Uncertainty of Hydrological Processes on Greenhouse Gas Emissions from Urban Rivers

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Urban rivers are significant sources of greenhouse gas (GHG, including CO2, CH4, N2O) emissions, however, high regional or global uncertainties remain in urban riverine GHG fluxes due to the dual effects of natural and anthropogenic factors on rivers in urban areas. This study conducted systematic field monitoring and analysis on different urban rivers in Shanghai, a typical megacity in China, aiming to better understand the temporal and spatial variation characteristics of GHG and more accurately estimate the GHG fluxes of urban rivers. Our results demonstrated that urban rivers serve as hotspots for GHG emissions, with the annual average flux 141.61±104.18 mmol m-2 d-1 for CO2, 0.64±0.76mmol m-2 d-1 for CH4, 87.89±74.40 mmol m-2 d-1 for N2O, respectively. The three GHG emissions showed an overall downward trend from the year of 2011 to 2021. This result indicated a great relationship with the greatly improved eutrophication in the urban waters. However, the CH_4 ebullition fluxes from the water column accounted for approximately 99% of the total CH_4 flux, exhibiting significant temporal variations and a strong positive correlation with water temperature. This suggests that the accumulation of organic carbon in localized sediment areas may enhance the temperature sensitivity of CH_4 ebullition. In addition, the sampling rivers are affected by tidal cycles and the water-level fluctuation zone contribute 3%, 13%, and 17% of the annual emissions of N_2O, CH_4, and CO_2, respectively. Our results indicated that rainfall dilution caused by typhoon events, drainage from pumping stations, sediment disturbance, and high gas transfer coefficients resulted in GHG diffusive fluxes that were 1–2 orders of magnitude higher than those during non-typhoon periods. The CO_2-equivalent emissions across different rainfall events followed the order: typhoon period (3.93 g m-2 h-1) > post-typhoon period (0.89 g m-2 h-1) > heavy rainfall (0.33 g m-2 h-1) > no precipitation (0.29 g m-2 h-1) > light rainfall (0.25 g m-2 h-1). Therefore, future research should comprehensively consider the impacts of hydrological changes induced by both natural and anthropogenic factors on GHG emissions from river water bodies.