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Asko Simojoki, Vaclav Krištůfek &  
Markku Yli-Halla**

**Microbial community in boreal  
acid sulphate soil:**

**vertical distribution, activity  
assessment, and potential for  
greenhouse gas emissions**

**Long-term links and collaboration  
(teaching, research)**

**between groups from  
Ceské Budejovice (CZ)  
and Helsinki (FI)**

# WHY

**microbial communities in the ASS?**

# **Soil microbial communities**

**= important in soils, but  
influencing the environment  
(water, air)**

# **WHY** microbial communities in the ASS?

- **The ASS occupy large areas**
- **The ASS are of a great importance**
- **The ASS have not been studied yet**

# **WHY** microbial communities in the ASS?

- **The ASS occupy large areas**
- **The ASS are of a great importance**
- **The ASS have not been studied yet**

**There is a potential to improve our knowledge about distribution of microorganisms in nature.**

**What has been (well) known?**

**Boreal ASS contain large  
amounts of**

**organic carbon and nitrogen  
in subsoils!**

# **ASS**

**greenhouse gas emission**

**Hot – Spots?**



## **ASS hot spots - hypothesis**

large emissions of CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O from AS soils could occur,

## **ASS hot spots - hypothesis**

large emissions of CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O from AS soils could occur,

if the soil conditions, e.g. aeration status, change, **provided relevant microorganisms are present !!!**

