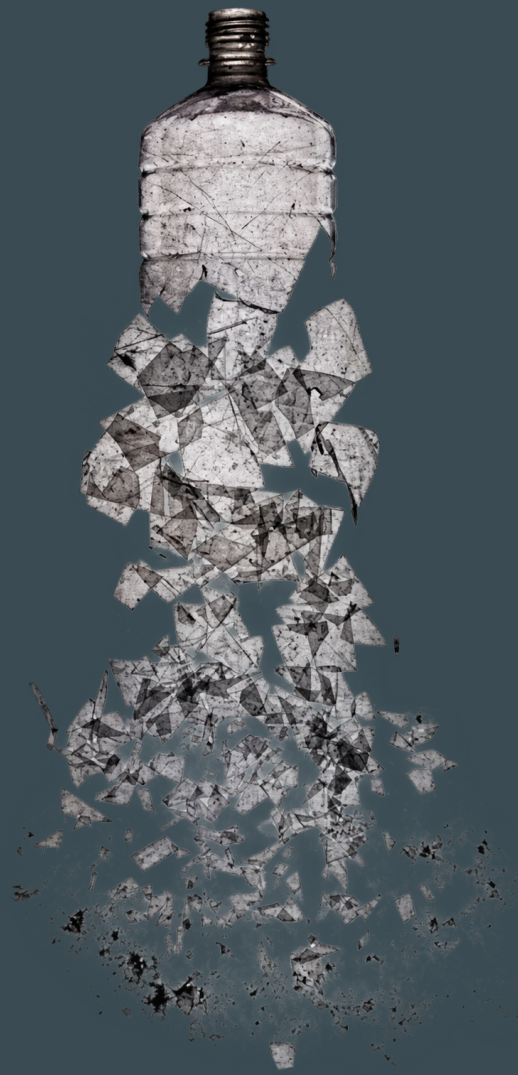
MicroSight

2nd SMASHING WORKSHOP

Low-Cost, Image-Based Identification and Classification of Microplastics in Freshwater Environments



