

Minimizing sulfide oxidation on AS soil farmlands by enhanced controlled drainage and subsurface irrigation

Österholm, P., Virtanen, S., Uusi-Kämppä, J., Rosendahl, R., Westberg, V., Mäensivu, M., Ylivainio, K., Yli-Halla, M., Turtola, E.

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Topics

- Comparison of sulfidic areas
- The nature of the AS soil problem in Finland
- Why controlled drainage and irrigation?
- Preliminary results from CATERMASS

Satellite image: Global Land Surveyor
2001-05-06, Processed by P.Peltola.



UNESCO world heritage area



10 km

Where do we have the biggest load?





Sulfidic sand pit 2007





E4 on AS soil

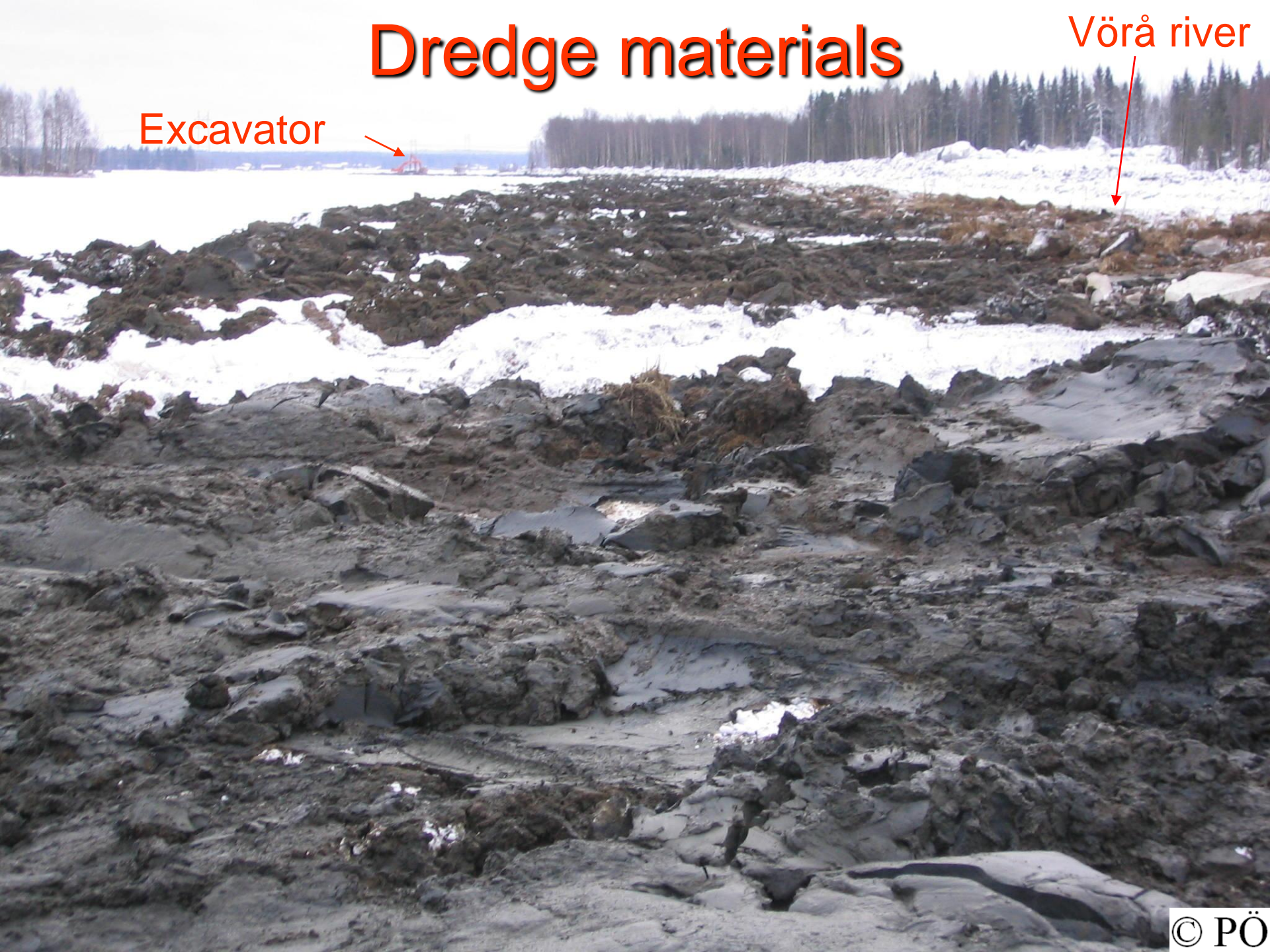


Dredge materials

Excavator



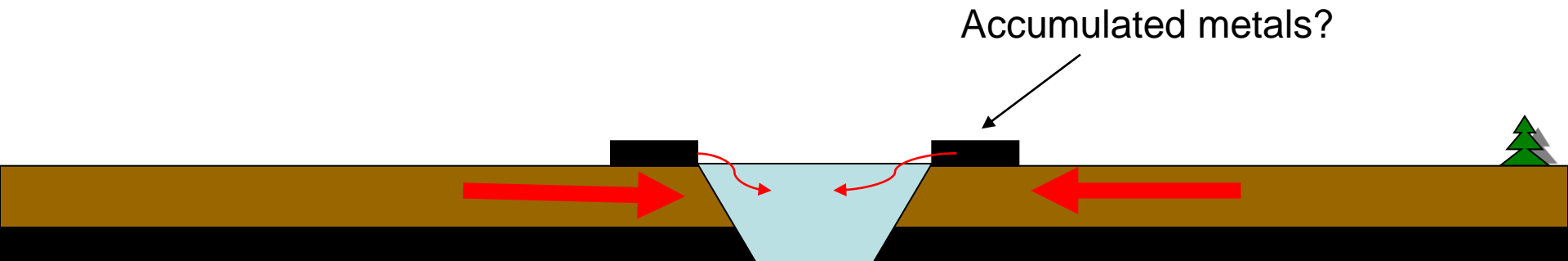
Vörå river



Dredging → quick oxidation/leaching but quantitatively small

Ex. Plan for 2 x 2 km dredging of Toby and Solf river mouths → totally 30000 m³ dredge material

