Modelling N2O emissions from Andosols in an intensive dairy farming region, Japan

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Soil greenhouse gas fluxes and net global warming potential from intensively cultivated vegetable fields in southwestern China

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Vegetable cropland in China has increased from 3 million ha in 1980 to 18.4 million ha in 2009, and the field management has been characterized with intensive fertilization and high density of cultivation. Therefore, the net effect of vegetable production on global warming deserves attention. Greenhouse gas fluxes were thus measured over approximately 18 months in two typical subtropical vegetable fields with intensive management and contrasting soil properties. Intensive fertilization consistently stimulated N_2O emission, while imposed complicated impact on soil respiration with CO_2 emission enhanced in one field and suppressed in the other field. The fertilizer-induced N_2O emission factors averaged 1.4 to 3.1% with large seasonal variations which could be explained by the interaction of soil temperature and moisture up to 71 to 94%. All the vegetable cropping systems were net sources of atmospheric radiative forcing, and the net global warming potential over the entire study period ranged from 1786 to 3569 g CO_2 equivalence m^{-2} for fertilized soils with net CO_2 emission contributing 53 to 67% and N_2O emission occupying the remaining 33 to 47%. The result suggests that sustainable management practices are pressingly needed to explore for vegetable farming to satisfy the increasing demand for vegetable while to mitigate its global warming effect through reducing fertilizer-induced N_2O emission as well as increasing carbon sequestration in vegetable fields.

Modelling N_2O emissions from Andosols in an intensive dairy farming region, Japan

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Estimates of agricultural Nitrous oxide (N_2O) emissions are needed to develop economical efficient as well as effective policies in mitigating and reducing greenhouse gas emissions in farming systems. In Japan compared with the beginning of 70's, the livestock sector grew two times in recent years to meet the increasing demand in meat and dairy productions and the N_2O emission related to manure increased However, the potential of alternative management practices to reduce soil N_2O emissions has been poorly studies, and quantitative estimates across fields remain uncertain. In addition, Japan is an active volcanic country, where Andosol covers 16.4% of the land surface and 46.5% of arable upland fields. These volcanic soils are originally acidic and have high friability, high porosity and high content of Al and Fe with high humus accumulated ability (Shindo and Honma, 2001). Consequently, those unique physical and chemical characteristics in Andosols can lead to different C and N cycles compare to other soil orders. So far, C and N cycles in those specific soils have not been modeled.

The objectives of this study were (i) to calibrate and validate the DNDC model for N_2O emission on Andosols under intensive dairy manure application, (ii) to estimate N_2O emissions in this agriculture system, (iii) to suggest potential N_2O mitigation solutions for managing dairy manure on Andosol.

Compared to summer crop season, winter crop season showed higher N_2O fluxes (Fig 1). The cumulative emissions were 0−1.22 kg N ha^{-1} in summer season (May-Sep) and 0.73−7.73 kg N ha^{-1} in winter period (Oct-Apr). The highest emission was found in the field with high clay and silt content and slurry application which provide a good condition for denitrification process (G/M3). Farm managements also significantly influenced N_2O emission, the farmer's practice the plowing immediately after composted manure application can significant decrease the N_2O emission (G/M1). Paddy fields showed significantly lower N_2O emission (0.89−1.43 kg N ha^{-1} yr^{-1}) than uplands (1.66 – 8.62 kg N ha^{-1} yr^{-1}). This result could be attributed to the highly anaerobic condition in paddy rice fields which lead to denitrification process producing more N_2 rather than N_2O compared with uplands.

After calibration, modelled crop parameters and soil parameters were comparable with the observed values and the typical values found in the literature. Mean yields of grass and maize were predicted reasonably well. But the rice yields have been significantly under estimated by DNDC. It suggested that the performance of DNDC was not good for low fertilizer application rates. Over estimate the soil moisture condition from DNDC was the main reason for the N_2O emissions.

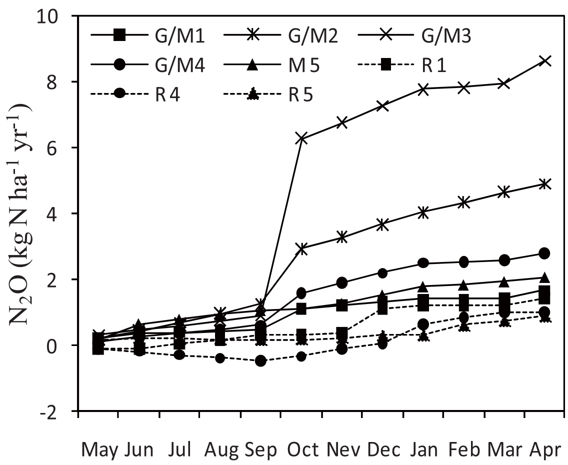

Fig. 1. Cumulative N2O emission of field through a whole year

Possible nitrogen removal through denitrification in the watershed scale

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The increase of N loading from anthropogenic sources such as agriculture, sewage, and atmospheric deposition have resulted in the increase in nitrogen concentration in river discharge, with a linear relationship often observed between riverine N flux per area and the net N input per area (Howarth et al., 1996). But importantly, the N output by river discharge is much less than the N input, suggesting a significant sink in river basin such as denitrification, accumulation to soil and vegetation, etc.. It is important to understand these potential nitrogen sinks to evaluate the impact of N input and N cycling in watershed scales.

Here, I discuss the potential importance of denitrification, which may significantly contribute to NO_3^- removal during the process of discharge especially lower reaches of rivers, on the basis of several preliminary results about ground water denitrification.

In a highland slope used for cabbage agriculture, the estimated NO_3^- concentration calculated from the N and