



Typical ASS landscape in W Finland

Photo: Rainer Rosendahl

Mapping Acid Sulfate Soils in Finland - methods and results

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Peter Österholm, Amelie Beucher & Markku Yli-Halla

- The latest Ice Age ended 10.500 years ago in this region (Ostrobothnia)

- The Litorina Sea, starting ca 8.000 years ago → today (Baltic Sea)

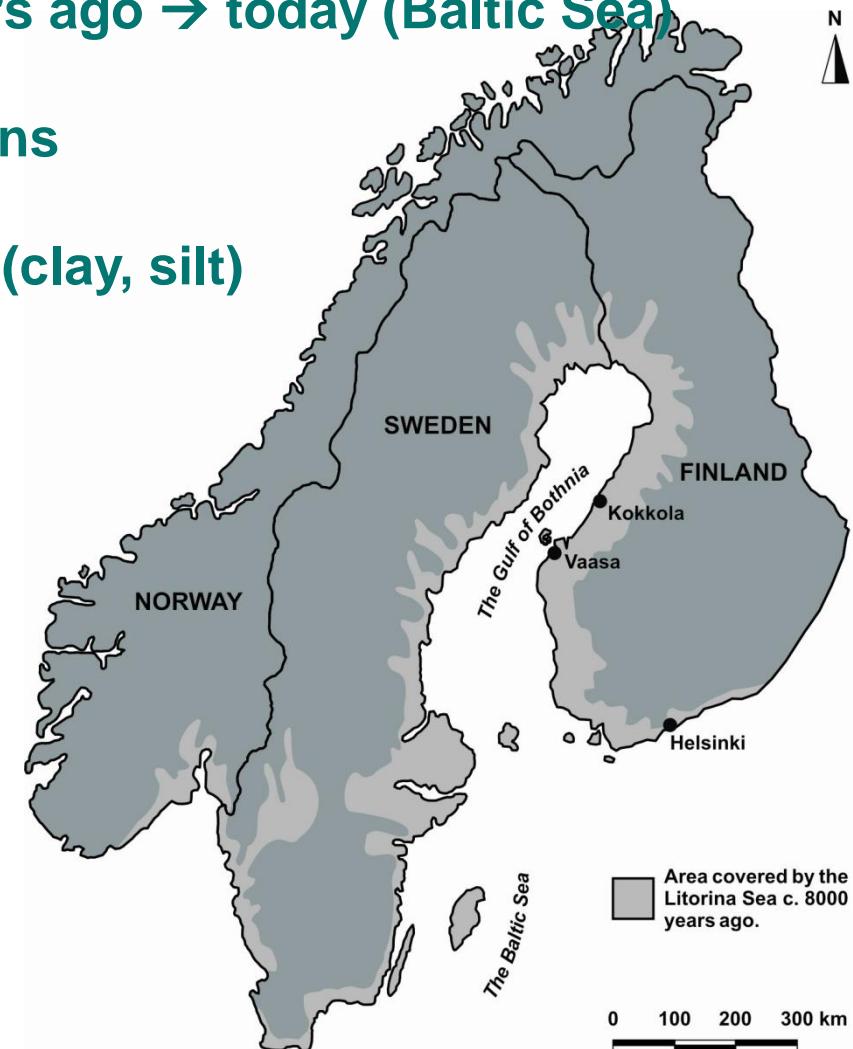
- Warmer climate → anaerobic conditions

- → Sulfide-bearing (gyttja) sediments (clay, silt)

Land uplift after that 100 – 20 m

→ Today >5 million ha of exposed land

where sulfide sediments can occur



Anton Boman, GTK 2012

Sulfide sediments still forming today (Excursion site on Saturday)



