Human exposure to micro- and (nano)plastics: What drives citizens’ concern?

Sabine Pahl, Professor of Urban and Environmental Psychology
University of Vienna & University of Plymouth
How concerned are citizens about plastic pollution?
Concern about plastic pollution in the context of other environmental issues

Table 1
Responses to ‘please indicate how serious you think each of the following environmental issues are’.

<table>
<thead>
<tr>
<th>Environmental Issue</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastic in the ocean</td>
<td>8.9</td>
<td>1.49</td>
</tr>
<tr>
<td>The amount of plastic waste produced</td>
<td>8.59</td>
<td>1.58</td>
</tr>
<tr>
<td>The amount of general waste going to landfill</td>
<td>8.45</td>
<td>1.61</td>
</tr>
<tr>
<td>Water pollution</td>
<td>8.34</td>
<td>1.62</td>
</tr>
<tr>
<td>Endangered species and biodiversity</td>
<td>8.26</td>
<td>1.71</td>
</tr>
<tr>
<td>Natural resource depletion (forest, water, energy)</td>
<td>8.14</td>
<td>1.75</td>
</tr>
<tr>
<td>Air pollution</td>
<td>7.93</td>
<td>1.78</td>
</tr>
<tr>
<td>Water shortages</td>
<td>7.93</td>
<td>1.91</td>
</tr>
<tr>
<td>Climate change (global warming)</td>
<td>7.73</td>
<td>2.34</td>
</tr>
</tbody>
</table>

Representative Australian sample
Concern about human health impacts of plastics in the context of marine threats

Mean level of concern (and 95% CIs) for human health effects of 16 marine threats.

- Plastic pollution
- Chemical/oil pollution
- Loss of marine species
- Contamination of seafood
- Collapse of fish stocks
- Plastic pollution
- Chemical/oil pollution
- Loss of marine species
- Contamination of seafood
- Collapse of fish stocks
- Plastic pollution
- Chemical/oil pollution
- Loss of marine species
- Contamination of seafood
- Collapse of fish stocks
- Plastic pollution
- Chemical/oil pollution
- Loss of marine species
- Contamination of seafood
- Collapse of fish stocks

Davison, White, Pahl et al., rev. submitted

https://sophie2020.eu/

N > 15,000

Europe +

Potential marine threat (highest to lowest in order of concern)

- 5 Plastic pollution
- 15 Chemical/oil pollution
- 3 Loss of marine species
- 14 Contamination of seafood
- 9 Collapse of fish stocks
- 1 Human & animal sewage in bathing waters
- 13 Drug-resistant microbes in seawater
- 4 Ocean acidification
- 11 Harmful algae
- 6 Coastal overdevelopment
- 12 Invasive marine species
- 2 Sea-level rise
- 16 Flooding & storms
- 10 Jellyfish swarms
- 8 Drowning
- 7 Sunburn & sunstroke
## Linking the marine environment to human health: Microplastics in seafood

<table>
<thead>
<tr>
<th></th>
<th>Beauticians</th>
<th>Students</th>
<th>Environmentalists</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First response</strong></td>
<td>“Oh my god”</td>
<td>“seems a bit fake”; “weird”</td>
<td>“Oh my god”; “Oh my goodness”</td>
</tr>
<tr>
<td><strong>Thoughts on general impact</strong></td>
<td>“it’s quite dangerous for the world around us basically”</td>
<td>“Does it physically harm the fish? Obviously I know it’s in their stomach but does it like poison them or something?”</td>
<td>[already talked about impact before]</td>
</tr>
<tr>
<td><strong>Thoughts on human health</strong></td>
<td>n/a</td>
<td>Concerns about <strong>MP in seafood</strong>: Get digested by animals. (S) And then you eat the animals. (S) You’re eating those. (S) Cos you can’t afford to eat plastic can you? (S)</td>
<td>[…] so that was a moment for me of just thinking that zooplankton, that's the beginning of the <strong>food chain</strong>. (E)</td>
</tr>
</tbody>
</table>

