Mercury in stream water at five Czech catchments across a deposition gradient

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1919 CZECH GEOLOGICAL SURVEY

USGS science for a changing world

Motivation

Given the history of high elevated Hg deposition

Is there high Hg in streamwater?

Outline

- CZ Hg dep history
- Study watersheds
- Hg and C dynamics
- Role of legacy S

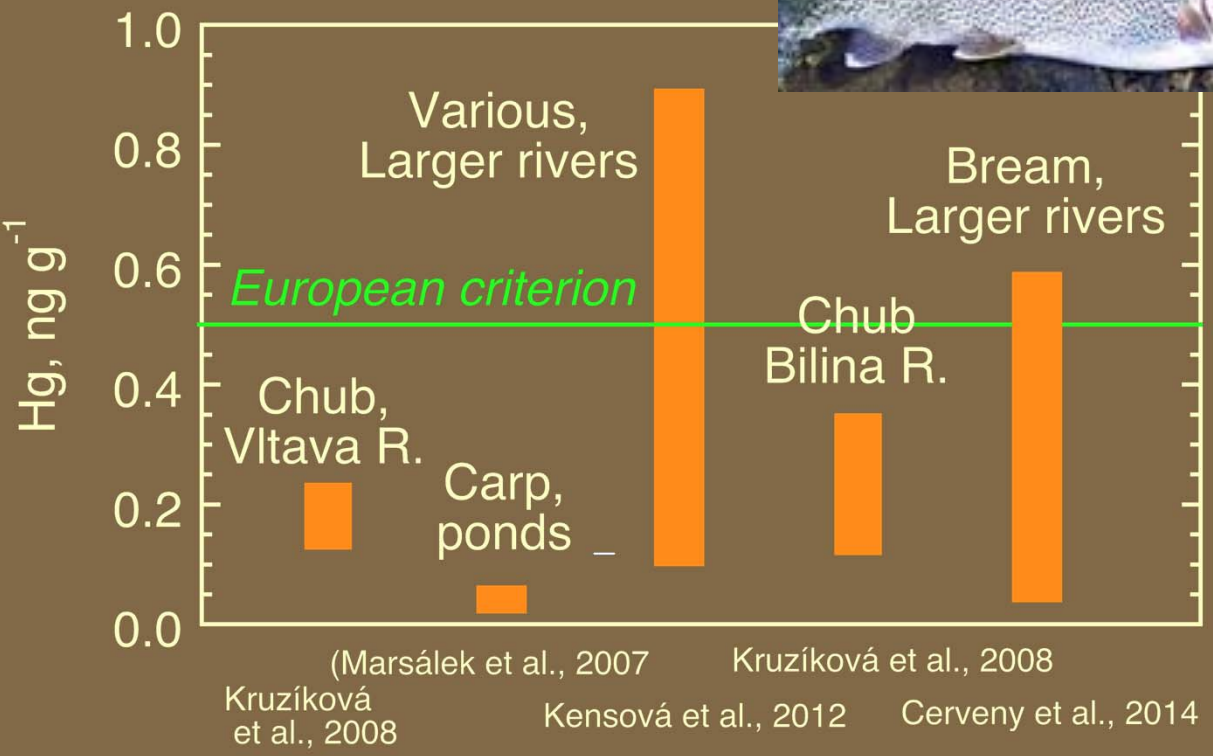
Mercury in the Czech Republic

Few studies

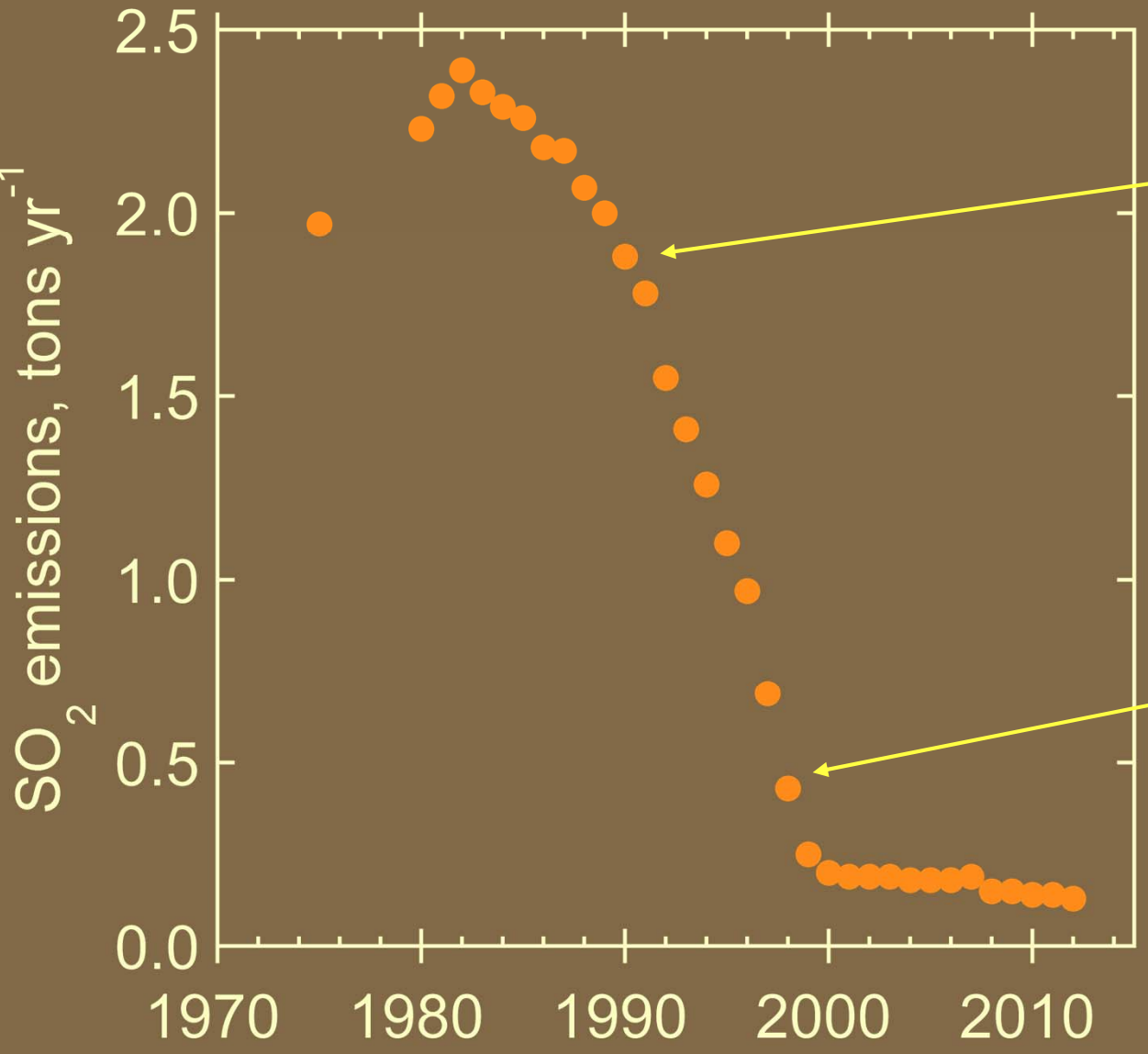
•2 soils papers, one stream paper from Navrátil group