Vassorfjärden 2006
Peter Österholm

TYPICAL ASS PROFILE

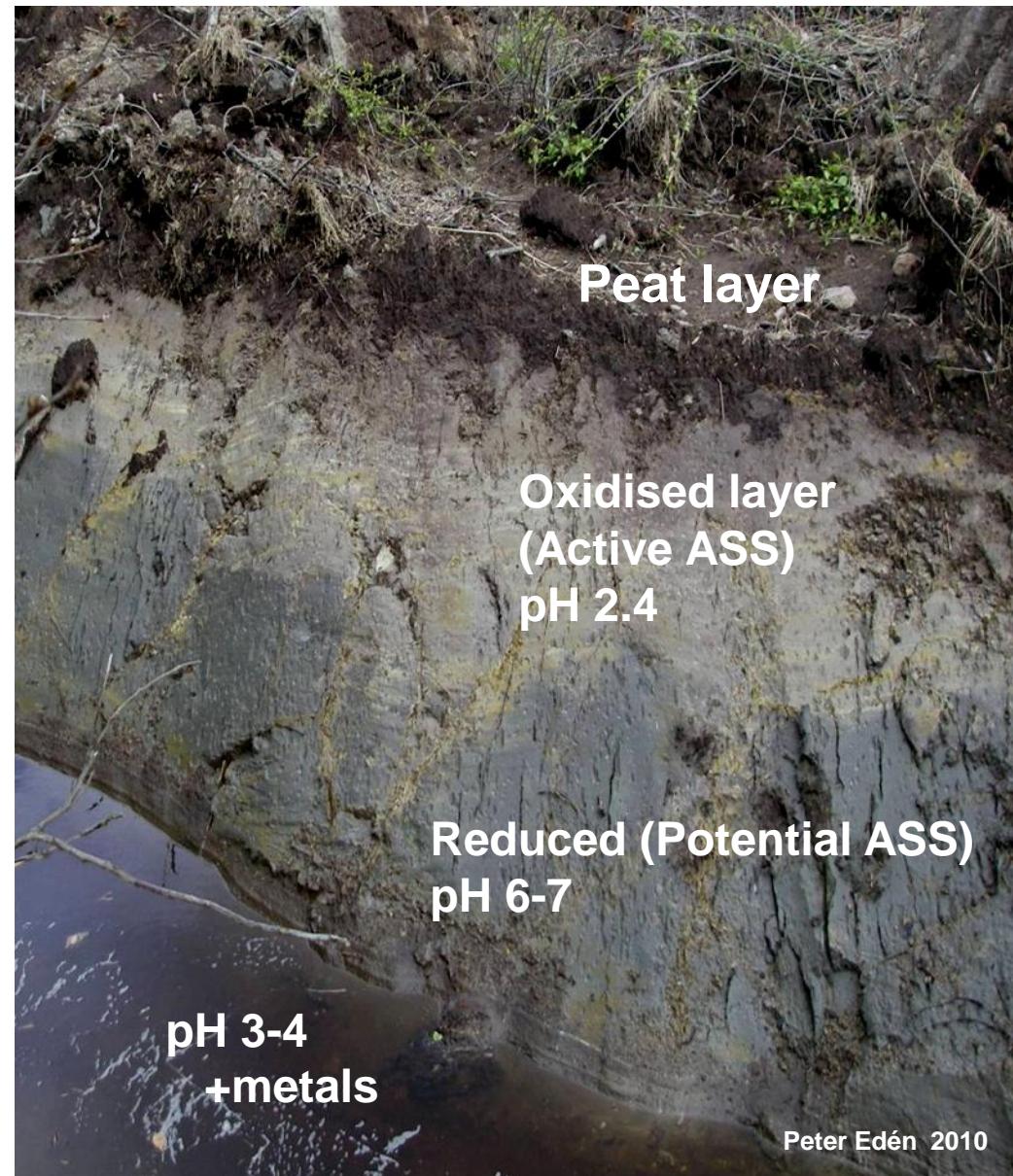
1. In natural state covered with peat

2. Draining / lowering of the water table

>> oxidation of the sulfides

>> sulfuric acid + metals

= active acid sulfate soil



Land use (in ASS landscape) cause the oxidation:

- Draining agricultural and forest areas
- Peat production
- All kinds of building activities



Also in forests under peat





After peat production:

- Sulfidic sediments uncovered and oxidised
- Water pH 3.2

ASS should be considered also in urban planning and building

Purola/ Bobäck, Vaasa 2011

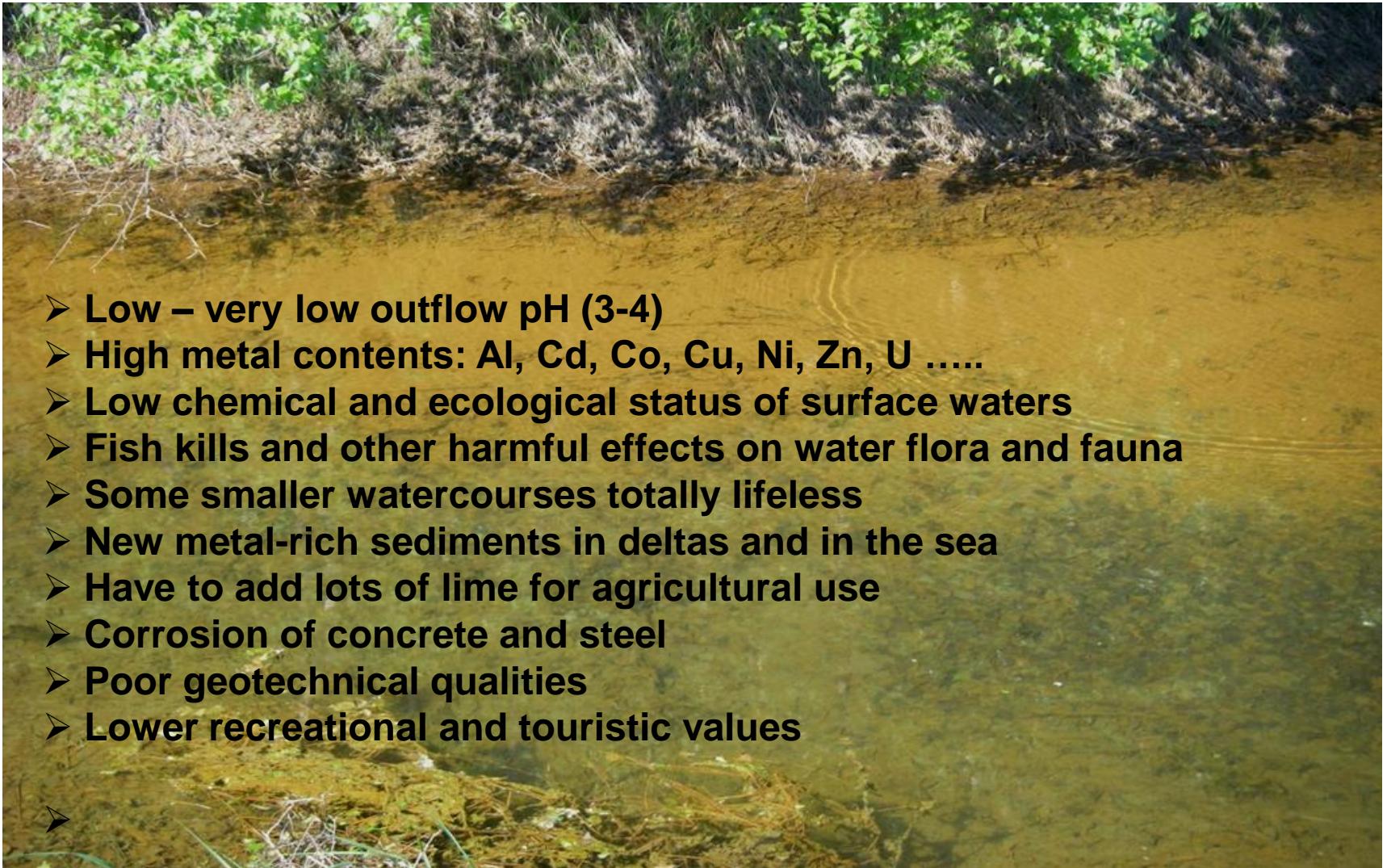


Peter Edén 2011

**Poor geotechnical qualities
Corrosion of constructions
Have to take care of the material**



HARMFUL EFFECTS OF ASS



- Low – very low outflow pH (3-4)
- High metal contents: Al, Cd, Co, Cu, Ni, Zn, U
- Low chemical and ecological status of surface waters
- Fish kills and other harmful effects on water flora and fauna
- Some smaller watercourses totally lifeless
- New metal-rich sediments in deltas and in the sea
- Have to add lots of lime for agricultural use
- Corrosion of concrete and steel
- Poor geotechnical qualities
- Lower recreational and touristic values

➤

EARLIER WORK

**Below the Litorina border
(100 m asl in N, 40 m asl in S)**

Some in 50's and 70's

KUTI –data (1994):

336 000 ha ASS (map)

