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Measurement of soil carbon content of Magyi mangrove forest, Mawtin coast

Abstract

The survey was carried out at two sites of Magyi mangrove forest in Mawtin Coast; U to Channel and Magyi Channel. The percentages of carbon content were the highest in the mangrove soils of tidal creeks, followed the channel soils. At both sites, the percentage of carbon content ranges in (98.294%-93.538%) and average carbon content at both sites is (96.465%). In some degraded areas, Finlaysonia obovata formed very dense vines that can change the overall ecological balance of the mangrove forest. The mangrove forests are not sustainably managed in Magyi. There were factory and construction sites at U to Channel during the study period. The mangrove forests of Magyi should be protected under a very strict and efficient conservation framework for sustainable development.

Keywords: degradation, Mawtin coast, nearly threatened, species composition, vegetation community

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Introduction

Mangrove vegetation plays a very important role within the land and marine carbon cycling,[1] where they contribute to ten percent of the total primary production, and twenty percent of the carbon burial within the international coastal zone although they are only 0.7 % of the coastal zones in the world.[2] Thus, they play as one of the important environmental roles in describing the alleviation of climate change.[3]

Mangrove wetlands occupy 834,951 to >137,000 km^2 of coastline, supporting ecosystem services for millions of individuals. This loss may be a worldwide issue in which tidal wetlands sequester carbon (C) as persistent biomass in soils. Soil stores two or three times extra carbon than exists in the atmosphere as CO_2.[4] The formation of forest soil encompasses several ecological processes comprising organic matter production, export, decomposition and sedimentation of inorganic matter. Mangroves constitute efficient sinks of organic carbon (C), nitrogen (N) and essential nutrients, which ensure the high rates of plant growth.[1]

The objectives of this research are to estimate the percentage of soil carbon content in Magyi mangrove forest, Mawtin Coast, to know the quantitative results of mangrove soil in Magyi, to record the degraded areas of mangrove species and habitat loss in the study area and to highlight why these areas are degrading of the species or habitat loss.

Materials and methods

Study area

The study was carried out in Magyi mangrove forest of Mawtin Coast, Ayeyarwady Region, Southwest Myanmar during April 2018. The coverage areas were about 1800 acres or 728.74 ha mangrove stands influenced by two tidal creeks (U To and Magyi Channels) and is inundated twice daily by tides.

Soil sampling and analysis

Ten plots were random set at each channel (Figure 1). Care was taken to collect the soils under mangrove plants, inside an equivalent distance from the seaward edge, tidal creeks and the same micro-topography. Samples were collected by inserting a Polyvinyl Chloride (PVC) tube (4 cm in diameter) cores into the soil to a depth of 1 foot (30.48 cm) (Figure 2A-C). One core was collected under mangrove plants at each plot. At the sampling location, the organic litter and living leaves, if present, are removed from the surface before inserting the corer. The corer was steadily inserted vertically into the soil. While it was inserting, the descent rate of the corer is kept low (e.g., gentle hammering) to minimize core compaction.

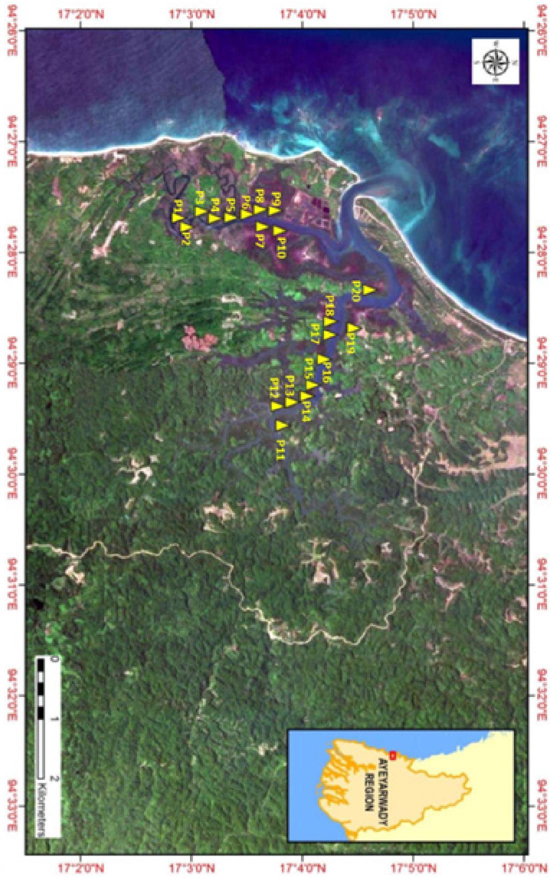

Figure 1 Map showing plots of U To (1-10) and Magyi (11-20) Channels in Magyi mangroves, Mawtin Coast (yellow triangle).

