GREENHOUSE GASES EMISSION IN U MINH THUONG NATIONAL PARK, KIEN GIANG PROVINCE

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ABSTRACT

This study was conducted to examine the CH_4 emission in the core zone and the effects of water and soil physical and chemical characteristics and water depth on CH_4 emission in U Minh Thuong National Park, Kien Giang Province. The study was carried out from September, 2016 to November, 2016. The CH_4 was collected by closed chambers. The results showed that the soil had a low pH (3.89 - 5.12), a high total phosphorus (0.1 % P_2O_5) and lower potential redox (from -186 to -145 mV). The organic matter (54.6 %) and total nitrogen (1.15 %) were high in thick peat layers. The organic matter (2.15 - 3.93 %) and total nitrogen (0.1 %) were low in thin or no peat layer. The surface water was polluted by organic matter and was not suitable for domestic use (QCVN 08-MT: 2015/BTNMT column A2). CH_4 emission in clay based and peat land based Melaleuca forest areas were 106 $mg.m^{-2}.h^{-1}$ and 135 $mg.m^{-2}.h^{-1}$, respectively. The CH_4 emission was not correlated with either water and soil physical and chemical characteristics or water depth, but might be correlated microbial factors. We need to study water, soil characteristics, CH_4 emission of months in years.

Keywords: U Minh Thuong, CH_4 emission, peat soil, water environment, soil environment.

1. INTRODUCTION

CH_4 is one of the factors which cause the greenhouse effect and increased atmospheric concentrations of CO_2, CH_4 and N_2O causing current global warming by substantially increasing the greenhouse gas (GHG) [1]. The CH_4 is formed through biodegradation process in anaerobic condition under bacteria's impacts [2]. Wetland is the main source of CH_4 emissions which covers about 40 % the earth surface [3]. The wetland Melaleuca forest ecosystem in the U Minh Thuong National Park is one of the last peat marsh in Vietnam and one of three most priority areas on wetland reservation in Mekong Delta [4]. Water storage and large number of litter fall affect CH_4 gases emission significantly. There have been some studies of GHG emission from natural wetland [5]; however, there was little research on CH_4 emission in the wetland

Melaleuca forest. Therefore, the study "Greenhouse gases emission in the U Minh Thuong National Park, Kien Giang province" was conducted.

2. MATERIALS AND METHODS

2.1. Experimental site and design

Water, soil and gas sample were examined at core zone of the U Minh Thuong National Park, Minh Bac and Minh Thuan villages, U Minh Thuan district, Kien Giang province. The study was performed from 9/2016 to 11/2016. The water and gas samples were examined on 13/9, 27/9, 11/10, 25/10 and 8/11. The soil sample was on 13/9, 11/10 and 8/11.

The soil, water and gas samples were examined at 6 places as Fig. 1. Among them clay 1 site, clay 2 site and clay 3 site were of Melaleuca restoration forest in clay (about 3 years old) of natural restoration ecosystem areas. Some places as peat 1 site, peat 2 site, peat 3 site in strict protection area have topographic higher than Melaleuca restoration forest in clay [6]. Peat 1 site and peat 2 site belong to natural Melaleuca restoration forest (about 5 years old) scattered thin peat layer which is a few centimeters on the ground, peat 3 site belongs to natural Melaleuca forest (over 10 years old) with thick peat layer from 1 - 3 meters [6]. Especially, water samples were examined sin some canals in park and sluice gate in order to compare water quality in park with canal's.

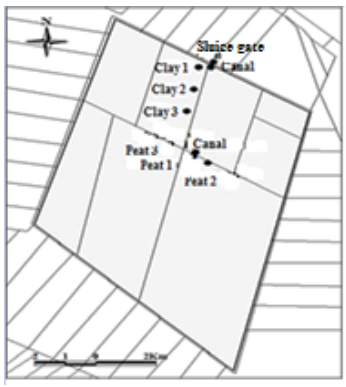

Figure 1. The map of examined site in U Minh Thuong National Park.