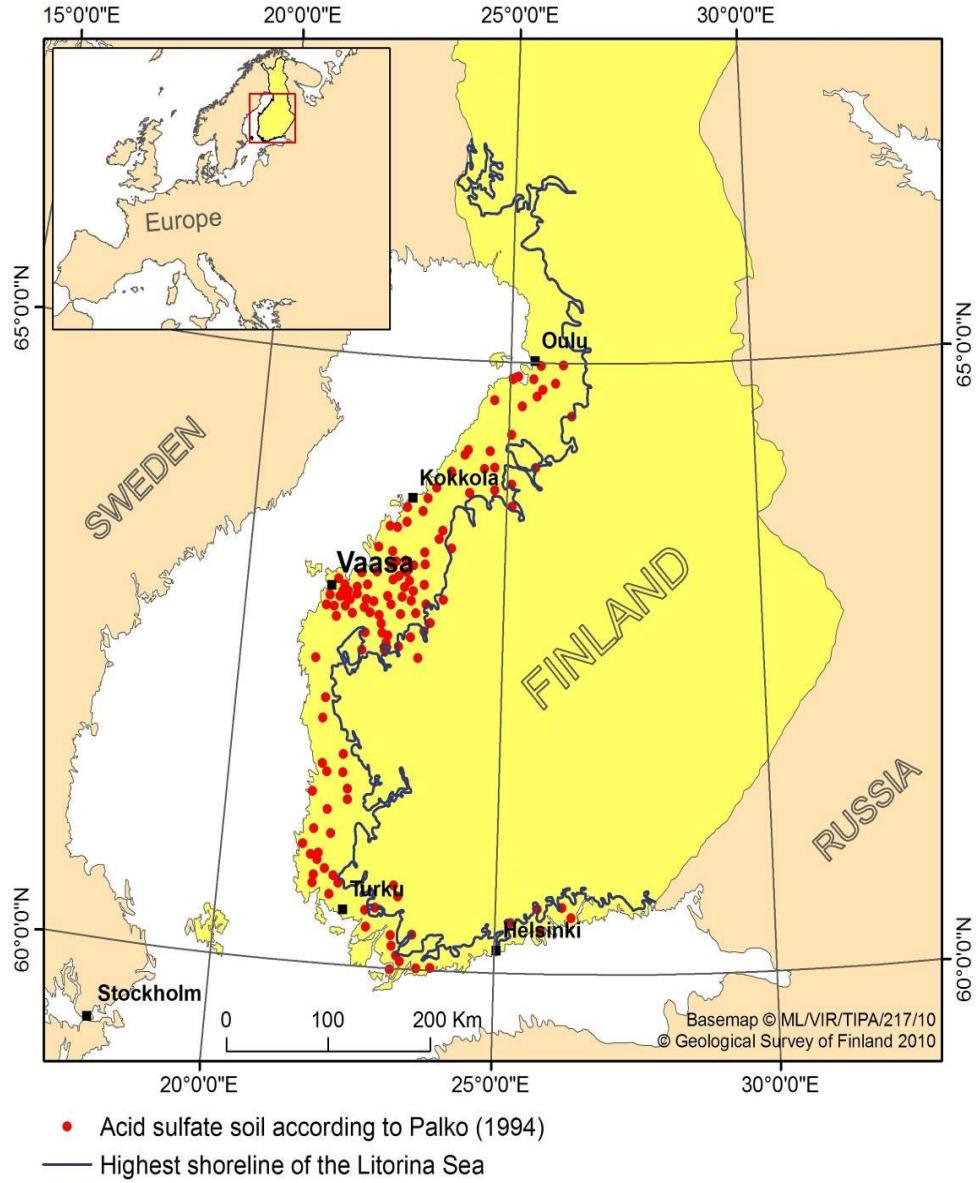
Yli-Halla et al (1999) used international criteria on KUTI → < 150 000 ha

Palko et al: several local projects

Varying methods and criteria used!

**ASS in Europe:
Finland and Sweden**

Worldwide > 20 mill ha ASS



- ASS and related problems known in Finland for over 50 years
- Fish kills 2006-2007
- EU's Water Frame Directive (WFD)
 - requirement for good ecological and chemical status of surface and groundwater by 2015



- GTK's pilot project 2008 >> Network 2009
- Two Ministries' National Strategy 2011
- River basin management program 2011



1. The requirements of WFD cannot be achieved in W Finland by 2015 because of ASS
2. ASS the most important cause for bad ecological and chemical status of surface water in W Finland
3. Mapping needed immediately (extent, depth, quality)
4. Information, education, development of mitigation methods, etc., should start asap

Climate change will increase the harmful effects!

MAPPING STARTED 2009 in two projects

1. Catchment of two big rivers: Siikajoki-Pyhäjoki 2009 – 2012
(EU (ERDF) and national / regional funds)
Action 1: Mapping (GTK)