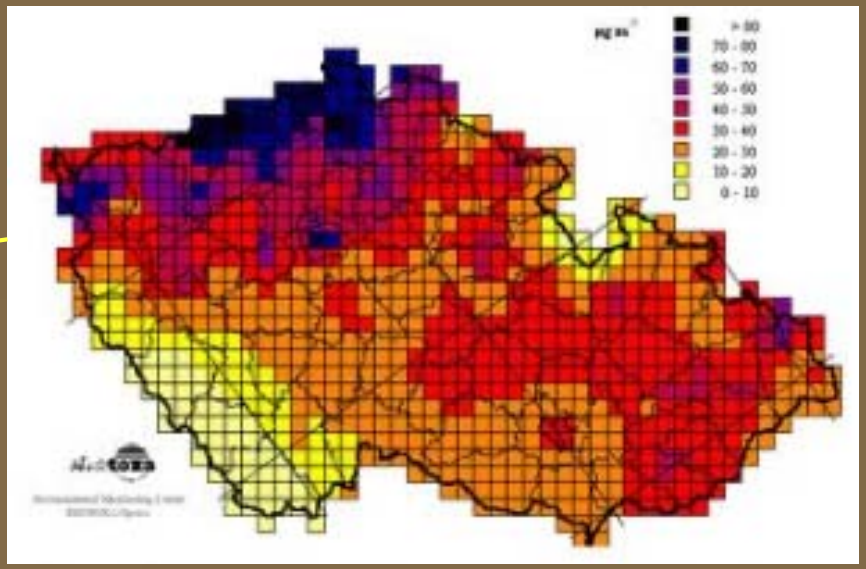
• Hg in peat cores, soils

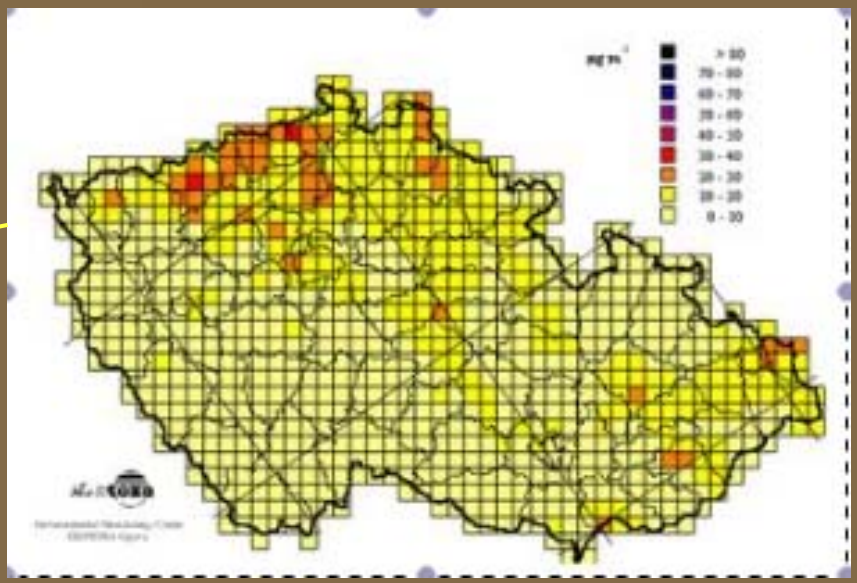
• Fish studies



Czech Republic SO2 emission trend



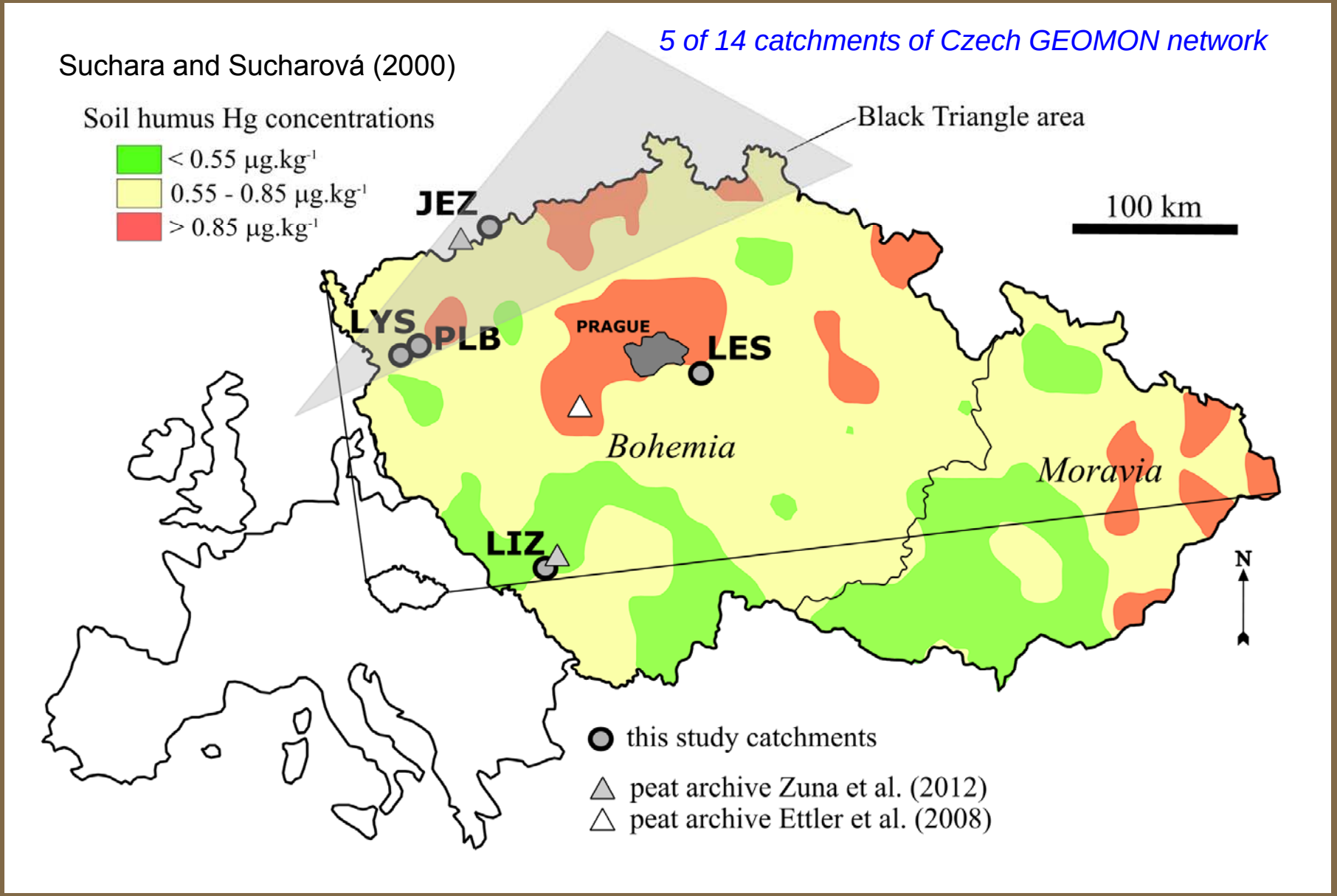




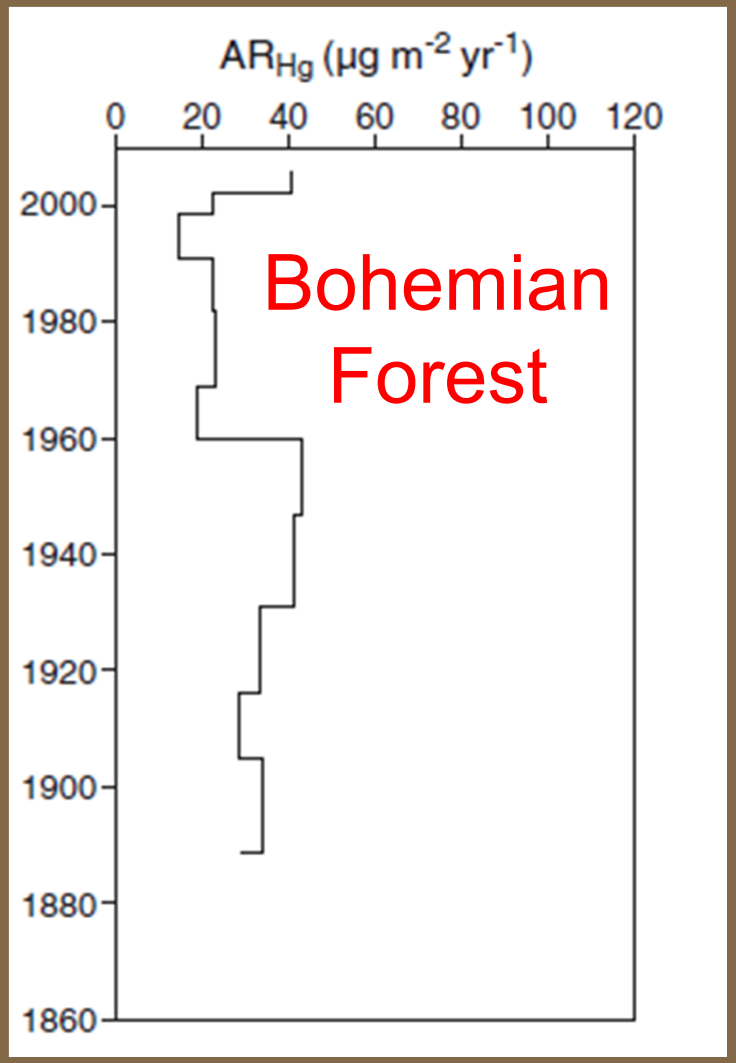
The connection between Hg and S

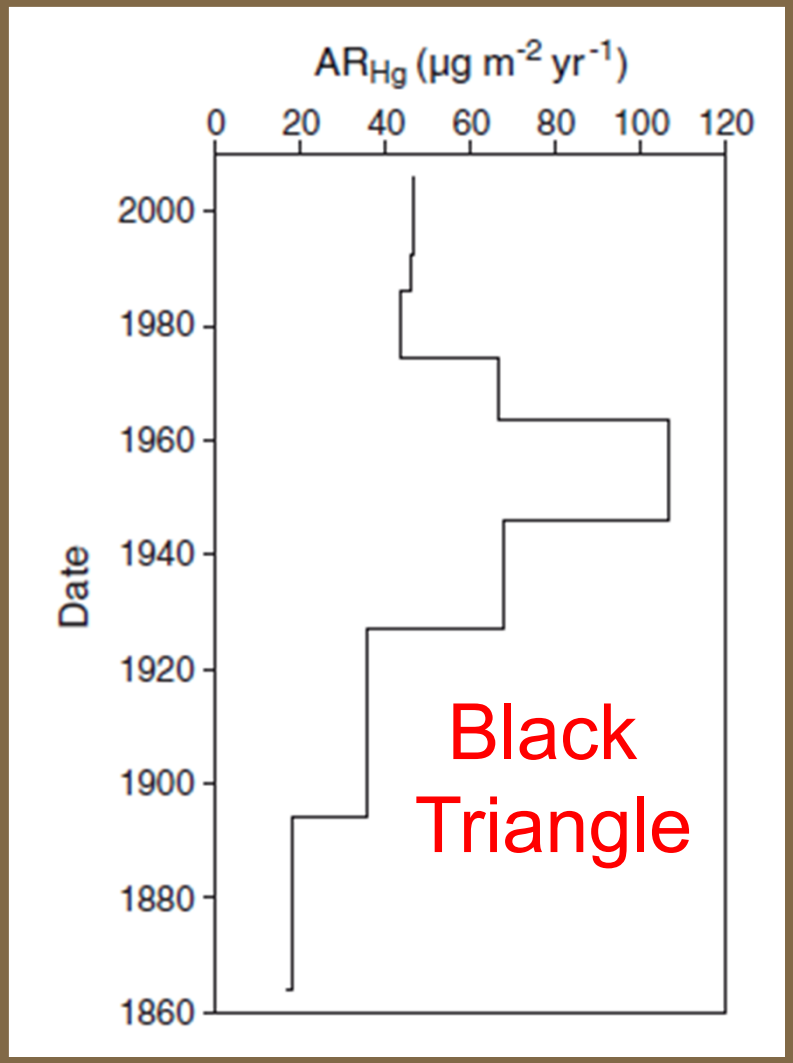
- Hg and S have strong affinity, co-exist in coal
- High acid deposition tends to correspond to high Hg deposition
- Hg has even stronger affinity for OM, but especially S-containing thiols
- S is an important driver of Hg methylation, methyl-mercury is the toxic form that biomagnifies

