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Spectral responses meet AI to detect Marine Litter

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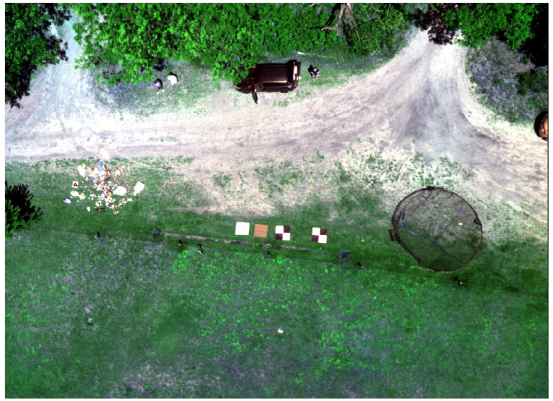
CONTENT

Artificial intelligence and drones supporting the detection and mapping of floating aquatic plastic litter (AIDMAP)

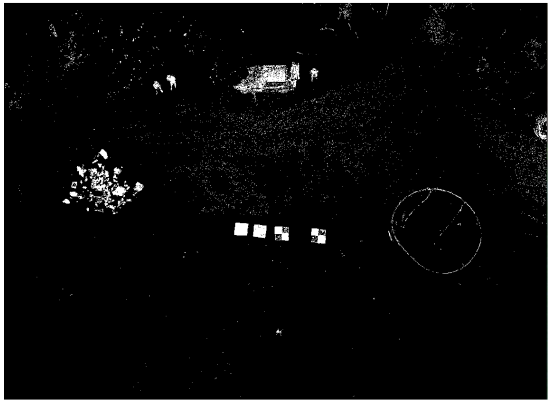
Plastic Flux for Innovation and Business Opportunities in Flanders (PLUXIN)

Artificial accumulation zone of litter

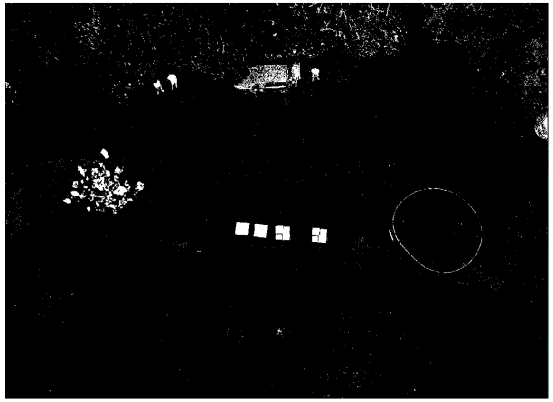
Litter detection: Binary approach



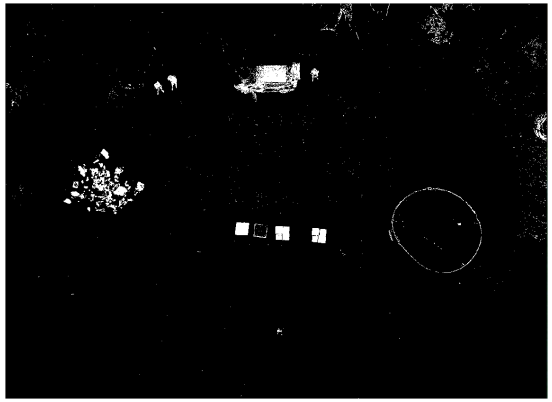
DT



SVM



RF



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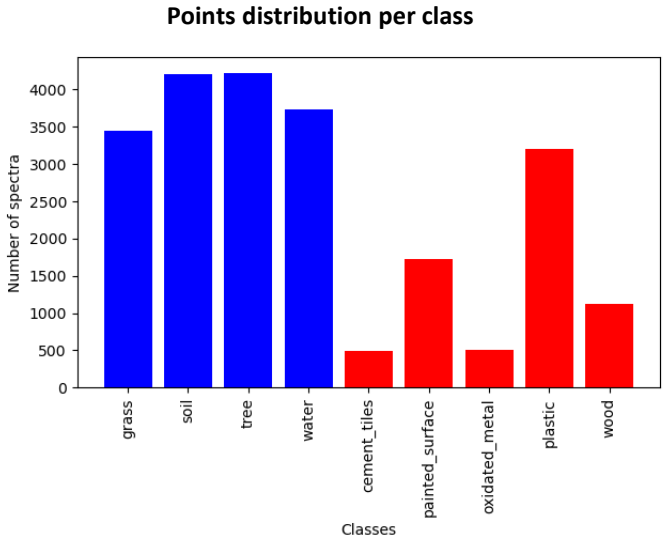
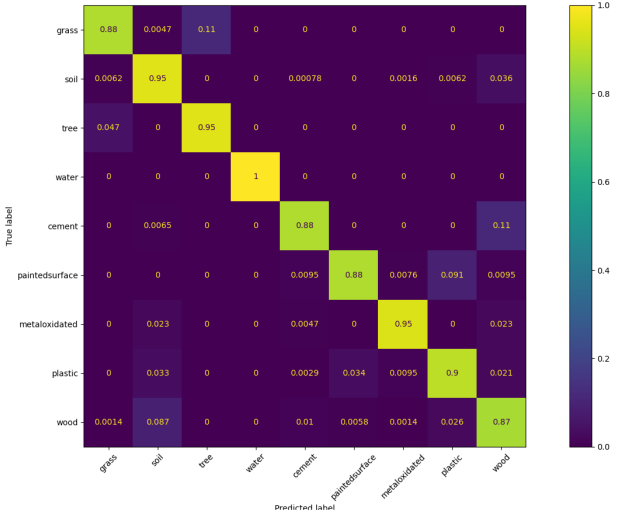
Litter detection: classification

