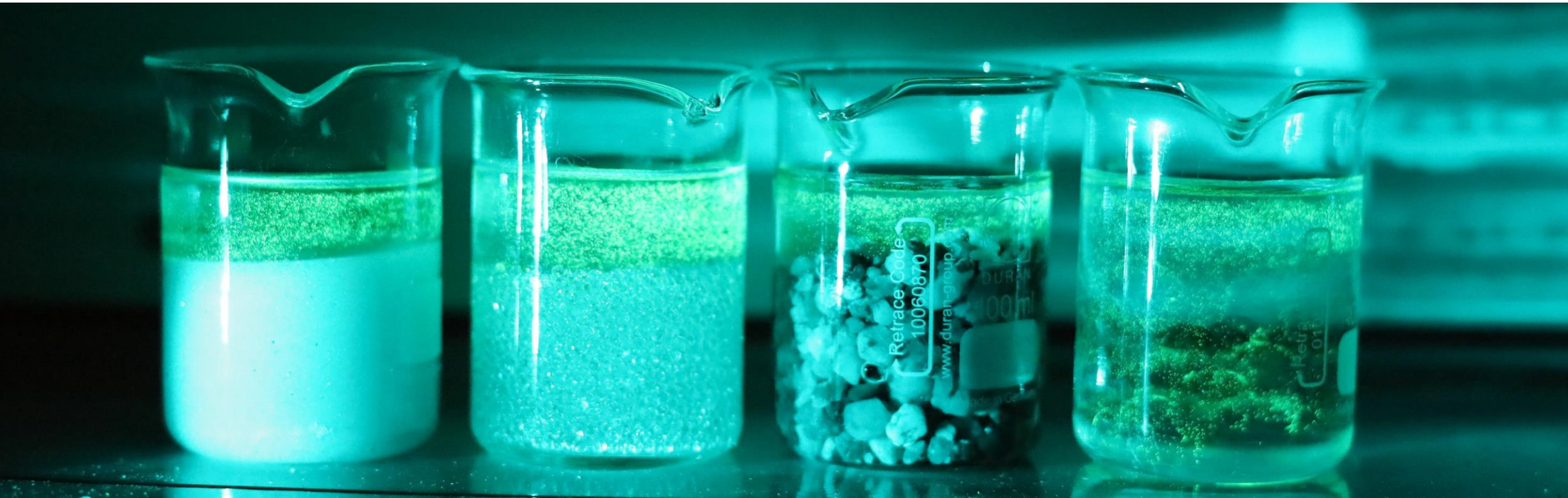
An experimental investigation of microplastic transport in fluvial systems

ITS2.7/HS12.2 Plastic in Freshwater Environments
D2401 – EGU 2020-3331

Jan-Pascal Boos,
Benjamin-Silas Gilfedder,
Hassan Elagami,
Sven Frei
Department of Hydrology, University of Bayreuth

jan-pascal.boos@uni-bayreuth.de



Motivation

- Microplastic (MP) is not only transported by rivers, but also retained in regions of lower current, leading to an accumulation in the streambeds
- Insight into the mechanisms of microplastic transport in a streambed is scarce, but needed for an assessment of MP effects on the environment, e.g. benthos

Research Objective:

- Understand the fundamental mechanisms of microplastic transport and retention in an open channel flow and the hyporheic zone

Research Goals:

- Behavior of microplastic particles under turbulent flow conditions
- Infiltration of MP into the sediment
- Mobility of MP in hyporheic sediments