Study watersheds



Hg in Peat Cores

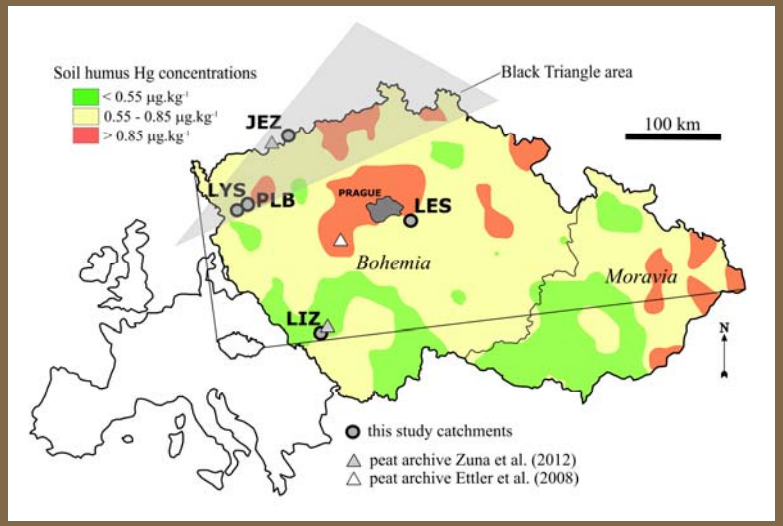




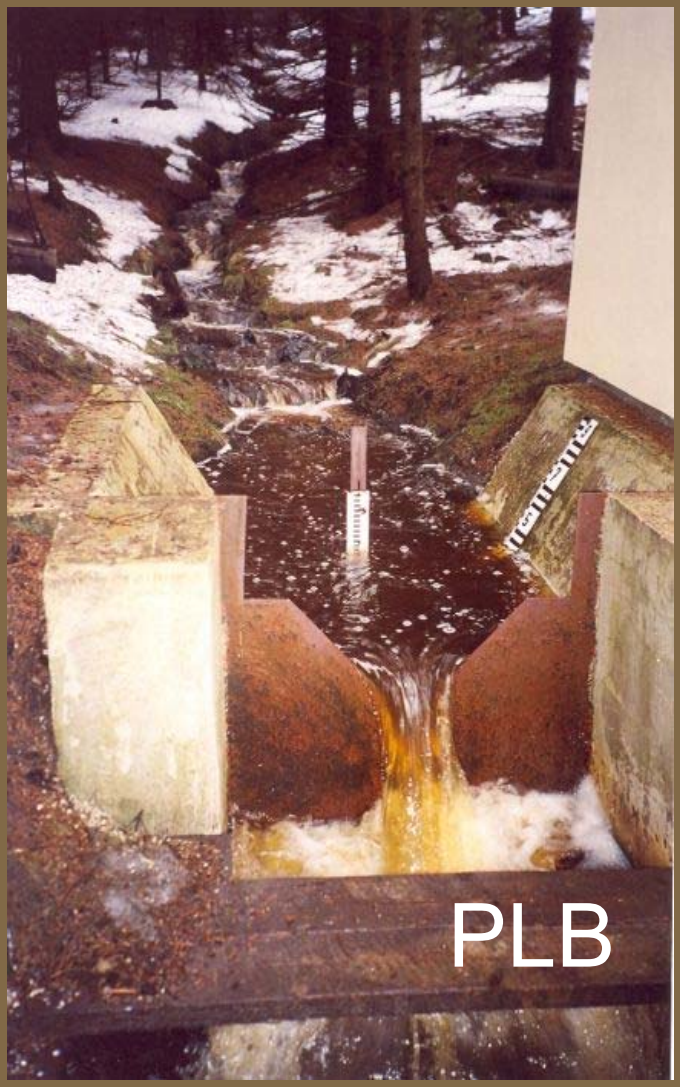
Zuna et al. (2012) - Atmospheric Environment 424.

Site characteristics

	JEZ	LES	LIZ	LYS	PLB
Area (ha)	261	70	99	27	22
Mean temp.	6.0	7.0	6.6	5.0	6.0
Precip (mm)	773	625	894	1001	810
Runoff ratio	0.49	0.17	0.43	0.46	0.35
Mean pH	5.5	5.1	6.4	4.1	7.2
S dep 1994 (kg/ha)	67	21	9	32	26
Bedrock	gneiss	granite	paragneiss	granite	serpentinite