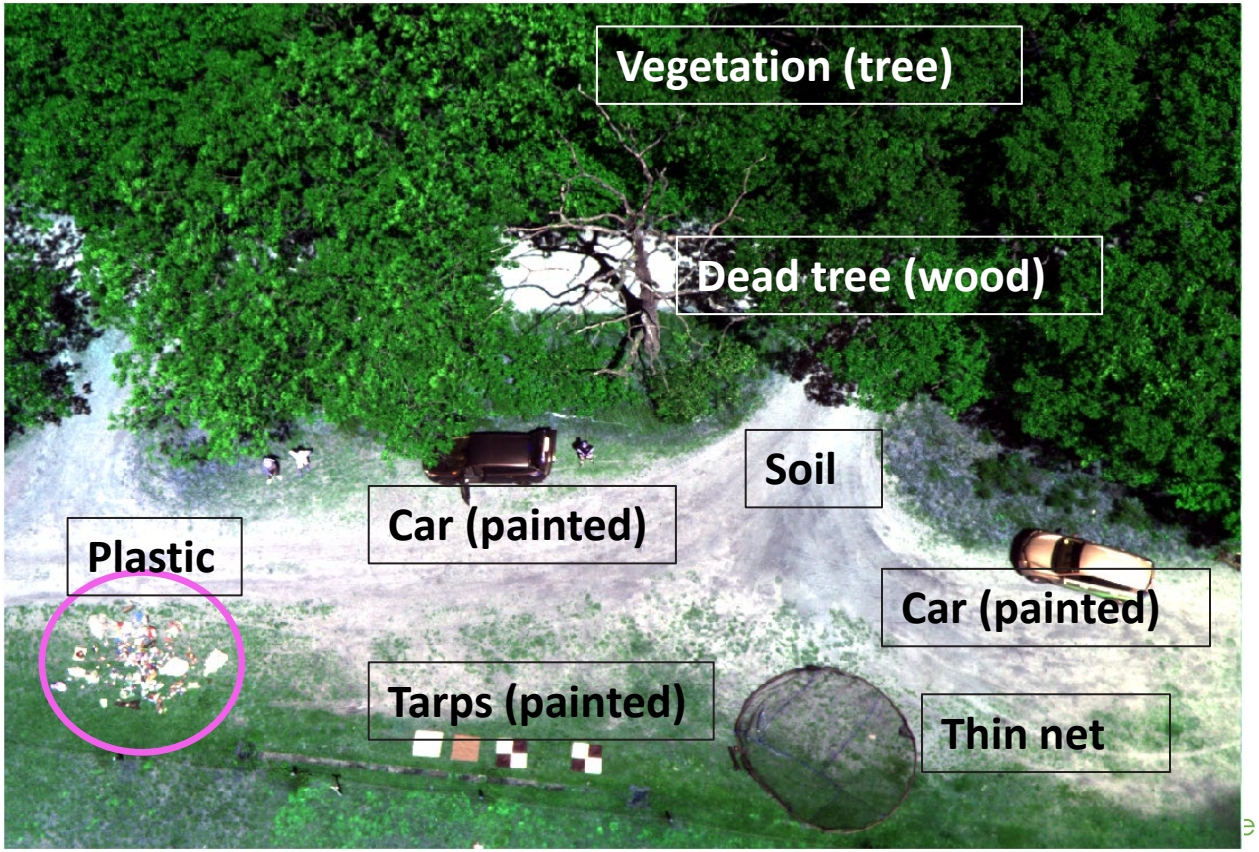
- 9 classes considered: 'grass', 'soil', 'tree', 'water', 'cement_tiles', 'painted_surface', 'oxidated_metal', 'plastic', 'wood'
- 22.688 points extracted from 32 images of one flight (over land)



	Precision	Recall	F1-score	Support
Grass	0.93	0.88	0.91	1074
Soil	0.91	0.95	0.93	1281
Tree	0.91	0.95	0.93	1244
Water	1.00	1.00	1.00	1109
Cement	0.88	0.88	0.88	153
Painted surface	0.90	0.88	0.89	528
Oxidated metal	0.91	0.95	0.93	215
Plastic	0.94	0.90	0.92	1363
Wood	0.86	0.87	0.86	690
Accuracy			0.93	7657

