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Parameter selection and its strategy for quantifying GHG emissions from Asian tropical paddy fields using a DNDC model

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Agricultural activities highly contribute to greenhouse gas (GHG) emissions, particularly in Asia. Rice paddy fields are a major and increasing source of entire methane (CH_4) and nitrous oxide (N_2O) emissions. According to a report of IPCC, rice paddies account for 11% of all global methane emissions. Previous studies have shown that water management has a significant effect on methane emission in the period of rice cropping season. Consequently, paddy water management has become a target scenario for GHG mitigations over rice-producing districts and it is expected to have accurate grasp of GHG fluxes in Asian tropical paddy regions.

The Mekong Delta is one of the most important rice producing regions in Viet Nam. However, in this area, quantification of the GHG emissions is still not very clear, and studies related to the mitigation potential remain limited, and we hence set up an experimental site in farmers' fields in Can Tho City, Viet Nam, the rice in which site is cropped 3 times a year. Two different methods in field water management were adopted in the experimental field in order to evaluate their effects on GHG emissions. Two kinds of irrigation technologies are applied to the fields as; 1) a continuously flooding condition (CF), and 2) an alternate wetting and drying (AWD) condition. It will require a great deal of labor and time to measure and monitor GHG emissions in situ due to the varieties in environmental and agronomic conditions. In this aspect, numerical modeling is a superior approach to estimate GHG emissions at various spatial and temporal scales. A dynamic, flexible and robust model is possible to predict the changes in GHG flux under different agricultural management scenarios, and a process-based model can take account of inter-relationships among various input factors (e.g. climate, soil types, water management, farming practices). The de-nitrification and de-composition model (DNDC) has been used extensively to predict GHG emissions for a wide range of agricultural activities in many countries around the world (Li et al., 1992; Li, 2000). In recent years, a revised DNDC model called DNDC-Rice has been developed and was successfully used to estimate CH_4 and N_2O emissions in Eastern Asian countries, in particular in Japan and China (Fumoto et. al., 2008; 2010).

In this study, we applied the DNDC-Rice model to rice paddies in the Mekong Delta Region. DNDC-Rice model requires parameters dealing with soil characteristics, daily climate, and agricultural management strategies, such as tillage, fertilization, irrigation, flood, manure amendments, and weeding. Because individual input datasets are obtained from various sources in different format and levels of spatial resolutions, and that quite a number of missing observed data occur, parameter tuning is a matter of great importance. We laid stress on parameter selection strategies and have tested the functionality in response to input parameters by using the DNDC-Rice interface under a set of scenarios that reflect AWD and CF water management. Currently, we are carrying out a simulating program to quantify GHG emissions based on the DNDC-Rice model and constructing a local and semi-regional DNDC database specific to this area. The predicted values of CH_4 and N_2O emissions vary in a large range in proportion to the changes in water management of CF and divisions. It is clear that CH_4 and N_2O emitted from the paddy rice fields are characterized by the periods of flooding in the Mekong Delta Region. Further simulations discussing these issues are currently underway.

Keywords: Greenhouse gases (GHGs), Methane emission, Simulation, DNDC-Rice model, Alternate wetting and drying (AWD), paddy fields in the Mekong Delta Region