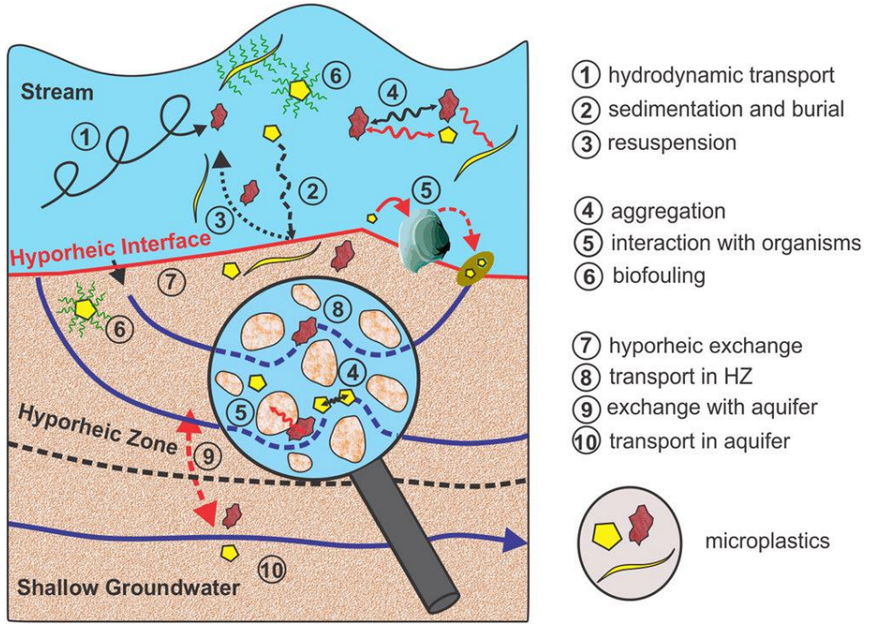


Fig 1: Mechanisms of MP transport in fluvial systems (Frei et al 2019)

Experimental Approach

- Recirculating flume
- Velocity measurement:
  Particle Image Velocimetry (PIV), Laser Doppler Anemometry (LDA)
- Particle Detecion (spatio-temporal)
  Fluorescence-Camera-System, Concentration measurement (fluorometer)

