ANDROMEDA WORKSHOP 1:

Scientist Perspectives on the Cost-Effectiveness of Microplastic Analysis Methods for Seawater Samples

Event Summary & Participant Recommendations

1st of February 2023

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Recommended citation:
Kopke K., Meyers N., Dozier A., Fitzgerald E., Power O-P., Agnew S., Everaert G., De Witte B., (2023). Scientist Perspectives on the Cost-Effectiveness of Microplastic Analysis Methods for Seawater Samples: ANDROMEDA Workshop 1 Event Summary & Participant Recommendations on Cost-effectiveness. JPI Oceans project.

1. INTRODUCTION

The JPI Oceans-funded ANDROMEDA project brings together a multidisciplinary consortium of 15 international partners to improve the quantification of nanoplastics and microplastics in our oceans and seas. ANDROMEDA aims to develop new sampling and advanced analysis methodologies that focus on microplastic (1-5mm) and nanoplastic (<1mm) 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. The primary objectives of ANDROMEDA are:

- The development of an instrument platform for in situ and cost-effective analysis of microplastics
- The advanced characterisation of nanoplastic and microplastic materials and for accelerated microplastic degradation, and
- The characterisation of microplastic degradation.

More information about ANDROMEDA can be found online at https://www.andromedaproject.net or on Twitter at @andromeda_EU. You can also contact us directly via email to the Project Coordinator: richard.sempere@mio.osupytheas.fr.

1.1 Andromeda Online Workshops

As part of the ANDROMEDA project, two online workshops were developed to act as a focal point for proactive engagement and mutual exchange of specialist knowledge between project partners and participating ANDROMEDA stakeholders. These workshops were developed to interactively present, discuss, and build a consensus around cost-effective microplastic analyses methods for seawater sampling. The workshops were specifically developed to allow for discussion and feedback to a survey designed and implemented by ANDROMEDA project partners, which was led by Nelle Meyers and colleagues from VLIZ & ILVO. The following document presents the findings from the first ANDROMEDA workshop, which was undertaken on the 1st of February 2023 with 10 participants from 8 European countries.

2. ANDROMEDA WORKSHOP 1

2.1 Purpose and Objectives

This online event aimed to facilitate knowledge exchange between scientists working in the field of micro- and nanoplastics, with a focus on i) collating feedback and input concerning preliminary results of the ANDROMEDA survey on cost-effective microplastic analyses methods for seawater samples and, ii) making recommendations relevant for policy and decision makers. The workshop had the following objectives:

- To highlight current ANDROMEDA research and upcoming research outputs concerning cost-effective microplastic analyses methods for seawater samples.
- To explore the preliminary results with scientists working in the field considering policy, legal and regulatory needs; and

- To work together on making recommendations relevant for other scientists as well as policy and decision makers.

2.2 Workshop Participants

The event was co-designed, trialled, and implemented by ANDROMEDA project partners from:

- MaREI, the SFI Centre for Energy, Climate, and Marine Research at University College Cork, who are responsible for project communication and stakeholder engagement.
- VLIZ, the Flanders Marine Institute, who are working on simple, high-speed, and low-cost methods to detect microplastics from seawater and marine sediments in ANDROMEDA.
- ILVO, the Flanders Research Institute for Agriculture, Fisheries and Food, who are leading ANDROMEDA work on in-situ and cost-effective sampling and analysis methods for detecting and quantifying microplastics in environmental samples.

Ten researchers and scientists representing eleven organisations from across eight European countries brought their expertise and insight to the 1st ANDROMEDA online workshop (see Table 1 for more details). Seven workshop participants also represented our JPI Oceans sister projects FACTS, RESPONSE, I-Plastic and MicroplastiX. Their participation and support strengthen synergies and collaborations between the projects funded under the JPI Oceans Joint Action Ecological Aspects of Microplastics 2020-2023, a pilot activity to study the sources, distribution, and impact of microplastics in the marine environment.

Individual workshop participants have not been named within this report to ensure that data protection is in line with European GDPR regulations. However, the project team is happy to assist readers of this document to establish contact with workshop participants if their expressed permission is granted.

Table 1: Organisations represented at the online workshop by country and relevant research project.

