

# THE CHANGE OF FOREST SOIL CONDITIONS IN BEECH STANDS (*FAGUS SYLVATICA*) OF THE VIENNA WOODS WITHIN THE LAST THREE DECADES DUE TO DECLINING DEPOSITION OF ATMOSPHERIC POLLUTANTS

Dipl.-Ing. Selina Türtscher

Ao. Univ. Prof. DI Dr. Torsten Winfried Berger

# Theoretical Background

LINDEBNER (1990): „The status of forest soils in beech stands of the Vienna Woods “

- Research of the long-term influence of atmospheric pollutants on chemical soil properties
- 152 beech stands were investigated  
Analysis of soil from the infiltration zone of stemflow near the base of the stem and from the between trees area
- significant impact of deposition of atmospheric pollutants  
→ soil acidification, increased sulfur (S) contents and loss of base cations



# Goal and Objectives

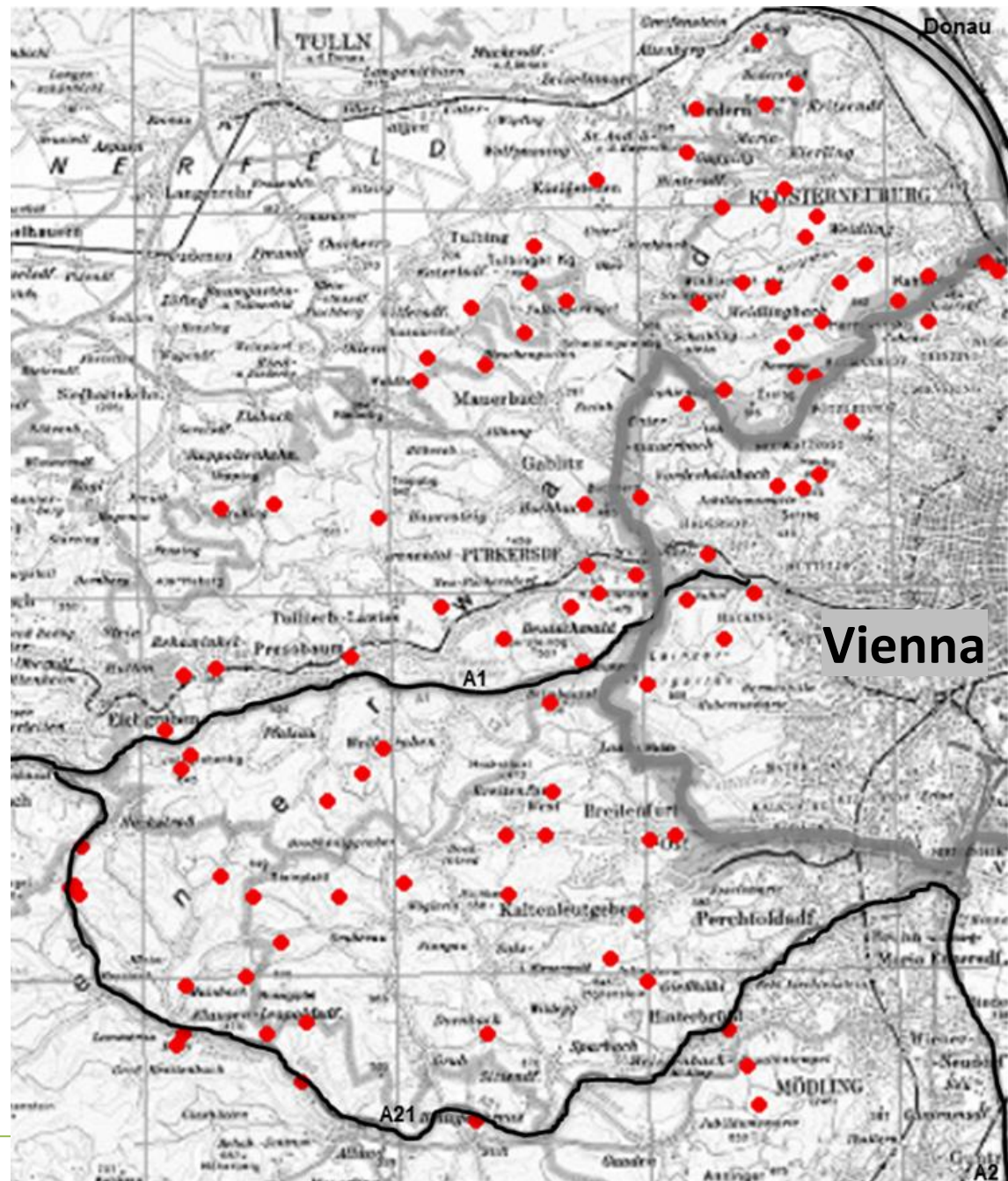
- Investigation whether after 30 years an improvement of the soil condition has occurred
- Working hypothesis:  
„soils recovered from acid deposition due to a strong decline of  $\text{SO}_2$  emissions since the investigation of Lindebner 1984“
  - Regarding pH-values
  - Regarding the concentration of base cations and heavy metals
  - Difference in the intensity of soil acidification between the infiltration zone of stemflow and the between trees area since 1984