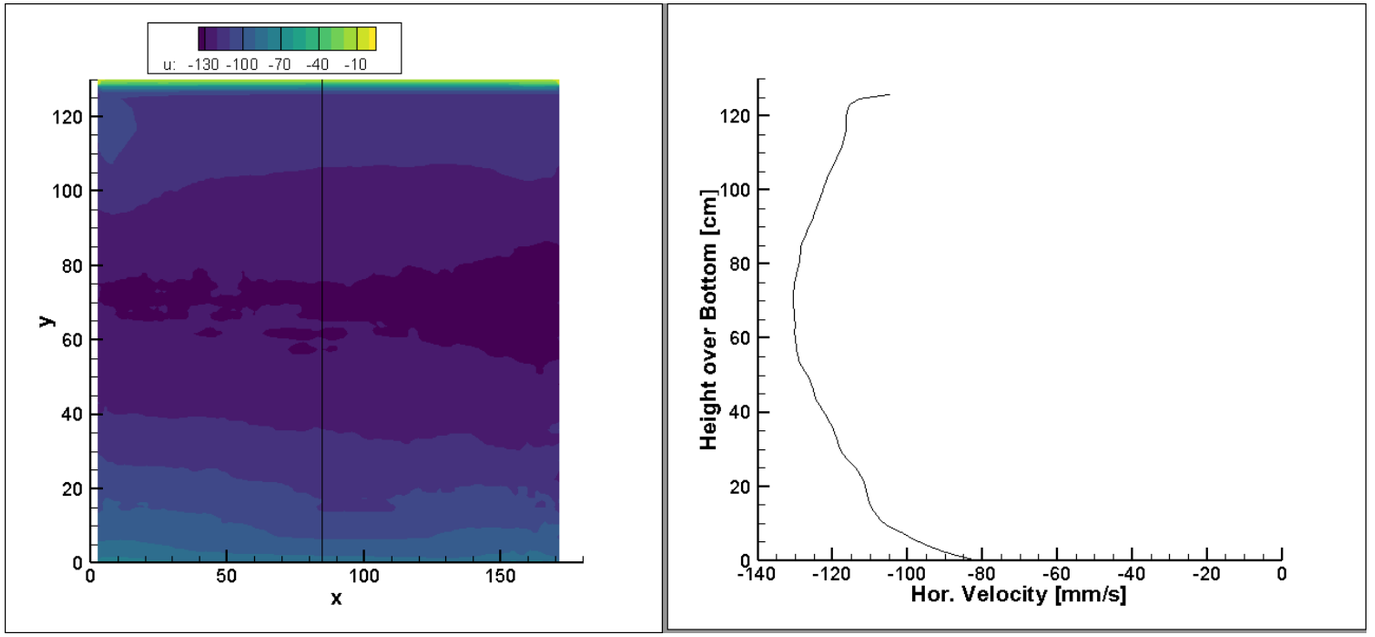


Fig 2: Exemplary velocity field (PIV) and profile for hydrodynamic analysis

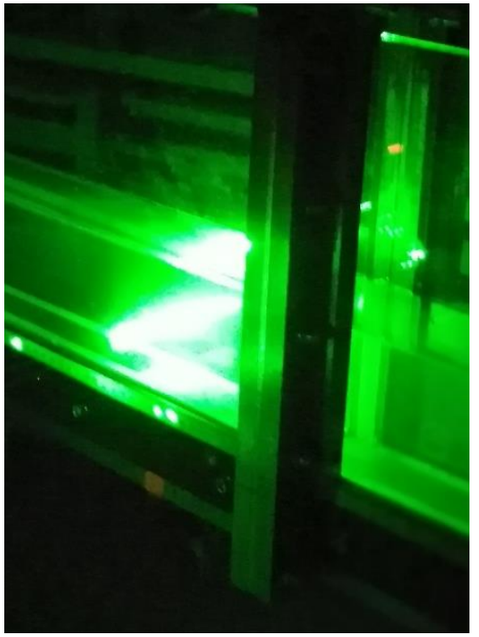


Fig 3: LDA

Preliminary Results

Fig 4: Darcy flow through porous media transports MP

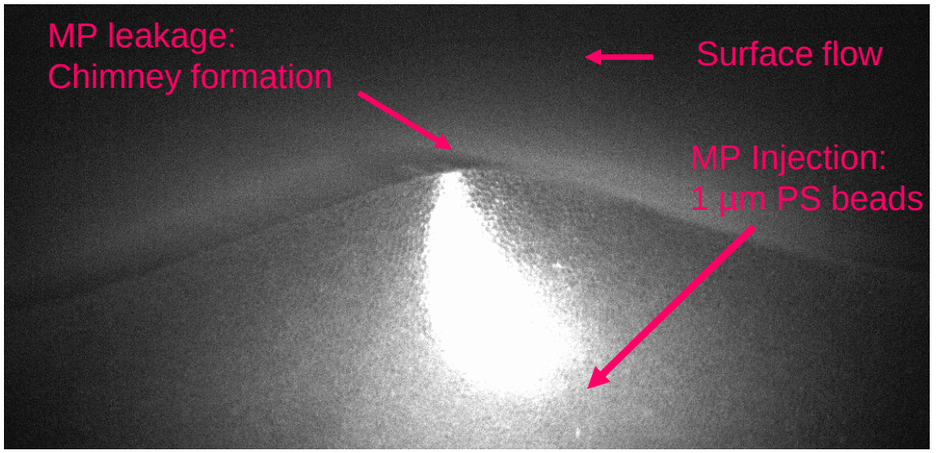


Fig 5: MP follow subsurface flow after injection into the sediment

- MP are mobile in the hyporheic zone
  Transport depends on:
  - Driving force: hydraulic gradient in riverbed pressure distribution
  - Properties of the porous medium: diameter (relative to MP), permeability
- MP are (temporarily) removed from the stream
  Sedimentation on streambed surface (gravitational)
  Interaction with porous medium (phisico-chemical filtration)