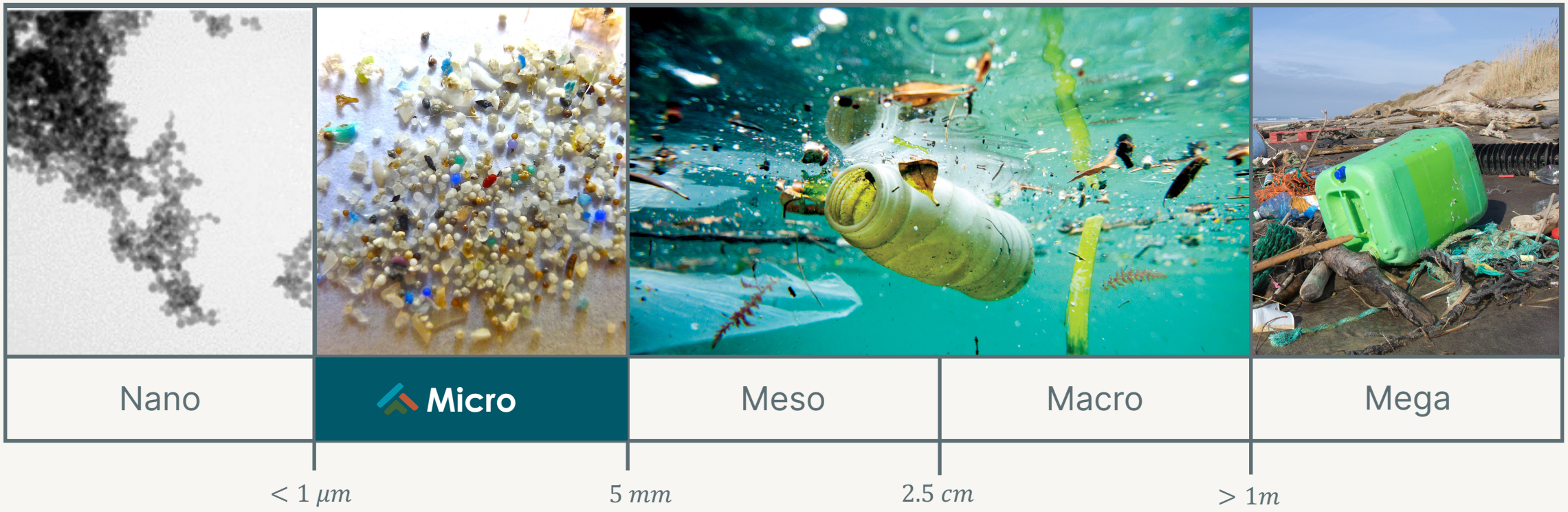
Nerea Portillo De Arbeloa, PhD

21 October 2026 · Vipava

UNIVERZA V LJUBLJANI
ViCOS visual cognitive systems lab
SMASH machine learning for science and humanities postdoctoral program
I FEEL SLOVENIA
Co-funded by the European Union
UNIVERSITY OF TRENTO
PLANT ERASTICS
FKKT Faculty of Chemistry and Chemical Technology

Microplastics

Microplastics (MPs) are solid plastic particles smaller than 5 mm, either intentionally manufactured at small sizes (primary MPs) or formed through the fragmentation of larger plastic items (secondary MPs)



Collection and Identification

SAMPLE COLLECTION



FILTERING



DRYING



SIEVING



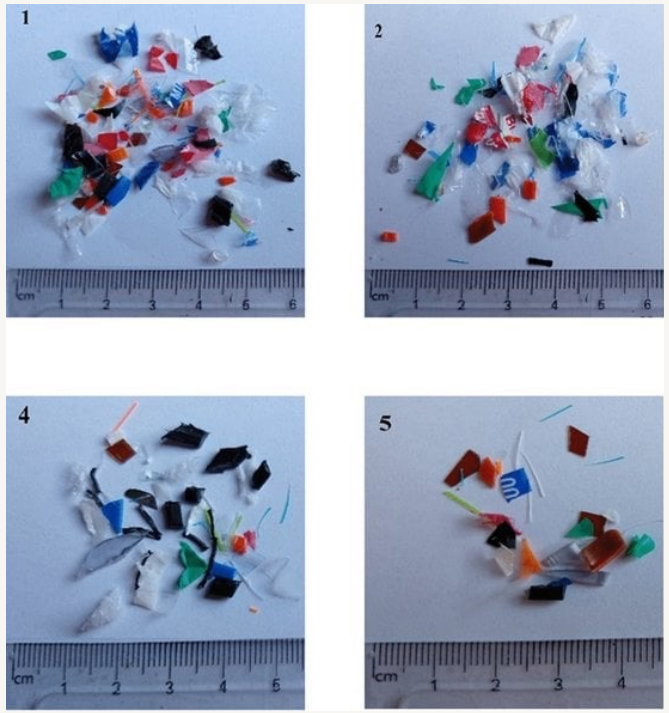
IDENTIFICATION/ QUANTIFICATION



River samples with high organic content take from 3 to 7 days per sample…

Identifying MP is slow!