Euroopan unioni
Euroopan aluekehitysrahasto

2. CATERMASS 2010-2012 LIFE+ (EUs env fund)

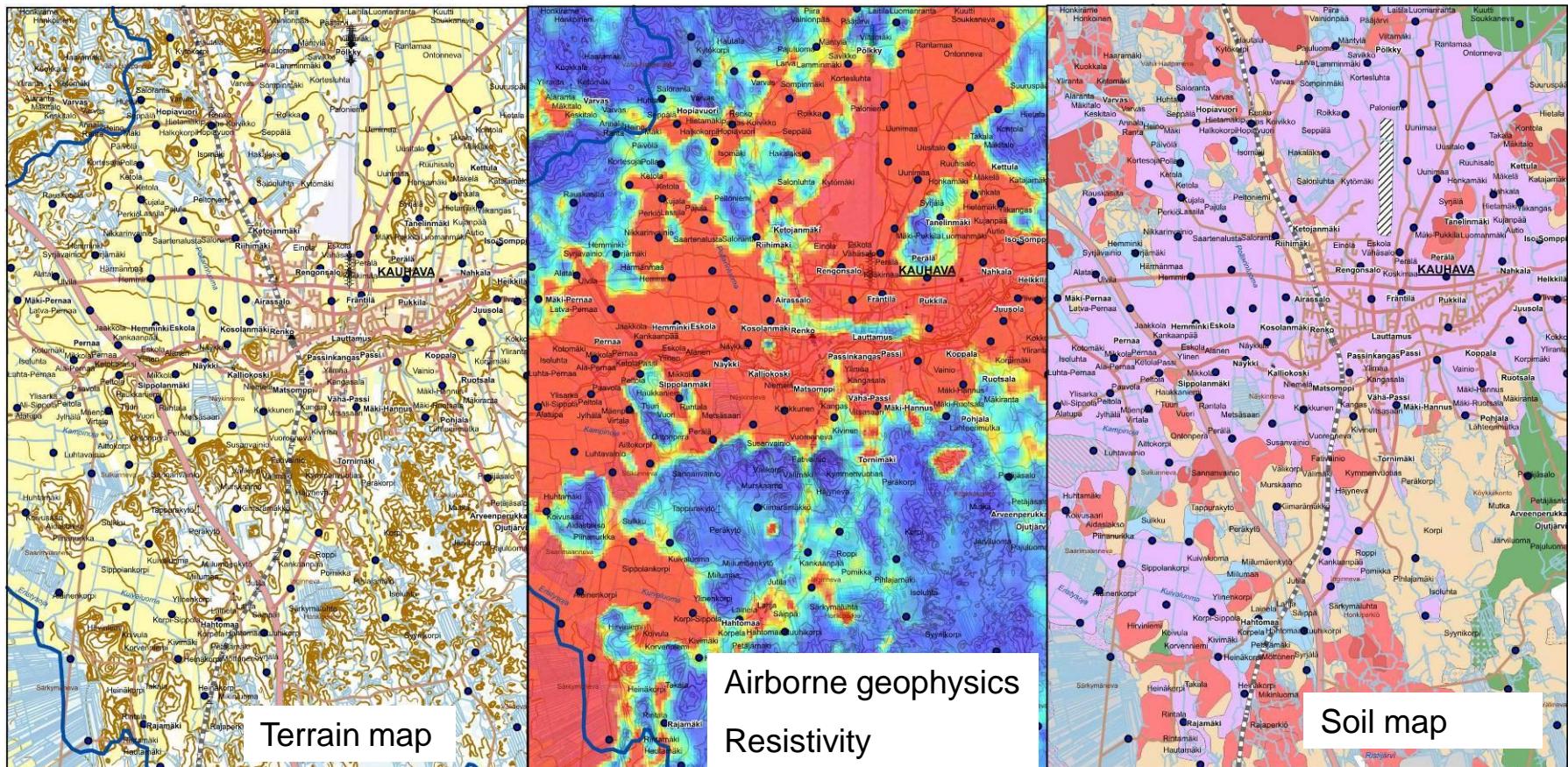
Climate Change Adaptation Tools for Environmental Risk
Mitigation of Acid Sulfate Soils



- ACTION 1: Mapping and risk classification of ASS
(GTK, ÅA, HY)

METHOD DEVELOPMENT DOMINATING IN THE BEGINNING

MAPPING: large catchments



Mapping points (black dots) planned at the office using
Terrain maps, aerogeophysical data, soil maps, elevation data, etc.

