



Presented at the FIG Working Week 2023,
28 May - 1 June 2023 in Orlando, Florida, USA

FIG WORKING WEEK 2023

28 May - 1 June 2023 Orlando Florida USA

Protecting
Our World,
Conquering
New Frontiers

Mapping the Plastic

confronting the global plastic 'pandemic'

SIMON IRONSIDE (New Zealand)
Co-Chair FIG WORKING GROUP 4.3 – a joint Commission 4
(Hydrography) and Young Surveyors Network initiative



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FIG Working Group 4.3 - Mapping the Plastic

A joint initiative of
FIG Young Surveyors Network
FIG Commission 4 (Hydrography)

Academic Partners
University of Novi Sad (Serbia)
University of Banja Luka (Bosnia and Herzegovina)

Business Partner
Trimble



FIG
YOUNG
SURVEYORS



Some confronting statistics...

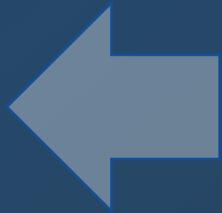
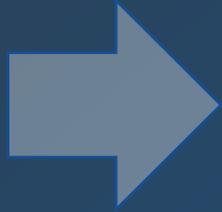
- **Almost every piece of plastic ever made is still on our planet in one form or another**
- **75% of all the plastic produced since 1950 is now waste, with most of it discarded into landfills or dumped into marine environments.**
- **8 million tonnes of plastic ends up in our oceans every year**
- **This equates to 15 tonnes of plastic entering our oceans every minute.**
- **Eighty per cent of all litter in our oceans is now made of plastic, and...**



**By 2050 WWF estimates there will be more plastic in the ocean than fish,
by weight**

The problem with plastic...

- **Only 9% of plastic waste is recycled as it is difficult to recycle**
- **It breaks down into microplastics that enter the food chain, causing harm to animals and, potentially, humans**
- **There is an estimated 14 million tonnes of microplastics residing on the ocean floor**
- **The average person ingests roughly 5 grams of microplastics each week, much of it from drinking water, but also from shell fish, beer and salt**
- **The production and transportation of plastic to their point of sale is fossil-fuel intensive, with significant climate change impacts**



Plastic in the ocean...

- **Once in the ocean, plastic and other marine debris is at the mercy of ocean currents**
- **The large and permanently rotating ocean currents known as gyres have the most impact on plastic/marine debris**
- **The five major gyres are**
 - **the North and South Pacific Subtropical Gyres**
 - **the North and South Atlantic Subtropical Gyres**
 - **the Indian Ocean Subtropical Gyre**

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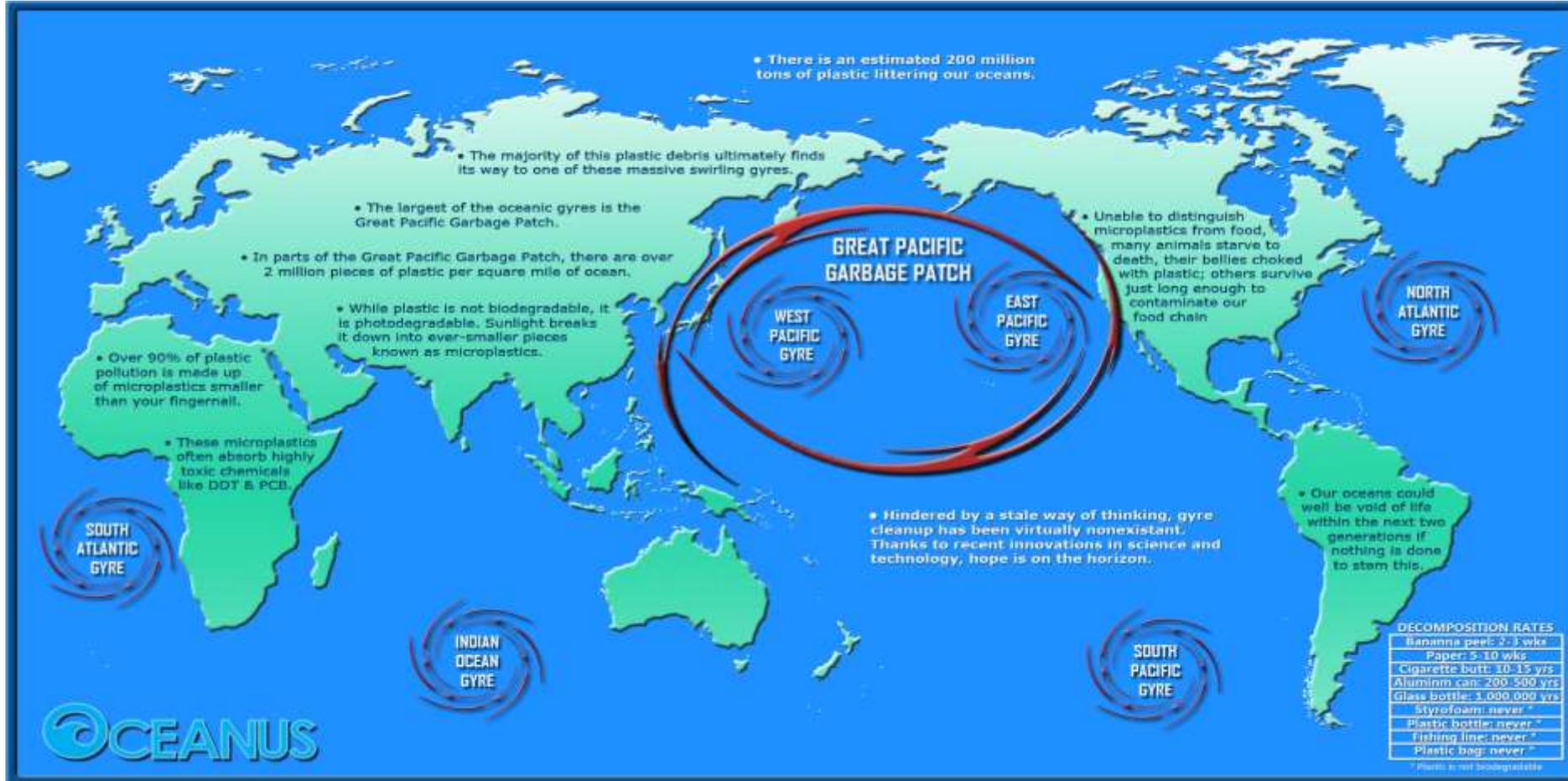