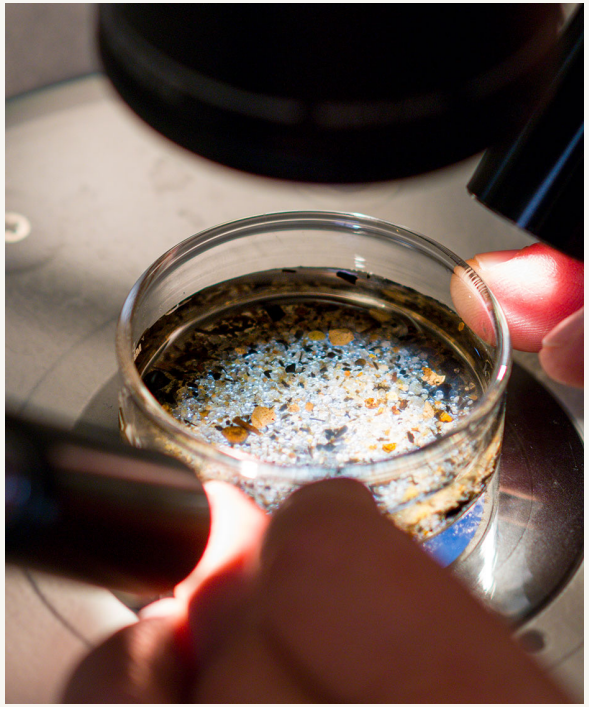
Current methods on identification



01 / VISUAL SCREENING

Manual visual sorting

Select visible candidates by eye or with a magnifier.



02 / OPTICAL CHARACTERIZATION

Optical microscopy

Measure size and classify morphology using magnified images.



03 / CHEMICAL CONFIRMATION

FTIR / Raman

Compare a particle’s spectrum with polymer references.

Shape matters

Particle morphology is critical for transport studies, source interpretation and monitoring. Reliable particle identification remains difficult to scale.



FRAGMENTS



FIBERS



PELLETS



FILMS



FOAMS

LAB INTENSITY

Spectroscopic confirmation requires specialist equipment.