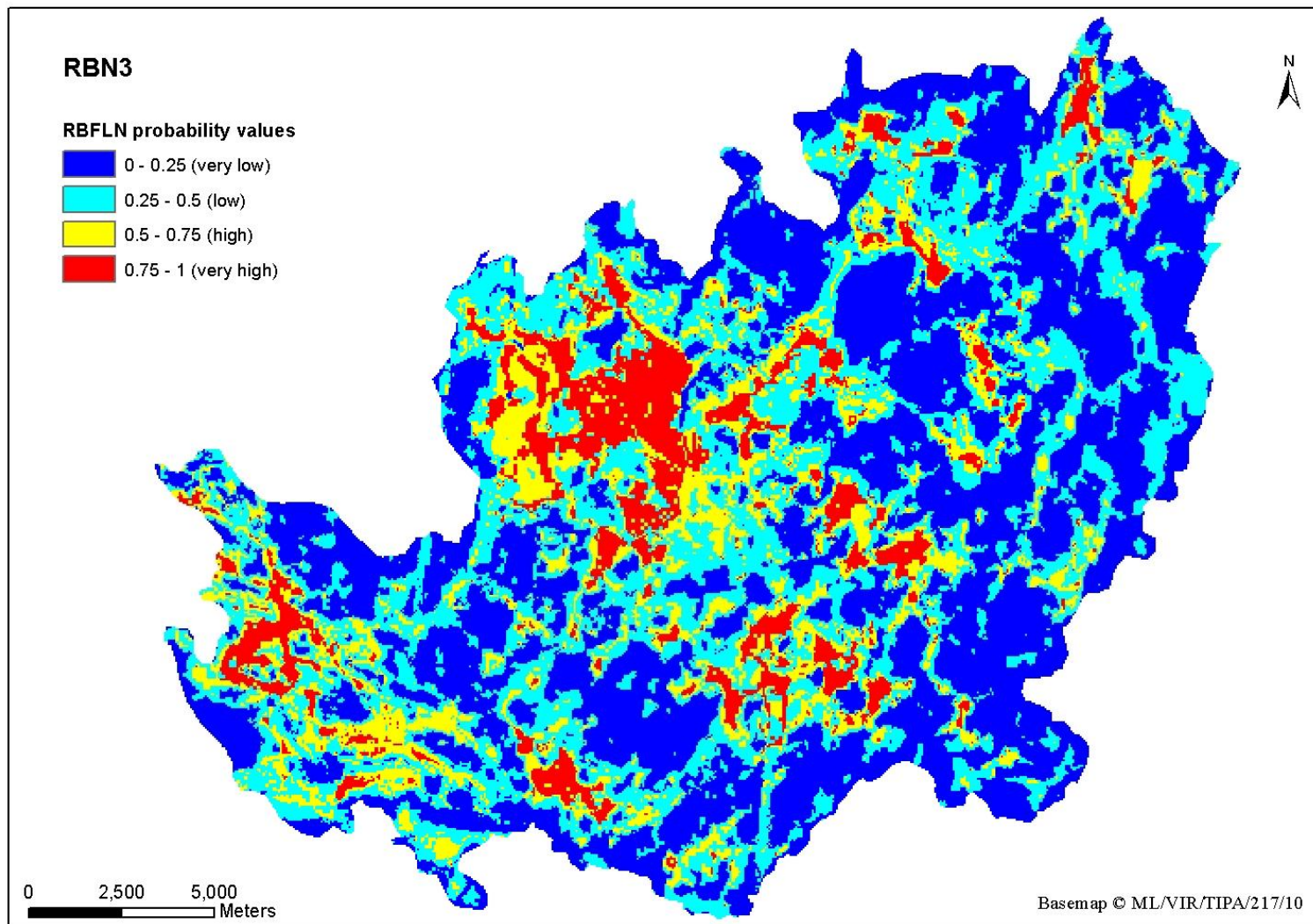
= oxidation of 3 ha PASS to a meter



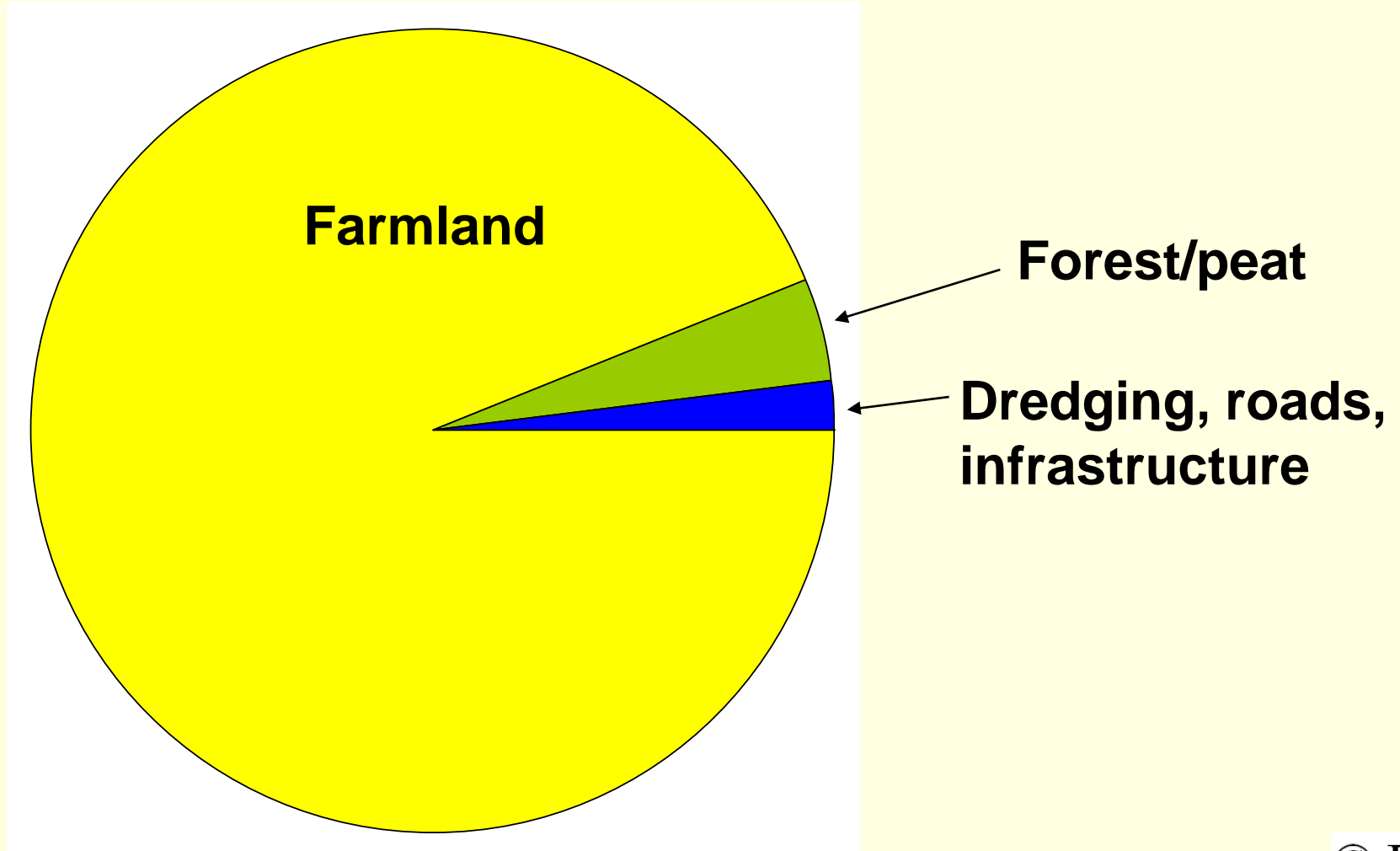
AS soils under peat and forest – more important in N-Finland?



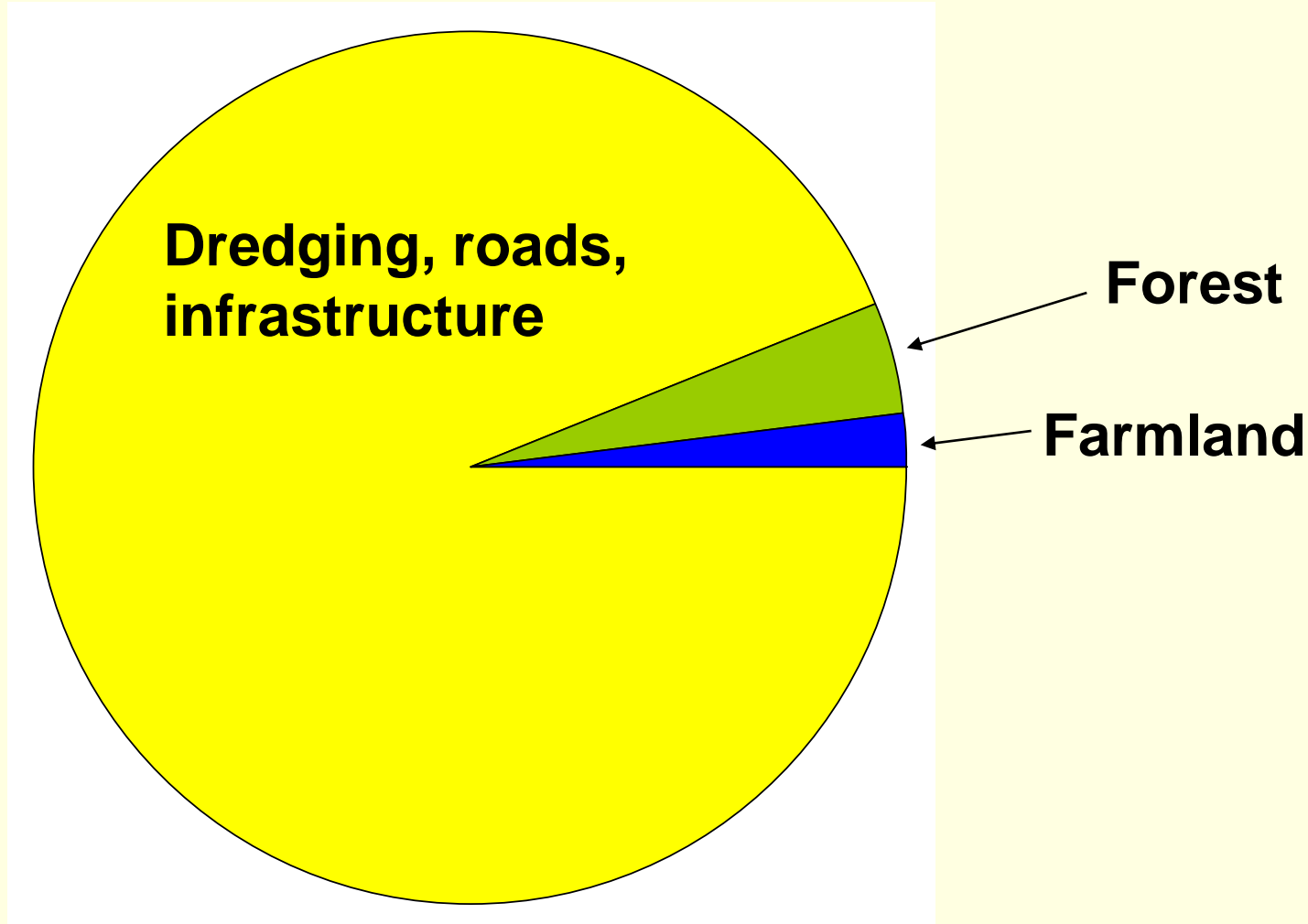
Catchment with farmland AS soils



The AS soil problem in Finland



The AS soil problem in Sweden?