Photo: projectoceanus.wordpress.com

Gyres...

- **The term is often used to refer to the collections of plastic and marine debris found in higher concentrations in the 5 subtropical gyres**
- **These accumulation zones are the result of diminished winds and currents occurring in latitudes synonymous with continental deserts**
- **Plastic is trapped within these currents, taking at least 10 years to cycle out – if it doesn't get eaten by marine life first or sink to the ocean floor**
- **These concentrations have been dubbed 'garbage patches'**
- **Most large debris in the Great Pacific Garbage Patch is made up of inexpensive fishing nets.**

Top 10 river systems contributing to ocean plastic

- Yangtze River, Yellow Sea, Asia
- Indus River, Arabian Sea, Asia
- Yellow River (Huang He), Yellow Sea, Asia
- Hai River, Yellow Sea, Asia
- Nile, Mediterranean Sea, Africa
- Meghna/Bramaputra/Ganges, Bay of Bengal, Asia
- Pearl River (Zhujiang), South China Sea/East Sea, Asia
- Amur River (Heilong Jiang), Sea of Okhotsk, Asia
- Niger River, Gulf of Guinea, Africa
- Mekong River, South China Sea/East Sea, Asia

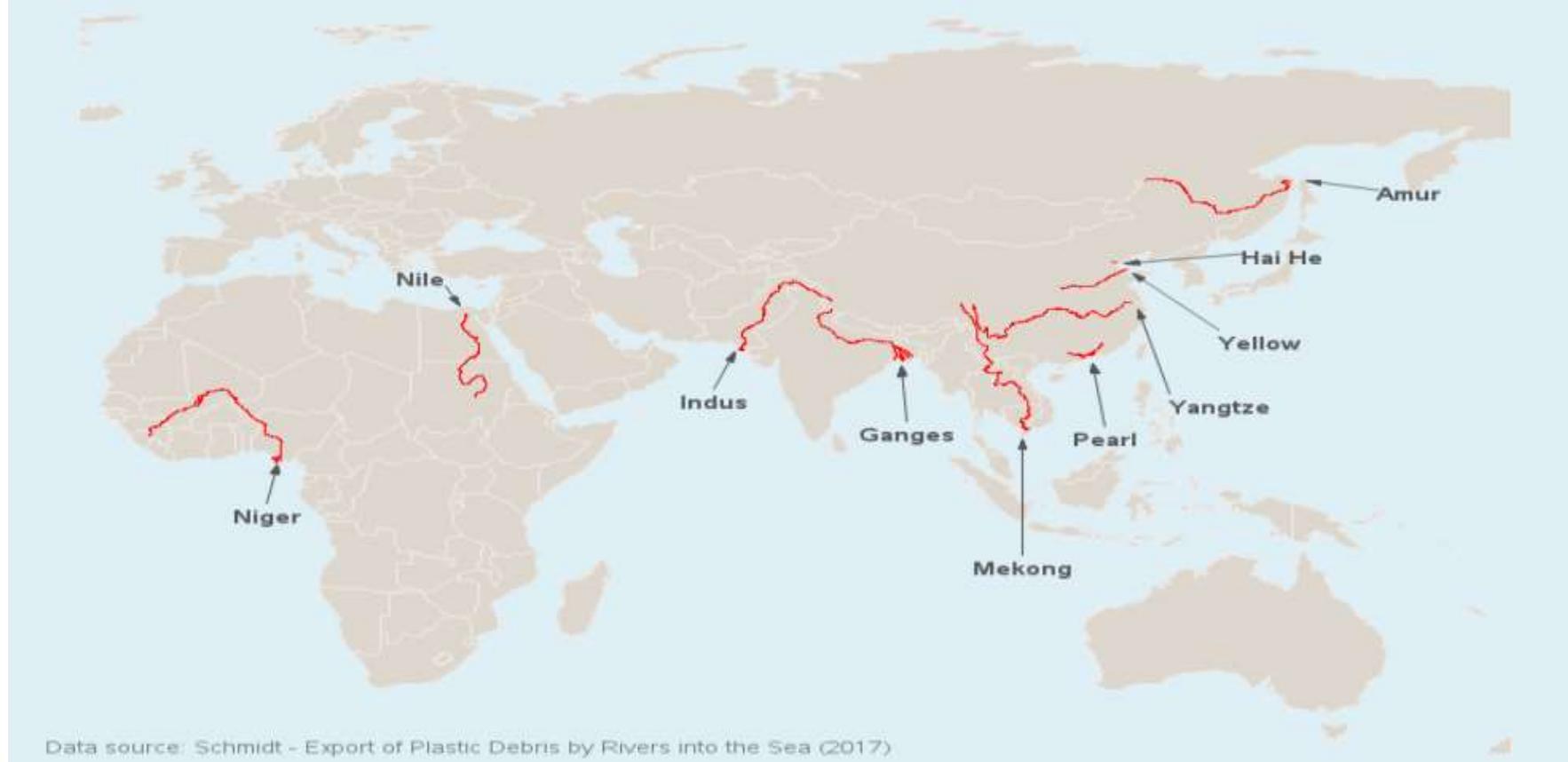
Export of plastic debris by rivers into the sea - Authors: Christian Schmidt, Tobias Krauth, Stephan Wagner, *Reprinted with permission from Environmental Science & Technology 2017, 51, 21, 12246-12253. Copyright 2017, American Chemical Society.*