Figure 2 Sampling a soil device using a PVC tube; A) Inserting the device to the soil, B) Taking out the soil samples from the soil corer, and C) Collected soil samples.

All the soil samples were put into the black plastic bags immediately and sealed firmly not to introduce the oxygenated air. Then, the samples are labeled in the field to avoid confusion and common mistakes in the sample identification, and write on the label using a permanent marker, and attach the labels using water-resistant tape. Then, all samples were dropped at the laboratory for additional analysis.

Soil samples were analyzed by using SHIMADZU EDX-7000 Energy-Dispersive X-Ray Fluorescence Spectrometer at Chemistry department of West Yangon University, Yangon (Figure 3).

Figure 3 SHIMADZU EDX-7000 Energy-Dispersive X-Ray Fluorescence Spectrometer used to analyze soil samples.

Results and discussion

The quantitative results on analytes of soil samples from 20 plots were described in (Tables 1 & 2) and (Figures 4 & 5). The percentage of carbon contents of all soil samples in two mangrove forests were also illustrated in (Table 3 & Figure 6).

At U to Channel, the carbon content was not found in the soil of the plots 2, 5, 8 and 10 among 10 sample plots. The highest percentage (98.294 %) of carbon content was found in plot 3 while the lowest (93.538 %) was in plot 9. The quantitative results of analytes of soil samples from 10 plots of this site were (9.861%) in Si, (11.289%) in Na, (10.284%) in Cl, (3.799%) in Al, (3.577%) in S, (0.577%) in Mg, (4.402%) in Fe, (0.741%) in K, (0.256%) in P, (0.944%) in Ca, (0.216%) in Ti, (0.015%) in Cr, (0.049%) in Br, (0.038%) in Mn,, (0.015%) in V, (0.032%) in Ni, (0.026%) in Sr, (0.009%) in Rb, (0.007%) in Zn and (0.014%) in Zr, 0.02% in Cu, 0.065% in Ag and 59.82% in plastic respectively. Among them, (0.020 %) in Cu was found only in plot 8, (0.003 %) in Y in plot 5, (0.065 %) in Ag in plot 8, (59.820 %) of plastics in plot 1. However, the soils consisting of O and Mo were not found at this site (Table 1 & Figure 4).

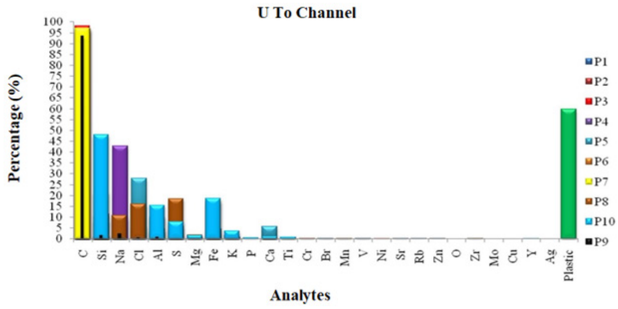

Figure 4 Quantitative results on analysts of soil samples from 10 plots of U To Channel.

At Magyi Channel, the carbon content was not found in the soil of the plots 4, 6, 7 and 9 among 10 sample plots. The highest percentage (97.264 %) of carbon content was found in plot 3 while the lowest (95.966 %) was in plot 9.

The quantitative results of analytes of soil samples from 10 plots of this site were in (9.936%) in Si, (7.449%) in Na, (9.077%) in Cl, (04.014%) in Al, (4.701%) in S, (0.594%) in Mg, (5.788%) in Fe, (0.868%) in K, (0.581%) in P, (0.546%) in Ca, (0.253%) in Ti, (0.018%) in Cr, (0.026%) in Br, (0.091%) in Mn, (0.013%) in V, (0.018%) in Ni, (0.012%) in Sr, 0.018% in Rb, (0.011%) in Zn, 68.17% in O, 0.021% in Zr, 0.034% in Mo, (0.003%) in Y respectively.

