Geophysical Research Abstracts
Vol. 21, EGU2019-11406, 2019
EGU General Assembly 2019

Controlled drainage and sub-irrigation – options to mitigate acid loads from AS fields

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The largest areas of acid sulphate soils (AS) in Europe are located on the coasts of the Baltic Sea in Finland. Those soils are mostly ancient sediments that became exposed by the isostatic land uplift are still emerging from the Baltic Sea. In the 19th century the soils were reclaimed for cultivation without knowing their negative consequences to environment. Most AS fields were drained by subsurface pipes at the depth of 1.0 -1.2 meters before the 1990s. The fields are highly valued for their excellent crop yields but still cause chronic and acute environmental hazards for aquatic ecosystems. Therefore, environmental friendly cultivation and water management methods have been urgently sought.

Studies in the 2000s showed that controlled drainage improved water quality where sulfidic materials occur below the drain depth. However, drop of groundwater level deep to sulphide bearing layers during winters and summers was found to be a problem. Sub-irrigation was introduced and implemented by farmers to improve yields and thus create a win-win situation for both the farmers and the environment. Seepage was identified as a common problem with sub-irrigation and a plastic sheet was installed to hinder seepage. Sub-irrigation and plastic sheet made it possible to maintain higher groundwater level at the Söderfjärden experimental field during summers, but groundwater level dropped deep occasionally during winters. The water quality improvements by sub-irrigation were only slight. In order to better understand the hydrology of AS soil fields and the effects of water management methods on water quality, a modelling study was initiated.

In the modelling, the field data and simulation results from Söderfjärden experimental field were used for comparing the effect of conventional subsurface drainage (ND), controlled drainage (CD) and sub-irrigation (CDI) on groundwater level, water balance components and pH of drainage discharge. Two 1-D models were used: a Drainmod-based model and the ionic flow model HAPSU developed in Finland in the 1990s. The NSE-values for simulating groundwater level were good (0.62-0.68) for ND field but lower (0.38-0.47) for CD field. Based on the simulations the groundwater level was expected to be higher in CD and CDI fields and consequently improvement of the water quality should be stronger than was observed from the measurements. Modelling revealed that regardless of the plastic sheet water seeped into the main ditch, which explained the drop of groundwater level during winters. In addition, the simulations indicated that the topography of the field affected the efficiency of control structure to maintain groundwater level even though the slope of the field was only 0.14%. The results showed that the pumping of water to the lowest control well did not raise groundwater sufficiently to saturate sulphide bearing horizons at the upper end of the field.

The modelling results suggested that the prevention of seepage could be improved by controlling the water level in the main ditch. In summer 2018, such a control dam was constructed in the main ditch and the preliminary observations suggested that groundwater level remained higher in the fields above the dam.