**NEW – qual/quant mental models study with EFSA just started**

Concern about microplastics compared to other food risks

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Concerned</th>
<th>Not Concerned</th>
<th>Don't Know</th>
<th>Missing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antibiotikaresistenzen</td>
<td>38</td>
<td>22</td>
<td>17</td>
<td>9</td>
</tr>
<tr>
<td>Mikroplastik in Lebensmitteln</td>
<td>35</td>
<td>24</td>
<td>21</td>
<td>10</td>
</tr>
<tr>
<td>gentechnisch veränderte Lebensmittel</td>
<td>29</td>
<td>21</td>
<td>22</td>
<td>10</td>
</tr>
<tr>
<td>Reste von Pflanzenschutzmitteln in Lebensmitteln</td>
<td>26</td>
<td>23</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>Salmonellen in Lebensmitteln</td>
<td>26</td>
<td>17</td>
<td>23</td>
<td>15</td>
</tr>
<tr>
<td>Glyphans in Lebensmitteln</td>
<td>29</td>
<td>12</td>
<td>20</td>
<td>8</td>
</tr>
<tr>
<td>Aluminium in Lebensmittelverpackungen oder -behältnissen</td>
<td>22</td>
<td>16</td>
<td>24</td>
<td>16</td>
</tr>
<tr>
<td>Schimmelpilzgifte in Lebensmitteln</td>
<td>22</td>
<td>14</td>
<td>15</td>
<td>9</td>
</tr>
<tr>
<td>Lebensmittelhygiene in der Gastronomie</td>
<td>13</td>
<td>20</td>
<td>34</td>
<td>21</td>
</tr>
<tr>
<td>Kohlenmonoxid</td>
<td>14</td>
<td>11</td>
<td>20</td>
<td>9</td>
</tr>
<tr>
<td>Listerien in Lebensmitteln</td>
<td>10</td>
<td>6</td>
<td>15</td>
<td>9</td>
</tr>
<tr>
<td>Coronaviren auf Lebensmitteln</td>
<td>7</td>
<td>5</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>Lebensmittelhygiene zu Hause</td>
<td>6</td>
<td>16</td>
<td>21</td>
<td>51</td>
</tr>
<tr>
<td>Campylobacter in Lebensmitteln</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>3</td>
</tr>
</tbody>
</table>

N = 1,019

Germany

Already in 2016 German representative survey, around 60% were worried about plastic particles in food and drinking water (reported in SAPEA, 2019)
Expert concern and reasons for actions
Microplastics science experts

How worried, if at all, are you about the current impact of a) everyday products made of plastic / b) microplastics on a) the natural environment / b) human health?

Please no sharing of unpublished data slides

Main effect of nat env vs. human health, $F(1,72) = 69.95$, $p < .001$, $n^2 = .493$

Note. Scale from 1 (Not worried at all) to 7 (Extremely worried), $N=73$; Means and SE

Grünzner, Pahl, White & Thompson (2021), unpublished data – preliminary analysis
Stocktake of global actions to reduce the flow of marine plastic and microplastic to the ocean

Pursuant to UNEA Resolution UNEP/EA.4/Res.6 OP 7a: “Take stock of existing activities and action ...........with the aim of the long-term elimination of discharge into the oceans”

Types of actions:
1) Legislative, standards, rules;
2) Working with people;
3) Technology & Processes;
4) Monitoring & Analysis

Locations of at least one action (from survey)

Analysis: Julie Goodhew, Francesca Tirotto & Sabine Pahl
Which type of impact or harm does the action target?

Please no sharing of unpublished data slides

**Figure 23: Types of impacts or harms that the action is related to. (Respondents were asked to choose all that applied.)**

<table>
<thead>
<tr>
<th></th>
<th>Legislative, Standards, Rules</th>
<th>Working with People</th>
<th>Technology and Processes</th>
<th>Monitoring and Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marine organisms</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biodiversity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Human health and wellbeing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ecosystem Services</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food chain</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economics and Trade</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All of the above</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Analysis: Julie Goodhew, Francesca Tiotto & Sabine Pahl
Evidence and lack of evidence
The best available evidence suggests that microplastics and nanoplastics do not pose a widespread risk to humans or the environment, except in small pockets. But that evidence is limited, and the situation could change if pollution continues at the current rate.
State of the evidence regarding plastic pollution

**Industry survey UK 2018**

<table>
<thead>
<tr>
<th></th>
<th>5.00</th>
<th>4.00</th>
<th>3.00</th>
<th>2.00</th>
<th>1.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>very good</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>good</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>fair</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>poor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>very poor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Science Magazine Feb 2021**

TOXICOLOGY

Microplastics and human health

Knowledge gaps should be addressed to ascertain the health risks of microplastics

Thompson & Pahl, University of Plymouth, July 2018

Reported in Pahl, Richter & Wyles, 2020
Types of evidence communication – Some examples

**Science**

Evidence on quantitative risk assessments

- Single study vs. synthesis
- Presence vs. Impact
- Reporting uncertainty / variance

**Media**

Microplastics revealed in the placentas of unborn babies

Health impact is unknown but scientists say particles may cause long-term damage to foetuses

[Links to articles]

https://www.thesun.co.uk/news/6871840/plastic-chemicals-food-packaging-make-penis-smaller/
PLASTIC CAN CAUSE BIRTH DEFECTS

NGO campaign
The power of visual images

From the psychology, neuroscience and social science literature

- **Visuals**
  - **Cognition**: attention, memory processes, flashbacks
  - **Motivation**: Interest, effort, elaboration
  - **Emotion**: Fear, disgust, anger
  - **Social**: Sharing, debate
  - **Behaviour**: Can provide cues for action; potential to facilitate new actions, break habits

- Neuro-science
  - 50% of the brain used for visual processing
  - 70% of the sensory receptors are in the eyes
  - 100ms to get a sense of the visual scene

Communicate messages quickly and powerfully; condense complex information

Can be linked to tailoring, feedback and goal setting

Overcome language or knowledge barriers

Beyond visuals: Impact and Spread

The stakes are high:
- Human health, (unborn) baby health
- Male sexuality / microplastics in the placenta
- Our food, the air we breathe, the water out of the tap

Vosoughi et al., the spread of true and false news online, Science, 2018

~126,000 stories tweeted by ~3 million people more than 4.5 million times
Factors that determine risk perception

- Technical > natural hazards
- Risk target
- Number of people affected
- Lack of controllability
- Delay
- Uncertainty / lack of knowledge (MNP)
- Correlation between risks and benefits
- Contamination?

