Image Credit: Natascha Schmidt

IN THIS ISSUE

ANDROMEDA Newsletter Issue No. 3

We are delighted to bring you ANDROMEDA's final project newsletter. In this issue, we highlight some of our project's key outputs over the last year, and revisit some of the key project milestones from throughout the project lifecycle.

In the following pages, you will find links to papers, presentations, and other activities of interest. You will also learn about our citizen science smartphone app which is now available to download on both iOS and Android devices, and how you can participate in our Europe-wide citizen science microplastics campaign.

The ANDROMEDA team!

The **ANDROMEDA** project is supported through the Joint Programming Initiative: Healthy and Productive Seas and Oceans (JPI Oceans).

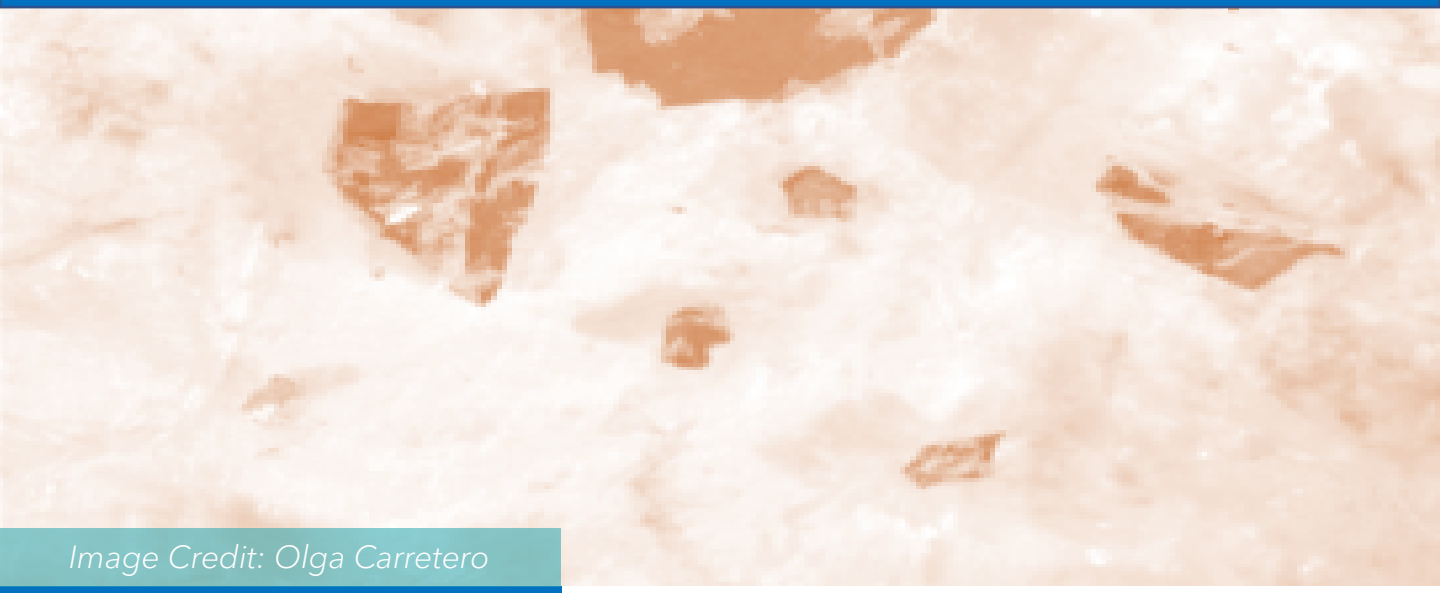


Image Credit: Olga Carretero

OBJECTIVES

ACHIEVE cost-effective analysis of microplastics by in-situ methods and low-cost laboratory analysis, including efficient sampling.

DEVELOP & OPTIMISE advanced techniques to measure and quantify small and challenging types of microplastic particles.

INVESTIGATE the degradation and fragmentation mechanisms of plastic into micro- and nanoplastic particles.

STUDY the release of additive chemicals during plastic fragmentation and degradation processes.

DISSEMINATE project results and developed protocols to a range of audiences, including public authorities, the private sector, academia, and the general public

About ANDROMEDA

The JPI Oceans funded ANDROMEDA project brings together a multidisciplinary consortium of 15 international partners in 9 European countries to improve the quantification of nanoplastics and microplastics in our oceans and seas.

The project will develop new sampling and advanced analysis methodologies that focus on smaller microplastic (< 10 µm) and nanoplastic (< 0.2 µm) particles to enable improved risk assessment of plastic pollution, along with *in situ* techniques and cost-effective measurement methods for improving the efficacy and efficiency of microplastic monitoring.