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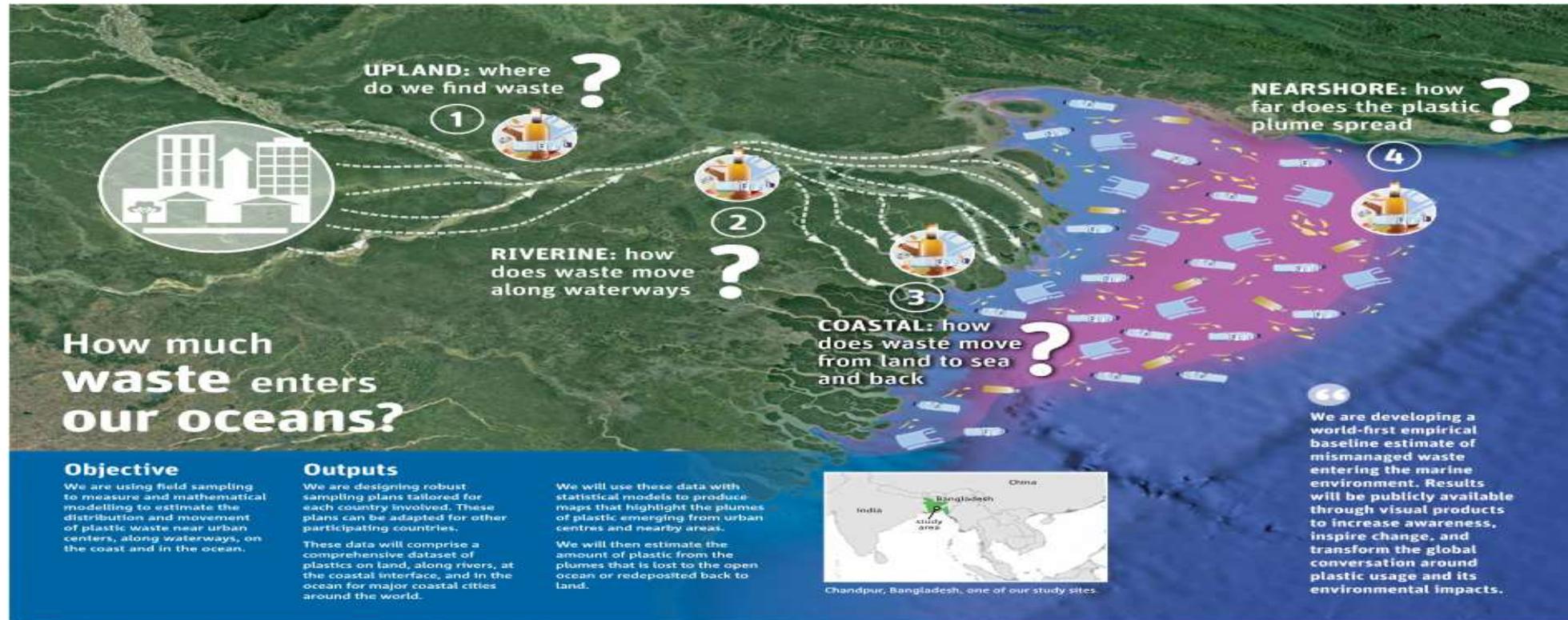
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**95% Of Plastic Polluting The World's Oceans
Comes From These 10 Rivers**