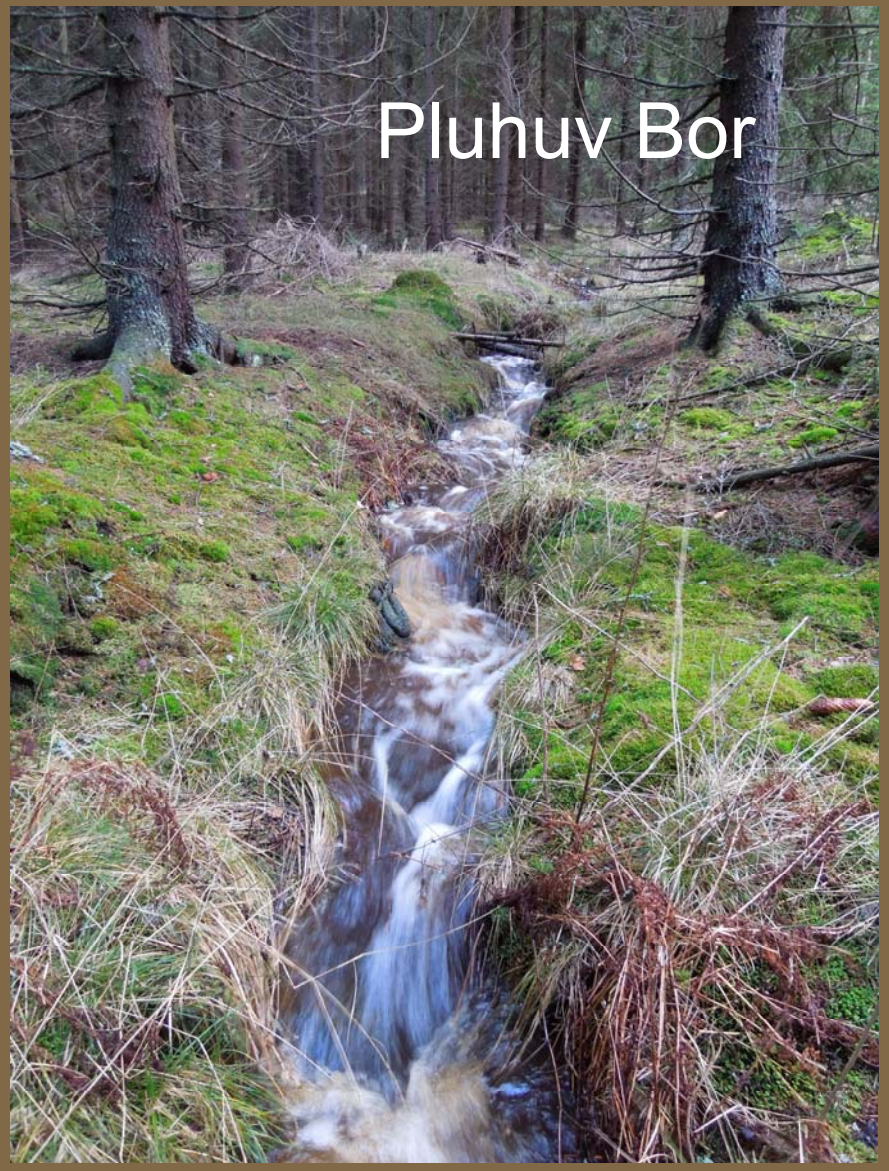


Stream gages

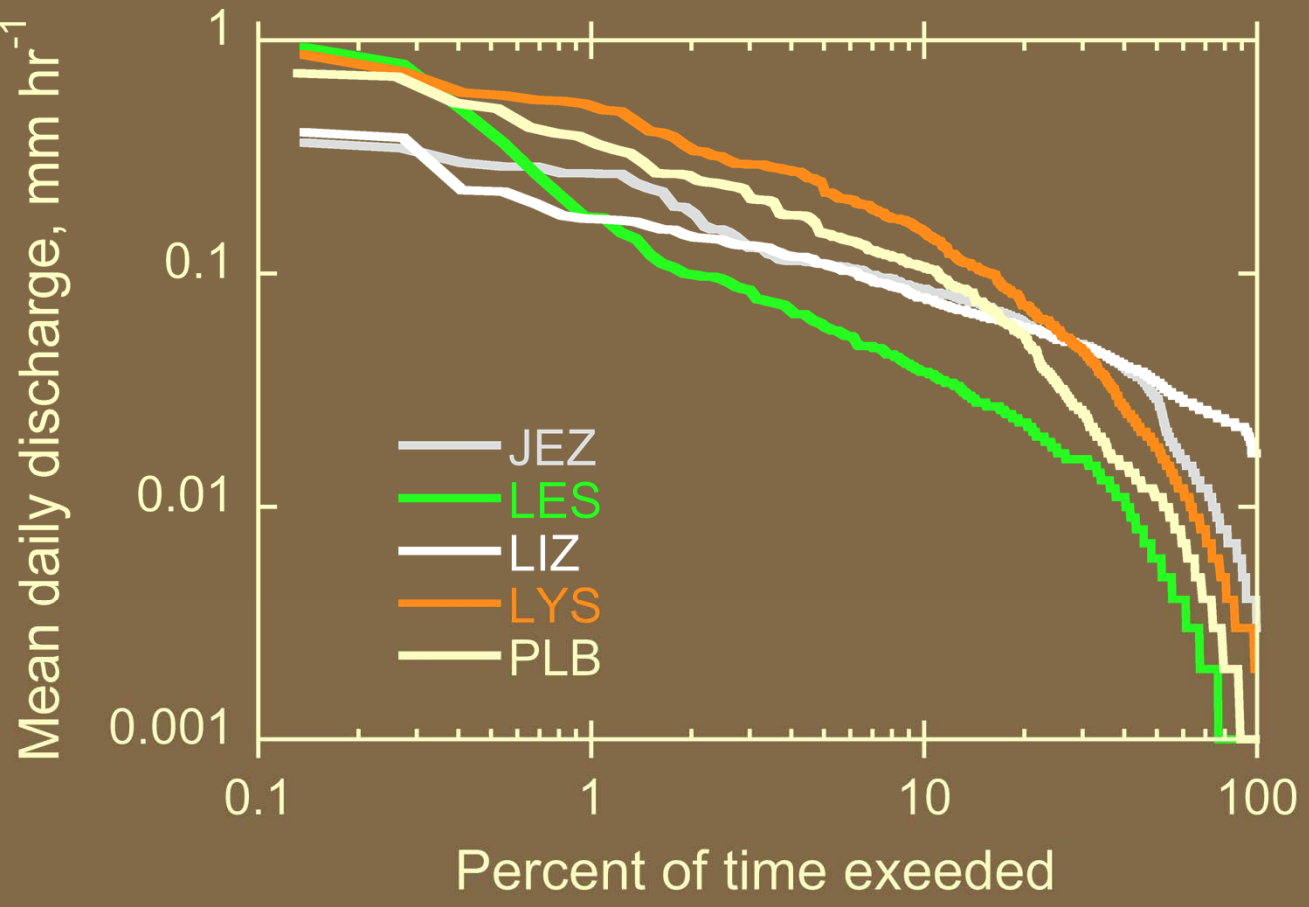


Methods

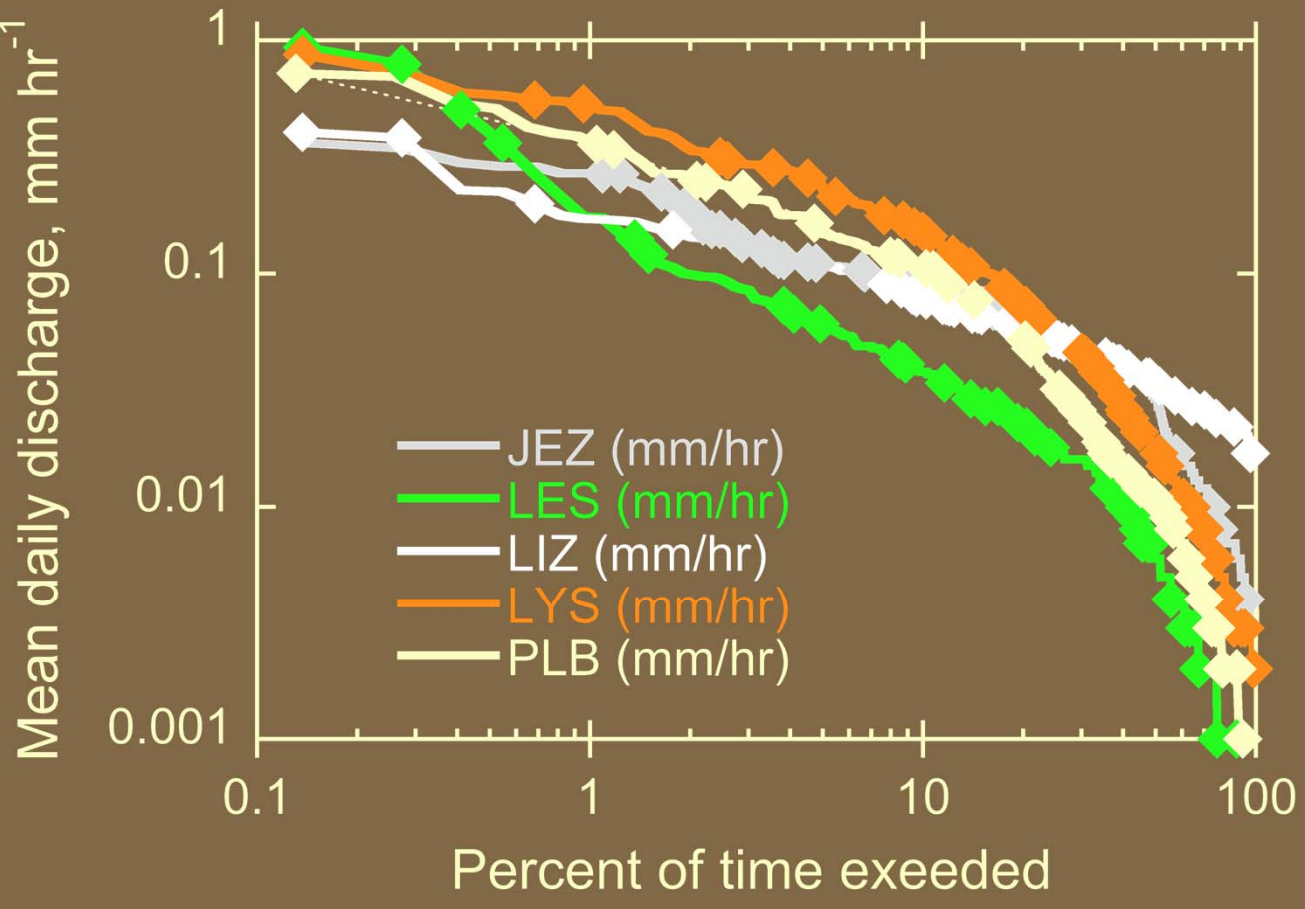
- Monthly sampling
- One large flood event – 2 June 2013
- Filtered 0.4-µm GFF
- Total Hg by CV-AAS, EPA method 1631
- DOC by Shimadzu TOC V-CPH analyzer
- UV absorbance @254 nm



