Nitrous Oxide in Mangroves and Surrounding Waters of the Andaman Islands

Jennifer Immaculate Divia

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ABSTRACT

Trace gases such as N_2O, CH_4, and CO_2 directly affect global climate change. N_2O though found in trace quantities have greater impact due to its longer residence time and higher radiative forcing. This study aids in a better understanding of N_2O emissions from coastal margins especially from mangrove forests and the surrounding creek waters which are not well documented. Most of our understanding of coastal biogeochemical processes is from studies in temperate areas and very few targeted studies have been made in tropical zones. Dissolved N_2O and nutrient concentrations and fluxes in three mangroves and transects from the Andaman Islands were estimated.

In the present study, the spatial transects did not show seasonality but still the N_2O emission was high when the temperature was high. Likewise the water column showed more potential for nitrification than denitrification as there was positive correlation between nitrous oxide and dissolved oxygen and ammonium. The dissolved N_2O followed the tidal mechanism where the highest concentrations always occurred at tidal minima in all the tidal sites. Dissolved N_2O in Wright Myo and Kalighat mangroves did not exhibit a distinct seasonal variation, although the wet seasons of August 2005 and 2006 showed comparatively higher concentrations than in the dry seasons.

The average denitrification rate was 9.54μMm^{-2}d^{-1} from all seasons and locations put together. The flux nitrous oxide (measured through other methods) is higher than already reported, through denitrification and so the mangrove sediments of Andaman Islands account for denitrification rates and the surrounding waters are thought to be a potential system for nitrification rather than denitrification.

The N_2O emission rates from Andaman mangroves varied between 0.161 and 3.02 μmol N_2O m^{-2} h^{-1} with an annual average of 5341.391μmol N_2O m^{-2} yr^{-1}. This was extrapolated for the entire mangrove cover of Andaman to give 155.76 g yr^{-1} of N_2O from the mangrove sediments and 249.58 g yr^{-1} of N_2O from the mangrove creek waters. N_2O emissions from mangrove creek waters exceeded those from the mangrove forest sediments but it is unclear what relative proportions of the creek fluxes derive from terrestrial and marine carbon and nitrogen sources. Such information is important for constraining the net carbon and nitrogen balances of mangrove ecosystems. Data from Andaman mangroves imply that emissions of N_2O when converted to CO_2 equivalents may exceed mangrove CO_2 fixation.

All the sites showed moderate N_2O concentration, becoming a weak source of this gas to the atmosphere. Factors to be considered here are that they are near pristine sites and heavily impacted by the Indian Ocean Tsunami prior to the study. The concentrations and emissions depend on nutrient availability, water temperature, dissolved oxygen, tidal variation and seasonal rates of organic input to some extent. Hence, mangrove ecosystems may be small net contributors to the greenhouse gas inventory of the troposphere.

Further work is needed in a wider range of tropical coastal environments with focus on niche-ecosystems such as compare emissions from sites before and after mangrove plantations and from eroding mangrove sites. To better quantify the overall N_2O emissions in mangrove and surrounding waters, direct simultaneous measurements of the various processes such as fixation, ammonification, nitrification and denitrification of the N cycle is of paramount importance. Such data are imperative to construct the N cycle in mangroves and N_2O pathways and device new methods to mitigate strategies to control nutrient loading and eventually N_2O emissions.