Organisation	Country	Microplastic Project
CNR-ISMAR, Institute of Marine Sciences, National Research Council	ITALY	JPI Oceans funded FACTS project
Tallinn University of Technology, Department of Marine Systems Institute (TalTech MSI)	ESTONIA	JPI Oceans funded RESPONSE & ANDROMEDA projects
Heriot-Watt University (HWU) Scotland	UK	JPI Oceans funded FACTS project
Institute of Environmental Science and Technology (ICTA-UAB)	Spain	JPI Oceans funded i-Plastic project
Polytechnic University of Marche	Italy	JPI Oceans funded RESPONSE project
University of Antwerp & Ghent University	Belgium	JPI Oceans funded RESPONSE project
GEOMAR Helmholtz Centre for Ocean Research	Germany	JPI Oceans funded FACTS project
Atlantic Technological University (ATU)	Ireland	JPI Oceans funded MicroplastiX

Organisation	Country	Microplastic Project
		project
Norwegian Institute for Water Research	Norway	H2020 funded EUROqCHARM project
University College Cork	Ireland	Marine Institute Ireland funded Plast_Chem_Cora Project

2.3 Workshop Structure

The event itself was divided into two sessions with a short break in between. The first session focused on the presentation of the preliminary survey results undertaken by Nelle Meyers, and an open Q&A session to allow for shared understanding of presented information. This was followed by a guided conversation approach, adapted for this context based on participant Group Facilitation Methods developed by the Institute of Cultural Affairs (ICA). Questions included in this session were designed using an ORID (Objective, Reflective, Interpretive, Decisional) methodology. This approach and method aimed to entice participants to engage with the group, and to ensure interactions were comfortable for all involved within the online workshop setting.

Table 2: Workshop Agenda

Andromeda Workshop 1 Agenda	
10:00 – 10:15	Welcome – Kathrin Kopke, MaREI - UCC
10:15 – 10:30	Roundtable Introduction
10:30 – 10:50	Preliminary Survey Results – Nelle Meyers, VLIZ/ILVO
10:50 – 11:00	Open Q&A
11:00 – 11:30	Coffee Break
11:30 – 12:30	Guided Conversation – Kathrin Kopke, MaREI-UCC
12:30 – 13:00	Summary & Wrap Up

2.3.1 Summary of Preliminary Survey Results Presentation

A cost-effectiveness analysis of microplastics analysis techniques was performed to compare investment and labour costs and the effectivity of different, commonly used methods for the analysis of microplastics in seawater on a European scale. Data for the analysis was obtained through an online survey that was sent around in autumn 2022 to various microplastics experts. Within the survey, a scenario was described of five seawater samples (a batch) that were acquired with a manta net and that were defined in terms of microplastic load, composition and size range, and SPM concentration. Survey questions were subdivided based on different steps within a microplastic analysis and focused on sample acquisition, sample processing and the actual sample analysis. Questions targeted two types of costs: (1) equipment costs and (2) labour costs, and this within each analysis step. Based on the obtained data, the methods used by participants could be classified into six major analysis method categories: (fluorescence) (stereo)microscopy; (stereo)microscopy + ATR-FTIR; (stereo)microscopy + µ-FTIR;

fluorescence (stereo)microscopy + µ-FTIR; (stereo)microscopy + µ-Raman; and GC-MS- based techniques. Calculated equipment and labour costs per method were used to simulate total analysis cost per batch of five seawater samples in terms of equipment usage intensity. Three different simulations were created, i.e. for high, middle and low wage European countries, as defined by the World Bank.

In the future, the performed cost-effectivity analysis and resulting predictive tools can help provide concrete and useful recommendations on which workflows provide the greatest value for money when analysing plastic. This cost-effectivity analysis supports the identification of cost-effective methods for given scenarios, and the resulting equations allow to calculate the actual total analysis cost associated with these methods. This way, the developed predictive tool can support researchers, policy makers and other stakeholders in their decision process of choosing between different microplastic workflows, e.g. for monitoring strategies.

