Group of Chief Scientific Advisors

Main Points

Discussion with Experts[1] on:

Human Health and Environmental Impacts of Micro and Nano Plastic (MNP) Pollution

Is short-term policy advice based on state-of-the-art scientific knowledge feasible and justified? If so, what should its scope be?

Thursday, 26th April 2018

ORBN - 08/A149 –No 8 Frère Orban Square, Brussels

The objective of this discussion was to ascertain the views of a number of scientific experts on whether or not the delivery of science-based advice to EU policy makers on microplastic pollution was considered timely and appropriate and, if so, to help shape the scope of and the approach to formulating such advice. The main points retained from this discussion are set out below.

Main points noted

1. The experts deemed science-based policy advice on microplastic pollution to be both necessary and timely. They acknowledged that the **Background Memo** (Appendix 2) with its list of questions was pertinent and topical with respect to the ongoing development of MNP science as well as the corresponding public and policy debates.
2. Some of the experts pointed to a number of **fundamental issues** which should also be an explicit part of the discussion on what science-based advice to policy could be envisaged. These included:
   a. Distinguishing between a **scientific assessment** of the risk of MNPs and the relevance of science to a situation where society has already decided to act and where the protection goals, if and when they exist, are not fixed by scientists
   b. When and where the **precautionary principle**[2] should or should not be applied
   c. Ensuring that the **fragmented and uncertain nature of a slowly emerging body of scientific evidence** is correctly communicated and factored into policy decisions, while not glossing over the knowledge gaps

[1] See full list of participants in appendix 1

[2] i.e. to apply restrictive measures in the absence of scientifically-established cause and effect relationships but where there is a credible threat of harm to human health or the environment

d. The different ways of **framing the MNP problem** corresponding to different risk paradigms (e.g. from a biological, ecotoxicological, ecological, economic, aesthetical, moral or societal point of view) within each of which the 'scientific perspective' itself can take on different tones depending on the relative weight accorded to the natural science, political science or social science angles

3. Scientific study of MNPs in the environment began in about 2006. Though the number of scientific publications has been increasing exponentially, the field is still **new and emerging**. Many methods and techniques for detecting and measuring the presence, composition and detailed characteristics of MNPs in different media are still being developed, especially for particle sizes from the micron down to the nanometre scale.

4. A concern is that some data from earlier studies continue to be cited even though they have been superseded my more recent, accurate and reliable data. Helpful in this regard are reviews and critical assessments of published studies (e.g. forthcoming paper by Hermsen et al. [2018]).

5. Even where experimental methods do exist, **standardised experimental protocols, controls and agreed definitions are often impossible** hampering comparability and reproducibility of baseline studies, the determination of effects on biota, etc.

6. Thus, **scientific advice based on a classical hazard/ exposure risk assessment approach on the impact of MNPs on biota, ecosystems and human health, is not yet possible** based on current knowledge.

7. In spite of this, the experts were adamant that a **rational scientific perspective** on MNPs has a lot to offer and can already bring valuable and well-founded evidence-based scientific insights to bear on both policy and the wider public debate.

8. The knowledge, know-how and data/evidence of relevance which is in the hands of **industry** is deemed to be substantial, which, if it were possible to access could be of considerable help.

9. As an example of the prevalence of scientific uncertainty in a post-normal science world, it was mentioned that even after two decades assessing **risks of engineered nanomaterials**, it is still not possible to provide policy with irrefutable evidence of their impacts.

10. For MNPs, there is **a growing body of research which demonstrates negative impacts of MNPs** on organisms mostly in conditions where concentrations of exposure exceed those which occur in the natural environment, though some studies do emulate natural concentrations.

11. The highly **diverse nature of MNPs** (in terms of number of different polymers, particle sizes, shapes, sources, additives, etc.) makes risk assessment (RA) very difficult. However, as no alternative to the RA approach exists, it should be possible to meaningfully adapt RA to MNPs as was possible for other complex materials such as crude oil. This would mean **applying RA to MNPs in highly context-specific** situations as opposed to general situations (e.g. to assess impact of a certain component of the MNP spectrum on, for example, the fertility or longevity of species X in medium Y).

12. From the perspective that plastics are here to stay but that all possible emissions into the environment should be stopped, **cost-benefit analysis** can play an important role in helping to bring about positive change. However, estimating benefits is also not possible as long as the risks are unknown.

