

Classification of riverine floating debris based on true color images collected by a low-cost drone system

Case study from the Citarum River, Indonesia

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Sentinels4marine plastic waste



Indonesia project-specific collaborators



Rivers: a major source of marine plastic

- Lebreton et al. 2017
 - Rivers release 1,150 – 2,410 Mt (mega tonnes) of plastic waste annually
 - Represents 86% total global plastic waste input to the oceans
 - Many top polluting rivers concentrated in Asia

Objectives

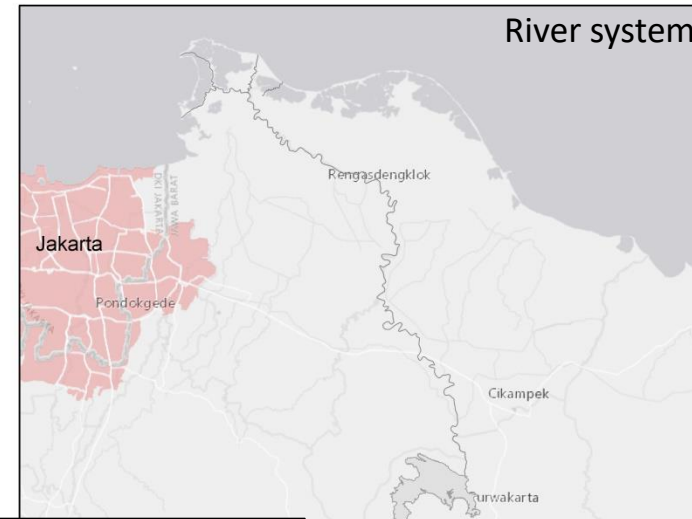
- Quantify floating debris in a river using real color images from a low-cost aerial imaging system
- Successful implementation using hierarchical Object-Based Image Analysis (OBIA) on aerial RGB images of agricultural areas (Tarantino & Figorino, 2012)



- Rivers are small compared to the ocean
 - Width > 60 m needed to utilize publically available low-orbit earth-orientated satellite images such as Landsat and Sentinel-2
 - Tropics are often cloud covered

Study system: Citarum River

- 7 survey locations
- From Sept. 24th – 30th, 2016
- Various debris coverage:



Legend

- Study area
- Citarum River
- Indonesia
- City

Coordinate System: WGS 1984 UTM Zone 48S
Projection: Transverse Mercator
Datum: WGS 1984
Author: Sabela Rodriguez Castaño