Litter detection: classification





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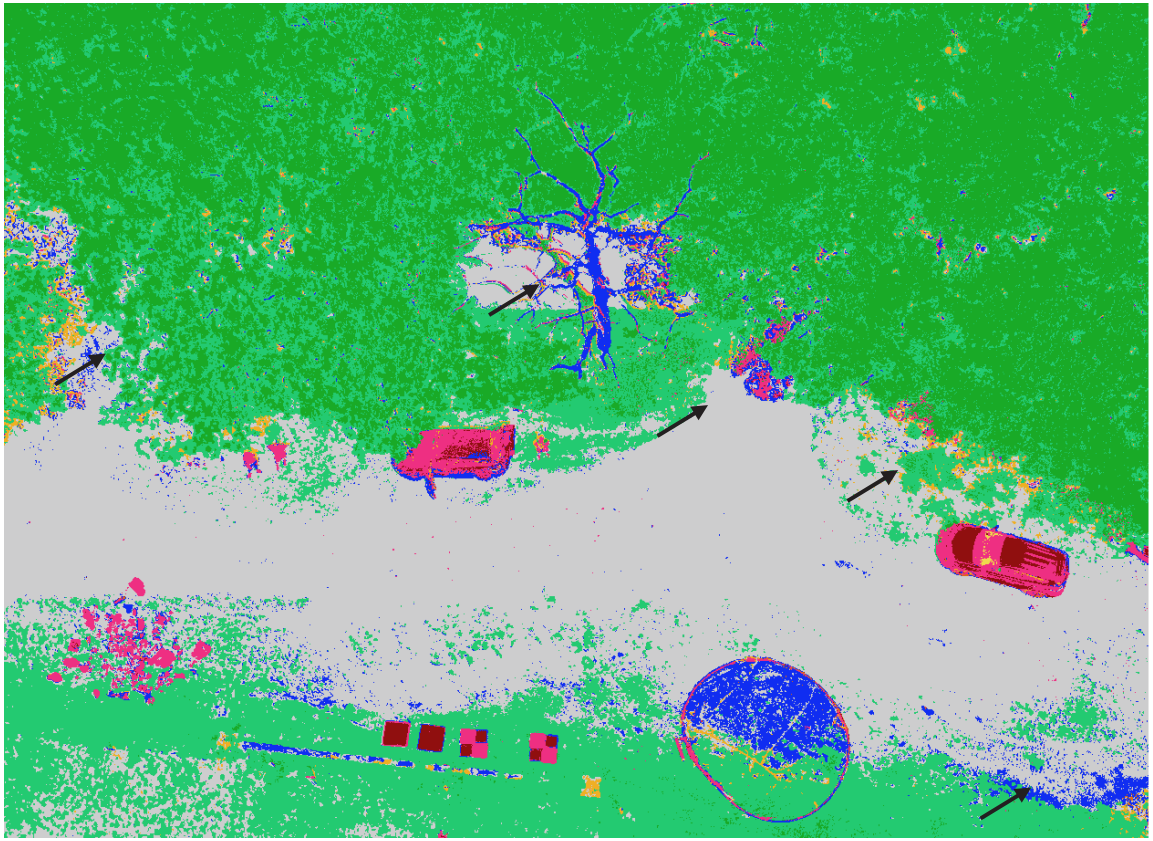
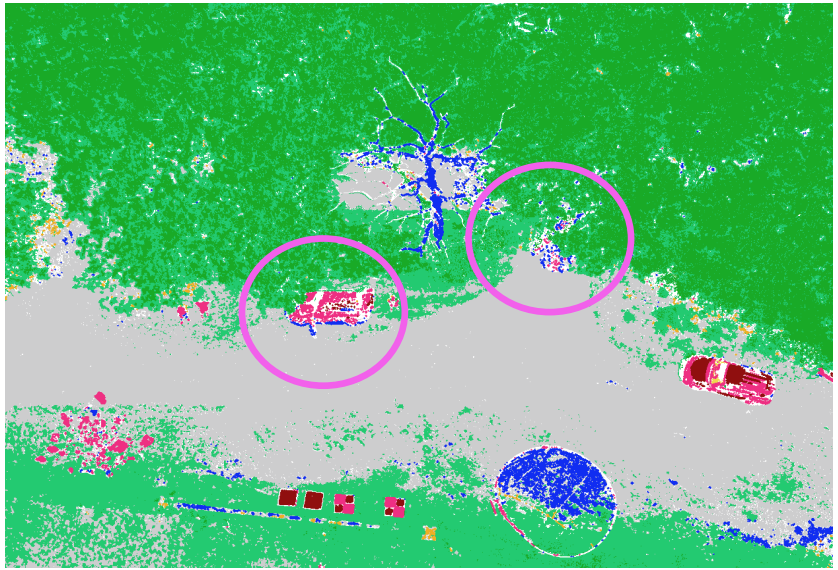
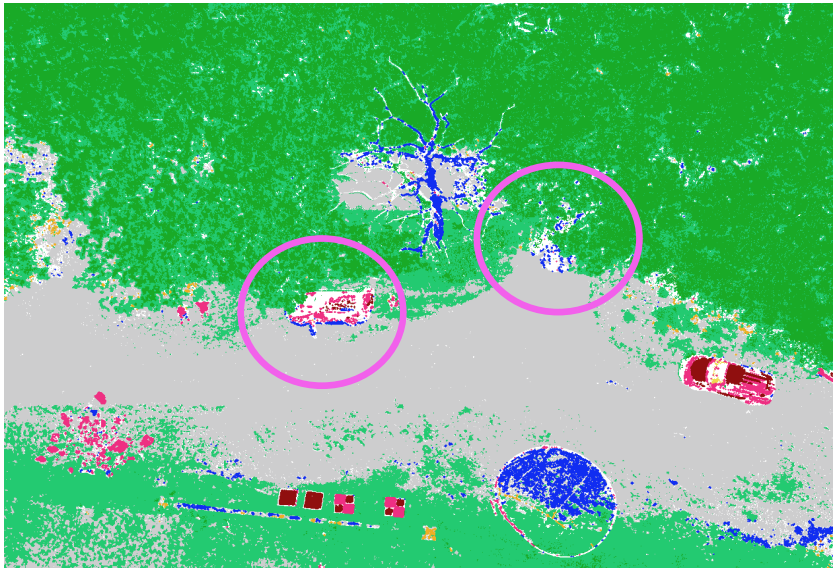
Classified image