# **Methods**

**Study area: Viiki Exp. Farm, Uni Helsinki**

**Soils: ASS (Sulfic Cryaquept)  
Control (Aquic Haplocryoll)**



**ASS (Sulfic Cryaquept)**



**Control (Aquic Haplocryoll)**





# **Methods**

**Sampling: 2008 (pilot),  
autumn 2009, 2010, 2011**

**Analyses: total C, N, mineral N, pH...etc.**

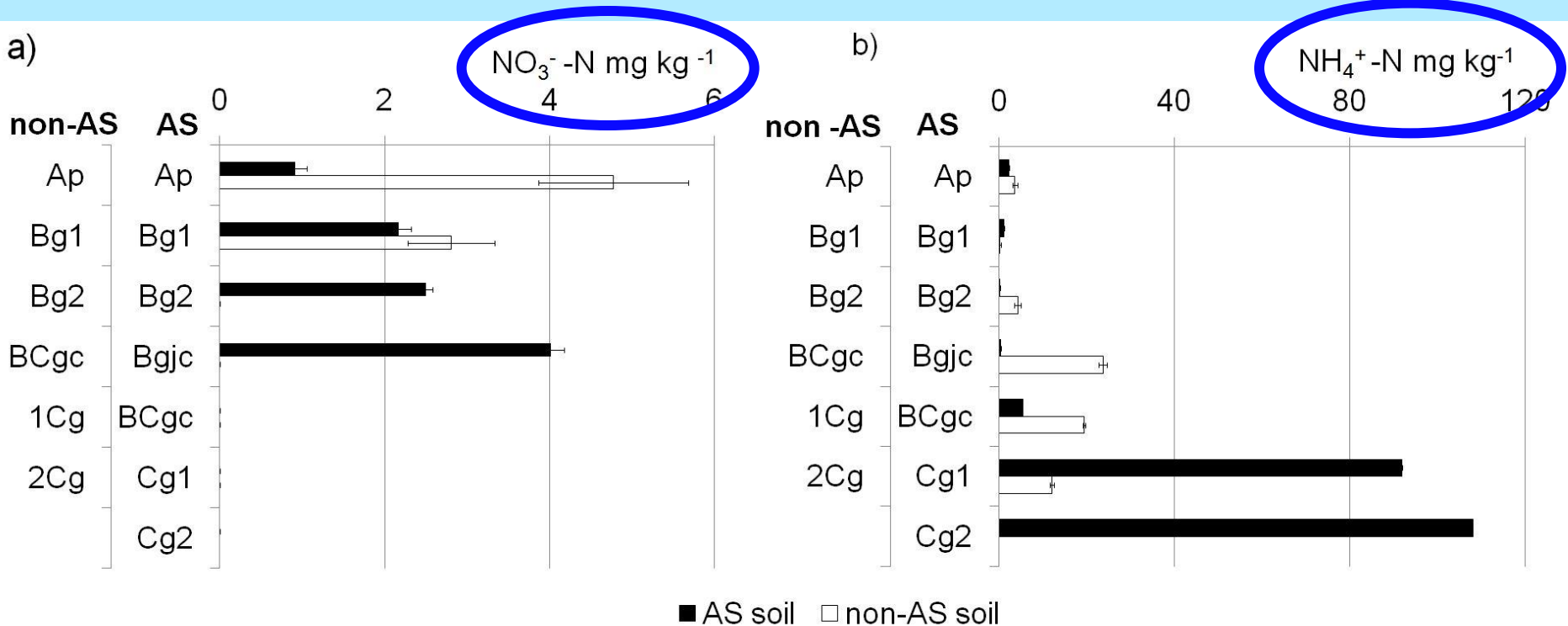
# **Methods (cont.)**

## **Analyses (2009):**

**Various „traditional“ microbiological  
measures:**

**Respiration, SIR, DHA, DEA, CFU, counting**

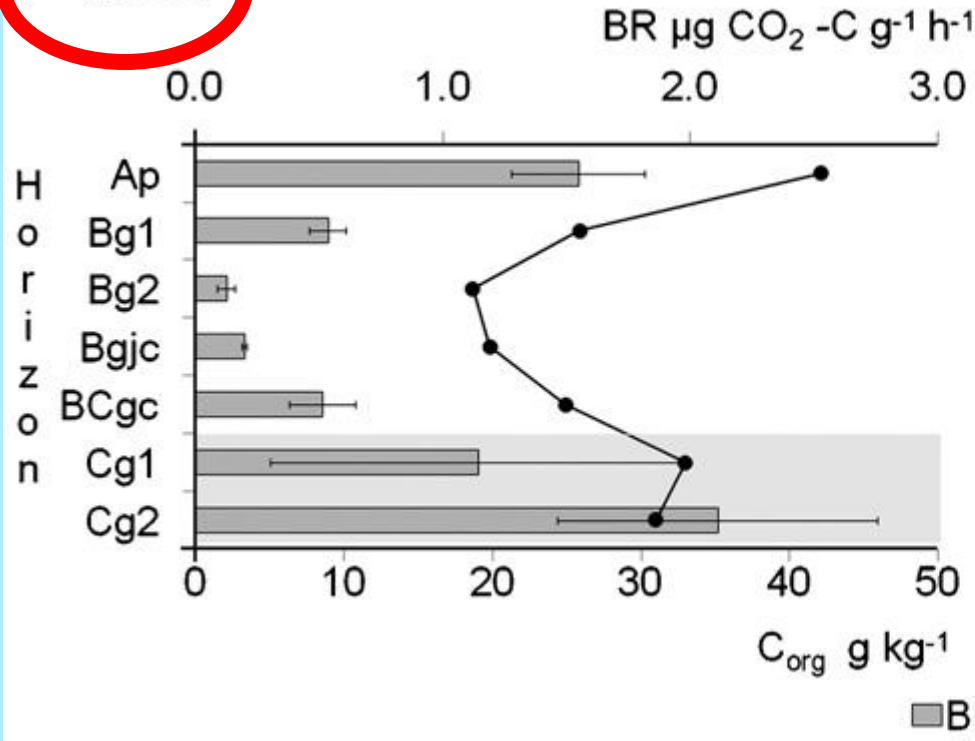
# Results



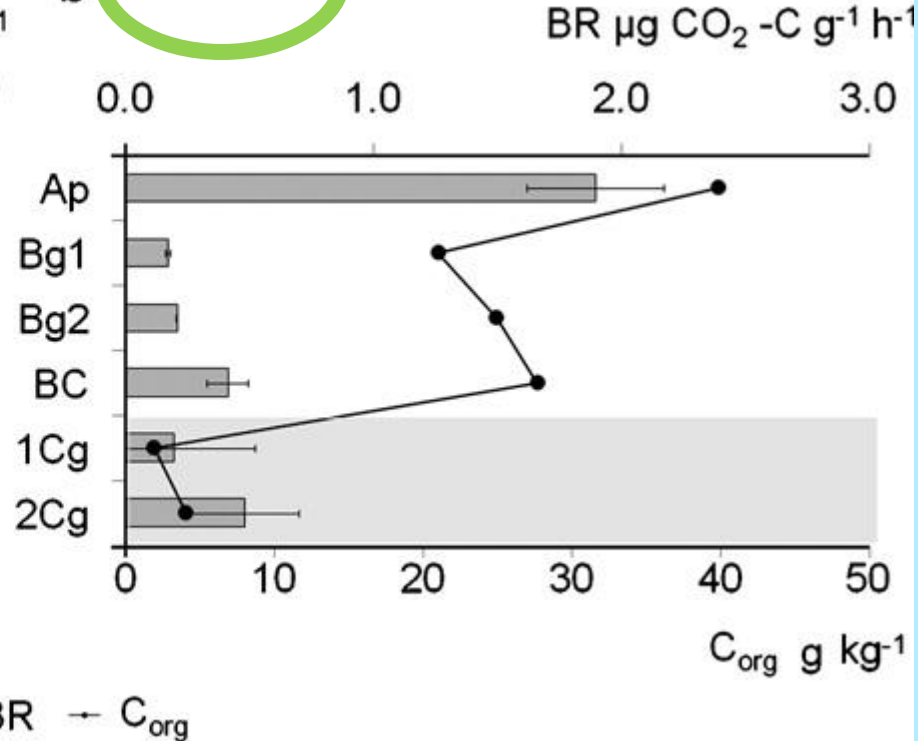
**Concentrations of  $\text{NO}_3^-$ -N (a) and  $\text{NH}_4^+$ -N (b) in different horizons of the AS soil and the non-AS soil. Values are means and standard errors of five replications. Note the different scales on the X axes.**

