Zonal and Seasonal Methane Emissions from Rice Production in the Vietnamese Mekong Delta

Vo, T.B.T.1,2,3, Asch, F1, Wassmann, R.2,4, Sander, B.O.2
1 University of Hohenheim, Germany; 2 International Rice Research Institute, Philippines;
3 Cuu Long Delta Rice Research Institute, Vietnam; 4 Karlsruhe Institute of Technology, Garmisch-Partenkirchen, Germany

Introduction

55% of Vietnamese rice are produced in the Mekong River Delta (MRD) (Fig. 1). Rice fields are known to emit large quantities of methane (CH4), but emissions strongly vary between seasons and locations within the MRD.

Rice in MRD is produced in three seasons, early year, mid-year and late-year season, and in three zones, saline, alluvial, and flood-prone zone (Figure 2).

At national scale, CH4 emissions are estimated based on the IPCC guidelines provide default emission factors (EFs) at sub-continental scale without taking into account such seasonal and zonal effects.

This study investigates the effects of season and zone on EFs in the MRD.

Conclusions

- CH4 emissions are mainly determined by cropping seasons and to a lesser extent by hydrological zones.
- In turn, using season-based EFs is preferable to zone-based EFs.
- EFs of CH4 in MRD rice production are in range 31 – 908 kgCH4 ha⁻¹ season⁻¹.
- These data clearly show that CH4 emissions in MRD rice production are well above the default IPCC value given for Southeast Asian rice production.

Results

Figure 1. a) Distribution of rice in Vietnam. b) Total rice area (E-green = early season, M-blue = middle season, L-gold = late season) c) Climate and cropping calendar in the MRD.

Figure 2. Seasonal CH4 emission rates from rice fields in the MRD. Frame color indicates alluvial (green), deep flood (blue) and saline (magenta) zones; Seasonal EFs (early year (E), mid-year (M) and late-year (L)) are color coded as in Fig. 1. Error bars = standard error; n = 3.

Table 1. Seasonal CH4 emission factors; average (± SD), max and min CH4 emission rates; No. = numbers of seasons measured. Values are aggregated across all hydrological zones.

<table>
<thead>
<tr>
<th>Season</th>
<th>No</th>
<th>Avg ± std</th>
<th>p *</th>
<th>Max</th>
<th>Min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early year season</td>
<td>12</td>
<td>174 ± 82</td>
<td>0.03</td>
<td>245</td>
<td>80</td>
</tr>
<tr>
<td>Mid-year season</td>
<td>8</td>
<td>277 ± 116</td>
<td>0.86</td>
<td>417</td>
<td>122</td>
</tr>
<tr>
<td>Late year season</td>
<td>4</td>
<td>356 ± 481</td>
<td>nd</td>
<td>908</td>
<td>31</td>
</tr>
</tbody>
</table>

* The statistical significance value (p) at the confidence of 95% determined by one-way ANOVA. (p ≤ 0.05: average emission factor of the two seasons are statistically significant different).

Notes on Materials and Methods

A data base derived from field measurements conducted at 12 sites with 24 cropping seasons using the closed chamber approach for field sampling in combination with laboratory analysis of CH4 concentrations and standardized crop management. The field design consistently encompassed three replicates with IPCC baseline management while sampling was done in weekly intervals. The gas fluxes were calculated using the equation given by Minamikawa (2015). Comparison of average CH4 emission rates among seasons and hydrological zones was performed using one-way analysis of variance (ANOVA) in SPSS v.20.