Dissolved greenhouse gases from the integrated urban river systems in Cuenca (Ecuador)

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Abstract:

Proper management and treatment of wastewater protect our local environment and ecology from serious damage as well as human health. However, concerns relating to urban wastewater systems being a major source of greenhouse gases (GHGs) and affecting the GHG emissions of their surrounding rivers have been recently raised. To investigate these concerns, we sampled three major GHGs, i.e. carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4), at 36 sites in the Cuenca river basin (Ecuador). It appears from the results of the sampling campaign that the more polluted water quality was, the higher concentration of GHGs was found in the rivers. More specifically, the pristine Yanuncay and Machangara rivers crossing two natural reserves produced low concentrations of dissolved GHGs. On the other hand, the Cuenca and Tomebamba rivers, which have been discharged by sewers and wastewater treatment plants, contained much higher concentrations of dissolved GHGs. By understanding the production of the GHGs in the integrated urban wastewater systems, a decision support system can be developed as a simplified integrated model to reduce and mitigate the GHG emissions.

Keywords: Climate change; Wastewater treatment; Greenhouse gas;

1. Background

Conveyance and purification of water and wastewater in urban wastewater systems (UWSs) contributes to the greenhouse gas (GHG) emission through energy consumption (indirect CO_2 emissions) and fugitive gaseous emissions such as nitrous oxide (N_2O) and methane (CH_4) (direct emissions). Specifically, CH_4 emissions from sewers are a significant contribution to the overall wastewater utility GHG emissions. Moreover, wastewater treatment plants (WWTPs) also release significantly GHGs to the atmosphere as a result of receiving a high and regular supply of organic matter and nutrients. In fact, the amount of N_2O and CH_4 emission can considerably contribute to climate change, occupying around 91.9%, expressed as CO_2 equivalent, of the total GHG emission from WWTPs. In fact, WWTPs are the sixth largest contributor to N_2O emission on Earth. Surprisingly, no surveys have been conducted to evaluate GHG emission from UWSs. This study investigates the GHG emissions of the integrated urban wastewater systems in Cuenca (Ecuador). Particularly, 36 sites in the Cuenca river basin were sampled during a sampling campaign conducted in September 2018 to explore the impacts of human activities, sewage pollution, and WWTPs on the GHG emission of the receiving rivers.

2. Results

2.1 Dissolved greenhouse gases from the Cuenca river basin

We monitored all five different rivers in the Cuenca river basin, including Cuenca, Machangara, Tarqui, Tomebamba, and Yanuncay rivers. The concentrations of dissolved GHGs varied among the rivers which can be a result of the different scale of anthropogenic impacts on each river. In fact, intensive urban activities can be found near to the Cuenca and Tomebamba rivers, which can lead to their high concentrations of dissolved GHGs. On the other hand, crossing two natural reserves, i.e. Cajas National Park and the Machangara-Tomebamba protected forest, Yanuncay and Machangara with pristine water quality conditions contained low concentrations of dissolved GHGs. The high variation of dissolved GHGs in the Tomebamba river can be correlated to its diverse water quality as a result of its considerable length among the rivers crossing from the protected areas to the urban areas.

2.2 Effect of water quality on greenhouse gas emissions

Basic Prati index, accounting for dissolved oxygen, chemical oxygen demand (COD), and ammonium, was used to indicate the water quality of the Cuenca river basins. The results show the effects of water quality on the concentration of dissolved GHGs in the Cuenca river basin. It appears that the more polluted water quality is the higher concentration of GHGs can be found in the rivers.