# Session: Biofilm ecology and ecotoxicology

## The role of biofilms for phosphorus removal in fluvial ecosystems: concentration- and time-dependent processes

Nuria Perujo[1], Lola Neuert[2], Markus Weitere[1], Patrick Fink[3]

*[1]Department of River Ecology, Helmholtz Centre for Environmental Research – UFZ, Magdeburg, Germany*

*[2]Department of Geography - Ludwig-Maximilians-Universität (LMU), München, Germany*

*[3]Department of River Ecology, Helmholtz Centre for Environmental Research – UFZ, Magdeburg, Germany, Department of Aquatic Ecosystem Analysis and Management, Helmholtz Centre for Environmental Research – UFZ, Magdeburg, Germany*

Microbial biofilms play a key role in phosphorus (P) removal from aquatic ecosystems through P immobilization in sediments. Within-biofilm P processes occur both intracellularly (i.e. P used for growth and P stored as polyphosphates) and extracellularly (i.e. P entrapment in extracellular polymeric substances -EPS- and mineralization of organic phosphorus by extracellular enzymes). We expect P removal efficiency to follow a sigmoidal function with a threshold (i.e. P supply concentration) which differentiates a zone of sustainable P supply concentrations from a zone of non-sustainable P supply concentrations and at which the P removal efficiency of the system decreases. However, specific knowledge on the relative importance of the within-biofilm P processes on the P removal efficiency and their P thresholds are still scarce. We performed an experiment in bypass flumes to the Holtemme River (Germany) to study tipping points and thresholds for P retention in mixed biofilm communities from river sediments. Experimental flumes were filled with sediment and after biofilm colonization, a gradient of P addition concentrations (from 25 µg P/L to 420 µg P/L) was applied.

Our results showed that relative P removal was time-dependent and small P additions ($\Delta P \approx$ 20 µg P/L) caused a subsidy effect. However, when surpassing this threshold ($\Delta P >$ 20 µg P/L) relative P removal efficiency in the flumes decreased. P threshold for the ecosystem function (i.e. water purification by P removal) was not the same as for the within-biofilm P retention processes. P accumulation in the biofilm followed a positive polynomial function which increased at intermediate levels of P addition ($\Delta P \leq$ 150 µg P/L) together with bacterial density. Other mechanisms such as luxury polyphosphate accumulation followed a negative polynomial function decreasing at intermediate levels of P addition ($\Delta P \approx$ 150 µg P/L). In terms of extracellular processes, alkaline phosphatase activity followed a negative exponential function which already decreased at small levels of P addition ($\Delta P \approx$ 20 µg P/L), indicative of high P availability in the ecosystem. Similarly, EPS followed a negative logarithmic function already decreasing at small levels of P addition ($\Delta P \approx$ 20 µg P/L). Our results demonstrate that (a) within-biofilm P retention processes respond differently to P concentrations and (b) P thresholds for biofilm processes do not necessarily coincide with thresholds for ecosystem function.