# Results

a AS soil



b non-AS soil



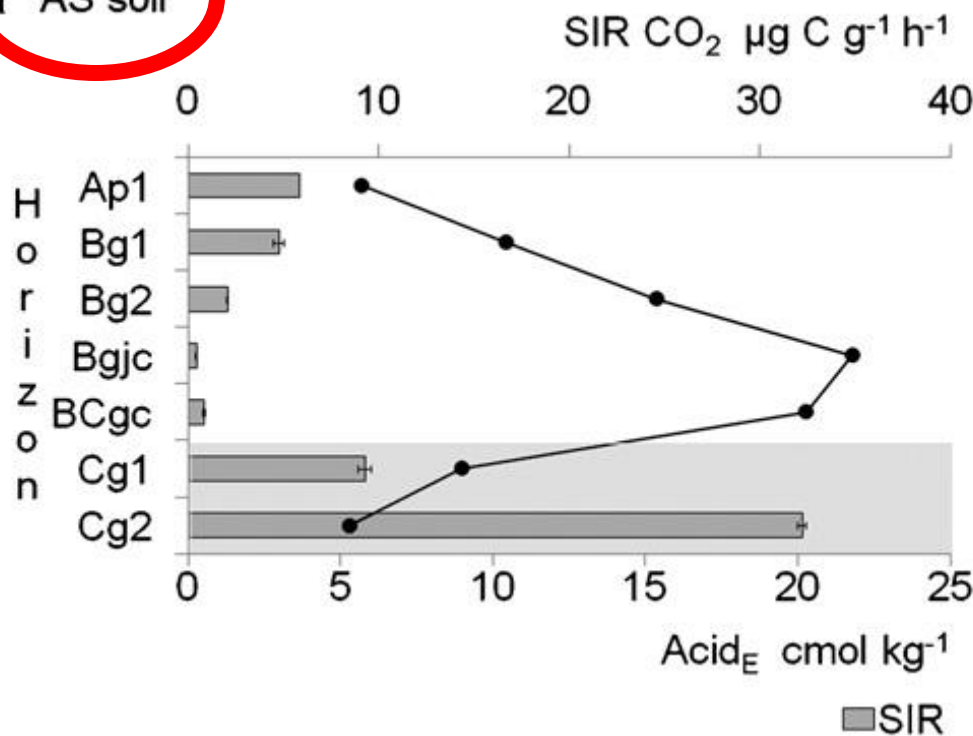
**Basal respiration (BR) and organic carbon ( $C_{org}$ ) in different horizons in the AS (a) and the non-AS soil (b).**

Values are means and standard errors of five replications. Permanently water-saturated soil horizons are shaded gray.

