Experimental investigation of microplastic residence times in lake systems during thermal stratification and lake turnover

Hassan Elagami*†[1,2], Sven Frei[1], Jan-Pascal Boos[1], Gabriele Trommer[3], and Benjamin-Silas Gilfedder[1,2]

[1]Department of Hydrology – Universitätsstr. 30 95447 Bayreuth, Germany
[2]Limnological Research Station – Universitätsstr. 30 95447 Bayreuth, Germany
[3]Water Management Office Ansbach – Dürrnerstraße 2 91522 Ansbach, Germany

Abstract

Microplastic residence time in a lake water column is a key factor controlling the uptake probability by lake organisms. In this work, we used a series of in-lake mesocosm experiments combined with random walk modeling to qualify microplastic residence time in the lake water column. Three sizes of fluorescent microplastic (1-5, 28-48, and 53-63 μm) were added to the mesocosm in pulses and detected using in-situ fluorescence detectors. Experiments were conducted over one year capturing thermally stratified and unstable conditions within the mesocosm. The residence times calculated from the detected microplastic concentrations in the mesocosm ranged between _˜1 and 24 days. The modeled residence times for the smallest particles during summer were close to the actual residence in the mesocosm. During lake turnover in autumn, the actual residence time of the 1-5μm particles was significantly lower than that during summer. The model has failed, however, to fit the actual residence time in the mesocosm in the autumn. This is likely to be attributed to the instability in the water column during autumn, which seems to be more complex than the highly simplified modeling of lake physics.

Keywords: microplastics, settling velocity, residence time, turbulent mixing, lake turnover

*Speaker
†Corresponding author: hassan.elagami@uni-bayreuth.de