# Methods

- LINDEBNER (1990): 152 old beech stands with similar stand structure (sample collection in **1984**)
- **2012**: 97 beech stands still existed → re-sampling of 97 of these 152 stands



## Infiltration zone of stemflow:

- 0-5cm (**S**) → pooled sample of 7 trees

## Between trees area:

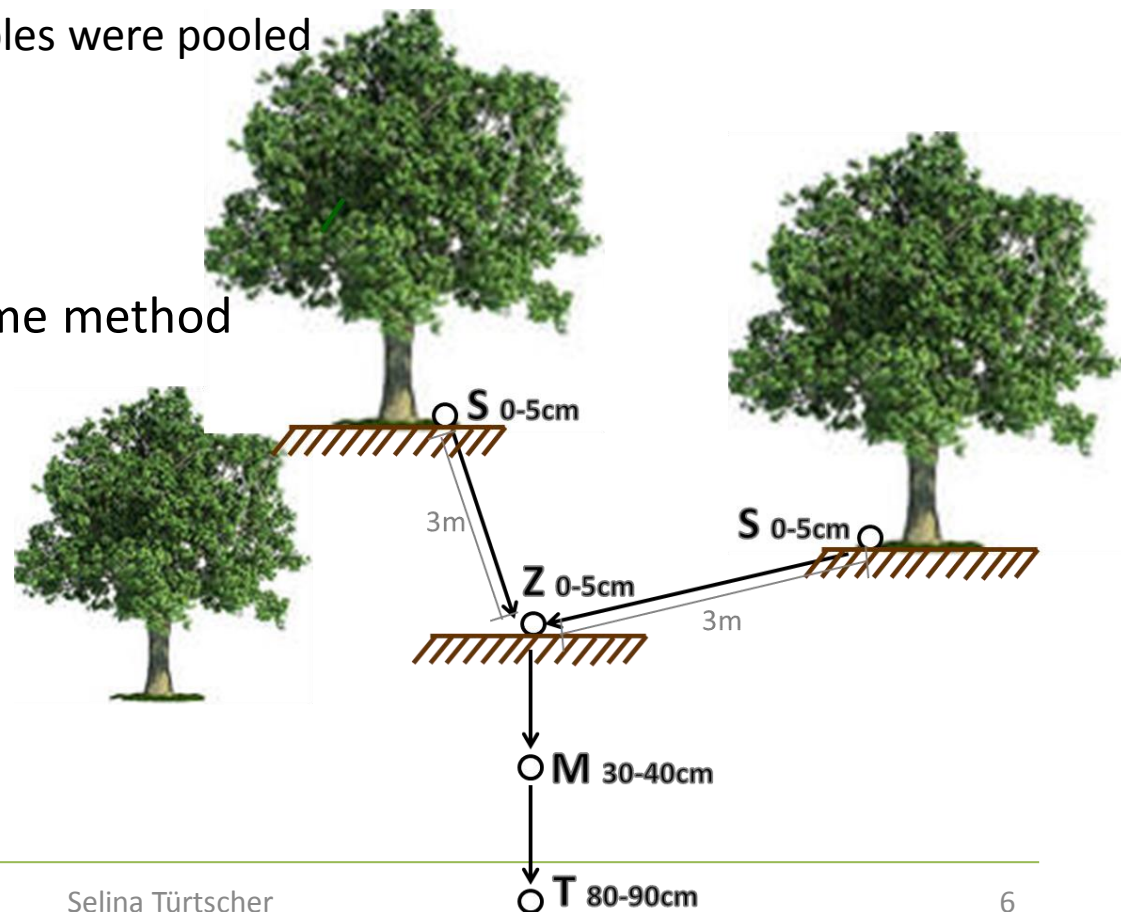
- 0-5cm (**Z**) → 7 soil samples were pooled
- 30-40cm (**M**) → 4 soil samples were pooled
- 80-90cm (**T**) → 4 soil samples were pooled