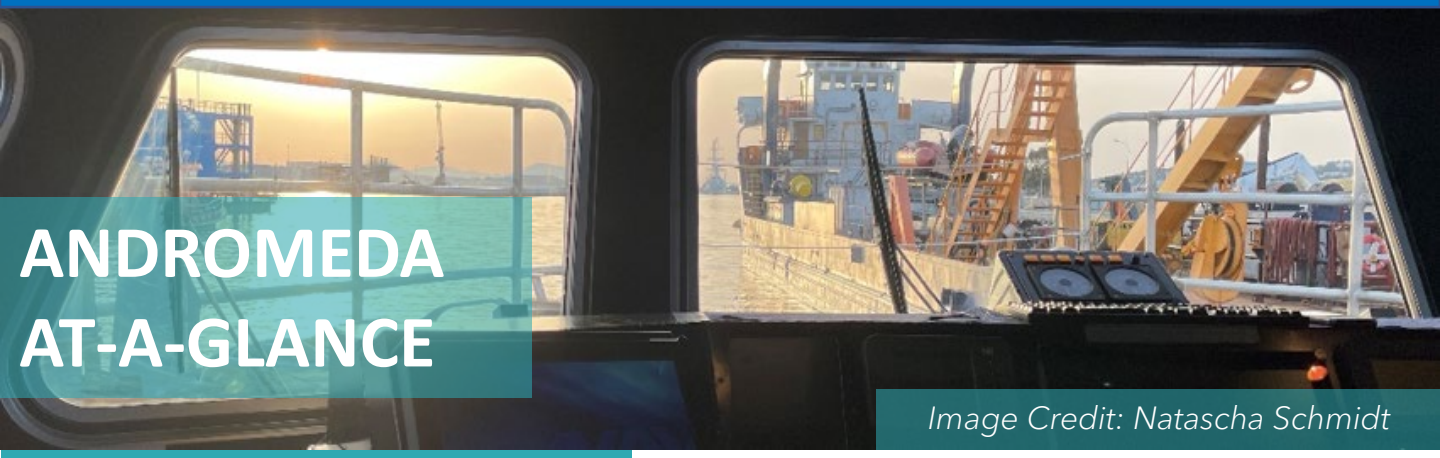
ANDROMEDA is one of six projects funded under the JPI Oceans Joint Action Ecological Aspects of Microplastics call.

ANDROMEDA is analysing challenging types of microplastics including:

Tyre Wear Particles

Microfibers

Paint Particles



ANDROMEDA AT-A-GLANCE

Image Credit: Natascha Schmidt

Key Deliverables

DEVELOP an instrument platform for *in situ* and cost-effective analysis of microplastics

ADVANCE characterisation of nanoplastics and microplastic materials and for accelerated microplastic degradation, and

CHARACTERISE microplastic degradation.

Milestones

53 Oral & poster presentations

36 Peer reviewed publications & reports

8 Smartphone app testing events

ACTIVITIES TIMELINE

Smartphone app Launch
May 2022

The ANDROMEDA smartphone app was officially launched in Malta at our annual consortium meeting.

Online Stakeholder Surveys
October 2022

An online survey on the cost-effectiveness of different microplastic analysis methods was launched by VLIZ & ILVO.in collaboration with UCC.

Stakeholder Workshops
April 2023

Based on the results of the stakeholder surveys, 2 workshops were organised with researchers from our JPI Oceans sister projects' and policy and decision makers to establish comprehensive recommendations.

ALSO ASM JPI Oceans' Sessions
June 2023

A session was accepted entitled `JPI Oceans Joint Action Ecological Aspects of Microplastics – What is needed to transfer the scientific findings into political knowledge for action?'. that showcased the range of work produced by the ANDROMEDA project.

Smartphone App Available for Download
June 2023

The ANDROMEDA smartphone app was made available on both Android and iOS devices for public use and participation in the Europe-wide citizen science initiative, .

ANDROMEDA Factsheets Launched
July 2023

The ANDROMEDA factsheets were finalised and made available on line in over 8 European languages. These factsheets give an overview of the issue of microplastics in our marine environment, and provide a step-by-step guide to using our smartphone app.

JPI Oceans Closing Event, Galway
September 2023

A JPI Oceans closing event was held to showcase the contributions made to microplastics research by the 6 projects funded under the JPI Oceans - *Joint Action Ecological Aspects of Microplastics* call in 2020.

ANDROMEDA Protocols
November 2023

A collaborative report containing 8 ANDROMEDA protocols was published to support the dissemination of methodological information developed throughout the project lifecycle.

Journal Special Issue
December 2023

A special issue with Environmental Pollution to be finalised, presenting over 41 peer reviewed research papers, highlighting key outputs from the 6 projects funded under the JPI Oceans - *Joint Action Ecological Aspects of Microplastics* call in 2020.

Final Report
December 2023

The final report for the JPI Oceans' funded ANDROMEDA project will be finalised.

Project Activities

+ Development of Cost-effective Microplastic Analysis Techniques Within ANDROMEDA

Bavo de Witte, ILVO

Microplastics occur in a wide range of sizes, shapes, colours or polymer types. This hampers the application of one method to measure all microplastics. Methods should be fit for purpose, and for monitoring purposes, large scale research projects or citizen science, measuring microplastics of a few micrometers is generally not necessary. Therefore, ANDROMEDA Work Package 2 focused on the optimisation of different sampling and analysis methods to analyze microplastics >50, >100 or >300 µm in a cost-effective way.

A central key to obtaining cost-effective methods is automation at each step of the workflow. The development of unmanned devices, such as a flow-through water sampling system to be applied on-board ferries or research vessels, or a large volume air sampler, are able to strongly reduce sampling efforts and only require limited training of personnel (Task 2.1). Analysis can be automated with the use of automated imaging techniques.

