

Taking Stock of Greenhouse Gas Emissions

Project Profile: Characterization of Greenhouse Nitrogen Emission from Wastewater Treatment Operations U4R07

Principal Investigator: Kartik Chandran, Ph.D., Columbia University

Biological nutrient removal (BNR) operations can lead to significant emissions of nitrogen greenhouse gases (N-GHG) such as nitrous oxide (N_2O) and the reactive nitrogen compounds nitric oxide (NO) and nitrogen dioxide (NO_2). Although carbon dioxide (CO_2) receives most of the attention when it comes to the greenhouse effect, NO_2 causes 300 times the warming effect of comparable amounts of CO_2 in the atmosphere.

Ongoing research led by Kartik Chandran, Ph.D., of Columbia University, is one of the first WERF projects on reducing the contribution of wastewater treatment operations on climate change and the first to tackle nitrogen greenhouse gases. Specifically, the project is developing an inventory and mathematical model for characterizing N-GHG emissions from wastewater treatment operations. Using this information, WERF hopes to develop approaches that will minimize the emissions of N_2O and other nitrogen compounds from wastewater operations. Ultimately, the project will make it possible to sustainably improve water quality without impairing air quality.

Taking stock

BNR treatment operations can result in the production of gaseous oxidized nitrogen products. With concerns about climate change, the release of N_2O or NO—which is rapidly converted to NO_2 in the atmosphere, causing smog—has become an issue for wastewater treatment facility managers. Under current and proposed air emissions regulations, large wastewater treatment plants (100 million gallons per day or larger) are potential major emission sources (100 tons per year or greater).

Potential limits on greenhouse gas emissions are driving research: it is critical



to identify and quantify greenhouse gas release from wastewater treatment processes operating under different conditions.

In addition to developing an inventory of releases and strategies to limit those releases, this project is characterizing nitrogenous GHG emissions from wastewater treatment plants. The project team has five monitoring locations:

- Blue Plains Wastewater Treatment Plant, Washington, D.C. Water and Sewer Authority
- Stamford Water Pollution Control Authority (Connecticut)
- Stickney, Northside and Calumet Water Reclamation Plants, Metropolitan Water Reclamation District of Greater Chicago
- San Jose Creek Water Reclamation Plant, Sanitation Districts of Los Angeles County

The Columbia University team conducted the first comprehensive monitoring event at San Jose Creek WRP in September 2008. Chandran will present an overview of the findings from the first sites during WERF's 4th Annual Research Forum in December.

Protocol pins down better estimates

One of the foremost products from this project is the development of a gas and liquid phase sampling protocol, reviewed by the U.S. EPA, to estimate a nitrogen-greenhouse gas (N-GHG) inventory at participating wastewater treatment plants. At the end of the study, WERF will provide the protocol to our subscribers.

WERF Research Profile

Researchers are using real-time sensors to collect full-scale data for N_2O measurement and surface emission isolation flux chambers. They have identified principal aqueous and gaseous intermediates in activated sludge tanks operated under different configurations, nitrogen loads, and dissolved oxygen concentrations. The team will conduct full-scale aqueous and gaseous sampling from facilities that cover a broad spectrum of BNR operating conditions.

The research team will develop a spreadsheet model to improve nutrient removal processes. They hope to minimize nitrogen fluxes from activated sludge

reactors, using recent models for gaseous N emission. Also, the team will examine reactor performance, biokinetics, microbial abundance, and gene expression using molecular methods protocols developed in the Kartik Chandran laboratories.

New partners, new efforts

WERF and the Columbia University team are participating in several initiatives that complement this project. Work is underway with the Global Water Research Coalition to share protocols and results with similar projects in the Netherlands, Australia, France, and England. And

Chandran is also working with the Centre for Climate Systems Research on ways to integrate the findings of this and related projects into upcoming N-GHG emissions guidelines, issued by the Intergovernmental Panel on Climate Change.

For good measure

Are you concerned that your wastewater treatment facility is emitting greenhouse gases (GHG)? Are you managing a facility with biological nutrient removal processes or do you have a secondary system that nitrifies? Would you like to work with WERF's Columbia University researchers to collect data on GHG emissions and document the process conditions which correspond with the emissions measurements? If so, please contact WERF Program Director Lauren Fillmore at lfillmore@werf.org. Participating facilities will be asked to contribute in-kind wastewater characterization data and funds for the collection of GHG emissions data from two site visits. You will receive a report on site-specific GHG emissions data as well as the project report and spreadsheet model.