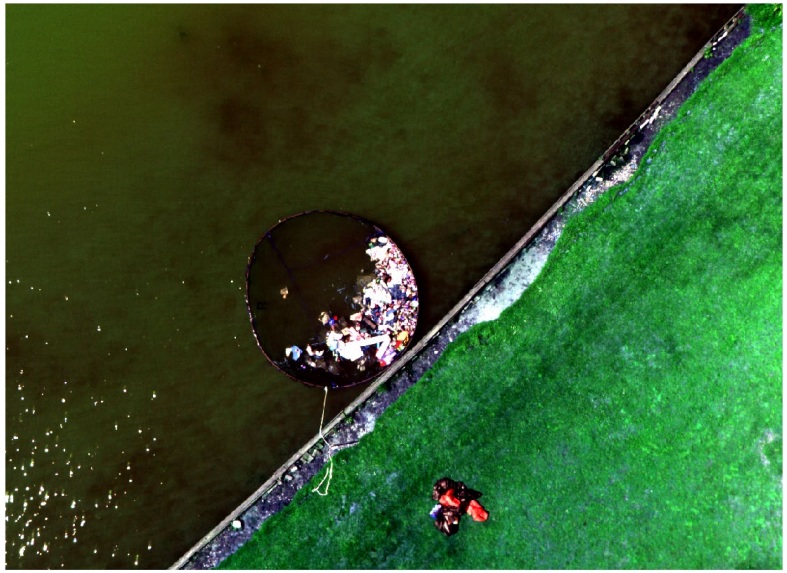


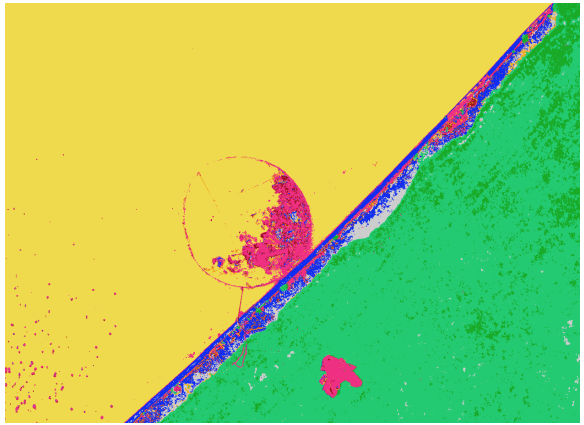
Thresholding + erosion/dilation to avoid plastic over-detection in shadowed areas



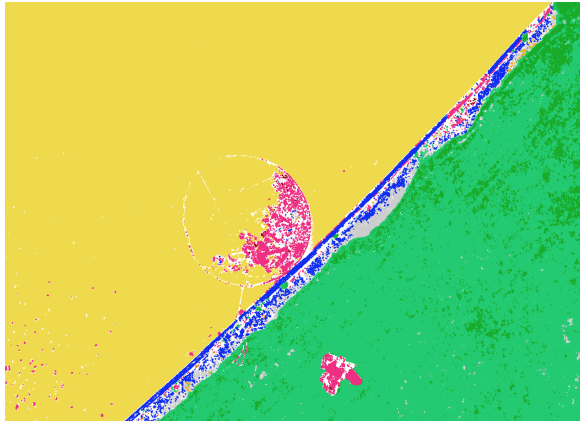


The RF classifier applied on water images



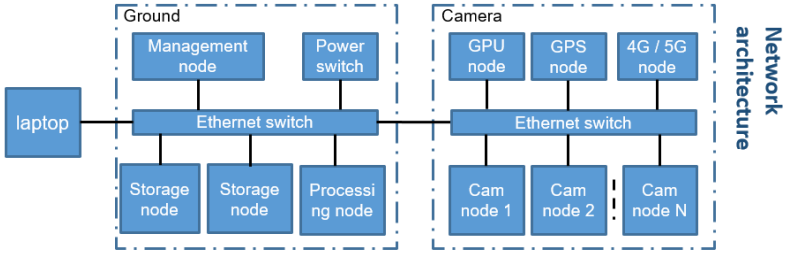


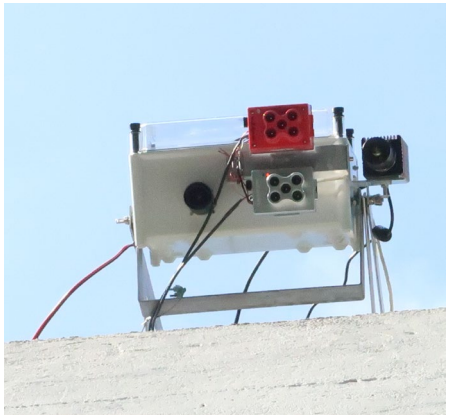
No post-processing



Dark pixels removed

Bridge campaigns (PLUXIN)