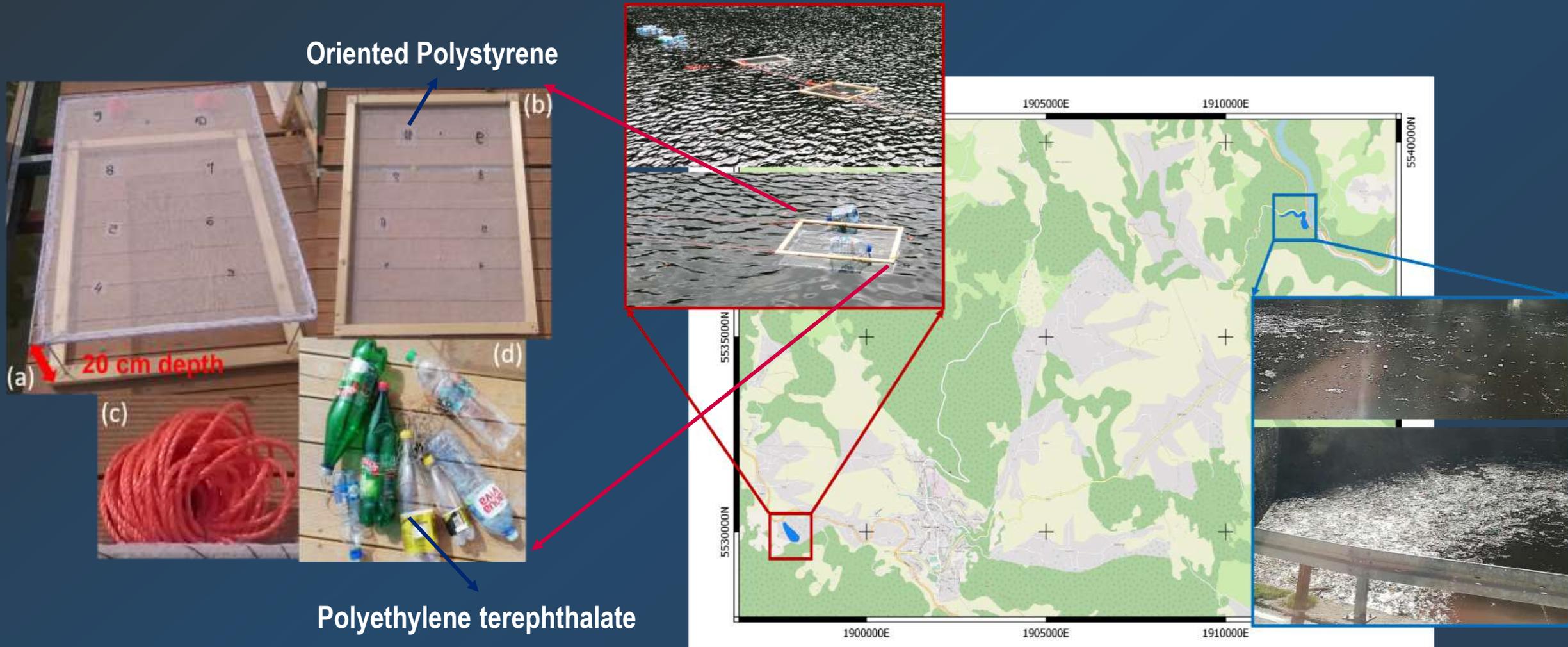


Plastic waste transportation (waterways)

courtesy of the Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia



Study areas - Lake Balkana (left) and Crna Rijeka River (right) EPSG:3857



UAV plastic surveys – height vs resolution

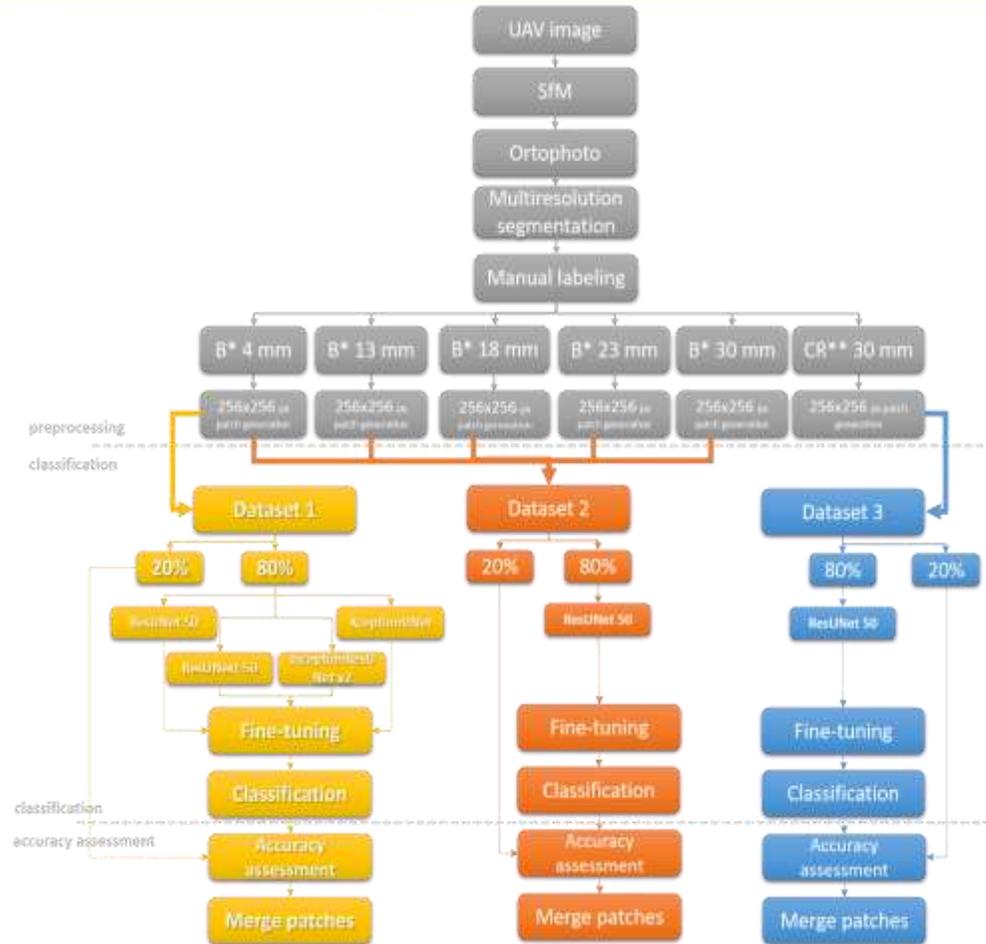
Flying height (m)	Spatial resolution (mm)	
	Balkana	Crna Rijeka
12	4	*
40	13	*
55	18	*
70	23	*
90	30	30



