Recovery of the streams in Czech Republic? - results from GEOMON network of catchments

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Introduction

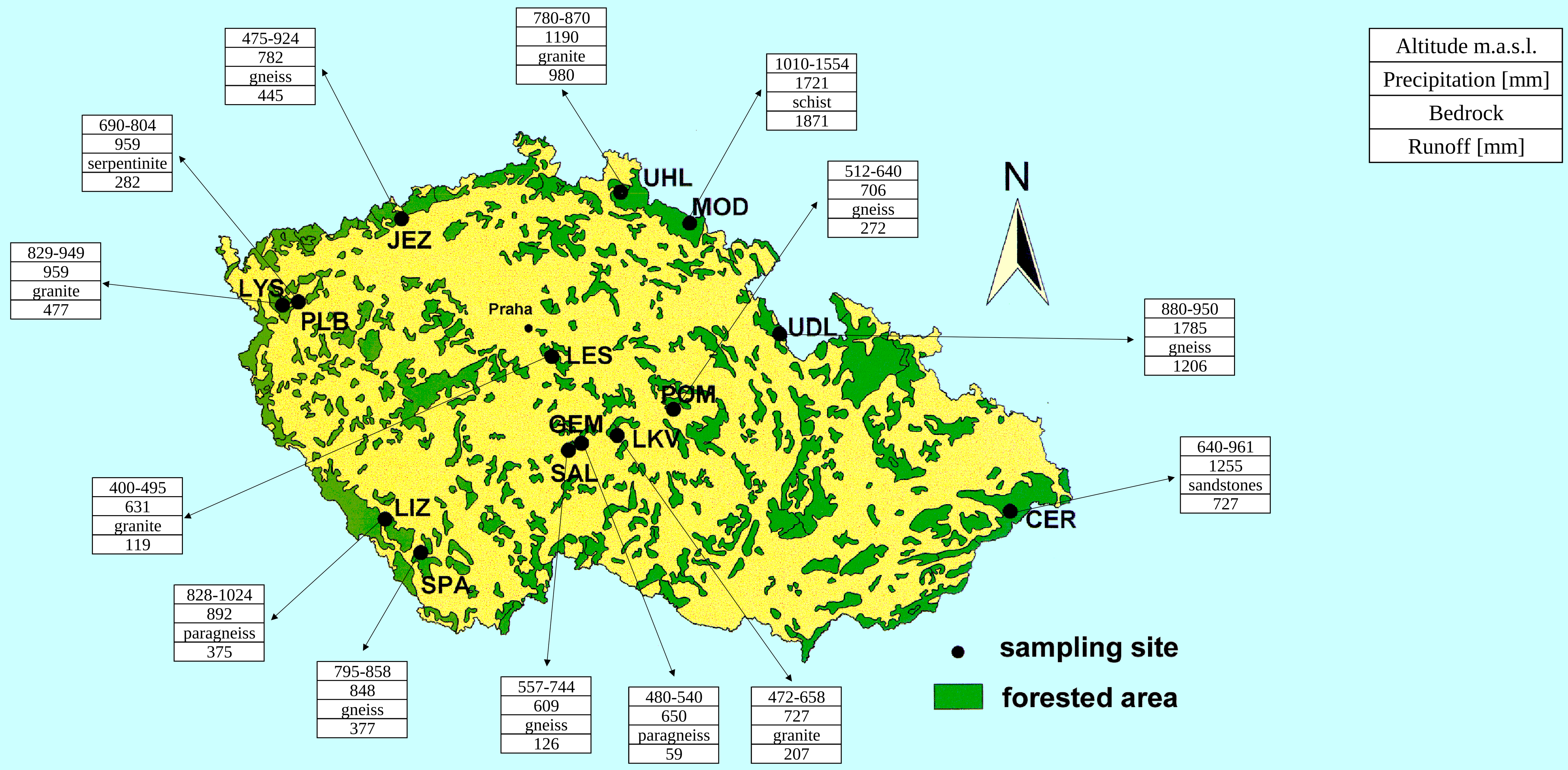
The GEOMON monitoring network was established in 1994 and has been maintained by the Czech Geological Survey. The network includes 14 monitoring sites distributed within forested areas of the Czech Republic (see map).