Umeå

pH 4.7
EC 510 $\mu\text{S}/\text{cm}$

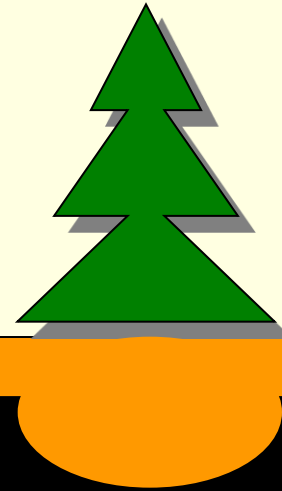


Pristine/unleached sulfides until 18th century

Syre

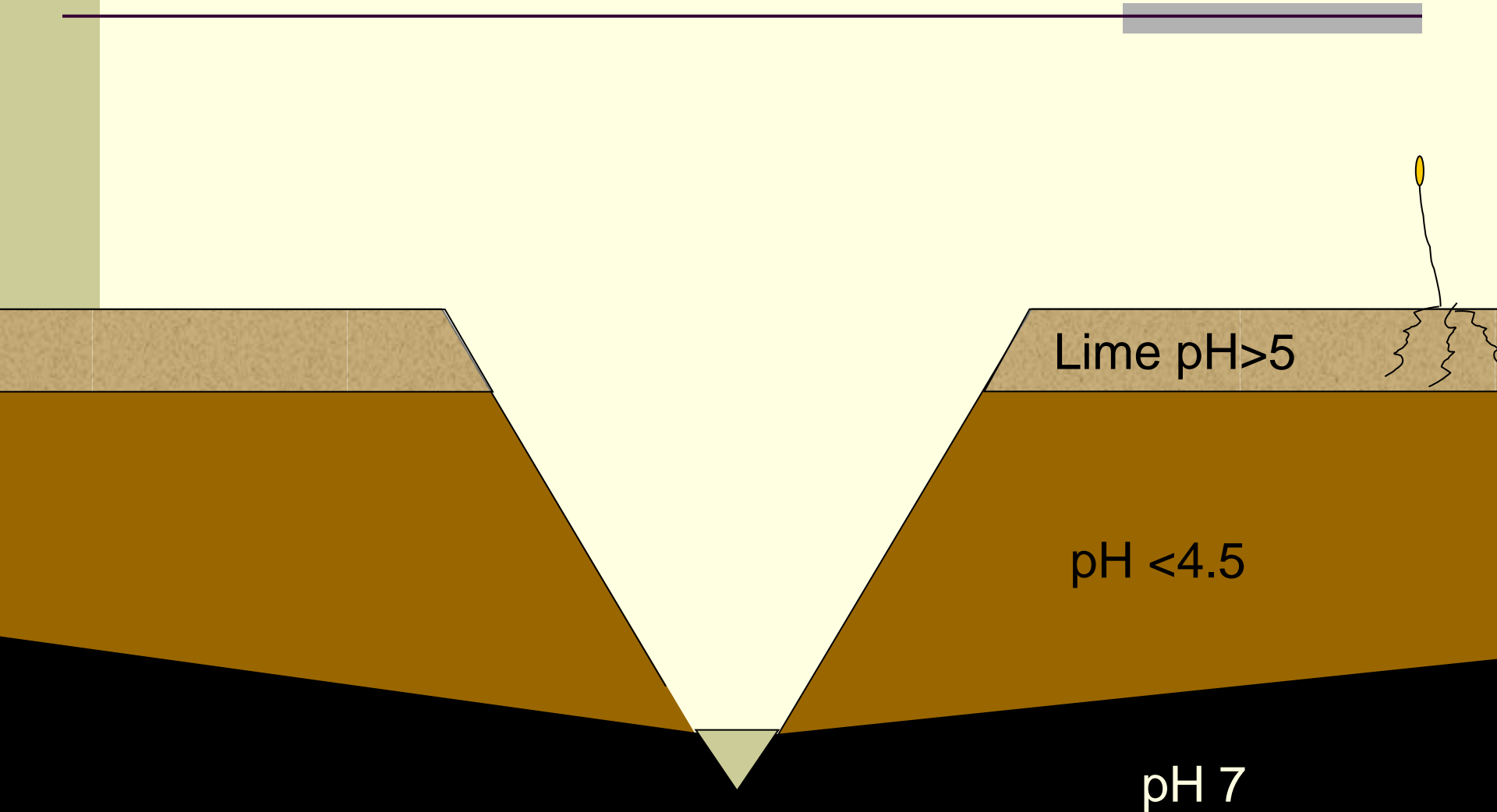


Groundwater



pH 7

Situation after 19th century



Helsingissä

loka kuun 27 p:nä 19 59

N:o 3107

Korsholman koulutilan hoitajalle

Viite: Aikaisemmat keskustelut

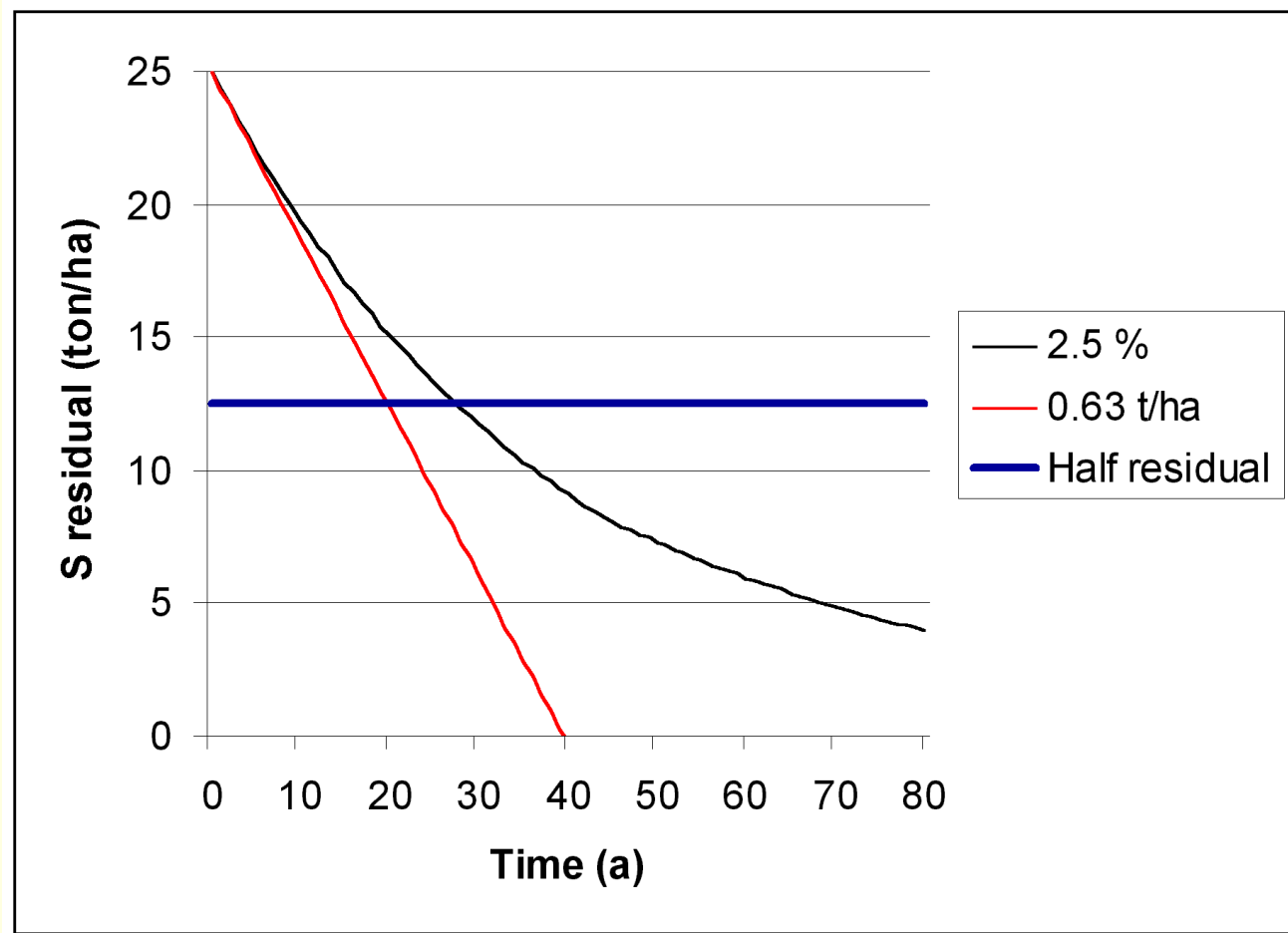
Asia : Risöfladan viljely

Instructions in 1959:

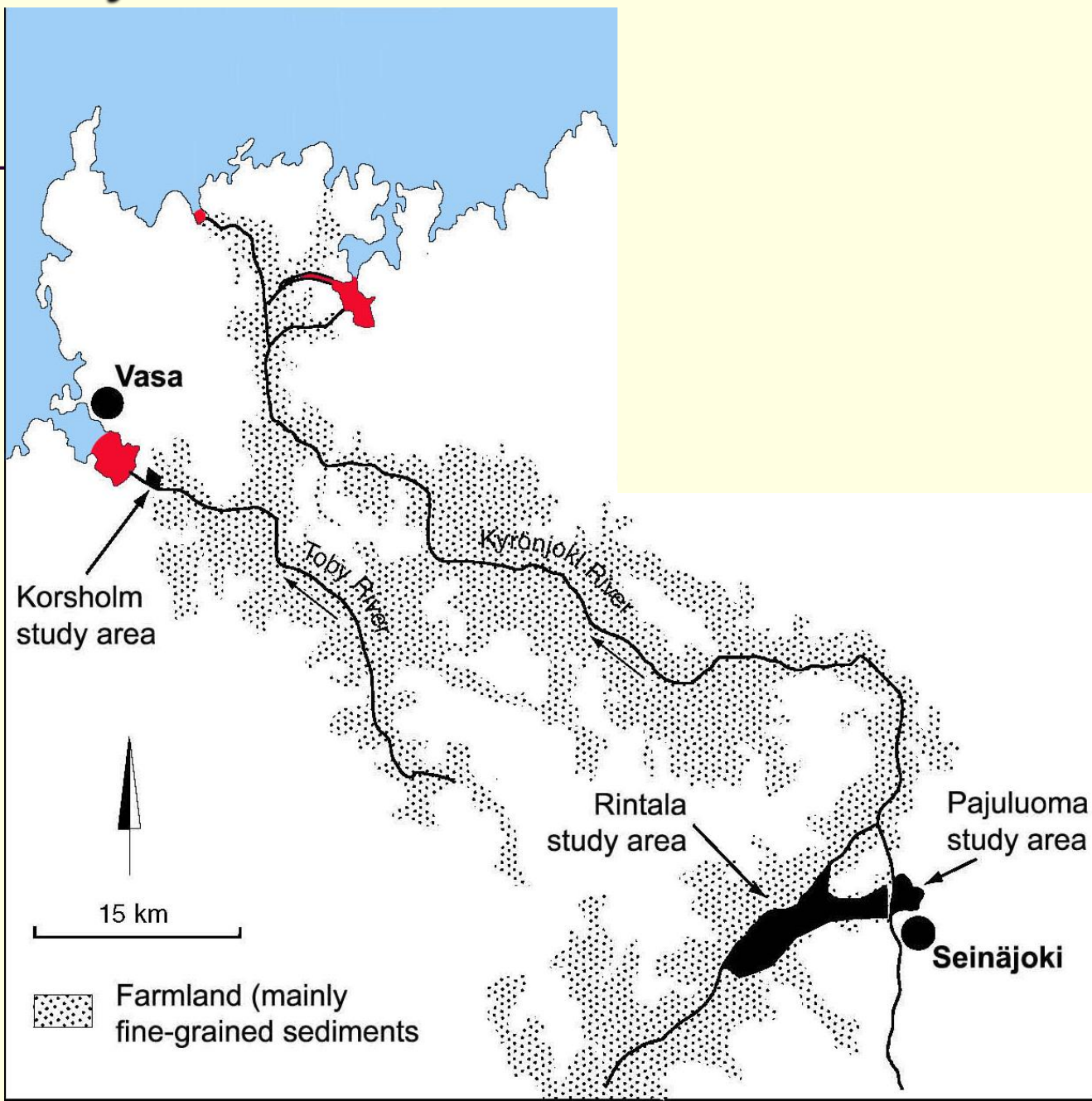
"Acidity and soluble aluminium [in the soil] is best cut down by oxidation, which leaches these away from the plough layer..."

ennen kuin maa tulee viljelyskasveille sopivaksi. Erikoisesti tri Puustjärvi painostaa, että kalkituksen suorittaminen tässä vaiheessa on kannattamatonta ja että sarkojen muoto täytyy pitää kuperana pintavesien valumisen edistämiseksi.