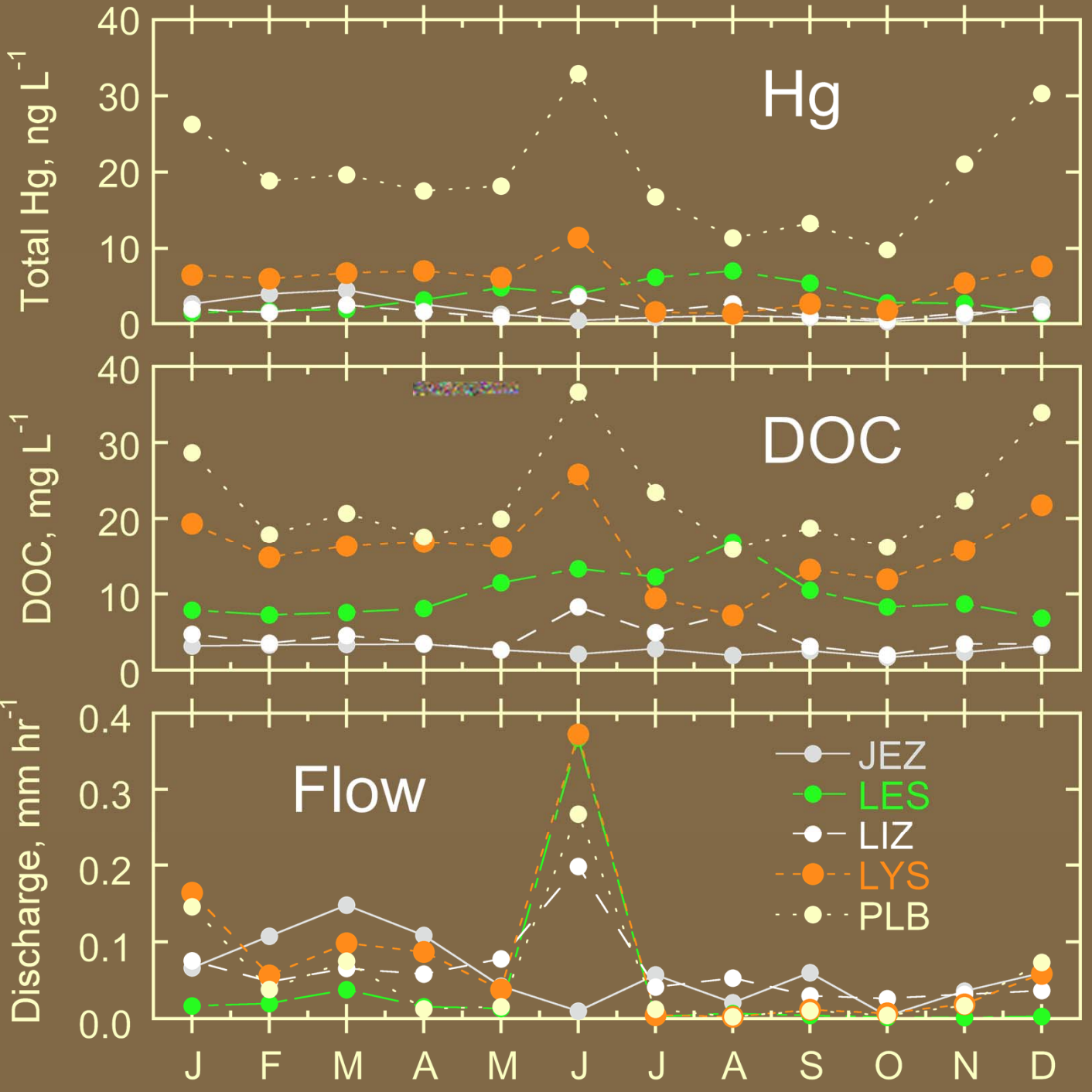
Flow duration curves



Flow duration curves with samples

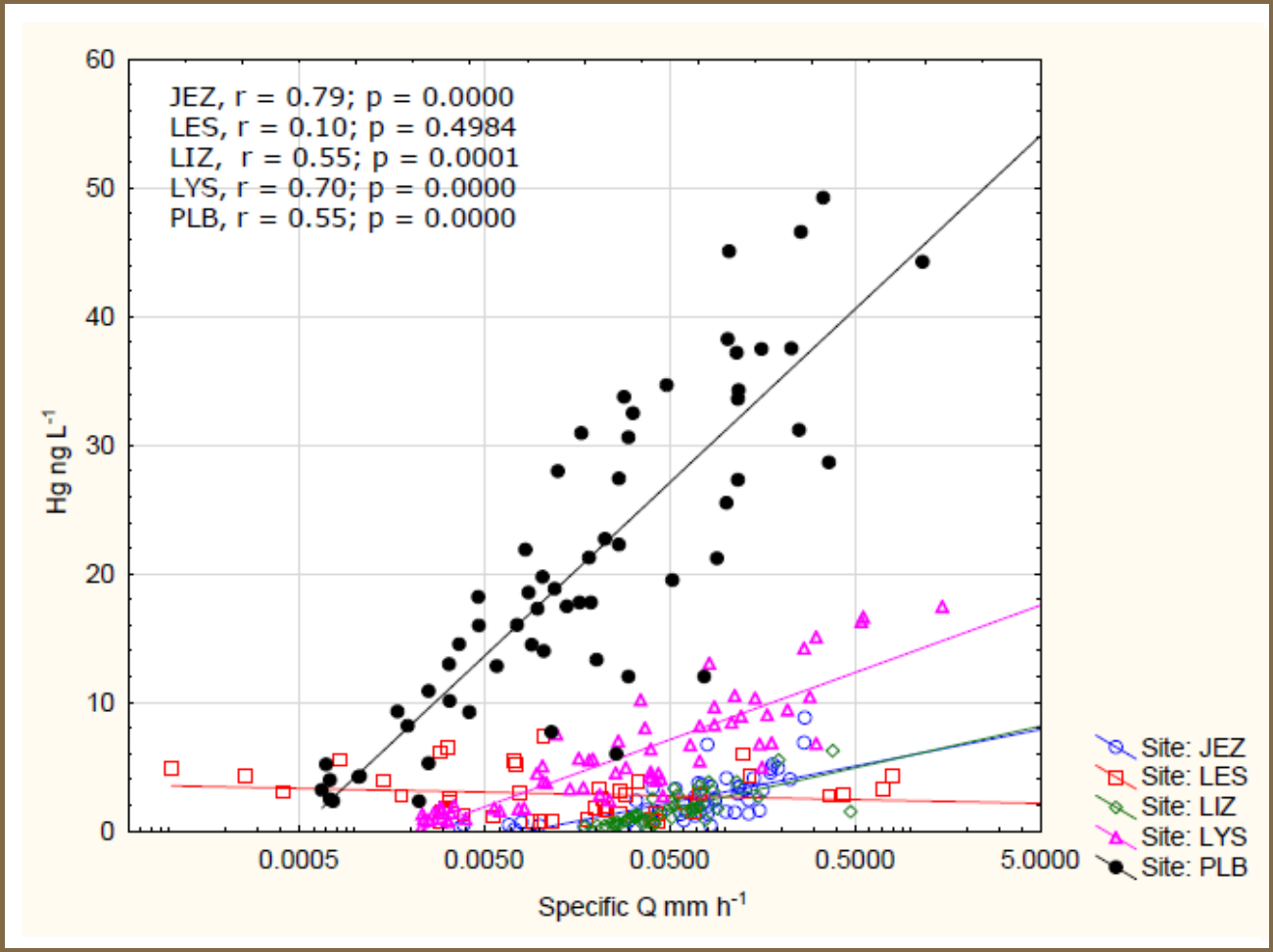


Timelines

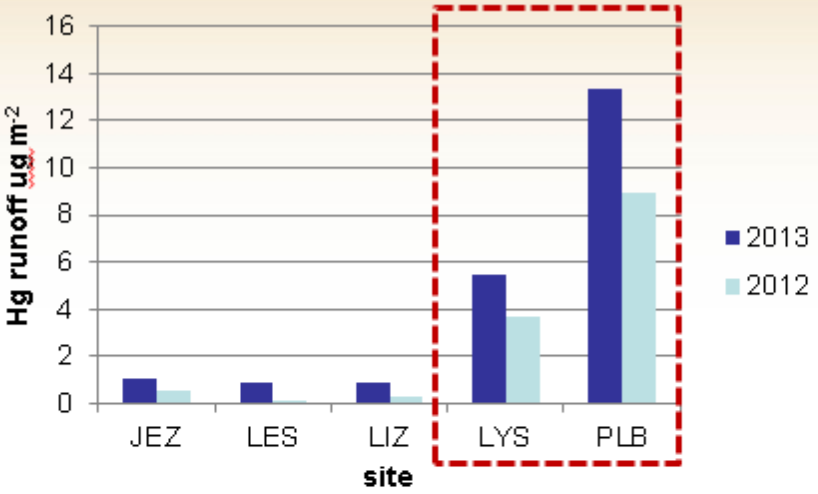

Hg
Total Hg, ng L-1
DOC
DOC, mg L-1
Flow
Discharge, mm hr-1
JEZ
LES
LIZ
LYS
PLB
J F M A M J J A S O N D

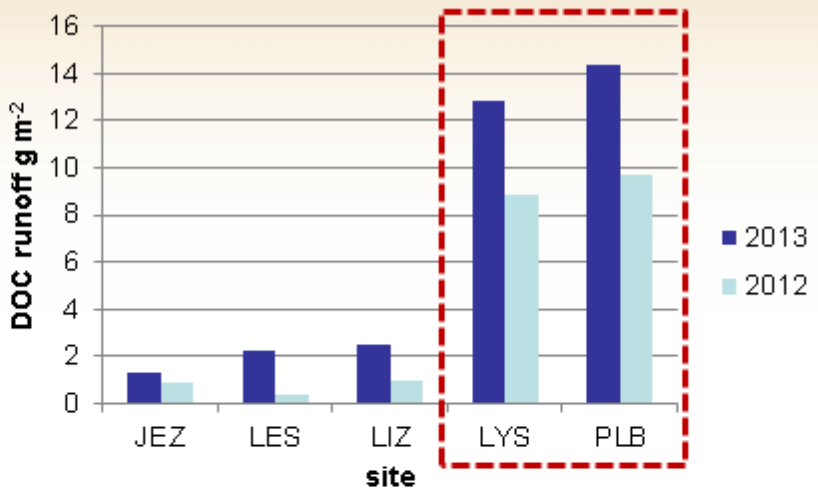
Discharge related Hg and DOC

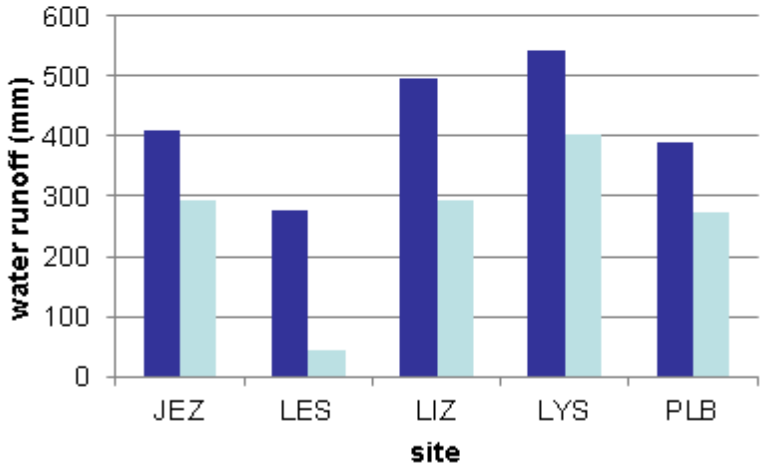
- site-specific changes in discharge determine the site-specific Hg and DOC runoff



Hg and DOC output fluxes







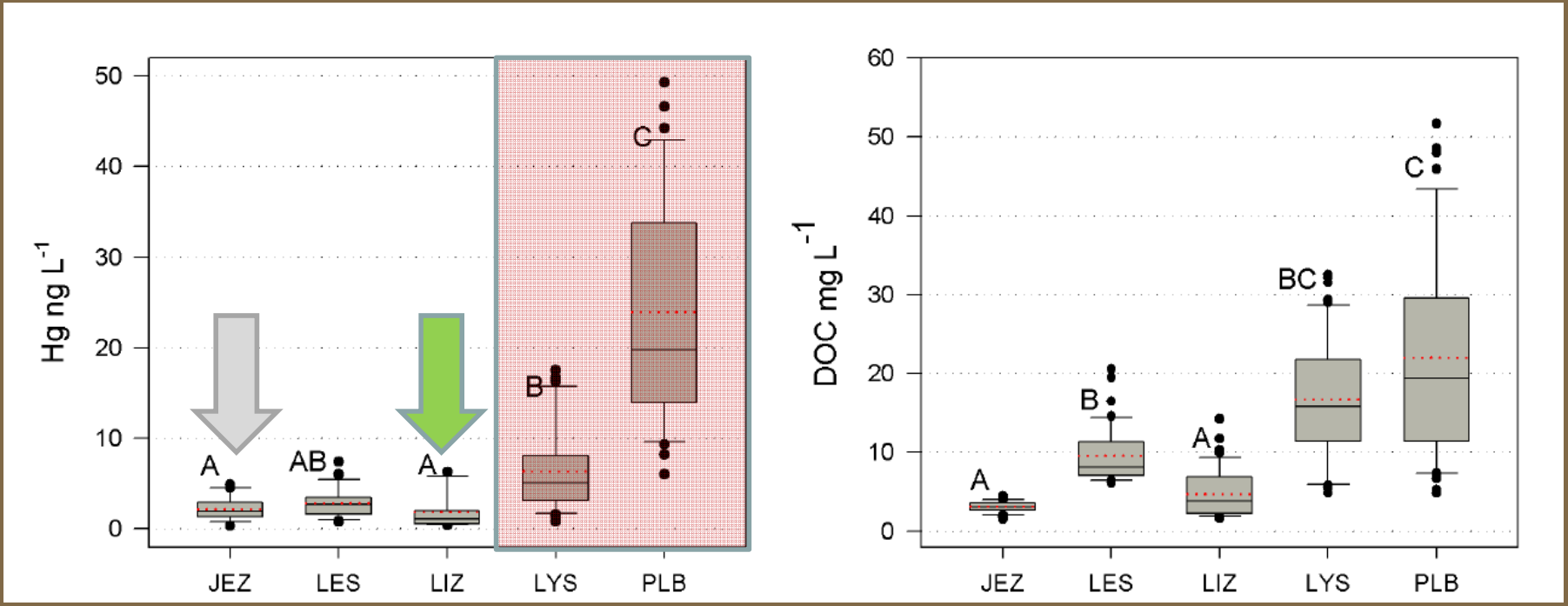
above average water year

below average water year

- how does stream water Hg link to soil Hg?