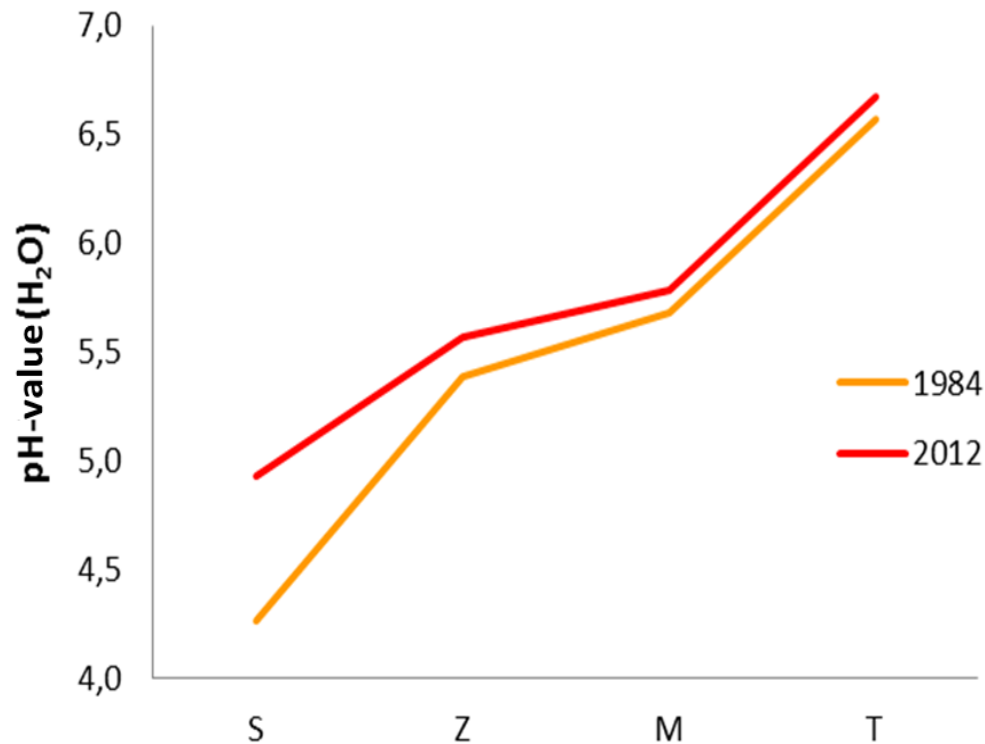
→ We resampled using the same method

→ Added 10-20cm soil depth  
(from the stem area and  
the between trees area)

**S 10-20 cm**

**Z 10-20 cm**





## Results - pH value(H<sub>2</sub>O)

→ quicker recovery of  
the stemflow area

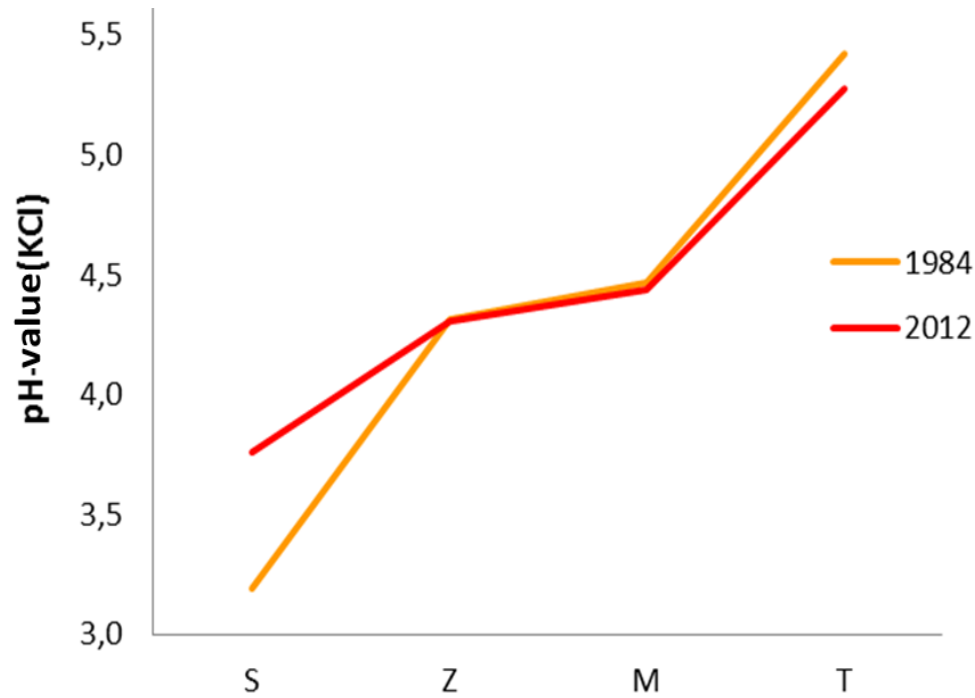


pH-value (H <sub>2</sub> O)	S (0-5 cm)		Z (0-5 cm)		M (30-40 cm)		T (80-90 cm)	
	1984	2012	1984	2012	1984	2012	1984	2012
min	3,7	3,9	3,9	4,0	4,3	3,9	4,8	4,5
max	5,8	7,5	7,8	8,4	8,1	8,5	8,7	8,9
<b>mean</b>	<b>4,3</b>	<b>4,9</b>	<b>5,4</b>	<b>5,6</b>	<b>5,7</b>	<b>5,8</b>	<b>6,6</b>	<b>6,7</b>
SD	0,4	0,7	0,9	0,9	1,0	1,1	1,2	1,3
paired t-test	***		**		ns		ns	
mean comparison test 1984*	a		b		c		d	
mean comparison test 2012*	a		b		c		d	