Rate of leaching



>4000 year old sulfides leached in a century!



Drainage started the problem, so can a change in drainage stop the problem?

Arguments for:

Still a lot of sulfide in oxidized zone

Still parent sediments that can be oxidised

Lab experiments on Finnish soils by Virtanen et. al

Etc.

Arguments against:

Irreversible soil structure

Evapotranspiration

Etc.

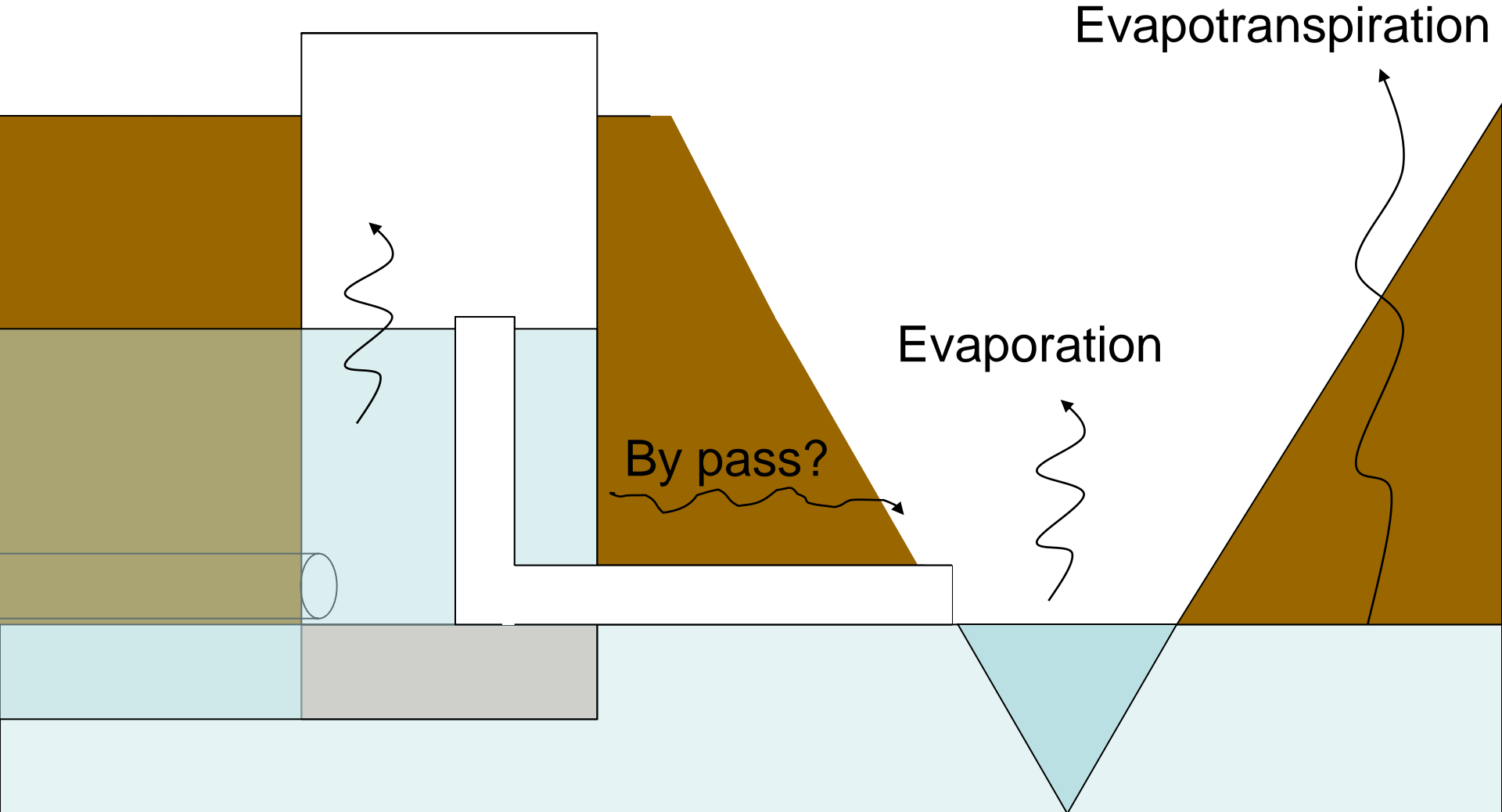
Water balance simplified

- C. 600 mm of rain
- C. 300 mm of evapotranspiration

Many landowners affected by regulation by dams/pumps etc.

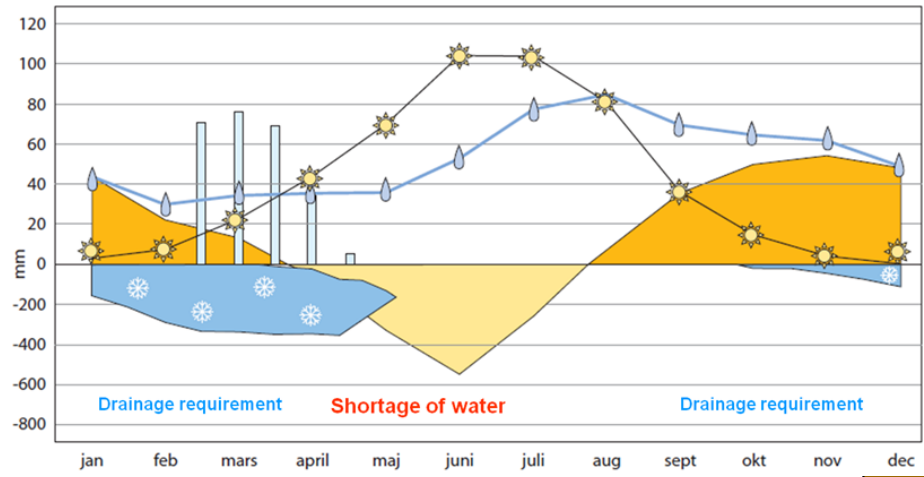
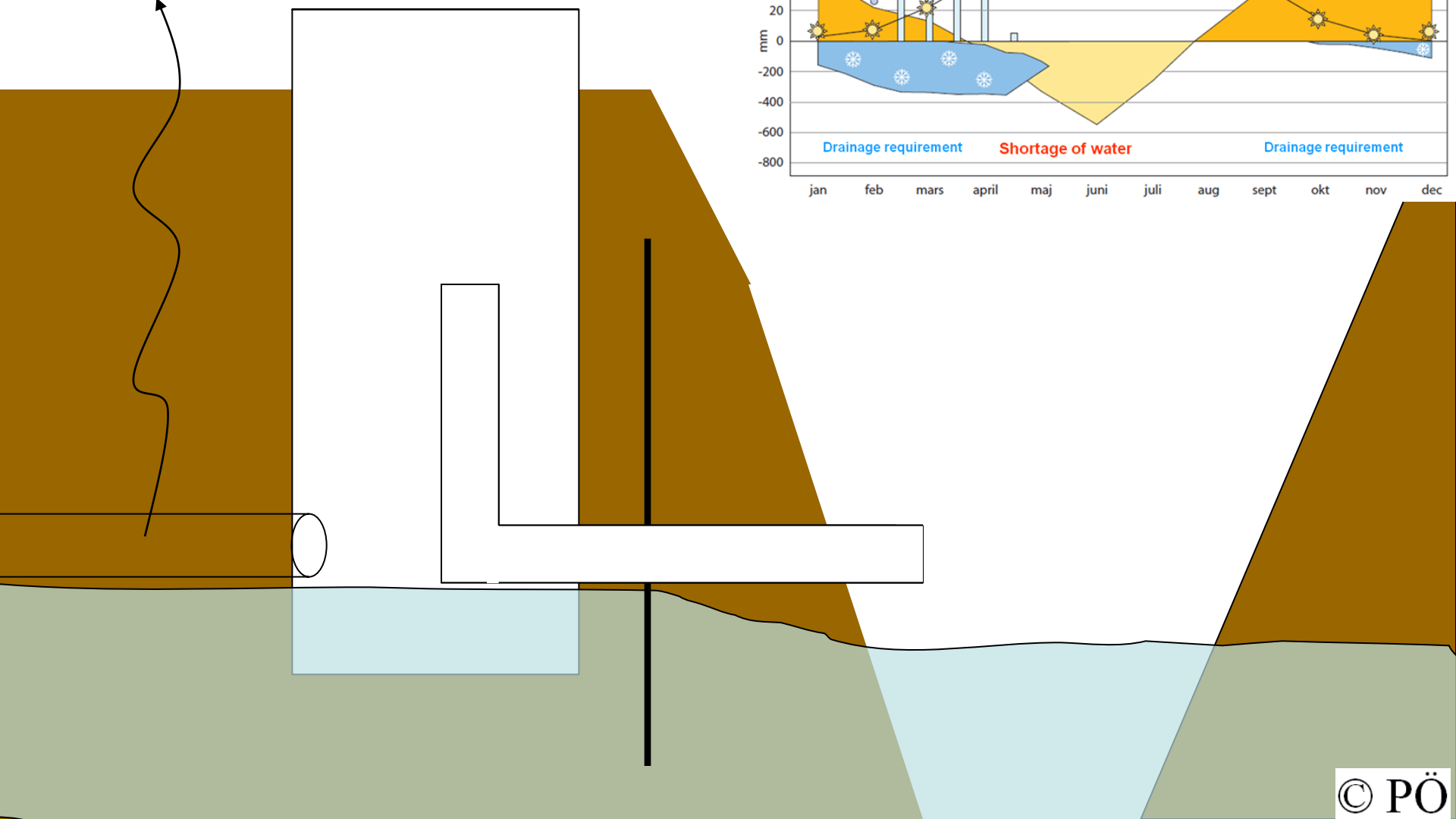


Controlled drainage adaptable by individual farmers



Management important

Evapotranspiration



“Plastic sheet will save the earth...”

