Detection of tire rubber particles from a football field in an urban estuary

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INTRODUCTION

- Tire rubber particles are a major constituent of microplastics in the environment
- In addition to rubber dust from tire wear, discarded tires downcycled to granulates used on sports fields as shock-absorbing infill are a major source (Fig. 1)
- Different tires can have different rubber and additive compositions, making detection and quantification of tire rubber in environmental samples challenging
- Several rubber marker combinations have been developed to enable comparisons of different tire materials

Figure 1: Tire rubber granulates from a football field spread into the environment

Figure 2: Map of the study area and sampling stations A-D

MATERIAL & METHODS

- The presence of tire rubber particles from a football field point source was investigated in sediments of a nearby estuary at four stations (A-D) with increasing distance from the field (Figs. 2, 3)
- Triplicate sediment samples and rubber dust from the football field (F) were freeze-dried and sieved to <500µm
- In addition, average rubber concentrations in the local granulate (G) were compared to a SBR1500 reference material
- All samples were analyzed with PYR-GC/MS without further pre-treatment for the following markers: **M4**: benzene, methylstyrene, ethylstyrene, & butadiene dimer; **M3**: methylstyrene, ethylstyrene, & butadiene dimer; **butadienes**: butadiene dimer, SB dimer, & SBB trimer; and the single marker **4-VCH**
- Technical replicates (n=8) were analyzed to establish marker signals for the different materials and the average rubber concentration in the local granulate (G), compared to a SBR1500 reference material

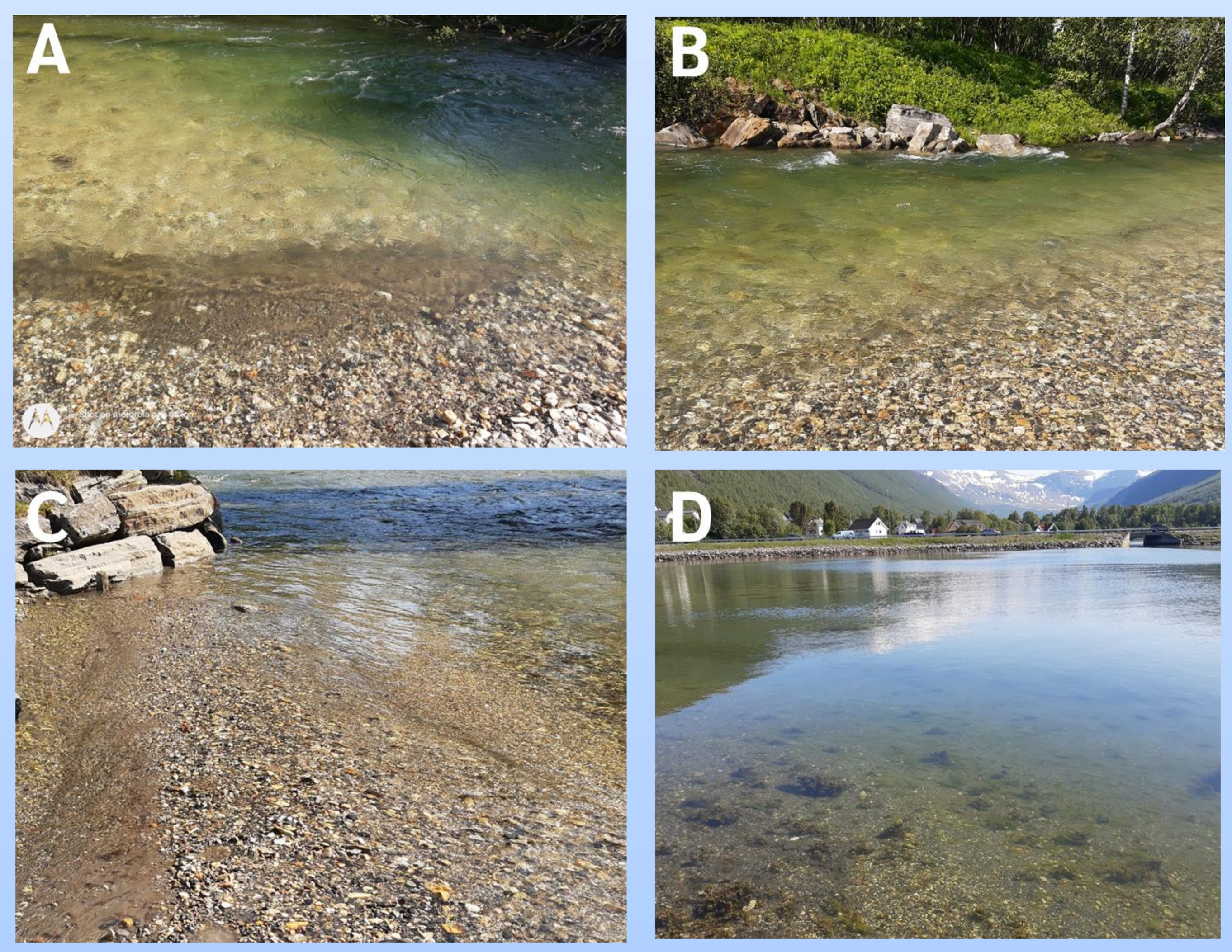

Figure 3: Sampling stations in Tromsdalen river estuary

RESULTS & DISCUSSION

Rubber concentrations in the pure tire granulate (G), shown in Fig. 4 (right panel), were an order of magnitude higher than in the dust from the football field (F). Except for VCH, which indicated much lower concentrations of rubber overall, the three markers Butadienes, M3, and M4 showed similar patterns across sampling locations.