Data acquisition

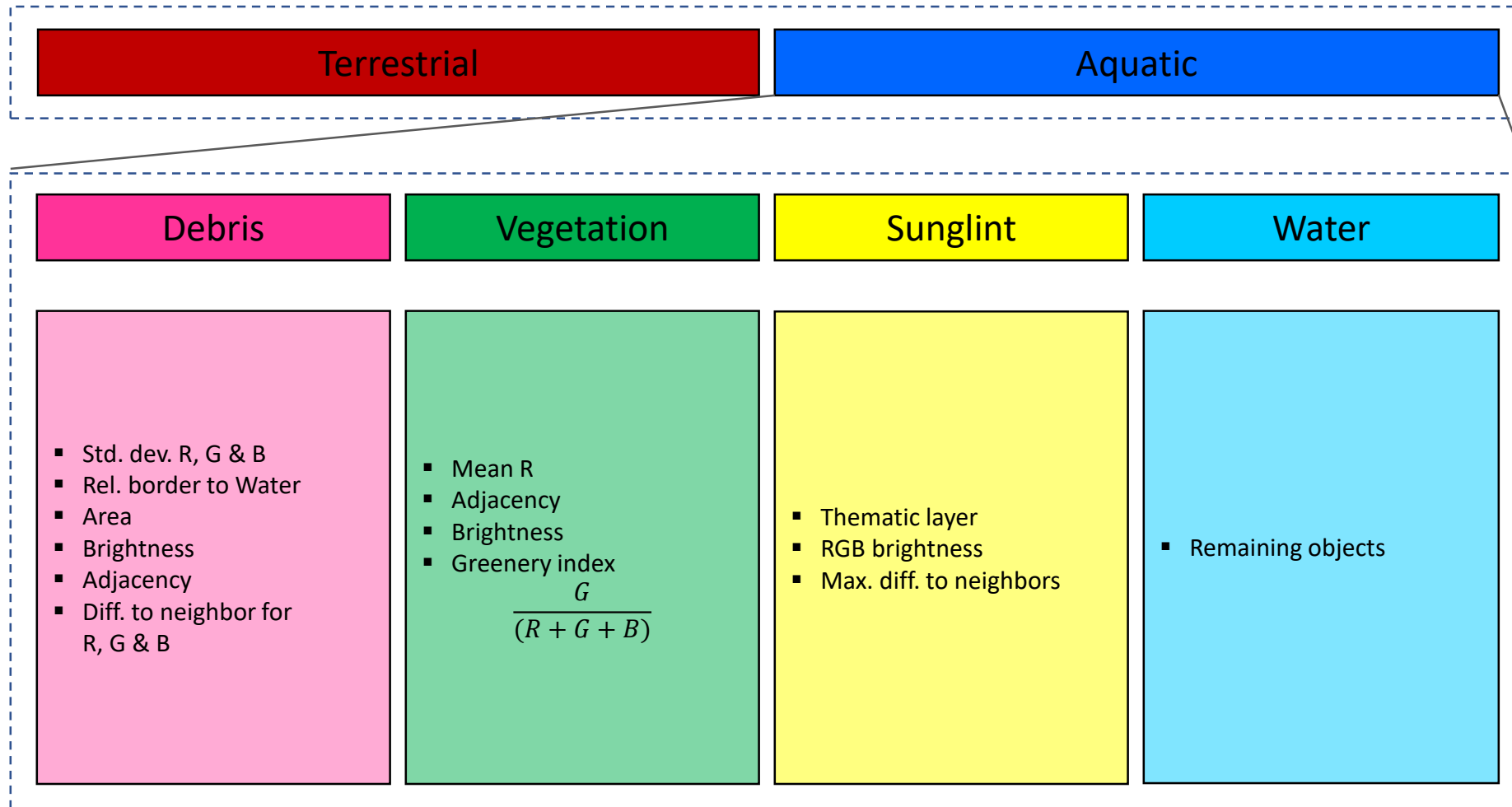
- **Equipment**
 - 3DR Solo drone
 - Camera GoPro4 Silver, equipped with a low distortion lens (Backbone, 1/2.3", 4.4 mm, M12)
- **Photos taken using**
 - 85% frontal overlap, 65% sidelap
 - 30-60 m above ground elevation
- **Image resolution**
 - 15-30 mm, dependent on flight height
- **Post-processing software**
 - AgiSoft
 - ERDAS



OBIA classification

Hierarchical Object-Based Image Analysis (OBIA)

