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Isotopic evolution of dissolved inorganic carbon in a lowland river downstream of a large reservoir

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The Upper Narew river (NE Poland) flows through a wide valley occupied by well-preserved riverine wetlands. River catchment consists predominantly of glaciall till which supports agriculture and forests. The only major anthropogenic disturbance to the river is a large, shallow Siemianowka reservoir. This highly eutrophic reservoir exerts a significance influence on the downstream water quality.

This study aims at evaluation of the reservoir influence on carbon cycling in the river via observations of the isotopic composition of dissolved inorganic carbon (DIC) and of the related physicochemical parameters. River waters were sampled along the 90 km long reach in parallel with a tracer test performed with Rhodamine WT in June 2006. The almost Lagrangian sample set was supported by observations of diurnal variability at one cross-section of the Narew and by samples taken from two main tributaries. The hydrological and meteorological conditions were very stable during sampling period with very little cloudiness and precipitation and moderately high air temperatures.

Stable isotope composition of DIC in the collected water samples varied in a wide range (-13 to -7 per mill). DIC in waters discharging from the reservoir was enriched in ^{13}C comparing to typical riverine values due to high productivity in the lake and due to the enhanced evasion of CO_2 from this shallow reservoir characterized by a relatively long mean water residence time (>6 months). $\delta^{13}C_{DIC}$ in open water bodies is typically controlled by the photosynthesis/respiration cycle and exchange of $CO_2$with the atmosphere what results in the positive correlation of $\delta^{13}C_{DIC}$ with pH and dissolved oxygen saturation as well as the negative correlation of pCO_2 with dissolved oxygen. These relationships are less pronounced in data from the 9.2 km long reach

downstream of the reservoir. Further downstream, due to the in-stream transformations of carbon and the increasing contribution of the tributaries to the flow, the $\delta^{13}C_{DIC}$ values assume values typical for lowland rivers on postglacial terrain. A pronounced diurnal variability of $\delta^{13}C_{DIC}$ and their relationships with the physicochemical parameters reflect control of the photosynthesis/respiration cycle on carbon cycling in this reach.

An inverse-mode mathematical model of $\delta^{13}C_{DIC}$ evolution in the river was proposed in order to quantify fluxes of DIC from and into the river and in-stream transformations of DIC.

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