Greenhouse gas emissions and nutrient losses to water from an acid sulfate soil with different drainage systems

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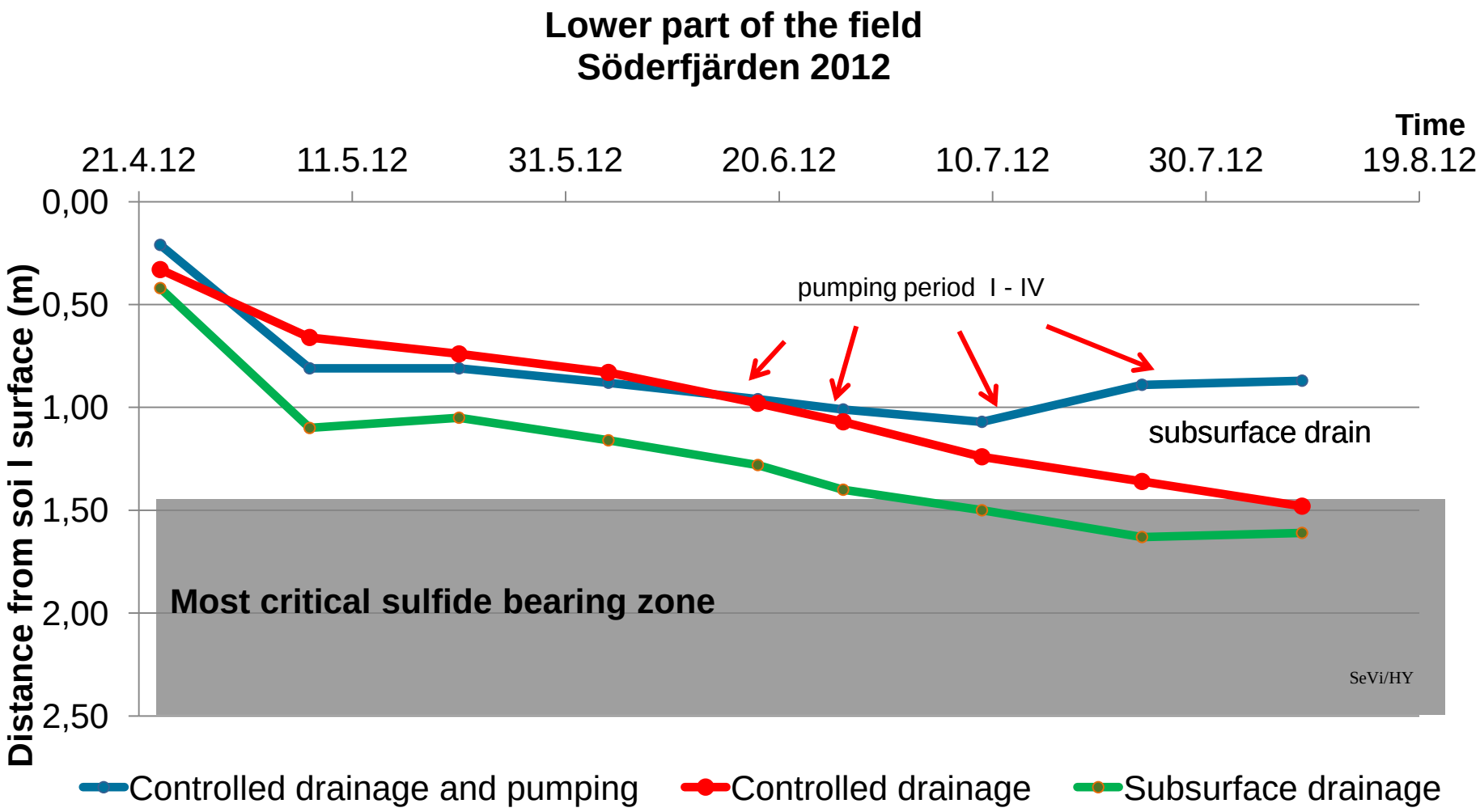
Groundwater level vs. sulfide zone



Aim of the study at Söderfjärden

To decrease oxidation of sulfide zones by keeping them below groundwater level. There was studied the effects of high groundwater level on