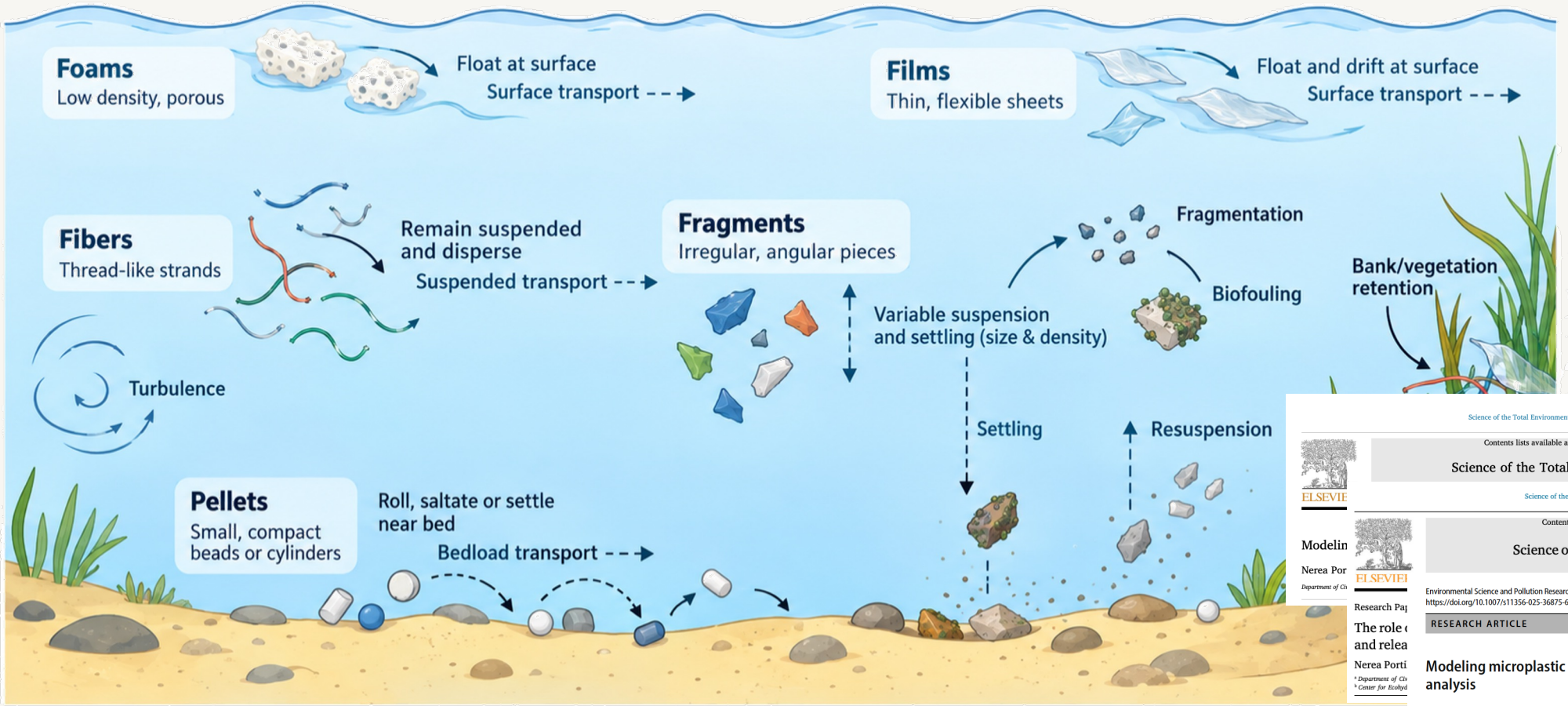
MANUAL EFFORT

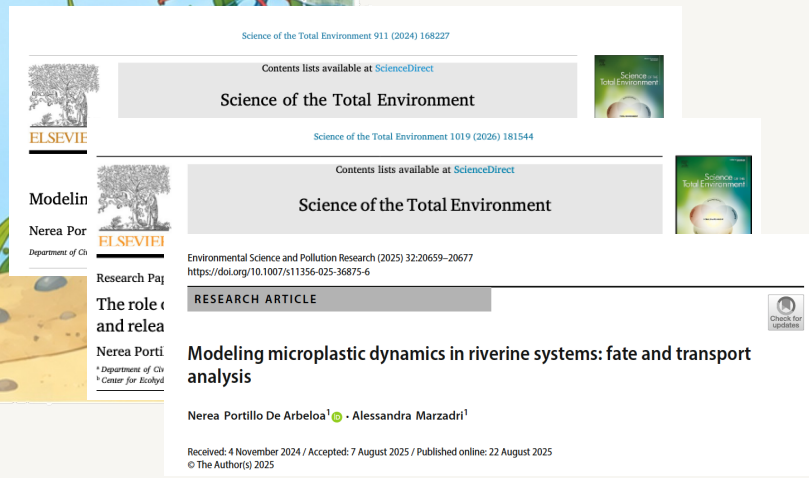
Counting and morphological labelling are time-consuming.

INCONSISTENT CONDITIONS

Backgrounds, particle size and imaging conditions vary.

Transport Dynamics




Science of the Total Environment 911 (2024) 168227
Contents lists available at ScienceDirect
Science of the Total Environment
Science of the Total Environment 1019 (2026) 181544
Contents lists available at ScienceDirect
Science of the Total Environment
Environmental Science and Pollution Research (2025) 32:20659–20677
https://doi.org/10.1007/s11356-025-36875-6
RESEARCH ARTICLE
Modeling microplastic dynamics in riverine systems: fate and transport analysis
Nerea Portillo De Arbeloa[1] · Alessandra Marzadri[1]
Received: 4 November 2024 / Accepted: 7 August 2025 / Published online: 22 August 2025
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Conceptual diagram: transport behavior also depends on size, density, aggregation, biofouling, and local flow conditions. Generated with AI.

The Microsight Project

MAIN OBJECTIVE

Develop a ML model that automatically detect, classify and count microplastics from consumer-grade images.

WHY IT MATTERS

Current particle screening is time-consuming, requires expertise and is difficult to scale across freshwater environments.