2.2. Sampling and sample analysis

Gas sample was collected at the same time when 9:3', 9:13' and 9:23'. Gas sample was collect by chamber (size 0.8 m x 0.6 m x 1 m) which was set a fan to easily mixing before the sampling. A cylinder was used to extract 10 ml from the chamber to glass vial. Gas sample after collecting was analyzed by Shimadzu chromatography - Flame Ionization Detector (Japan). Simultaneously, water temperature and water depth at sampling site were recorded in through sampling times. The used equation for CH_4 emission is the following [7]:

$$F = \frac{M_C}{22{,}4} \times a \times h \times 60 \times \frac{273}{273 + T} \times \frac{1}{100}$$

F: speed of CH_4 emission ($mg.m^{-2}.h^{-1}$); M_C: mass of CH_4 molecular (12 $g.mol^{-1}$); a: slope of a linear y = ax + b; h: height of chamber after subtracting water depth of the chamber (cm); T: temperature in chamber (^oC).

Table 1. Parameters and analysis method of water and soil sample.

Characteristics	Unit	Analysis method
pH	-	Eutech Instruments (Singapore)
EC (Electrical Conductivity)	µS/cm	Martini Mi 306 machine (Rumani)
Eh (Redox Potential)	mV	SANSYO SWC-201R machine (Taiwan)
DO (Discovery Oxygen)	mg/L	HANNA HI 9146 machine (Rumani)
COD (Chemical Oxygen Demand)	mg/L	Open reflux method
Organic matter	%	Walkley Black method
Total nitrogen	%N	Inorganic by H_2SO_4 – acid salicylic distil nitrogen by Kjeldahl method
Total phosphorus	$\%P_2O_5$	Inorganic by H_2SO_4đđ - $HClO_4$, show color of phosphomolybdate with reducing agent is acid ascorbic, colorimetric at wavelength 880 nm.

2.3. Data analysis

The analysis of difference between average of examined site and level of confidence 95 % was performed by statistic software SPSS 20.0 (statistical Product and Services Solutions), statistics One- Way ANOVA and Duncan test. The correlation between CH_4 emissions and water depth, water and soil physical and chemical characteristics was determined using software STATGRAPHIC Centurion XV (StatPoint Technologies, Inc., USA).

3. RESULT AND DISCUSSION

3.1. Physical and chemical water characteristics

Because the study time was on rainy season, sluice gate was closed to store water. The main source of water supplying for core zone National Park was the rain water, so pH of water at the examined sites fluctuated from 5.36 to 6.64 (Fig. 2a). pH of water of Melaleuca forest zone in clay was higher (from 5.86 to 5.95) than Melaleuca forest zone in peat (from 5.36 to 5.93) due to the amount of rain water at Melaleuca forest zone in clay was more than (water depth in forest from 76.7 to 84.2 cm) Melaleuca forest in peat (water depth in forest from 58.9 to 86.2 cm). For canals in forest, pH of water in canals 6.23 and 6.46, respectively. The result was not suitable for routine activities [8].

In National Park area (except sluice gate), EC at all of the examined sites were low (less than 1000 µS/cm), fluctuated from 113 to 232 $\mu S.cm^{-1}$ (Fig. 2b). Sites in the national park had low EC value might be due to diluted ions in rain water. In contrast, sites outside of main sluice gate had high EC value may be due to have several water sources from buffer zone. Sites in national park had Eh fluctuate from 18.8 to 35.4 mV (Fig. 2c) because water was not circulated and large amounts of organic matter decomposing. Clay 3 site had the lowest Eh value (-31.4 mV). Sites outside main sluice gate had flow rate so water in oxidation (112 mV) higher than the other sites of the park.

