EUROPEAN TYRE & RUBBER manufacturers' association

2018/09/28

CARDNO CHEMRISK/DELTARES STUDY ON TYRE AND ROAD WEAR PARTICLES ENVIRONMENTAL FATE ASSESSMENT

KEY MESSAGES

Objective and scope

- Several studies addressing the quantification of tyre and road wear particles generated by road transport in EU Countries concur to indicate that approximately 1 kg/person/year of tyre tread particles are lost during vehicle use. This quantifiable mass has prompted **questions about the fraction of tyre and road wear particles (TRWP) that may reach the marine environment.**
- In this context, **ETRMA proactively launched a study**, in March 2017, **to build knowledge about TRWP fate and transportation up to the estuary and their potential contribution to microplastics in the marine environment**.
- The study design and results have been evaluated by a scientific advisory board composed by experts from the Technical University of Berlin and INERIS (Institut National de l'Environnement Industriel et des Risques).
- In September 2018, the results of the final report on TRWP environmental fate assessment have been published on the **peer-reviewed journal *Science of the Total Environment*.**[1,2]

Methodology

- While plastics are generally characterized as having "low" densities, microplastics particles have different densities below or above that of freshwater (~1 g/cm^3). Available literature show that, due to the aggregation of rubber and asphalt matters, **TRWP have a density of** ~1.8 g/cm^3 **higher than water** this, along with other factors such as particle size (5µm to 350µm) and shape, particle settling, environmental degradation and weathering processes, biofilms etc, **affects the mobility of the particles in the different environmental compartments**.[3]

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[1] K.M. Unice, M.P. Weeber, M.M. Abramson, R.C.D. Reid, J.A.G. van Gils, A.A. Markus, A.D. Vethaak, J.M. Panko. Characterizing export of land-based microplastics to the estuary - Part I: Application of integrated geospatial microplastic transport models to assess tire and road wear particles in the Seine watershed. Science of the Total Environment, Volume 646, 2019, pp. 1639-1649. https://authors.elsevier.com/a/1Xj-3B8ccgcq~

[2] Unice K.M., Weeber M.P., Abramson M.M., Reid R.C.D., van Gils J.A.G., Markus A.A., Vethaak A.D., Panko J.M. 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, 2018. Volume 646, 2019, pp 1650-1659. https://authors.elsevier.com/a/1Xj-3B8ccgdqu

[3] Kreider, M.L., Panko, J.M., McAtee, B.L., Sweet, L.I. and Finley, B.L., 2010. Physical and chemical characterization of tire-related particles: Comparison of particles generated using different methodologies. Science of the Total Environment, 408(3), pp.652-659.

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- Differently from other microplastics particles, TRWP particles cannot be univocally identified, also in consideration of the complex nature and variety of factors influencing its composition. Based on recent lab-scale studies, the mineral encrustation fraction from the road surface within TRWP is estimated to be approximately 50% w/w while the original polymeric fraction of TRWP is estimated to be approximately 25%.
- Since **a large number of factors contributes to the fate and transport of TRWP**, Cardno ChemRisk and Deltares have developed an integrated modelling approach to estimate the fate of TRWP from formation on roadways to transport to the estuary environment.
- This study adopts a sophisticated approach **at a watershed scale** (Seine and the Scheldt basins have been selected as representative watersheds). The model owe its robustness to the fact that the actual hydrological conditions could be considered (by using the E-HYPE European-scale hydrology model). The hydrological model has been integrated with a mass transport model (the open-source Delft3D-WAQ water quality model).
- The study shows the results of the mass balance for **several scenarios** varying most relevant parameters affecting the fate and transportation of the particles in the freshwater. The key parameters were identified through a **sensitivity analysis** and then, based on the results, they have been simultaneously varied to derive the **probabilistic distribution of the results**.
- This is why this study is **closer to environmental reality** in the approach and in the results compared to most of the studies published so far which are mainly based on theoretical calculations not taking into account the transportation phenomena.

Results

- The results of the probabilistic model indicate that **only 2% to 5% of TRWP released may reach the estuaries.**
- The **most important parameters** affecting the transportation of the TRWP to the estuary are their **diameter and density.**
- The results demonstrate the **potential for appreciable capture and retention of TRWP prior to reaching the freshwater or even the estuary**.
- **Soil and freshwater sediments result to be important compartments** that prevent the release of TRWP to marine waters for the watersheds analysed. In particular, the **trapping efficiency of** TRWP in freshwater results to be most likely about **90%** and this is supported by the comparison with the average concentration of TRWP measured in the Seine sediments.
- The results on the **trapping efficiency of TRWP in freshwater sediments** are supported by the comparison with the average concentration of TRWP measured in the Seine sediments[4]. The Seine has been selected as one of the two considered watersheds in order to **support the model outcome with observations in river sediments.**

[4] Unice, K.M., Kreider, M.L. and Panko, J.M., 2013. Comparison of tire and road wear particle concentrations in sediment for watersheds in France, Japan, and the United States by quantitative pyrolysis GC/MS analysis. *Environmental science & technology*, *47*(15), pp.8138-8147