13. From a public good perspective, robust RA results are needed to avoid that quick-win, no-regret measures such as cosmetics microbeads bans **do not lead to complacency** and neglect of potentially more damaging components of MNP pollution. As one expert put it, as every member of the population is exposed to MNPs, it is imperative to determine the nature and degree of public health risks, if indeed any exist.

14. Given the presence of naturally-occurring micro and nano particles in different environmental compartments, one of the key challenges to science is to determine if there is **any additional and different impact of MNPs compared to that of the natural background component** – the key question is "under what conditions do MNPs behave and impact in a fundamentally different way than natural particles?"
15. It was suggested that **MNP science should build wherever it can on other bodies of research,** such as the field of engineered nanomaterials or the study of the ecological effects of soot, black and activated carbon which are ubiquitous in the environment and chemically more similar to MNPs than most engineered nanoparticles (see paper by Nowack & Bucheli, 2007).
16. The **utility and relevance of MNP science** can be increased in ways such as:
    a. Responding to clearly-set and defined **protection goals** by policy makers/ risk managers
    b. **Finger-printing** polymers in a way which identifies source producers if possible. This has worked to reduce drastically crude oil spillages. **From a regulatory perspective** it would be helpful to be able to identify who is responsible for unwanted/ undesirable emissions of such pollutants into the environment.
    c. Identifying possible **high-risk scenarios** now and in the future on the basis of robust assumptions and determining impact/ effects which are in addition to the baseline effect of natural particles (modelling)
    d. Responding to **clear questions from policy/ risk managers** e.g.: Is REACH fit for purpose? Are exposure models working? How much more plastic would have to be dumped into the environment before effect on population would become manifest (similar to climate change studies)? / Under what circumstances would there be harm and over what time scale? What are the most sensitive species (corral, etc.)? …
17. Plastic as a matrix behaves differently (chemically, etc.) from other matrix materials (metals, glass, ceramics & carbon) irrespective of the scale (nano, micro, meso or macro) - due to this as well as the socio-ecological perspective, the MNP issue needs to be seen as **a component part of the overall plastics pollution problem**.
18. Regarding **regulatory science implications**, views were expressed that a priority could be to focus on plastic **particle toxicity** and consider regulating polymers under REACH (currently excluded) – the restriction or authorisation of some additives to plastics often cited in the literature is already taking place under REACH so long as they are cause for concern
19. A recurring theme in the discussion was the potential added value of scientific advice to policy which could come from an analysis of the **social sciences and humanities** findings of relevance to the topic (from sociology, psychology, political sciences, etc.). Some of the aspects on which scientific study would be helpful include:
    a. Understanding the factors which determine **risk perception** by the general public – e.g. the reporting of results such as the imbalance between the numbers of reports showing impact and the number showing no impact (the Journal of Negative Results was mentioned in this context) and **risk communication** (see Chapter in Freshwater Microplastics by Syberg et al [2018])
    b. Ways and means for findings from the natural and exact sciences to be **introduced into both the public and the more-specialised stakeholder/ policy debates**[3]

[3] See for example D. Bowman and G. van Calster, 'Smoke that Thunders - Risk, Confusion and Regulatory Frameworks for New Technologies', in *Nano Meets Macro: Social Perspectives on Nanoscale Sciences and Technologies* Wickson *et al* (eds.), Sangaore, Pan Stanford Publishing, 2010, 359-386

c. The **variability of social norms** and their impact on attitudes and action taken (by media/ opinion makers, stakeholders, policy makers) – in the MNP context of emerging knowledge and understanding of the impacts (uncertain, ambiguous), a map of how people socially, psychologically and culturally understand the problems would help (e.g. microbeads may be a case in point with valuable lessons)

d. **Different concepts of what constitutes evidence** and what value to ascribe to it depending on the problem framing and the individual perspective (scientist, journalist, activist, citizen, business)

e. **Scientifically-informed ways** of involving and engaging with citizens on the issue

20. A valuable element of any SAM activity on MNPs would be a **well-structured overview of the state-of-the-art** which would enable comparable and systematic debates to take place in scientific, policy and public milieus.

