Study points to global streams and rivers' contribution to climate change

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A new study led by Auburn University researchers and published in the journal, *Nature Climate Change*, shows a four-fold increase in emissions of the potent greenhouse gas nitrous oxide—a major contributor to climate warming—in global streams and rivers.

"Nitrogen loads on headwater streams and groundwater from human activities, primarily agricultural nitrogen applications, play a significant role in the increase of global riverine nitrous oxide emissions," said lead scientist Professor Hanqin Tian, director of the International Center for Climate and Global Change Research in Auburn's School of Forestry and Wildlife Sciences.

The study, "Increased global nitrous oxide emissions from streams and rivers in the Anthropocene," published Dec. 23 is the work of Tian and fellow scientists from the International Center for Climate and Global Change Research, along with Australia-based climate scientist Josep G. Canadell, executive director of the Global Carbon Project, a project of Future Earth and a research partner of the World Climate Research Programme.

Tian says the innovative study presents an improved model representation of nitrogen and nitrous oxide processes of the land-ocean aquatic continuum. Researchers provided a new ensemble of multiple data products, providing quantification for the way changes in nitrogen inputs—including fertilizer, deposition and manure, climate and atmospheric carbon dioxide concentration and terrestrial processes—have affected nitrous oxide emissions from the world's streams and rivers since 1900.

Canadell said nitrous oxide is considered the "unspoken greenhouse gas" because of its food production, which no one wants to compromise.

"We now have a more precise quantification of its impacts to help us target mitigation strategies which, in most cases, also makes farming more sustainable and increases farm-level economic gains," Canadell said.

Professor Shufen Pan, director of Auburn's GIS and Remote Sensing

Laboratory in the School of Forestry and Wildlife Sciences, co-authored the study.

"One of the most compelling new findings is the importance of surface and subsurface processes in nitrous oxide emissions from the world's river networks," Pan said. "Previous estimates ignored or underestimated large nitrous oxide emissions from headwater or small rivers."

Co-author Yuanzhi Yao, who recently received his doctorate from Auburn, added, "Small rivers in headwater zones—those lower than fourth-order streams—contributed up to 85 percent of global riverine nitrous oxide emissions."

The study's new insights on the quantities, distribution and hotspots of riverine nitrous oxide emissions will ultimately support the management strategies that increase crop nitrogen efficiency, thus reducing nitrogen losses and the associated environmental impacts, according to Tian. The new research emphasizes the critical need to reduce nitrogen loads into headwater streams that are close to human livelihood.

"All greenhouse gas emission pathways consistent with the goals of the Paris Climate Agreement require large and sustained reductions on nitrous oxide emissions, which in turn require improved quantification, process attribution and methodological transparency," Tian said.

School of Forestry and Wildlife Sciences Dean Janaki Alavalapati said the work of Tian and his team is significant in the study of climate change.

"This study, which focuses on the way nitrous oxide in global streams and rivers contributes to climate change, could have a resounding impact on the study of climate change and ways it is approached by scientists worldwide," Alavalapati said.

More information: Yuanzhi Yao et al. Increased global nitrous oxide emissions from streams and rivers in the Anthropocene, *Nature Climate Change* (2019). DOI: 10.1038/s41558-019-0665-8

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