Workshop on Microplastics from Tyre Wear: Knowledge, Mitigation Measures, and Policy Options

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Summary note

Monday 18 – Wednesday 20 May 2020

Virtual Meeting

The Workshop on *Microplastics from Tyre Wear: Knowledge, Mitigation Measures, and Policy Options* was held virtually from Monday 18 to Wednesday 20 May 2020, 13-16h CEST. The purpose of this workshop was to gather experts from industry, academia, international organisations and NGOs to collect state-of-the art knowledge on TRWP characteristics and potential impact to water and aquatic ecosystems, and explore preliminary policy recommendations to mitigate and manage TRWPs in aquatic environments.

Disclaimer: this summary note synthesises key insights from the presentations given at the workshop and from ensuing discussions. This information has not been independently verified by the OECD nor agreed upon by all participants. As the workshop was held under Chatham house rule, this summary note does not identify individual speakers nor their institution.

Setting the scene

Framing the challenge of microplastics pollution of marine and freshwaters

Emerging evidence indicates that natural environment is widely contaminated with microplastics, i.e. plastic fragments, particles, or fibres with a diameter smaller than 5mm.[1] These originate from a variety of sources: e.g. the degradation of plastic litter dispersed in the environment, the wear and tear of products containing synthetic polymers, the loss of plastic pellets, and the intentional discharge of microbeads.

The prevalence of microplastics in the environment raises concerns for the impacts that they may have on the environment and human health. Microplastics released into the environment are believed to persist for a long time and accumulate in natural habitats, only potentially degrading into smaller and smaller microplastics. There is evidence that aquatic species, from planktons to large marine mammals, commonly ingest microplastics, either directly or via the ingestion of contaminated seafood, potentially leading to several adverse health effects.[2] Toxicity may also emerge from known or suspected endocrine disrupting

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[1] GESAMP (2016), *Sources, fate and effects of microplastics in the marine environment: Part 2 of a global assessment*. Science for Sustainable Oceans, http://www.imo.org.

European Chemicals Agency (ECHA) (2019), *Annex XV restriction report proposal for a restriction - intentionally added microplastics*, ECHA, Helsinki.

[2] Science Advice for Policy by European Academies (SAPEA) (2019) *A scientific perspective on microplastics in nature and society* Berlin: SAPEA. https://doi.org/10.26356/microplastics

chemical additives present in plastics and other hazardous chemical substances adsorbed from the environment. Humans are also exposed to microplastics via the ingestion of contaminated seafood and drinking water, as well as via the inhalation of airborne microplastics in the smaller size range. Several knowledge gaps persist with regards to the modes of toxicity of microplastics on humans, especially for nanoplastics.[3]

The scientific community has advised for **action to reduce, prevent, and mitigate microplastics pollution**. For the moment, although there may already be locations where microplastics concentrations already surpass critical thresholds, evidence does not indicate that current average concentration levels of microplastics in the natural environment pose harm to aquatic species and humans.[4] As our human population and dependence on plastics continue to grow at current rates, a steady increase in microplastics concentrations in aquatic environments is expected in the next decades. Action is required in order to mitigate the emissions of microplastics to the environment and prevent widespread ecological and human health risks.

Intervention will be required on all sources of microplastics and pathways into the environment. While the degradation of marine plastic litter is likely to be the major source of microplastics, mitigation actions also need to address microplastics emitted into the environment directly in the micro-size (e.g. microbeads present in cosmetic and personal care products, microfibres originating from synthetic textiles, tyre and road wear particles, microplastics originating from the application of paint). In this regard, several countries in recent years have implemented regulatory efforts to ban the use of microbeads, i.e. microplastics intentionally added to products such as cosmetics. Yet, there remains a large policy gap in terms of microplastics unintentionally released during the use phase of products, such as microfibres shed from clothing and tyre particles emitted during road transport activity.

Tyre and Road Wear Particles (TRWP)

In the context of microplastics pollution, there is general agreement that further understanding the contribution of vehicle tyres to the problem is emerging as a priority to define mitigation priorities. Employing currently available data, modelling estimates find that tyre wear may be a major contributor to the emissions of plastics in the micro-size into surface waters.[5] There are also concerns that inadequate and different analytical methods for sampling and characterisation may be both underestimating the amount of, or falsely confirming presence of, TRWP in the natural environment.