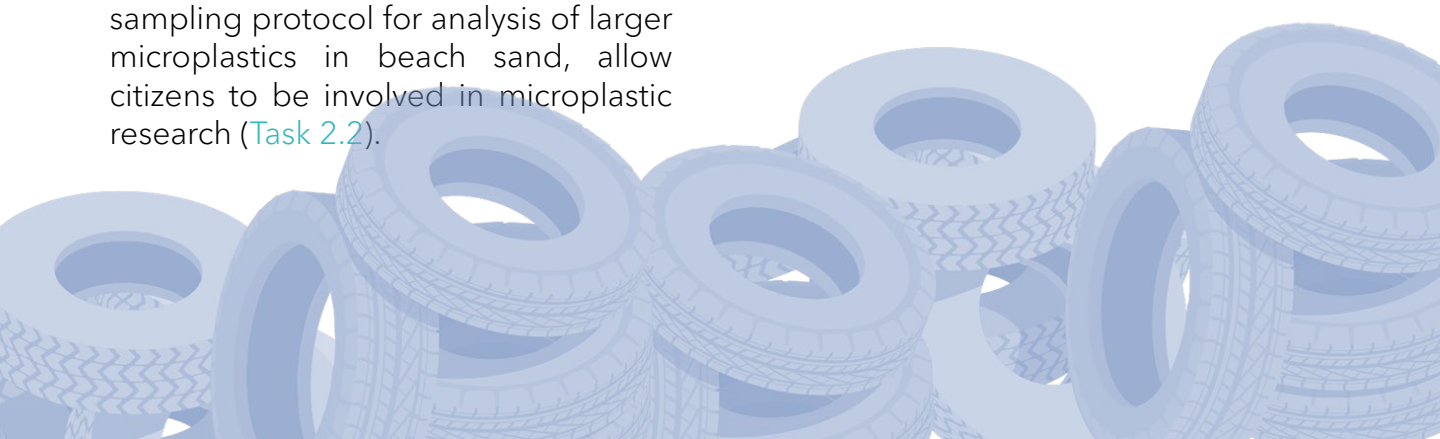
The development of a freely downloadable app, together with a sampling protocol for analysis of larger microplastics in beach sand, allow citizens to be involved in microplastic research (Task 2.2).

Automated imaging and data processing are a prerequisite to handling high amounts of citizen science data obtained by photographing microplastics.

The use of image recognition algorithms in hyperspectral VIS/NIR imaging (Task 2.3) or Nile red-based methods (Task 2.5) allow laboratory analyses of microplastic samples from various matrices in a cost-effective way, even combining microplastic analysis with polymer identification.

This allows a higher throughput of samples or may allow prescreening of samples in order the reduce the workload on high-end techniques such as µFTIR or µRaman.

Tire wear particles are microplastics which are difficult to measure with microscopy-based techniques as they strongly absorb light. Measuring chemical markers by gas or liquid chromatography-based methods (Task 2.4) proved to have potential for assessing microplastic exposure to biota for both tire wear particles as well as other microplastic polymers.



Hyperbaric samples (Image Credit: Natascha Schmidt)

Project Activities

+ Development of Cost-effective Microplastic Analysis Techniques Within ANDROMEDA

...Continues from page 04

Methods based on chemical markers, hyperspectral imaging or Nile-Red based techniques, as optimized within Andromeda, all have specific characteristics and selection of the best available technique depends on the type of matrix and the research or monitoring purpose. The availability of a portfolio with different techniques for microplastic analysis is of high value.

The high accuracies reached with each of the optimised methodologies indicate that the harmonisation of microplastic analysis should focus on defining required quality criteria rather than putting forward one single analysis method.

We have summarized an overview of state-of-the-art methods and main instruments available within the consortium. Learn more by clicking on the icons below!

Analysis Methods

Artificial Microplastic Degradation Methods

Instrument Availability

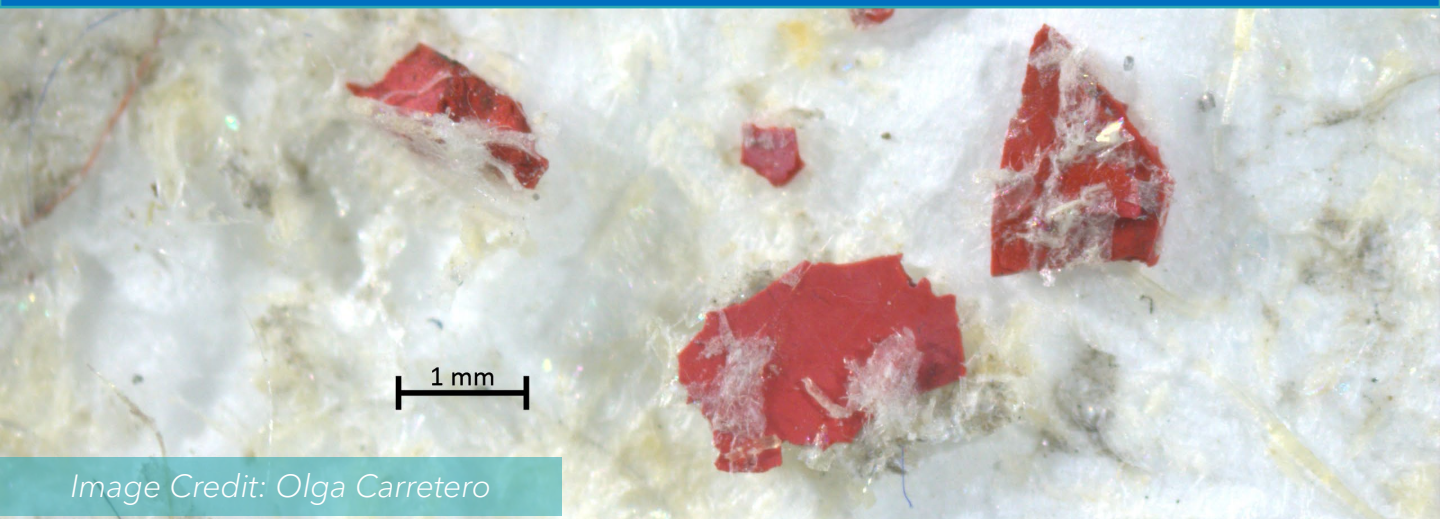


Image Credit: Olga Carretero

Project Activities

+ Tire wear Particles in Coastal Areas: Are There Suitable Chemical Indicators of Exposure in Blue Mussel (*Mytilus edulis*)?