The monitoring period 1994 - 2004 covered important changes in the Czech environmental policy. The desulfurization of the main coal power stations was started in 1993 and completed in 1999. Effects of desulfurization processes have been causing changes to chemical composition of bulk and throughfall solutions at all sites.

The mean bulk deposition flux of S (from all sites) decreased from 11 $kg.ha^{-1}$ to 6 $kg.ha^{-1}$ and mean deposition flux of S in spruce throughfall (from all sites) decreased from 36 $kg.ha^{-1}$ to 16 $kg.ha^{-1}$ in period between 1994 and 2004. Other elements including N did not reflect the pattern of changes of S due to considerable influence of other sources of air pollution apart from coal burning.

Further large decreases of acid deposition are not expected since all the coal powerplants in the Czech Republic were desulfurized in the 1990s. The residual deposition flux of S was attributed to long-range transport and residual S emissions.

How these changes in deposition fluxes affected the stream recovery?



Site description & Sampling methods

Presented data cover period from 1994 to 2004.

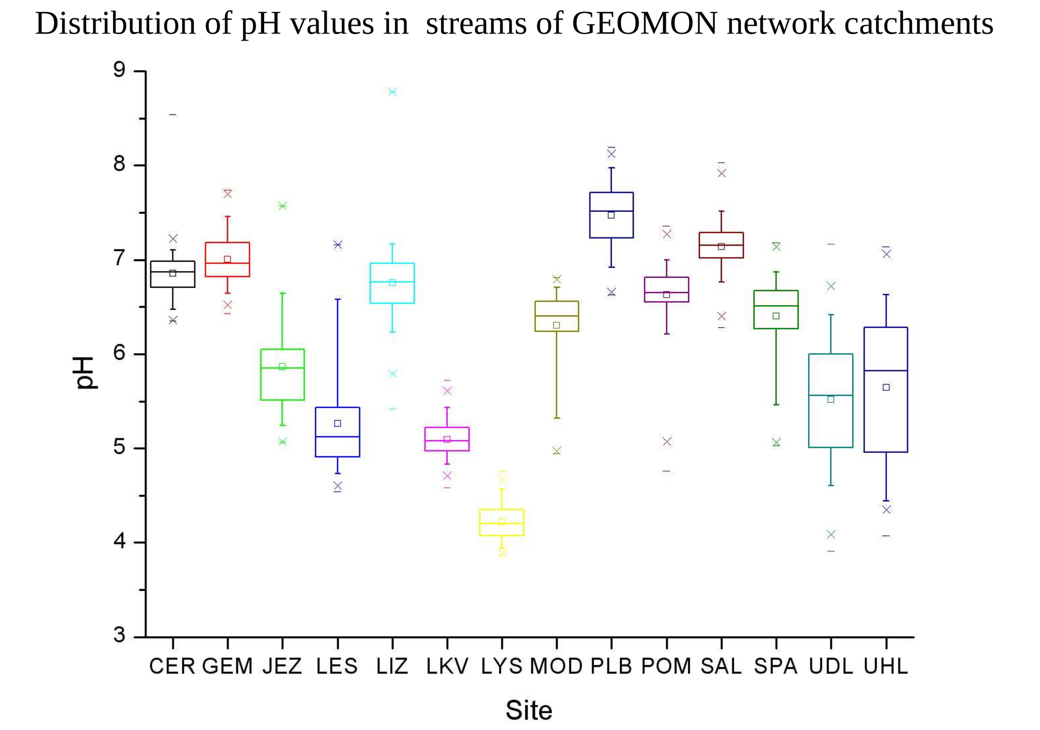
Bulk streamwater outputs from all the sites were monitored in monthly time step. All sampled solutes were analyzed for concentrations of main cations (Na, K, Mg, Ca and NH_4), main anions (F, Cl, NO_3 and SO_4) and pH.