→ potential areas → plan → field observation and sampling

Reconnaissance, 2-3 m



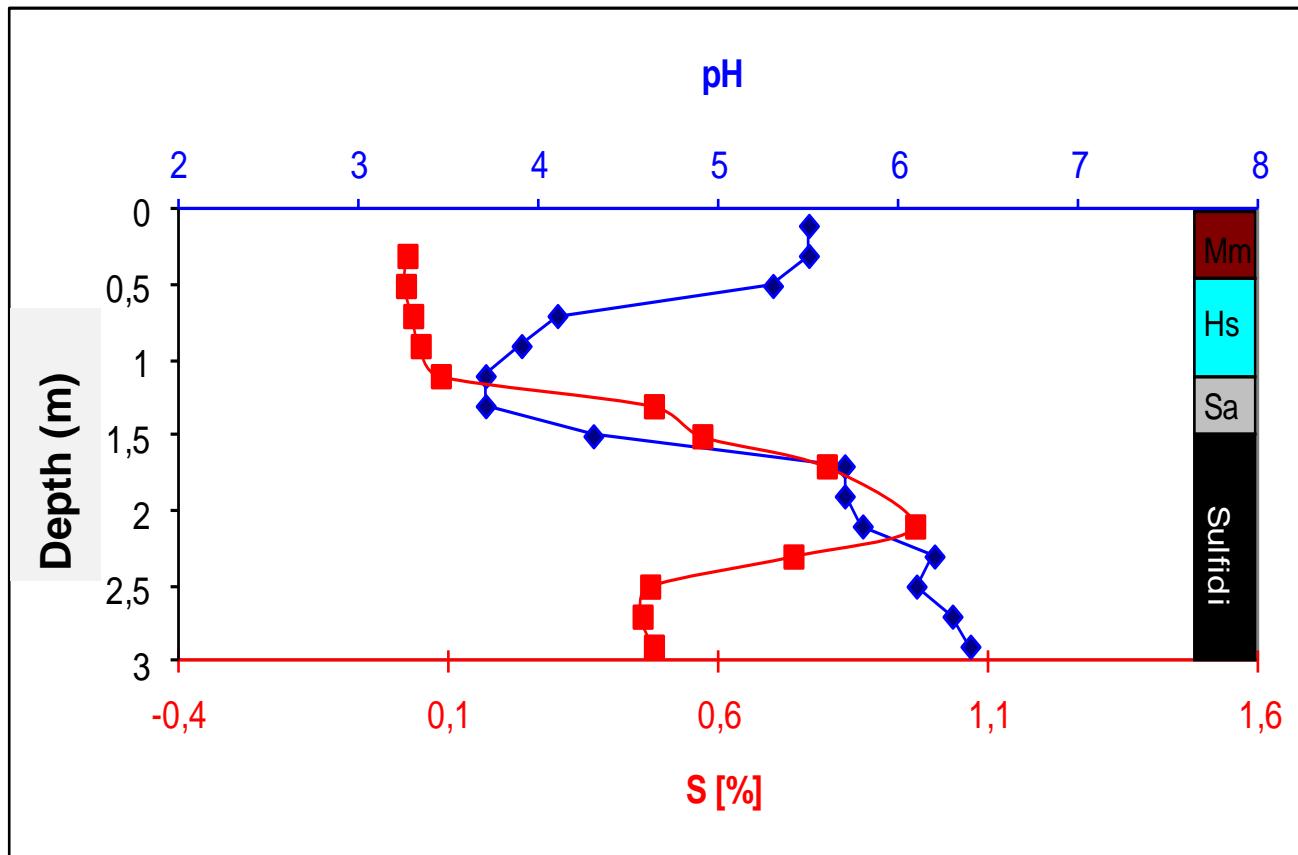
Drilling, 3 m
Profile sampling



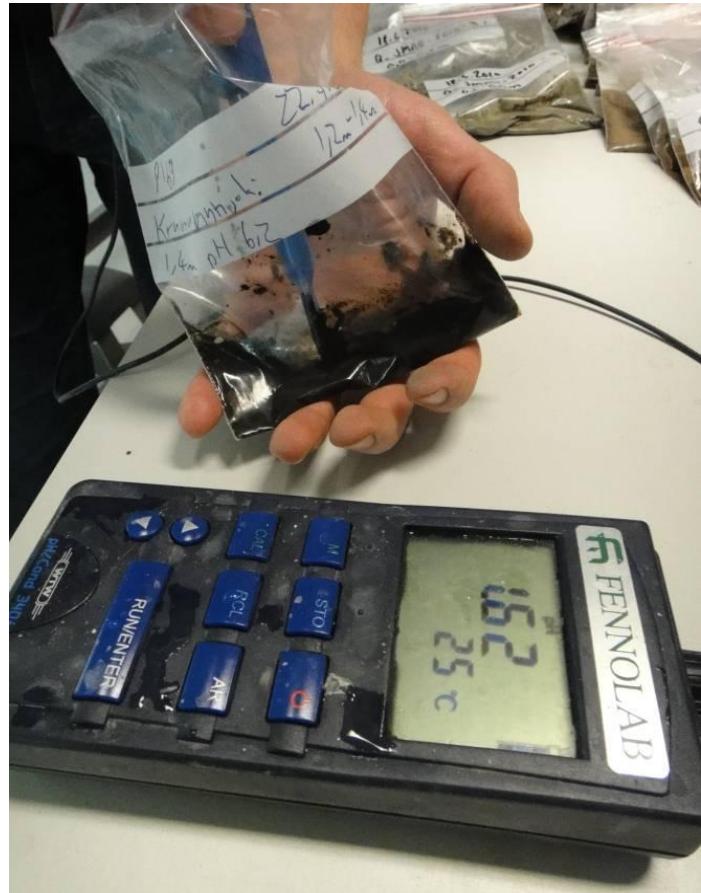
pH from sample, data → database
sampling → chemical analysis, incubation



pH- and Sulfur-profiles



- Chemical analyses:
Aqua Regia + ICP-OES
→ Sulfur + 30 other elements
- Incubation (oxidation 10-16 weeks),
measuring change in pH



**Field pH 6,2
Incubation: pH →1,6**

AREA TO BE MAPPED

Area below the Litorina –border
ca. 5 100 000 ha

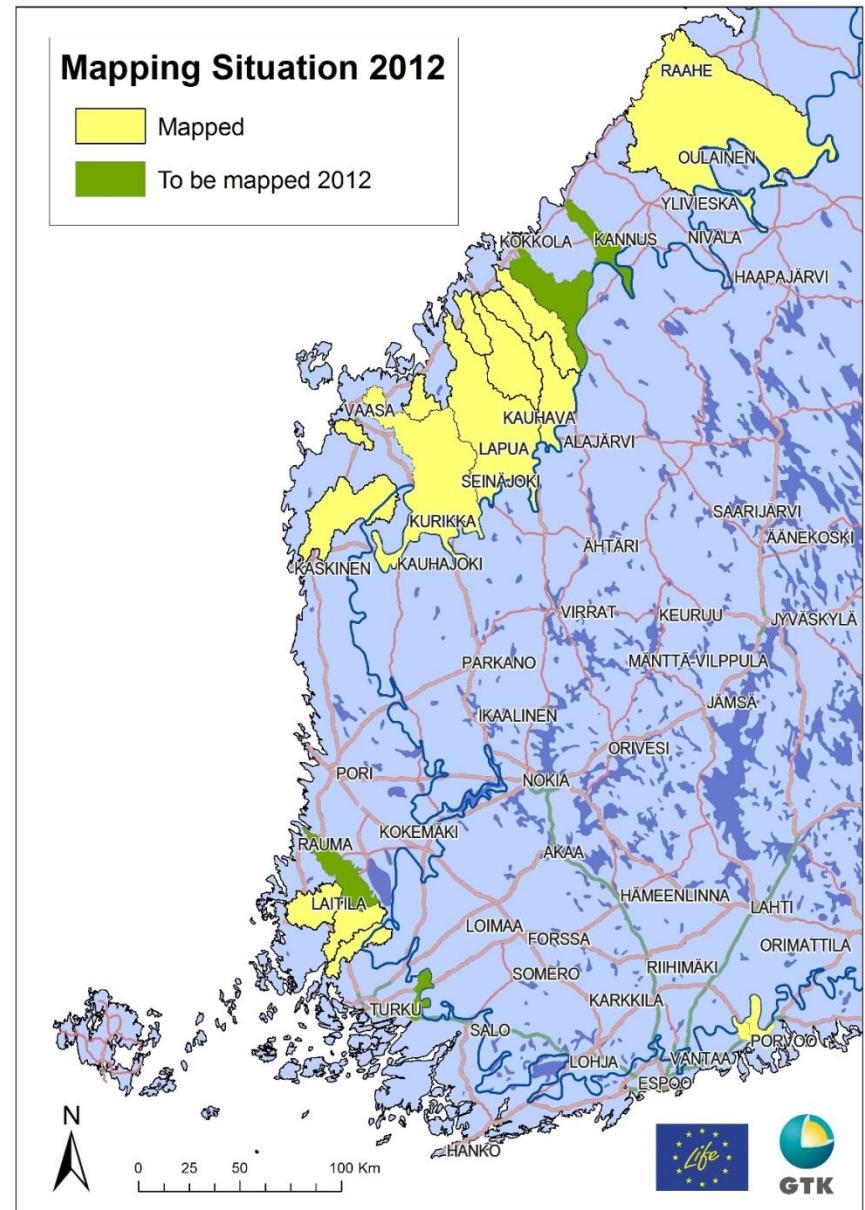
MAPPING SITUATION 31.07.2012

Recoinnassance drillings	> 8.000
Profile drillings	> 700
Mapped area	> 1.600.000 ha
Analyses	> 2.800

Observation density:

1 observation / 2-2,5 km² (whole area)

1 observation/1 km² (area potential for ASS)



RESULTS

Available for the public on GTK's web-pages

- ¤ **Maps + site cards**
- ¤ **Reports**
- ¤ **Guide leaflets**

RISK CLASSIFICATION OF ACID SULFATE SOILS 2012

(GTK, ÅA ja HY)

1. Sulfides occur

CLASS 1	STARTING DEPTH OF PASS (m)
1	0-1,0
2	1,0-1,5
3	1,5-2,0
4	2,0-3,0
5	sulfides entirely oxidised
6	no sulfides at 0-3 m depth

Mapping depth 3 m

Classification for a site / sample is given in this form:

Sulfides starting depth / pH_{min} / S(tot)
E.g., **2 / A / II**

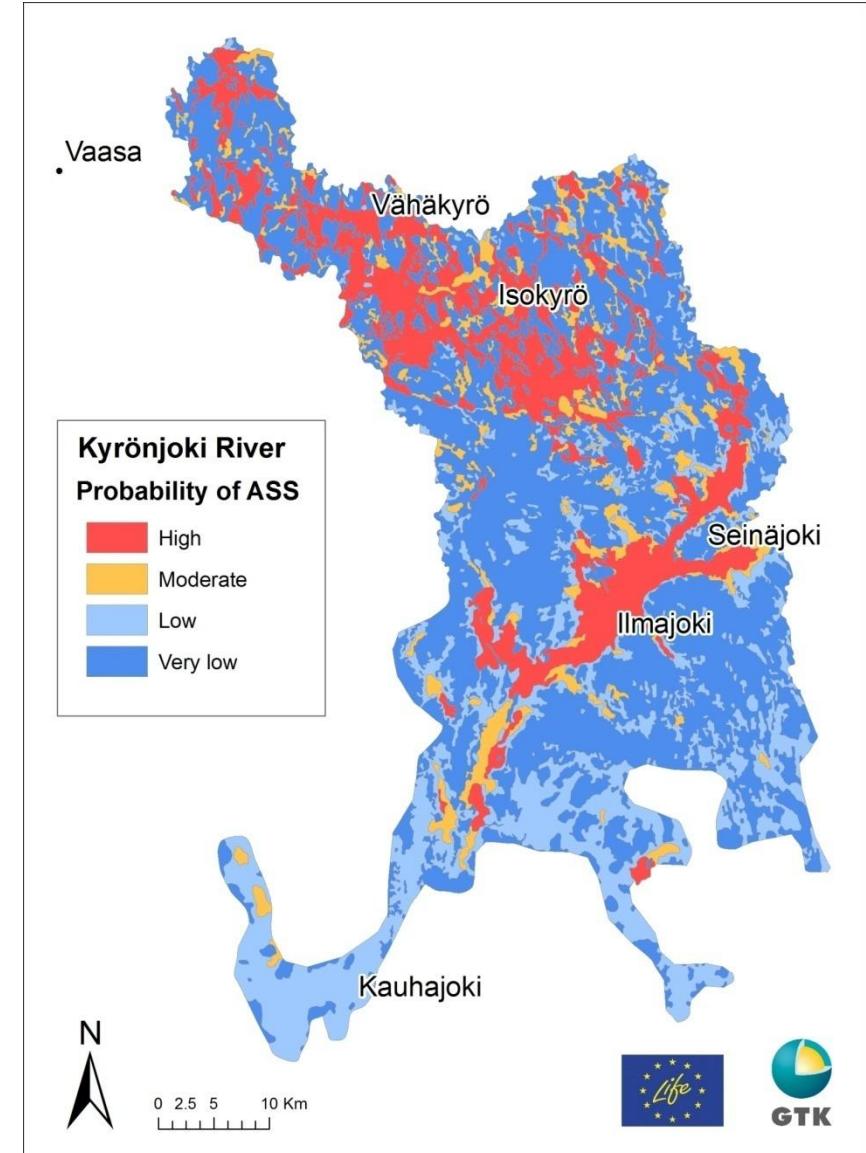
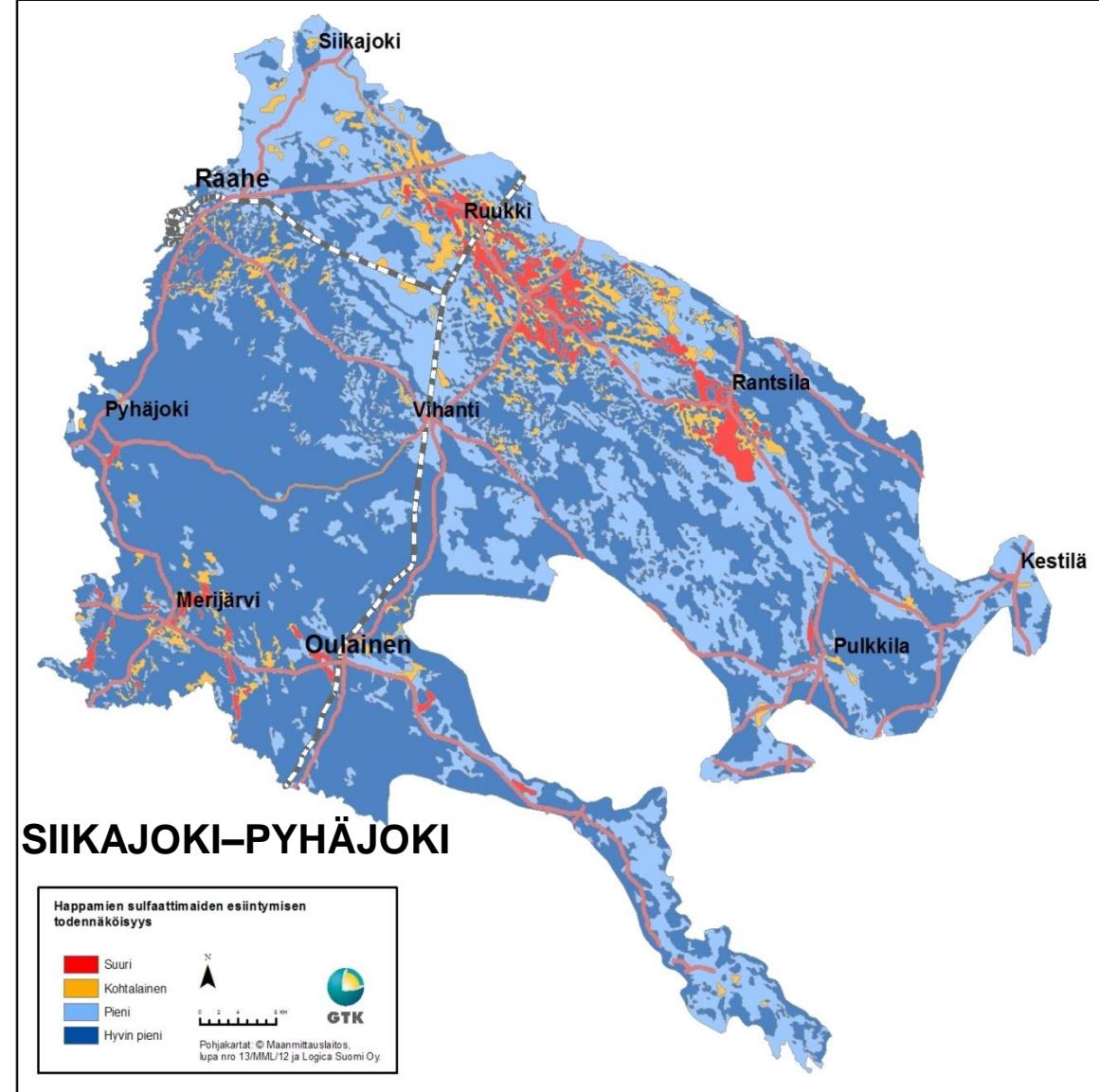
2. Field pH_{min}