Aurelio G. Foscari F.W., Riham Mowafi, Bettina Seiwert, Dorte Herzke, Bavo De Witte, Daan Delbare, Gustavo Blanco Heras, Thorsten Reemtsma (Various affiliations)

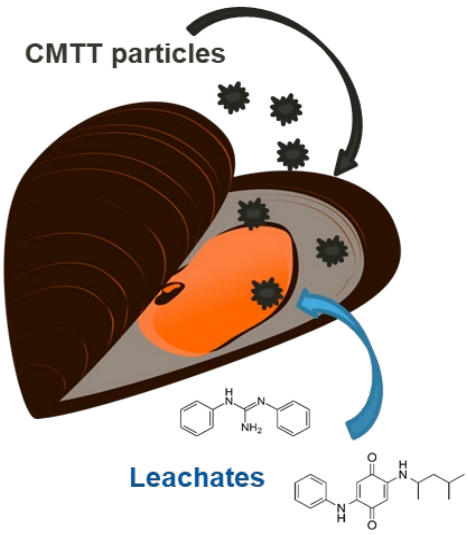
A large knowledge gap still remains regarding suitable chemical markers and indicators that are able to assess tire wear particles (TWPs) exposure in biota.

A successful exposure study was conducted to investigate both organic compounds and Zn content after exposing a cryo-milled tire tread (CMTT) mixture to blue mussels (Mytilus Edulis) for 7 days, followed by a depuration time of the same duration.

As a result, 20 target compounds and 17 suspected tire-related compounds (e.g., vulcanization accelerators and antioxidants) were detected, the concentrations of which reflected the current level of exposure and some of them were still present in the mussels after the depuration period. In contrast, Zn content did not reflect TWP uptake.

In conclusion, organic leachates were found to be appropriate indicators of TWP in biota samples rather than Zn. In addition, the evaluation of transformation products is crucial for a better understanding of the fate of organic chemicals in biota.

Two Possible Scenarios



Project Activities

+ Assessing Methods for Characterising and Quantifying Nanoplastics

Andy Booth, SINTEF Ocean

A comprehensive physical and chemical property characterization of samples containing heterogeneous nanoplastic particles is needed, but currently remains an analytical challenge.

As no single instrument is capable of generating such data, it requires a combination of complimentary measurement techniques to improve the accuracy and robustness of the results.

Andromeda researchers from SINTEF Ocean teamed up with scientists from across Europe to evaluate the suitability of batch methods, separation/fractionation methods and analysis methods for the determination of nanoplastic size, shape, chemical composition and quantification.

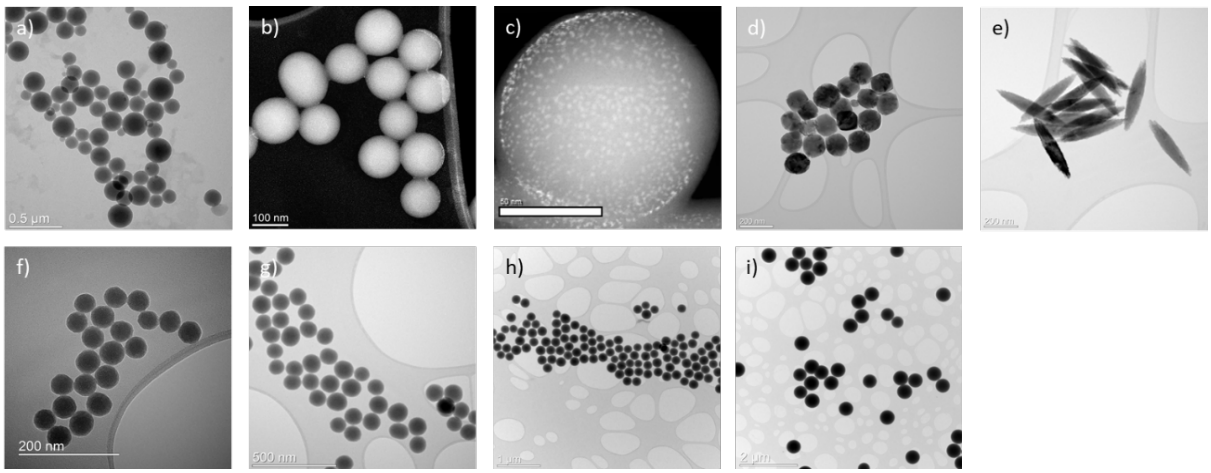
We used a suite of representative test particles exhibiting different chemical properties, including polyethylene (PE), polystyrene (PS), titanium dioxide, and iron oxide nano-scale particles, to assess the applicability and limitations of the selected methodologies.

The batch methods tested were:

- Dynamic light scattering (DLS)
- Nanoparticle tracking analysis (NTA)
- Tunable resistive pulse sensing (TRPS)
- Transmission electron microscopy (TEM)
- Scanning electron microscopy (SEM)

The separation and analysis methods tested were:

- Centrifugal liquid sedimentation (CLS)
- Field-flow fractionation (FFF)–multi-angle light scattering (MALS) combined with pyrolysis gas chromatography mass spectrometry (pyGC–MS) or Raman microspectroscopy (RM)



TEM images of different nanoplastics and inorganic nanoparticles (a) polyethylene, (b and c) polystyrene, (d) iron oxide spheres, (e) elongated iron oxide, (f, g and h) titanium dioxide (Huber et al., 2023).