Vbl 22.7.2009



Försöksprojektet i Kållby är ett samarbete mellan Pro Agria, Åbo Akademi och Geologiska forskningscentralen. Dräneringstekniker Rainer Rosendahl, projektchef Peter Edén och forskningsledare Peter Österholm förevisar den plastfilm som grävs ner i marken. Foto: Karolina Isaksson

Reglerad dränering är en beprövad metod mot försurning på sura sulfatjordar. I Kållby försöker man dessutom förhindra urlakning med hjälp av plastfilm som grävs ner i marken.

Plastfilm i marken ska rädda jorden

PEDERSÖRE

Ann och Mats Nylunds åker i närheten av riksväg 8 i Kållby,

– Det ska förhindra att det magasinerade vattnet läcker ut förbi reglerbrunnen via por- och

djupgående analyser, för vi vill ju inte gå ut och tala för en metod som inte testats, säger Rainer Ro-

Plastic sheet at 30-180 cm in Pedersöre 2009

- Prevents "by-pass flow"
- c. 4 €/m, all included
- Financed mainly by Renlunds stiftelse, Salaojituksen tukisäätiö and KWH-pipe.
- Site owned by farmer/politician Mats Nylund



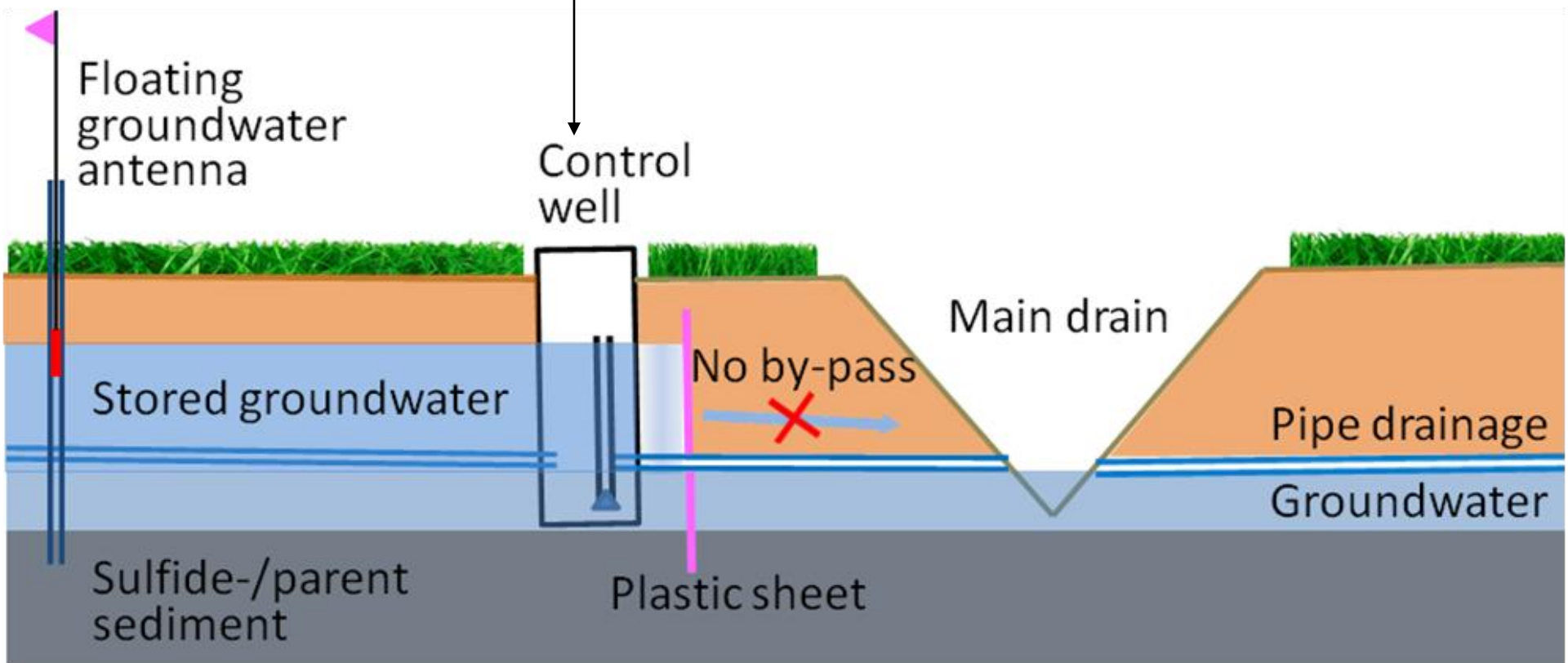
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Climate Change Adaption Tools for
Environmental Risk Mitigation of Acid
Sulfate Soils



Subsurface irrigation





Test sites

Pedersöre



Söderfjärden



Pedersöre site 2008



Pedersöre site 2009



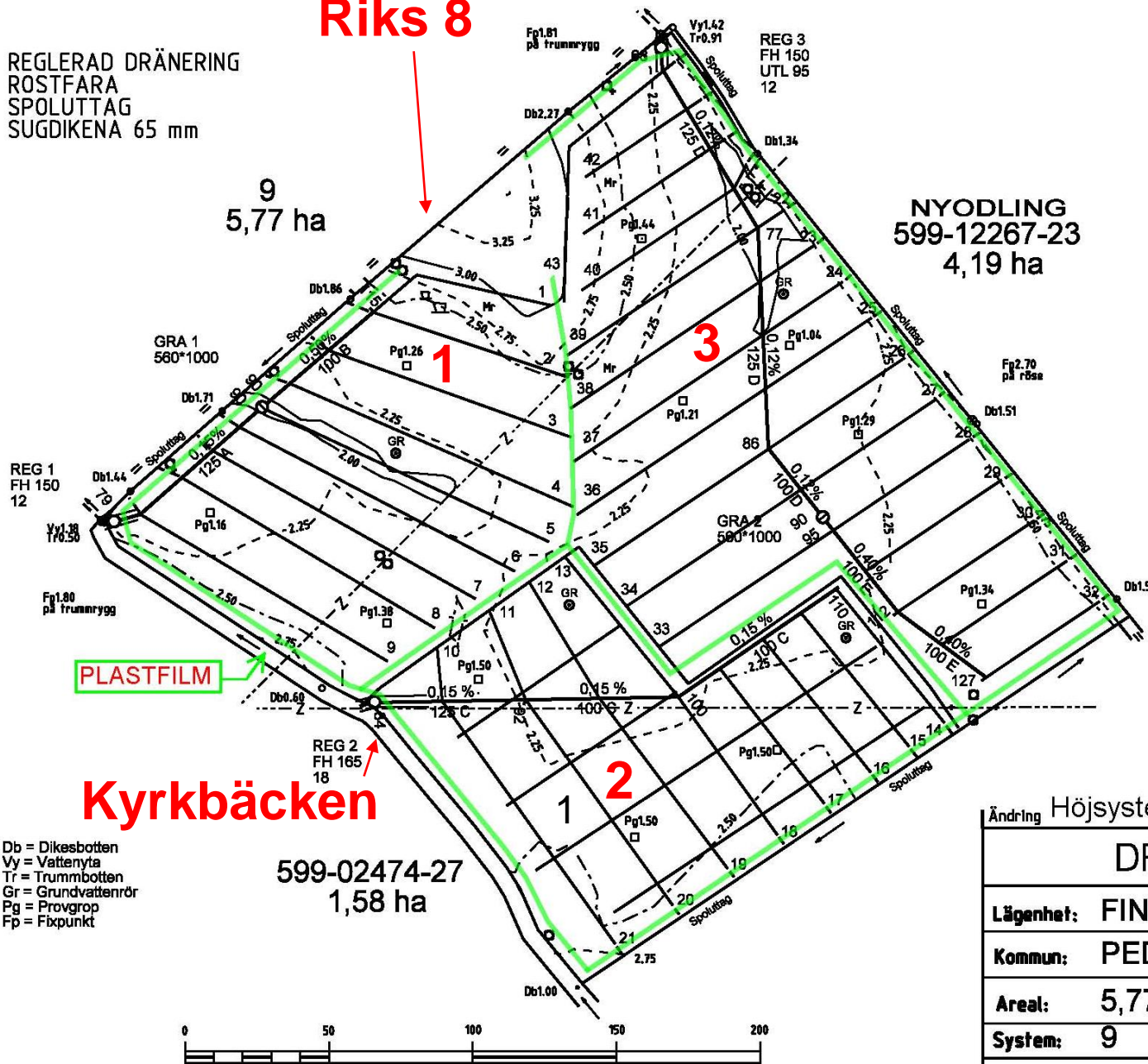
Riks 8

Förr.nr. 48 652

REGLERAD DRÄNERING
ROSTFARA
SPOLUTTAG
SUGDIKENA 65 mm

9
5,77 ha

NYODLING
599-12267-23
4,19 ha



Kyrkbäcken

599-02474-27
1,58 ha

Db = Dikesbotten
Vy = Vattenyta
Tr = Trumbotten
Gr = Grundvattenrör
Pg = Provgrop
Fp = Fixpunkt

