Temperature Influencing on Carbon and Nitrogen Ratio in Mangrove Soil

K. Swangjang and W. Bunpraserth

***Abstract*—**Mangrove forests are important to the coastal eco-systems, as essential sources of nutrients. These nutrients are come from the decomposition of dead plant, and others become to be available nutrients. Carbon and nitrogen ratio is important factor to indicate the rate of microbial degradation. This study aims to assess changes in C/N ratio with relation to temperature effect. The study is mangrove area of the upper part of Gulf of Thailand. Soil samples were sampling from three land use types within mangrove forest. The sampling soils were treated with 10 ppt NaCl and *Rhizophora mucronata* leaves. The incubating is set to the temperature of 20±2 ^{o} C, 28±2 ^{o} C and 35±2 ^{o} C for the periods of 28 and 45 days. The results were found that C/N ratio illustrate positive statistical significance with organic carbon ($p<0.05$), however, negative correlation is found for nitrogen, with high statistical association ($p<0.01$). Duration of decomposition show a negative statistical association ($p<0.01$). Although no statistical association is found for temperature, the tendency is noted.

***Index Terms*—**carbon and nitrogen ratio, mangrove soil, Thailand

I. Introduction

Mangroves are deciduous forests, there have a short-lived about 10 years. There are homes to a large variety of aquatic animals and they serves as nurseries for the larvae of aquatic, to be essential to source of food for coastal communities and the dense root of mangrove plant trap sediments that helps stabilizes coastline and prevents erosion from waves. Also mangroves are important to affecters of CO_2 level in atmosphere via trapping sediments and sequestrating carbon [1]. There are many factors that will control productivity and diversity in mangroves such as climate, tidal level, salinity of water and so on [2].

A concern to mangrove areas is trend to be decrease due to mangrove ecosystems are being threatened by global temperature riseing [3], coastal development, the expansion of construction and invasion of land used of support oneself excessive [4]. In Thailand, total mangrove area is approximately 166,182 ha (Central region is 5,449 ha, east 12,658 ha and the south 148,075 ha). Thailand have been continued conservation as a result the role of decreasing mangrove forest areas is reduced.

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C/N ratio indicative of performance degradation of organic matter and nitrogen meets the demand of micro-organisms. That can used to indicate the type of material and simplicity of decomposition; A high C/N ratio is a hard woody materials and a low C/N ratio is more resilient than soft materials.

The study area is Klong-Khone, Samut Songkram province, which is located at the western of Bangkok (47 ^{o} N; Fig 1). Klong-Khone is the part of major mangrove area of the upper part of Gulf of Thailand. As part of Klong-Khone, the covering mangrove area is 6 km^2 (~0.48 ha).

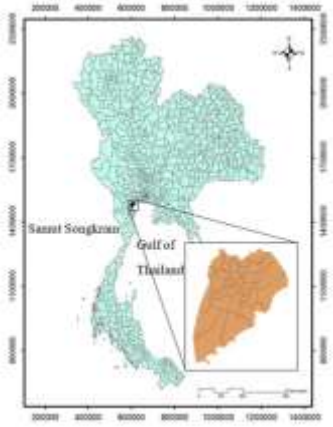

Fig. 1 Study area

II. Procedure for Paper Submission

Satellite interpretation was done to classify the land use of Klong-Khone mangrove forest. Three main types of land use are dominate. These are shrimp farm area, mangrove forest, and building area. From these main land use, sampling plot was done by lining method. The area of plot size was 250 m x 10 m and soil samplings by core method were done within them. Soil was collected in the depth of 0-30 cm.

Soil collected in each plot was deposited. Total plots were 54 plots. Basic soil properties of each land use were analyzed. The methods were as following; soil texture by hydrometer method [5], pH and salinity by a new method for testing soil pH [6], moisture by oven-drying method [7], organic carbon by walkley-black method [8], and nitrogen by kjeldahl method [9].

Total soils were mixed. Salinity treatment was done by using 10 ppt Sodium Chloride (NaCl) since this is the average salinity of the brackish water along the coastal area of Samut-Songkhram [10].

The leaves of *Rhizophora mucronata* which is dominant species of Klong-Khone mangrove forest were collected during

soil sampling. These leaves were crushed and mixed to the mangrove soils prepared above. The ratio used was 1:93.75 1:237.50 and 1: 3,106.25 kg soil·ha/kg crop. These mixtures were them incubated at the sets temperature of 20±2 ◦ C, 28±2 ◦ C and 35±2 ◦ C for the periods of 28 and 45 days which are the during periods in which fifty percent of the crops are decomposed by bacteria.

The treated soils were analyzed carbon by walkley-black method [8] and nitrogen by kjeldahl method [9]. The ratio of carbon and nitrogen were calculated. Statistical association were done.

III. Result

A. Background of Mangrove area

Mangrove area of Klong-Khone is well known as tourist attraction. Hence, the land use has been developed since the past decade. Beside tourist development, shrimp farms have also been rapidly grown. Subsequently, the areas of mangrove forest have been magnificent declined.