Outlook: Quantitative Work with MP

- Methods of quantitative detection of microplastic particles in a flume environment are being developed (particle abundance $\approx 10^6/\mathrm{L}$)
- Example: Preparation of MP solutions with a defined concentration

  Problem: Hydrophobicity causes surface adhesion, reducing concentration

  Preliminary results:
  - MP „loss“ during pipetting in the order of 1 ‰
  - Continuous control of stock solution advisable

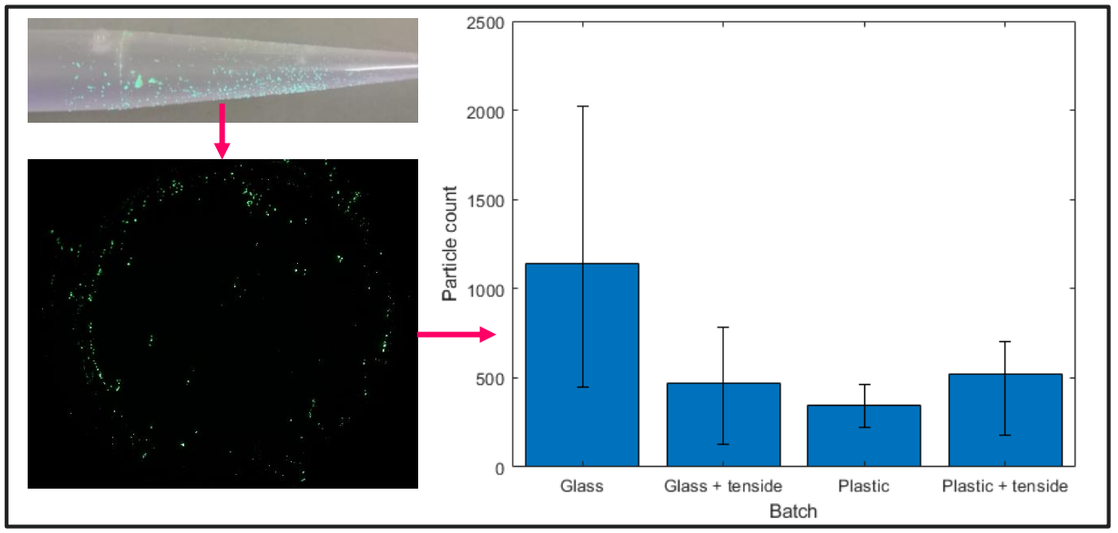


Fig 6: MP „loss“ during pipetting: surface adhesion, filtration and particle counting

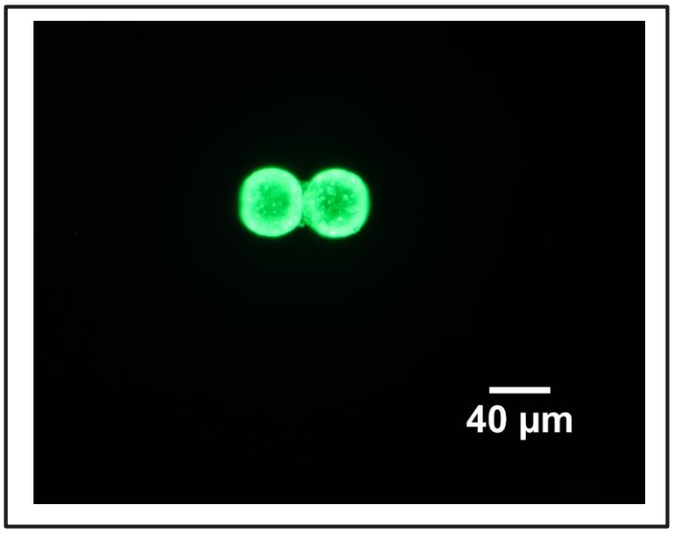


Fig 7: PS beads, under fluorescence microscope