

DYNAMICS OF METAL AVAILABILITY AND TOXICITY IN FLOODPLAIN SEDIMENTS

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BACKGROUND

The floodplains of the River Rhine are under reconstruction to renaturalize river habitats (see artist impression). Exposure of uncovered old sediment in new secondary channels is likely to lead to exposure of aquatic biota to metals from historic deposits. To quantify potential ecotoxicological effects, clean and polluted sediments from the Afferdensche and Deetsche Waarden (see map) were transferred to artificial streams with a continuous flow of natural river water. In this setup, redox profiles were continuously measured and changes in the availability of Cu were quantified by DGT and related to uptake and effects in benthic organisms.



Afferdensche en Deetsche Waarden, a floodplain from the river Waal (Netherlands). The coloured overlay indicates pollution of the floodplain soil, with darker colours being more polluted. Two sites were sampled: Red dot: polluted site, green dot: non-polluted reference site

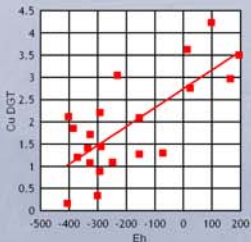
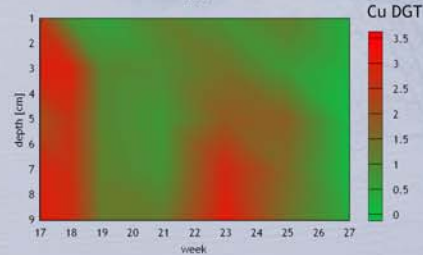
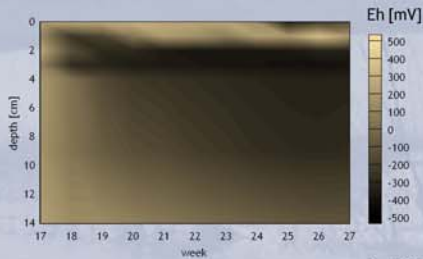


Artist impression of the reconstructed floodplain, with a newly constructed side-channel cutting through both clean and polluted layers accumulated in the floodplain soils.



Sediments with and without historic sediment pollution were transferred to outdoor and indoor incubation facilities. The outdoor artificial channels provided a continuous flow of natural river water.

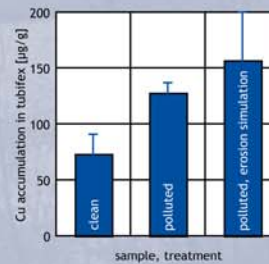
METAL AVAILABILITY AFTER FLOODING



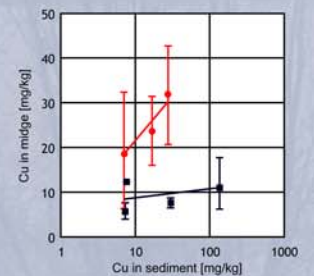
Flooding of floodplain soils causes long term changes in redox potential profiles. Top layers are quickly reduced, while in deeper layers changes occur more gradually.

The availability of copper as measured with DGT shows a consistent relationship with time and depth-related fluctuations in Eh. Already within 1 week high concentrations of total copper are immobilized and no longer available.

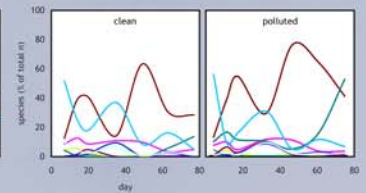
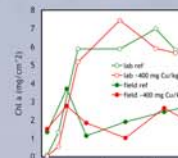
UPTAKE AND EFFECTS



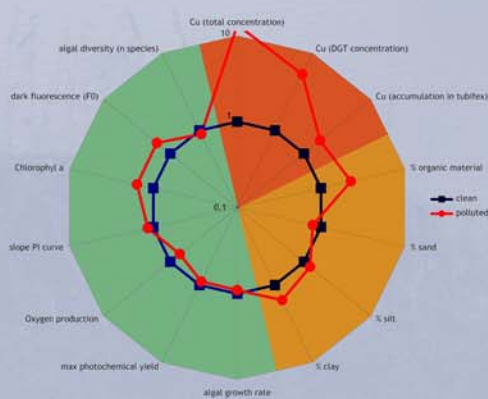
Differences in total and available copper concentrations are reflected by copper accumulation in tubifex worms. Hydrological conditions influenced accumulation: during erosion simulation more copper was accumulated.



Copper accumulation in midge larvae is influenced by algal growth on polluted sediment. More copper was accumulated when an algal biofilm developed on the polluted sediment (red line) in comparison with polluted sediment on which cultured clean algae were added before the accumulation experiment.



Sediment associated copper did not influence colonization, growth and succession of the benthic algal community, both in terms of biomass (left graph) and in terms of species composition (right graphs), or parameters directly linked to photosynthesis (see circular diagram).



Overview of results: polluted sediments (red line) compared relatively to clean sediments (blue line). Similar sediments from the same floodplain (orange segment) differed in metal concentrations and uptake in fauna (red segment), but no effects on functional and structural characteristics of the benthic algal community were observed (green segment).

CONCLUSION

The availability of copper in floodplain sediments shows a very high variability in relation to immersion and uncovering of polluted sediments.

Polluted sediments showed more than ten-fold higher levels of total copper. Yet, this difference shows up only partially when comparing the available copper fraction (DGT-Cu), while introduced Tubifex showed only marginally different levels of accumulated Cu. Although the accumulation of Cu in invertebrates is influenced by the presence of benthic algae, the colonization, growth and succession of algal communities on polluted sediments is not impaired.