The results of satellite interpretation in this study was found four main types of land uses within mangrove areas. These are shrimp farm, mangrove forest, building areas and miscellaneous forests (Fig. 2)

Currently, mangrove areas of Klong-Khone have been restored. However, the sewage discharged from shrimp farms are also continually the hidden impacts.

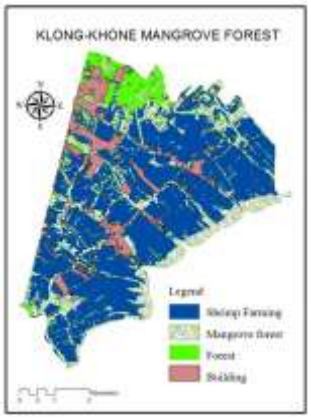

Fig. 2 Land use within study area

B. Mangrove soils properties

The results of mangrove soil properties analysis showed in Thable I. Soil texture is mainly silty clay, excluding the seaward area. Different pH values are dramatically found in different land uses, with 5.39 7.50 and 8.33. Shrimp farm illustrates the highest salinity and pH values are declined at the area approached the coast. It may be due to the influence of wastewater effluence from shrimp farms and also the precipitation of salts. The results of moisture content show the sane tendency with pH values.

Everywhere, the amount of organic carbon is very high, in which the highest is at shrimp farm. Organic carbon is declined at the area with closer the coast. Generality, nitrogen is the major limiting factor of plant growth but mangrove area in this study illustrate the small amount of nitrogen and declined with the closer of coast. It may be due to fluctuations of sea water in the coastal areas which dissolve water-borne nutrients.

Pearson correlation coefficient of mangrove soil properties is illustrated in Table II. High statistical associations are found for all. Salinity, moisture, organic carbon and nitrogen content show significant statistical correlation ($p<0.01$). Although high significant correlation is also found between pH and the other soil properties, the negative correlation is notable.

TABLE I
MANGROVE SOIL PROPERTIES

Land use	Texture	pH	Salinity (ppt)	Moisture (%)	OC (%)	N (%)
Shrimp Farm	Silty Clay	5.39	11.95	13.88	4.32	0.036
Mid Forest	Silty Clay	7.50	10.96	12.54	3.22	0.031
Seaward	Clay loam	8.33	10.03	10.37	2.4	0.018

TABLE II
PEARSON CORRELATION COEFFICIENT OF MANGROVE SOIL PROPERTIES

	pH	Salinity	Moisture	OC	N
pH	1				
Salinity	-.972**	1			
Moisture	-.902**	.950**	1		
OC	-.987**	.993**	.946**	1	
N	-.814**	.913**	.947**	.894**	1

** Correlation is significant at the 0.01 level (2-tailed).

C. Carbon and nitrogen of different temperature condition

From observation, the color of incubated mangrove soils with different temperature is clearly different. Table III shows the amount of organic carbon in soil at different temperature conditions, with 28 days and 45 day incubated. It was found that, for 28 days incubated period, the amount of organic carbon at the temperature incubated at 20 ^{o} C are the highest, comparing with 28 ^{o} C and 35 ^{o} C, These results are dominant for the 1: 237.50 of soils and leaves ratio. However, for 45 days incubated period, the amount of organic carbon is declined but no significant trend of organic carbon is found. (Fig 3.)

Table IV shows nitrogen content in soil at different temperature incubated conditions, at 28 days and 45 day, It was found that during 28 days and 45 days nitrogen is proportional to temperature. However, the tendency of nitrogen contents is correspond with the temperature. That is the same as the increasing of incubated period (Fig 4.).

TABLE III
ORGANIC CARBON IN SOIL AT DIFFERENT TEMPERATURE CONDITION

Incubation Periods	Temp.	Organic Carbon (%)		
		1: 93.75*	1: 237.50*	1: 3,106.25*
28 days	20 ±2 ° C	3.8218	4.1189	4.0679
	28 ±2 ° C	3.8172	3.9795	3.9511
	35 ±2 ° C	3.7674	3.5785	3.9168
45 days	20 ±2 ° C	3.5043	3.7066	3.9584
	28 ±2 ° C	3.3740	3.7361	3.4283
	35 ±2 ° C	3.7747	3.8287	4.1711

Remark * the crop ratio of soils and leaves (kg soil·ha/kg crop)

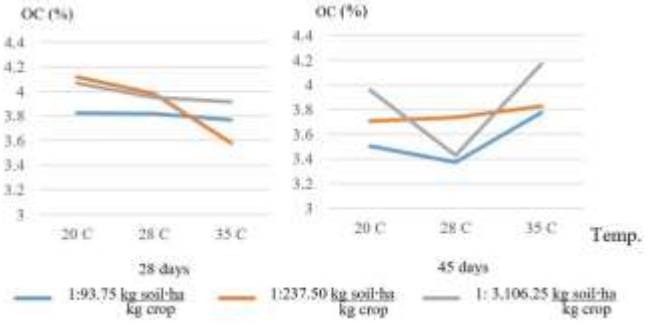

Fig. 3 Relation between organic carbon and temperature

TABLE IV
NITROGEN IN SOIL AT DIFFERENT TEMPERATURE CONDITION

Incubation Periods	Temp.	Nitrogen (%)		
		1: 93.75*	1: 237.50*	1: 3,106.25*
28 days	20 ±2 ° C	0.03107	0.03150	0.03292
	28 ±2 ° C	0.03081	0.03269	0.03320
	35 ±2 ° C	0.02937	0.03287	0.03121
45 days	20 ±2 ° C	0.04502	0.03761	0.03628
	28 ±2 ° C	0.03191	0.03434	0.03427
	35 ±2 ° C	0.03344	0.033605	0.03521