CLASS 2	Minimum pH (0-3 m depth)
A	< 3,5
B	3,5 - 3,9
C	4,0 - 4,4
D	≥ 4,5

3. Sulfur (complement)

COMPLEMENT	Total S-content (%)*
I	S(tot) ≥ 1,0 %
II	0,6 % ≤ S(tot) < 1,0 %
III	0,2 % ≤ S(tot) < 0,6 %
IV	S(tot) < 0,2 %

*Given as the mean for the uppermost 40 cm of the sulfidic (PASS) horizon



General map showing probability for ASS. Not for use at property level!



Site Card

Profilipiste Q_JMAU-2011-6

Havaintotiedot

Havainnonnottaja: GTK
Havaintopäivä: 09.06.2011

Havaintopaikan tiedot

Maakunta: Pohjanmaa
Kunta: Isokyrö
Valuma-alue: Kyrönjoen valuma-alue
Maankäyttö: Peltomaan

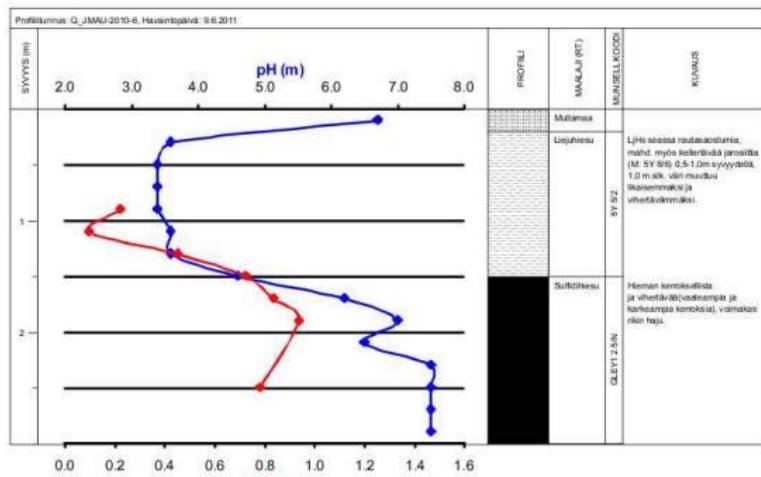
Koordinaatit (YKJ):
x 3261143
y 6996324

Korkeustaso
(MML laserkeilalausaineisto): z 21 m



Kuva profilipisteeltä.

pH, kokonaisrikki S(tot) sekä maalajit ja kerrosjärjestys



Kokonaisrikkipitoisuus (Stot) määritetti laboratorioissa ICP-OES -teknikalla 20 cm kokoomanäytteistä.
pH(m) määritetti maastossa suoraan maanäyteestä pH-mittarilla 20 cm välein.
Maalajien väri määritetti Munsell-värikodeille (Munsell Soil-Color Charts).



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pH-inkubaatio

Syyt. (m)	pH(m)	pH(i)
0,1	6,7	6,3
0,3	3,6	5,7
0,5	3,4	4,1
0,7	3,4	4,0
0,9	3,4	
1,1	3,6	
1,3	3,6	
1,5	4,6	
1,7	6,2	
1,9	7,0	
2,1	6,5	3,1
2,3	7,5	3,1
2,5	7,5	
2,7	7,5	3,2
2,9	7,5	3,1

pH(m) = maastossa mitattu pH
pH(i) = inkuboidtu pH

pH(m) alle 4,5 /todellinen hapan sulfaattimaa
pH(i) 4,0 tai alle ja pudotusta vähintään 0,5 yksikköä

pH-inkubaatiossa näytteiden annetaan hapettua 8 -16 viikkoa, jonka jälkeen maastossa mitattuja pH-arvoja verrataan hapetuksen jälkeisiin arvoihin. Mikäli pH-arvo on laskenut neljään tai alle ja pudotusta on tapahtunut vähintään 0,5 yksikköä, voidaan näytteissä todeta esiintyvä sulfideja.

Todellinen hapan sulfaattimaa on hapan kerros maaperässä, joka on syntynyt sulfidien hapettumisen seurauksena. Todellisen happaman sulfaattimaan pH on alle 4,5. **Potentiaalisessa happamassa sulfaattimaassa** sulfidit eivät ole hapettuneet ja pH on yleensä 6,0 tai yli.

Riskiluokitus

Profilipisteen luokitus: 2/A/II (sulfidin esiintyminen / minimi pH (0-3 m syv.) / kokonaisrikkipitoisuus)

Sulfidin esiintyminen

LUOKKA	SULFIDIN ALKAMISSYYVYS (m)
1	0-1,0
2	1,0-1,5
3	1,5-2,0
4	2,0-3,0
5	sulfidi kokonaan hapettunut
6	ei sulfida 0-3 m syvyydellä

Maastossa mitattu minimi pH

LISÄMÄÄRE	MINIMI PH (0-3 M SYV.)
A	< 3,5
B	3,5-3,9
C	4,0-4,4
D	≥ 4,5

Sulfidin esiintyminen kertoo millä syvyydellä hapettumaton sulfidikerros alkaa ja kertoo siten mm. happamoitumiskierristä suhteessa kuivatustilanteeseen.

Maastossa mitattu minimi pH kuvastaa maaperän hapettumisen ja happamoitumisen nykytilan nettaa. **Rikki** kuvastaa maaperän sulfidipitoisuutta ja ennustaa happamuusuomituskuon mitukseen määrästä.

Profiilikuvat

Syvyydet metreinä maanpinnasta.