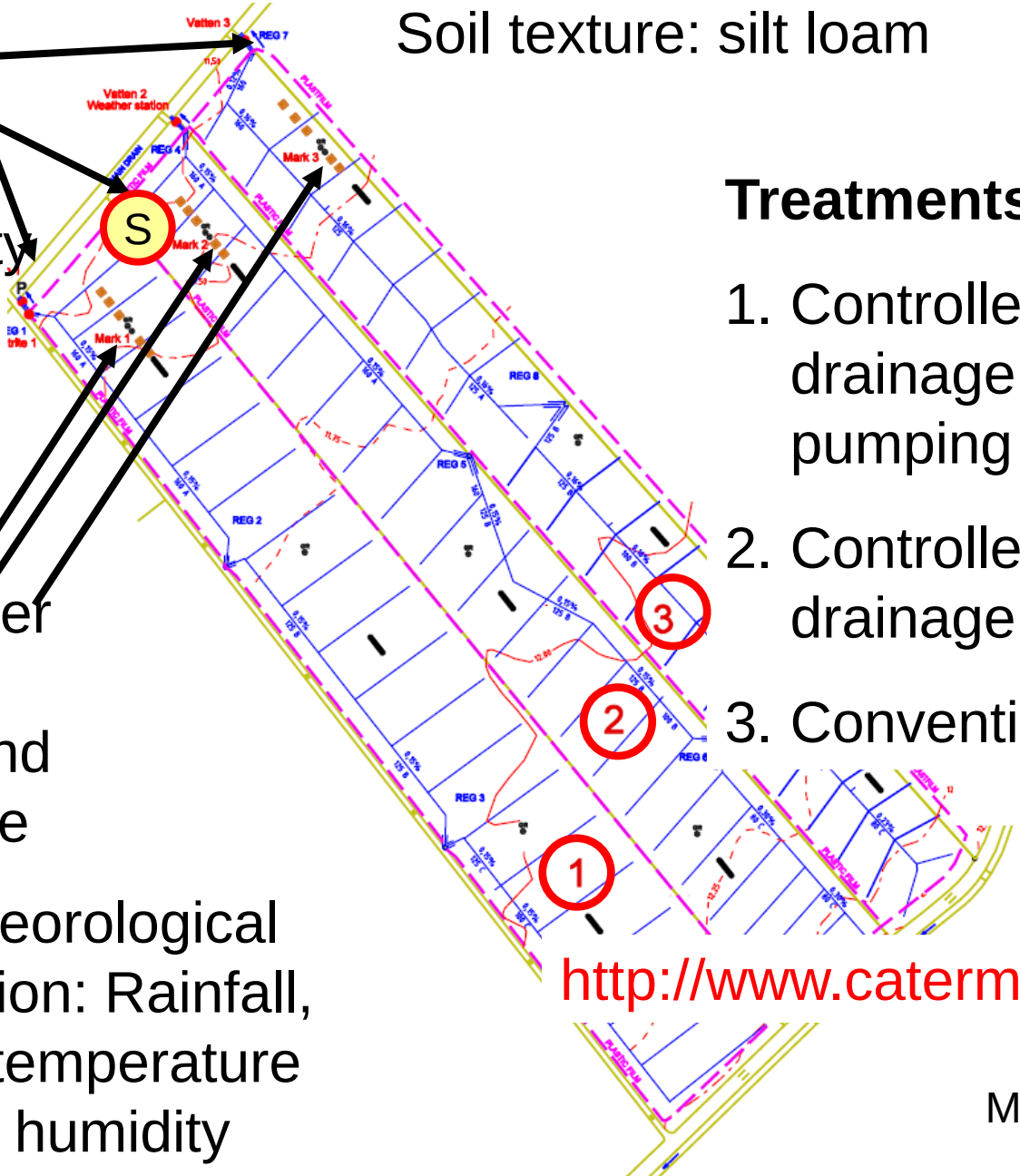
- production of acidity
- greenhouse gas emissions
- nutrient and metal losses to water
- cultivated crops

Söderfjärden experimental field

Vatten 1–3:
Water flow, pH, Conductivity

Mark 1–3:
Groundwater level, Soil moisture and temperature

Soil texture: silt loam



Treatments:

1. Controlled subsurface drainage with additional pumping of water
2. Controlled subsurface drainage
3. Conventional drainage