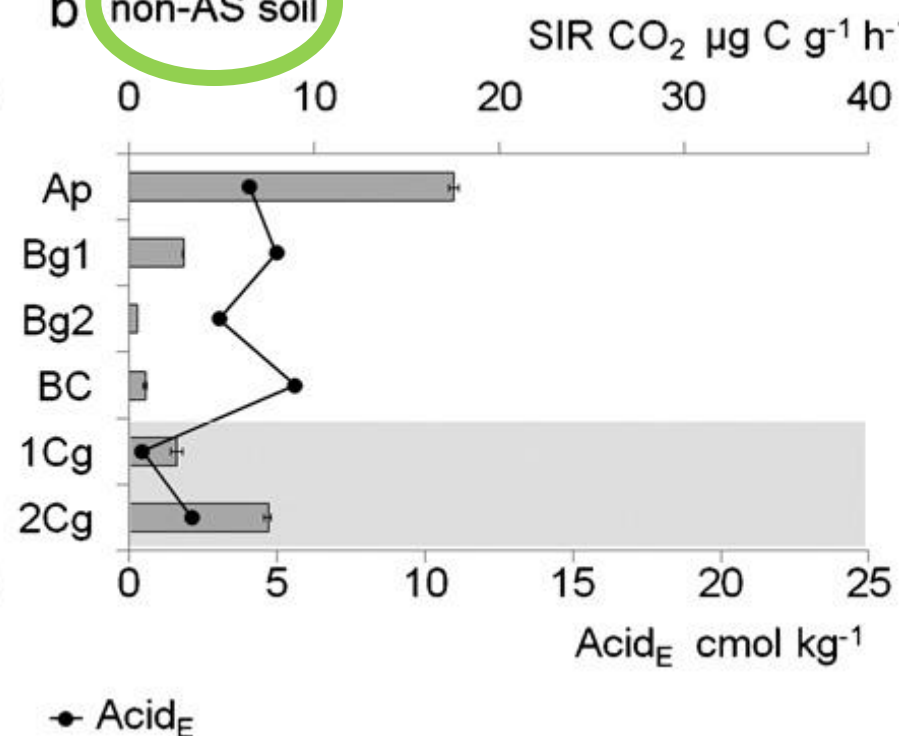


# Results

a AS soil



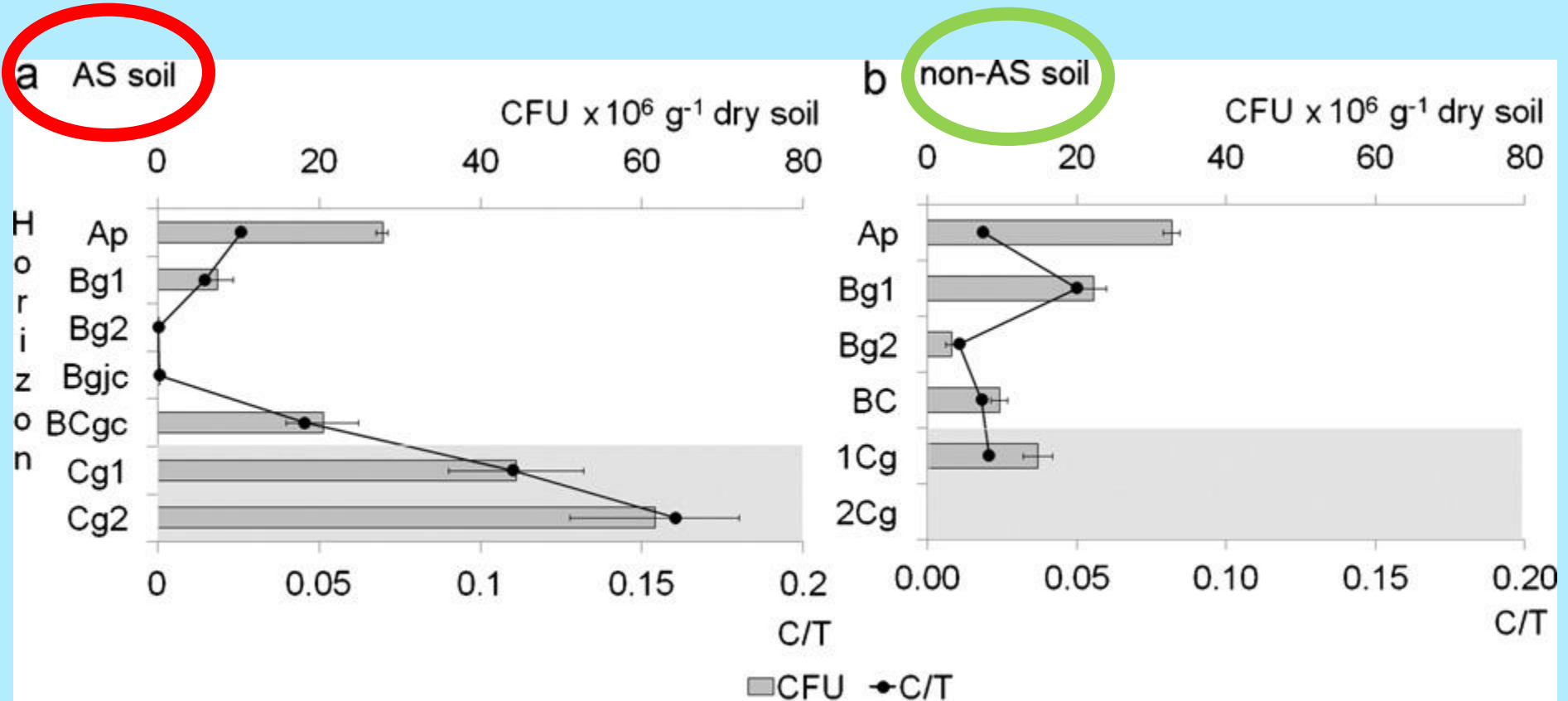
b non-AS soil



**Substrate induced respiration (SIR) and extractable acidity (Acid<sub>E</sub>) in different horizons in the AS soil (a) and the non-AS soil (b).** Values are means and standard errors of five replications.

Permanently water-saturated soil horizons are shaded gray.

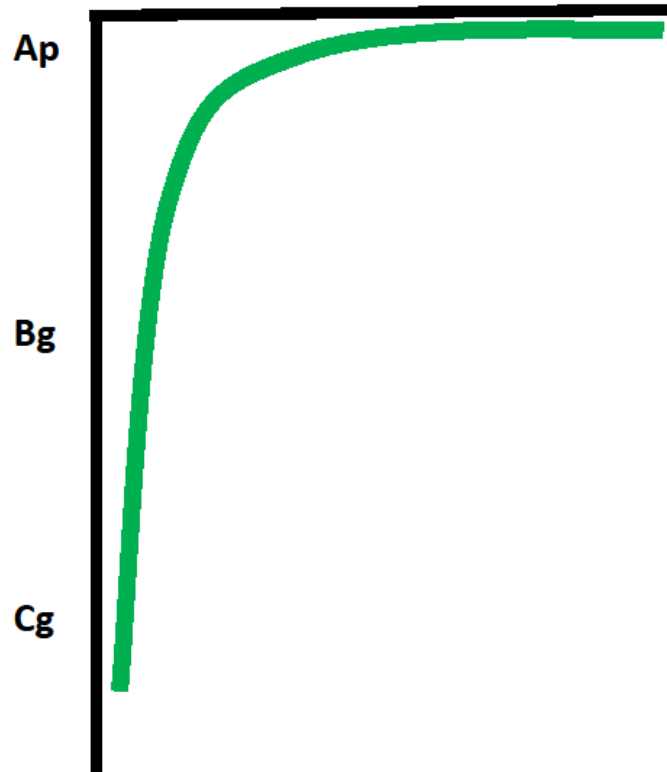
# Results



**Colony forming units of bacteria (CFU) and the ratio of culturable to total bacteria cell numbers (C/T) in the different horizons of the AS soil (a) and the non-AS soil (b).** Values are means and standard errors of four replications. Permanently water-saturated soil horizons are shaded gray. Data for the 2Cg horizon of the non-AS soil are not available for technical reasons.