– eCognition software, segmentation using scale 10, shape 0.1

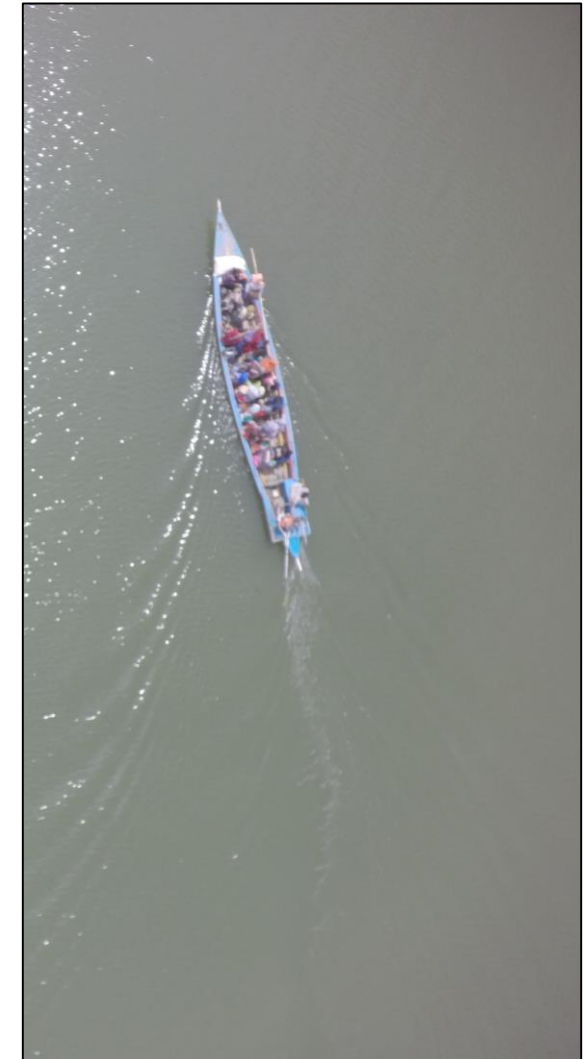


Validation

- **Direct ground control points difficult**
 - Moving river highly dynamic
 - Coverage changes with boat sampling

- **Visual analysis**
 - Independent classifier with no knowledge of classification scheme
 - 300 random points, half in Debris category, half in other categories

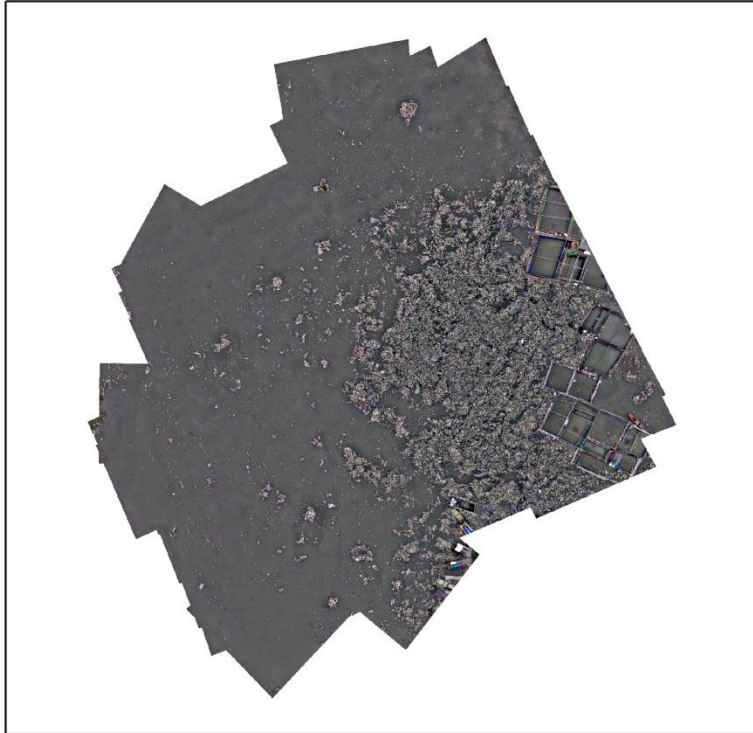
- **Confusion matrix**
 - Overall accuracy
 - Kappa coefficient



