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[WG3] Understanding Acid Sulfate Soils: The Key to Their Proper Management

Subsurface Chemigation of Acid Sulfate Soils - a New Approach to Mitigate Acid and Metal Leaching

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In this paper we present a new method for in situ treatment of farmland acid sulfate soils.
By utilizing the subsurface drainage system, oxidation-inhibiting chemicals mixed with irrigation water are injected into the environmentally critical subsoil. Laboratory and field tests have been performed in the four-year project PRECIKEM (Chemical precision treatment of acid sulfate soils to prevent the formation of acid). The project has completed its third year, and promising results are emerging.

As sulfide-rich sediments are drained, atmospheric oxygen gains access to the sulfides through macropores in the soil material. This initiates a combined chemical/microbiological process that eventually produces an acid sulfate soil. In order to inhibit further microbially mediated sulfide oxidation along the hydrologically active macropores, the soil is treated by passing a suspension of fine-grained (d50 = 2.5 μm) calcium carbonate or calcium hydroxide through these macropores. Fine-grained materials are necessary in order to avoid sedimentation and possible clogging of the drainage system, as well as to facilitate both dissolution and dispersion of chemicals in the soil.

In the laboratory, column leaching experiments have been performed by passing suspensions under hydrostatic pressure through cylindrical soil samples. In our experiments, pH, EC, ORP, as well as sulfate and chloride, and occasionally Al, Fe, Zn, Mn, Ni and Co, have been measured in the outflowing solution. Depending on an inherent variation in the size and abundance of macropores, the flow through the different soil columns varied greatly. Nevertheless, reproducible effects have been obtained.

Corresponding large-scale field experiments have been performed during two consecutive years at the Risöfladan experimental field. This field consists of nine hydrologically separated 1-hectare subfields. Each subfield has its own drainage system, consisting of subsurface drainage pipes, a collector pipe and a control well. Suspensions have been created with water from the nearby Toby River. Treatments have been performed in late summer when groundwater levels are below drainage depth, and have consisted of injections of calcium carbonate suspensions (4 and 8 g L^{-1}), calcium hydroxide suspensions (2 and 4 g L^{-1}), and river water. Solutions/suspensions are pumped via the control well into the drainage system for about 10 hours, with a flow rate of about 3 litres per second. The system of macropores allows the suspensions to spread in the field at drainage depth. Treatment effects are monitored by sampling drainage and groundwaters (Österholm et al. this volume).

The sediment in the Risöfladan area is representative of the region, with a clay content of 40%, an organic carbon content of 1.6%, and a total sulfur content of 0.9% (Nordmyr et al. 2006). Also, typical for the region is significant oxidation and leaching in the uppermost 1.5-meter soil layer. This results in significantly lower S concentrations in this oxidation zone and an enrichment of secondary sulfides in the narrow transition zone just above the parent sediment. The microbial community in the Risöfladan soil material has also been studied (Wu et al. 2013). Several known acidophilic microorganisms have been identified, as well as gene sequences previously found in cold environments. These results indicate that the metal and acid release from the Risöfladan soil material is catalyzed by indigenous microorganisms adapted to low pH.

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