Faculty of Geosciences
Copernicus Institute of Sustainable Development

Universiteit Utrecht

Constructing wetlands: measuring and modeling feedbacks of oxidation processes between plants and clay-rich material

Rémon Saaltink*, Stefan C. Dekker, Jasper Griffioen, Martin J. Wassen (*submitted to BGD*)
**r.m.saaltink@uu.nl*

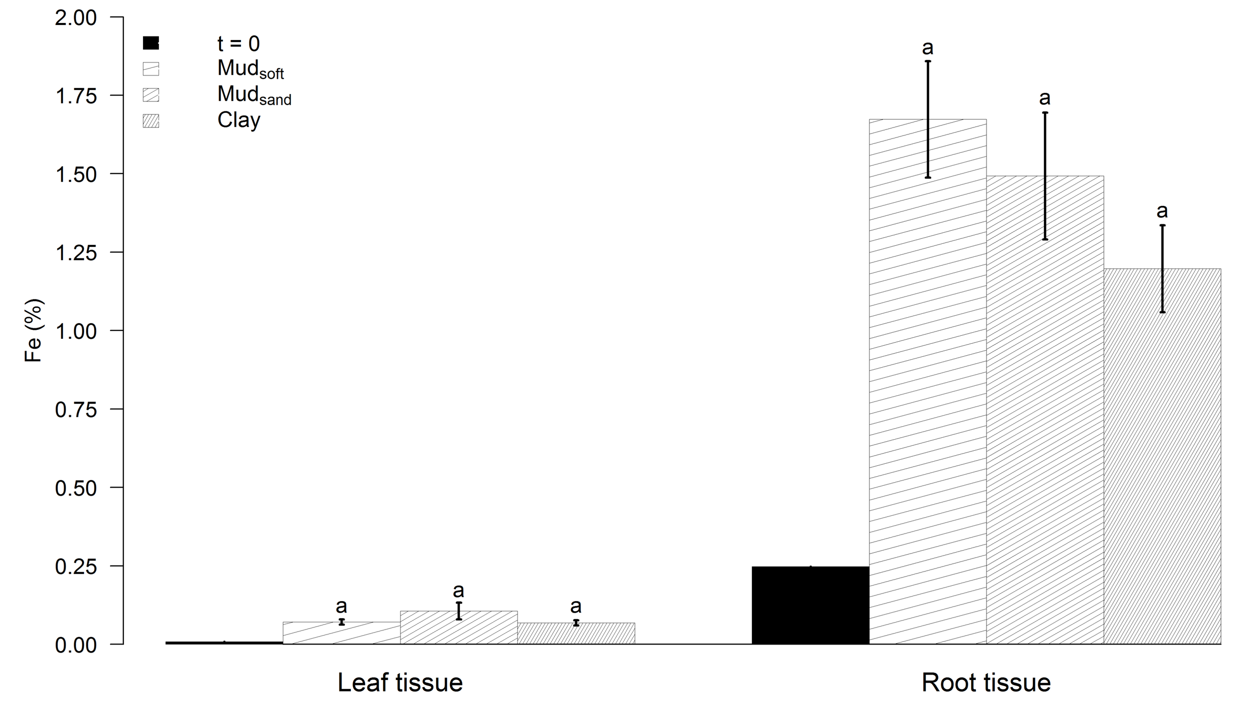
Research in perspective

In the Netherlands, a soft clay-rich lake-bed sediment in the Markermeer (an artificial lake of 691 km^2) is causing serious turbidity problems: primary productivity is impeded and biodiversity in the lake is declining. To improve the ecological conditions in the lake, the Dutch Society for Nature Conservation (Natuurmonumenten) and Boskalis (a dredging company) designed a plan to dredge some of the soft clay-rich sediment and use it to construct approximately 10,000 ha of wetland: the Marker Wadden.

The acquired scientific knowledge will be used to assess which ecosystem services will evolve and how such systems should be managed. The results of this project may both guide the design of the project and serve as an international, scientific example of building with mud to create new land.

PRESENT: Turbid water of lake Markermeer (right of embankment) impedes primary productivity.

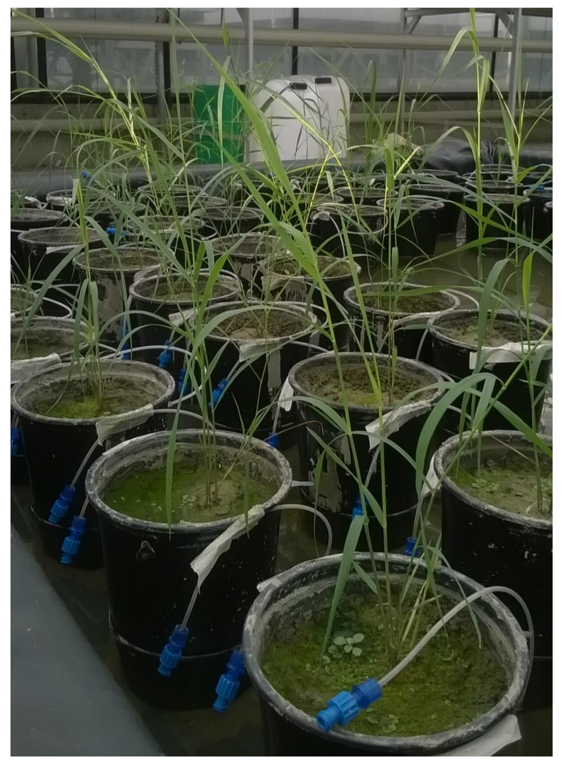
FUTURE: The Marker Wadden project will decrease turbidity in the lake, while at the same time constructing wetland.

