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Assessing Greenhouse Gas Fluxes in Himalayan Reservoirs Integrating Regional Parameters and Climate Change Scenarios

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Assessing greenhouse gas emissions (biogenic CO2 and CH4) from hydropower reservoirs requires a multi-pathway approach that accounts for diffusive flux, ebullition, and degassing. These approaches differ according to the nature of the emissions considered, the use of geography-specific data, and the technique ranging from direct field measurements to generic modeling. Himalayan region demonstrates further complexity due to rapidly warming temperature, complicating microbial process modeling in absence of a comprehensive dataset like pre- and post-impoundment fluxes. This study utilizes the integrated framework incorporating reservoir-specific emissions models and state-of-the-art CMIP6 climate change projections. We analyze planned and under construction reservoir cases in the central Himalayas under four shared socio-economic pathways using local parameters. This approach incorporates the specific characteristics of each reservoir, such as geometry, land cover inundation, operational strategy, high-head turbine configurations, and monsoon-driven sediment-organic carbon loads which highly influence results. Preliminary modeling suggests that localized degassing in high-head systems and release from seasonal drawdown zones contributes to the carbon footprint. Our results highlight the importance of strategic design and operational interventions to ensure that Himalayan hydropower expansion aligns with the Paris Agreement and national carbon-neutrality roadmaps. This research addresses the data gap regarding carbon cycling in the region providing a rigorous framework for proper "green" component evaluation to the planned reservoir.