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Assessment of Greenhouse Gas Emissions from Urban Domestic Wastewater Discharge in China

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A portion of urban domestic wastewater is treated by wastewater treatment systems and discharged as tailwater into water bodies, while the remainder is released directly without treatment. The pollutant concentrations in both pathways exceed those in the receiving water bodies, thereby increasing greenhouse gas emissions from these waters. This study examines China as a case to assess greenhouse gas emissions from urban domestic wastewater discharge over the past two decades (2001–2020). The results show that despite a population increase of 420 million, China's greenhouse gas emissions from urban domestic wastewater decreased from 8.7 Tg in 2001 to 4.3 Tg in 2020. This reduction is primarily attributed to a 2.7-fold improvement in wastewater treatment rates, which significantly reduced pollutants within treatment systems. In 2001, greenhouse gas emissions from untreated wastewater accounted for over 85% of total emissions, but this proportion decreased to 12% by 2020. Similarly, at the provincial level, regions with higher wastewater treatment rates exhibited lower contributions to greenhouse gas emissions from untreated wastewater. By 2020, all provinces had achieved urban domestic wastewater treatment rates exceeding 95%, with tailwater now being the primary contributor to greenhouse gas emissions in receiving waters. Notably, 11 highly populous provinces and cities contributed 63% of national emissions, suggesting that population size is a key influencing factor. This study concludes that wastewater treatment systems not only reduce pollutants directly but also effectively mitigate greenhouse gas emissions in receiving waters. To further accelerate progress, we recommend prioritizing the optimization of treatment infrastructure to prevent high-concentration untreated wastewater discharges and enhancing carbon recovery during treatment processes to minimize emissions.