\*paired comparison, Bonferroni test;  $\alpha=0,05$



# Results - pH value (KCl)



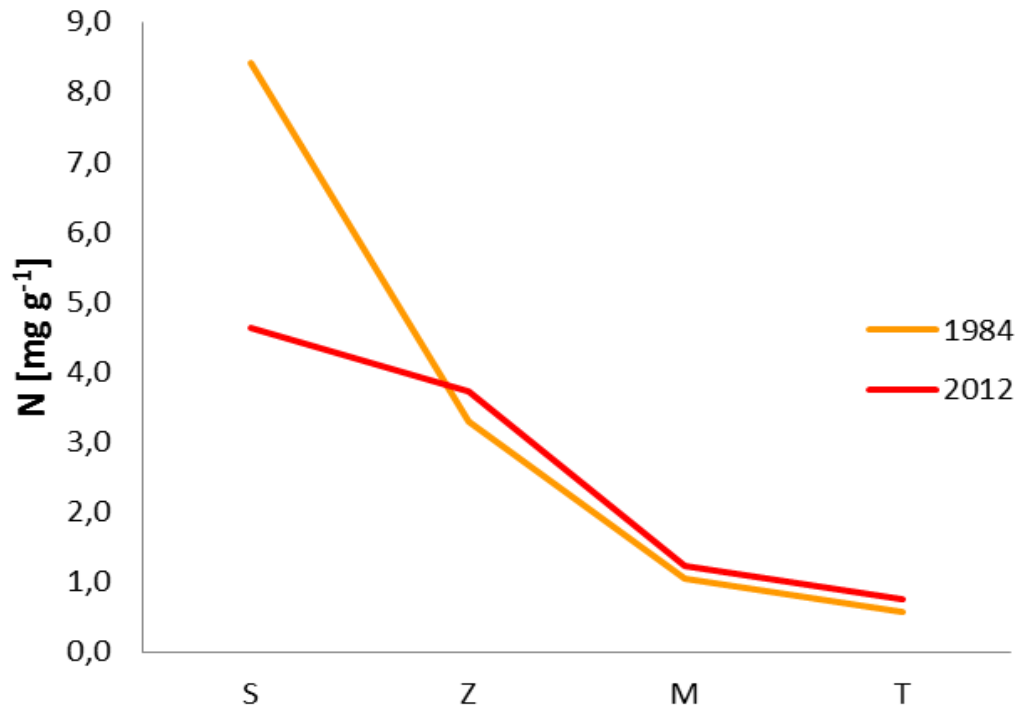
→ shift into deeper soil horizons



pH-value(KCl)	S (0-5 cm)		Z (0-5 cm)		M (30-40 cm)		T (80-90 cm)	
	1984	2012	1984	2012	1984	2012	1984	2012
min	2,7	2,9	2,8	3,0	2,9	3,3	3,4	3,5
max	5,1	6,6	7,0	7,3	7,5	7,6	7,8	7,8
<b>mean</b>	<b>3,2</b>	<b>3,8</b>	<b>4,3</b>	<b>4,3</b>	<b>4,5</b>	<b>4,4</b>	<b>5,4</b>	<b>5,3</b>
SD	0,4	0,8	1,1	1,1	1,2	1,2	1,5	1,6
paired t-test	***		ns		ns		ns	
mean comparison test 1984*	a		b		c		d	
mean comparison test 2012*	a		b		b		c	