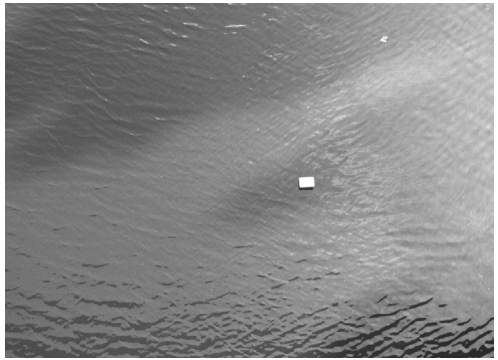


3 cameras (from left to right):
- HR RGB camera
- Multispectral camera – 10 spectral bands in VIS-NIR
- Xenics SWIR camera

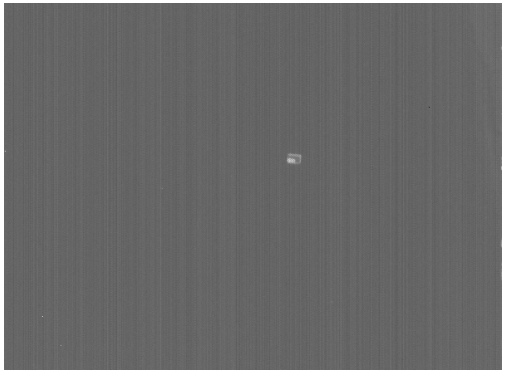
Pointing a same location

bridge campaign (PLUXIN)

RGB
auto exposure
image every 3 sec

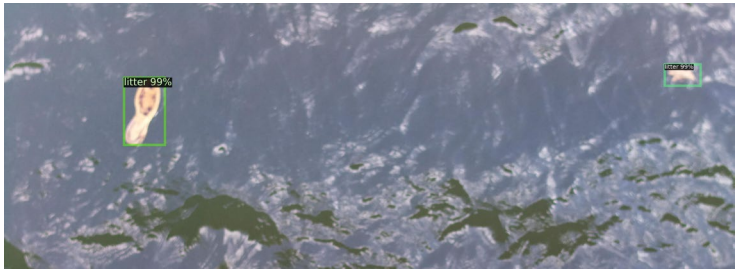


Micasense dual
auto focus / auto exposure
image every 5 sec
16 bit TIFF

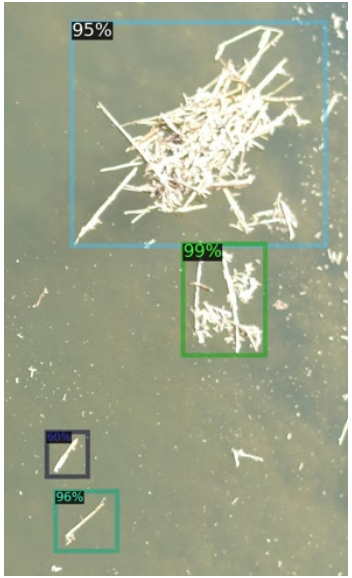


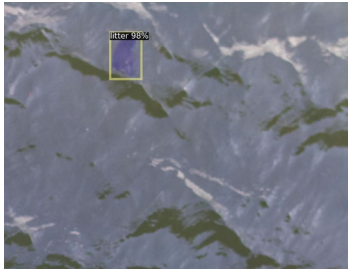
SWIR
12,5mm lens
Aperture 2.5
image every 5 sec