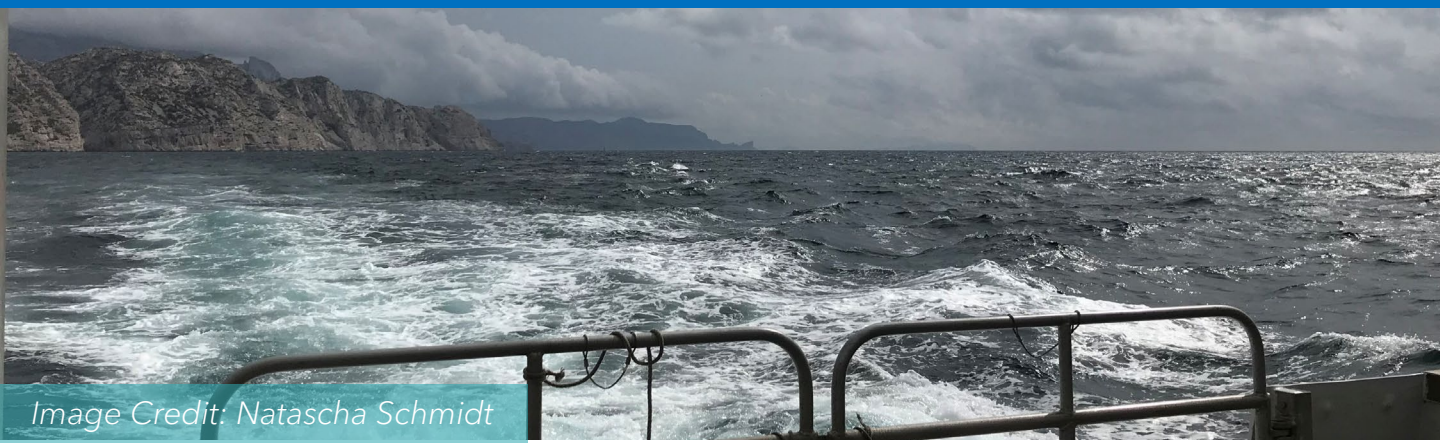


Image Credit: Natascha Schmidt

Project Activities

+ Assessing Methods for Characterising and Quantifying Nanoplastics

.... Continued from Page 07

The test particles had a range of physical properties, including narrow size distributions, broad size distributions, as well as spherical and elongated shapes..

Particle sizes and number-based concentrations obtained by the batch methods (DLS, NTA, TRPS) were comparable for spherical samples with a narrow size distribution, but an increasing degree of deviation was observed for particles which had a broad size distribution, were agglomerated (stuck together) and for non-spherical particles. Detailed morphological/shape information can be generated quite easily using electron microscopy approaches (SEM/TEM).

We found that combining FFF-MALS with RM was able to provide information about the physical and chemical properties of nanoplastics via online measurements (automatic transfer of the sample from one instrument to the next).

We also found that offline pyGC–MS analysis of specific particle size fractions produced using FFF allowed for both identification of polymer particles (vs. inorganic particles) and their quantification.

Combining multiple techniques was found to be highly beneficial, but much more time consuming and difficult to achieve robust data. Furthermore, techniques for the isolation and preparation of nanoplastics from environmental samples are still lacking.

Ultimately, identification and quantification of nanoplastics in complex environmental samples (e.g., sediments, biota, soils) will continue to present a major challenge for the evaluated techniques without significant improvements in sample preparation.

Huber, M. J., Ivleva, N.P., Booth, A. M., Beer, I., Bianchi, I., Drexel, R., Geiss, O., Mehn, D., Meier, F., Molska, A., Parot, J., Sørensen, L., Vella, G., Prina-Mello, A., Vogel, R., Caputo, F. (2023). Physicochemical characterization and quantification of nanoplastics: Applicability, limitations and complementarity of batch and fractionation methods. *Analytical and Bioanalytical Chemistry* 415, 3007–3031

READ MORE

PROJECT ACTIVITIES

+ ANDROMEDA Smartphone App and Citizen Science Microplastics Campaign

University of Malta

Our ANDROMEDA project partners from the University of Malta have successfully developed and launched a citizen science microplastics smartphone application that will allow members of the public to help scientists collect valuable information on microplastics, by participating in local beach sampling activities. The app itself, uses artificial intelligence to analyse photos of microplastics taken by the app user, and learns to identify them over time.

The app was officially launched in May of 2022 in Malta at Rinella Bay, and it is now available to download on both iOs and android devices!

To support the uptake in the smartphone app, ANDROMEDA partners have participated in beach sampling activities and demonstrations across eight test sites over the last 12 months to address the ongoing threat of microplastics in our marine environment.

The most recent beach cleaning activity took place in Rinville Bay, Oranmore, Co. Galway Ireland as part of the JPI Oceans end-term meeting proceedings.

This beach cleaning activity was conducted in collaboration with the Plastic Pirates Go Europe! Campaign You can learn more this campaign by clicking on the following link!

Beach cleaning activities at Rinville Bay, Oranmore as part of JPI Oceans closing event (Image Credit: Orla-Peach Power).

PROJECT ACTIVITIES

The ANDROMEDA microplastics factsheets are currently available in eight different languages (Dutch, English, Estonian, French, German, Maltese, Norwegian, and Spanish). Click on the image above to learn more!