Tyre and Road Wear Particles (TRWP) are emitted due to the friction occurring between the vehicle tyres and the road surface, during normal use of tyres. These are composed of a mixture of tyre tread material (e.g. synthetic and natural rubber, silica, oil, carbon black, sulphur compounds, zinc oxide) and

[3] Nanoplastics is a term usually employed in the literature to refer to particles < 1 µm.

[4] Science Advice for Policy by European Academies (SAPEA) (2019) *A scientific perspective on microplastics in nature and society* Berlin: SAPEA. https://doi.org/10.26356/microplastics

[5] Eunomia (2018) *Investigating options for reducing releases in the aquatic environment of microplastics emitted by (but not intentionally added in) products*

road pavement material. Other mineral particles originating from road surfaces or contained in road dust may be present in samples collected in the environment. While at the point of emission TRWP may be composed of **tyre tread material** and **road wear components** in equal parts, recent studies have shown that the contribution of the polymer part tends to decrease with time, as other materials get embedded in TRWP. The specific physico-chemical properties of TRWP may vary depending on the generation conditions, but they are generally elongated particles (cigar shaped), generally below 1mm in length[6] (typically between 70-100um, with a fraction in the PM size range, i.e. smaller than 10µm), and an average density of 1.8.

The contribution of TRWP to marine and freshwater microplastics pollution remains difficult to quantify. Estimates find that vehicle tyres generate yearly per capita emissions of 0.5-1.5 kg of TRWP.[7] However, the emitted TRWP may not necessarily reach water bodies. TRWP may be emitted into the air, settle onto vehicle and road surfaces, or be flushed into aquatic pathways by the action of rain events. In general, the **size** of the particle is an important determinants of their fate: small particles typically become airborne, while larger ones get deposited on the road surface, get trapped in asphalt pavement, or are transported into soils, sewers and/or surface waters. Participants highlighted that the **density** of the particle may also be an important factor: with an average density of 1.8, TRWP may be prone to sinking in water. Studies modelling the environmental fate of TRWP are few, but these seem to indicate that the majority of TRWP remain close to the side of the road, or trapped into the asphalt pavement (45%). A large portion of TRWP are transported by road runoff (45%). These may be captured by wastewater systems (especially in urban environment) or be transported to surface waters (50:50). Research has suggested that 2-5% of TRWP might reach estuaries via rivers.[8] An additional relevant pathway is air deposition (up to 10%). However, available models generally look at the initial fate of the emitted particles, while several gaps in data and knowledge persist with regards to the final sinks of TRWP in the environment.

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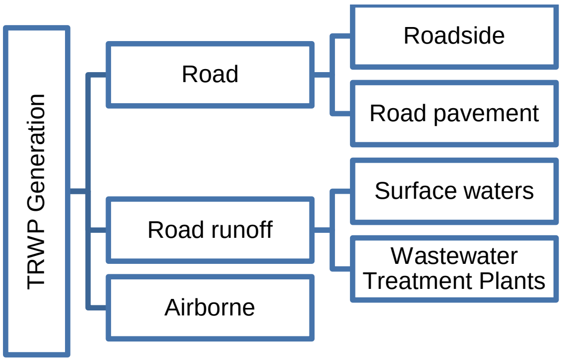
[6] As tyre particles have a synthetic rubber component and are generally way smaller than 5mm, they are often classed as microplastics in the literature.

[7] Wagner, S. et al (2018) *Tire wear particles in the aquatic environment-a review on generation, analysis, occurrence, fate and effects*. Water Res. 139, 83-100.

Sieber R. et al (2020) *Dynamic probabilistic material flow analysis of rubber release from tires into the environment.* Environmental Pollution 258, 113573.

[8] Wagner, S. et al (2018) *Tire wear particles in the aquatic environment-a review on generation, analysis, occurrence, fate and effects.* Water Res. 139, 83-100.

Unice, K. et al (2019) *Characterizing export of land-based microplastics to the estuary - Part II: Sensitivity analysis of an integrated geospatial microplastic transport modeling assessment of tire and road wear particles.* Science of the Total Environment 646, 1650-1659.