Among them, (0.018 %) in Rb was found in plot 6, (68.173 %) in O in plot 9, (0.034 %) in Mo in plot 6. However, the soils consisting of Ag and plastics were not recorded at Mayi Channel (Table 2 and Figure 5). At both sites, the percentage of carbon content ranges in (98.294%-93.538 %) and average content was (96.465%). The highest percentage of carbon content was found in plot 3 of both sites: (98.294 %) in U To Channel and (97.264 %) in Magyi Channel.

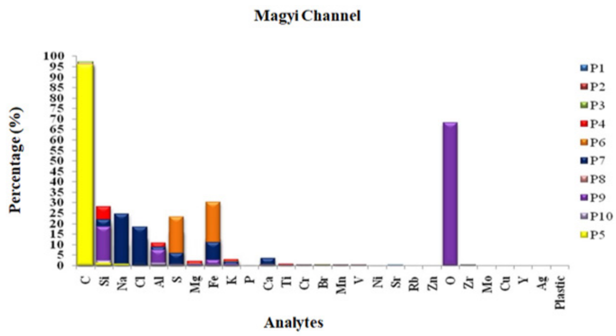

Figure 5 Quantitative results on analytes of soil samples from 10 plots of Magyi Channels.

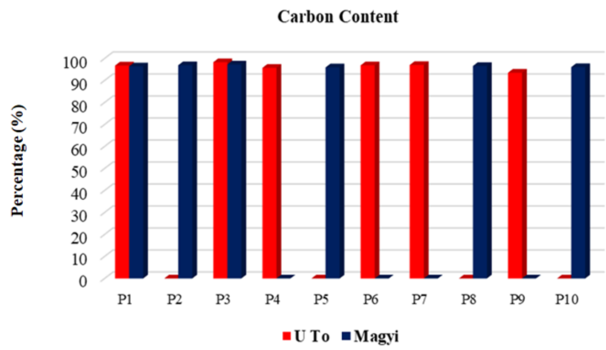

Figure 6 Carbon content (%) of soil samples from each 10 plots of U To and Magyi Channels.

Table 1 Quantitative results on analytes of soil samples from 10 plots of U to channel

Analytes	Results (%)										Average
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	
C	96.797	-	98.294	95.756	-	96.902	97.056	-	93.538	-	96.391
Si	1.71	11.524	0.654	1.36	8.199	1.993	1.692	21.457	1.893	48.131	9.861
Na	0.655	9.268	-	1.421	42.788	-	-	11.02	2.582	-	11.289
Cl	-	6.178	-	0.383	27.984	-	-	16.212	0.665	-	10.284
Al	0.455	4.68	0.331	0.645	3.603	0.688	0.78	10.258	0.896	15.655	3.799
S	0.158	2.445	0.369	0.122	5.619	0.149	0.172	18.576	0.077	8.083	3.577
Mg	0.077	0.821	0.073	0.088	-	0.088	0.116	1.938	0.12	1.874	0.577
Fe	0.074	2.464	0.12	0.12	4.783	0.103	0.11	17.427	0.128	18.694	4.402
K	0.029	0.774	0.03	0.049	0.813	0.047	0.05	1.744	0.065	3.811	0.741
P	0.021	-	-	-	-	0.005	-	-	-	0.743	0.256
Ca	0.014	1.684	0.12	0.035	5.803	0.011	0.007	0.41	0.012	1.344	0.944
Ti	0.008	0.244	0.007	0.015	0.242	0.012	0.014	0.495	0.017	1.114	0.216
Cr	0.001	0.015	-	0.001	-	0.001	0.001	0.046	0.001	0.06	0.015
Br	-	0.025	-	0.001	0.073	-	0.001	0.106	0.001	0.137	0.049
Mn	-	0.013	0.001	0.001	0.021	0.001	-	0.074	0.001	0.199	0.0389
V	-	0.011	-	0.001	0.011	-	0.001	0.028	0.001	0.056	0.015
Ni	-	0.006	-	-	-	-	-	0.05	-	0.04	0.032
Sr	-	0.011	-	-	0.022	-	-	0.025	-	0.048	0.026
Rb	-	0.006	-	-	0.012	-	-	-	-	-	0.009
Zn	-	0.005	-	-	0.009	-	-	-	-	-	0.007
O	-	-	-	-	-	-	-	-	-	-	0
Zr	-	-	-	0.001	0.016	0.001	-	0.049	0.001	-	0.014
Mo	-	-	-	-	-	-	-	-	-	-	0
Cu	-	-	-	-	-	-	-	0.02	-	-	0.02
Y	-	-	-	-	0.003	-	-	-	-	-	0
Ag	-	-	-	-	-	-	-	0.065	-	-	0.065
Plastic	-	59.82	-	-	-	-	-	-	-	-	59.82

