Value for money: A cost-effectiveness analysis of microplastic sampling and analytics

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Microplastics (MPs) are pieces or plastics between 5 mm and 1 µm which can enter the environment directly as primary MPs, or indirectly as secondary microplastics as a results of progressively fragmentation of larger plastic items.The quest for increasingly small microplastic particles, together with their potential impact on ecosystems has expedited the development of microplastic research in recent years. A wide range of sampling procedures, sample processing steps and sample analysis techniques, both manual and automated, have been established. Despite this progress, this diversification of techniques impedes cross-study comparability and it confuses reseachers. Moreover, many of the currently applied procedures are perceived as expensive. At the same time, unanswered questions concerning MP abundance, composition, distribution and fate in the marine environment emphasize the need for standardised and reliable, cost-effective techniques with short processing times. Assisting researchers and policy makers in the decision-making process could be done by identifying and comparing the economic efficiency of these frequently used techniques and writing up recommendations.

In our study, performed within the JPI Oceans Andromeda project, we performed a cost-effectiveness analysis (CEA) of frequently used techniques for microplastic analysis in seawater on a European scale, in terms of 1) sample acquisition, 2) sample processing and 3) sample analysis. Data for this study was collected through an online survey. The CEA based on real experiences of experts in the field allowed us to evaluate different techniques in terms of their relative costs, and identify the economically most efficient techniques. The analysis outcome provides valuable information that can be used to support decision-making and guide choices to be made by reseachers, policy makers and other stakeholders. To perform the CEA of frequently used methods for microplastics analysis in seawater, data was collected through an online survey consisting of 97 questions related to sample acquisition, sample processing, and sample analysis of preset scenarios. In these scenarios, seawater samples were defined with specific information on microplastic load and composition, microplastic size range, and suspended particulate matter (SPM) concentration. Total working hours, personnel costs, sector of employment, European marine region of employment, and equipment costs/depreciation/usage were also included in the survey. The survey was performed during autumn 2022 and was spread to experts in the field through personal contacts in various European microplastics expert groups.

Based on the data obtained (partial data, n=30), six main microplastics analysis techniques could be identified (in order of popularity): techniques combining (stereo)microscopy (1) or fluorescence (stereo)microscopy (2) with µFTIR-based analysis, techniques combining (stereo)microscopy with ATR-FTIR (3), GC-MS-based techniques (4), purely (stereo)microscopy or fluorescence (stereo)microscopy-based techniques (5), and techniques combining (stereo)microscopy with µ-Raman-based analyses (6).

Median working time and equipment cost per step within the whole sample characterisation process was determined for each of the six methods, taking into account equipment purchase price and depreciation time. This data, combined with median European wages, was used to constructed a predictive tool that allows to identify the most cost-effective techniques for microplastic analysis based on set criteria, such as equipment usage intensity and income. Key outcomes of the CEA were also discussed during two different workshops held with microplastics researchers and policy makers. Their opinions and perspectives were then used to write up recommendations.

Obtained results allowed to gain insight on which techniques provide the greatest value for money for seawater samples of a defined composition, as well as on key elements to which the CEA outcome is sensitive. These results may act as baseline data for researchers, policy makers and other stakeholders to make informed decisions on the choice of microplastic analysis method, e.g. during future marine monitoring campaigns in the scope of the MSFD[1].

Reference
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