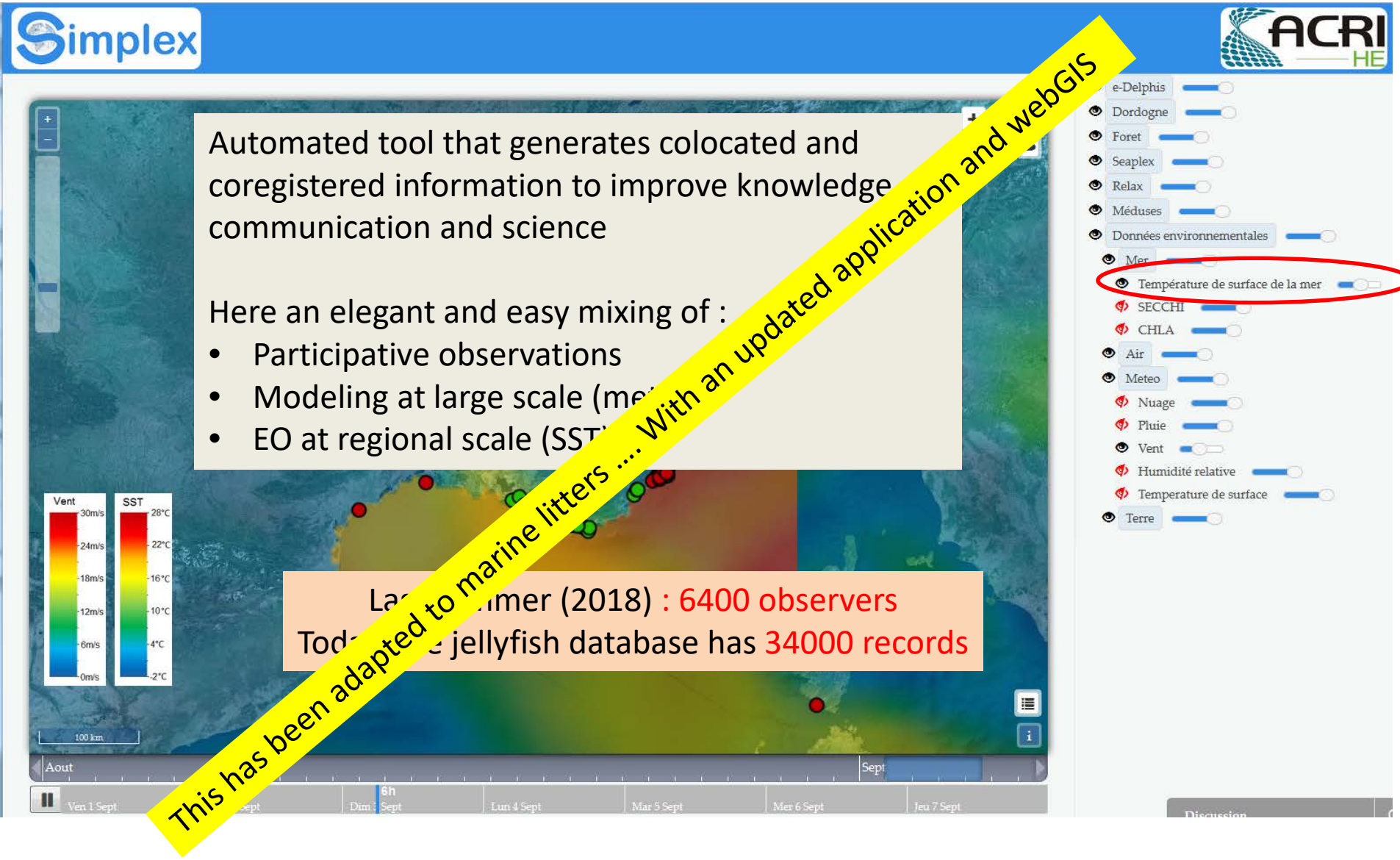
ARGANS







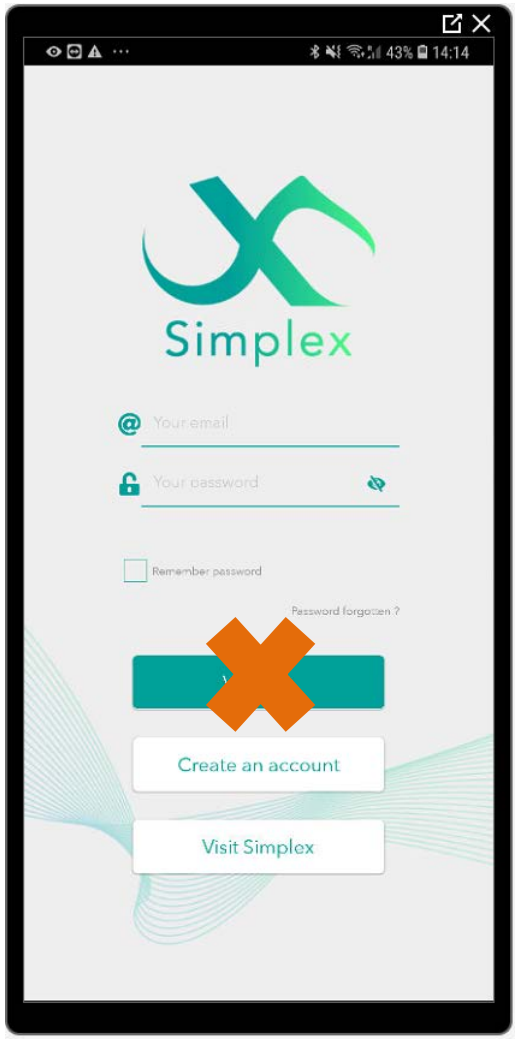
SIMPLEX™ - aggregation of data