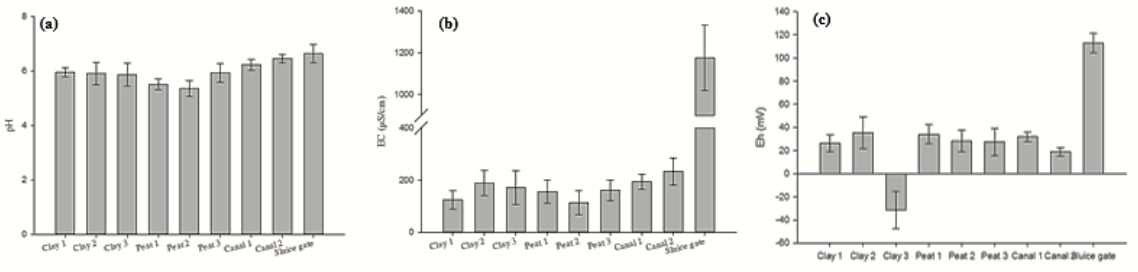

Figure 2. pH (a), EC (b) and Eh (c) water at sampling times in the U Minh Thuong National Park.

DO of water of examined sites was low (less than 0.7 mg.L^{-1}) (Fig. 3a) because of high amount of litterfall in unaerobic conditions and coverage of Pontederiaceae, Azollaonwater surface affecting oxygen diffusion into water environment. DO in all sites were lower than national technical regulation on surface water quality QCVN 08 – MT: 2015/BTNMT column A2 (≥ 5 mg.L^{-1}).

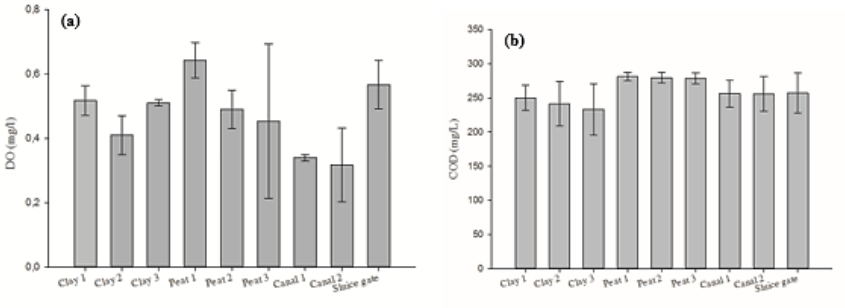

Figure 3. DO (a) and COD (b) water at sampling times in the U Minh Thuong National Park.

The peat zone had COD (279 mg.L^{-1}) higher than the clay zone (241 mg.L^{-1}) and canals (256 mg.L^{-1}) due to decomposing vegetation. Comparing to national technical regulation on surface water quality QCVN 08 – MT: 2015/BTNMT column A2, COD content was higher than the standard several times (≤ 15 mg.L^{-1}) showing organic pollution. The reason caused this pollution that large amount of litterfall in forest decomposing in a long time and the flow and was not circulated**.** According to [9] Melaleuca leaves were main component of litterfall (account for over 80 %), litterfall at Melaleuca forest in the U Minh Thuong from 1.57 to 1.61 ton**.**ha^{-1}

3.2. Physical and chemical soil characteristics

Organic matter on top soil depended on the rest peat layer after forest fires. Melaleuca restoration forest in clay had lowest organic matter (from 2.15 to 2.97 %). Topsoil at peat 1 site and peat 2 site and thin peat layer had medium organic matter content (3.23 and 3.93 %). The peat 3 site had very high organic matter content (54.5 %) because of the process of accumulation of organic matter from the decomposition of vegetation.

Total nitrogen at examined sites is from 0.1 to 0.15 %N, especially peat 3 site had high total nitrogen 1.15 %N (Fig. 4b). Total nitrogen at fired forest was 0.25 %N and primary forest (thick peat layer 40 cm) were 1.83 %N, higher than the study result [10].