S Meteorological station: Rainfall, Air temperature and humidity

http://www.catermass.fi/

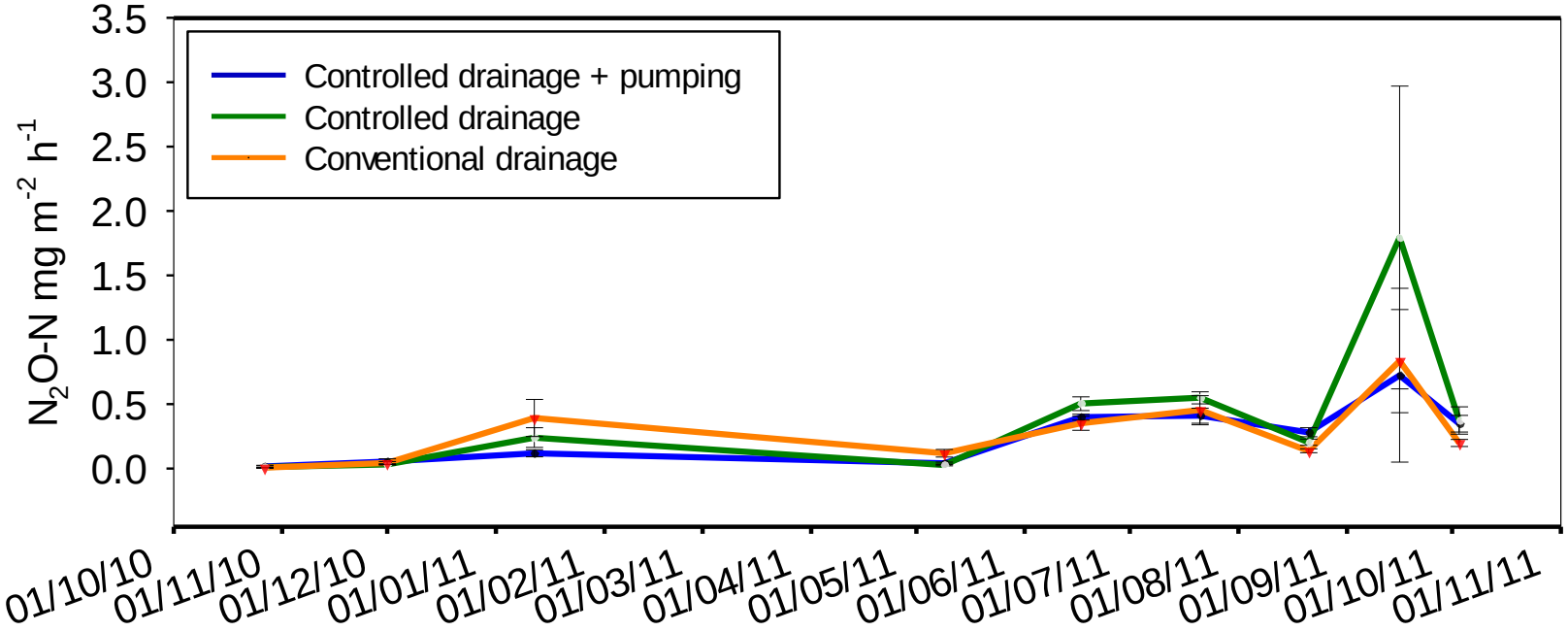
Map: R. Rosendahl

Manual and *automatic* measurements

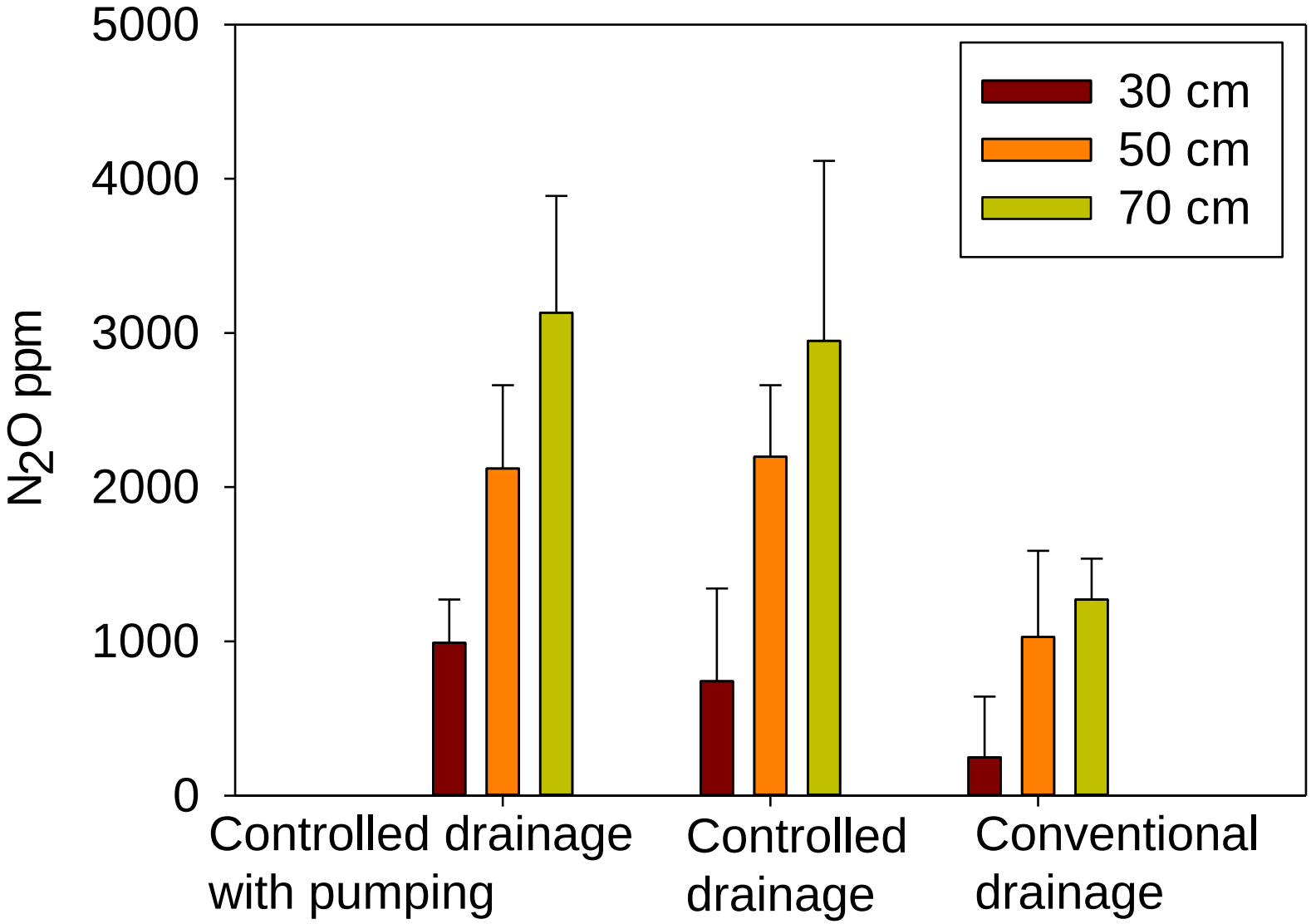
- Greenhouse gas emissions: N_2O, CO_2
- Groundwater level: *lower end of each plot*
- Drainage water: *concentrations of nutrients and metals, flow, pH, conductivity,* NO_3-N + NO_2-N
- Soil: *pH, concentrations of plant-available nutrients, soil temperature and moisture*
- Meteorological station: *Rainfall, air temperature, air humidity*
- Crop: *grain yield, concentrations of nutrients and harmful heavy metals*