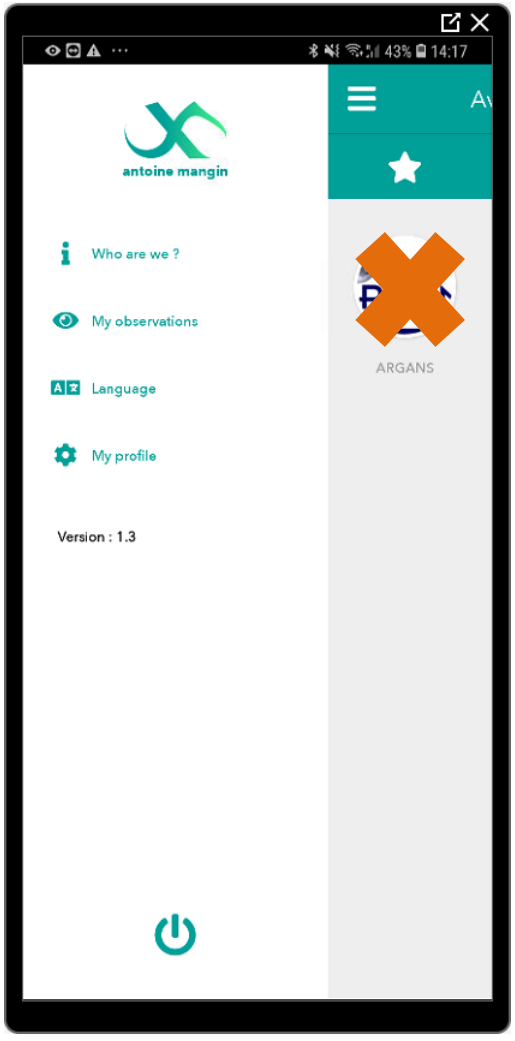


La mer (2018) : 6400 observers

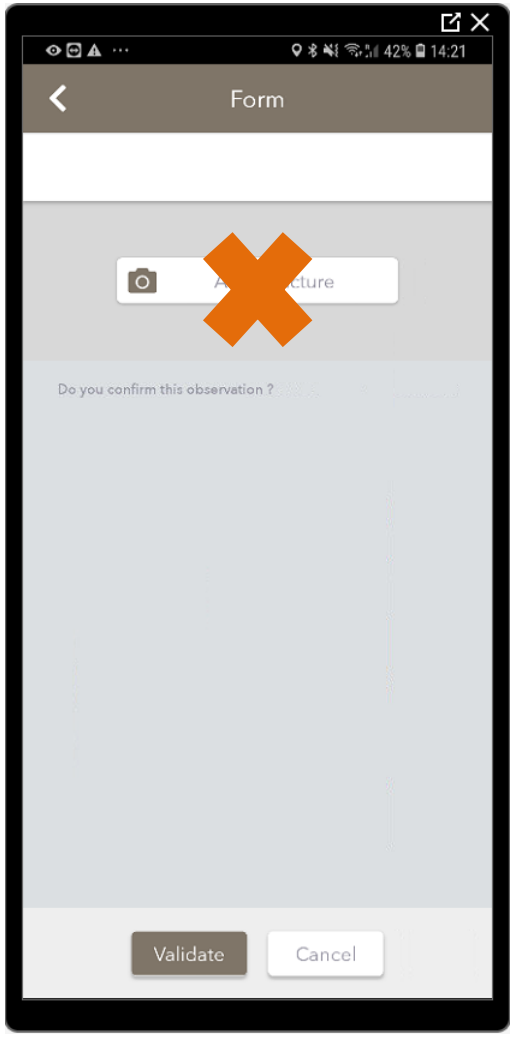
Tod e jellyfish database has 34000 records