Ändring Höjsystem N60, Koordinatsystem KKS

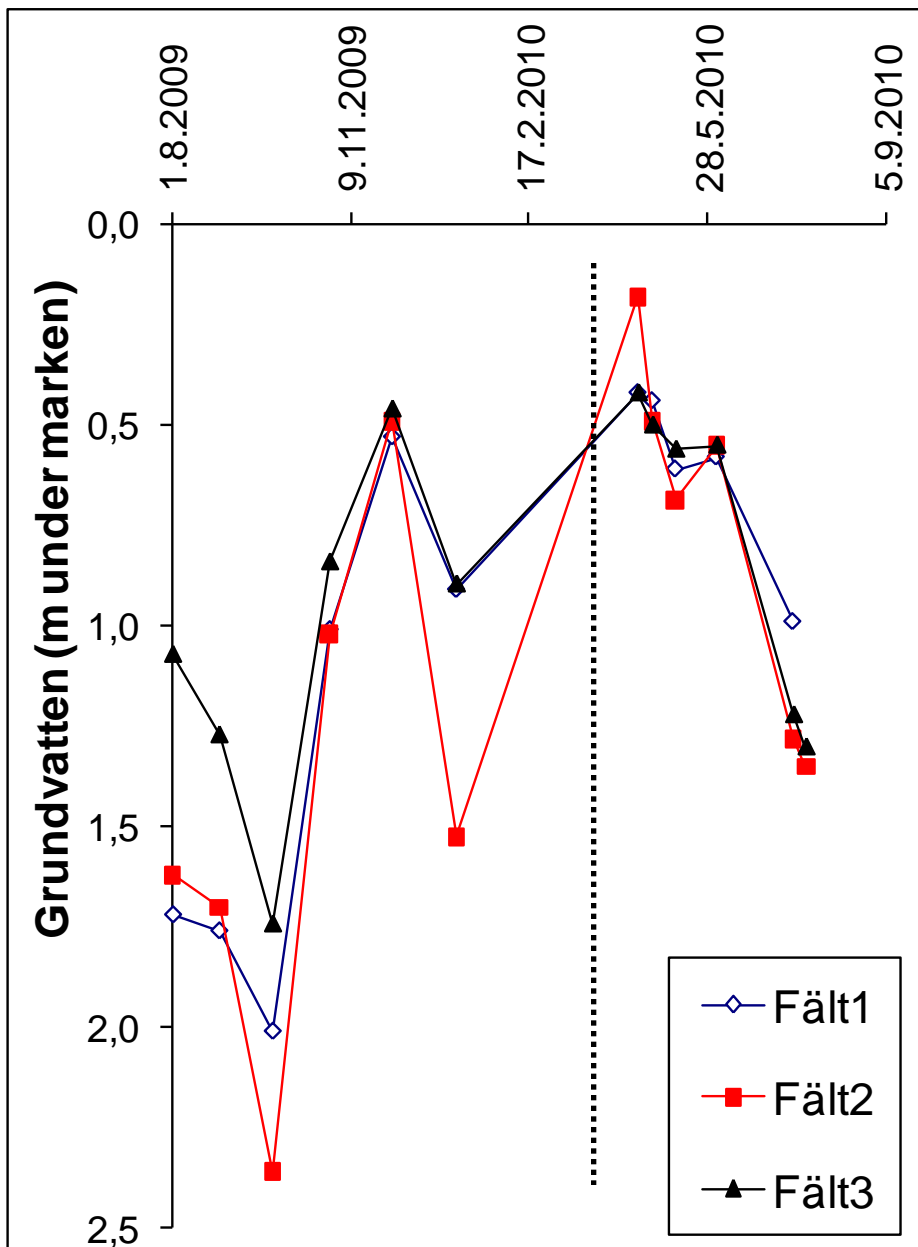
DRÄNERINGSPLAN

| | | | | | |
|-----------|------------|------------|-------------|----------|--------|
| Lägenhet: | FINNA 4:54 | Kart | R.Rosendahl | Rifat | RR |
| Kommun: | PEDERSÖRE | Planerat | RR | Granskat | RR |
| Areal: | 5,77 ha | Dimension. | RR | Skala | 1:2000 |
| System: | 9 | Datum | 8.1.2009 | | |