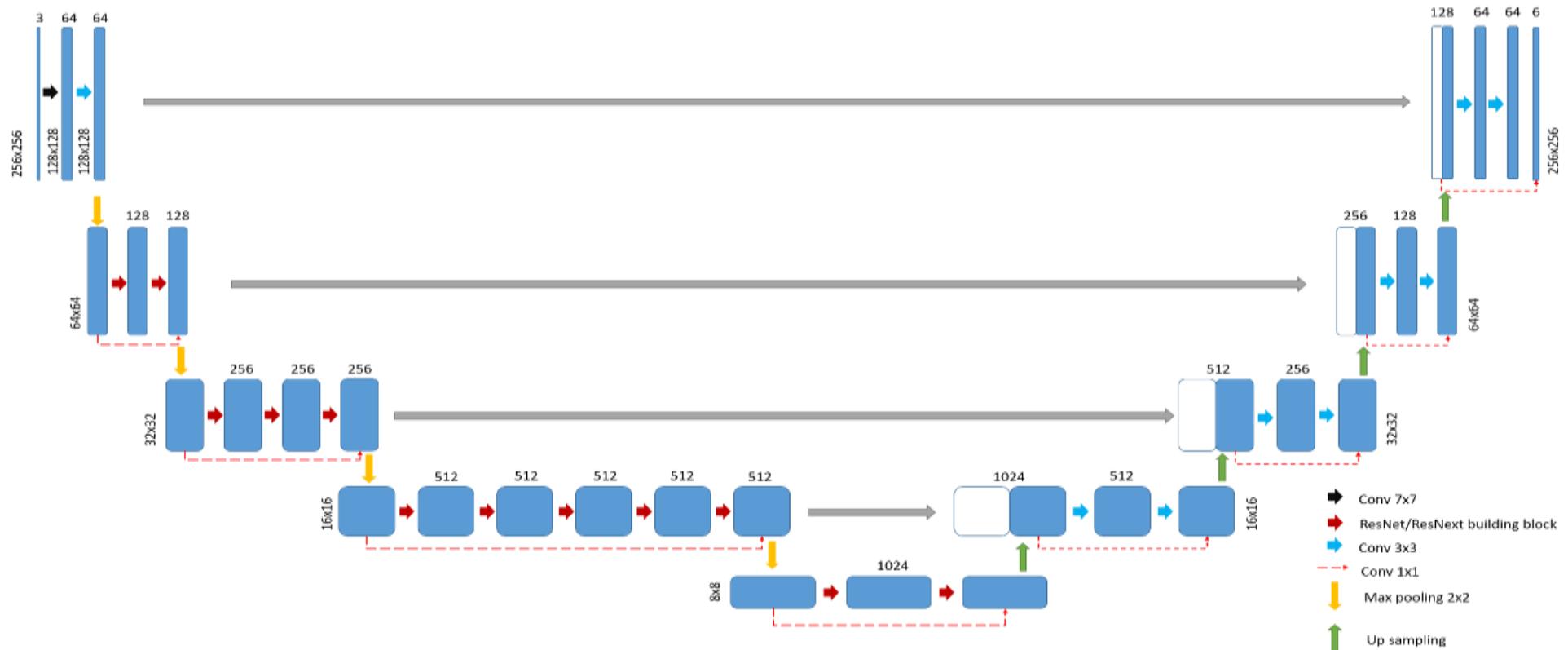
DJI mavic pro

Processing methodology

- Low amount of training data
- Highly imbalanced dataset
- Accuracy of ground truth data