# Results 2009 - Summary

number of  
microorganisms, activity



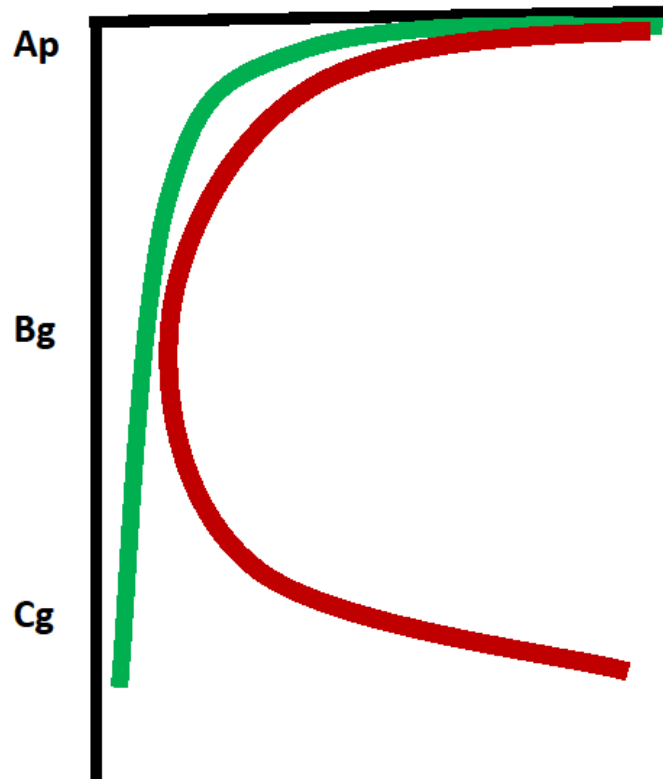
## EXPECTED

Common distribution of microorganisms in the soil profile follows the same pattern:

high amounts, high activity in topsoil (0 – 10, 15, ? ... cm), and sharp decreases in depth

# Results 2009 - Summary

number of  
microorganisms, activity



**FOUND**

In contrast to „normal“ common distribution of microorganisms in the soil profile, **very unusual distribution of microorganisms and microbial activity** was found in the ASS from Helsinki region.

# **Results 2009 - Published**

**Šimek, M., Virtanen, S., Krištůfek, V., Simojoki, A., Yli-Halla, M., 2011.**

Evidence of rich microbial communities in subsoil of boreal acid sulphate soil conducive to greenhouse gas emissions.