Symbols C, carbon; Si, silicon; Na, sodium; Cl, chlorine; Al, aluminum; S, sulfur; Mg, magnesium; Fe, iron; K, potassium; P, phosphorus; Ca, calcium; Ti, titanium; Cr, chromium; Br, bromine; Mn, manganese; V, vanadium; Ni, nickel; Sr, Stronium; Rb, rubidium; Zn, zinc; O, oxygen; Zr, zirconium; Mo, molybdenum; Cu, copper; Y, yittrium; Ag, silver

Table 2 Quantitative results on analytes of soil samples from 10 plots of Magyi channel

Analytes	Results (%)										Average
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	
C	96.401	96.93	97.264	-	95.966	-	-	96.595	-	96.076	96.534
Si	1.402	1.634	1.784	28.032	1.541	20.467	21.996	1.703	18.595	2.207	9.936
Na	0.881	-	-	10.36	0.946	-	24.616	0.444	-	-	7.449
Cl	0.245	-	-	13.819	0.332	12.51	18.481	-	-	-	9.077
Al	0.561	0.744	0.504	10.887	0.63	8.326	8.975	0.862	7.53	1.119	4.014
S	0.131	0.322	0.143	16.076	0.225	23.348	6.072	0.051	0.505	0.136	4.701
Mg	0.141	0.109	0.1	2.18	0.118	1.332	0.785	0.119	0.939	0.112	0.594
Fe	0.087	0.185	0.093	12.899	0.155	30.156	11.217	0.141	2.717	0.231	5.788
K	0.038	0.054	0.032	3.064	0.048	2.244	2.096	0.055	0.971	0.077	0.868
P	-	-	-	0.609	-	-	0.552	-	-	-	0.581
Ca	0.101	0.007	0.059	0.78	0.019	0.692	3.594	0.009	0.18	0.015	0.546
Ti	0.009	0.012	0.014	0.868	0.013	0.576	0.735	0.014	0.264	0.021	0.253
Cr	0.001	0.001	0.003	0.072	0.001	0.04	0.047	0.001	0.015	0.001	0.018
Br	0.001	0.001	0.001	0.089	0.001	0.067	0.042	-	0.011	-	0.026
Mn	0.001	0.001	0.001	0.063	0.001	0.102	0.671	0.004	0.062	0.001	0.091
V	-	0.001	-	0.036	0.001	0.022	0.033	0.001	0.011	0.001	0.0133
Ni	-	-	-	0.027	0.001	0.032	0.022	-	0.007	-	0.018
Sr	0.001	-	-	0.018	-	0.023	0.016	-	0.004	-	0.012
Rb	-	-	-	-	-	-	0.018	-	-	-	0.018

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Table 2 Continued...