01 IMAGE DATASET

Create an **Open**, **Labeled** Microplastic Image Dataset with controlled and complex backgrounds

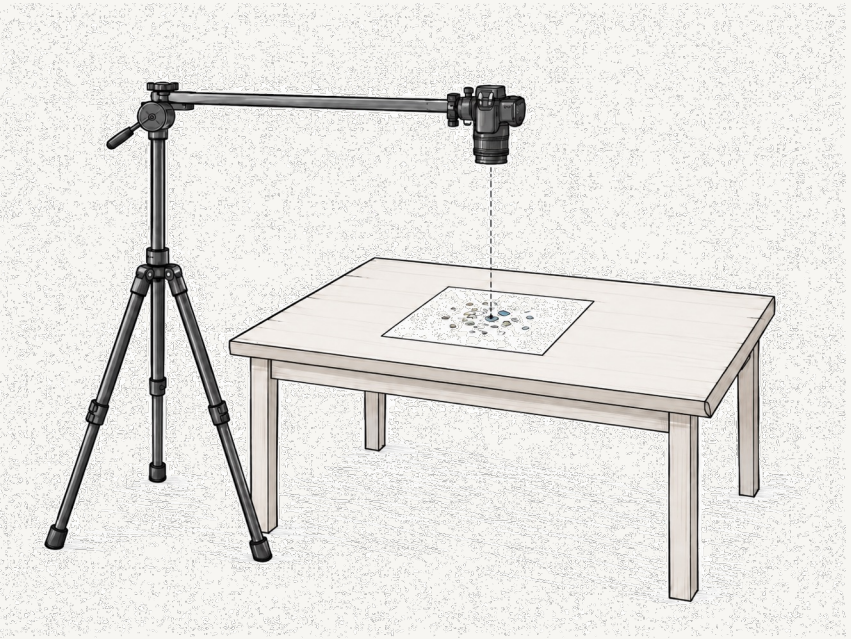
02 MACHINE LEARNING

Automated detection, measurement and classification

03 OPEN-ACCESS PLATFORM

AI-assisted recognition for scalable freshwater monitoring

From images to a reusable observation





Date
MP Type
Sample ID
...



PREPARATION

↓

CAPTURE

↓

ANNOTATE

↓

CLASIFY

Print at 100% on A4 — do not scale | Circle outer Ø mm



ample 017 fragment 2026-09-18

Sub-sample: Date:

Ø 25.25 mm

(A4 print only)



017 fragment 2026-09-18

Sub-sample: Date:

Ø 25.25 mm

Pilot Test: Pellets and Fragments

Latest experiment combines sediment scenes with MP-only reference photographs

232 **Training particle annotations**

74 pellets and 158 fragments

234 **Evaluation particle annotations**

45 pellets and 189 fragments

ResNet-18 U-Net with a pretrained encoder
Training combined MP-only reference images and sediment images

Examples of model input tiles



Pellets in sediment



Fragments on paper

Preliminary counting results with reference mixing

212 of 234

annotated appearances located for counting

Counting F1: 0.910

Precision 91.4% Recall 90.6%

Actual / predicted	Pellet	Fragment	Missed
Pellet	**39**	0	6
Fragment	0	**173**	16
FP	7	13	—

Stricter full-mask matching: 147 / 234 (IoU ≥ 0.5) F1: 0.631

Counting diagnostic: at least 50% of a candidate lies inside one annotated particle, with one-to-one matching.

Pellets among sediment



Detail from a 10-pellet scene
Full scene: 8 / 10 located

Green: full-mask match
Magenta: partial prediction
Yellow: ground-truth outline

Promising first results

Pilot: 212/234 candidate-presence matches; only 147/234 satisfy strict full-mask matching (IoU ≥ 0.5).

KNOWN LIMITATIONS

- Small dataset with just few particles
- Pellets and low-contrast MPs remain difficult
- Partial and extra masks affect counting

WHAT COMES NEXT

- Validate on new particles and sediments
- Cross morphologies, backgrounds and lighting
- Explore alternative approaches: Test and refine different methods to improve MPs detection and classification (e.g. anomaly detection, supervised segmentation)
- Mixed morphology samples: Introduce different MPs types into the same sediment sample to evaluate the model's ability to detect, distinguish, and classify particles under more realistic conditions.

MicroSight

THANKS!

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