The presented parameter ANC was calculated as the difference between base cations and strong acid anions:

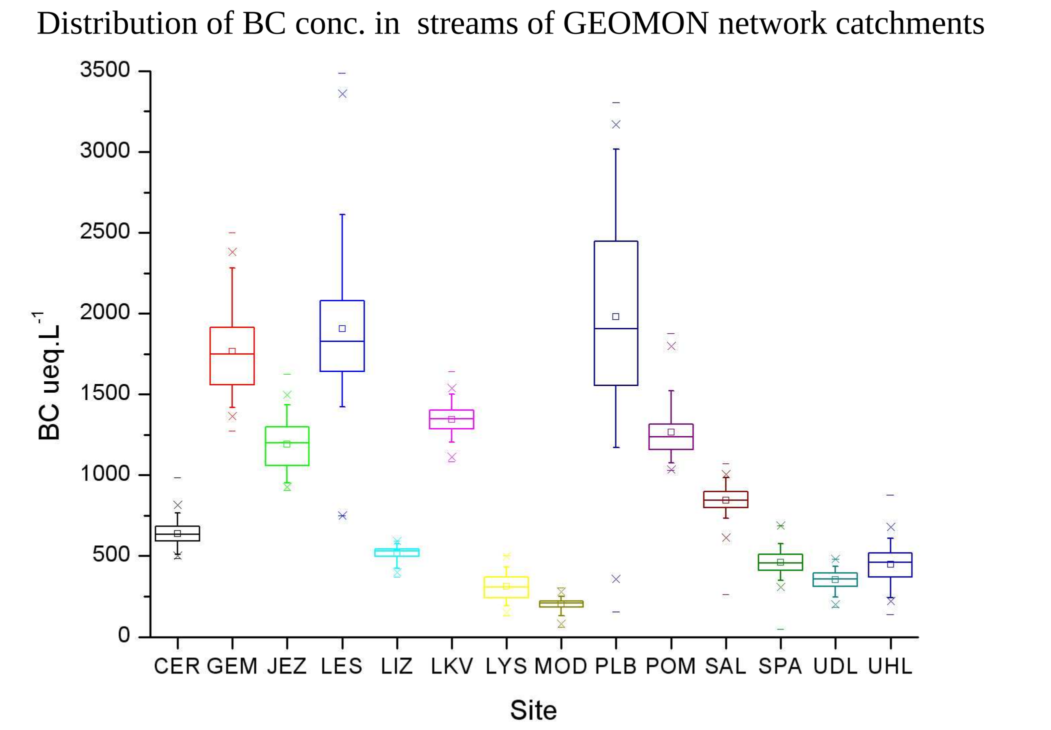
ANC = Ca + Mg + Na + K – SO4 – NO3 – Cl – F

The testing of trends significance has been performed using Seasonal-Kendall with Covariance Inversion. This non-parametrical method was used because data often exhibit skewed distributions. The trends were often curved but monotonic, the variance in some cases varied over time and the data were autocorrelated in time with a strong seasonal variation. The magnitude of trend Sen Slope was estimated for the time series of each month and the slope estimated as the average of the monthly Sen slopes. The used statistical methods were adopted from Folster and Wilander, 2002. The software for trend tests was written by Grimvall and Libiseller from the University of Linkoping.

