

# Influence of Organic Matter Decomposition on the Metal Mobility in Wetland Soils

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## INTRODUCTION

Wetlands are often among the most productive of all natural systems. They play an important role in the biogeochemical transformation of nutrients and the sequestering of metals and organic compounds (Tockner & Standford, 2002). Wetlands are typically characterized by a high accumulation of organic matter. The anaerobic decomposition of organic matter is far less efficient than the decomposition in aerobic circumstances. Reed plants (*Phragmites australis*) and willows (*Salix* sp.) are common plants in wetland ecosystems in Belgium. The effects of the decomposition of organic matter originating from those plants on metal mobility in a wetland soil were assessed in a greenhouse experiment.

## METHODS

Two (1-2) times six (A-F) recipients (20 x 30 x 15 cm) were filled with a metal polluted soil originating from an overbank sedimentation zone called 'Lippensbroek' near the river Scheldt in Hamme. Soil total metal levels were 8.8 mg kg<sup>-1</sup> DM for Cd and 780 mg kg<sup>-1</sup> DM for Zn. The metal contamination probably originated from sediment deposition. The soil was mixed with six different quantities of organic matter. A: no addition of organic matter, B: addition of 3.5% reed leaves, C: addition of 7% reed leaves, D: addition of 7% willow leaves, E: addition of 10% reed stalks, F: addition of 20% reed stalks.

Wetlands are characterised with specific redox conditions which affect the metal mobility and bioavailability (Gambrell, 1994). To mimic the effects of varying redox conditions on the metal mobility two flooding regimes were applied: one recipient was permanently flooded (1) and another one was alternately submerged for two weeks and allowed to dry for one week (2). These regimes were continued during 140 days. Redox potential was measured with a combined platina and reference electrode (HI 3090 B/5) and the pore and surface water was sampled regularly with Rhizon soil moisture samplers for metals and organic matter (Eijkelkamp BV, Giesbeek). The water samples were analysed for metals (Cd, Cu, Ni, Fe, Mn, Pb, Zn, Ca, Na, K and Mg), anions (Cl<sup>-</sup>, NO<sub>3</sub><sup>-</sup>, SO<sub>4</sub><sup>-</sup>) and total organic carbon (TOC) content. Soil characteristics (pH, EC, DM-, OM- and CaCO<sub>3</sub>-content, CEC, C/N-ratio, texture, AVS and metal content) were determined before and after the test. The water that percolated out of the soils was quantified and analysed for metal and TOC-content.

## RESULTS AND DISCUSSION

The redox potential of the soils that were permanently submerged decreased below -250 mV after 140 days. The redox potential dropped faster in the soils where organic matter was added than in those without OM addition, but after two weeks this difference was no longer visible. The soils subject to an alternating hydrological regime showed a fluctuating redox potential. The redox potential reached the same low values at the end (below -240 mV) but during the drying period, the soil redox potential was positive for the most treatments.

The pH decreased in all treatments, but most in the alternating regime. In the permanently submerged soils, the decrease in pH was more pronounced in the soils where leaves (willow or reed) were added than in those where reed stalks were present.

Metal concentrations in the pore water of the permanently flooded soils with organic matter added (B1-F1) were higher than in those without. For Cd and Cu this was only true during the first twenty days. On the other hand, the Fe, Mn, Zn and Ni concentrations increased rapidly in the beginning of the test and decreased slowly after twenty (for Ni and Zn) to sixty (for Fe and Mn) days (e.g. Fig. 1). These concentrations were always much higher than those in the reference treatment (A1). The addition of leaves resulted in a greater dissolution of Fe- and Mn-oxides in the first eighty days of the test.

For the alternating regimes (2) a similar pattern was seen, but during the weeks when the soil dried, the Fe, Mn, Ni and Zn concentrations in the pore water decreased and the Cd and Cu concentrations increased. Pb concentrations were for both regimes below the detection limit of  $2 \mu\text{g L}^{-1}$ . The metal leaching was higher for the treatments with added organic matter (B2-F2).

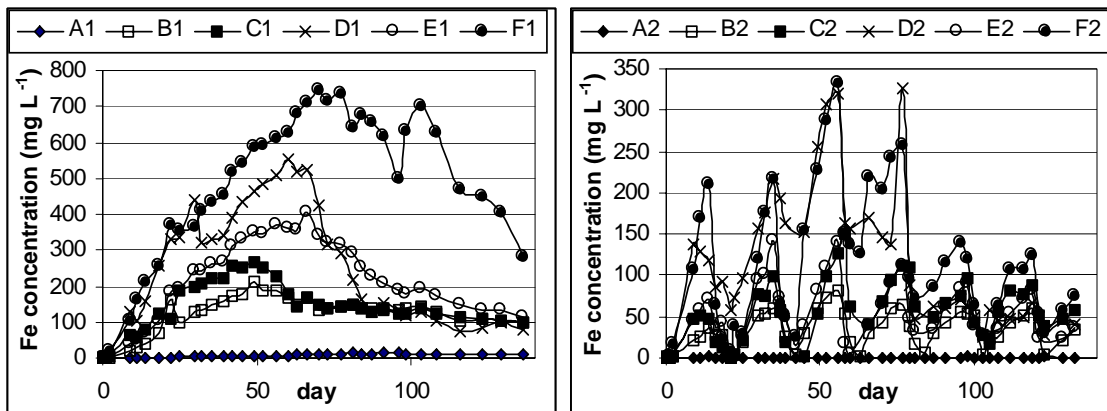


Fig. 1. Fe concentrations in the pore water of the permanently (1) and the periodically flooded regime (2) (A = no organic matter added, B = 3.5% reed leaves, C = 7% reed leaves, D = 7% willow leaves, E = 10% reed stalks, F = 20% reed stalks)

## CONCLUSIONS

Decomposition of organic matter plays an important role in determining pore water metal concentrations. Not only the amount of organic matter that is present, but also its type and origin have an effect on metal release or binding. In each treatment where organic matter was added, an increase of pore water concentrations of metals was observed within the first few days of the experiment.

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