While the phenomenon of TRWP generation has been known for a long time, recent concerns with microplastics pollution have brought new attention on the issue in the research arena. The toxicity of TRWP on aquatic organisms may derive both from their physical (i.e. that caused by the transition or permanence of particles in organisms) and chemical toxicity (i.e. that caused by the chemicals leached out from the particles following ingestion). Early research has found that TRWP are unlikely to significantly impact the health of freshwater and sediment dwelling species. However, more research is required in this field, especially to understand the potential toxicity of chemical leachate from TRWP on aquatic species, as well as to assess toxicity on humans.

Mitigation measures

Entry points: understanding influencing factors on tyre wear

The generation of TRWP is a complex phenomenon influenced by a wide set of factors. These are summarised below:

- **tyre characteristics**: size, tread depth, construction, tyre pressure and temperature, contact patch area, chemical composition, accumulated mileage
- **vehicle characteristics**: weight and size, powertrain, distribution of loads, location of driving wheels, wheel alignment, traction control
- **road surface characteristics**: pavement type, road surfacing construction, material choice, maintenance, traffic load
- **driving behaviour**: speeding, acceleration/deceleration, cornering;
- **tyre maintenance:** inflation pressure, storage, age, wheel alignment
- **composition and intensity of road traffic;**
- **weather conditions;**

Set of mitigation measures identified

1) To reduce the emission of particles

Enhancing tyre resistance to abrasion at the level of *tyre design and manufacturing* can optimise tyres for a reduction in the degree of abrasion. Tyres are designed to achieve a balance between safety and environmental performances, such as abrasion, braking, wet grip, rolling resistance, and noise. With current technologies, these performance characteristics are variously antagonistic to each other, i.e. exceptional performance in one area may compromise performance in another. The development of innovative solutions in tyre design will be required in order to see significant reductions in the rate of tyre wear whilst preserving high standards in other performance areas.

In the European context, work is ongoing to develop a standard to measure the tyre abrasion rate, i.e. the total amount of matter lost from the tyre tread due to interaction with the road per unit of distance travelled. This is a complex process, as it requires a thorough assessment of the feasibility and reproducibility of the method by tyre manufacturers. The development of a standard test method is an important prerequisite to advance research on mitigation options for tyre abrasion, and potentially include this information in legislation (e.g. via tyre labelling schemes).

Improving the composition and maintenance of road pavement surfaces. The characteristics of roads can significantly affect the degree of wear, especially where these have a coarser surface. While replacing existing infrastructure would be expensive, there may be space to include considerations on tyre wear during their regular renewal, or during the *design and development* of new roads. For instance, one participant highlighted that the use of rubber modified asphalt has shown to improve the roughness and frictional characteristics of the road surface and can effectively mitigate the generation of TRWP. At the same time, proper *maintenance* of road surfaces is important to minimise tyre and road surface wear.

In addition to road maintenance, **road cleaning technologies** such as street sweeping, can effectively mitigate runoff materials from roadways, including TRWP loading into stormwater and surface water.

Optimising vehicle use and maintenance. The adoption of eco-driving practices (e.g. constant speeds, slow acceleration and deceleration) as well as best practices for optimal tyre maintenance (e.g. correct tyre inflation) can reduce the amount of tyre and road wear. Several participants also highlighted that, as tyre wear is also dependent on vehicle weight and kilometres driven, reversing current trends towards heavier vehicles and more road traffic may also be beneficial for TRWP mitigation. Additionally, further research should be conducted to evaluate the impact that increased use of electric vehicles has on the generation of TRWP due to factors such as increased vehicle weight and torque.

2) To capture the emitted particles

Improving road runoff management. Technological solutions to retain road runoff and treat it near the source of emission may be most cost-effective, especially in rural areas. For instance, roadside gully pots, i.e. retention basins embedded in the ground, are common options to retain solid particles contained in stormwater runoff. In order to ensure the effectiveness of gully pots, these need to be emptied regularly, which is seldom the case. Stormwater sedimentation ponds and wetlands can also be effective solutions to contain and/or filter TRWP and other pollutants contained in stormwater. Without proper maintenance, ponds and wetlands may become sources of water quality issues, especially during heavy rainfall.