Nitrous oxide emissions

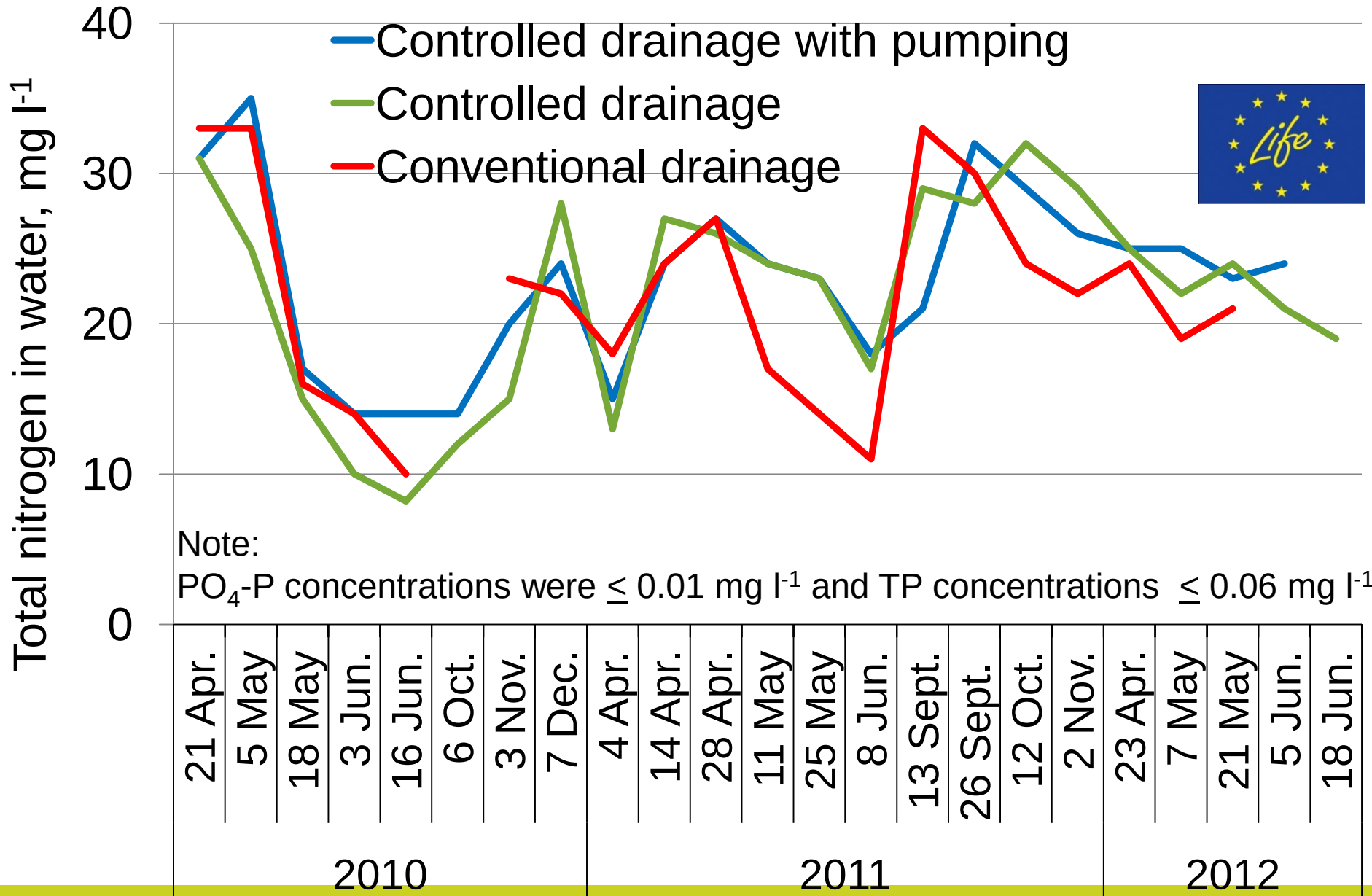
- Average flux of N_2O was 79 g N ha^{-1} day^{-1} which is very high compared to mineral soils in general and high even if compared to organic soils.
- There were no statistically significant differences in N_2O emission rates between the three drainage treatments.