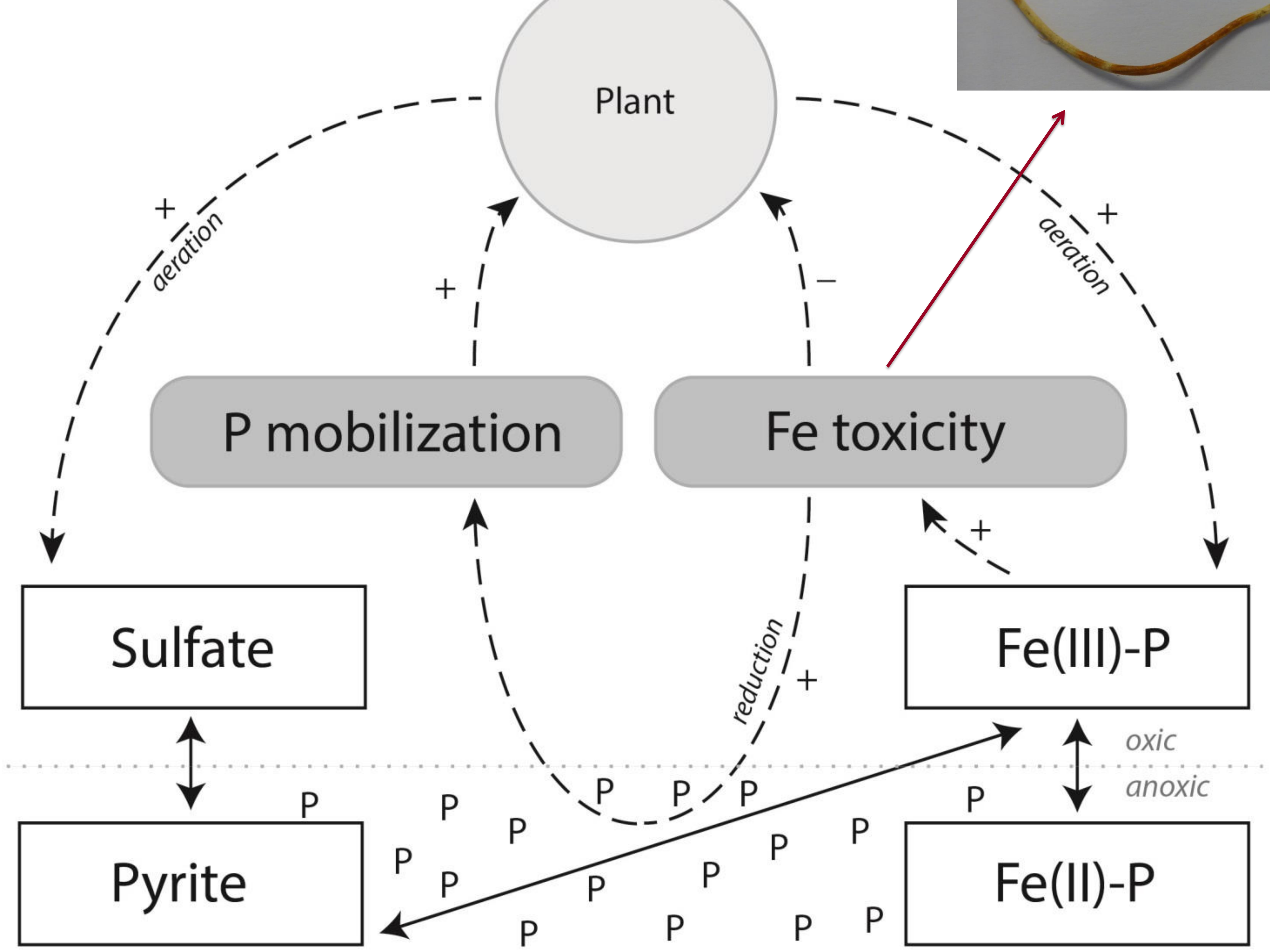


Fe concentration (% of dry weight) in leaf and root tissue grown in three different sediment types from Markermeer (with error bars when n = 5).

Aim: Identifying biogeochemical plant–soil feedback processes that occur when oxidation, drying and modification by plants alter the biogeochemical conditions in sediment from lake Markermeer, thus in turn affecting vegetation development.

Method: A greenhouse experiment was conducted where reed (*Phragmites australis*) was used as an eco-engineer. For 24 weeks, porewater-, soil- and plant quality was measured and used to model biogeochemical processes in the PHREEQC program.





Most important biogeochemical processes and feedbacks identified in this study. + indicates positive feedback, - indicates negative feedback (Saaltink et al., submitted).

Results & Conclusions

- Concentrations of SO_4^{2-} rose rapidly as a result of pyrite oxidation at the top-soil.
- Fe-P appeared to be the dominant P pool in all three soils.
- Ten weeks after transplantation, leafs shriveled green or turned yellow.
- Radial oxygen loss caused Fe-P to precipitate on roots, inducing indirect iron toxicity.

- We identified **a negative feedback loop** that arises because plant roots induce aeration, which promotes iron toxicity that decreases plant growth.
- We identified **a positive feedback loop**, as iron toxicity induces reduction processes as a result of root death, which leads to P mobilization and hence enhances plant growth and regeneration.

Recommendations

When constructing the Marker Wadden, using Fe tolerant species as eco-engineers is recommended as our results point in the direction of iron toxicity as a bottleneck for fast ecosystem development when fine sediment from Markermeer is used as building material.