Importantly, the prevention of Combined Sewer Overflows, i.e. the discharge of untreated sewerage occurring due to heavy rainfall, would reduce the emission of TRWP, together with other pollutants commonly contained in stormwater and urban wastewaters.

Optimising wastewater treatment. In urban areas with a combined sewer system, road runoff may be directed to local wastewater treatment plants (WWTPs) for treatment. Wastewater treatment generally involves several stages: the removal of settled and floating materials (primary treatment), the removal of dissolved and suspended biological matter (secondary), additional steps of chemical treatments and microfiltration (tertiary), and disinfection. Primary and secondary treatment remove the majority of microplastics contained in the influent. Studies have found some technologies already available to purify sewer-based wastewaters may effectively retain up to 99% of microplastics contained in the influent. In this sense, investing in WWT technological improvements can be a (costly) option. Further, improving the operational effectiveness and ensuring regular maintenance of WWT plants can also be part of the solution.

Yet, in order to be effective, end-of-pipe microplastics mitigation action will also require **improved management of sludge**, i.e. the waste by-product of wastewater treatment containing the pollutants removed from the influent. While sludge is in some cases incinerated to prevent the spread of pollutants present in wastewaters, it is common practice to treat wastewater sludge and reuse it in agriculture due to its high nutrient content and its beneficial effects on crops. The use of sludge in agricultural applications leads to the contamination of terrestrial environments with microplastics commonly found in WWTP influents. In this sense, participants expressed concerns that, in some cases, improving WWTP retention efficiency may only shift microplastics from one environmental media (i.e. freshwater) to the other (i.e. soil).

Overall, decisions on upstream and end-of-pipe solutions will be driven by considerations of feasibility, costs, and cost-effectiveness. Yet, several participants highlighted the lack of comprehensive reliable cost-benefit analyses related both to upstream mitigation options, and to the construction, operation and maintenance of various end-of-pipe solutions.

Microplastics pollution in the context of End-of-Life-Tyres (ELTs)

In several OECD countries, recent developments in waste management policy have contributed to improving the collection of ELTs (i.e. tyres which can no longer be used for their original purpose), and reducing the amount of old tyres being mismanaged and dispersed into the environment.

The development of legal frameworks for the end-of-life collection of vehicle tyres also resulted into a proliferation of solutions to reuse tyres and/or close material loops in the sector, while reducing landfilling. Several options exist for the management of ELTs. These are mainly:

1) material recovery, including the production of rubber granulate to be used in a variety of industrial applications (road infrastructure, synthetic sport turfs, tiles); and

2) use for energy recovery

It is estimated that around 90% of ELTs are recovered globally, and used in applications such as material recovery, energy recovery or civil engineering.[9]

In this context, the use of rubber granulate[10] derived from ELTs as infill in artificial sport turfs and playgrounds has been identified as a source of microplastics pollution of water streams. Rubber granulate may be transported off the pitch during use (e.g. by athletes) or during maintenance. Also, substances contained in rubber granulate may leach out and be transported into drains by rainwater.

The use of rubber granulates as infill material for synthetic sport fields offers several advantages compared to natural alternatives: e.g. durability, resistance to varying weather conditions, good shock absorbance, low costs, as well as a lower need for virgin materials. In the U.S., about 5.75% of ELTs are used for sports surfaces, while in Europe 18% of ELTs are used for synthetic turfs applications.

Research on the contribution of the use of tyre rubber granulate in sports fields to microplastics pollution is limited, but seems to indicate that artificial sport turfs are a relatively small source of microplastics. Rubber crumb particles originate from a limited number of point sources, and tend to be larger (usually in the 0.5-2.5mm size range) than tire wear particles generated from abrasion of tires, and thus their spread into the environment may be more easily prevented. In terms of potential environmental risks posed, one participant pointed to toxicological tests concluding that ELT derived rubber is not classified as hazardous to aquatic environments.