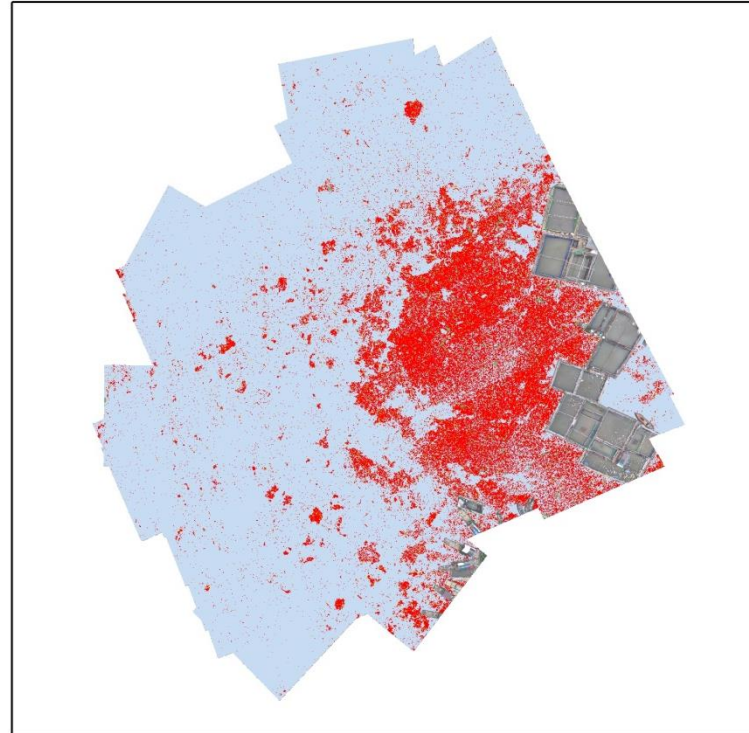
Jangari 1

High debris coverage

Mosaic



Classification



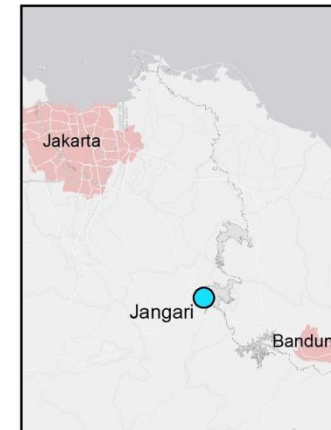
Legend

- Vegetation
- Debris
- Sunlint
- Water
- Study area



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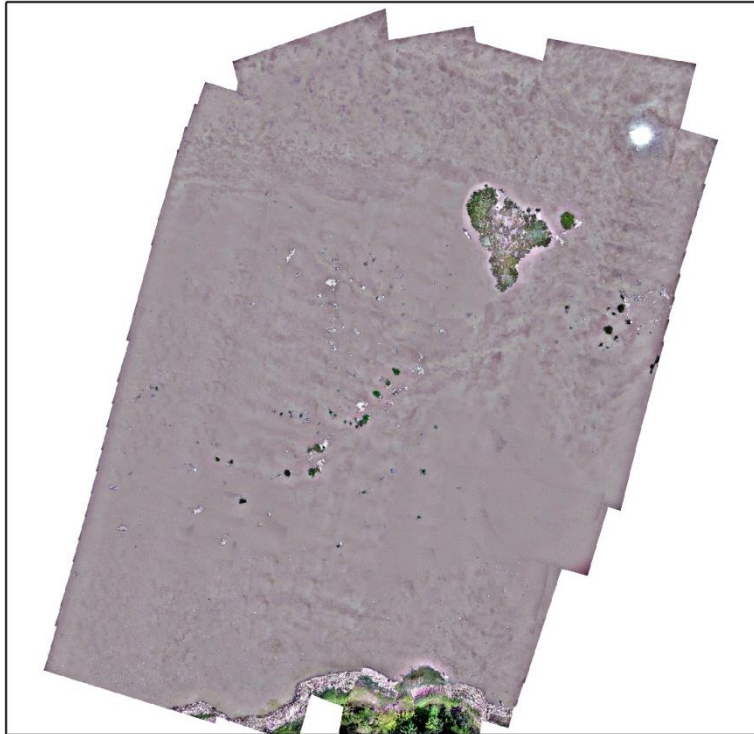


