Potent greenhouse gas in estuaries firmly linked to human activity

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A University of Otago Marine Science PhD graduate has found a direct causal relationship between the production of a potent and harmful green-house gas emitting from estuaries in New Zealand and escalating impacts of human activity.

Catherine Gongol has just graduated with a PhD in Marine Science. Her thesis looked at the process of denitrification in four South Island Estuaries, in which she set up multiple testing sites to determine the efficiency of natural estuarine systems to remove excess nitrogen caused by human activities.

Estuaries worldwide are often affected by excess nutrients, especially nitrogen, caused by urban and agricultural run-off and wastewater discharge.

For the first time, she compared a pristine and heavily forested estuary at Tautuku in the Catlins area, with less pristine estuaries at Waikouaiti, Tokomairiro and the Avon-Heathcote near Christchurch, where run-off was more pronounced due to farming and urban activity.

“Denitrification in estuaries is an ecosystem service - a natural bacterial process which removes excess nitrogen from estuarine systems and returns the nitrogen in its stable form – N_2 – harmlessly back to the atmosphere,” Dr. Gongol says.

“If you get too much nitrogen you can get toxic algae which can kill fish

and other fauna, for example, so denitrification is an important ecological service of estuaries."

But the other product of denitrification, the environmentally harmful nitrous-oxide gas, which is 310 times more potent than the greenhouse gas CO_2, can also be released during this process of denitrification.

In a feature unique to this study, Dr .Gongol measured and compared the amount of this environmentally harmful gas released in the pristine estuary in Tautuku with the amount released in the other three estuaries affected by urban and farm run-off.

Using the Tautuku estuary as a benchmark for the way estuaries work in their most natural state, she found a direct relationship between increased run-off and increased production of this long-lasting greenhouse gas.

The Estuary at Tautuku produced "miniscule" amounts of nitrous oxide, compared to the Avon-Heathcote, which produced gas levels some eight times greater than at Tautuku.

"I found that as the human impact on estuaries increases, so does the production of this greenhouse gas," she says.

Several other international studies have previously confirmed a link between human activity and nitrous oxide gas emissions, but none have compared gas emissions against an environment as pristine and in its natural state as the estuary at Tautuku – thus providing a baseline against which to assess estuaries impacted by human activities.

Dr. Gongol also found that the three estuaries more affected by human activity were still relatively efficient at performing the ecologically important role of denitrification. However, the Tautuku estuary was

“slightly more efficient” at this task because of its pristine state.

She says the environmental message from her work is clear: “Lowering the nutrient loading in estuaries would be a way to reduce the amount of nitrous oxide being produced.”

“It‘s important to emphasise, however, that nutrient levels in New Zealand estuaries are still low on a global scale, compared to Europe, for example, where populations are much greater,” she says.

Of the three estuaries affected by human activity, the Avon-Heathcote Estuary produced the most nitrous oxide. But at the time of her study, a wastewater treatment outfall was located in the Estuary and this was probably responsible for the higher level of gas.

She says that since her research was completed, however, a new wastewater pipe diverting nutrients away from the Estuary and out into Pegasus Bay has been constructed.

Provided by University of Otago