

The Vertical investigation of carbon storage and sequestration potentiality of a tropical coral island into the Bay of Bengal.

Abstract: With a limited amount of carbon storage, Saint Martin Island possesses a very unique soil and environmental characteristics. It needed to be documented about the carbon and organic matter percentage ~~for~~ years ago for the proper measurement of carbon sequestration but the work was not completed. As the investigation started to collect the data, the experiment faces many obstacles in the whole experimental work because the information we needed was too less to conduct any experiment. We see that SOC densities vary widely among various soil depths and various locations. Different land types and land use requires different carbon storage. The percentage of organic matter count and carbon storage in this Island is typically lower than other parts of the Bangladesh. The MAT and MAP framework was included with the variable climatic conditions which lead to make a conclusion that the environmental impact and consequences are needed to be estimated for the betterment of future research. With the analysis of carbon storage there is some information we included about soil bulk density, wet soil mass and dry soil ~~soil~~ mass, and carbon stock indifferent vertical scale that may leads to better understanding about carbon storage and sequestration analysis in the future by comparing this data which may open a new windows of knowledge of carbon storage flux and global warming. To determine the degree of carbon sequestration in this Island a large number of proper experiments are needed to be done.

Keywords: Saint Martin Coral Island, Changing Environment, Global warming, soil Carbon sequestration and vertical carbon storage.

Introduction

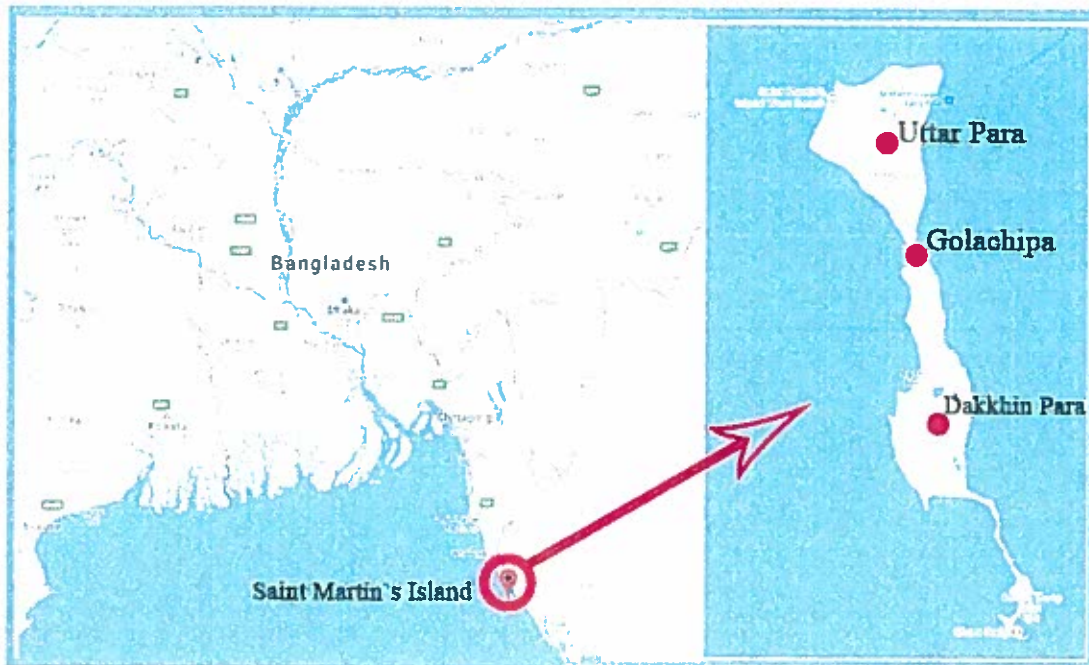
Saint Martin is the small island of Bay of Bengal with 8 km² area in the northeastern part of the ~~part of~~ the Bay of Bengal about 9 km south of the tip of the Teknaf and forming the southernmost part of Bangladesh. It is about 8 km west of Northwest coast of Myanmar, at the mouth of Naf River [1]. It also called Narikel Gingira and Coconut Island. At the corner newly formed island named as Chera Dip Island. It posited 20.34 to 20.39 norths Latitude and 92.18 to 92.21 Longitude. It carries 4000 peoples most of them are fisher. The first human settlement grown in 1800 A.C. The coral island length of 6 km and width 0.5 km, it has 200 m of offshore with 1.3 m² colony [1]. The coral Island has five areas: Uttar Para, Golachipa, Modha para and Dakhin Para [2]. It is isolated in the monsoon season due to high rainfall in this reason. From October to February, mild weather remains, on the other hand, from March to September, remains high temperature and unpredictable weather condition. The Saint Martin coral Island formed due to sedimentation of Ganges, Barhmaputra and Jamura River which sediment almost 6% of global sediment. The Saint Martin coral island can be playing an important role for the sequestration and release of carbon from the soil body. Soil organic carbon plays an important role for the the environment [3]. In recent decades, Understanding of carbon dynamics in different ecosystem has increased significantly. One of the major emission CO₂ is of 8-20% of total emission from land use and deforestation which is