\*paired comparison, Bonferroni test;  $\alpha=0,05$

# Results - nitrogen (N)



→ Increase in the  
between trees area  
due to a increase of  
NOx emissions

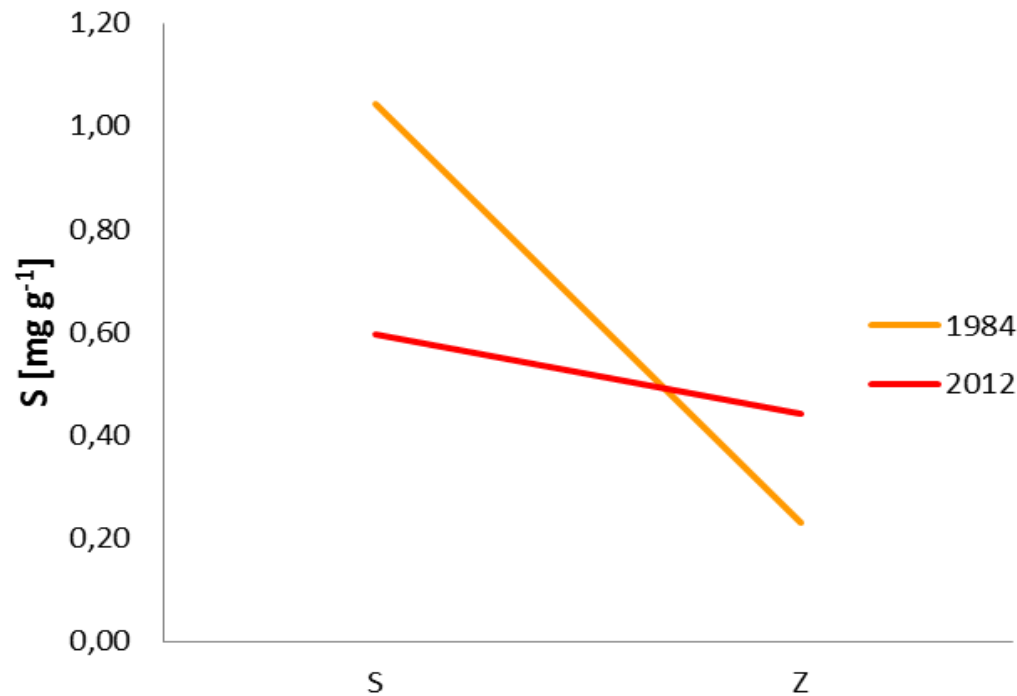


N [mg g <sup>-1</sup> ]	S (0-5 cm)		Z (0-5 cm)		M (30-40 cm)		T (80-90 cm)	
	1984	2012	1984	2012	1984	2012	1984	2012
min	2,0	0,9	1,2	1,4	0,2	0,4	0,1	0,2
max	50,8	18,7	9,8	9,9	6,6	5,8	4,7	4,0
<b>mean</b>	<b>8,4</b>	<b>4,6</b>	<b>3,3</b>	<b>3,7</b>	<b>1,0</b>	<b>1,2</b>	<b>0,6</b>	<b>0,8</b>
SD	4,4	2,9	1,9	1,8	0,9	1,0	0,6	0,5
paired t-test	***		**		**		**	
mean comparison test 1984*	a		b		c		d	
mean comparison test 2012*	a		b		c		d	

\*paired comparison, Bonferroni test;  $\alpha=0,05$



# Results - sulphur (S)



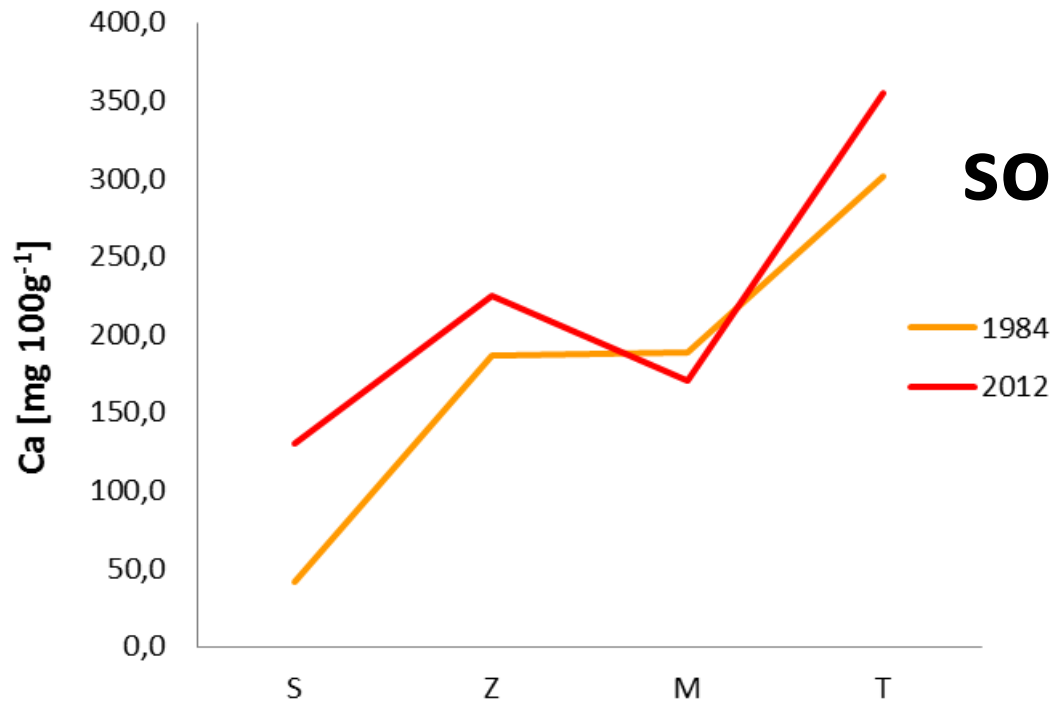
- Input through stemflow decreased sharply
- decrease of S due to increased release and leaching

S [mg g <sup>-1</sup> ]	S (0-5 cm)		Z (0-5 cm)	
	1984	2012	1984	2012
min	0,10	0,20	0,05	0,20
max	2,93	2,40	1,39	1,60
<b>mean</b>	<b>1,04</b>	<b>0,60</b>	<b>0,23</b>	<b>0,44</b>
SD	0,58	0,38	0,15	0,28
paired t-test	***		***	
mean comparison test 1984*	a		b	
mean comparison test 2012*	a		b	