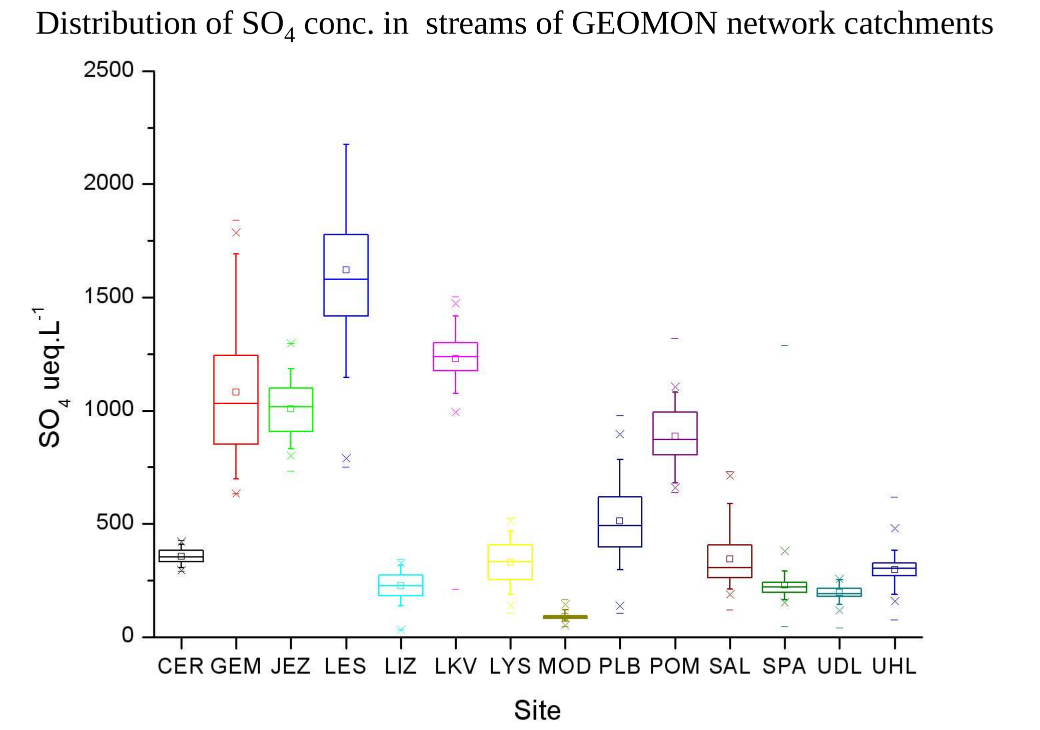
Distribution of pH values in streams of GEOMON network catchments



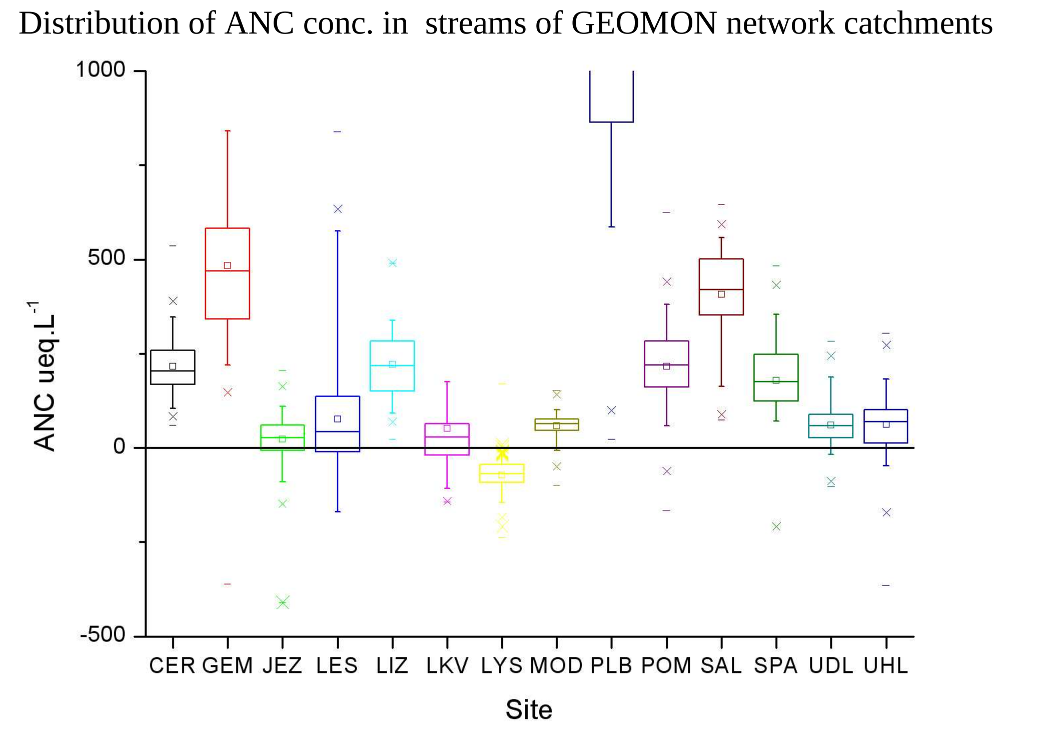
Distribution of BC conc. in streams of GEOMON network catchments



