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Rice agriculture increases nitrogen concentrations and loadings in catchment surface and ground water bodies

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Severe water quality deterioration in rice agriculture catchments challenges ecologists and hydrologists in exploring how rice agriculture affects water quality and nutrient loading. This research aims to quantify the relationships between rice agriculture, water quality, and nitrogen (N) loading in surface and ground water bodies, through a five years catchment observation. The observation shows that intensive rice agriculture deteriorates stream water quality in the catchments. The concentrations and loading of ammonium-N (NH4+-N), nitrate-N (NO_3–N), and total N (TN) in stream water non-linearly increase with the areal proportion of rice agriculture in the catchments, through a numerical fitting analysis using the Boltzmann sigmoid function. Whereas, these non-linear increases can only be detected when the areal proportions of rice agriculture are greater than 13-29% of total catchment area, indicating the minimal areal threshold of rice agriculture to deteriorate catchment surface water quality. The factorial correspondence analysis suggests that rice agriculture can impose severe groundwater NH4+-N pollution and potentially increase groundwater NO_3-N and TN concentrations due to large quantities of N leaching into groundwater system beneath the paddy fields. The high groundwater NO_3-N concentrations result in strong N loading through catchment base flow process. The LOADEST model estimated that, the NO_3–N loading through base flow reaches 0.12-0.27 kg N ha-1 month-1 in the rice agriculture catchments, contributing 27.3%-36.5% of the total NO_3–N loading through stream discharge. Therefore, best management practices for N reduction and the smart land use planning should be applied to improve water quality and mitigate N loading in the rice agriculture catchments.