Modeling the efficiency of drainage practices at present and future climate scenarios on acid sulphate soils in Finland

Background

Drainage practices such as controlled drainage, lime filter drains and controlled drainage system with additional pumping of water during dry periods have been suggested to abate acid sulphate soil problems. In this study, the long-term effectiveness of these techniques is studied with the HAPSU model using future climate scenario data. Moreover, new experimental data is used to test the validity of the model.

Ionic Flow Model for Acid Sulphate (AS) Soils

The ionic flow model HAPSU was developed to simulate SO₄²⁻, Ca²⁺, Fe and Al leaching from the runoff areas build up with AS soils and non-acidic soils in boreal conditions (Huhta et al. 1996). The model consists of normal drainage practice, lime filter drains and controlled drainage (Bärlund et al. 2004). Also the pumping of additional water into the drains can be simulated with the HAPSU model.

Water protection practices and climate scenarios

The simulations were done on the Kyrönjoki area in normal and future climate scenarios. Borelmann et al. (2004) suggested that the long-term effectiveness of the drainage techniques is studied especially with HAPSU for the period 2040–2069. The lysimeter experiment provided evidence for the pH increase of AS soil horizons in the lysimeter experiment in the beginning and at the end of the experiment. The pH increase in the lysimeter experiment was similar to the pH increase in the model. However, in reality the pH increase is more intense in the Cg horizon and the bacteria in the lysimeter experiment can be seen as microbial catalysts.

Lysimeter experiment

In the study, the model performance was also tested by the data from a lysimeter experiment of AS soil. The lysimeter experiment AS soil monoliths (Sulfi Crayquupts), which included oxidized sulfuric B horizons and a reduced sulfidic C horizon, were subjected to different water management treatments, controlled drainage (a), capillary rise (b) and no action (c). The lysimeter experiment AS soil monoliths (Sulfi Crayquupts) were shown to be affected significantly by the different water management treatments.

Conclusions and future challenges

HAPSU model shows the differences of water protection practices on metal and hydrogen ion loads. There is a rise in metal and hydrogen ion loads, which is shown in the model as well. The model is very sensitive to the input data, which is why the model results can be used to simulate the efficiency of different drainage practices. However, there is a need for further research on the microbial catalysts and their role in the acid sulphate soil leaching process.

Table 1. Measured and modeled values for metal concentrations and pH for whole Finland and Kyrönjoki.

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<tr>
<td>pH</td>
<td>4.7 ± 0.4</td>
<td>4.7 ± 0.4</td>
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<tr>
<td>SO₄²⁻</td>
<td>29.3 ± 70.1</td>
<td>29.3 ± 70.1</td>
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<tr>
<td>Al</td>
<td>1.7 ± 0.9</td>
<td>1.7 ± 0.9</td>
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<td>Fe</td>
<td>1.4 ± 1.7</td>
<td>1.4 ± 1.7</td>
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References