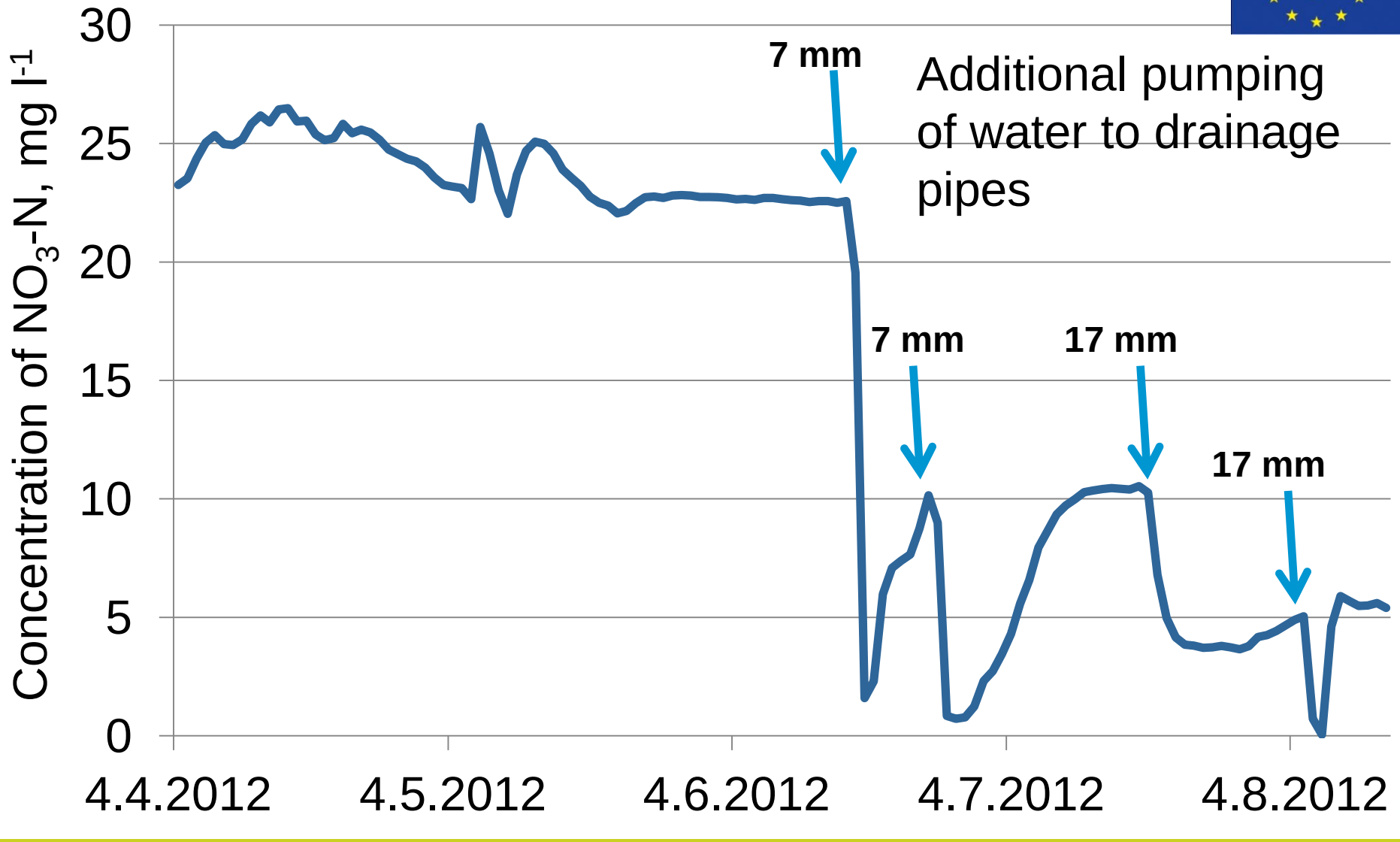
N_2O concentration in soil profile



Total nitrogen in drainage water

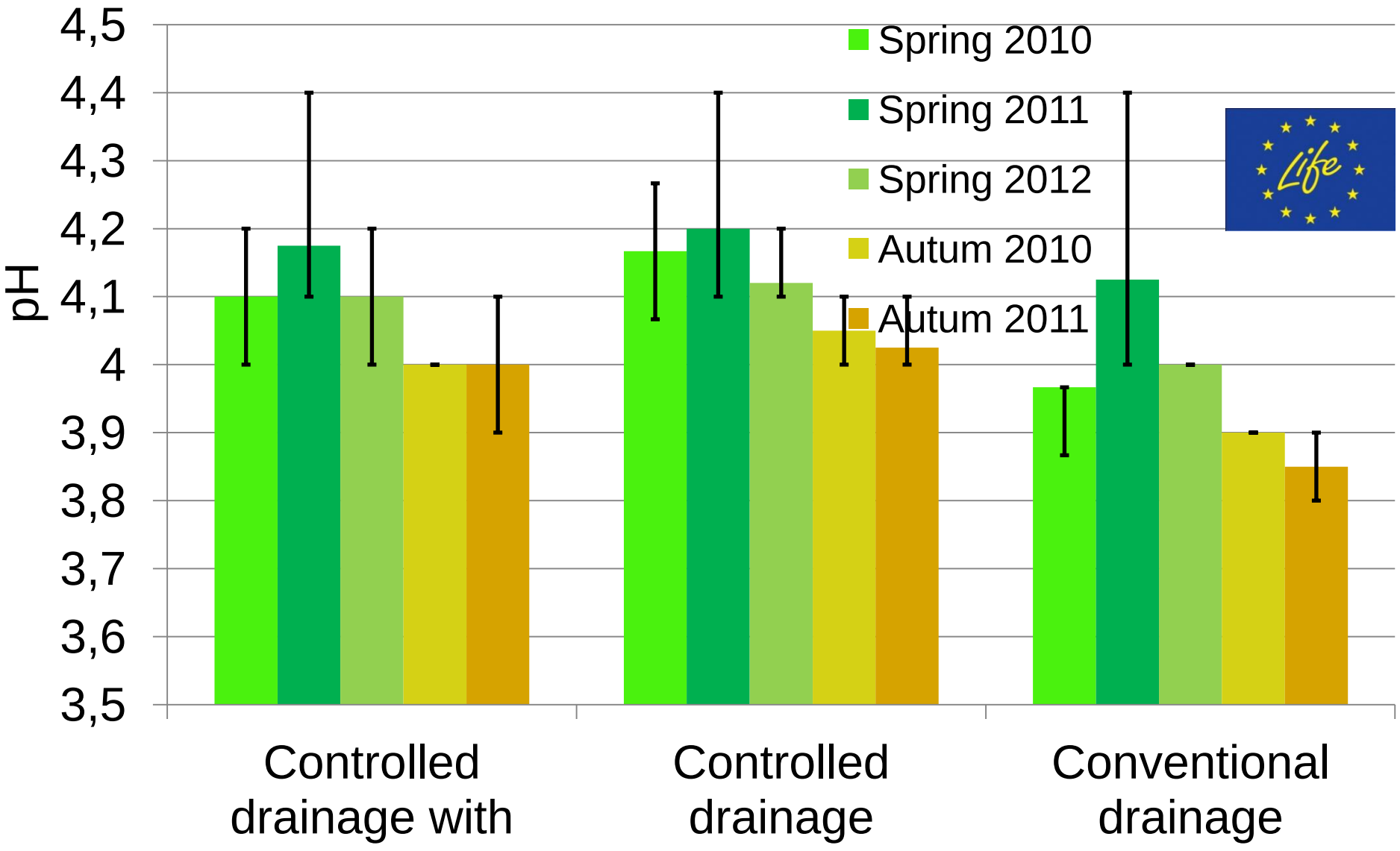


NO_3-N in water from controlled drainage with additional pumping

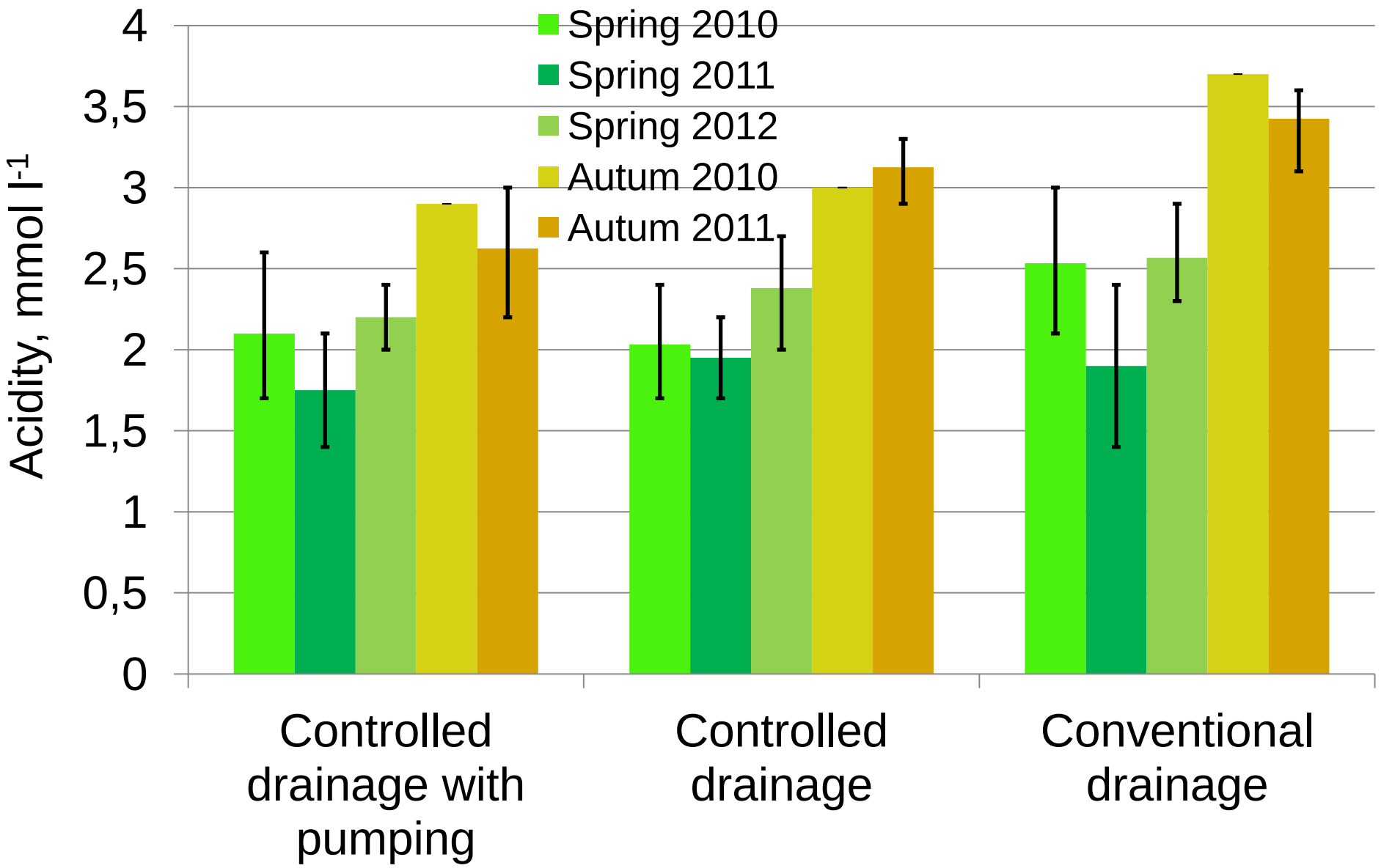


pH in drainage water

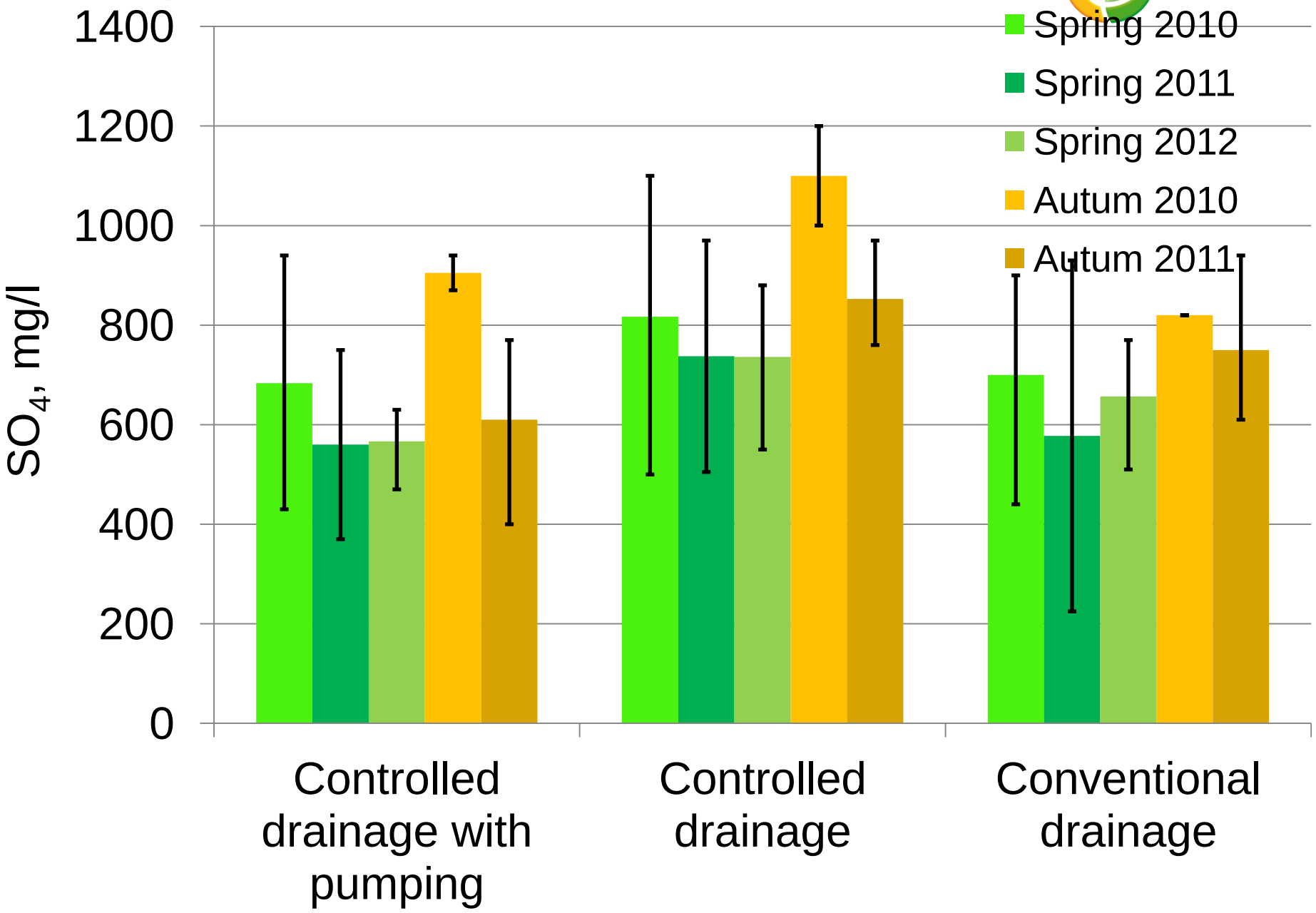
Soil pH: 6.6–7.1 in plough layer (0–25 cm) and 5.4–6.5 in subsoil (25–40 cm)



