Biostabilization of fine sediments in reservoirs – a manipulative experiment to address the hydraulic impact

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Introduction: Reservoirs, in particular those providing access to clean water and green energy, will become more important in the near future due to demographic and climate changes. Profound knowledge on the erosion, transport, deposition and consolidation cycle (ETDC) of fine sediments will greatly assist in exploiting, tackling and minimising the effects of ongoing siltation within reservoirs. Recent studies confirmed the importance of organic compounds and in particular of the microbially-produced mucilaginous matrix of extracellular polymeric substances (EPSs) in changing the erosional response to hydraulic forcing within cohesive and mixed intertidal as well as riverine sediments (Gerbersdorf and Wieprecht 2015). Thereby, it is important to note that this microbial biostabilisation is not restricted to the very surface but impacts the mechanical properties of much deeper layers by mutual feedback mechanisms between bacteria, EPSs and consolidation processes Nevertheless, until now, biostabilisation is hardly addressed within reservoirs. This paper addresses the first manipulative experiment to show the biostabilisation potential of microbial communities within reservoirs under varying hydrodynamic conditions.

Methods: Natural biofilm were grown in novel flumes (DFG project GZ GE 1932/1) on glass beads (resembling fine sediments) under controlled conditions of light, temperature and turbulence. 200L of reservoir water were collected from the Schwarzenbach reservoir on 13th July 2016, Germany, to serve as an inoculum for each 3m recirculating flume (x6). The flow velocities within the reservoir are generally low (~0.00-0.04 m/s) during dry summer periods, therefore the minimum detectable velocities (0.51 ± 0.06 L sec-1) were maintained in the flumes during the initial biofilm development phase (42 days). Strong and weak biofilms were selected randomly from each individual flume on day zero for biochemical and adhesion measurements prior to the hydrodynamic treatment and subsequently periodically over the next 28 days after alteration to the hydrodynamic conditions. After data collection on day 0, the discharge was increased to a high discharge rate (2.25 ± 0.04 L sec-1) in three random flumes and allowed to equilibrate for 24 hours before sampling on day 1. The remaining three flumes were maintained at a low discharge (LF; 0.51 ± 0.06 L sec-1). Small cut-off syringe cores (0.3 cm3) were used to extract replicate samples from the top 4mm of sediment. Five small cores were collected from each cartridge as 'technical' replicates, homogenised and divided into separate Eppendorf tubes for further extraction and processing (e.g. extracellular polymeric substances (EPS), microalgal biomass, bacterial cell numbers and microbial community). During the experimental time, biostabilisation was closely monitored measuring biofilm adhesion and sediment stability by MagPI (Magnetic Particle Induction).

Results: The results are still largely under evaluation and the presentation will then give details on adhesion measurements, EPS data as well as the diversity of the microbial community during growth period and hydrodynamics treatment.

Discussion: The biostabilisation potential of reservoir sediments has been proven to be significant (by preliminary MagPI data available) and the influence of varying hydrodynamic conditions can be clearly seen.

Conclusions: The stabilizing effect of biofilms upon lotic fine sediment is currently unaddressed in reservoirs despite its broad range of economic and ecological implications. Reservoir managing (ranging from daily basis up to extreme events such as flushing) should take the biostabilisation potential into account to maximize their efforts in decreasing siltation or optimizing the removal of sediments where necessary.

References: [1] Gerbersdorf and Wieprecht (2015) *Geobiology*: 68-97;