Pro Agria Lantbrukssällskap

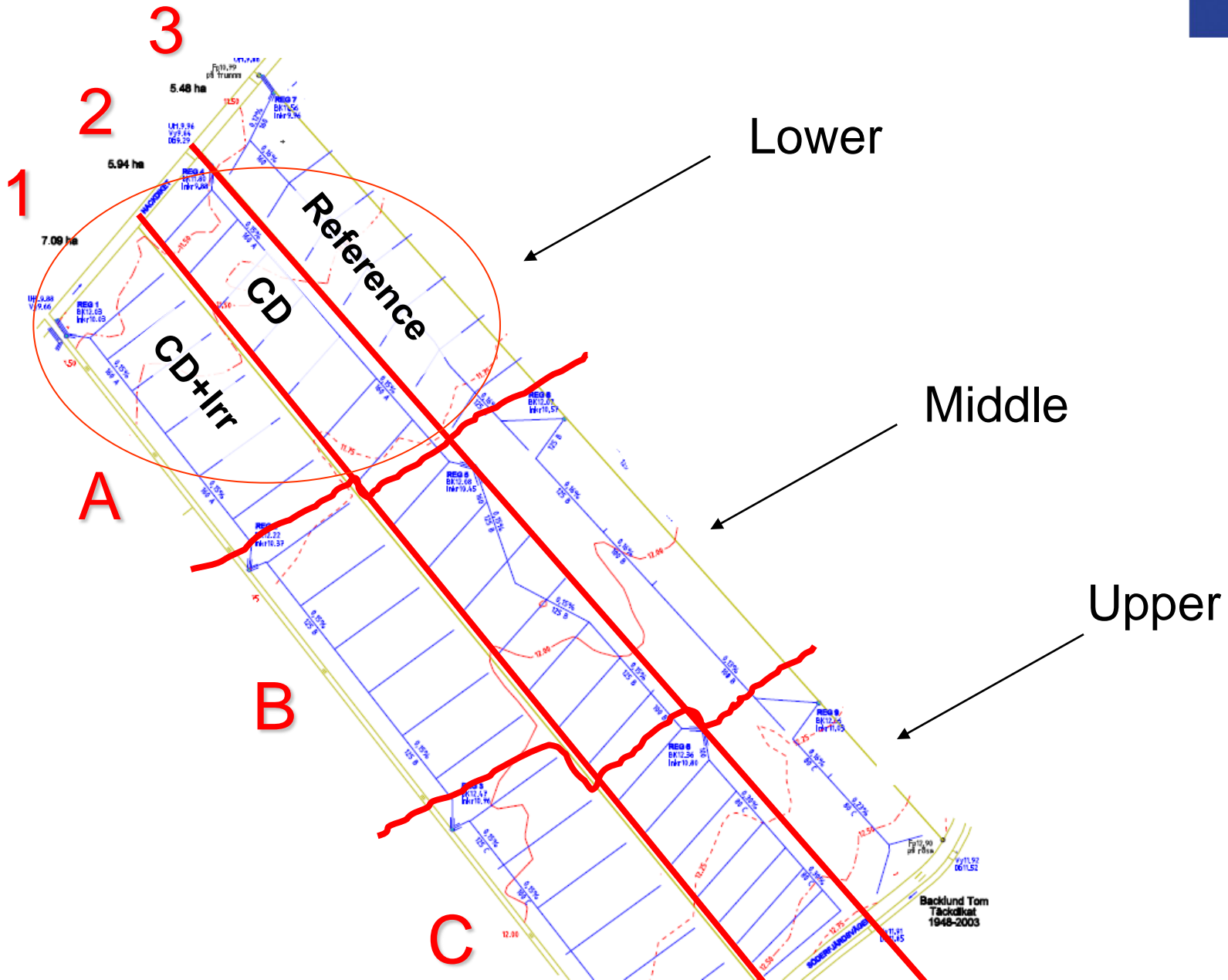


Groundwater in Pedersöre



Groundwater dropped $>0,1$ m/week in middle of July

Söderfjärdens test site





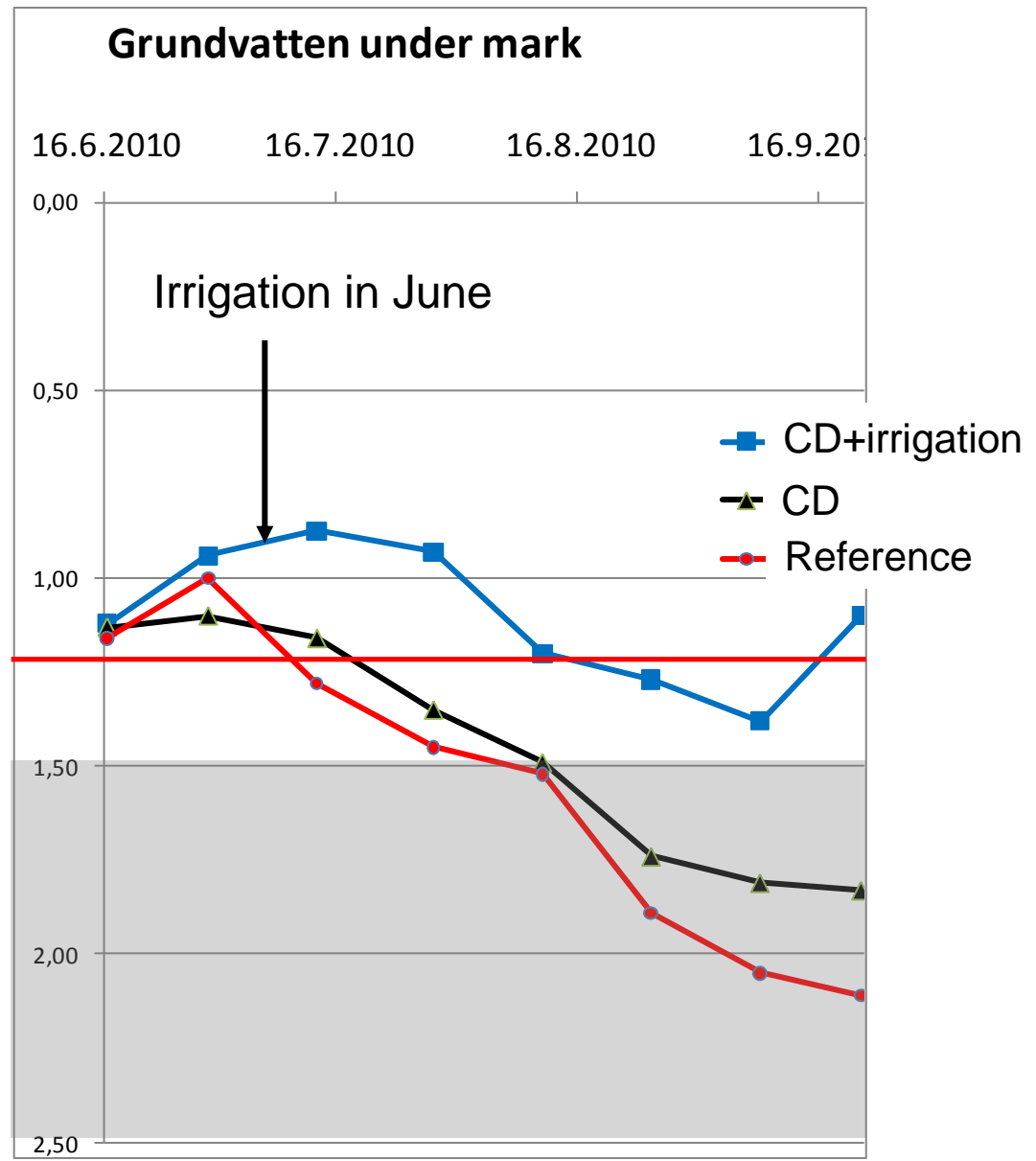
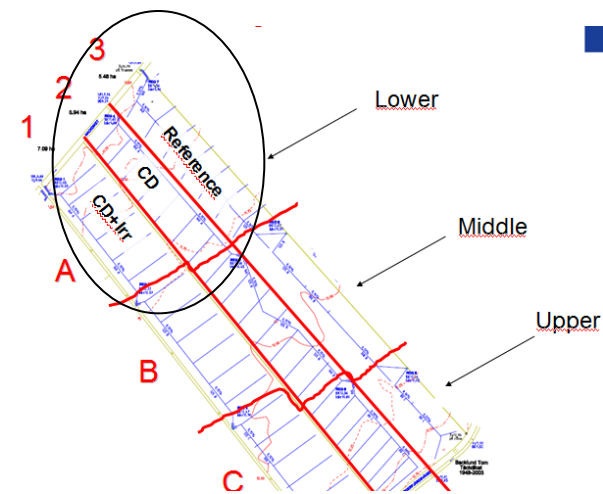
Subsurface irrigation