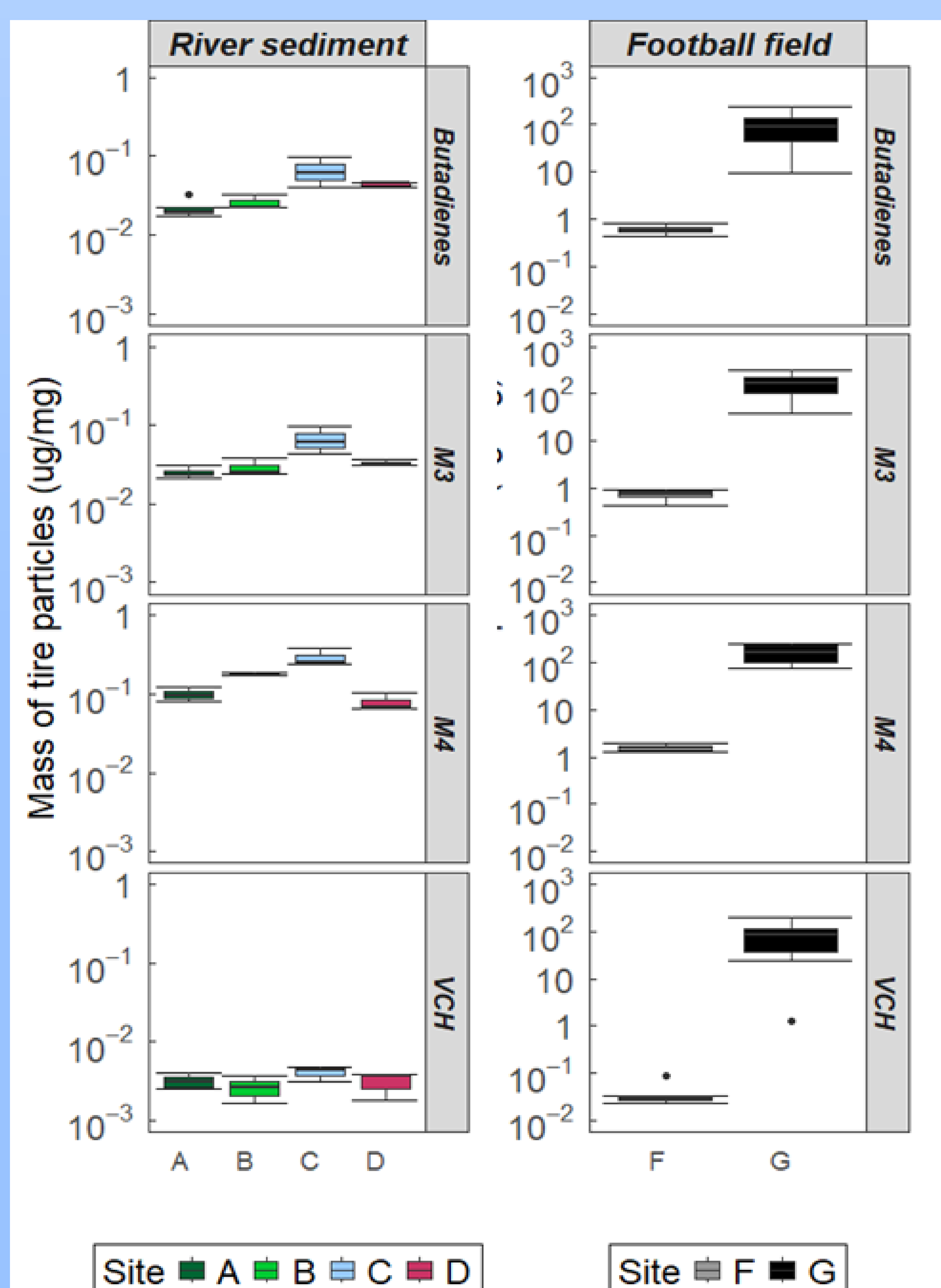

Figure 4: Boxplot showing mass concentrations of tire particles in the river sediments (stations A-D, left panel) and from the football field (right panel); football dust (F) and tire granulate (G).

Contrary to the expectation that the rubber levels would follow a decreasing trend with distance from the football field, station C had the highest rubber concentrations, while stations A and D had the lowest values. Station B had varying rubber levels compared to the other stations depending on the marker. Since we could not discern rubber from the football field and contamination with tire wear particles from adjacent roads, especially E6 with high traffic densities, it is possible that the values at station C reflect additional tire rubber sources. More field replicates need to be analyzed to confirm the observed distribution patterns.