\*paired comparison, Bonferroni test;  $\alpha=0,05$



# Results - soil nutrients (Ca)

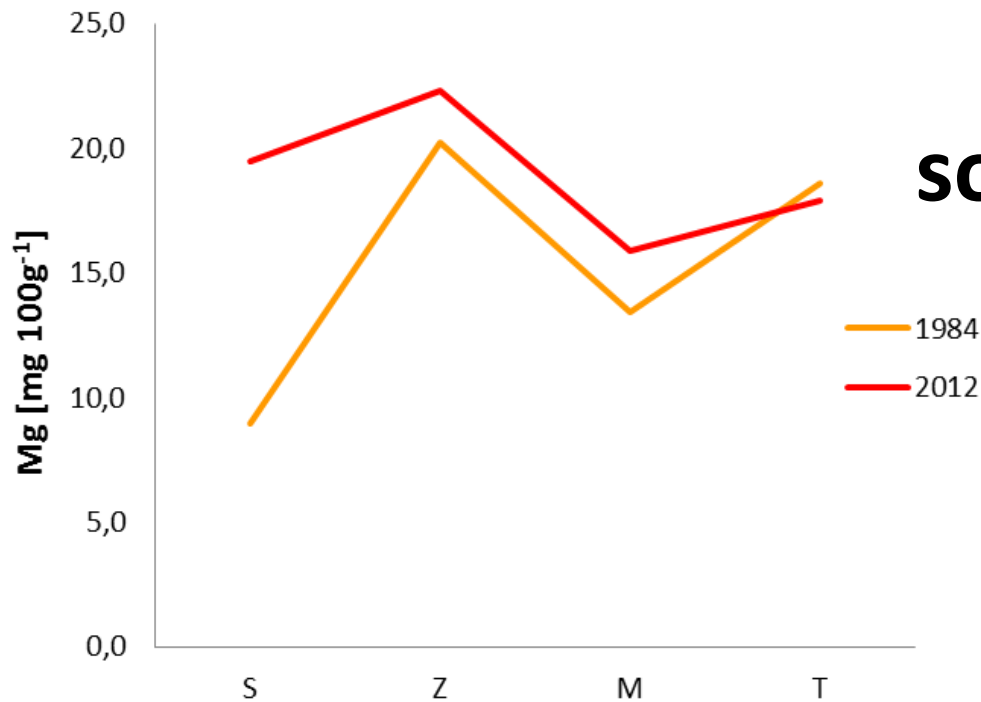


→ Ca-pump effect of  
beech



Ca [mg 100g <sup>-1</sup> ]	S (0-5 cm)		Z (0-5 cm)		M (30-40 cm)		T (80-90 cm)	
	1984	2012	1984	2012	1984	2012	1984	2012
min	10,9	8,4	11,2	10,9	8,4	1,1	2,8	1,2
max	313,8	1 010,6	809,0	1 208,2	738,0	1 051,3	822,0	1 000,2
<b>mean</b>	<b>41,3</b>	<b>130,5</b>	<b>186,6</b>	<b>224,9</b>	<b>188,5</b>	<b>170,6</b>	<b>301,2</b>	<b>355,1</b>
SD	42,5	198,7	176,5	260,7	174,3	223,1	198,8	257,8
paired t-test	***		*		ns		*	
mean comparison test 1984*	a		b		b		c	
mean comparison test 2012*	a		b		a		c	