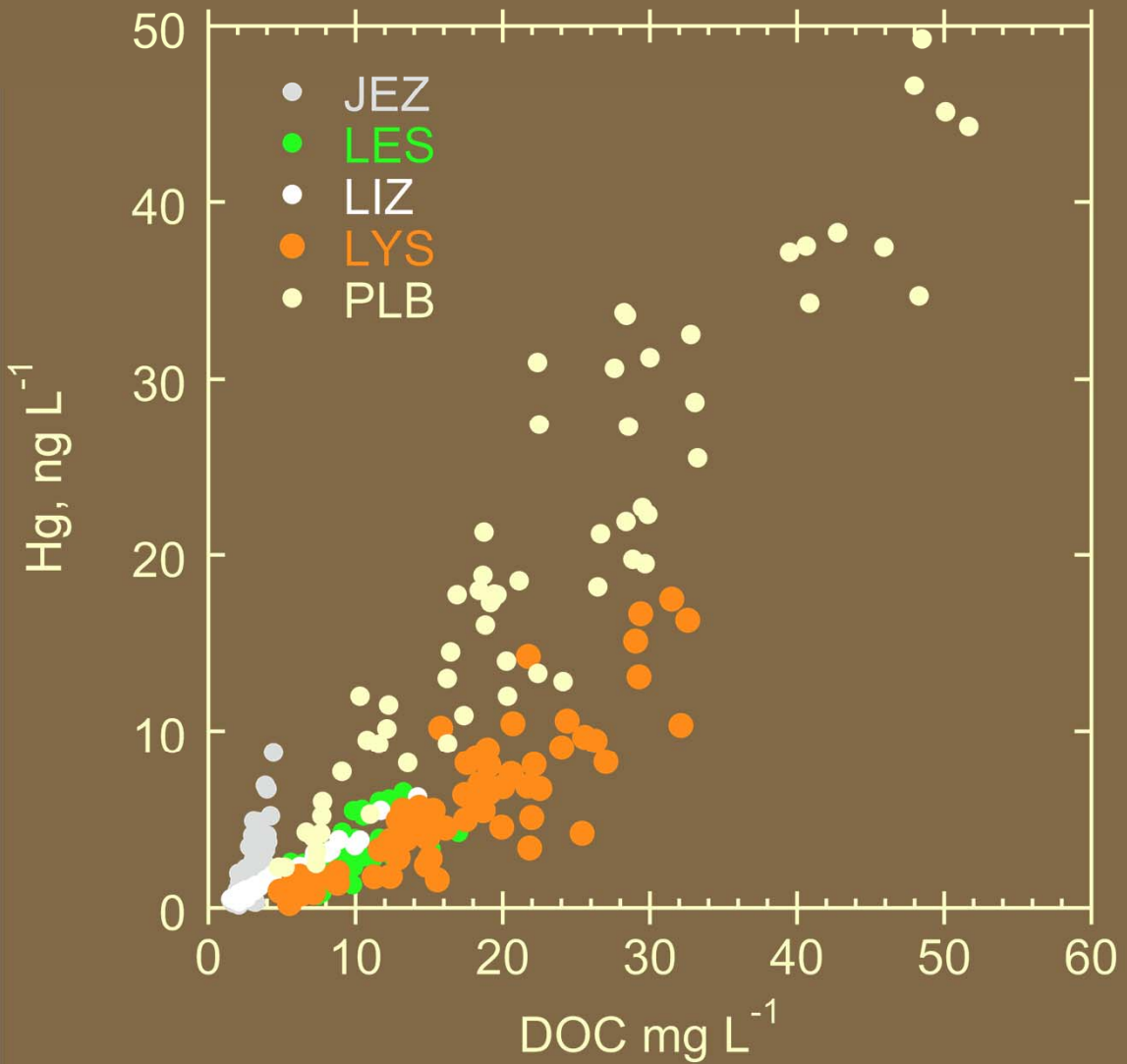
Stream water Hg and DOC

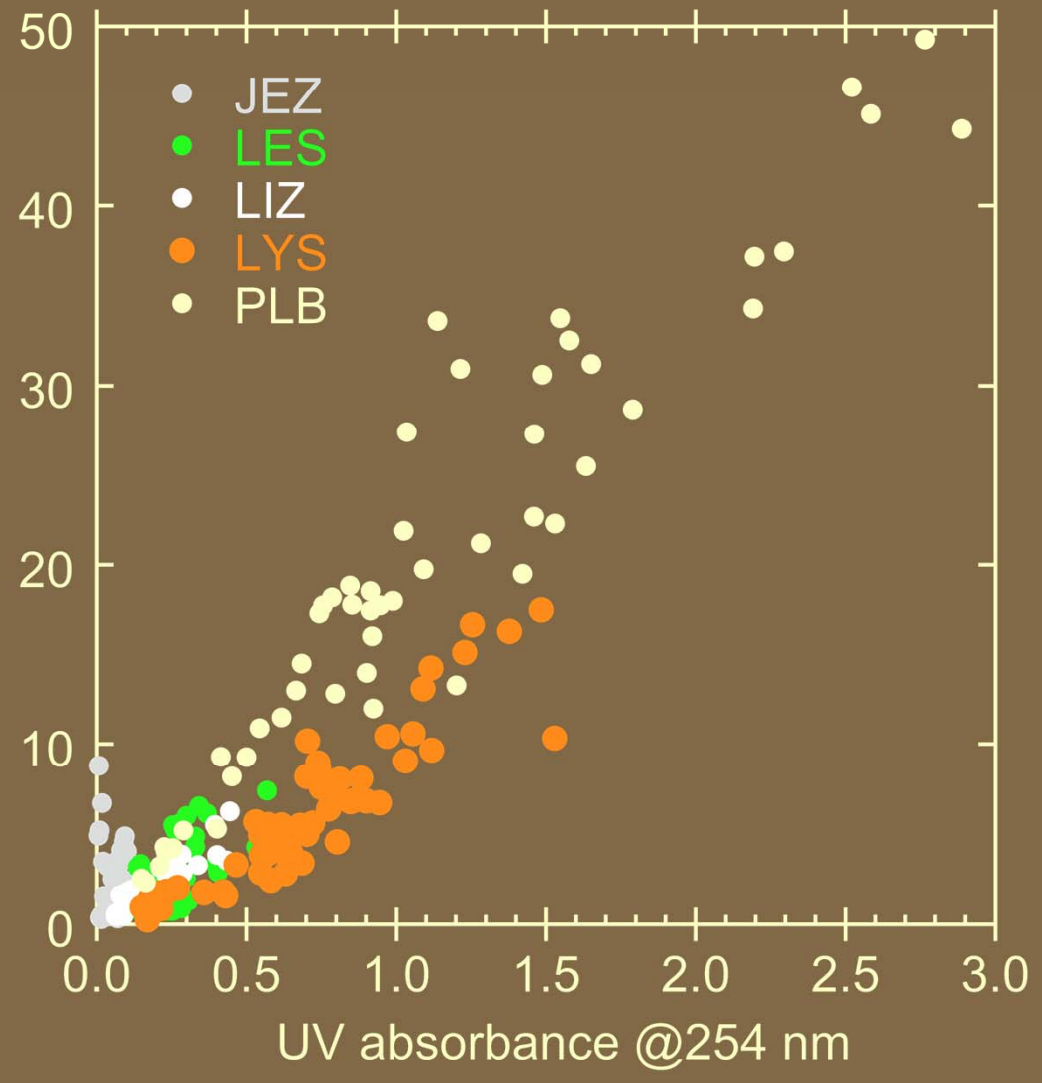
- export of DOC from forested catchments is governed by competing processes of ***production, decomposition, sorption*** *and* ***flushing***



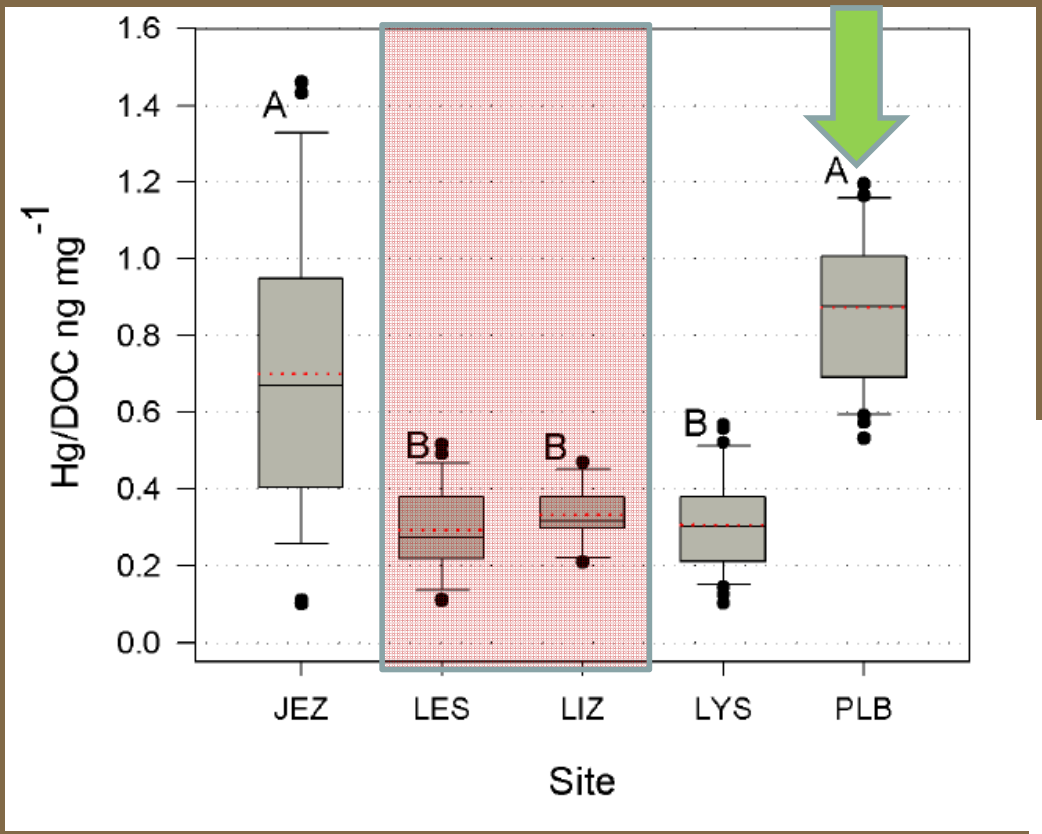
- site by site stream water Hg concentration determined by stream water DOC concentration!