ResUNet 50 (deep learning) architecture



Results - study area 1

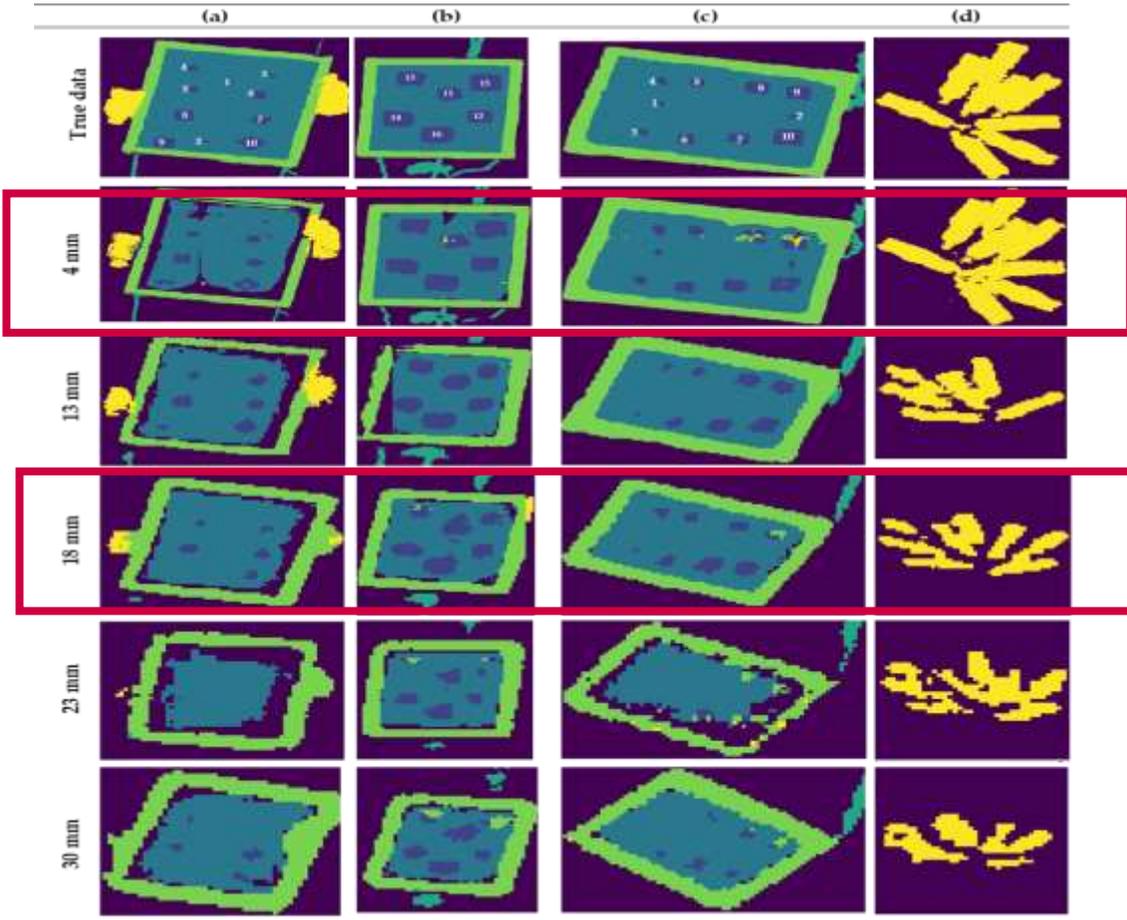
Training the deep neural network

- Data augmentation
- Transfer learning
- Accuracy assessment
 1. Recall
 2. Precision
 3. F1-score

	4 mm			13 mm			18 mm			23 mm			30 mm		
	P	R	F1	P	R	F1	P	R	F1	P	R	F1	P	R	F1
OPS	0.86	0.86	0.86	0.88	0.77	0.82	0.69	0.71	0.7	0.79	0.31	0.44	0.75	0.45	0.56
Nylon	0.92	0.85	0.88	0.89	0.75	0.82	0.91	0.52	0.66	0.76	0.26	0.39	0.87	0.2	0.33
PET	0.92	0.92	0.92	0.92	0.83	0.87	0.78	0.84	0.81	0.83	0.68	0.75	0.77	0.7	0.73

Visual inspection of results – Area 1

Legend: water OPS gauze nylon wood PET



CSIRO
(1 cm²)

NOAA, OSPAR
(2.5 cm²)