Stefan Östman





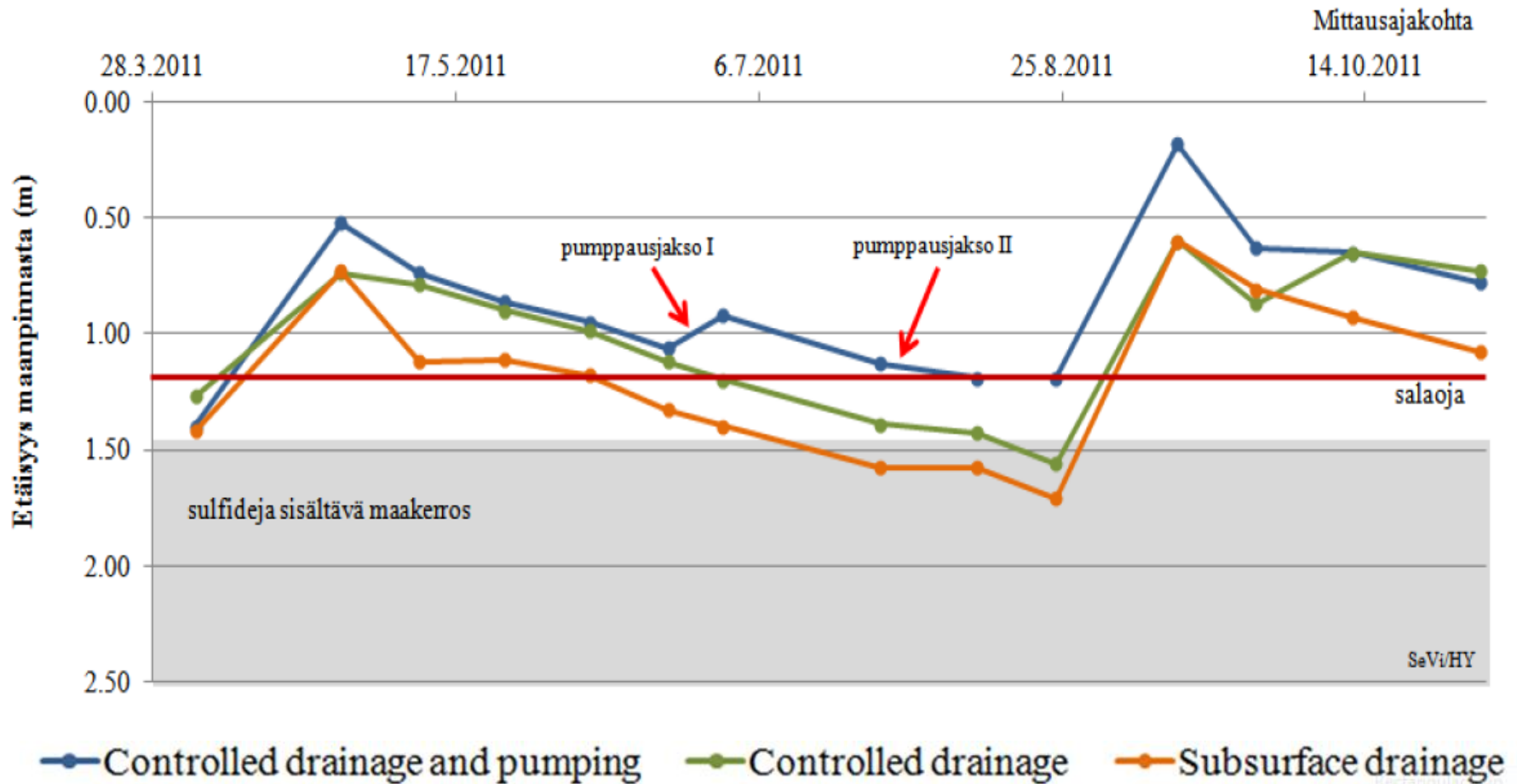
Groundwater in Söderfjärden lower 2010



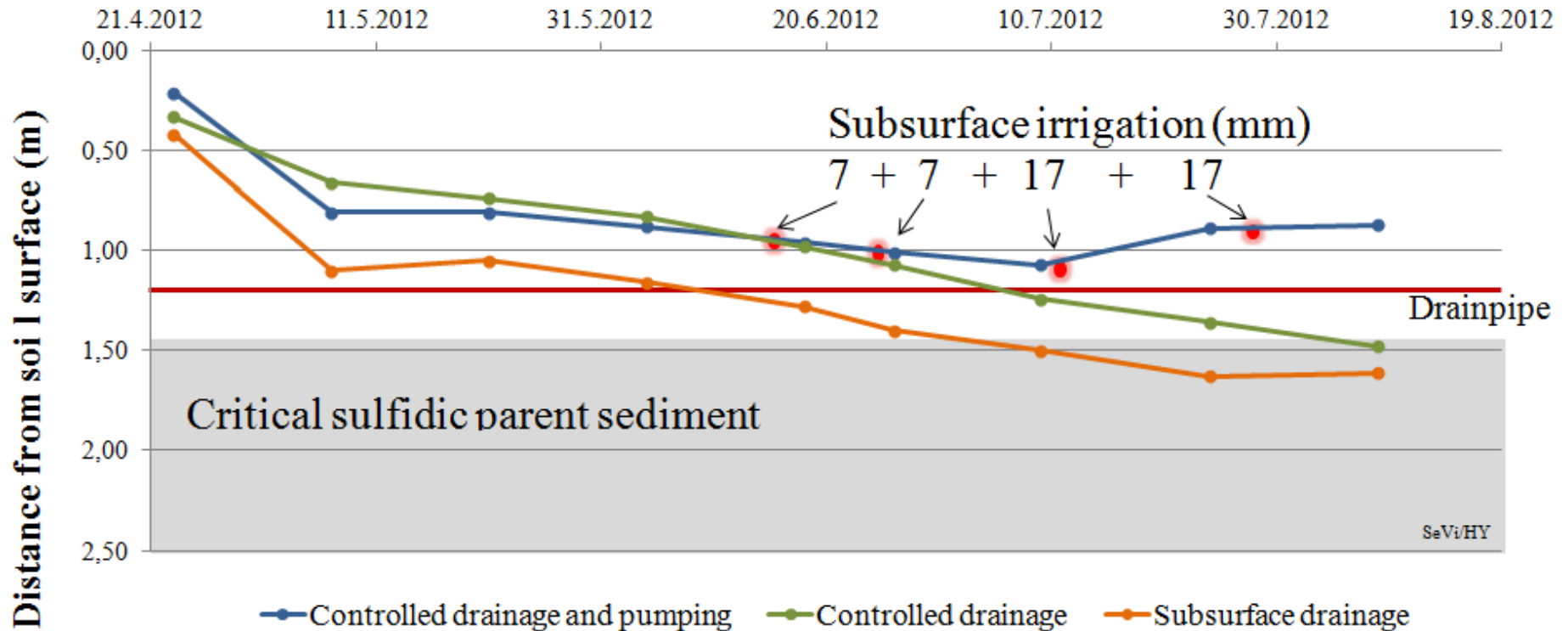


Groundwater in Söderfjärden lower 2011

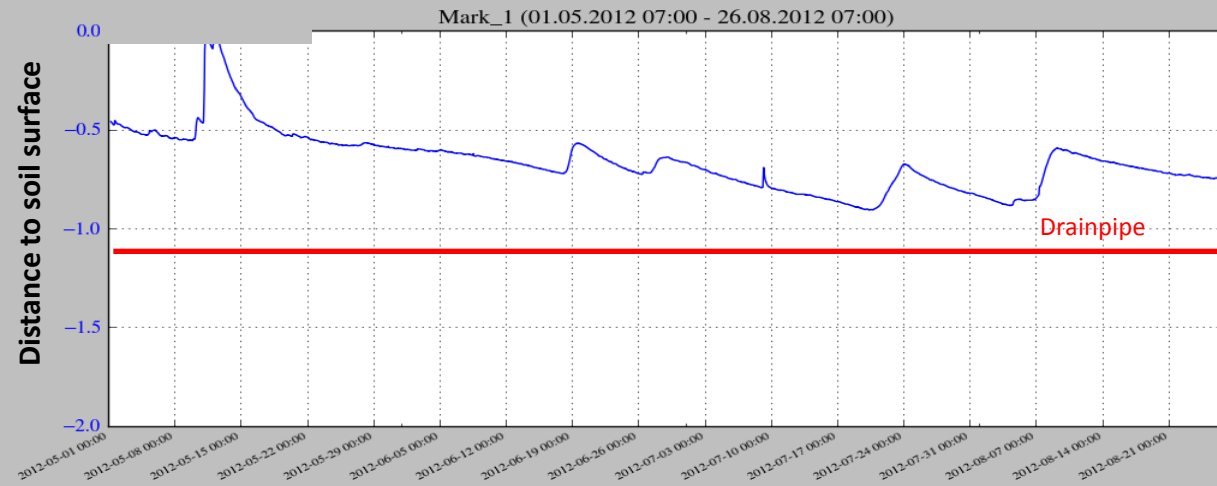
Pohjaveden korkeus eri salaojitustavoilla
Söderfjärden 2011, lohkon alaosa



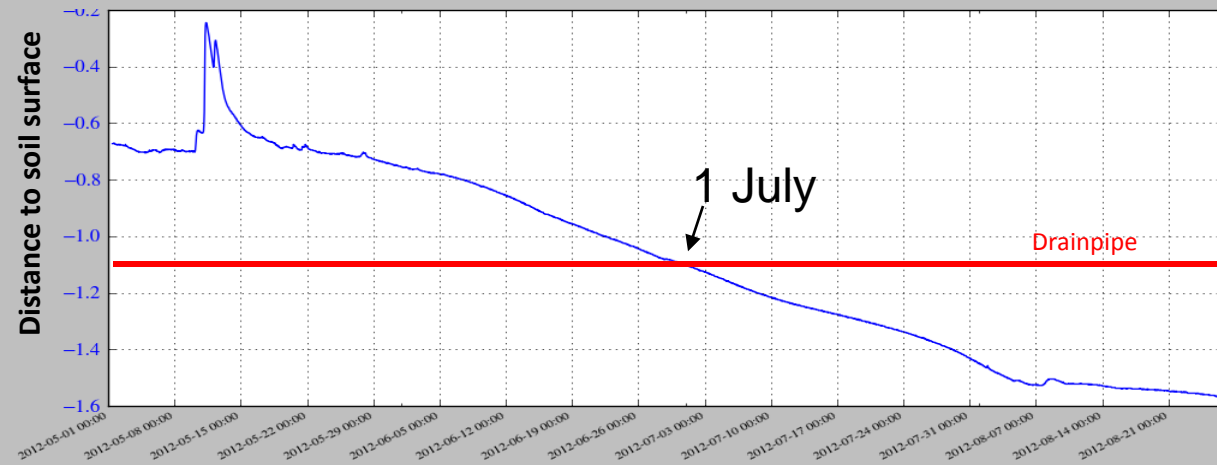
Söderfjärden low 2012



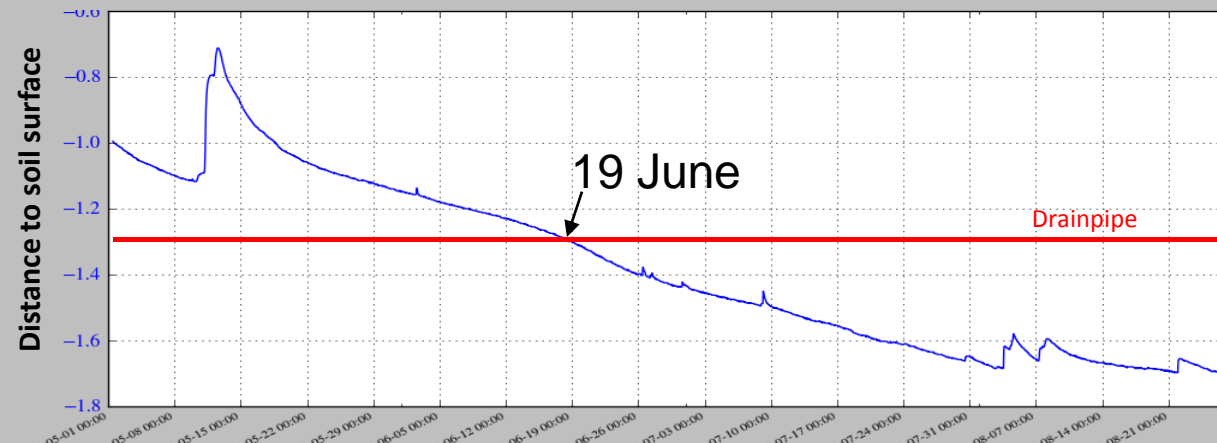
Söderfjärden 2012



Controlled drainage + irrigation



Controlled drainage

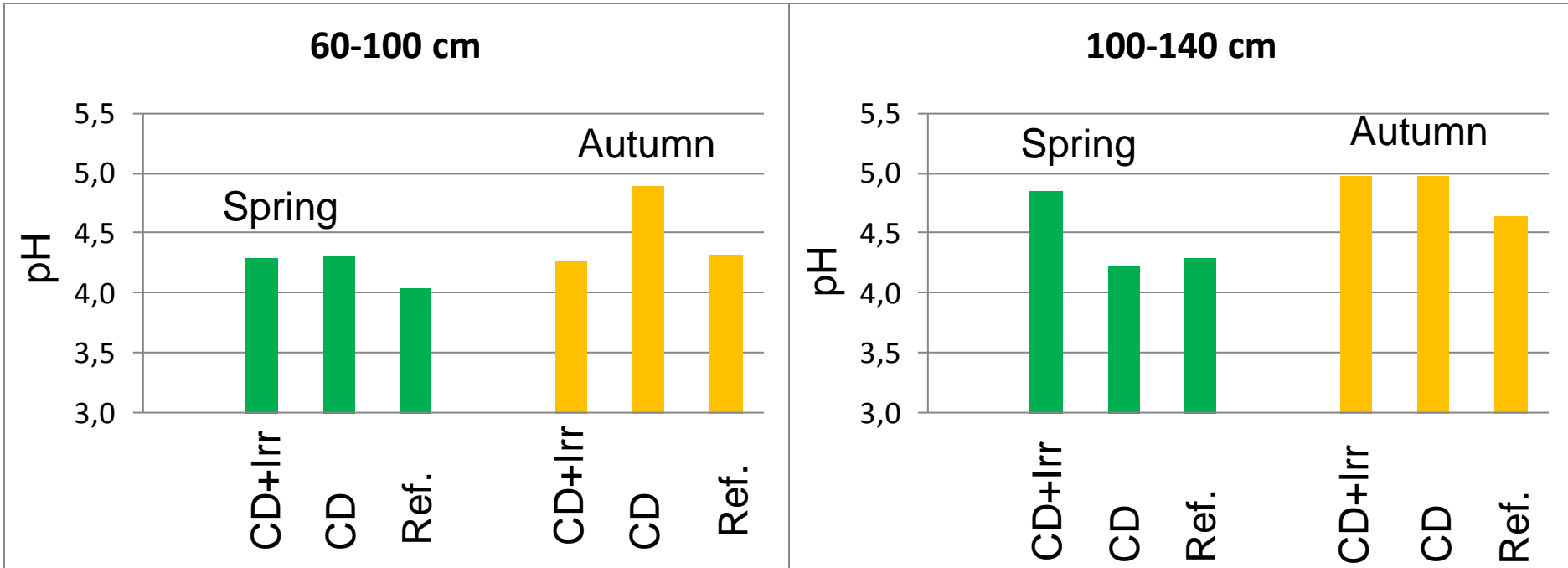


Reference

Söderfjärden water balance 2011

| Water (mm) | CD+Irr. | CD | Reference |
|-----------------------|----------------|------------|------------------|
| Precipitation (water) | 405 | 405 | 405 |
| Precipitation (snow) | 135 | 135 | 135 |
| Irrigation | 31 | | |
| Total input | 571 | 540 | 540 |
| Runoff | 190 | 196 | 194 |
| Evapotranspiration | 381 | 345 | 346 |

Soil pH in Söderfjärden lower 2012



Note pH>4

Conclusions

- Farmland AS soils quantitatively important
- Drainage is the cause, and smarter drainage perhaps the solution
- In theory, an increase in groundwater can decrease sulfide oxidation and reduce sulfate

Conclusions

- CD no effect if water not stored in spring
- CD with by-pass flow prevention can be used to delay the groundwater drop
- Irrigation with by-pass flow prevention can raise groundwater significantly
- Effects on soil chemistry not yet seen