Way Forward: policy options and insights/priorities

Participants recognised the importance of **fostering research** to inform policy decisions. Concerns with the environmental impacts of TRWP are relatively recent, and several knowledge gaps persist with regards to the sources, drivers of emission, fate, and impacts of TRPW in aquatic and non-aquatic environments. There is in particular a need to develop real-world data on the pathways, occurrence, and degradation of TRWP in the environment, as the majority of existing estimates are based on modelling rather than data gathered in the field. Further research is also required on the development of mitigation measures, their implementation feasibility, their potential effectiveness in preventing the generation of TRWP and/or retaining the emitted particles (including potential synergies and trade-offs between alternatives).

Encouraging knowledge sharing through expert platforms and fostering stakeholder involvement can facilitate cooperation between different sectors and accelerate research, methods standardisation, and policy action, as already shown by existing platforms. Academic and industry-led initiatives exist at the international level to create standardised methodologies for investigating TRWP. In the same context,

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[9] World Business Council for Sustainable Development (2019) *Global ELT Management – A global state of knowledge on regulation, management systems, impacts of recovery and technologies*

[10] Rubber granulate typically contains rubber derived from tyres, but can also include rubber derived from other sources. Participants highlighted that it significantly differs from TRWP in the composition, shape, and size: generally it would not contain material originating from the road pavement, it would be cubic in shape, and in the 0.5-2.5mm size range.

participants also highlighted the importance of developing and agreeing on a common methodology to identify and quantify TRWPs in the environment.

In the context of microplastics and other pollutants of emerging concern, a key question is which are the most appropriate entry points for mitigation action. TRWP is a diffuse source of pollution, hence action as much **upstream** as possible is likely to have the largest mitigation potential. However, upstream options will remain limited as there will be trade-offs: upstream options may conflict with other policy priorities (for e.g. tyre safety and tyre energy efficiency). Since mitigation upstream cannot entirely alleviate TRWP pollution, this will need to be complemented by effective **end-of-pipe** capture solutions, to prevent that the emitted reach surface waters and reduce the risk of pollution of the water cycle. Here again, options may be limited as costly decisions on the design and operation of WWTPs and sludge management will be mostly driven by other pollutants than TRWP: the issue is about identifying and valuing co-benefits.

In broader terms, it clearly emerged from the workshop discussions that TRWP pollution cannot be effectively targeted by a simple technological fix or by a single type of mitigation measure. Rather, the complex nature of the issue calls for **an evidence-based and holistic approach** address a multiplicity of entry points - design of tyres and road surfaces, use (driving behaviour and maintenance of vehicles and road pavement), and end-of-pipe stages -, and **co-ordination of a number of different stakeholders**. In particular, several participants highlighted the need to foster collaboration and knowledge sharing between industry and academia.

Box 1. A multi-stakeholder approach: The European TRWP Platform

The **European Tyre and Road Wear Particle Platform** was initiated by the European Tyre Rubber Manufacturers Association in July 2018. It aims to create open and inclusive stakeholder dialogues in order to: a) share scientific knowledge and foster research, and b) engage all relevant parties to explore a holistic approach to TRWP mitigation options.

From the first year of collaboration emerged the following priorities for action:

- Working on methodologies to develop a test for the tyre abrasion rate
- Creating incentives for consumers towards positive driving behaviour
- Addressing knowledge gaps
- Developing a permanent platform to share and disseminate knowledge
- Identifying hotspots to facilitate the launch of regional pilots
- Launching awareness raising campaigns

Overall, action on TRWP pollution will need to be embedded in larger policy frameworks and will require a combination of several policy instruments: regulatory measures may be employed to regulate substances of concern or to introduce requirements for tyre abrasion, together with economic instruments (e.g. to influence individual behaviour, and to fund the costs of mitigation and end-of-pipe capture) and information schemes.

From a policy perspective, a strategic way of approaching the issue is to firstly focus on *"no-regret policies"* and technological solutions which may mitigate TRWP pollution by exploiting synergies with other policy concerns such as environmental, climate and safety issues. For instance, policies supporting the wider uptake of eco-driving practices to reduce GHG emissions, non-exhaust emissions and their impact on air quality, and to improve drivers' safety, may also contribute to reducing the emission of tyre particles into surface waters. Similarly, policies aimed at reversing trends towards heavier vehicles can reduce fuel consumption, mitigate the impact of road traffic on air quality, while contributing to TRWP mitigation.