Results – study area 2

	Precision	Recall	F1
Plastic	0.82	0.75	0.78
Maybe plastic	0.62	0.34	0.43

Visual inspection of results – Area 2

Legend: ■ water ■ OPS ■ gauze ■ nylon ■ wood ■ PET

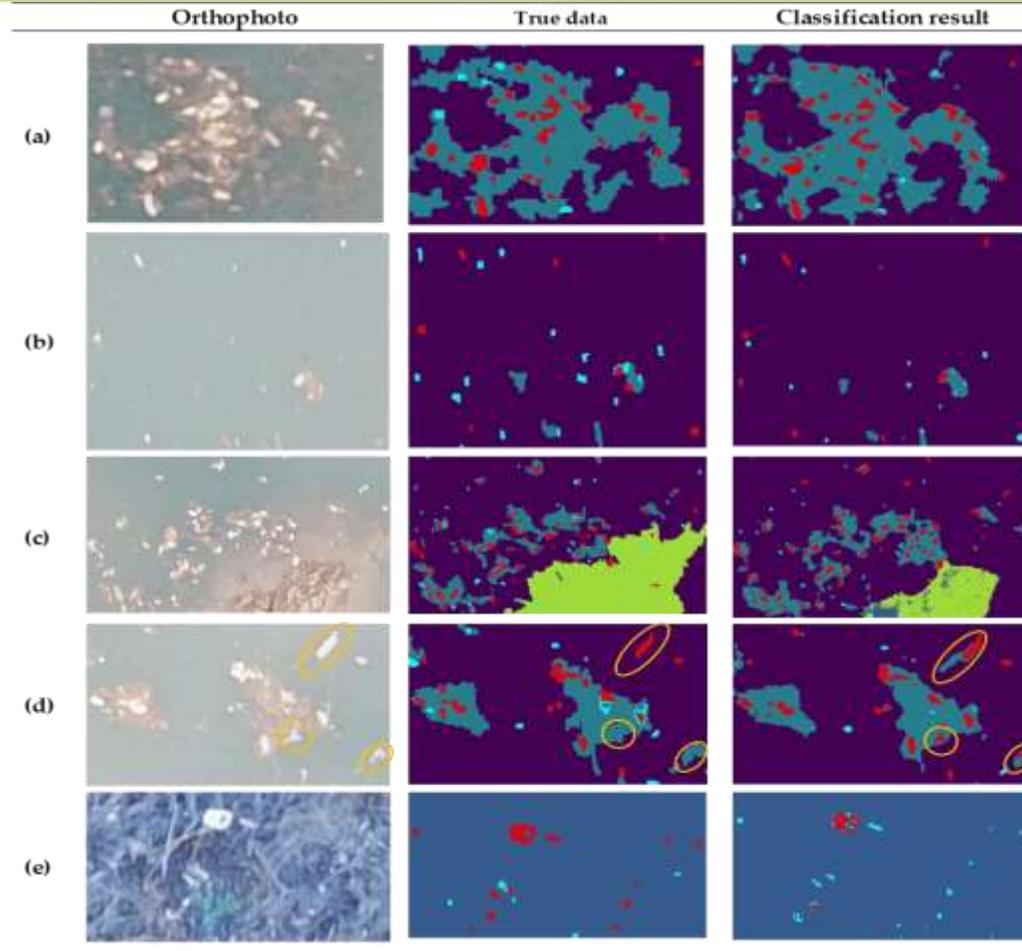
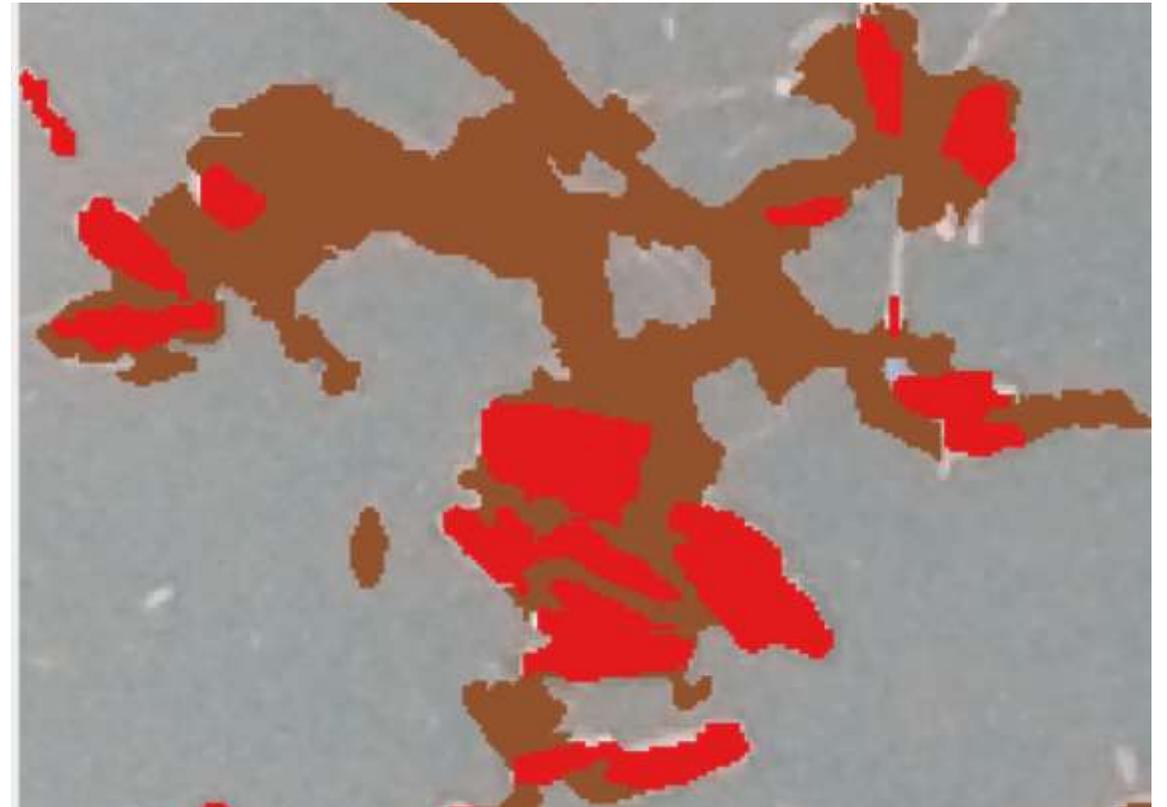