0-1 m



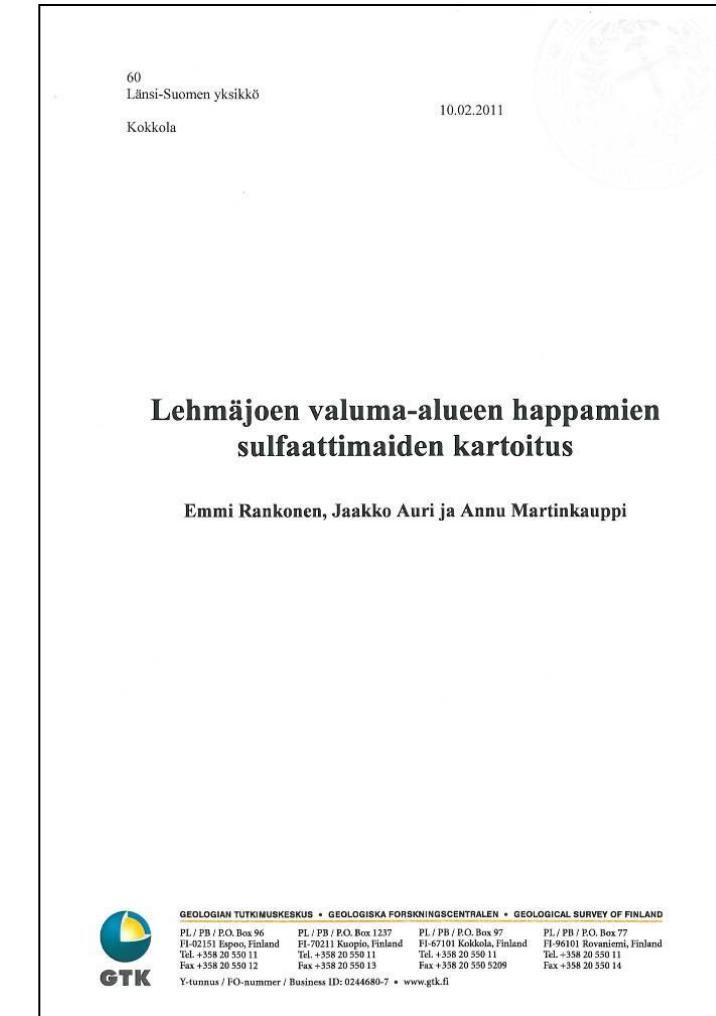
1-2 m



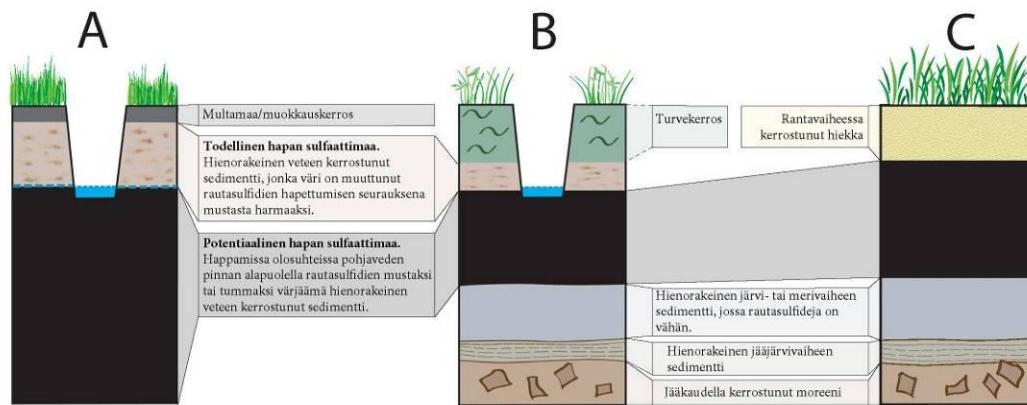
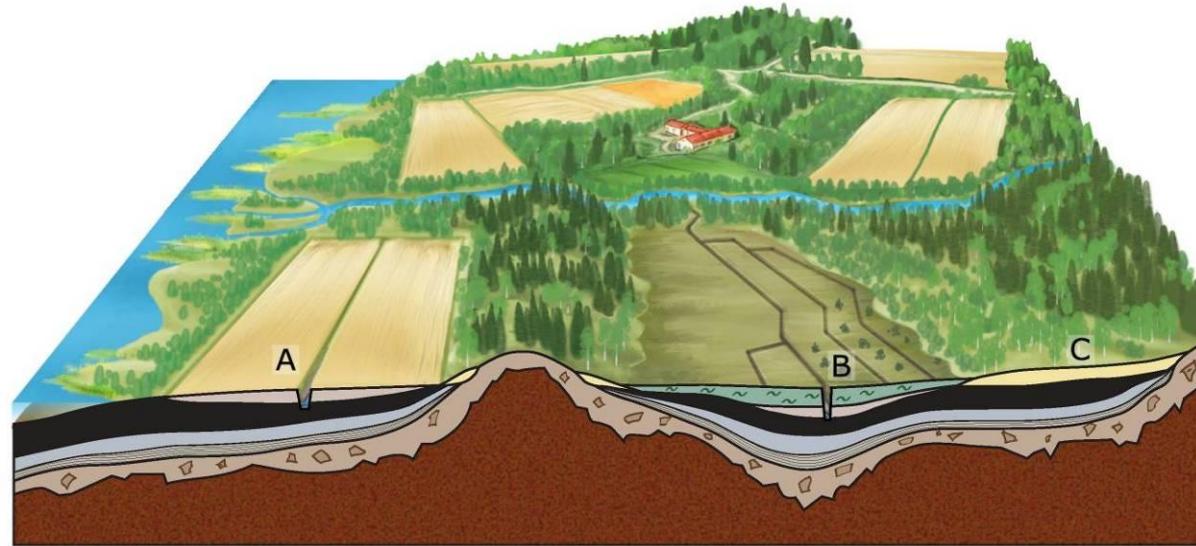
2-3 m

Reports

- Raportit sulfaattimaiden ominaisuuksista ja esiintymisestä valuma-alueittain
- Kartat ja tutkimustulokset esitetään *www – karttapalvelussa*



Guide: Happamat sulfaattimaat. Esiintymis- ja kerrostumisypäristöt.Tunnistaminen



Kuvat: Harri Kutvonen / GTK

The results will benefit / ASS should be considered :

- national and regional planning /decision making
(Ministries, regional councils, municipalities, ELY, AVI, consultants,)
- agriculture and forestry (farmers, landowners, their organisations,
"ditching companies")
- peat production and earthworks, all kinds of land use in ASS landscapes
- In the future when deciding about EU subsidies

What's next:

>> GTK and the ministry:
ASS General Map (+ some detailed mapping)
by the end of 2015

THANK YOU
TACK
KIITOS

THANK YOU
TACK
KIITOS