**Agriculture, Ecosystem and Environment,  
140, 113-122**

## **A new experimental setup (2010):**

**Same AS and control non-AS soils**

**+ pristine reedy soil,**

**„traditional“ microbiological measures:**

**respiration, SIR, CFU, counting**

**+ PLFA-based + DNA-based**

**analyses**

**of microbial community**

**+ potential CH<sub>4</sub>, N<sub>2</sub>O, and CO<sub>2</sub>**







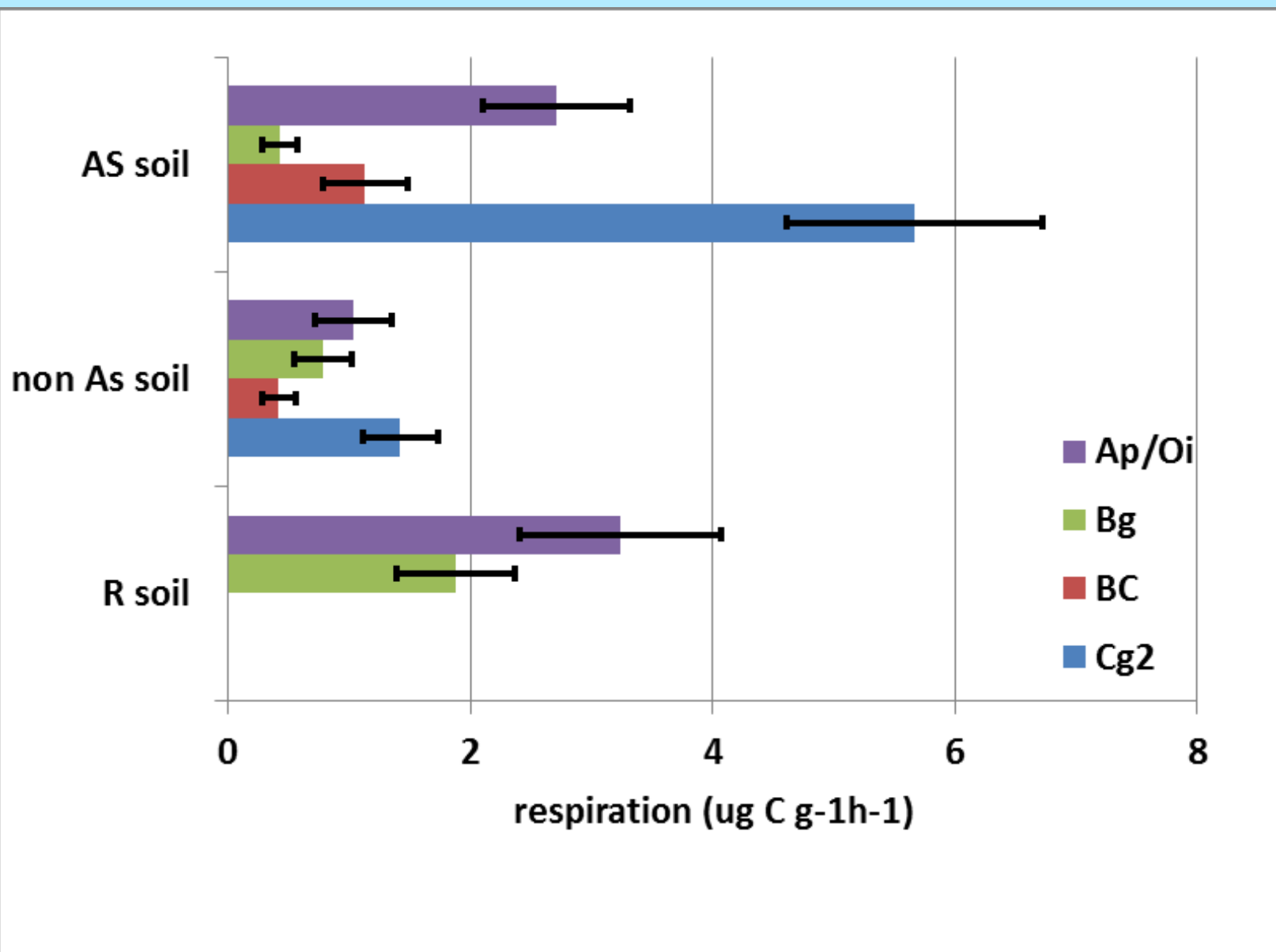








# Results 2010 - Example



## **Results 2010 – Summary**

**Information from the 2009-study was**

- (i) confirmed**
- (ii) completed by PLFA- and DNA- based approaches**

**Rich microbial communities in the deepest Cg2 horizon were found.**

**High emissions of GHG could occur when high water table is lowered because of arable farming.**

## **Results 2010 – Summary**

Rich microbial communities in the deepest Cg2 horizon were found.

High emissions of GHG could occur when high water table is lowered because of farming.

**The paper was recently submitted:**

**The microbial communities and greenhouse gas production in boreal acid sulphate, non-acid sulphate, and reedy sulphidic soils**

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# **Continuation – 2011 soil sampling**

**two acid sulfate fields located on the  
Ostrobothnia:**

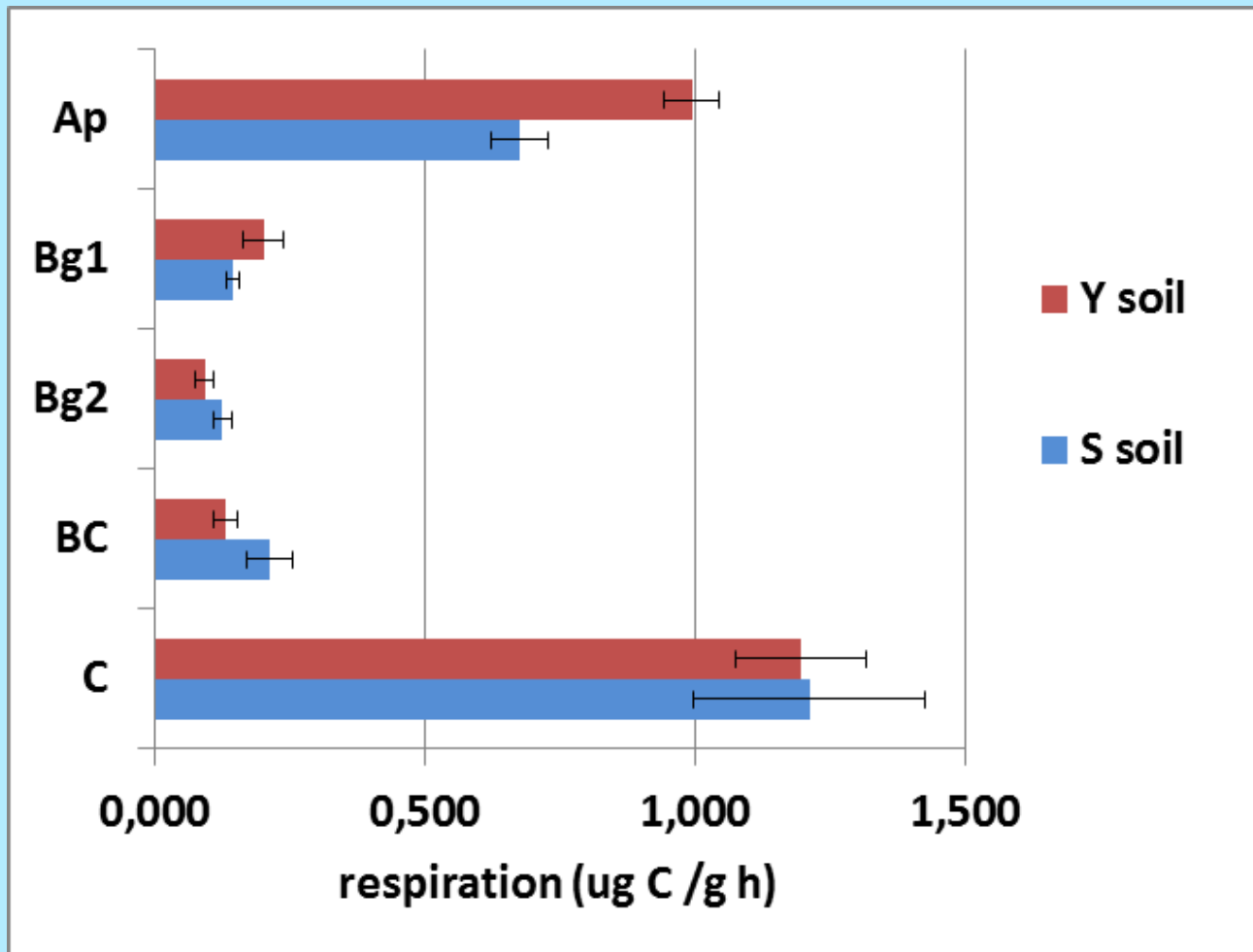
## **Söderfjärden**

0-20 cm (Ap), 40-50 cm (Bg1), 80-90 cm (Bg2), 100-115(BC)  
150-170 cm (C)

