

The dual role of lakes as buffers and amplifiers of dissolved organic matter temporal dynamics: Buffering transport and amplifying transformation

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Lakes that disrupt the flow of water and its constituents within the fluvial continuum can modify the downstream dynamics of dissolved organic matter (DOM). Potential causes of this change may include the hydrological buffering capacity of lakes relative to streams and rivers and the amplification of biotic processes. To test this hypothesis, we measured DOM quantity and quality at the inflow and outflow of sub-alpine Lake Lunz (Lower Austria) during one year. DOM quality was characterised using optical metrics indicative of the humic-like composition (fluorescence peak C), humification (HIX), and aromaticity (SUVA) degree, predominance of autochthonous components (BIX), and average molecular weight (E2:E3).

Total annual variability was found to be lower in the outflow compared with the inflow ($SD_{out}:SD_{in} < 1$) for dissolved organic carbon (DOC) concentration and HIX. These variables showed a minimal seasonal variation in both inflow and outflow, together with a more accentuated response to hydrology in the inflow. Mean DOC concentration was significantly higher in the outflow ($1.70 \pm 0.14 \text{ mg L}^{-1}$) than in the inflow ($1.3 \pm 0.25 \text{ mg L}^{-1}$), and this pattern was only occasionally reversed during high flow.

By contrast, the total annual variability of peak C, SUVA, BIX and E2:E3 was higher in the outflow than in the inflow ($SD_{out}:SD_{in} > 1$). This was due to the large seasonal variability in the outflow, which contrasted with a reduced temporal dynamics in the inflow. Combined, this created a shift from similar inflow-outflow DOM characteristics during winter, to uncoupled DOM characteristics during summer. This uncoupling consisted in a higher signal of the autotrophic origin of DOM, a lower average molecular weight, as well as a lower aromatic and humic-like content in the outflow.

Overall, these results highlight the role of the Lake Lunz as a DOC source and as a buffer of hydrological pulses of DOC export. Moreover, results emphasise the capacity of the lake to amplify the seasonal variability of DOM quality, creating a maximum uncoupling between the inflow and the outflow during the months of increased biotic processing in the lake.