Acidity of drainage water



SO_4 in drainage water



Grain yields and nutrient concentrations

- Barley yield was 4000 – 5400 kg ha^{-1} in 2010 and wheat yield 5500 – 5900 kg ha^{-1} in 2011. No differences were detected between treatments so far.

- There were no differences in test weight (kg hl^{-1}) or thousand seed weight between treatments.

-Concentrations of nutrients and harmful heavy metals in the harvested crops were within the normal range during the first two years

Conclusions

- N_2O emissions were very high from the AS soil. High microbial activities and N content in the subsoil may be the source of the high emissions.

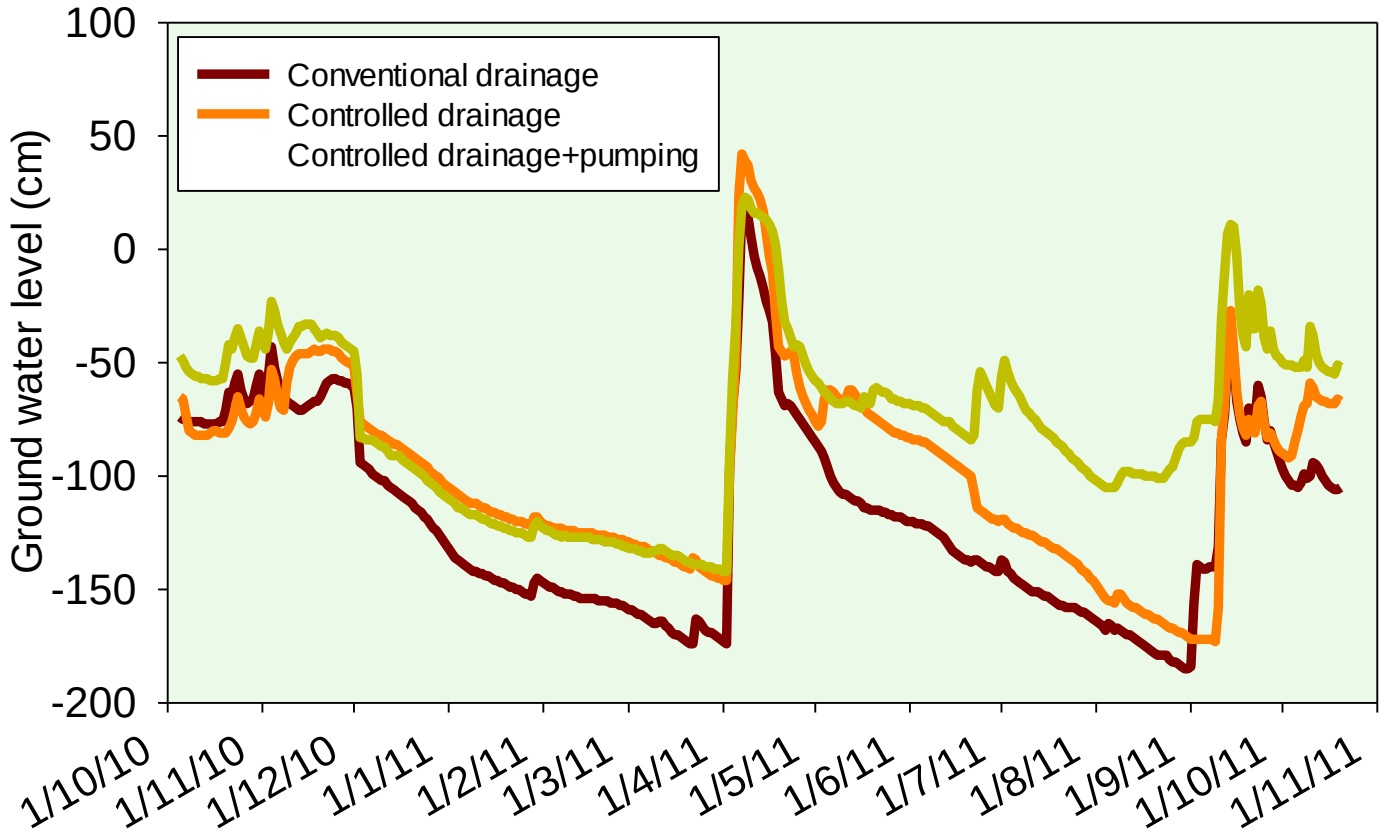
- Cereal cultivation of AS soil seems to produce large NO_3-N losses to drainage water (50 kg ha^{-1} yr^{-1}) as well.