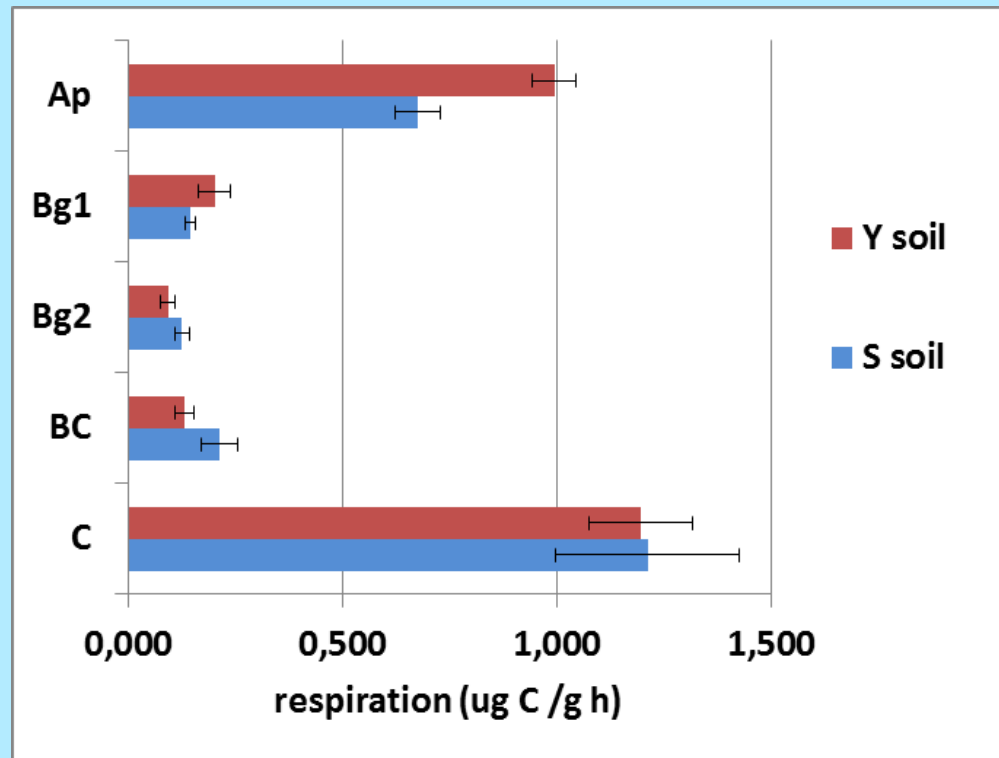
## **Ylistaro**

0-20 cm (Ap), 40-55 cm (Bg1), 85-100 cm 8Bg2), 130-150 cm  
(BC), 215-235 cm (C).

# Results 2011 - preliminary



## Results 2011 - preliminary



**Again, very high respiration  
(and other characteristics, not shown)  
were found in the depth of the AS soils!**

## General Conclusions

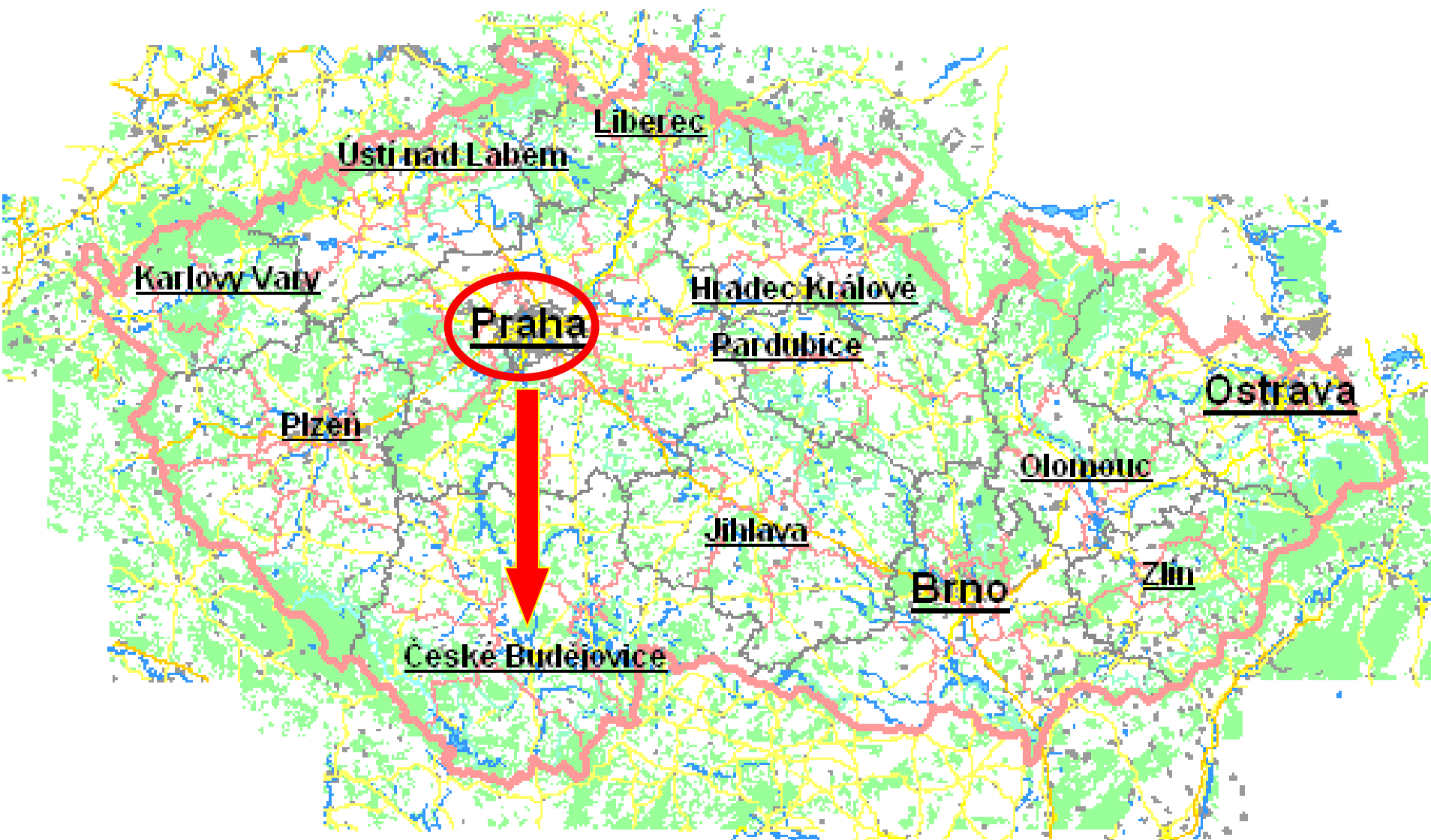
**Results show unusual distribution of microorganisms in the profile of ASS.**