Overall accuracy: 88.67%
Kappa coefficient: 0.77

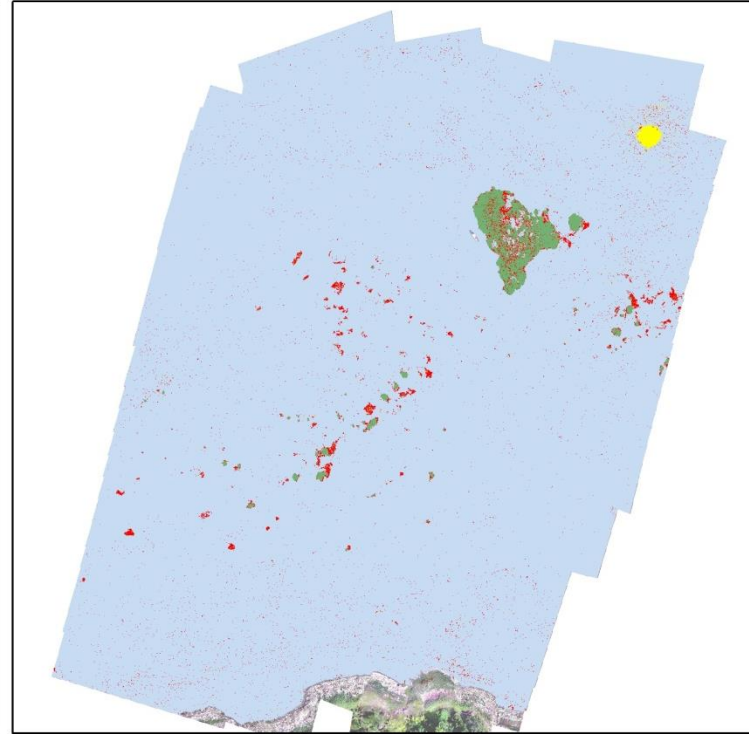


Cibeber West Medium debris coverage

Mosaic



Classification



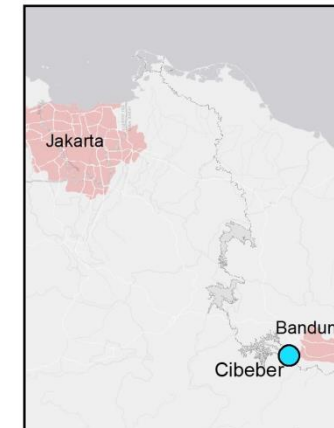
Legend

- Vegetation
- Debris
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Overall accuracy: 90.00%
Kappa coefficient: 0.80

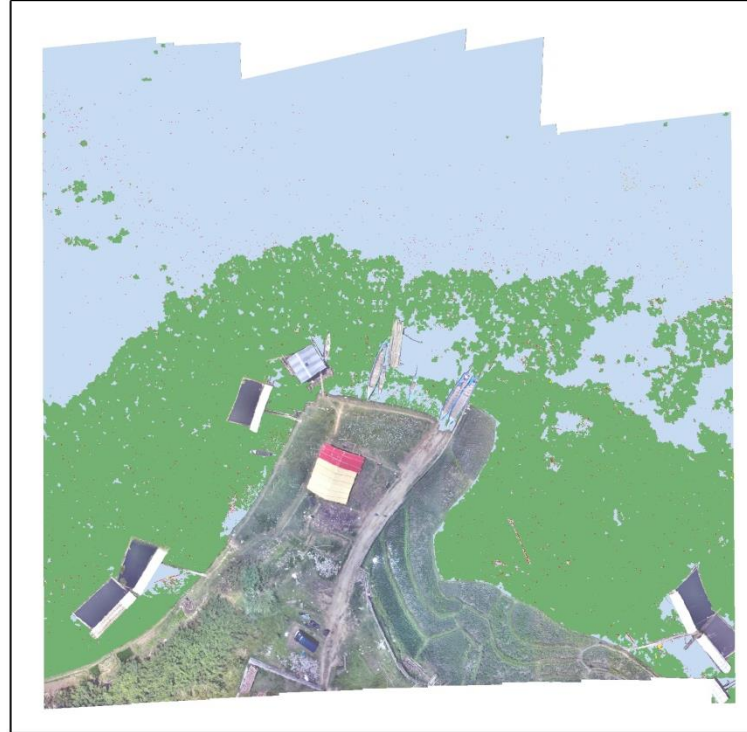


Galumpit Low debris coverage

Mosaic

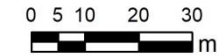


Classification



Legend

- Vegetation
- Debris
- Sunglint
- Water
- Study area



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Overall accuracy: 67.67%
Kappa coefficient: 0.35



