

Mercury cycling during acid rain recovery at the 14 forested catchments of the GEOMON monitoring network, Czech Republic

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Cycling of mercury within the temperate forest ecosystem was studied at 14 forested catchments included within the GEOMON monitoring network managed by the Czech Geological Survey. The catchments have variable size, elevation, bedrock and forest composition, and were monitored a monthly time step for mercury (Hg) inputs (bulk, throughfall, litterfall) and outputs (runoff) for more than two hydrological years (2021-2022). Air Hg concentrations at all the sites were assessed using passive samplers,

Across the 14 GEOMON catchments, the volume-weighted Hg concentration in bulk precipitation was low, averaging $1.8 \pm 0.3 \text{ ng L}^{-1}$. Mean bulk precipitation Hg deposition across the GEOMON catchments averaged $1.7 \pm 0.4 \text{ } \mu\text{g m}^{-2} \text{ yr}^{-1}$, ranging from 1.1 to $2.3 \text{ } \mu\text{g m}^{-2} \text{ yr}^{-1}$. Mercury concentrations in throughfall were elevated, averaging $6.7 \pm 1.8 \text{ ng L}^{-1}$ and site means ranged from 3.3 to 11.1 ng L^{-1} . The mean spruce throughfall Hg deposition from the 14 catchments was $4.5 \pm 1.5 \text{ } \mu\text{g m}^{-2} \text{ yr}^{-1}$. Site-specific mean volume weighted spruce throughfall Hg concentrations correlated positively with those of DOC ($r=0.86$, $p<0.001$; $n=14$). Both site-specific annual bulk precipitation and throughfall Hg deposition were positively correlated with annual precipitation amount ($r= 0.83$ and 0.74 , $p<0.001$; $n=14$).

Gaseous elemental mercury (GEM) in air varied little at the monitored catchments; it ranged from 1.25 ng m^{-3} at a background catchment to 1.66 ng m^{-3} at a catchment affected by the emissions from a coal-fired power plant.

The main pathway of Hg input into the 14 forested catchments was litterfall. Across the 14 GEOMON catchments, mass-weighted Hg concentration in spruce litterfall was relatively high, averaging $89.9 \pm 20.6 \text{ } \mu\text{g kg}^{-1}$. At catchments LES and JEZ, site-specific average mass-weighted Hg concentrations in beech litterfall were 49.6 and $47.3 \text{ } \mu\text{g kg}^{-1}$ and Hg in birch litterfall at JEZ averaged $40.3 \text{ } \mu\text{g kg}^{-1}$. The mean spruce litterfall Hg deposition across the GEOMON catchments averaged $44.5 \pm 15.7 \text{ } \mu\text{g m}^{-2} \text{ yr}^{-1}$, ranging from 23.4 to $72.9 \text{ } \mu\text{g m}^{-2} \text{ yr}^{-1}$. Hg in beech litterfall at LES and JEZ amounted 32.5 and $26.8 \text{ } \mu\text{g m}^{-2} \text{ yr}^{-1}$ and litterfall Hg deposition in the JEZ birch stand was $14.2 \text{ } \mu\text{g m}^{-2} \text{ yr}^{-1}$.

The stream Hg output from the forest ecosystems averaged at $1.5 \pm 1.7 \text{ } \mu\text{g m}^{-2} \text{ yr}^{-1}$, ranging from 0.2 to $6.9 \text{ } \mu\text{g m}^{-2} \text{ yr}^{-1}$. The average retention rate calculated by comparing Hg inputs (throughfall + litterfall) and outputs (stream runoff) of the 14 catchments representing the central European forest ecosystems was 97%.

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