Methods for measuring and modelling plastic transport and accumulation in large rivers

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Measurements

- Plastics consist of different polymers that can be buoyant, neutral, or sink (Anderson et al., 2016; Cole et al., 2011)
- Higher density polymers with added mineral fillers
- Plastic particles change in size and density by aggregation or by the growth of biofilms
- \(\rightarrow\) A methodology addressing multiple depths is needed (comparable to suspended sediment sampling) (Haimann et al., 2014)
Measurements - New device

• New device was constructed for collecting measurements in medium- and large-sized natural streams

• High flow velocities and turbulence provide a demanding environment especially when handling large-sized nets

• Adapted basket sampler (BfG sampler) currently used by the Federal Institute of Hydrology in Koblenz, Germany
• Example multi-point measurement (Danube, Hainburg); 13.01.2015 at a discharge of 3.392 m³ s⁻¹; Plastic conc. [mg/1000m³] is displayed for each net
Yield Hainburg (micro-plastic) in an average year < 20 t/a (may vary drastically depending on flow conditions and flood events)

- Micro-plastic transport at Hainburg at average discharge values: 15 - 80 kg/d
- more measurements are needed!!
A relevant quantity of microplastic in rivers can be explained by plastic passing waste water treatment plants.

Measured microplastic:
96 - 320mg/1000m³
Modelling - Accumulation Zones

- 3D numerical model
  Haslau (2,5 km)

- 3D numerical model
  Wildungsmauer-Witzelsdorf (4,2 km)

- 2D large scale model
  Vienna-Bratislava (25,6 km)
Modelling – 3D Water age based on particles

Water age

- 980 m³/s
- 1930 m³/s
- 3000 m³/s
Modelling – 2D Large Scale model – Particle movement

Particle Tracing (2D) – Innundation area
Modelling – shore line splash zone

Characterisation of accumulation zones

- Bank near/shore line accumulation
- Classification of discharge periods based on 25% and 75% quartiles

Autumn & Winter: Q1000 – Q2000

Spring & Summer: Q1450 – Q2850
Numerical Model

- Flood plain accumulation
  - High accumulation potential related to specific discharge
  - Decreasing accumulation potential depending on the distance from the outflow caused by filtration effect of vegetation

Specific discharge (m³/m²) in the inundation area Haslau at Q6000 m³/s
Schematic model – First results

Q: 1800 m$^3$

MQ: 1930 m$^3$

Q: 3000 m$^3$
Conclusions

• New device was developed for measuring plastic transport at multiple depths in medium and large natural streams

• The methodology is applicable and leads to profound results (Liedermann et al., 2018)

• Comparably measured data from other Rivers would be interesting!

• Plastic transport at the Danube varies between 15 to 80 kg / day; Yearly loads at Hainburg (micro-plastics) in an average year < 20 t/a

• A relevant quantity of micro plastic in rivers can be explained by plastic passing waste water treatment plants

• Particle movement can be reproduced by numerical models

• Hydrodynamic modelling serves as a perfect tool for explaining acculmation zones and finding particle paths (where does it come from, where does it go?)
Thank you for your attention!