AI on RGB images

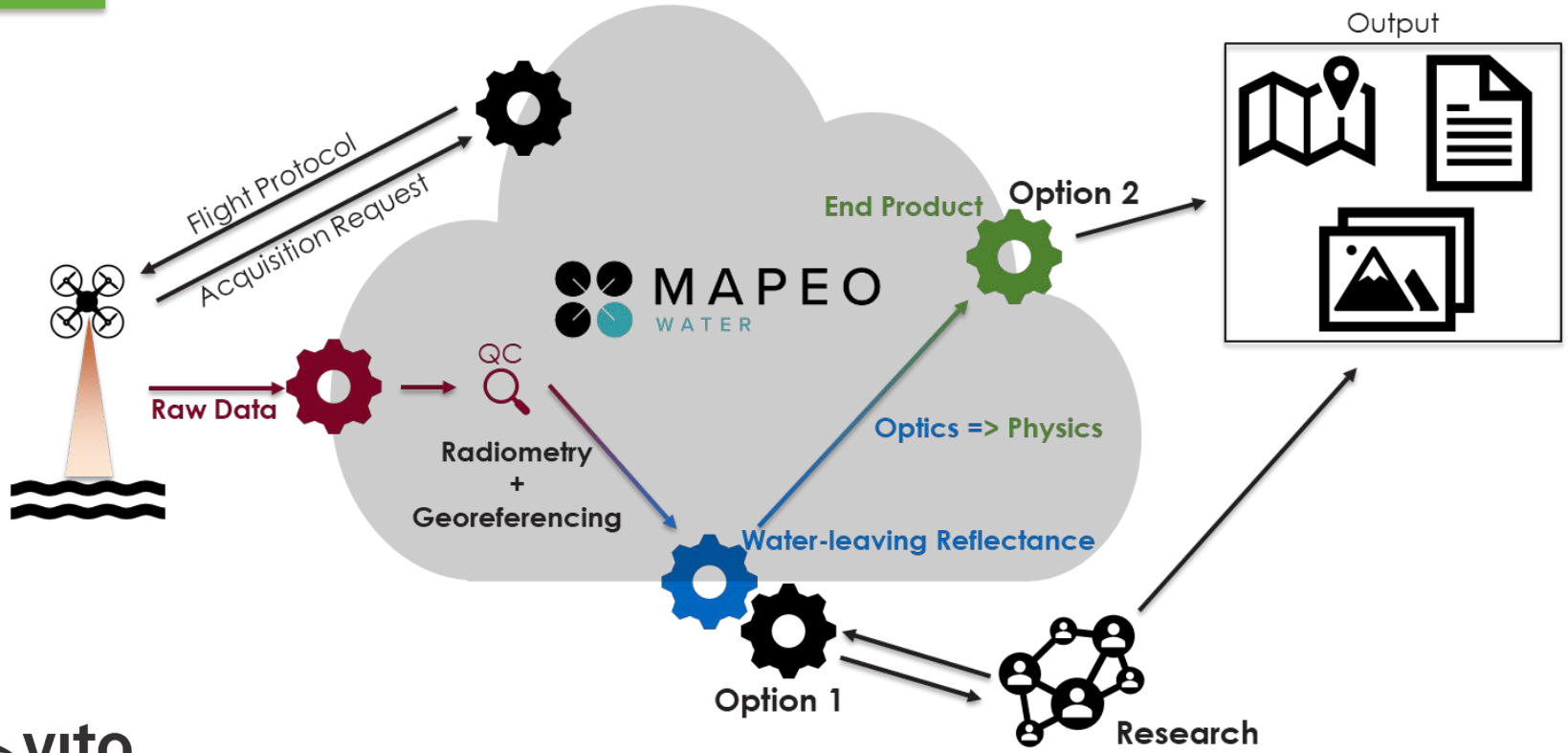


- Sort out input (750 input images with object presence in the water)
- Random patch extraction from each image to have same size images
- Annotation with one category named litter
- Data augmentation
- Divide data set to train/validation with 80-20 percentage
- Register both train and validation data set into detectron2
- Faster RCNN (Region-Based Convolutional Neural Network) used for training
- Results on validation evaluated based Average precision metrics
- Average precision 50 obtained at 88.74 percent
- Inference results with detectron2 Visualizer