- No yield effect during the first two years due to elevated ground water level.

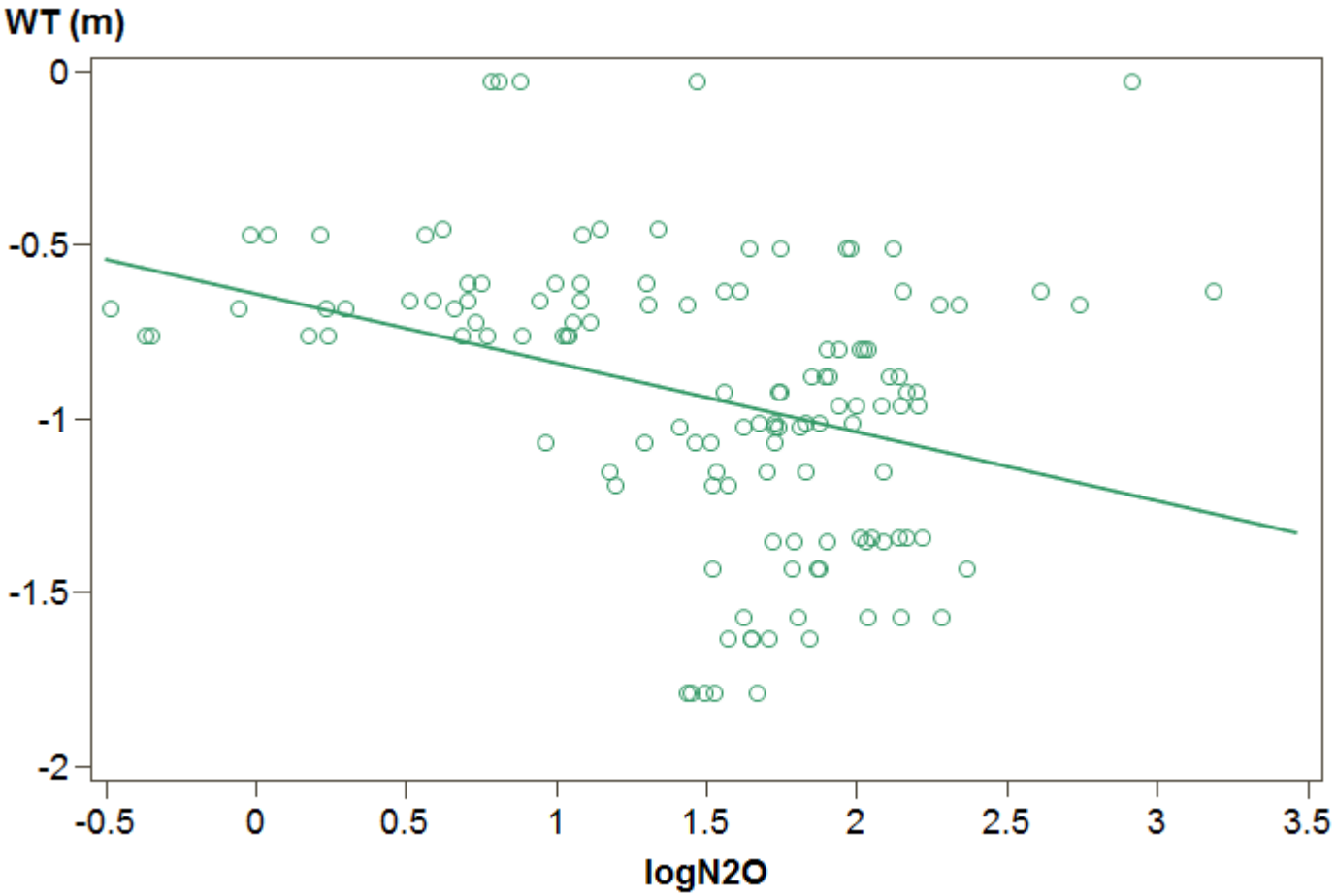
- These are preliminary results and monitoring should be continued for some years.

Thank you for your attention!

Introduction



Effect of water table level



- Lowest flux rates of N_2O were found with high groundwater (r=0.34***)

Experimental soils in Söderfjärden

- Soil texture silt loam

-Soil pH was 6.6 – 7.1 in plough layer (0-25 cm) and 5.4-6.5 in subsoil (25-40 cm)

-Macronutrients (P, Ca, Mg, K, S) were at least the level of satisfactory. Only field number 3 had a lower plant available P compared to fields number 1 and 2

→ Field 3 fertilized with mineral fertilizer containing P (15 kg ha^{-1})

-Plant available micronutrient concentrations (Cu, Mn, Zn, Fe) were analyzed with AAAc-EDTA method.

→ Zn and Mn concentrations were below the level of satisfactory