Figure 5 shows a multivariate PCA analysis of the marker distribution in all samples, including a SBR1500 reference material. The sediment samples and the dust samples from the football field are somewhat different possibly due to increased weathering in the sediments, but cluster together due to high levels of benzene (Fig. 5), while the SBR1500 reference material shows a more homogeneous composition of all markers. The tire granulate likely represent particles from different tires as they show a wide-spread across rubber markers.

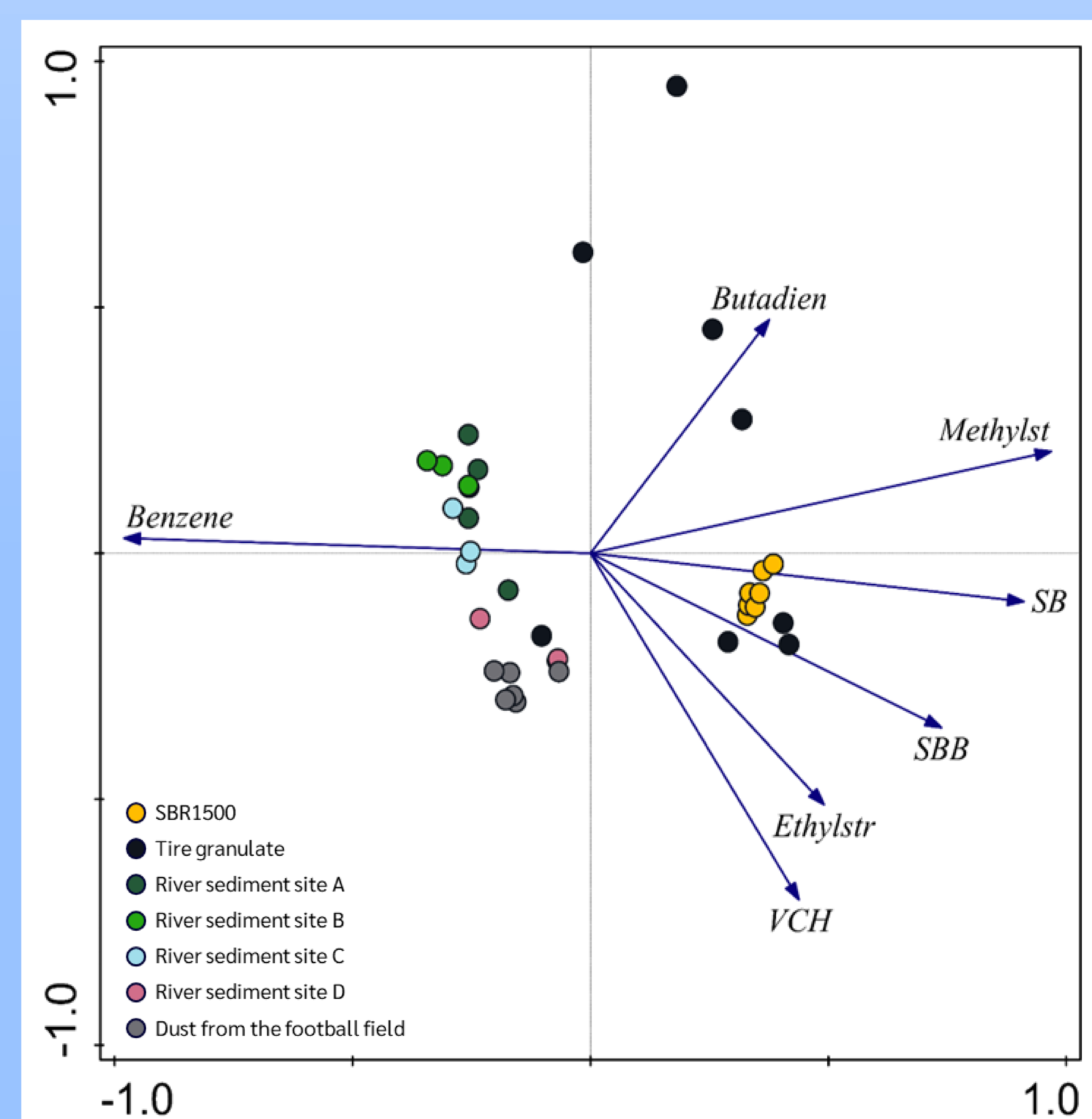

Figure 5: Principal components analysis (PCA) using the percentage contribution of each pyrolysis marker to look at grouping and distribution of different sample types.

CONCLUSION

Tire rubber was detected in the sediment samples and the chemical signature resembled that of rubber from football field dust. The results point to additional environmental sources of benzene in the field samples, suggesting the need for pre-treatment to remove these before the PYR-GC/MS analysis. Here, we removed benzene altogether and used the M3 marker combination to reduce the impact of additional benzene sources.

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