Estimation of tyre and road wear particle emissions in urban aquatic systems

Victoria Gutiérrez Domínguez[a*], Prof. Alistair Boxall[a], Dr. Colin McClean[a]

[a]Department of Environment and Geography, University of York, Heslington, York, YO10 5NG, UK

*Contact email: vggd500@york.ac.uk

INTRODUCTION

- Tyre abrasion as a result of the contact between vehicle tyres and the road has been identified as a major **source of secondary microplastics** in the environment.
- These particles can be transported by rainwater runoff into sewers and surface waters causing **toxicity to aquatic organisms.**

AIM OF THE PROJECT

The general aim of this study is to **assess exposure** to tyre and road wear particles (TRWP) in urban aquatic systems by analysing their emission pathways and fate processes at high spatial and temporal resolution.

Initially, the city of York in the UK was used as a case study. These findings may help to have better management in the future and an improved road run-off treatment.

METHODOLOGY

- ✓ The traffic data for the city of York was downloaded from the UK Department of Transport (https://roadtraffic.dft.gov.uk/local-authorities/202) and the city of York Council (https://www.york.gov.uk/).
- ✓ The wear and tear was calculated using the **specific emission factors per vehicle-km method** for urban roads.
- ✓ For the estimation of TRWP emissions in the city of York a high-resolution modelling approach developed in Matlab software (MATLAB ver. R2018a) was implemented.

MATLAB

Key factors presented in this model approach:

- ➢ Uses a bottom-up mechanistic approach **(source-pathway-receptor).**
- ➢ Provides highly resolved local exposure patterns.
- ➢ Accounts for local temporal variations in emissions **(rainfall events).**
- ➢ Full characterization of anthropogenic factors such as, **sewage systems** and **waste water treatment plants**.
- ➢ Division of the study area into sub-catchments (considered here as **hydrological zones**) and the urban aquatic systems into **river sections** (RS). These Hydrological zones (HZs) were delimited taking into account all the sections of the city´s sewage network, therefore, the pollutants emitted in each HZ will be discharged into their corresponding river section.

PRELIMINARY RESULTS

- The total amount of TRWP emitted in the city of York was **108.71 tonnes/year** (TRWP emission per capita 0.50 kg/year).
- Total emission of TRWP to York's river system over the simulated year was **55.65 tonnes/year** (Fig. 1).

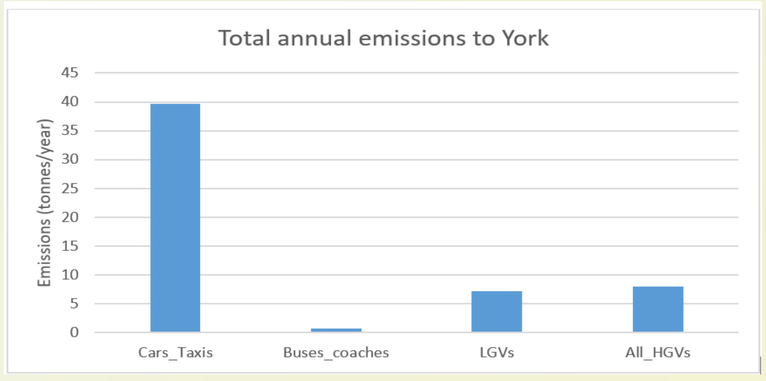

Figure 1. Estimated total emissions of TRWP to York's river system during the year 2017 for Cars and Taxis, Buses and coaches, Light good vehicles (LGVs) and Heavy good vehicles (All_HGVs).

The river sections receiving the highest runoff emissions are OUSE1, OUSE5 and FOSS3, whereas the lowest emissions are OUSE3 and FOSS2 (Fig. 2).

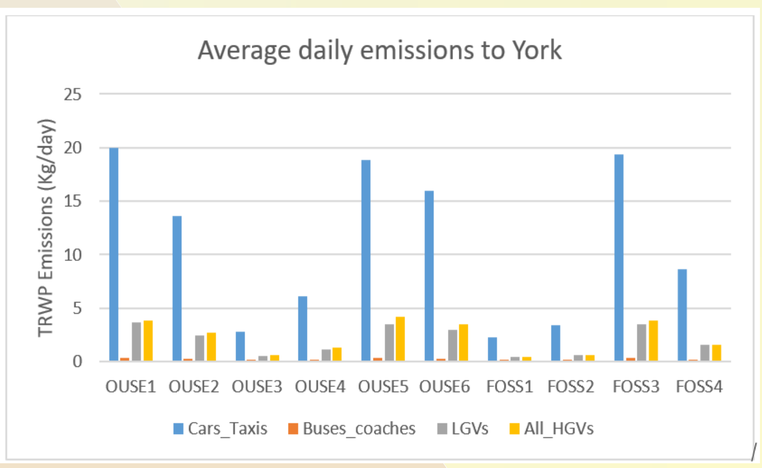

Figure 2. Mean daily emissions of TRWP to York's river sections (OUSE1, OUSE2, OUSE3, OUSE4, OUSE5, OUSE6, FOSS1, FOSS2, FOSS3 and FOSS4) during the year 2017 per vehicle type (Cars and Taxis, Buses and coaches, Light good vehicles (LGVs) and Heavy good vehicles (All_HGVs).