2.4 Post-Workshop Evaluation

The ANDROMEDA project team invited workshop participants to take part in a short post-workshop evaluation survey to provide the opportunity for feedback, as well as to allow the project to assess and improve the quality and relevance of further engagement. Ten out of ten workshop participants chose to take part.

Participant responses were captured using a combined methodology including a five-point Likert Scale methodology with responses ranging from 1-5 with 1 meaning 1 Strongly Disagree and 5 meaning strongly agree, a multiple-choice question and open-ended comments. All respondents' scores for questions on a five-point Likert scale showed they felt positive towards the duration and organisation of the event, as well as the quality of the presented material and the way it was presented.

All survey respondents indicated that the event was relevant to their work, with six of the respondents indicating that participation may influence their future work and eight respondents indicating that participation in this workshop may support their engagement with people working in the same field in the future. Multiple choice questions showed that four respondents found all elements of the workshop useful for their purpose of attending, with another four participants indicating their preference for the presentation of the preliminary results and another two participants selecting the guided conversation element of the workshop as most useful for them.

In open-ended comments, respondents emphasised their appreciation for the active participation and engagement of everyone in the discussion and the constructive inputs from their peers. Participants valued that the preliminary results of the survey were shared and the associated discussion on impact. Respondents suggested that similar workshops could also employ tools such as Mentimeter or Slido and that it may be useful to get access to survey results prior to the workshop, so that participants have time to think about results before the event and provide more detailed feedback.

3. DISCUSSION

The guided conversation segment of the workshop (summarised below in 3.1-3.3) presented a series of questions to workshop participants that encouraged reflection on the presented work towards making recommendations for policy and decision makers to support informed decision making that considers cost-effectiveness of sampling, processing, and analyses of microplastic samples from seawater. These recommendations are outlined in Section 4 of this summary report below. The questions were posed to allow participants to express their thoughts in relation to the topic and to explore certain areas of interest in more detail.

3.1 Positive Aspects and Concerns

Workshop participants were asked to identify positive aspects and concerns in relation to Nelle Meyers's presentation and the subsequent Q&A, which have been summarised in sections 3.1.1. and 3.1.2.

3.1.1 Positive Reactions from Scientists

General positive reactions from participants included:

- Research is critically needed, as it supports planning of sampling, monitoring, and processing activities and can inform policy and decision-making processes.
- Provides a holistic perspective of the costs associated with sampling and processing.
- Great that the costs of certain techniques decrease as their use increases.
- Will be valuable to reference this study once it is published, as such input will be very useful for the sector and can be built upon by future research.
- The research can be used as a tool for us to explain and justify why researchers chose one method or another.

Positive reactions to the **methodology** that were identified included:

- The distinction between low-income and high-income countries
- The comparison between different processing techniques and the cost of each technique.

3.1.2 Concerns Identified by Scientists

Concerns surrounding the **results of the survey** included:

- Need to be careful and not over-emphasise cost-effectiveness over method and technical process when looking at basic or applied research. Cost is one factor, but cost can be very variable for monitoring programs.
- Need to consider and evaluate for purpose that one method may be more cost-effective, but another is superior in terms of accuracy.
- In the short term many labs will need to use the instruments that they already have available and won't be able to change. There are questions in terms of affordability and investment over time that need to be considered.

Concerns surrounding the **participation and uptake** included:

- Not all countries are starting at the same economic starting line and decisions might have repercussions for sampling and collection from one country to another.
- Need to consider what non-European countries want and how they can contribute by producing valuable data to a global database.
- The survey used in the presented research was quite long, which may have resulted in limited response rate.

3.2 Cost-Effective Decisions for MP Sampling, Processing, & Analyses

Workshop participants discussed cost-effective decision making from their perspective in relation to ongoing and planned research. Participants noted that sampling methods, environmental controls, and any issues with the material etc. vary with particle size, and will all affect lab processing time, and therefore costs.

Further considerations that might affect sampling costs, such as seasonal disruption or nets being clogged with organic matter need to be considered as they will also add to costs. However, sampling methods can direct what kind of processing technology is required, and if resources are low and a lab only has access to basic processing equipment, then a suitable sampling method can be used to optimise the number of hours in the lab. The selection of specific brands for scientific equipment was also suggested as an influencing factor, considering that customer service, required assistance and the level of expertise needed to operate equipment can vary significantly.

