CARBON STORAGE IN MANGROVE SOILS AND SOME INFLUENCED FACTORS

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Abstract- The central part of Thailand is the main agricultural area and mangrove forest located along the western coast. However, the changes of area due to urbanization have been rapidly happen in the last two decades. These further affect the change of ecosystem and carbon global cycle. This study aims to investigate and compares the factors which have an effect on carbon storage in mangrove soils. The study was taken in two stages. The first is to consider the soil properties which related to soil organic carbon (SOC). Ten samples were taken from two parts, including SamutSakorn and SamutSongkram. The results were found that SOC was not different between both sites, ranging from 42.53%-73.04%. Statistical association showed positive significance ($P<0.01$) between clay content and cation exchange capacity (CEC). The values of pH have an effect on SOC, with negative statistical association ($P<0.01$). In the second stage, seasoning change which affecting to SOC was concentrated hence the same station of mangrove soils were monitored covering one year period. Negative correlation between atmospheric air temperature and SOC were found and two stations showed statistical association ($p<0.01$). Land use transformation of both areas was shown to consider the pattern of land use change of both areas.

Keywords- Mangrove Forest, Soil Organic Carbon, Temperature, Thailand.

I. INTRODUCTION

There are many evidence and researches that supported the important of wetland to global carbon cycles. The UN framework Convention in climate change (UNFCCC) has been increased particular attention on to reduce or offset green house gas emission by restore or maintain ecosystem, especially wetland ecosystem.

Soils can influence in the carbon content of the atmosphere because they can store carbon or emit large quantities of CO_2 [1]. Soil contain approximately 1500 Pg of organic carbon, twice the amount of carbon stored in the atmosphere and roughly three times the C stored in terrestrial vegetation [2][3][4. The amount of C stored in a soil is the balance between inputs, as mainly by vegetative cover, and output, as resulting from environmental process such as leaching, erosion [2]. Many experts remark that agriculture and forestry are the only activities that can achieve this effect through photosynthesis and the carbon corporation into carbohydrates [5][6][7][8].

There are several factors which affect carbon stores in soils. Among those factors, land use change is the second greatest cause of carbon emission. Many researches confirmed the sensitivity of SOC resulting from land use change [6] [9] [10] [11]. For the others, climate, precipitation, temperature, land management and topography are also concerned [12][13][14][15][16].

Thailand, as one of country in tropical region, in the year 2009, there are approximately2440.10 km^2 of mangrove forest [17]. However, several factors have been effect on the mangrove areas. The changes of mangrove area have been depended mainly on economic benefit and government policy. These are for example; urban expansion, aquaculture, shrimp ponds. After 1996, Thailand government adopted The Ninth National Social and Economic Development Plan policy focused on mangrove rehabilitation both planting and protecting mangrove trees.

This study selected SamutSakorn and SamutSongkram as the case study. The reasons are that they are the province close to Bangkok, the Thailand's capital. Mangrove areas of these provinces have been dominant, approximately two-third from the totals (Table 1), comparing with the others of the central of Thailand. Moreover, land use changes of these areas are our interested by their specific characteristics. They can serve the aim of this study. That is to investigate and compare the factors which have an effect on carbon storage in mangrove soils. The considered factors include land use, basic soil properties and air temperature.

Table 1: Mangrove area in the central of Thailand (unit: km2)

Years	SamutSakorn	SamutSongkram	Total area in central part	Percentage per total
1975	185	82	359.16	74.34
1979	144.16	76.48	301.22	73.08
1986	1.42	0.49	9.13	20.92
1996	16.96	11.45	49.54	57.35
2000	30.80	25.53	92	61.23
2004	23.85	22.58	61.24	75.82
2009	40.41	22.84	95.69	66.10

Source: Department of Marine and Coastal Resources; 2015

II. MATERIAL AND METHODS

The study was divided into two main parts. The first is to analyse the relationships between mangrove soil properties and SOC. Mangrove soils of SamutSakorn and SamutSongkram were taken in the depth 0-20 cm. The samples were air dried and sieved through a 2-mm sieve. The parameters were total nitrogen by Macro Kjeldahl digestion, SOC by Walkley-Black wet combustion, Cation Exchange Capacity (CEC) by compulsive exchange method, percentage of clay by hydrometer methods [18] total carbon by Total Organic Carbon Analyzer, and pH by pH meter.

The second is to consider the relationshipbetween temperature and SOC. Selected mangrove soils of six stations were sampled and monitored in February, April, June, August, October and December, 2014 which cover one year round of Thai's season.Atmospheric temperature was also recorded.In this step, only SOC was analysed.

The results were evaluated the statistical values. Pearson Correlation Coefficient was mainly performed to determine the relationships of the factors considered and SOC. Data analysis was done with SPSS version 11.5 for windows package.

III. RESULTS AND DISCUSSION

1.1. Mangrove within the study areas

Mangrove of the study areas covered the total approximately 52.14% of the total of mangrove areas in the central part of Thailand [17]. The change of mangrove area from mangrove to urban and other aquaculture areas considered from the value of Landscape Transformation Index (LTI) adapted from [19] and illustrated in Table 2.

It was found that the change of mangrove areas to the other land use purposes after the year 2000 have been more accelerated than previous one. Because of industrial areas located, land use developed to urban area inSamutSakorn has been rapidly more than SamutSongkram. In contrast, SamutSongkram has been dominant by agriculture areas, hence, the development of land use to urban area has been slightly changed. Normally, mangrove areas in SamutSongkram have been demolished by tourism activities and shrimp ponds.