\*paired comparison, Bonferroni test;  $\alpha=0,05$



# Results - soil nutrients (Mg)

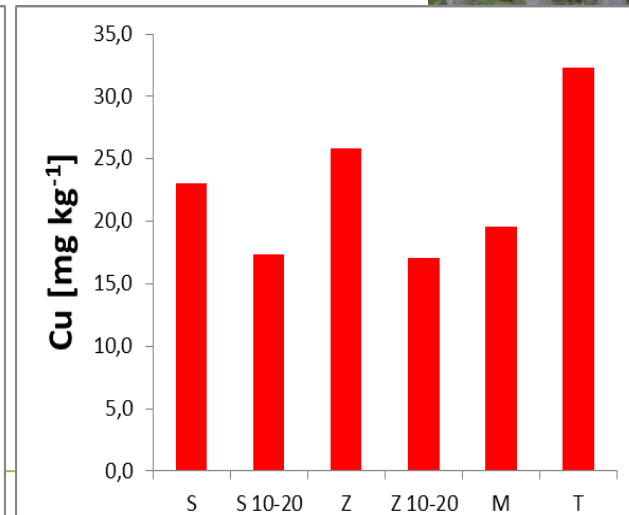
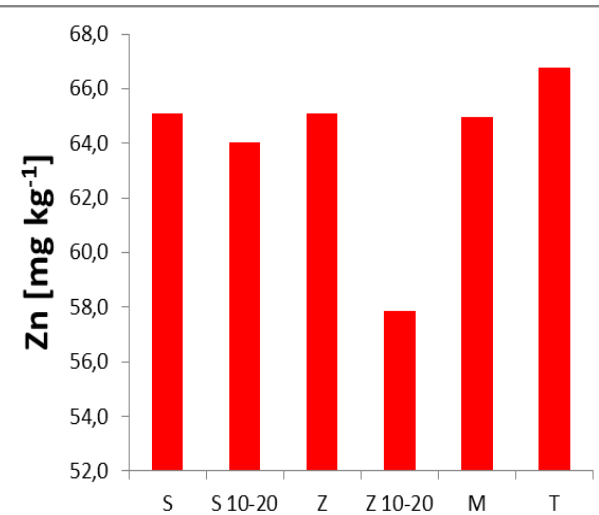
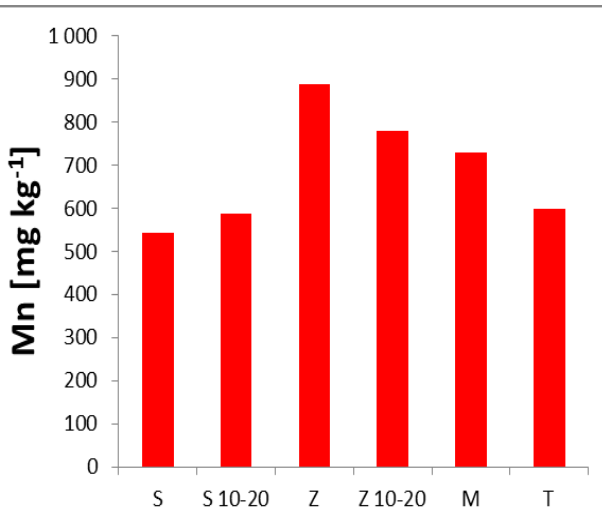
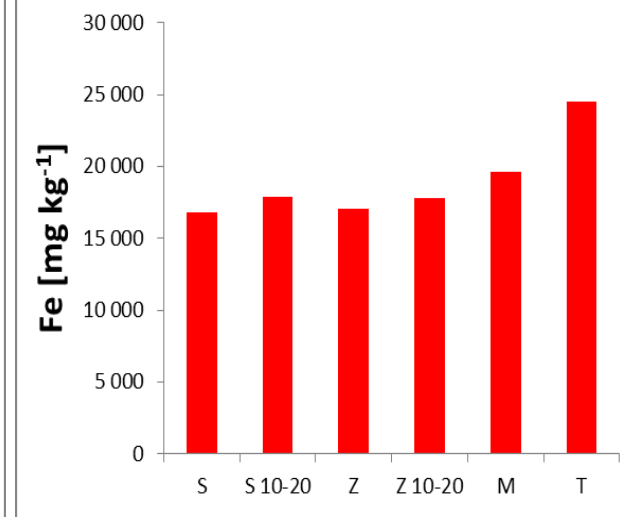
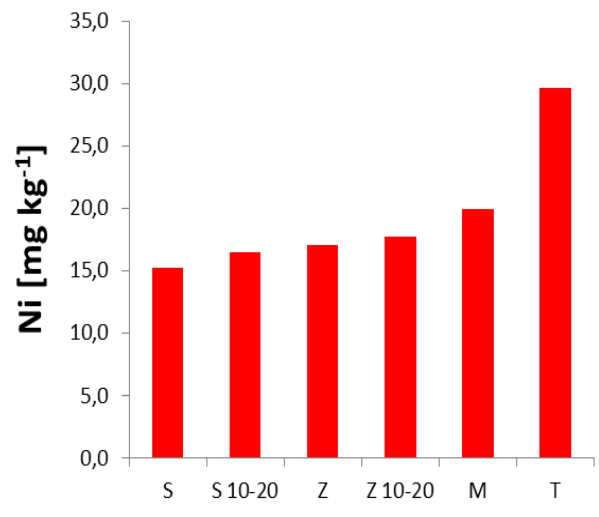
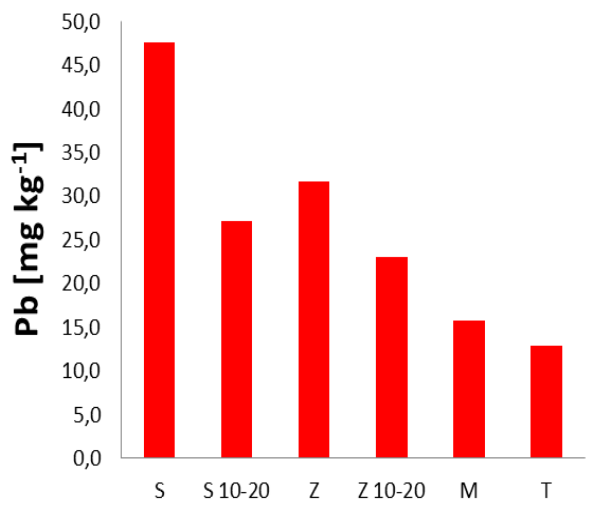
→ increase in S due to  
input of basic  
substances (dust)