Remark * the crop ratio of soils and leaves (kg soil·ha/kg crop)

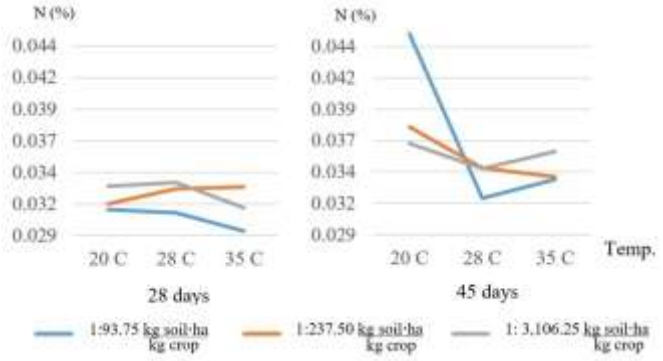

Fig. 4 Relation between nitrogen and temperature

D. The ratio of carbon and nitrogen

Sodium Chloride (10 ppt) was treated to control the salinity in soil samples during incubated. The results of carbon and nitrogen contents in Table III and IV were calculated their ratio. The carbon and nitrogen ratio illustrates in Table V. It was found that, for 28 days incubated, the results are not inconsistent. Those are different for 45 days incubated. The incubated soil samples of 1: 237.50 crop ratios with higher temperature incubated shows remarkably increasing of carbon and nitrogen ratio. The clear picture of the results illustrates in Fig 5.

TABLE V
THE RATIO OF CARBON AND NITROGEN WITH DIFFERENT TEMPERATURE CONDITIONS

Incubation Periods	Temp.	C/N ratio		
		1: 93.75*	1: 237.50*	1: 3,106.25*
28 days	20 ±2 ° C	123.0022	130.7712	123.5655
	28 ±2 ° C	123.8828	121.7494	119.0090
	35 ±2 ° C	128.2650	108.8848	125.4982
45 days	20 ±2 ° C	77.8353	98.5667	109.0979
	28 ±2 ° C	105.7249	108.8132	100.0379
	35 ±2 ° C	112.8798	113.9325	117.0967

Remark * the crop ratio of soils and leaves (kg soil·ha/kg crop)

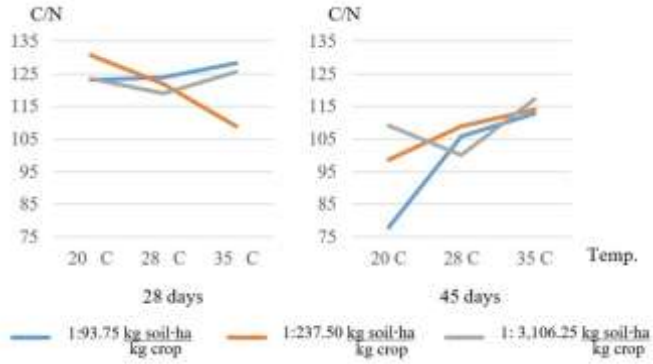

Fig. 5 Relationships between C/N ratio and temperature

Table VI shows Pearson correlation coefficient of mangrove soil properties. It can be found that the C/N ratio illustrates positive statistical significance with organic carbon ($p<0.05$), however, negative correlation is found for nitrogen, with high statistical association ($p<0.01$). Duration of decomposition is another important and negative statistical association ($p<0.01$) is found. The more duration of decomposition is used, the less ratio of carbon and nitrogen is found.

As to temperature condition, no statistical association is found. However, the result illustrate the tendency of temperature effect to carbon and nitrogen content in mangrove soil, as illustrated in the table.

TABLE VI: PEARSON CORRELATION COEFFICIENT OF MANGROVE SOIL PROPERTIES.

	OC	N	C/N ratio	Duration	Temp
OC	1				
N	-0.184	1			
C/N ratio	.589*	-0.868**	1		
Incu duration	-0.302	.604**	-.707**	1	
Temp	-0.152	.375	.234	.00	1

*Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

IV. Conclusion

The results of this paper clearly illustrate strong relationship of mangrove soil properties among different land uses. Land use types within mangrove forest directly affect their soil properties [11]. Mangrove trees is also effect the amount of organic carbon which further affects the ratio of carbon and nitrogen. The incubated mangrove soils, delineated in this study, are essential to represent the mechanism of the change of nutrients in actual conditions.

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