Table 2:Landscape Transformation index of study area

Years	Landscape Transformation Index	
	SamutSakorn	SamutSongkram
1994	0.0084	0
2001	0.3049	0.0608
2007	0.6821	0.1749
2009	0.5851	0.2678

Note: Pearson Correlations Coefficient = 0.755

1.2. Relationships of mangrove soil properties and SOC

Table 3 showed basic properties of mangrove's soils in two main areas. Clay contents , CEC and bulk density of SamutSakorn part were higher than SamutSongkram. The range of clay contents in SamutSakorn and SamutSongkram were between 60.23%-73.04% and 42.52%-56.66%, respectively.Clay content is the special properties which affect the others properties, especially CEC withsignificant correlation ($p<0.01$) (Table 4). Pearson correlation coefficient also showed high significant relationships of SOC, TOC and N ($p<0.01$). Importantly, the values of pH showed high significant correlation with SOC ($p<0.01$), however, the opposite correlation was found.

. **Table 3:Soil properties and SOC**

Samples	OC (%)	TC (%)	N (%)	pH	Clay (%)	Bulk Density (g/cc)	CEC (meq/100g)	Moisture (%ovendried)
Samutsakorn								
1	2.51	2.28	0.19	6.23	63.6148	1.08	30.55	10.16
2	3.32	3.89	0.25	5.98	61.0079	0.48	30.83	10.16
3	4.63	4.73	0.25	5.11	73.0389	1.17	35.17	5.74
4	3.18	3.12	0.20	6.77	69.9270	1.18	32.43	6.22
5	1.71	2.09	0.19	6.78	60.2342	1.04	30.39	8.32
SamutSongkram								
1	6.64	6.33	0.32	3.54	54.9555	0.82	26.37	7.77
2	1.34	2.01	0.13	6.46	42.5327	1.11	12.56	3.27
3	3.68	3.34	0.28	6.23	54.9836	0.45	26.68	9.58
4	3.31	3.21	0.21	5.24	56.6617	0.97	22.45	9.14
5	1.94	2.05	0.17	6.17	50.1963	1.10	19.02	6.41

Table 4:Pearson correlation coefficient between soil properties and SOC

	OC	TC	N	pH	Clay	Bulk density	CEC	Mf
OC	1							
TC	0.969**	1						
N	0.831**	0.876**	1					
pH	-0.842**	-0.875**	-0.692*	1				
Clay	0.225	0.295	0.311	-.010	1			
Bulk density	-0.216	-0.299	-0.593	0.129	0.145	1		
CEC	0.294	0.376	0.495	-0.054	0.939**	-0.109	1	
Mf	0.719*	0.736*	0.810**	-0.704*	0.105	-0.562	0.227	1

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

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

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3.3.Relationships of SOC and atmospheric temperature

Selected sampling points of two areas were monitored the SOC and atmospheric air temperature was recorded (Table 5). SOC of mangrove areas which are approached the beach(SamutSongkram: Sample 1, 2 andSamutSakorn; Sample 3) were lower than the inland sites (SamutSongkram: Sample 1, 2 and SamutSakorn; Sample 3). The reason was thatplant residues were higherand the influence of sea level. Relationships between SOC and temperature in Table 6 were found in the same direction, importantly, with the negative correlation. Negative significant correlation($p<0.01$) was found two from six sampling points. The results pointed out that the temperature is one of significant factors to the SOC values in mangrove soil. The results agreed with previous studies that higher temperature affected higher soil degradation.

Table 5:SOCand temperature

	T	SamutSongkram			SamutSakorn		
Month		1	2	3	1	2	3
February	28.3	0.30	0.17	3.92	2.73	2.60	1.94
April	29.6	0.42	0.23	3.36	3.58	2.66	2.78
June	27.8	0.19	0.18	4.08	3.34	2.55	3.19
August	27.9	0.43	0.44	4.56	3.12	1.89	1.95
October	27	0.16	0.44	3.66	2.65	2.67	2.06
December	22.6	0.59	0.63	6.35	4.08	2.78	2.61

Table 6: Pearson correlation coefficient between SOC and temperature

	SSongkram 1	SSongkram 2	SSongkram 3	SSakorn 1	SSakorn 2	SSakorn 3	T
SSongkram 1	1						
SSongkram 2	0.559	1					
SSongkram 3	0.707	0.768	1				
SSakorn1	0.773	0.417	0.664	1			
SSakorn2	-0.052	-0.026	0.060	0.249	1		
SSakorn3	0.015	-0.222	0.062	0.625	0.394	1	
T	-0.501	-0.824*	-0.923**	-0.541	-0.317	-0.053	1

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

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

CONCLUSION

The change of land useto urbanization is the main factor that reduces mangrove areas. Mangrove area as one of SOC pools was directly affected by the declining of mangrove due to the change of land use.

The resultsof this study showed the factors affecting SOC in mangrove soils. There are two notable finding points. The first is the values of pH. The condition of lower pH showed the higher of SOC in mangrove soils. The location of mangrove was one of the SOC storage. Mangrove that approached the beach was directly influenced by sea levels, hence, SOC in this area was lower than inland mangrove.

The second is seasoning change.This factor directly concerns atmospheric temperature which further resulted to SOC in mangrove soils. These are because of the increasing of soil respiration process. High temperature increases the rate of soil degradation and further release carbon into the atmosphere [4][12][13]. Hence, the lower of SOC was shown in high temperature than lower temperature.

Magnitude of soil carbon loss related to the conversion of green area to the other activities, especially in tropical region [20].This study strongly confirms the importance of maintaining and increasing mangrove trees, indirectly, to reduce the rate of soil degradation.

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