Summary: Jenkins et al., 2020, Trends in Food Science and Technology
The power of strong emotions: disgust

Contact, contagion

Taste test

Rozin et al., 1986, Journal of Personality and Social Psychology
Direct disgust?  
Moral disgust?  

No data on (micro-)plastics yet

Rozin et al., 1986, Journal of Personality and Social Psychology
The social amplification of risk framework

Kasperson et al., 1988; picture from Pidgeon & Barnett, 2013
Discussion
Key messages

• High level of citizen concern about macro- and microplastic pollution including human health impacts
• Experts more concerned about environmental impact (?), but lack of scientific evidence & debate even among scientists
• People are exposed to different (social / media) messages including powerful visuals
• Psychological and social processes can explain responses and spreading of news -> social amplification
• Risk is a societal issue between ‘technical’ risk assessment and values, emotions, trust etc. (‘beyond mere facts’)
• We need to understand public concern and behaviour to ensure successful policy actions
Thank you

Sophie Davison
Maja Grünzner
Mathew White
Julie Goodhew
Francesca Tirotto
Isabel Richter
Kayleigh Wyles

Contact: sabine.pahl@univie.ac.at

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Additional slides if questions
The plastic system

Macros-, Micro-, Nanoplastics

Perceptions & communications drive concern and action

Credit: GRID-Arendal and Maphoto/Riccardo Pravettoni
http://www.grida.no/resources/6908

Pahl, Richter & Wyles, 2020
Increase in **MP in food** publications;
- social & behavioural science publications not represented yet
Concern about human health impacts of plastics in the context of marine threats

Davison, White, Pahl et al., rev. submitted

Figure 2: A country breakdown of mean concern (and 95% CIs) for 16 marine threats - plastic pollution indicated by circle.
Support for research

Marine research area (highest to lowest in order of support)
- 3 Marine species/wildlife protection
- 5 Plastic pollution in marine waters
- 2 Coastal protection/defences
- 7 Education and awareness raising
- 12 Marine renewable energy
- 1 Bathing water quality
- 4 Marine-climate change issues
- 15 Behaviour change to improve health/wellbeing
- 9 Sustainable aquaculture
- 13 Sustainable shipping
- 8 Health/wellbeing effects of spending leisure time in and around marine environments
- 6 Health/wellbeing effects of living by the sea
- 11 Biotechnology from marine organisms
- 10 Jellyfish swarms and algal growth
- 14 Deep-sea mining
Bostrom et al. (2018): Communicating risks: Principles and challenged

Shannon-Weaver Model of Communication: sender, message, receiver

Fig. 11.1 Key components of risk information processing

Conversational implications / interpretation; nuance
Risk Perception and Communication Unplugged: Twenty Years of Process

Table I. Developmental Stages in Risk Management (Ontogeny Recapitulates Phylogeny)

- All we have to do is get the numbers right
- All we have to do is tell them the numbers
- All we have to do is explain what we mean by the numbers
- All we have to do is show them that they’ve accepted similar risks in the past
- All we have to do is show them that it’s a good deal for them
- All we have to do is treat them nice
- All we have to do is make them partners
- All of the above

Fischhoff, 1995

- Empower ‘them’
- Co-create the future
- Co-create science
Most scientific studies (67%) frame microplastics risks as hypothetical or uncertain, while 24% present them as established.

In contrast, most media articles reporting on microplastic impacts (93%) imply that risks of microplastics exist and harmful consequences are highly probable.

The creation of simple narratives (journalists) and the emphasis on potentially negative impacts (scientists) contribute to this inconsistency.
Plastic can cause cancer, heart disease and Alzheimer’s

Chemicals in plastic can cause cancer, heart disease, Alzheimer’s, dementia, Parkinson’s, arthritis, impotency and even harm babies in the womb. Scientific evidence is piling up. It’s becoming impossible to ignore, inevitably pointing in the same direction. Plastic is everywhere: plastic particles, nanoplastics, microplastics are in food, drinks (tap water and bottled water) and in the air we breathe. For example, from the wear from car tyres in the air and microfibres from synthetic clothes. Cosmetics also contain plastic: lipstick, mascara, nail polish, anti-aging cream... The list goes on and on and on.
How visual images may trigger behaviour

**Impact visualisation**

Cue: Person preparing for shopping trip

**Immediate reaction**

Viewer: That’s awful! I ought to be more careful with plastics

**Later consequences**

(vivid image comes back)

Cue: Person seeing plastic bag in the environment

I think I’ll pick that up before it does more damage

I must remember to take my own bags – that looked terrible

**End result:** Reduced plastic waste

Adapted from Pahl et al., 2016, https://doi.org/10.3389/fpsyg.2016.00092
Emerging Risk Governance