21. To maximize the novelty and policy-advice relevance and utility of such an overview, the experts agreed that it should have four key components – **1. Natural sciences; 2. Social sciences and humanities; 3. Regulatory frameworks – national and international; and 4. Modelling studies**.

Conclusions

22. Based on the discussion of the background memo and questions, a consensus emerged that a **scientifically informed statement on MNPs by the group of Chief Scientific Advisors is timely, needed and could be very helpful to EU policy makers**.

23. The suggestion was made that the group of Chief Scientific Advisors consider a SAM activity on MNPs following a three-stage approach:

i. The drafting of a **short document** before the summer of a few pages which would be provided to the college of Commissioners for comment/ endorsement in which, *inter alia*, the Scientific Advisors would acknowledge the attention it has given thus far to microplastics, set out some initial views on the topic and announce the nature of its intention to deliver more substantial advice on the topic in subsequent stages

ii. The first such substantial element would be a summary **overview of the State of the Art** in the form of an Explanatory Note with four components:

1) **A rapid evidence review, map and summary of existing natural sciences reviews and overview reports**, incorporating a digest of the latest primary literature not covered by existing reviews

2) A digest and analysis of the **social science** work of relevance in terms of issues such as risk perception by citizens, the behaviour of stakeholders, the political economy and psychology of the microplastic debate, public good and opportunity cost policy considerations, etc. (this was viewed as something which would be a substantial new addition as no or very few overview reports have dealt with such aspects)

3) A political science and legal sciences analysis of the different national and international **legislative/ regulatory/ policy frameworks** of relevance – including substance-focused (REACH, drinking water ,…) and ecosystem-focused (water framework directive, marine strategy framework directive, …)

4) An overview assessment of various **modelling approaches** and of their potential to shed light on some of the more complex aspects of microplastics including future "what if?" and "under which conditions?" scenarios.

iii. The third stage would be to develop a **full Scientific Opinion** based on the Explanatory Note with recommendations to the Commission by spring 2019.

24. **All experts participating expressed a willingness to help with this work** if finally launched by the group of chief scientific advisors, subject to availability constraints and compatibility with the expertise domain of each.

25. SAPEA – represented at the meeting by Jackie Whyte – expressed its readiness to manage the production of a state-of-the-art overview within a timeframe compatible with its working procedures and subject to its Board approval. SAPEA also asked to be involved in the elaboration of the first short document.

26. A **timeline** put forward for the three stages was:

i. First short document finalised and sent to the Commission by end of June 2018 as basis for discussion and the preparation of subsequent steps

ii. State-of-the-art overview to be completed before the end of the year and to involve (prior to peer review) a detailed validation/ critique type workshop and wider discussions with a broad range of experts and stakeholders on the basis of a first full draft sometime in the autumn, and

iii. A full Scientific Opinion to be prepared and delivered in early 2019

27. The participating experts offered suggestions on what additional expertise would need to be involved in the state-of-the-art overview ((indoor air, particle/air/fibre toxicologists, marine plastic scientists, polymer specialists, SSH & risk perception expertise,…) including the names of some individuals and some relevant publications. JRC also indicated its willingness to participate. SAPEA indicated that they would have experts at their disposal through the network of academies subject to internal time/procedural considerations.

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Appendix 1: List of Participants

Prof Rolf Heuer (**Chair**) Prof Pearl Dykstra **(Dep Chair)**	Group of Chief Scientific Advisors
EXPERTS	
Prof Thomas Backhaus	University of Gothenburg, SE
Dr Nicole Brennholt	Federal Institute for Hydrology, DE
Prof Geert van Calster	KU Leuven, BE
Prof Tamara Galloway	University of Exeter, UK
Dr Nanna Hartmann	Technical University of Denmark, DK
Prof Bart Koelmans	Wageningen University & Research, NL (by WebEx)
Dr Anja Verschoor	National Institute for Public Health and the Environment, NL
Assoc Prof Martin Wagner	Norwegian University of Science and Technology, NO
Guy van den Eede	DG JRC
SAM Unit	
Johannes Klumpers	Head of Unit
Jeremy Bray	Deputy Head of Unit
James Gavigan	Policy Officer
Dulce Boavida	Policy Officer – SNE
Annabelle Ascher	Policy Officer
SAPEA	
Jackie Whyte	SAPEA Senior PO

Appendix 2: Background Memo

Background and Questions for Discussion

Discussion with experts on:

Human Health and Environmental Impacts of Micro and Nano Plastic (MNP) Pollution

Is short-term policy advice based on state-of-the-art scientific knowledge feasible and justified? If so, what should its scope be?