Spatial variation of emissions

The highest TRWP emissions concentrate in the Northeast and Northwest of the city (hydrozones HZ8 and HZ1 respectively) with also high contributions from the South (H12) (Fig. 3)

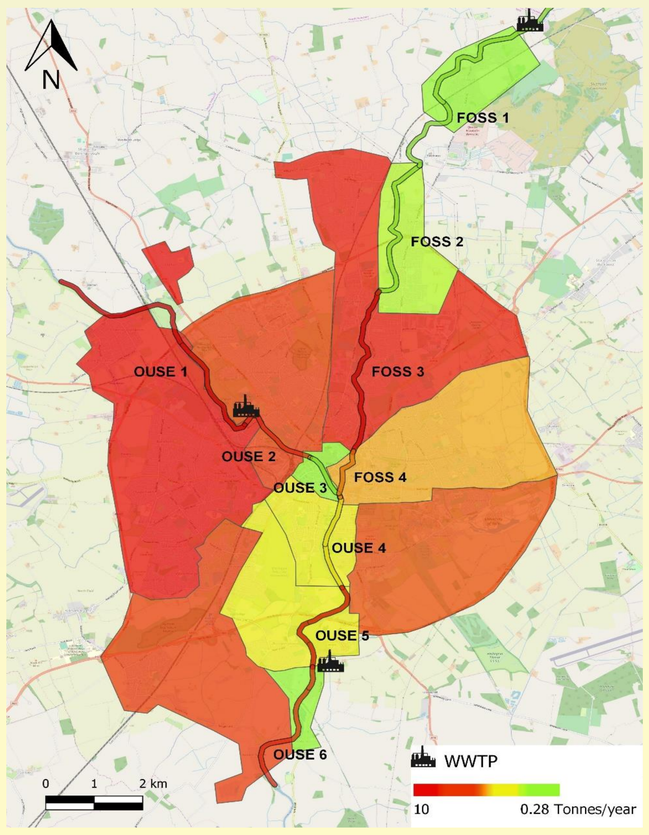

Figure 3. Total estimated emissions in Tonnes to York for the year 2017 per Hydrological zone and River section.

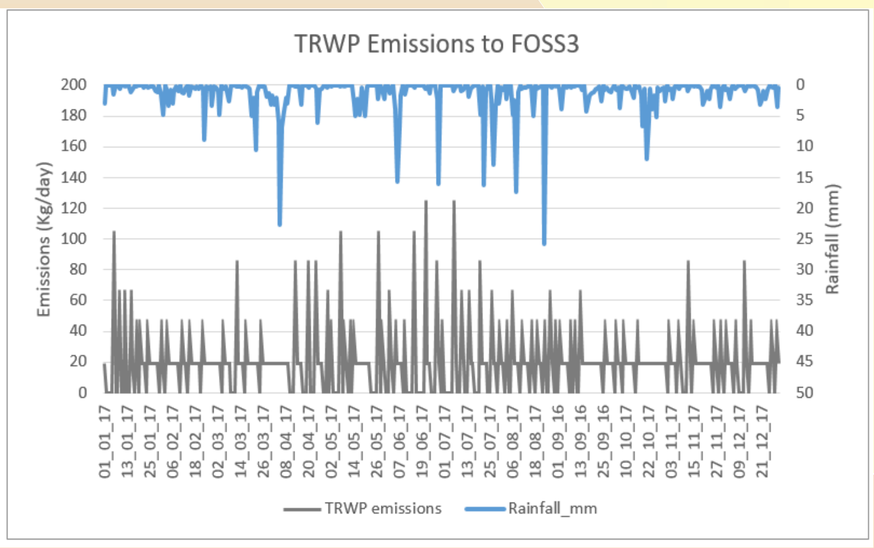

Figure 4. Daily TRWP estimated emissions for the RS FOSS3 over the year 2017 in kg (in grey) and the rainfall pattern for the same year (plotted in blue in the secondary axis).

Temporal variation of emissions

Run off emissions vary proportionally to the rainfall frequency for traffic emissions.

Dry days = zero emissions.

Rainy days = the influence of the runoff pattern is predicted and higher emissions peaks are expected. (Fig. 4).

FUTURE WORK

The next step in the project is to implement an integrated time– and spatially-resolved surface water fate model proposed by Domercq et al., (2018) to assess the transport and fate of TRWP in the York river system.

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