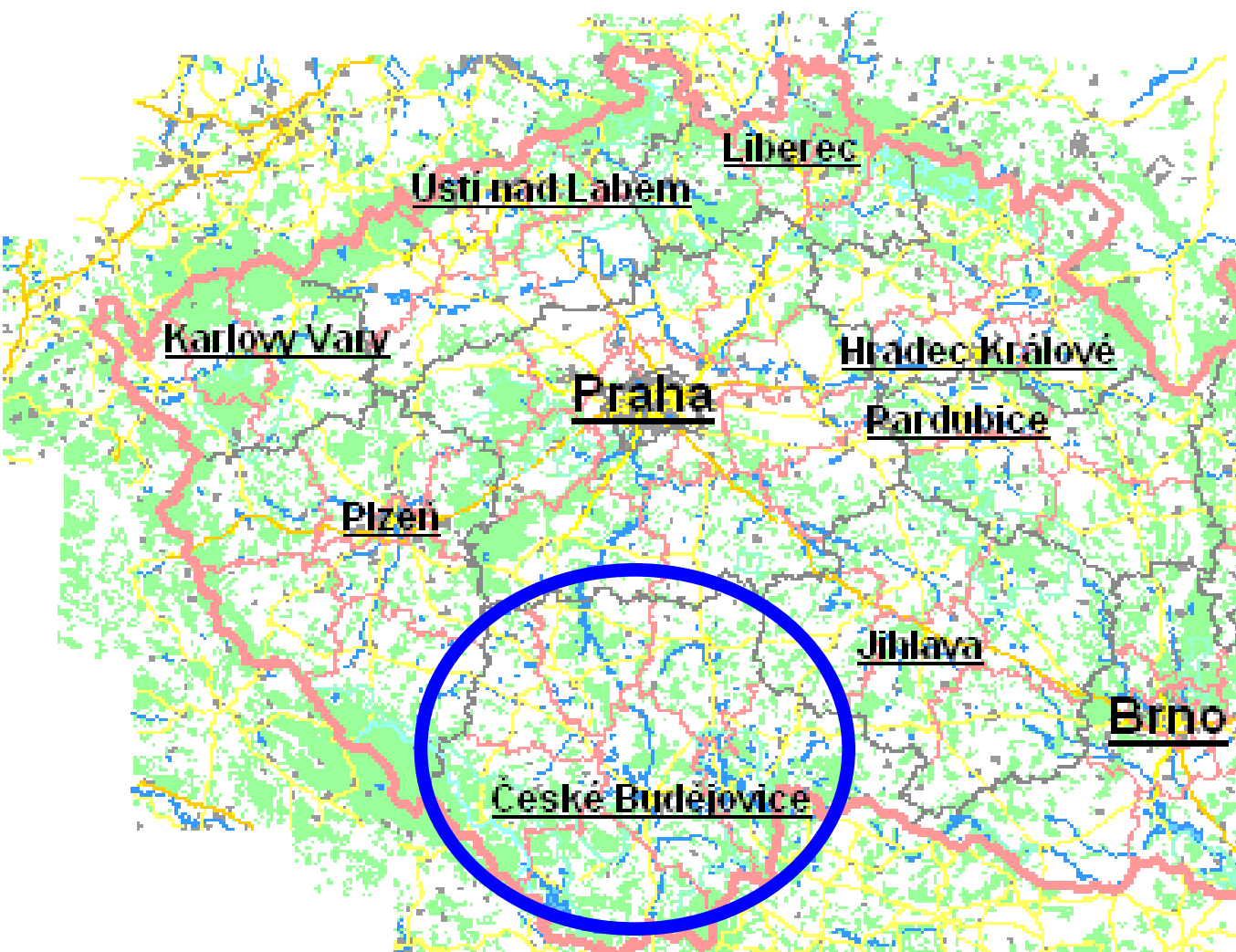
**Microbial communities in C horizons are very rich and together with large C and N stocks represent a potential for high GHG fluxes.**



# Thanks to

**Seija Virtanen,  
Asko Simojoki, Markku Yli-Halla  
&  
Vaclav Krištůfek**





**City České Budějovice  
capital of South Bohemia region**

- 
- **Biology Centre - Institute of Soil Biology,**
  - **University of South Bohemia, Faculty of Science**

**České Budějovice, Czech Republic**

**Thank you  
for your  
attention!**