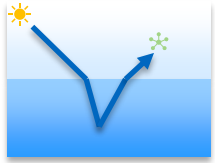




Preprocessing of multi-spectral data



Radiometric Correction



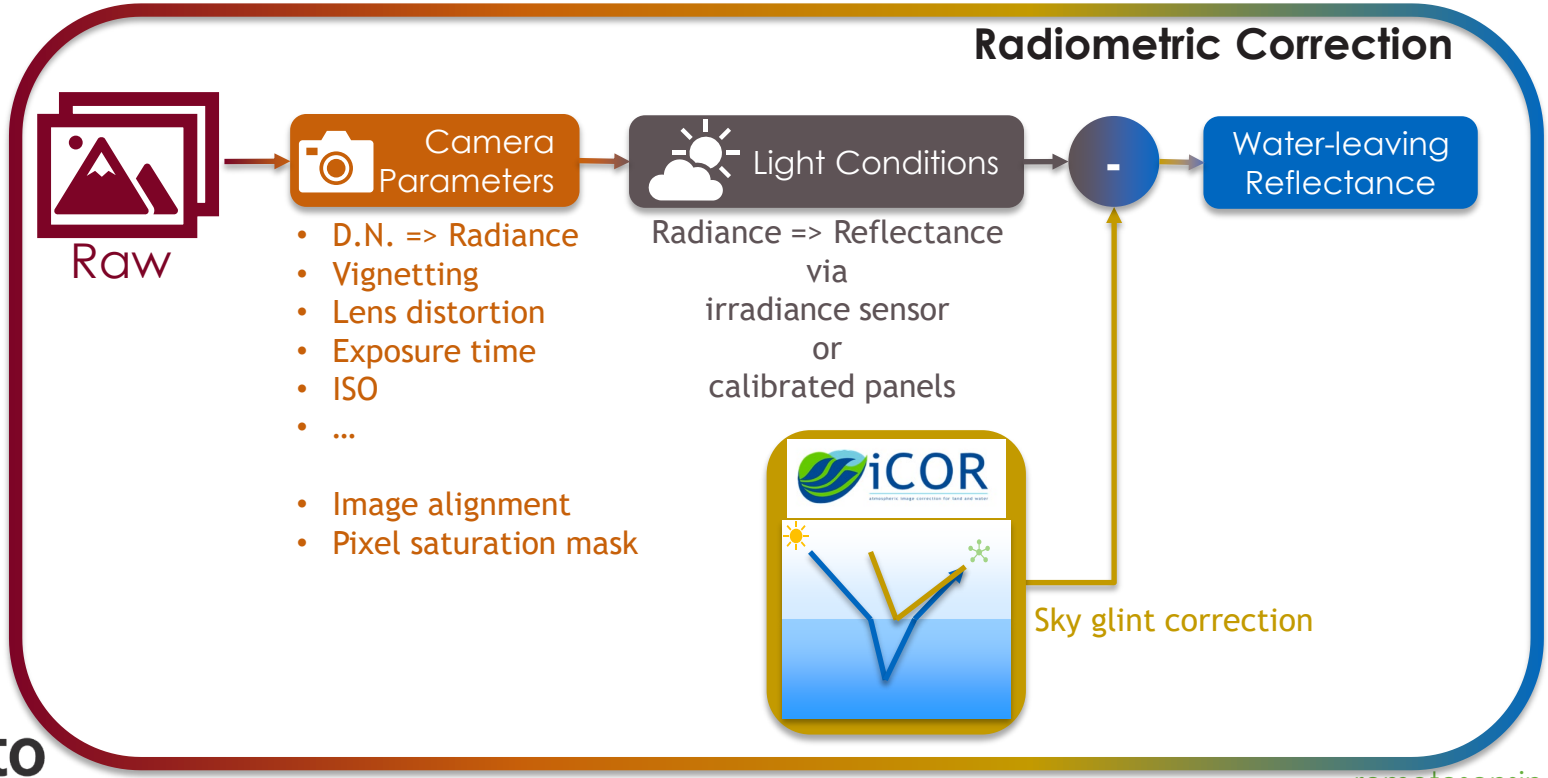


Image Alignment

Individual Images

Aligned Images

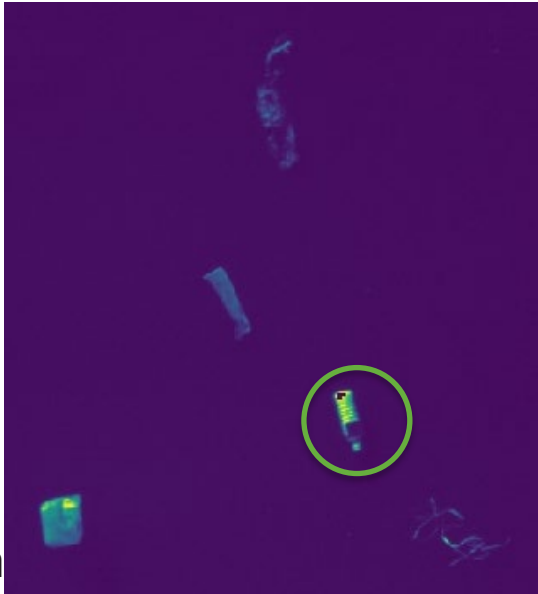
Preprocessing: Pixel Saturation Mask

Few plastic objects (bright) floating on water (dark)
=> Avoid auto-exposure

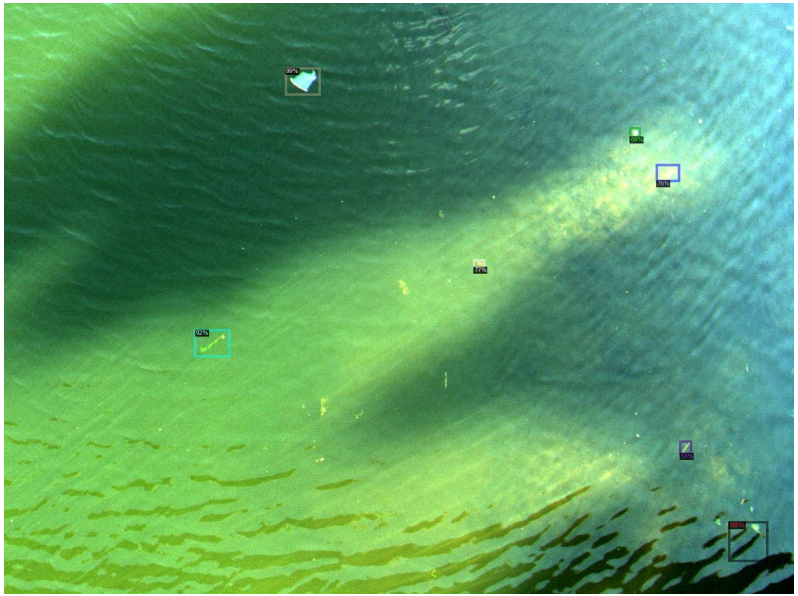
444nm

Saturation mask ~ f(wavelength)

842nm



Object detection on constructed RGB



A marine litter satellite mission ?

Marine litter conceptual design study

- Identify high impact marine plastic use cases
- Assessed the feasibility of monitoring them from space
- Work out a suitable instrument & mission concept

Primary use cases

Landfills

Major source of marine litter
Many are unknown (80% of landfills illegal in SE Asia)

Beach Litter

Majority – 84% – of all beach rubbish is made of plastic. Plastic fragments, fishing gear and packaging are most common