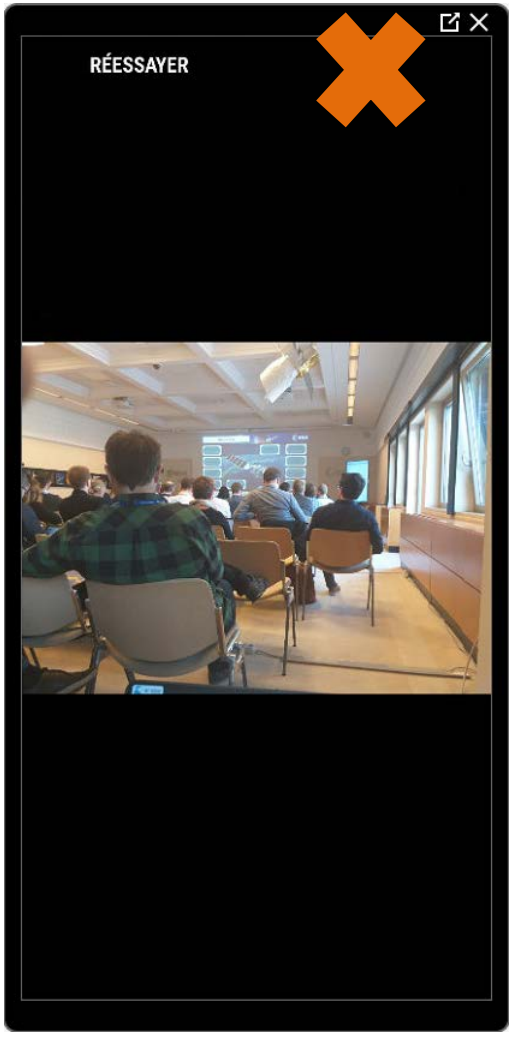
Marine Litter configuration of Simplex

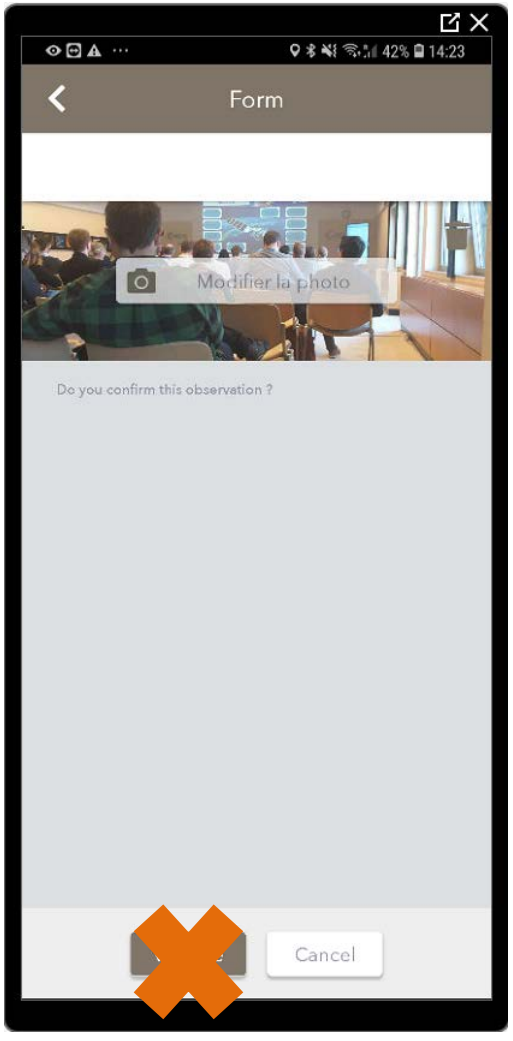




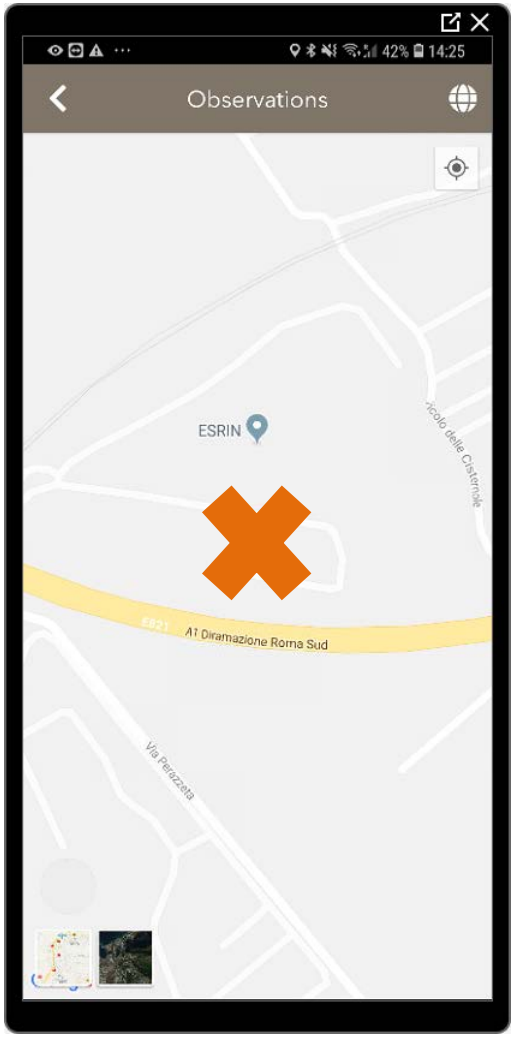
Marine Litter configuration of Simplex

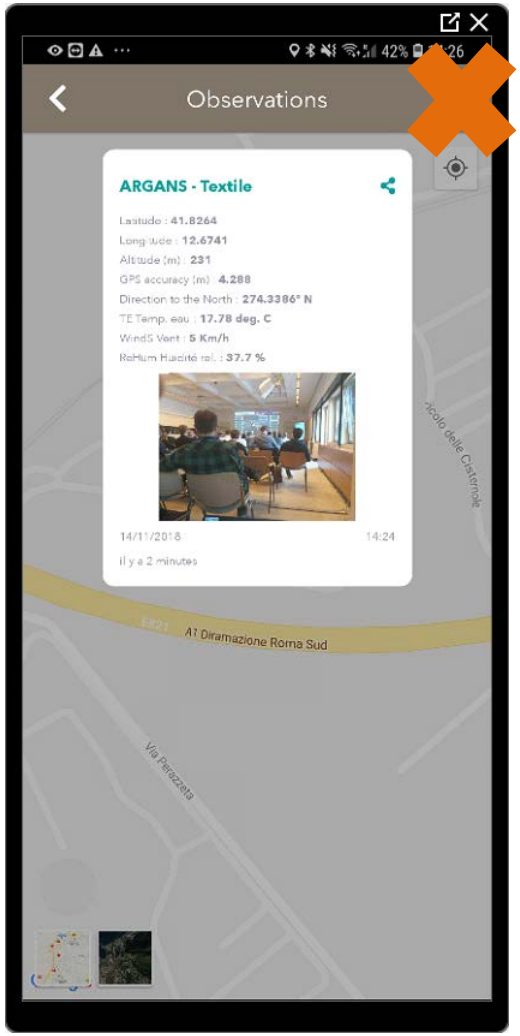


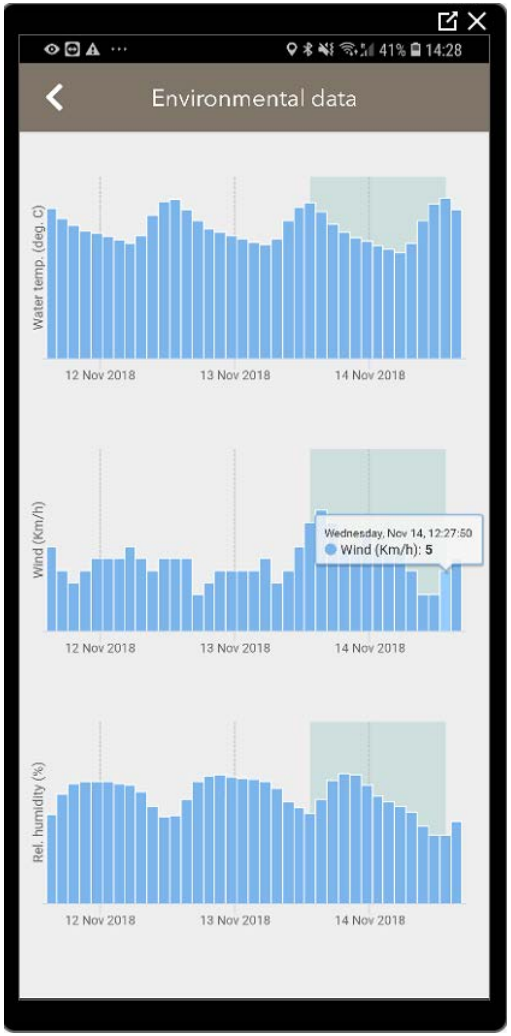




Marine Litter configuration of Simplex







…and the map

Monitoring with « citizen » - is not only a matter of tool !

The most difficult part is to mobilise people – under which conditions and to which level of participants ?

Emission / release of macro-waste

- Participative observation by **professional networks** of river monitoring and **citizens (environmental association) for wadi (traps of macrowaste)**

Landing/beaching

- Participative observation by **citizens and professional** (many associations are existing, contacts are taken in France, Morocco , Algeria) – organisation of observation in // with « the annual cleaning day »

Floating filaments and patches

- Participative observation by **marine professional** (fishermen, transportation…) - AZTI (Biscay)

Participative observation is foreseen as a very good starting point (not unique) for collaboration **South/North** in the frame of UNEP-MAP/MSFD

The monitoring system for marine litters in the Western Mediterranean is built around different and complementary facets of the observation (the *NewMonitoring* ?)

Use of EO

Interesting results for specific spectral bands (or pairs of) for marine litter detection (S2)
Involvment of new actors in the field that would also help the participative observations (e.g. the ocean clean up)

Citizen/ participative observatories

Reliable tool for monitoring
Engagement of the participants :

- Make the distinction between : one-shot campaign every year and continuous observation,
- Rewarding participant ?
- Making them participate to the final analysis…

Modelling is beginning

Thank you for attention

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