Geophysical Research Abstracts
Vol. 19, EGU2017-14773, 2017
EGU General Assembly 2017

A floodplain mesocosm study: Distribution, mobility, aging, and functioning of engineered silver nanoparticles at the aquatic-terrestrial interface

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With increasing use of engineered nanoparticles (ENPs) in different commercial products the risk for their release into the environment is continuously increased. The aging, distribution, mobility, biological availability, and ecotoxicological impact of ENPs in aquatic and terrestrial compartments will be influenced especially by the natural dynamics of meadow areas, which represent a sensible zone between these two compartments. In this study we present a newly developed floodplain stream mesocosm system linking aquatic and terrestrial aging of ENPs in one system. Using this system we investigated the distribution, mobility, and biological effects of silver nanoparticles (Ag NPs) at the aquatic-terrestrial interface. The mesocosm consists of a main channel, floodplain area, and transport columns simulating an aquatic compartment with river bed, aquatic-terrestrial transition zone, and terrestrial area, respectively. The system contained water sampled from the River Rhine, quartz sand as sediment phase and natural repacked soil from a Rhine floodplain. Every 3 weeks floodplain area was flooded for four days by increasing the water level in the main channel. The dispersions of Ag NPs were injected into the main channel as a pulse function with the pulse duration of 3 weeks and interval of 3 weeks between pulses. The biological effects of Ag NPs on the benthic organism *Gammarus fossarum* were evaluated in the bioassays during and between the Ag NP pulses. The total duration of the experiment was 33 weeks. The results of mesocosm experiments showed a fluctuating but successively increasing concentrations of total silver in the aqueous phase. At the end of the experiment 0.5% of the silver was still available in the aqueous phase mostly as nanoparticles. Although the major part of silver was immobilized in sediment and soil especially in their top layer, the feeding activity of *Gammarus fossarum* was not consistently affected. It is most likely due to the low concentrations of silver applied in the experiment and limited dissolution of Ag NPs. Furthermore, extremely high enrichment factors of silver were determined for leaves (up to 11000) and algae (up to 30000) suggesting possible bioaccumulation of silver in aquatic organisms feeding on leaves and algae.