Distribution of SO_4 conc. in streams of GEOMON network catchments



Distribution of ANC conc. in streams of GEOMON network catchments

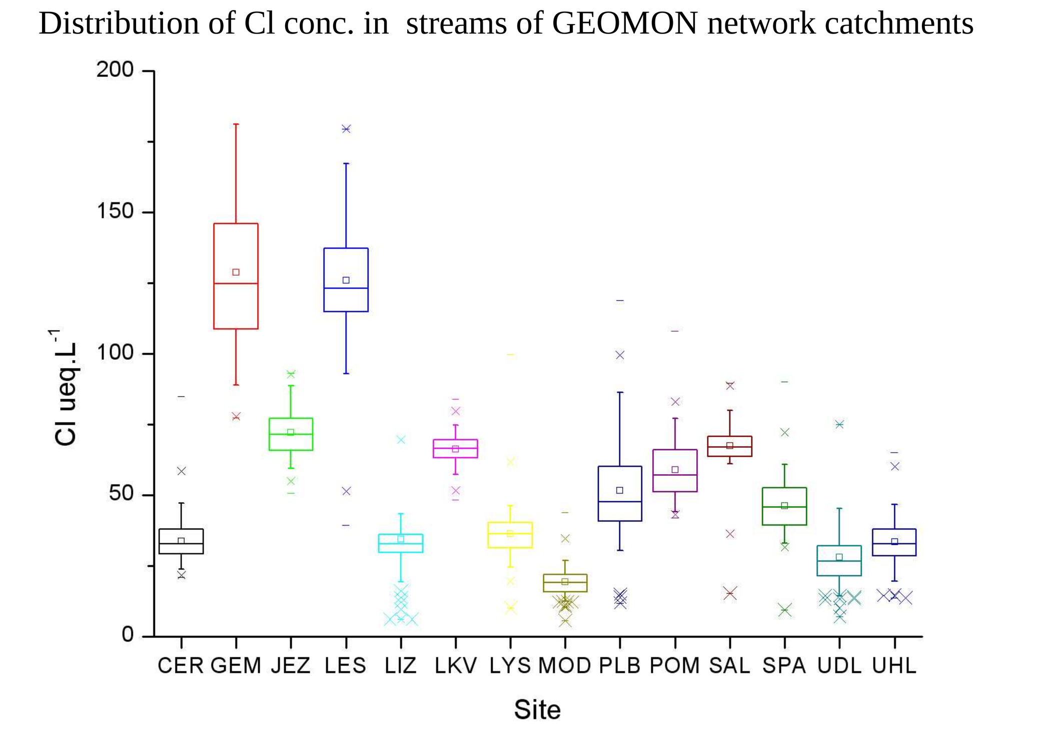


Tab. Annual changes in water chemistry of GEOMON network forest streams in period 1994 - 2004

Site	H^+ ($ueq.L^{-1}. yr^{-1}$)	BC ($ueq.L^{-1}. yr^{-1}$)	ANC ($ueq.L^{-1}. yr^{-1}$)	SO_4^{2-} ($ueq.L^{-1}. yr^{-1}$)	Cl^- ($ueq.L^{-1}. yr^{-1}$)	NO_3^- ($ueq.L^{-1}. yr^{-1}$)
CER	0.0	**-7.9**	-0.1	**-6.7**	**-0.9**	0.0
GEM	0.0	**31.1**	-0.2	**28.1**	2.3	**-3.2**
JEZ	**-0.3**	**-38.9**	-3.5	**-33.0**	**-0.6**	**-2.7**
LES	-0.3	**-27.4**	-7.0	-22.2	0.7	**-2.3**
LIZ	0.0	-4.0	1.6	-2.3	**-0.8**	**-2.2**
LKV	-0.3	0.9	-4.6	5.0	-0.2	-0.3
LYS	-1.0	**-11.5**	**8.3**	**-18.2**	**-0.5**	**-0.7**
MOD	0.0	**-4.1**	0.8	**-1.9**	**-0.8**	**-2.9**
PLB	0.0	-13.8	**28.3**	**-43.7**	-0.7	0.5
POM	0.0	**-33.7**	6.6	**-32.8**	**-1.7**	**-7.4**
SAL	0.0	-3.3	-1.7	-3.0	0.1	0.8
SPA	0.0	-6.2	2.6	**-4.0**	1.0	**-0.5**
UDL	**-0.7**	-1.8	4.6	-1.8	**-0.7**	**-3.8**
UHL	-0.3	-4.3	**5.6**	-5.5	**-0.9**	**-4.3**

Trends significant at the 95% level are bold.