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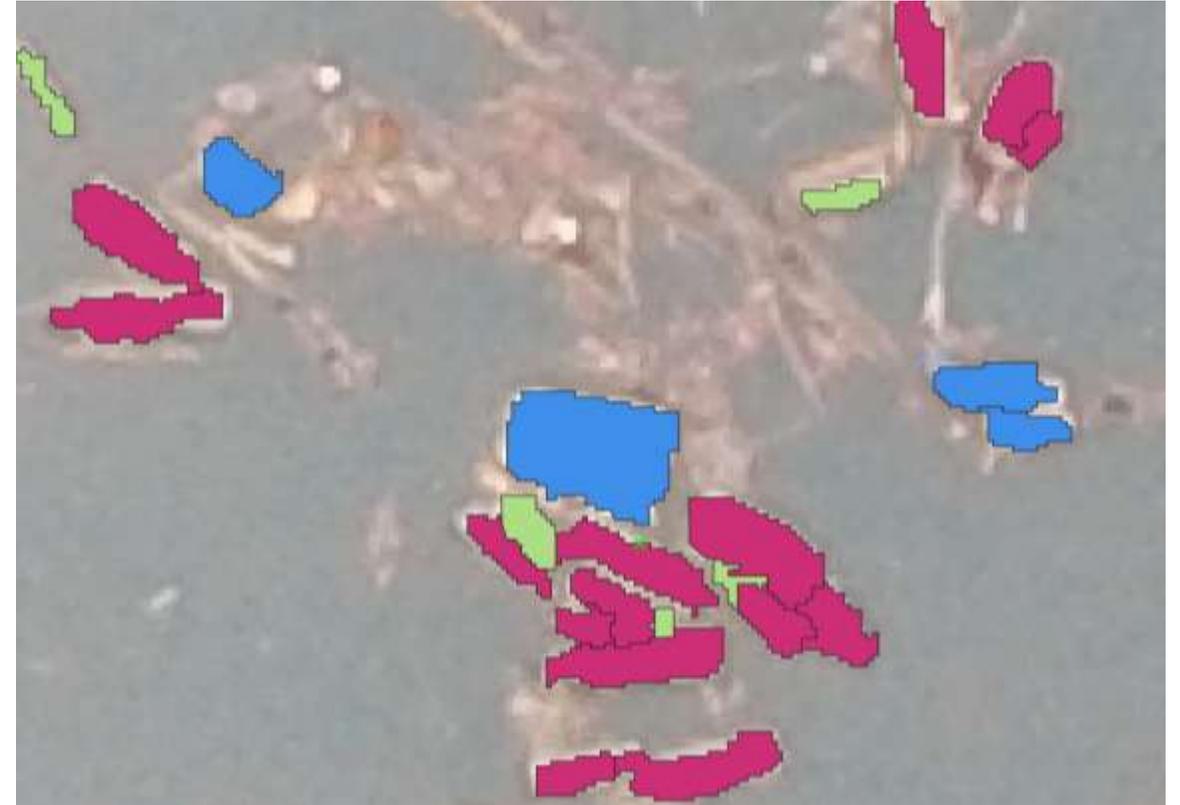


■ plastic
■ wood

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- bottle
- food containers
- food packaging
- other

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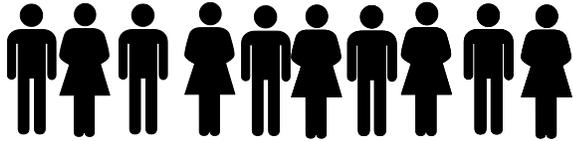


TRADITIONAL BEACH SURVEY

Covered area



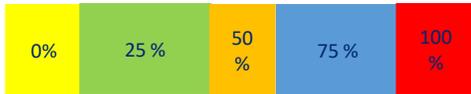
Data collection



Data processing



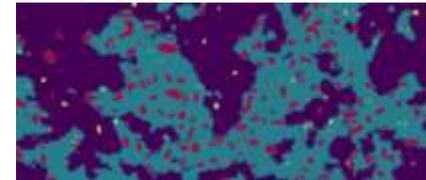
Results



OUR APPROACH



Near real time



Thank you, on their behalf!

<https://www.fredfoundation.org/work/albatross/>



<https://www.economist.com/science-and-technology/2020/03/12/plastic-rubbish-smells-good-to-turtles>



<http://poopy.org/land-pollution/seal-trapped-in-plastic-pollution/>