

Atmospheric deposition, soil and soil water chemistry in primeval forests in the Transcarpatian Mts., the western Ukraine

Filip Oulehle¹, Jakub Houška², Ruslan Hleb², Pavel Šamonil³, Jeňýk Hofmeister¹ and Jakub Hruška¹

¹ Department of Environmental Geochemistry and Biogeochemistry, Czech Geological Survey, Klárov 3, 1118 21 Prague, Czech Republic

² Department of Geology and Pedology, Mendel University of Agriculture and Forestry in Brno, Zemědělská 1, 613 00 Brno, Czech Republic

³ Department of Forest Ecology, The Silva Tarouca Research Institute for Landscape and Ornamental Gardening, Lidická 25/27, 657 20 Brno, Czech Republic

INTRODUCTION

In the last decades, effects of acidic deposition on forests were studied in many mountain region worldwide. The Transcarpatian Mts. belong to the most forested and remote region in Europe. Compared to Central Europe, Transcarpatian Mts. were considered to be low polluted region. We started measurements of deposition, soil and soil solution chemistry in two primeval forests with different tree species composition and bedrock in 2007. We attempted to evaluate (1) present acidic deposition in this region and compare it with Central Europe and (2) whether soil condition and soil solution chemistry differ from heavily acidified mountain regions in Central Europe.



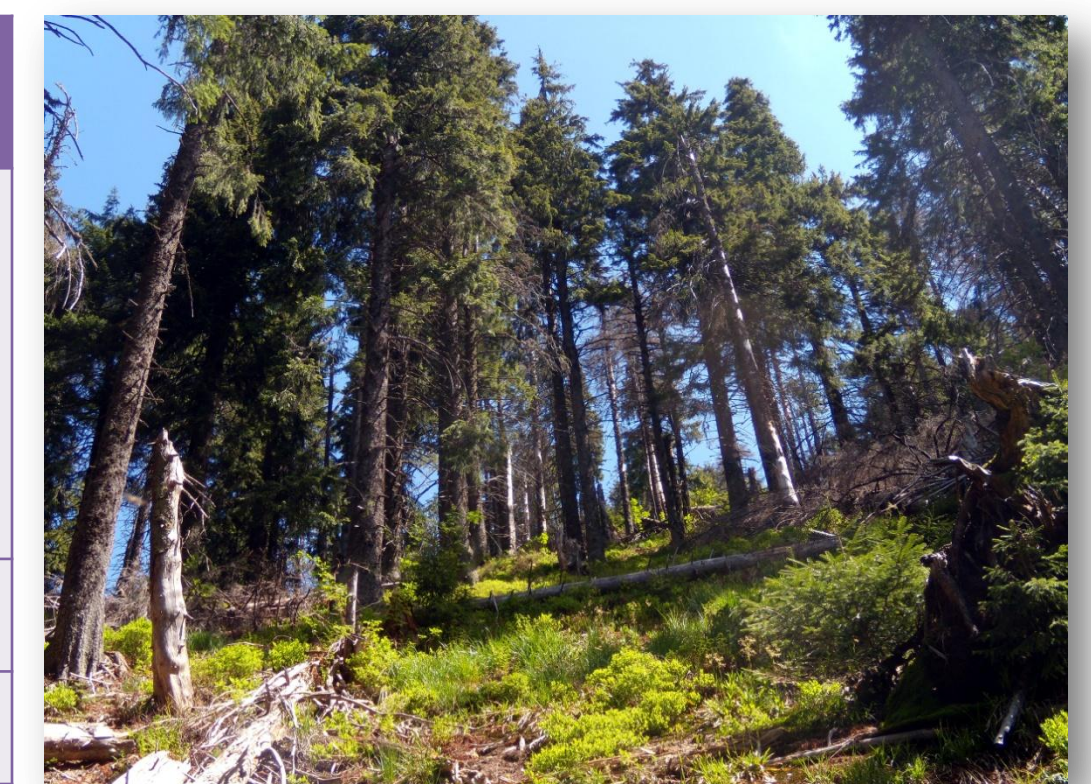
JAVORNIK

Tree species composition with growing stock (m ³ .ha ⁻¹) (Hrubý Z., 2001)	<i>Fagus sylvatica</i> – 487 <i>Acer pseudoplatanus</i> – 7.7 <i>Acer platanoides</i> – 0.06 <i>Abies alba</i> – 0.002
Elevation (m a.s.l.)	802-899
Geology	Flysch

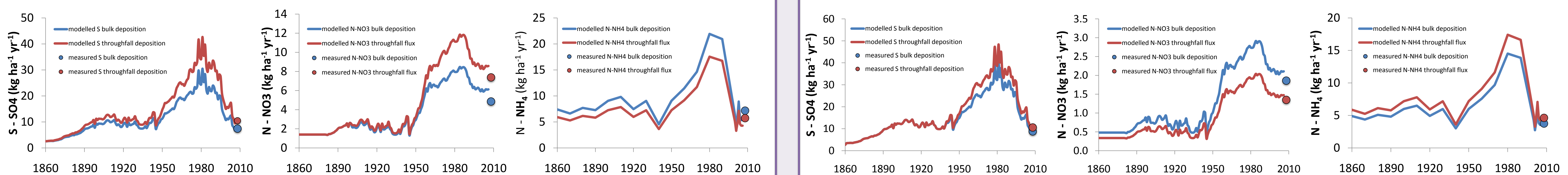


POP IVAN

Tree species composition with growing stock (m ³ .ha ⁻¹) (Hrubý Z., 2001)	<i>Picea abies</i> – 424 <i>Abies alba</i> – 0.17 <i>Fagus sylvatica</i> – 0.11 <i>Sorbus aucuparia</i> – 0.09
Elevation (m a.s.l.)	1426-1526
Geology	Crystalline schist