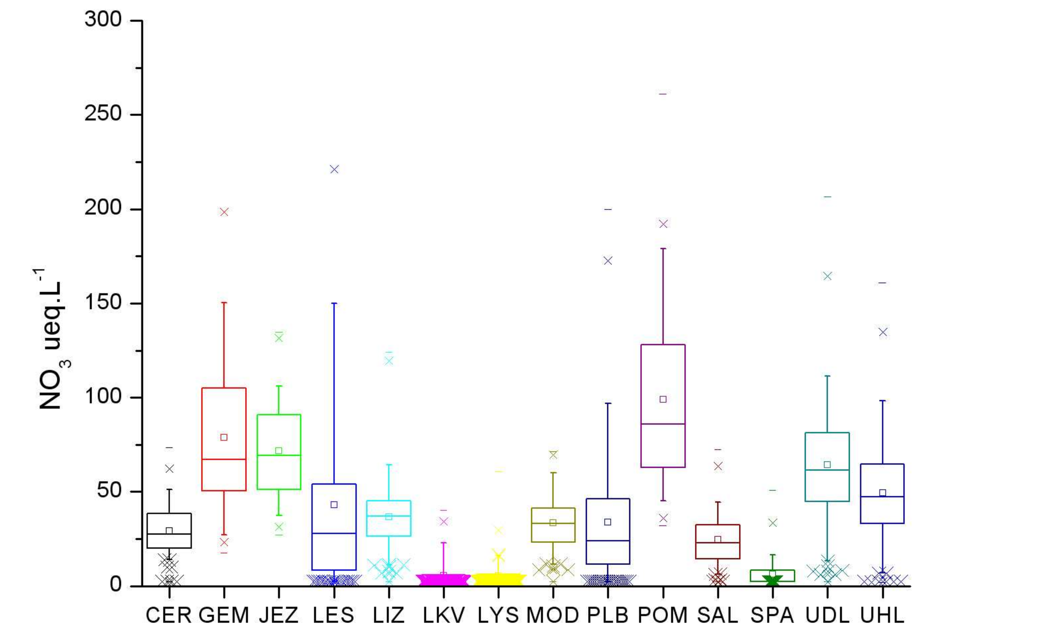
Distribution of Cl conc. in streams of GEOMON network catchments



Results

- decline of H^+ concentrations was monitored at 6 sites (negative values in Table) but only at JEZ catchment it was statistically significant
- all of these catchments have poor buffering soils and bedrock (see map)
- with two exceptions concentration of BC declined, at some sites the decline of BC was accompanied by decline of SO_4^{2-}
- only site with significantly increasing trend of SO_4^{2-} concentration was GEM site, where the soils are running out of their SO_4^{2-} high adsorption capacity what causes the increasing sulfate in stream
- nitrate concentrations have been significantly decreasing at 11 catchments (at 10 significantly)

Distribution of NO_3 conc. in streams of GEOMON network catchments



On all figures - 50% percent of values are within the boxes the line inside the box represents median value.

- declining concentrations of Cl at 10 sites (at 8 sites significant) suggests that these sites were also influenced by industrial emissions of Cl or decreasing deposition of marine aerosols
- declines of Cl^- and NO_3^- concentrations should then be additional contribution to ANC increase due to declining SO_4^{2-} concentrations
- ANC has been increasing at 8 sites but significant increase in ANC occurred only at PLB catchment with the serpentinite bedrock

Conclusion

The significant decrease in acid deposition caused decline of BC concentrations (decreased BC leaching) in streamwater at most sites. But streamwater ANC values keep further decreasing or insignificantly increase at the most of sites.

References

Folster J., Wilander A. (2002) Environmental Pollution 117, 379-389.

Grimvall A., Libiseller C. The Partial Mann-Kendall Test for Detection of Trend in the Presence of Covariates, http://www.mai.liu.se/~cllib/welcome/PMKtest.html

Acknowledgments

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