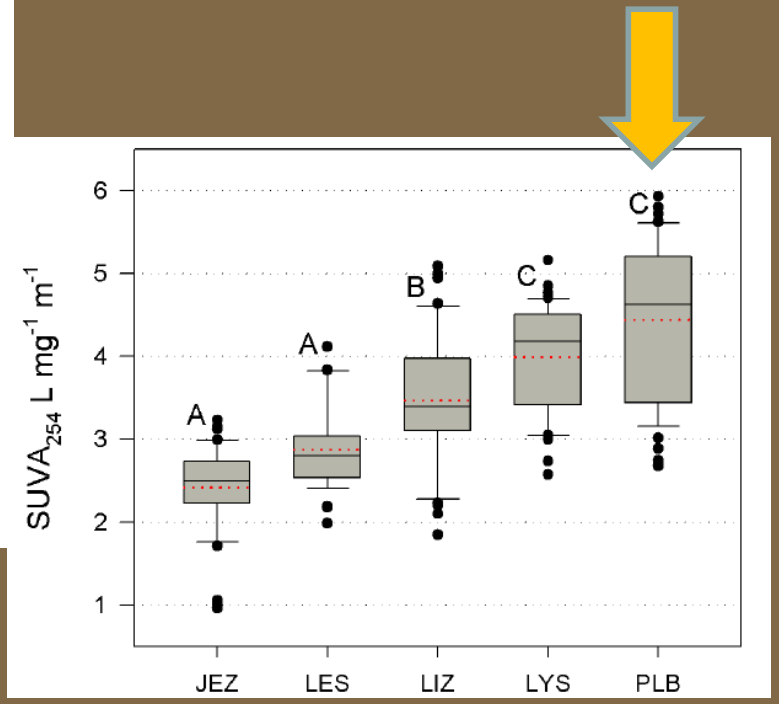
Hg vs. DOC and UV254





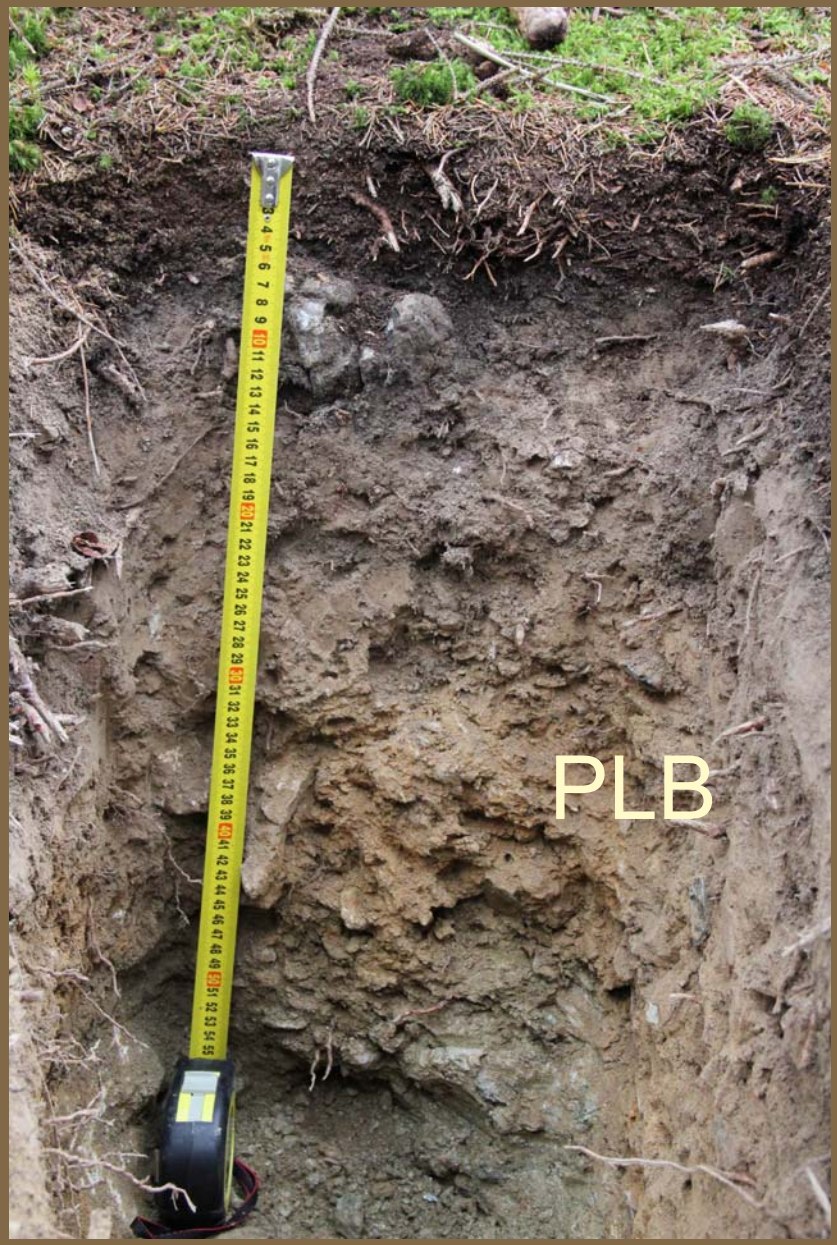
Stream water Hg/DOC ratio



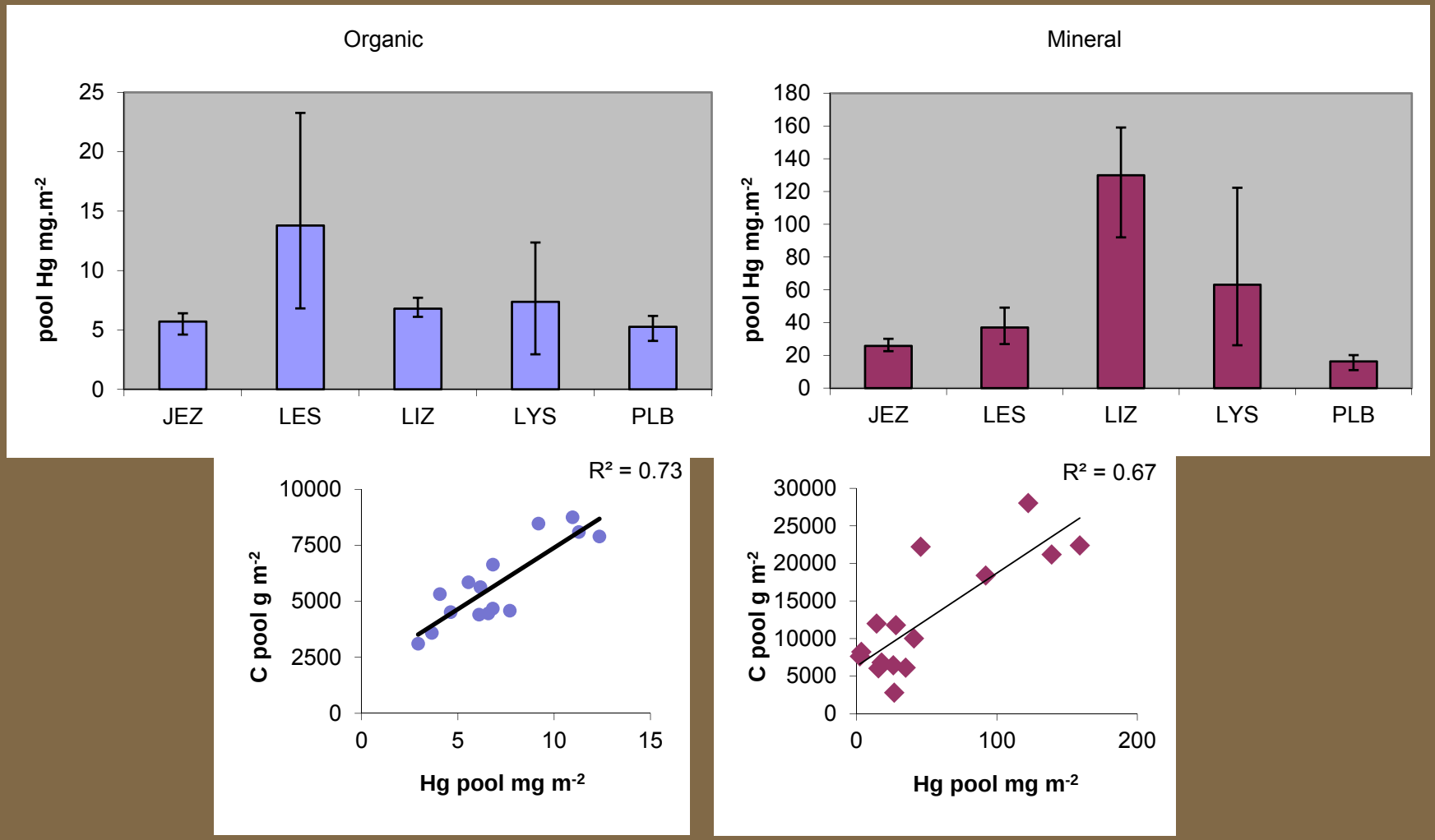


- high stream water Hg/DOC ratios at JEZ site with possibly the highest Hg historical deposition and **at PLB the alkaline site** (serpentinite bedrock)

