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Mapping of acid sulfate soils in Finland

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Acid sulfate soils (ASS) are in Finland defined as soils, sediments (including glacial till), organic material (e.g. peat) containing hypersulfidic materials which upon oxidation, either naturally or during incubation in the laboratory, form sulfuric acid that significantly lowers soil-pH to <4 for mineral soil materials and <3 for organic soil materials. In Finland, ASS are disturbed in agriculture, forestry, peat production, dredging and infrastructure developments.

The sulfidic sediments responsible for ASS formation have been developing after the latest glaciation in parts of the Baltic Sea beginning during the Littorina Sea (c. 8000–3000 years ago) and today continuing in shallow coastal waters. Post-glacial isostatic uplift has brought these sediments above sea level and they are now consequently mostly found in coastal areas. The most common type of ASS in Finland consist largely of fine-grained (clay and silt) and often gyttja-containing soil materials that generally have been deposited in estuary systems where the input of organic matter is high and the conditions for sulfide formation are favourable. In these soils, the reduced hypersulfidic material is often dark coloured indicating the presence of iron monosulfides.

The problems with leaching of acidity and metals into recipient waters related to ASS have been known for centuries, but not until 2009 did systematic mapping and characterization commence on the responsibility of the Geological Survey of Finland (GTK). At the observation points, soil probing and sampling down to 2–3 m is done and observations of sediment texture and structure, pH and oxidation depth are made. Samples are collected for analyses of incubation-pH, trace- and major elements (aqua regia dissolution and ICP-OES), loss on ignition and grain size.

Fine-grained ASS contain a relatively high concentration of sulfur (median c. 0.5%) and a large pool of easily mobilised metals. During the mapping process it has become evident that there are also coarse-grained soils (fine sand and sand), constituting of glaciogenic and/or re-deposited glaciogenic material, which have low concentrations of sulfur (0.01–0.1%) metals and organic matter and that are strongly acidified to pH well below 4 when oxidised in the laboratory. Due to the lower concentrations of acidity and metals, the negative environmental impact of these coarse-grained ASS is much less or more short-lived than that of fine-grained ASS. However, because of the poor buffering capacity of these soils, even a low sulfur content can induce leaching of acidity strong enough to cause fish kills in recipient streams. Also sulfidic till and peat have been encountered, often in association with black schists, and reportedly have had a negative impact on the environment.

By the end of 2018, about 82% of the total potential 5 million hectares has been mapped. To date, >21 000 observation points (observation density c. 0.5/km^2) and >10 000 analyses have been made. Once the mapping is finished, the area of ASS is very likely to exceed that of earlier estimations of 336 000 ha. The results from the mapping (incl. probability maps, site descriptions and analyses) are made public at http://gtkdata.gtk.fi/Hasu/index.html.