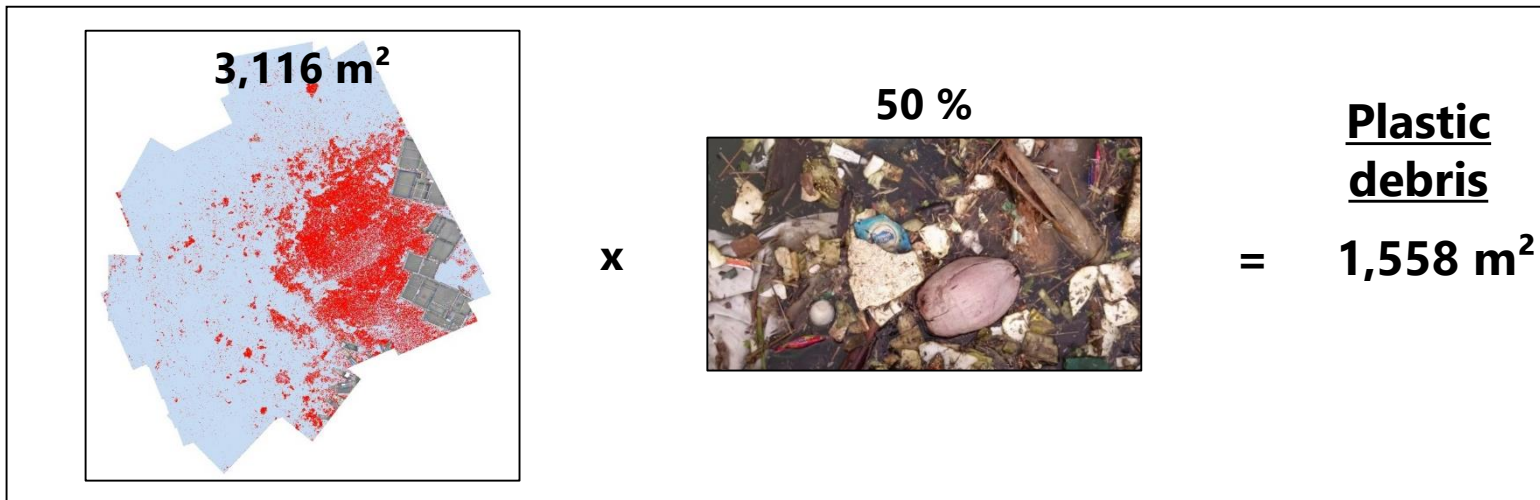
Floating debris detection

	Total (m ²)	Debris (% / m ²)	O.A. / Kappa	Water turbidity	Vegetation
Cibeber East	27,910.46	1.16 / 324.93	90.00 / 0.80	***	
Cibeber West	71,574.69	1.19 / 853.38	90.00 / 0.80	***	
Jangari 1	17,031.09	18.30 / 3,116.17	88.67 / 0.77	**	
Jangari 2	12,242.91	14.20 / 1,738.73	93.00 / 0.86	**	
Citara Dam	25,831.97	0.00 / 0.47	60.98 / N.A.	*	
Galumpit	11,435.41	0.38 / 42.99	67.67 / 0.35	*	
Ciranjang	11,262.64	1.68 / 189.15	73.58 / 0.47	**	

- **Difficulties and limitations**
 - Debris in constant motion
 - Debris object shapes / sizes more complex as compared to Tarantino & Figorino (2012)
- **Best accuracy: medium and high debris coverage locations**
 - Reduction with increased water plant coverage
 - Turbidity here seemingly irrelevant
- **Low turbidity + low debris coverage not well captured**
 - Flowering hyacinths especially difficult

Conclusion and future research

- Successful quantification of floating debris using a low-cost, easy to implement system
 - Highest accuracy over high and medium coverage areas, aquatic plants introduce more variability
 - Stopages of drainage canals cause disastrous flooding events during the monsoon season