Thursday, 26th April 2018 - 8:30 - 14:00

ORBN - 08/A149 – 8 Frere Orban Square, Brussels

Overall objective: *In the context of a fast-moving public debate and the efforts of policy makers to keep up-to-speed, the objective of this discussion is to ascertain what, if any, specific MNP issues call for science-based advice to be delivered in the short-term to EU policy makers and, if so, to scope and plan the evidence review which would be needed to underpin such advice.*

Initial Considerations:

Interest in the presence of plastic particles - mostly invisible to the naked eye - in environmental media (soil, air and water) and their effect on biota and human health is increasing among scientists, as is concern among the general public and policy makers. This results to some extent from increasing media attention to the unrelenting rise in plastic pollution of the ocean, dramatized by images of floating garbage patches, littered beaches, entangled fish, birds, turtles and marine mammals and videos of plankton ingesting microscopic pieces of plastic. This wave of concern initially focused on visible pollution by large macroscopic plastic litter but now extends to the mostly invisible debris at the sub-five millimetre down to nanometre scale.

The overall thrust of the public debate is dominated by a common-sense consensus that the amount of plastic entering the environment - intentionally or unintentionally - constitutes pollution and should be curtailed and where possible eliminated, in view of a multiplicity of hypothetical negative impacts on biota including humans and ecosystems. This consensual view must also be reconciled with the ubiquity of plastics in our world plus the fact that their use is set to increase in the future rather than diminish.

An understandable consequence of this is a rise in legislative restrictions by public authorities and voluntary measures by businesses, action groups and citizens aimed at reducing or eliminating plastic pollution.

However, at the same time it would seem to be important for stakeholders to sustain a rigorous critique of the ensemble of such actions and related policies with a view to maximising public good outcomes. This means not taking for granted that such actions and policies are necessarily the right ones, but more importantly, to ensure that the right targets are chosen in the first place and if not, to correct for this. Science and evidence-based scientific advice clearly can play an important role in this regard alongside other social, economic and political considerations.

Take, for example, the banning of the use of plastic microbeads in cosmetic products. Some countries have introduced such a ban with more to follow suit, including on-going preparations for a possible EU-level ban. Already, some industries have voluntarily eliminated their use in light of negative media attention and the existence of alternatives. Absent from this development however is any serious consideration and irrefutable demonstration that these microbeads actually cause harm. The lack of such scientific evidence in itself is not a reason to allow their continued use – better safe now than sorry later when science may be in a position to prove or disprove such effects.

However, taking a step back, one can ask what is the net effect or opportunity cost of devoting scarce time and energy to implementing an "easy win" ban as opposed to directing such time and energy to eliminating other better-documented sources of pollution which are harmful to the environment and human health? In addition, as such microbeads purportedly represent approximately 1% of the microplastic pollution problem; this raises the question of where the priority concerns with microplastic pollution should be – i.e. what are the main sources of such pollution? can they be attenuated? etc.

Apart from this example, the European Commission's group of chief scientific advisors is also struck by the views published by some scientists that call for a thoughtful and carefully-weighted approach to the micro- and nano-plastics (MNP) issue to counter what is deemed to be a disturbing trend of unrealistic studies concluding that microplastics are a severe environmental threat.

For example:

"The process of determining microplastics risk should be an analysis of true risk (realistic exposure relationships to adverse effects). It should be documented in the field. Much greater and pervasive ecosystem risks often occur where microplastics are at their highest concentrations and are well-documented and rampant globally; including excess nutrients, low dissolved oxygen, solids from erosion, pathogens, altered flows, degraded habitats, temperature and the loss of shading. These common and major stressors should first be dealt with by regulators and environmental advocacy groups before focusing on the minor and questionable threats."

G. Allen Burton Jr., Environ. Sci. Technol., 2017, 51, 13515-13516

"Microplastic research is an emerging field, and there is a lot of misunderstanding and in some cases overreaction or misinterpretation of results from MP science in the public. We therefore strongly suggest that future studies of MP impact on marine ecosystems should also include concentrations that have been documented in the environment to yield more realistic estimates of sublethal effects."