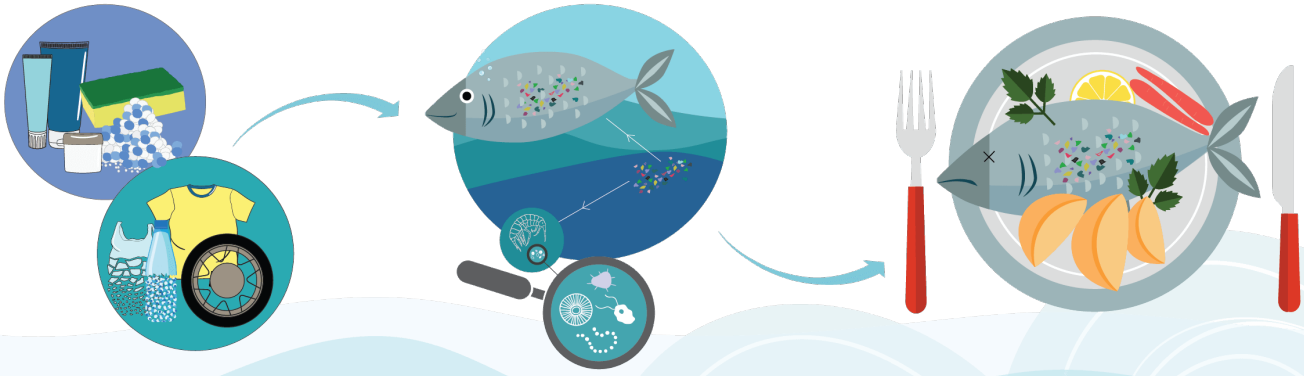
+ ANDROMEDA Factsheets - Microplastics

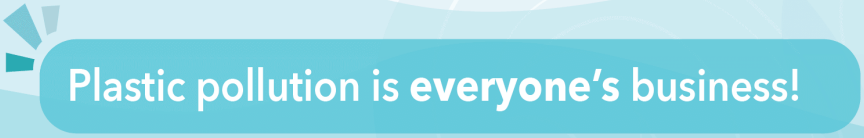
University College Cork

As part of the ADNROMEDA project a number of targeted visual products (factsheets, brochures etc.) were developed by the Coastal & Marine Science Communication, Stakeholder Engagement and Societal Impact (SCEI) research group at University College Cork to support project specific activities and tasks. Chief among them was two project factsheets developed to support the uptake of the ANDROMEDA smartphone app, and the European-wide citizen science microplastics initiative.

The first of these factsheets was a two-page infographic developed in collaboration with ANDROMEDA partners that provides a comprehensive overview of the issue of microplastics in our environment. It provides information regarding the different types of microplastics that are present in our marine environment, along with important information relating to their sources, pathways, and associated impacts.

This factsheet was designed to be used at front facing events and demonstrations, and as a complimentary information sheet to be used during school engagement events and beach sampling activities for the ANDROMEDA citizen science app.





RECORD YOUR BEACH SAMPLES IN 4 EASY STEPS

Step 1
Set up your sample area

Step 2
Sieve sand samples from sample area

Step 3
Photograph samples using recording card

Step 4
Submit your records using the app.

PROJECT ACTIVITIES

+ ANDROMEDA Factsheets – App

University College Cork

The second factsheet was developed in collaboration with our partners at the University of Malta and were to support the use of the ANDROMEDA smartphone app, and the launch of the project's Europe-wide citizen science microplastics campaign.

This factsheet gives an accessible overview and background information for the purpose of the research and an easy 'how-to' guide for the use of the smartphone app in recording microplastics from beach-sampling activities. It also provides information on how users can submit their microplastic information for analysis.

Our ANDROMEDA smartphone app factsheets can be printed and brought to your sampling exercises at your local beach, and are available in eight different languages (Dutch, English, Estonian, French, German, Maltese, Norwegian, and Spanish).

If you would like to take part in this citizen science activity, you can simply download the ANDROMEDA smartphone app on Android or iOS at the following link and follow our how-to guides linked below!

Download our factsheets by clicking on the images below!

PROJECT ACTIVITIES

+ Cost-Effectiveness of Different Microplastic Analysis Methods Survey and Workshops

Nelle Meyers, Flanders Research Institute for Agriculture, Fisheries and Food (ILVO), and Flanders Marine Institute (VLIZ)

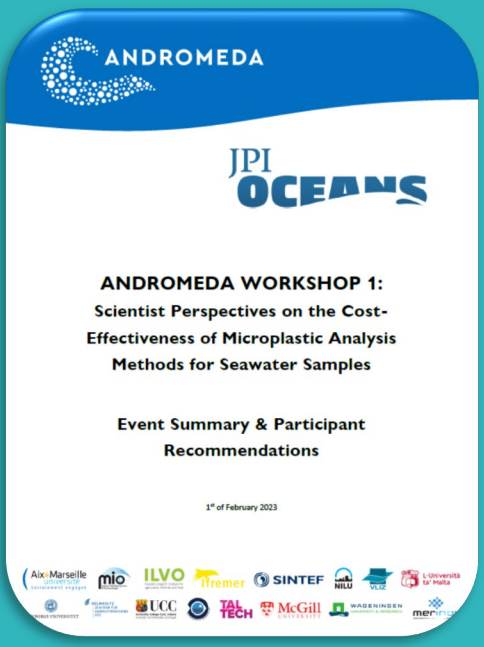
Nelle Meyers launched an online survey in October 2022 on the cost-effectiveness of different microplastic analysis methods, which aimed to provide a useful starting point for researchers, policy-makers, and other stakeholders when choosing between different microplastic workflows that aim to achieve the same outcome. This survey work allowed Nelle to gain insight into which workflows provide the greatest value for money for particular samples, and also on key elements to which the outcome are sensitive.

Based on the results of the survey, two workshops were undertaken with focus groups from our JPI Oceans sister projects to collate feedback and input towards providing concrete and useful recommendations of monitoring strategies in terms of cost-effectivity.