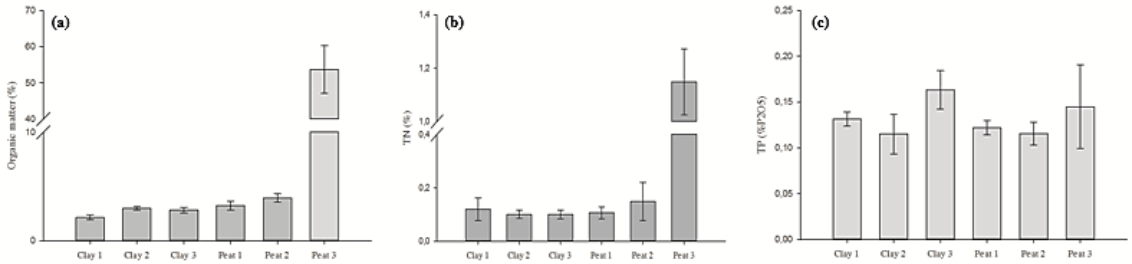

Figure 4. Organic matter (a), total nitrogen (b) and total phosphorus (c).

The examined sites had total phosphorus more than 0.1 $\%P_2O_5$ (Fig.4c) that was rich in phosphorus [11]. The examine result was consistent with the total phosphorus content from 0.08 to 0.12 $\%P_2O_5$ [10]. The results showed that soil physical, chemical characteristics at forest in clay and in peat zone were almost similar, except peat 3 sites due to the peat layer mainly peat. Soil in the U Minh Thuong National Park had low pH and high total nitrogen and in strong reduced condition.

3.3. CH_4 emissions

The results showed that CH_4 emissions had drastically changes over examined period (Fig. 5). At Melaleuca restoration forest in clay. CH_4emissions fluctuated from 59.3 to 181 $mg.m^{-2}.h^{-1}$. At natural Melaleuca forest in the peat had CH_4 emissions was from 44.3 to 306 $mg.m^{-2}.h^{-1}$. Mean CH_4 emissions Melaleuca forest in clay (106 $mg.m^{-2}.h^{-1}$) lower than Melaleuca forest in the peat (135 $mg.m^{-2}.h^{-1}$).

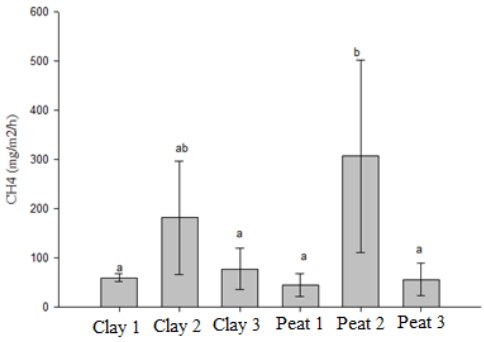

Figure 5. CH_4 emissions in different sites in the U Minh Thuong National Park

The CH_4 emission was not correlated with the observed physical, chemical parameters of soil and water might be due to it is correlated with microbial activities of methanogenesis. CH_4 emissions in peatland Northern regions from 0.42 to 20.8 $mg.m^{-2}.h^{-1}$[2] lower than this study. There were different results about CH_4 emissions on the field. With continuous flooding and more organic soil, average CH_4 emission on the field from 20 to 40 $mg.m^{-2}.h^{-1}$ [12]. Comparing to the field, CH_4 emission in the U Minh Thuong National Park were higher.

4. CONCLUSIONS

Water in the Park was - polluted by organic matter, not suitable for domestic use (QCVN 08-MT:2015/BTNMT column A2). Soil of the U Minh Thuong National Park had low pH (from

3.88 to 5.12), high total phosphorus (> 0.1 %P_2O_5) and strong reduction (from -145 to -186 mV). Thick peat layer sites had high organic matter (54.6 %) and total nitrogen (1.15 % N). the peat layer sites were low in thin or no peat layer, organic matter content in low or medium (from 2.15 to 3.93 %), low total nitrogen (0.1 %N). CH_4 emission fluctuated during the examined period. CH_4 emission at forest in clay and peat were 106 $mg.m^{-2}.h^{-1}$ and 135 $mg.m^{-2}.h^{-1}$, respectively. The research result showed that water and soil physical and chemical and water depth characteristics were uncorrelated to CH_4 emission but might be correlated with microbial factors.

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