Another aspect to consider is the availability of new technologies and automation via artificial intelligence (AI) that may help streamline the diversity of applied methods and equipment. Participants highlighted that to make cost-effective decisions, a more robust methodology is required where similar sampling and processing techniques are applied. Inter-collaboration studies were highlighted as a great example for researchers and scientists to see if results are comparable. Such studies are currently being undertaken in the Baltic Sea between Estonian and Finnish Institutes to see which methods allow for comparable results.

3.3 The Presented Approach & Informed Decision Making

Workshop participants highlighted several key areas that required further consideration when building on the presented approach towards informed decision making.

3.3.1 Microplastics Size Class & Diversity of Analytical Methods

Participants felt that the decision to focus the research on microplastics of a specific size class was both a strength and a weakness. Certain analytical methods are better suited for larger microplastic particles, while others are required when scaling down to smaller particles sizes, all of which will have a direct impact on any cost calculations. Participants encouraged ANDROMEDA partners to publish the results of the exploratory exercises (survey and workshops respectively) and highlighted the need to define within the publication, the limits of the research criteria.

Participants highlighted the need to clarify that this survey focused on cost-effectiveness only, and that the quality of the method was not included in the survey. While the study was perceived as very useful, participants highlighted the importance of context when communicating the research parameters and findings. Given that the calculations are not general, they should not be projected towards smaller or larger particles, or different sampling methodologies.

3.3.2 Financial Context

Affordability and cost-effectiveness in the context of national income and GDP was a strong theme running throughout the workshop discussions and was viewed as an area where further study would be very beneficial. Participants thought it would be useful to include calculations that use less expensive equipment or protocols and adjust for different batch level sizes in future research.

Participants further emphasised that funding and/or organisational investment is required to change methods and equipment, especially if processing and analysis time is critical. There was consensus that the presented approach is a very useful starting point in this context, especially when decisions are being made to change equipment and methods.

3.3.3 Government Monitoring Programmes

Participants discussed the presented survey results in relation to required government monitoring programmes. Here it was posited that it would be prudent to use the monitoring systems already available to save costs, and then to identify where and what needs to be added and adapted to improve the system.

Participants suggested that because there is not one, clearly defined method on data collection and sampling in relation to microplastics, that scientists always need to ensure that the data being collected is put into perspective (i.e., standardized by area, by volume etc.), so that it is comparable to data obtained in other countries.

4. PARTICIPANT RECOMMENDATIONS

The online workshop captured a wealth of information and input from workshop participants, from which specific recommendations have been summarised in the below bullets:

- Scientists need to actively engage with policy and decision-makers concerning the definition of what to measure for the purposes of government monitoring programmes, ensuring that the data being collected is put into perspective.

- Affordability and cost-effectiveness should be considered in the context of national income and GDP.

- Limitations of the research and data should be more clearly stated to show that the work focuses on cost-effectiveness only, and that the quality of the method is not included in the survey. Additionally, that the calculations are not general but instead pertain to a specific size of microplastic.

- Future Research:

  - ✓ Should incorporate environmental factors to obtain a more detailed picture of costs that occur for different size classes.

  - ✓ Should consider cost based on the findings of inter-collaboration studies between institutes that apply different methodologies and techniques but get comparable results.

  - ✓ Include calculations that use less expensive equipment or protocols and adjust for different batch level sizes.

The ANDROMEDA project team would like to thank all workshop participants for taking the time to attend this workshop and for their effort and expertise, which contributed to and shaped the event.

ANDROMEDA is funded by JPI Oceans through support by the following national funding agencies: Belgium: the Belgian Federal Science Policy Office (BELSPO), France: The National Research Agency (ANR), Estonia: Ministry of the Environment of the Estonian Republic (MoE) and the Estonian Research Council (ETag); Germany: Federal Ministry of Education and Research (BMBF), Ireland: Marine Institute, and the Dept of Housing, Planning, and Local Government (DHPLG); Malta: Malta Council for Science and Technology (MCST); Norway: The Research Council of Norway (RCN); Spain: Spanish State Research Agency (AEI); Sweden: the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (FORMAS).