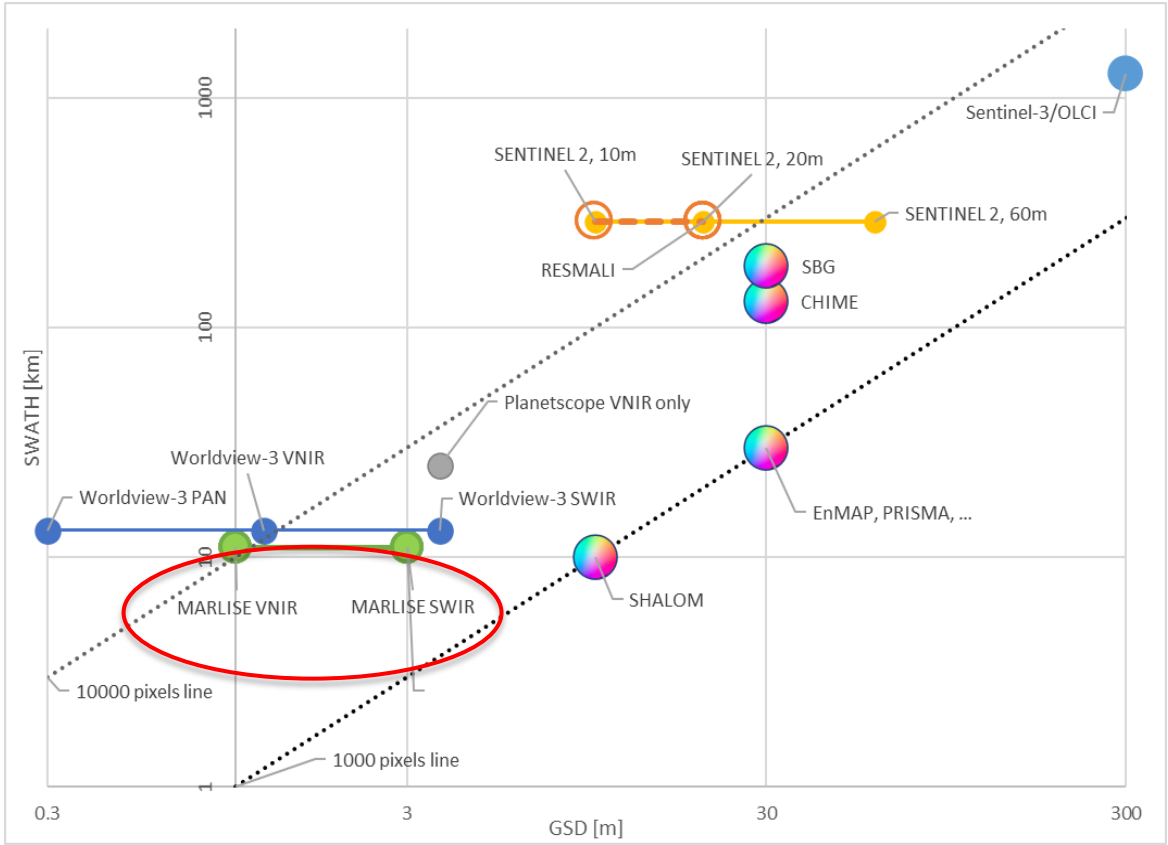
Coastal windrows

aggregations of floating litter, seafoam, seaweeds, plankton
a few m to several km long, and up to 100 m wide

- insufficient info available from field data
- Support policies
- understanding mass balance and pathways of plastics

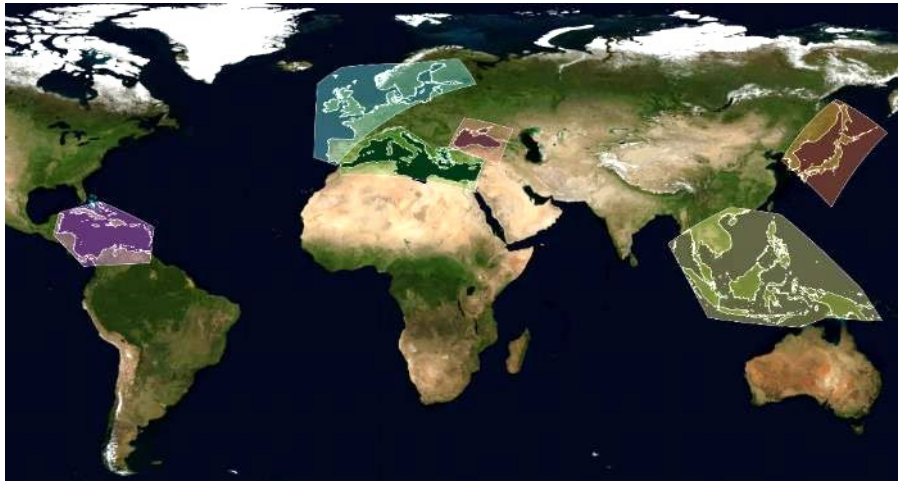
Consolidated requirements

characteristics		consolidated	unit
Spatial resolution	GSD	**1-3**	m
Coverage	Swath	**10**	km
Spectral	range	**400-2400**	nm
Spectral	bands	**20-26 bands identified**	
Spectral resolution	FWHM	**2.5-20**	nm
Radiometric resolution	average SNR	**High (200)**	
Temporal		**monthly/seasonal**	



Coverage

Selected coastal zones
11km swath + 30° roll pointing



areas in Europe, Caribbean, South-East Asia & Japan

total imaging	30000	km^2/day
with pitch movement	9000	km^2/day
data volume	1326	Gbit/day
compression ratio	2.32	
Svalbard downlink	570	Gbit/day

https://remotesensing.vito.be/case/marine-plastic-litter

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THANK YOU

remotesensing.vito.be

Sentinel-2 image Copernicus Sentinel data (2016)