Analytes	Results (%)										Average
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	
Zn	-	-	-	-	-	-	0.016	-	0.005	-	0.011
O	-	-	-	-	-	-	-	-	68.173	-	68.17
Zr	0.001	-	0.002	0.103	0.001	0.029	-	-	0.01	0.001	0.021
Mo	-	-	-	-	-	0.034	-	-	-	-	0.034
Cu	-	-	-	0.016	-	-	0.013	-	-	-	0.015
Y	-	-	-	-	-	-	0.004	-	0.002	-	0.003
Ag	-	-	-	-	-	-	-	-	-	-	0
Plastic	-	-	-	-	-	-	-	-	-	-	0

Symbols C, carbon; Si, silicon; Na, sodium; Cl, chlorine; Al, aluminum; S, sulfur; Mg, magnesium; Fe, iron; K, potassium; P, phosphorus; Ca, calcium; Ti, titanium; Cr, chromium; Br, bromine; Mn, manganese; V, vanadium; Ni, nickel; Sr, Stronium; Rb, rubidium; Zn, zinc; O, oxygen; Zr, zirconium; Mo, molybdenum; Cu, copper; Y, yittrium; Ag, silver

Table 3 Carbon content (%) of soil samples from 10 plots of U To and Magyi channels

Carbon content (%)											Average
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	
U To	96.797	-	98.294	95.756	-	96.902	97.056	-	93.538	-	96.3905
Magyi	96.401	96.93	97.264	-	95.966	-	-	96.595	-	96.076	96.53867

The current study showed that the carbon in mangrove soil was not found at all plots during the study period, but the percentage of carbon content was over 90% at the two sites. The percentage of carbon content at U To Channel was higher than the content of Magyi Channel. The mangroves of U To Channel are more mature and larger than those of Magyi Channel. Forrester et al.,[5] stated that mature forest would have larger vegetation biomass and greater net productivity, as well as more plant litter and dead root input as organic matter for the soil, which would explain the carbon-rich thick sediment formed in the 0-50 cm soil layers. Moreover, Holguin et al.,[6] reported that mangrove forests possess efficient sinks for organic C, and even essential nutrients to increase the rate of plant growth.

The contents of soil carbon were different in plots of these sites which have different species composition during the study period. Sherman et al.,[7] examined that the dynamics and distribution of the content of soil organic carbon in mangroves may be different due to species composition, sedimentation, tide, the biomass of vegetation and productivity. Also, Zhang et al.,[8] investigated that the organic carbon content of soil sediment is affected by the spatial variation of forests with coastal areas.

According to the researches of carbon, mangrove forests are now a new market for carbon trading. Zakaria et al.,[9] reported that the importance of mangrove forests has been highlighted as a carbon sink by several studies and publications. Besides, they also recorded that the season is one of the important roles in storing carbon in the soil. They reported that carbon contents were higher in the dry season than the wet season, concurred by the current research which was also conducted in April (the wet season).

Some plants of Magyi mangrove forests are mature mangrove plants, but most are not very tall plants. It may be that local people may use mangrove plants for their household uses. Alongi[1] stated that carbon payment must not depend on the size of carbon stocks and species diversity, but on carbon sequestration rate. The mature forest can gain more carbon sequestration rate than rehabilitated forests, thus conservation by preserving the mangrove intact and minimal use is the key.

The decreasing of the mature mangrove forests showed the rapid colonization of vines and mangrove associated species. There are very dense forms of the vine Finlaysonia obovata that prevents the recolonization of those areas by the propagules of true mangrove species (Bruguiera, Ceriops, Rhizophora spp, etc), changing the overall ecological balance of the forest. This vine is growing on some mature remaining trees, strangling them and shading their leaves.

The Magyi mangrove forests are not sustainably managed. Some areas are degrading deeply because villagers near the sites seem to use mangrove plants for their household uses, firewood, charcoals, etc. In U To Channel, there were factory and industrial areas, which may impact some mangrove forests and water quality. Thus the mangroves in Magyi should be protected under a strict and efficient conservation framework for sustainable development.

Conclusion

The current study discovered that the contents of soil carbon in mangroves were not investigated at all plots of the two sites. However, the carbon content of all sampled soils was very high (over 90 %). The carbon gathered from both undisturbed and degraded areas showed that they were both capable of storing a high amount of carbon. The contents of carbon were the highest in the mangrove soils of tidal creeks, followed by the channel soils validating the other research that differences in hydrology and autochthonous production versus allochthonous input can have intense effects on carbon sequestration in tidal mangrove wetlands. However, this study only sampled 1 foot (30.48 cm) deep soil, which could be quite shallow and therefore, the results expressed here could be underestimated compared to the other studies.

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Conflicts of interest

None.

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