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A scientific perspective on microplastics in nature and society

List of conclusions

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CONCLUSIONS OF CHAPTER 2. THE NATURAL SCIENCE PERSPECTIVES

1. Microplastics are present in virtually all environmental compartments, including in biota (2.4).

2. In order to be able to understand the fate of NMP and to build models for prospective risk assessment, there is a need to develop methods to assess the relationships between polymer structural characteristics and the formation of smaller plastic particles (NMP) in nature, due to embrittlement, fragmentation or degradation (2.3.2, 2.6).

3. There is a need to develop markers and/or approaches to causally link plastic that one can find in nature to its origin, source or manufacturer (2.3.1).

4. Some knowledge of microplastic concentrations exist for the ocean surface and to a lesser extent for freshwaters. However, hardly anything is known about air and soil compartments and about concentrations and implications of NMP below the ocean surface (2.4.1, 2.4.2, 2.4.4, 2.4.5).

5. Hardly any information is available on measurement methods, fate, effects, and risks with respect to nanoplastics (all passages indicated by grey sidebars).

6. There is a need to improve NMP measurement methods, to standardise and internationally harmonise them, to obtain agreement on them internationally, such that they can be applied on a comparable routine basis in a regulatory context (2.6 and all passages indicated by grey sidebars).

7. There is a need to develop adequate NMP risk assessment methods, including those involving NMP interactions with other stressors (chemicals, climate change, eutrophication (a dense growth of plant life), acidification) to standardise and internationally harmonise them and to obtain agreement on them internationally, such that they can be applied on a routine basis in a regulatory context (2.6).

8. There is a limited number of promising theoretical models that simulate the fate and transport of NMP in environmental compartments, including food web transfer, that are potentially relevant for prospective risk assessment with respect to nano- and microplastics. However, validation is lacking (2.7).

9. There is a need to understand fate, exposure and risk for those NMPs that are most relevant to sensitive receptors across all environmental compartments, based on specific protection goals set. (Risk assessment always has a different protection goal in different contexts.) (2.3, 2.6)

10. There is a need to understand the abundances of NMP in the human diet, drinking water and air, specifically down to sizes <10 µm, in order to be able to start assessing risks for human health (2.4.7, 2.5.4).

11. There is a need to understand the potential modes of toxicity for different sizes, shapes and types of NMP in human models (2.5.4).

12. For microplastics, the working group has formulated three conclusions with respect to ecological risks: one concerning present local risks (12A), one concerning present widespread risks (12B) and one concerning the likeliness of ecological risks in the future (12C) (2.6). These conclusions are:

> A. There may at present be at least some locations where the predicted or measured environmental concentration exceeds the predicted no-effect level (PEC/PNEC>1).
>
> B. Given the current generally large differences between known measured environmental concentrations (MEC) and predicted no-effect levels (PNEC), it is more likely than not that ecological risks of microplastics are rare (no widespread occurrences of locations where PEC/PNEC>1).
>
> C. If microplastic emissions to the environment will remain the same, the ecological risks of microplastics may be widespread within a century (widespread occurrence of locations where PEC/PNEC>1).'

13. The evidence described above in Chapter 2, and later in Chapter 3 and Chapter 4, supports the position that, even though 'high quality' risk assessment is not yet feasible, action to reduce, prevent and mitigate pollution with NMP is suggested to be needed. At the same time, it is important to develop and use risk assessment approaches for NMP to be able to prioritise these actions, and to plan where and when to apply them.

CONCLUSTIONS OF CHAPTER 3. SOCIAL AND BEHAVIOURAL SCIENCES PERSPECTIVES

1. Human decisions and behaviour are the sole cause of plastic pollution - there is no natural variation of plastics in the environment (3.1).

2. There is a considerable influence of media and politics in parallel to scientific communication on the public discourse regarding NMP (3.2).

3. This influence is governed by risk perception principles. The evidence suggests that (for other pollutants) visual images and elite sources may attract more attention and topics are intensified by social media peer-to-peer sharing (3.2).

4. Communicating transparently about the uncertainties in scientific evidence is a safer approach than assuming and communicating a lack of risk, especially in sensitive domains such as food and human health (3.2, 3.3.2, 3.3.3).

5. Differences between technical or scientific assessment of risk and risk perception processes are governed by different values and judgemental factors (3.3).