Mg [mg 100g <sup>-1</sup> ]	S (0-5 cm)		Z (0-5 cm)		M (30-40 cm)		T (80-90 cm)	
	1984	2012	1984	2012	1984	2012	1984	2012
min	1,5	1,7	1,9	2,4	1,4	0,4	0,7	0,3
max	78,0	286,7	150,8	218,3	102,7	148,6	97,0	86,1
<b>mean</b>	<b>8,9</b>	<b>19,5</b>	<b>20,3</b>	<b>22,3</b>	<b>13,4</b>	<b>15,9</b>	<b>18,6</b>	<b>17,9</b>
SD	11,0	42,5	31,3	39,2	13,5	27,8	14,7	15,4
paired t-test	<b>**</b>		<b>ns</b>		<b>ns</b>		<b>ns</b>	
mean comparison test 1984*	a		b		c		b	
mean comparison test 2012*	ab		a		bc		ac	

\*paired comparison, Bonferroni test;  $\alpha=0,05$

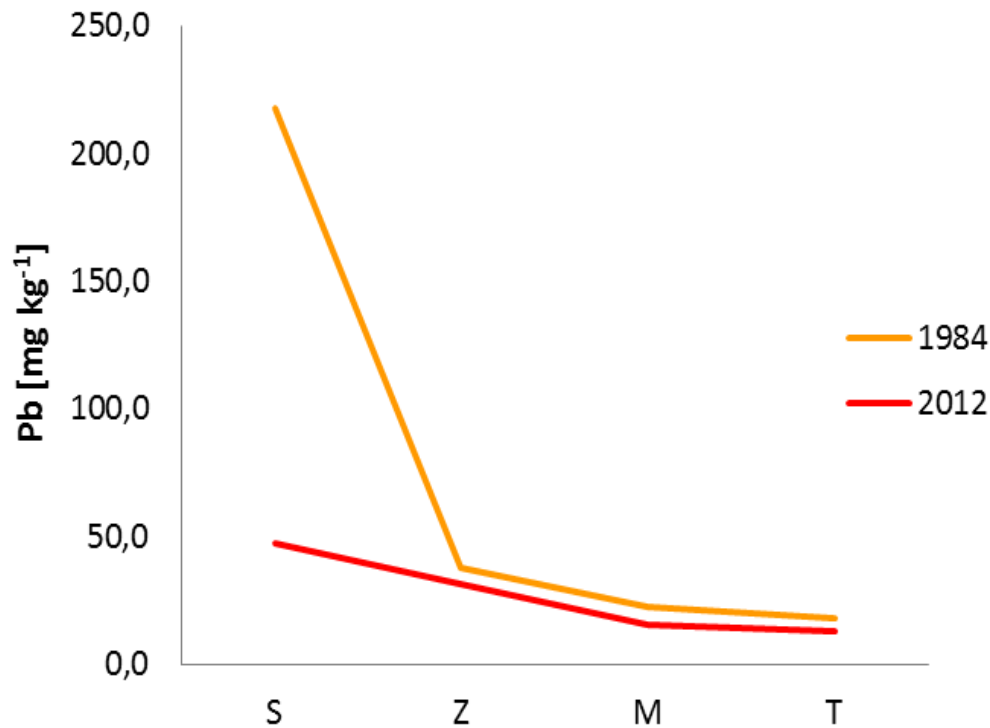


# Results – heavy metals





# Results - lead



→ Accumulation in S + depth gradient indicate a significant impact of emissions in 1984



Pb [mg kg <sup>-1</sup> ]	S (0-5 cm)		Z (0-5 cm)		M (30-40 cm)		T (80-90 cm)	
	1984	2012	1984	2012	1984	2012	1984	2012
min	7,5	7,9	6,8	12,1	3,6	0,02	3,8	0,2
max	613,5	146,4	80,3	66,2	54,1	30,0	73,5	51,7
<b>mean</b>	<b>218,0</b>	<b>47,5</b>	<b>38,2</b>	<b>31,6</b>	<b>22,3</b>	<b>15,7</b>	<b>17,8</b>	<b>12,8</b>
SD	124,7	22,9	12,8	10,2	9,4	7,0	8,4	8,2
paired t-test	***		***		***		***	
mean comparison test 1984*	a		b		c		d	
mean comparison test 2012*	a		b		c		d	

\*paired comparison, Bonferroni test;  $\alpha=0,05$

# Summary

The reduction of deposition of atmospheric pollutants has led to a partial soil recovery

- significant improvement of the top soil (0-5 cm)
- Increase of pH-value and decrease of S and N contents  
→ higher trends of recovery for the stem area than for the between tree area
- In deeper soil horizons (30-40 cm and 80-90 cm) only a small effect was observed



# THANK YOU FOR THE ATTENTION!