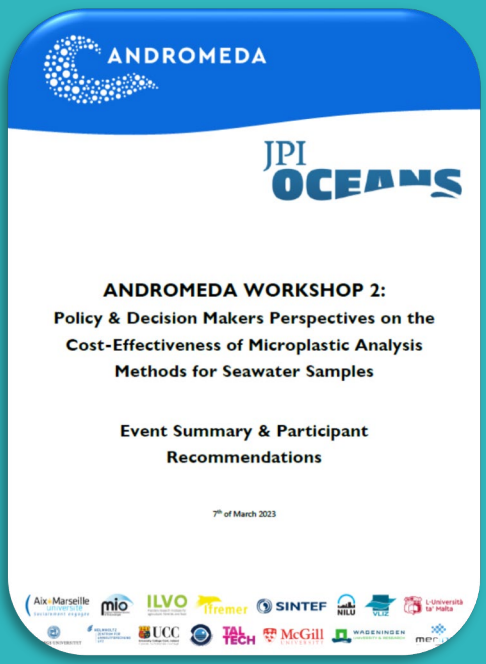
These results were finalized in two workshop reports designed to support researchers, policy makers, and other stakeholders working in the area of microplastics analysis and mitigation.

WORKSHOP REPORTS

ANDROMEDA Workshop 1
Scientists Perspectives
Kopke et al., 2023



ANDROMEDA Workshop 1
Policy & Decision Maker's Perspectives
Kopke et al., 2023



Project Activities

+ ANDROMEDA Final Project Meeting

ALL Partners

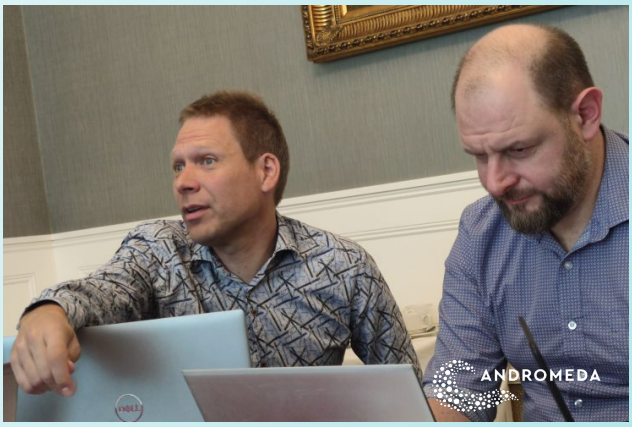
The ANDROEMDA project draws to a close this year, after 3 wonderful years working with our consortium,. To celebrate the conclusion of ANDROMEDA, we held our final project meeting in the beautiful Oranmore, Co. Galway, Ireland on the 13th of September, in advance of the JPI Oceans closing event (14th-15th of September) at the Marine Institute (p.14).

As part of the day's proceedings, we discussed our project outputs and successes to date, and planned for upcoming project outputs.

In the coming months, the ANDROMEDA consortium will deliver a collection of eight protocols (p.15) to address the pressing need for a portfolio of optimal, and fit-for-purpose microplastic methodologies.

As well as the publication of these protocols, a special journal issue will be delivered that will focus on innovative research in the field of microplastics and nanoplastics research.

This special issue represents a collaboration with JPI Oceans, and the six sister projects funded under the joint action 'Ecological Aspects of Microplastics', and will collate 30 research papers, five of which will be written by the ANDROMEDA consortium.



Final meeting of the ANDROMEDA project (Image Credits: Orla-Peach Power).

Click the icons below to keep up to date with our upcoming publications and activities.

Image Credit: PtJ_Christin Lambertz

Project Activities

+ JPI Oceans End-Term Meeting

ALL Partners

The JPI Oceans end-term meeting was was held at the Marine Institute, Oranmore, Co. Galway from the 14th-15th September, and was organised to showcase the results of the 6 projects funded under the joint action 'Ecological Aspects of Microplastics'.

Our ANDROMEDA partners did an amazing job of showcasing the range of research activities undertaken throughout the project lifecycle. They delivered seven presentations across four sessions, with Andy Booth and Karin Mattsson chairing sessions on both days. As part of this event the ANDROMEDA consortium also submitted 12 posters many of which are now available to read as OA journal articles.

At the end of Day 1, our partners at University of Malta, showcased the ANDROMEDA smartphone app, before the attendees were brought to Rinville Point, to participate in a beach clean activity lead by a representative of the 'Plastic Pirates Go Europe!' campaign.

Aurelio G. Foscari & Richard Sempéré hanging Aurelio's research poster at JPI Oceans closing event in Galway (Image Credits: Orla-Peach Power).

We were delighted to learn that UM will be partnering with this campaign to help promote the use of the ANDROMEDA app across Europe ensuring the legacy of the technology and an expansion of the recently launched citizen science microplastics campaign!

We would like to take this opportunity to thank Jella Kandziora and Willem De Moor from JPI Oceans, and Veronika Cunningham from the Marine Institute for all their support in developing and implementing this event and for their ongoing support in the delivery of our project.

COLLABORATIONS

+ Special Issue: Environmental Pollution

Jella Kandziora (JPI Oceans Secretariat),and JPI-Oceans funded projects: ANDROMEDA,RESPONSE, FACTS, Microplastix, Hotmic, and i-plastic,

This JPI Oceans special issue forms part of the ongoing collaborative communication and dissemination strategies developed throughout 2023 with the JPI Oceans secretariat, to maximise on the impact of project activities from all six sister projects.

This special issue will contain a total of 30 publications (five from each sister project) that highlight new and innovative research in the field of microplastics and nanoplastics research.

The ANDROMEDA project consortium will contribute five publication to this special issue in total. Furthermore, our project coordinator Richard Sempéré will further contribute to this issues by participating as a co-guest editor.