6. There is a feeling of co-responsibility in the public and a willingness to make change where they feel it is possible; some citizen and stakeholder initiatives are actively engaged in campaigns and projects (3.4.3).

7. Overall, there appears to be consensus between different societal actors – to date there has been little indication of plastic pollution deniers.

8. The evidence supports that societal actors and stakeholders, and their interrelationships and interconnectedness, should be mapped systematically to inform potential interventions (3.4.1).

9. Behaviours should be identified and quantified to target behaviour change campaigns (3.4.2).

10. Knowledge or information on its own is not a key predictor of behaviour but is useful to facilitate change (3.4.4).

11. Behaviour change programmes can be faster and more cost-effective at achieving changes in motivation and awareness than policy tools. Policy measures are important to reduce situational barriers, otherwise motivational change may not lead to behavioural change (3.4.2, 3.4.4).

12. Incentives and charges vary in effectiveness in different contexts and are not equally acceptable. Different tools and instruments are needed for different actors and different behaviours (3.4.4).

13. It is important to go beyond incentives and charges, because such an exclusive economic focus has substantial risks. Where possible, interventions should consider and communicate intrinsic motivations and values to encourage spillover effects that can achieve broader, longer-term changes (3.4.4).

14. There should be rigorous evaluation of measures and interventions to understand unintended consequences and side-effects of alternatives, including trade-offs with other important outcomes such as carbon footprint and health (3.4.4).

15. Research on public knowledge and awareness has so far focused on certain sources of microplastics, such as microbeads and marine litter, but others are closer to people's daily experience and thus potentially perceived as more threatening (3.3).

16. Policies such as the plastic bag charge may catalyse wider awareness of plastic waste and lead to 'policy spillover,' i.e. greater support for other waste-reduction policies (3.3, 3.4.4).

17. Close interdisciplinary collaboration is desirable between the natural, technical and social/behavioural sciences to address the complex issue of plastic waste and pollution (1.2).

18. Capacity-building and training are needed to form a new generation of scientists that think in an interdisciplinary way, which the evidence shows is needed to find solutions to such environmental issues (1.2).

CONCLUSIONS OF CHAPTER 4. REGULATORY AND LEGISLATIVE ASPECTS

1. Legislation addressing plastic pollution can be grouped into measures that are aimed at market authorisation for materials and products and influence NMPs downstream of macroplastics; those that aim to protect the marine environment (such as MSFD); and those that are focused on waste (such as the Waste Directive) (4.2).

2. In the current relevant legislation for these three groups, in general NMPs are not mentioned explicitly, nor is monitoring required specific risks for NMPs (4.2).

3. Specific legislative risk-based criteria have not yet been established for NMPs (4.4.1).

4. The scientific foundation for these groups of legislations are somewhat different, and especially the foundation for the environmental legislations are based on only a few, but comprehensive reports and monitoring studies (e.g. Life Cycle Analysis for waste-focused regulations, and monitoring studies for environmental and marine protection) (4.4.2).

5. Due to a lack of scientific understanding, the precautionary principle has been part of the foundation for current regulation (in accordance with the Treaty) (4.3).

6. Extended producer responsibility can be viewed as an implementation of the polluter pays principle (4.3).

7. A large array of measures has proven to be useful for addressing plastic pollution, such as fees, bans, EPR and voluntary agreements. All have pros and cons (4.6 and 4.7, also reviewed in Chapter 3).

8. This suggests that effective interventions will be accepted and lead to a significant reduction in the current and future risks of NMP. The uses of plastic posing the highest risks will be related to high volumes, high emission profiles, and/or intrinsic hazardous properties of the materials (4.4.2).

9. At present, a systematic overview on policy options and their predicted efficiency and relevance to reduce current and future risks of NMP is not available (4.4.2).

10. It will be important to implement both agreements and legislation which are focused on emission reduction and the use of less hazardous materials, as agreements that set protections levels in the environmental compartments that society aims to protect, such as marine and surface waters, air, food products and drinking waters. In general, measures or protection levels that can be enforced are often laid down in legally binding texts, and these can create new markets for innovative solutions (4.5).

11. As socioeconomic developments increase, in a business-as-usual scenario use of plastics and associated problems will increase. There is a need for more work to look at these socio-economic scenarios, more research on consumers and less on producers and industrial processes (Chapters 2, 3 and 4).