Lenz et al, PNAS, 2016, 113 – 29, E4121 – E4122

There is also the high-profile retraction in 2017 of the article "Environmentally relevant concentrations of microplastic particles influence larval fish ecology" by Oona M. Lönnstedt and Peter Eklöv, published in *Science* on 3 June 2016.

The group of chief scientific advisors also takes note of some views recently published in response to the above cited opinion of G. Allen Burton Jr. including a piece "Superficial or Substantial: Why Care about Microplastics in the Anthropocene" by Kramm, Völker and Wagner (2018) and an exchange of views entitled "Microplastics in the environment: much ado about nothing? A Debate" by Backhaus and Wagner (2018).

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Questions for Discussion with experts:

In light of the above and an initial perusal of relevant scientific literature, the group of chief scientific advisors would like to engage in a discussion with a number of scientific experts in relevant fields in order to ascertain the potential for providing the European Commission with evidence-based scientific policy advice on the harmful effects of M&NP pollution.

The questions which the group of chief scientific advisors proposes to cover in such a discussion with experts are as follows:

1. Putting M&NP pollution into context

1.1. When considering the full range of environmental pollutants and stressors in conjunction with what is known of their harmful effects, what position of priority does M&NP pollution actually occupy in the eye of both citizens and politicians? Should its position of priority be logically higher or lower, based on what is known scientifically and if so why?

1.2. In terms of human exposure to MPs and NPs, do food-contact plastics form part of the overall picture, and if so, in what way?

2. **Relative importance of micro- versus nano-plastics**

2.1. What is the current scientific understanding of the relative incidence and importance/ impact of MP versus NP pollution (in terms of both the amount of material [numbers and size distributions of particles, aggregate mass, etc.]) in each of airborne, soil-borne and waterborne media?

2.2. What scientifically-relevant phenomena would require different considerations regarding the potential harmful impacts of MPs as opposed to NPs in each specific environmental medium (air, water, soil) and in different living systems (animal, plant, ..)?

3. Geography of the M&NP problem and the components of the biosphere

3.1. What proportion of the global M&NP problem is Europe responsible for/ affected by?

3.2. How much of this plastic ends up in European marine and coastal areas? (note that for marine plastic pollution Schmidt et al [2017] calculate that between 88-95% comes from the catchment areas of just ten rivers – eight in Asia and two in Africa)

3.3. What about the air and soil borne components?

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4. Complexity of plastic pollution

4.1. What potential problems / negative impacts are due to the plastic particles themselves as opposed to: their potential to adsorb and concentrate other pollutants in the environment; or the extent to which breakup of plastic releases additives (plasticizers, colorants, flame retardants, etc.) which are more toxic than the plastics themselves?

4.2. What does current scientific knowledge suggest to be the order of priority of problems (in terms of: sources; uses; classes of plastic materials; etc.)? and

4.3. How might science suggest that public policy respond to these problems regarding potential harmful effects on:

- Human health via food chain
- Ecosystems and the biota therein

- Economic activity (tourism impact of visual pollution, …)
- Other …?

5. **Current policy and regulatory tendencies regarding M&NP and science** – in terms of existing, planned and expected measures plus others under consideration (such as those listed in the EU Plastics Strategy)
   5.1. What is the view from science on the rationales upon which these policy measures are, or are likely to be, based? Is there any example therein of disregard for science?
   5.2. From a political science analytical perspective, what is the assessment of such measures in terms of: their public good potential; their fitness-for-purpose; and their executability under present regulatory regimes?
   5.3. Is there scope for science-based advice to better inform the policy development, implementation and evaluation/ revision processes of such measures?
   5.4. What further insights on the feasibility and appropriateness of such measures can social sciences and the humanities (including policy sciences) as well as studies of citizen and political psychology, offer to underpin scientific advice to the Commission?

In addressing the above questions, it is expected that the experts will bear in mind and distinguish clearly for the European Commission's group of chief scientific advisors between what is known and what is not yet or only partially known. It is understood that this, as in all scientific disciples, is a moving target, but that the focus should be on what advice can be formulated in the midst of uncertainty and incomplete knowledge, rather than on the identification of knowledge gaps and research questions.

*** END ***