Deposition



Soil chemistry

Horizon	pH(H ₂ O)	Ca	Mg	K	CEC	BS	C/N
cm		mg.kg ⁻¹			mmol _c .kg ⁻¹	%	
L+F	4.86	6860	718	1024	472	91	25
H	4.26	3260	258	302	218	87	21
0-10	3.98	574	62	115	99	37	14
10-20	4.11	276	30	62	77	22	13
20-40	4.31	275	25	43	67	24	13
40-85	4.61	323	36	36	60	30	16
Pool		Ca	Mg	K	C	N	
kg.ha ⁻¹		2046	211	328	126744	9020	

Horizon	pH(H ₂ O)	Ca	Mg	K	CEC	BS	C/N
cm		mg.kg ⁻¹			mmol _c .kg ⁻¹	%	
L+F	3.71	1200	232	273	168	51	28
H	3.33	448	120	140	168	21	24
0-10	3.82	73	46	61	128	8	18
10-20	4.35	35	22	39	88	6	15
20-40	4.69	18	8	18	47	5	18
40-80	4.98	10	2.5	7.3	19	6	29
Pool		Ca	Mg	K	C	N	
kg.ha ⁻¹		186	65	105	212164	10569	

Soil water chemistry

Horizon	pH	Ca	Mg	K	Al	NH ₄	NO ₃	SO ₄
cm		mg.L ⁻¹						
Forest floor	4.82	6.1	0.84	5.6	0.43	0.63	20.2	3.2
30	4.87	4.7	0.63	0.32	0.26	0.14	9.6	4.4
90	5.62	5.3	0.99	0.49	0.05	0.18	12.8	5.4
Flux		Ca	Mg	K	Al	N	S	Bc/Al
Based on Cl balance	mm	kg.ha ⁻¹ .yr ⁻¹						
Forest floor	726	44	6.1	40	3.1	37	7.7	21
30	540	26	3.4	1.7	1.4	12	7.9	16
90	547	29	5.4	2.7	0.3	17	9.8	106

Horizon	pH	Ca	Mg	K	Al	NH ₄	NO ₃	SO ₄
cm		mg.L ⁻¹						
Forest floor	4.06	1.2	0.43	1.4	0.46	0.57	4.7	3.8
30	4.47	0.35	0.34	0.11	0.79	0.03	1.8	3.7
90	4.57	0.65	0.44	0.15	0.64	0.02	3.1	4.2
Flux		Ca	Mg	K	Al	N	S	Bc/Al
Based on Cl balance	mm	kg.ha ⁻¹ .yr ⁻¹						
Forest floor	779	9.2	3.3	11	3.6	12	9.9	4.8
30	1326	4.6	4.5	1.4	11	5.7	16	0.9
90	2133	14	9.3	3.1	14	15	30	1.6

CONCLUSIONS

1. Deposition

Estimated historical emissions of SO₂, NO_x and NH₃ were used for estimates of S and N deposition at primeval forest ecosystems in Ukraine Transcarpatian Mts. between 1860 and 2008. Currently measured S bulk deposition of 7.4 kg ha⁻¹ yr⁻¹ was similar to those estimated for the 1st half of 20th century in the Javornik and measured S bulk deposition of 8.8 kg ha⁻¹ yr⁻¹ was similar to those measured at the end of 19th century in the Pop Ivan. Deposition of S and N was similar to those measured recently in Central Europe. Total N deposition was lower at Pop Ivan compared to Javornik, namely because of significantly lower NO₃ deposition. High leaching of N was observed at Javornik site, suggesting N saturation of the old growth forests in the area.

2. Soils

Relatively high base saturation of mineral soil (29%) and a high concentration of base cations in soil solution was observed at Javornik where high weathering rate of underlined flysch was able to mitigate the adverse effects of acidic deposition. Contrary to Javornik, low soil base saturation of 6.5% was measured at Pop Ivan. Depletion of base cations was caused by low weathering rates of the bedrock, high water flux and relatively high S deposition in the past. Low soil water Bc/Al ratio (0.9) was observed in the upper mineral soil in the Pop Ivan. This suggests, that the spruce forest ecosystems in the area are vulnerable to anthropogenic acidification with respect of adverse effects of Al on forest root systems.

Acknowledgements

This project was funded by the Czech Science Foundation (grant No. 526/07/1187)

References

Hrubý, Z. (2001). Dynamika vývoje přirozených lesních geobiocenóz ve Východních Karpatech. Dissertation thesis (in Czech). Mendel University of Agriculture and Forestry in Brno, 104 p. + 39 p. suppl.