This edition will be open access and will be made available in early 2024 so don't forget to follow our Twitter account and website (p.13) to keep up to date with forthcoming project activities!

ANDROMEDA Protocols

A collaborative report containing 8 ANDROMEDA protocols will be published to support the dissemination of methodological information developed throughout the project lifecycle.

List of Protocol Contributions

1. *Operating An Automated Microplastic Sampling Device for Ferryboxs*
2. *Tire wear particle chemical indicators as a marker for biological exposure*
3. *Determination of plastic related chemicals in biological tissue*
4. *Optimised detection of microplastics by adapted Nile-Red staining*
    - Standardised operating procedure for seawater samples
    - Standardised operating procedure for sediment samples
    - Standardised operating procedure for marine biota samples
    - Standardised operating procedure for automated microplastic analysis using machine learning models
5. *Photo-Oxidation of Microplastics Materials in water*

ANDROMEDA PROJECT RESEARCH PUBLICATIONS

Alimi, O., Claveau-Mallet, D., Lapointe, M., Biu, T., Liu, L., Hernandez, L., Bayen, S., Robinson, S., Ghoshal, S. and Tufenkji, N., 2023. Effects of Weathering on the Properties and Fate of Secondary Microplastics from a Polystyrene Single-Use Cup. *Journal of Hazardous Materials*, 131855.

Alimi, O.S., Claveau-Mallet, D., Kurusu, R.S., Lapointe, M., Bayen, S. and Tufenkji, N., 2021. Weathering Pathways and Protocols for Environmentally Relevant Microplastics and Nanoplastics: What Are We Missing? *Journal of Hazardous Materials*.

Alkan, N., Alkan, A., Castro-Jimenez, J., Royer, F., Papillon, L., Ourgaud, M. and Sempere, R., 2020. Environmental occurrence of phthalate and organophosphate esters in sediments across the Gulf of Lion (NW Mediterranean Sea). *Science of the Total Environment*.

AMAP, 2021. *AMAP Litter and Microplastics Monitoring Guidelines. Version 1.0. Arctic Monitoring and Assessment Programme* (AMAP), Tromsø, Norway.

Askham, C. Pauna, V., Boulay, A-M., Fantke, P., Jolliet, O., Lavoie, J., Booth, A., Coutris, C., Verones, F., Weber, M., Vijver, Martina G., Lusher, A.L. and Hajjar, C., 2023. Generating environmental sampling and testing data for micro- and nanoplastics for use in life cycle impact assessment. *Science of the Total Environment,* Vol. 859 (2).

Brandt, J., Mattsson, K. and Hassellov, M., 2021. Deep Learning for Reconstructing Low-Quality FTIR and Raman Spectra - A Case Study in Microplastic Analyses. *Analytical Chemistry*.

Carretero, O., Gago, J., Filgueiras, A.V. and Viñas L., 2022. The Seasonal Cycle of Micro and Meso-plastics in Surface Waters in a Coastal Environment (Ría de Vigo, NW Spain). *Science of the Total Environment,* Vol. 803.

Castro-Jiménez, J., Cuny, P., Militon, C., Sylvi, L., Royer2, F., Papillon, L. and Sempéré, R., 2022. Effective Degradation of Organophosphate Ester Flame Retardants and Plasticizers in Coastal Sediments Under High Urban Pressure. *Scientific Reports*, 12 (1):20228.

Fauvelle, V., Garel, M., Tabburini, C., Nerini, D., Castro-Jiménez, J., Schmidt, N., Paluselli, A., Fahs, A., Papillon, L., Booth, A. M. and sempéré, R., 2021. Organic Additive Release From Plastic To Seawater Is Lower Under Deep-Sea Conditions. *Nature Communications* 12 (4426).

Foscari, A., Schmidt, N., Seiwert, B., Herzke, D., Sempéré, R. and Reemtsma, T., 2023. Leaching of chemicals and DOC from tire particles under simulated marine conditions. *Frontiers in Environmental Science*, 11:1206449.

Gondikas, A., Mattsson, K. and Hassellöv, M., 2023. Methods for the Detection and Characterization of Boat Paint Microplastics in the Marine Environment. *Frontiers in Environmental Chemistry*, 4:1090704.

Hakvåg, S., Brakstad, O.G., Kubowicz, S. and Booth, A., 2022. Composition, properties and other factors influencing plastics biodegradability. In *Biodegradability of Conventional Plastics: Opportunities, Challenges, and Misconceptions*. Elsevier.

Hernandez, L.M., Grant, J., Farner, J., Shakeri Fard, P. and Tufenkji, N., 2023. Analysis of ultraviolet and thermal degradations of four common microplastics and evidence of nanoparticle release. *Journal Hazardous Materials Letters*, 4, 100078.

Hernandez, L.M., Farner, J., Claveau-Mallet, D., Okshevsky, M., Jahandideh, H., Matthews, S., Roy, R., Yaylayan, V. and Tufenkji, N., 2023. Optimizing the Concentration of Nile Red for Screening of Microplastics in Bottled Water. *ACS ES&T Water*, 3 (4), pp.1029-1038.

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Tyre and road wear particles from source to sea


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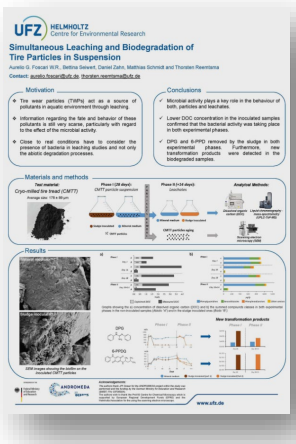
Citizen Science Microplastics Factsheet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Simultaneous Leaching and Biodegradation of Tire Particles in Suspension

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