Acid sulfate soil in Sweden – distribution, AI maps, and environmental impact in a changing climate

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In many coastal areas in Sweden, especially along the Bothnian Bay coast, acid sulfate soil occur which can have a negative impact on nearby surface waters. We have mapped their occurrence along the Bothnian coast.

Background

In Sweden AS-soils are often associated with organic-rich clay and silt sediments that were deposited and reduced during anoxic conditons, in brackish-water environments. Due to the postglacial isostatc rebound potental AS-soils have been uplifed.

Predictive mapping

With machine learning, we have mapped AS-soil occurrence along the Bothnian coast in Sweden. The map predicts the distributon of three classes:

1) No acid sulfate soil
2) Active acid sulfate soil
3) Potential acid sulfate soil

The model behind the map pt.1

The model is based on data from 1,135 sites that were classified with pH data. Soils with an oxidised zone and pH below 4 were classed as active AS-soils. Reduced soils with pH below 4 after incubation in the laboratory were classed as potential AS-soil.

The model behind the map pt.2

Data from the classifed sites was used with other geographical data such as maps of Quaternary deposits, and most importantly a high-resoluton digital elevaton model based on LiDAR from which several derivatives were extracted.

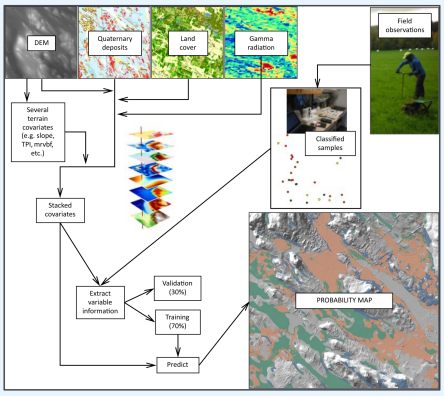
Results

The modelled map shows that active AS-soil is common in flat areas with fine-grained sediments close to the coast, where the groundwater level has been lowered by ditches.

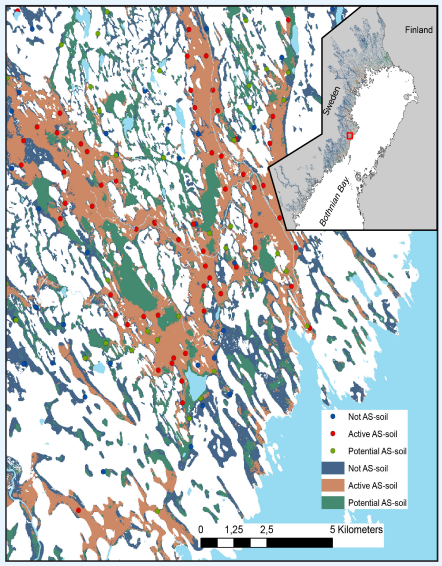
Potental AS-soil is common in peat covered wetlands and is found in larger geographical area compared to actve acid soil.

Benefits

The map can be used for planning infrastructure projects and actions to mitigate negative influence from AS-soil. The map can also be used when planning ditch cleaning and to recognise sites suitable for restoration of wetlands to prevent further negative influence.



The Random Forest model was created from field data and several environmental covariates, such as maps of Quaternary deposits, and most importantly a high-resolution elevation model from which several derivatives was extracted

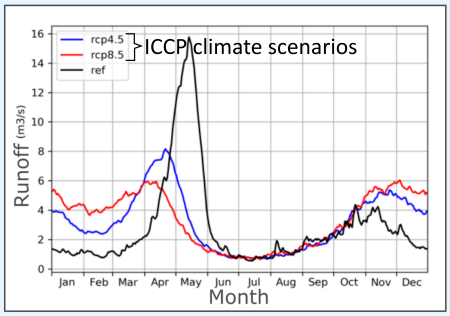


The modelled distribution of AS-soils along the Swedish coast of the Bothnian Basin. Field observations are marked as points. Most of the active AS-soil are underlain by potential AS-soil.

Typical active AS-soil (left) and potential AS-soil (right). The active AS-soil has a field pH below 4 and often contains visible iron oxides and sometimes the yellow mineral jarosite. The potential AS-soil has a field pH above 6 and is often coloured black by iron monosulfides.

Climate change impact

Periods with low groundwater levels can cause formation of active AS-soil. If that is followed by high runoff it will affect surface waters negatively. The predicted higher groundwater during winter is assumed to mitigate acid shocks from spring floods.



Models from climate scenarios, in Västerbotten, shows an increase of runoff during autumn and winter, where the increase in winter is the largest. Spring runoff is clearly estimated smaller. The summer results are more uncertain but indicate less runoff – more drought.

References

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