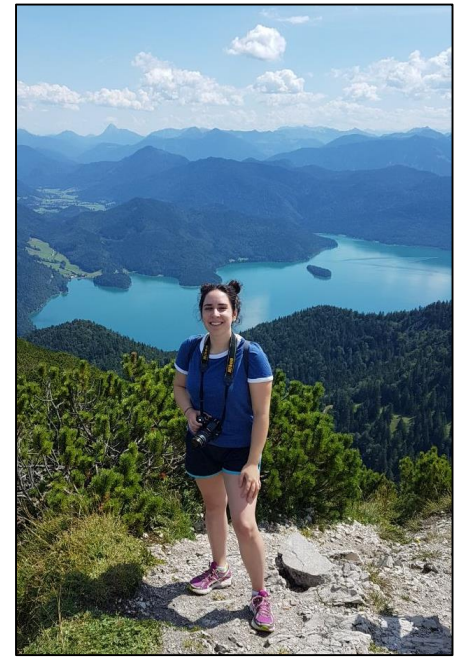
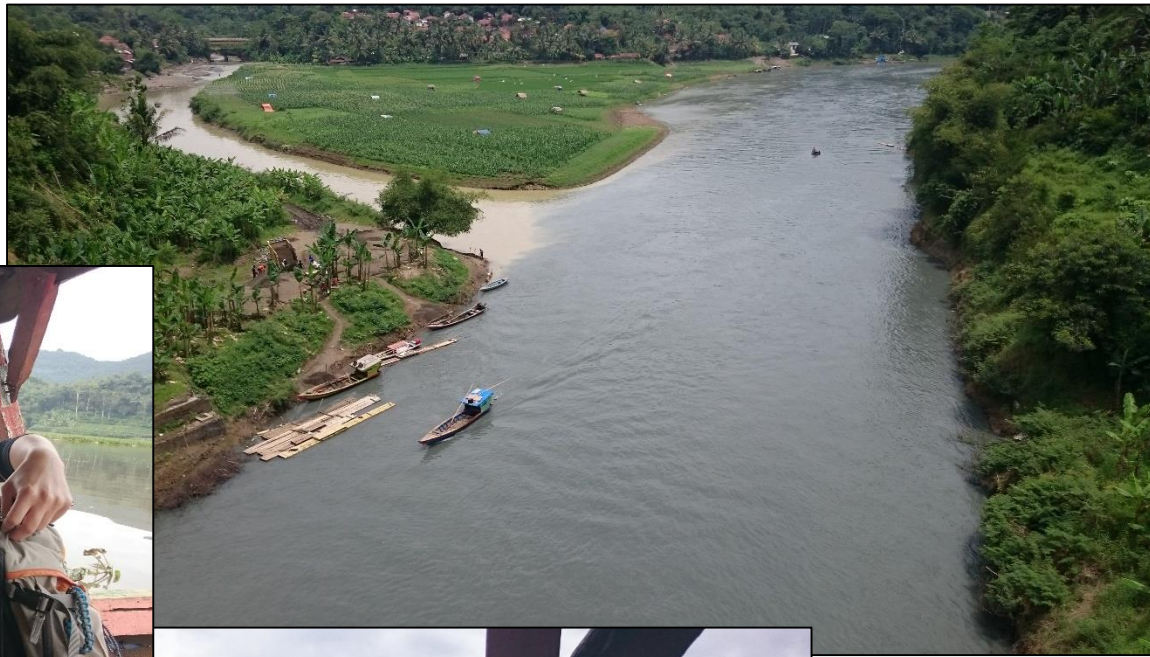


using ratios such as

aking few but much

- Estimating floating plastic from debris
 - Higher resolution photos taken closer to surface can be subsampled to estimate % floating debris which is plastic

Thank you



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Questions?



References:

- Lebreton, L. C., Van der Zwet, J., Damsteeg, J. W., Slat, B., Andrady, A., & Reisser, J. (2017). River plastic emissions to the world's oceans. *Nature communications*, 8, 15611.
- Tarantino, E., & Figorito, B. (2012). Mapping rural areas with widespread plastic covered vineyards using true color aerial data. *Remote Sensing*, 4(7), 1913-1928.