Dual carbon isotopes ($\delta^{13}C$ and $\Delta^{14}C$) were used to reveal the main sources and input fluxes of dissolved inorganic carbon in a karst reservoir in winter

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Abstract

Understanding the sources and fluxes of dissolved inorganic carbon (DIC) in karst reservoirs is essential for regional carbon cycling studies, particularly concerning the "karst effect". This study utilized dual carbon isotopes ($\delta^{13}C_{DIC}$ and $\Delta^{14}C_{DIC}$) to estimate the contribution rates and input fluxes of DIC from various sources in the Aha Reservoir (AHR), located in southwestern China. Our results indicated that the DIC concentrations (22.33-32.79 mg·L-1) and $\delta^{13}C_{DIC}$ values (-10.02‰ to -8.55‰) were nearly homogeneous both vertically in the water column and laterally across the reservoir ($p > 0.05$). The $\Delta^{14}C_{DIC}$ values (-246.31‰ to -137.86‰) exhibited homogeneous along the vertical profile, while significant differences were observed horizontally ($p < 0.05$). Horizontally, the $\Delta^{14}C_{DIC}$ values at the mouths of the inflowing rivers decreased from -149.57±10.27‰ to -232.85±2.37‰. We found that the inflowing rivers contributed the largest portion of DIC to AHR, accounting for 70% of the total input. Groundwater and atmospheric CO_2 contributions were relatively minor, at 18% and 12%, respectively. The DIC input fluxes from the inflowing rivers were quantified as follows: Jinzhong River 2.01 t/(km^2·mon), Youyu River 1.29 t/(km^2·mon), and Baiyan River 1.03 t/(km^2·mon). This study highlights the significant impact of anthropogenic activities on DIC input in AHR. The discharge of industrial and domestic wastewater had a larger influence than agricultural activities and acidic mine wastewater inputs. These findings underscore the critical need to manage and mitigate the impacts of human activities on karst reservoir ecosystems.