Soils



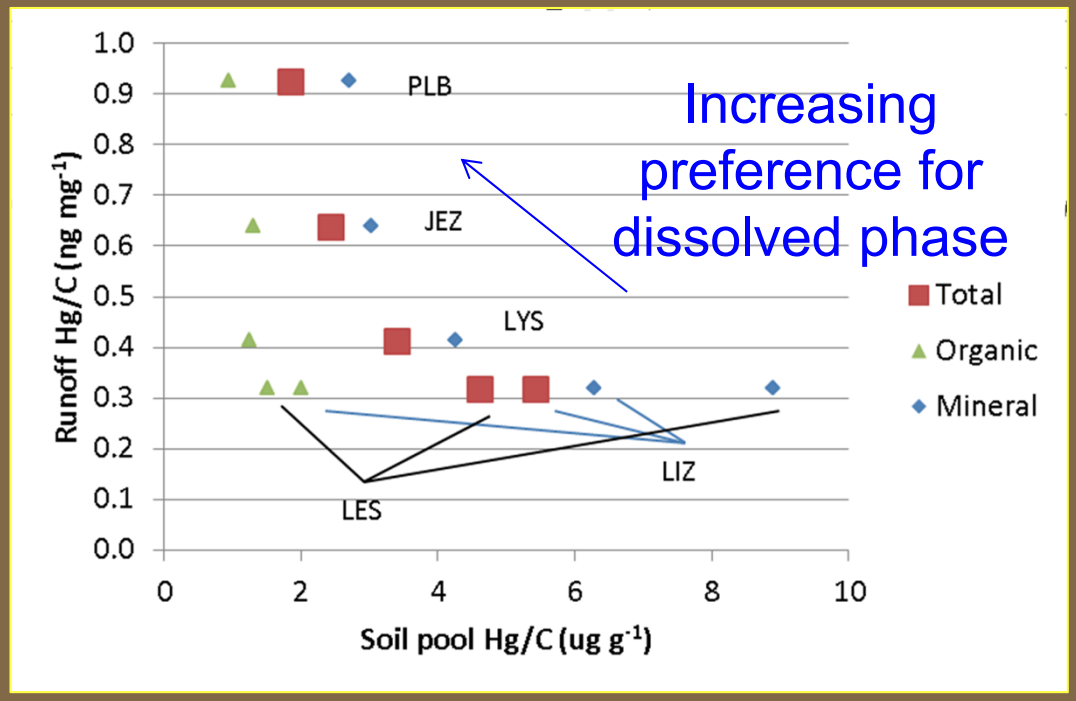
Soil Hg

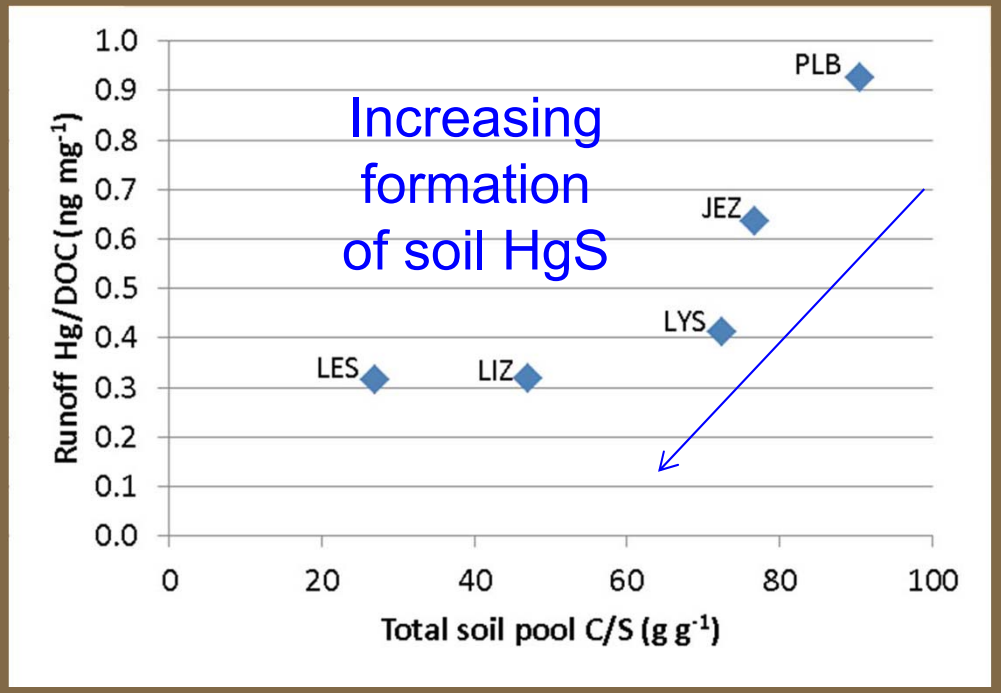


- size of soil Hg pools determined by size of C pools…

Source: Navrátil et al. (2014) - *Water, Air and Soil Pollution* 225

Does soil Hg drive stream Hg?





Where did Hg go?

Conundrum – At highest Hg deposition site, very low stream and soil Hg

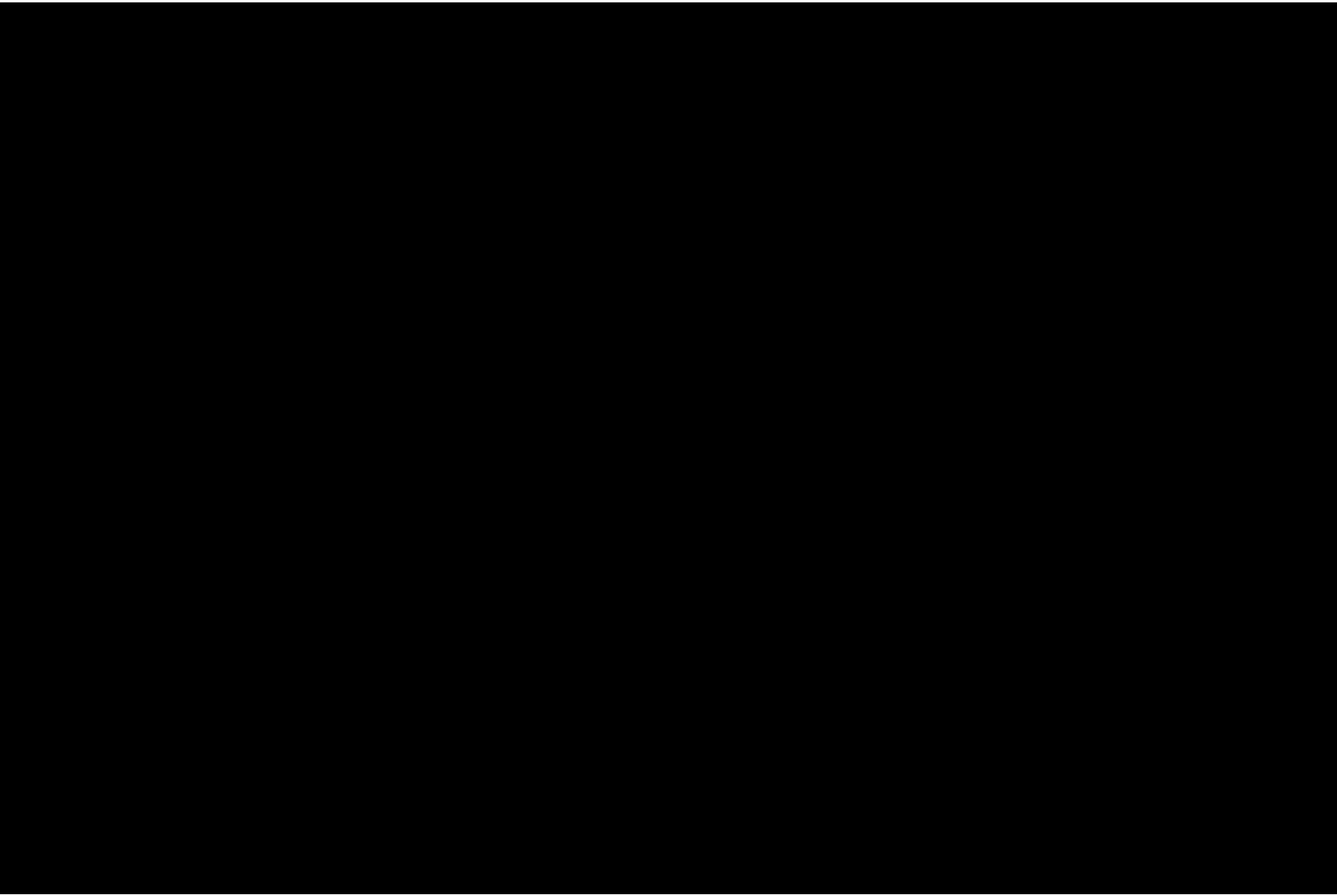
- Was watershed response rapid?
- Role of volatilization?

Conclusions

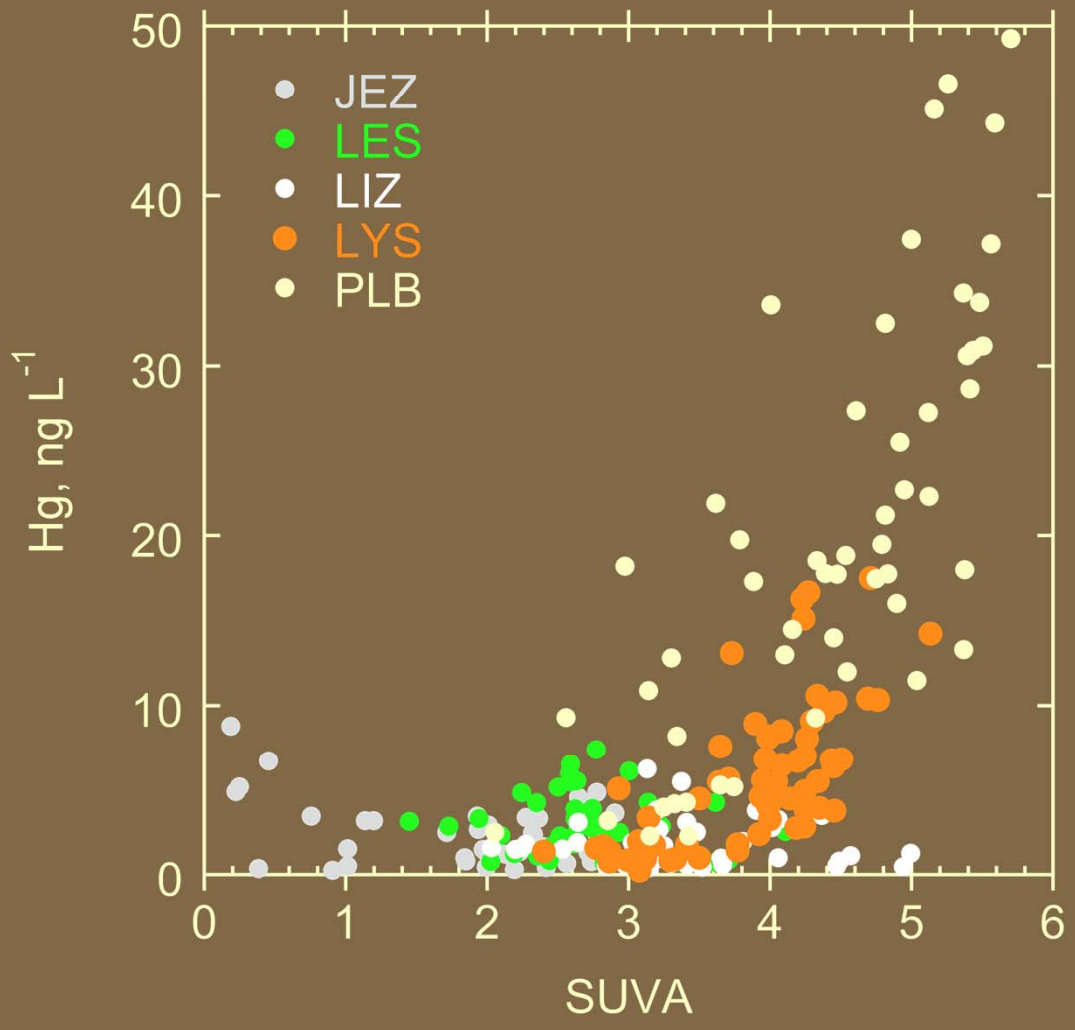
- Hg in streams does not follow Hg deposition gradient.
- Dissolved Hg export at two sites is among highest in literature, but fairly low at highest-deposition site.
- Hg export in Czech streams far more a function of OM availability, including in soil.
- Some Hg may combining with legacy S and precipitating as immobile HgS phases.

Navrátil, T.; Shanley, J.; Rohovec, J.; Oulehle, F.; Krám, P.; Matoušková, Š.; Tesař, M.; Hojdová, M. Mercury in stream water at five Czech catchments across a Hg and S deposition gradient. *Journal of Geochemical Exploration* **2015,** *158* 201-211. 10.1016/j.gexplo.2015.07.016

Navrátil, T., Shanley. J.B., Rohovec, J., Hojdová, M., Penižek, V., and Buchtová, J., 2014. Distribution and pools of mercury in Czech forest soils. Water, Air, and Soil Pollution 225: 1829. DOI 10.1007/s11270-013-1829-1



Hg vs. SUVA



Hg/DOC vs. SUVA