43 concerning [6, 7]. Climate change and correlated policies have a very high impact on tropical
44 communities and ecosystems thus underscoring an importance of vigorous carbon estimation
45 of soil [4].

RR 46 Soil is the most important natural resources of our planet for surviving life because of it
47 holding and storing different micro and macro nutrients which helps to grow plant and
48 subsequently plays importance role for our existence [11]. Among them, Carbon plays more
49 important mechanism for our environment [10]. Soil organic carbon is a vital element which
50 storage by different dynamics processes like- Photosynthesis, Decomposition, Deposition.
51 Soil respiration and so on. Soil carbon or organic matter absorbed and desorbed by different
52 minerals and colloidal particle which allow to retain with the soil body, otherwise it will
53 leached with the infiltrated water into the ground and losing the capacity of holding nutrients
54 into the soil and pollutes the followed ground water [11]. So, Soil organic carbon is very
55 essential part for the soil body ^{for physical, chemical and Biological sustainability}. In recent
56 time, different man made activity like, deforestation, intense cultivation, urban ^{development} civilization
57 can reduce soil organic carbon and reduce the capacity of holding carbon storage capacity.
58 Soil carbon can be store and remove from the soil body. Release of carbon from the soil
59 body leads to more release of carbon di oxide and other greenhouse gases to the atmosphere
60 that having a huge impact to the global warming and others hazards [11]. /RR

61

RR 62 / Bangladesh is a newly formed delta that suffering huge land degradation and erosion[12] that
63 may lead polluting the environment most prominently water of the river, lakes, ground water
64 and surface water [18] but the river water quality is mostly polluted rather than surface water
65 and surrounding oceans[13,22]. As a reason ~~the~~ the surrounding of water quality of Saint
66 Martin coral island is moderately superior to the average river water quality. The extreme
67 unusable water quality found in the sewage wastewater in the Dhaka city rather than
68 anywhere of the country [17]. The overall reason behind the dirty histories of polluted water
69 behind under the soil erosion, fertility status, soil properties [14, 15, 16] and the excessive
RR 70 / uses of pesticides like diazinon [19]. These pollution of land and water may leads to many
71 diseases like cancer, skin diseases, diarrhea and so on by direct or indirect contact [21].



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74 **Figure1. Study area of Saint Martin Coral Island of Bangladesh.**

75 The amount of C in soil represents a significant portion of the carbon found in terrestrial
76 ecosystems of the planet. Total C in terrestrial ecosystems is approximately 3170. Of this
77 amount, nearly 80% (2500 GT) is found in soil [9]. Soil carbon can be either organic (1550
78 GT) or inorganic carbon (950 GT). The latter consists of elemental carbon and carbonate
79 materials such as calcite, dolomite, and gypsum [9]. The amount of carbon found in living
80 plants and animals is comparatively small relative to that found in soil (560 GT). The soil
81 carbon pool is approximately 3.1 times larger than the atmospheric pool of 800 GT [22].
82 Only the ocean has a larger carbon pool, at about 38,400 GT of C, mostly in inorganic forms
83 [8]

? unit
✓

84 There was no research oriented about carbon storage of Saint Martin coral island. This is the
85 first steps to scientific research study of the Islands. So, as a first step for assessment of
86 carbon storage analysis and estimated carbon storage which helps in the future research.
87 Present study can leads future research comparison and better analysis. As a tropical coastal
88 zone, a variety of ecosystem services (e.g. food sources, first layer of defense system such as
89 tsunami if mangrove forest present) are provided [5]

/? RR
/ RR

90 **Materials and Methodology:**

91 To assess the carbon storage analysis, the soil samples are collected from 5 different points
92 and 3 full profile of soil up to 100 cm of Soil. All of the survey sites were owned and/or
93 managed by pastoral farmers, who gave permission for the survey. The field studies did not
94 involve any endangered or protected species.

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97 **Study areas**

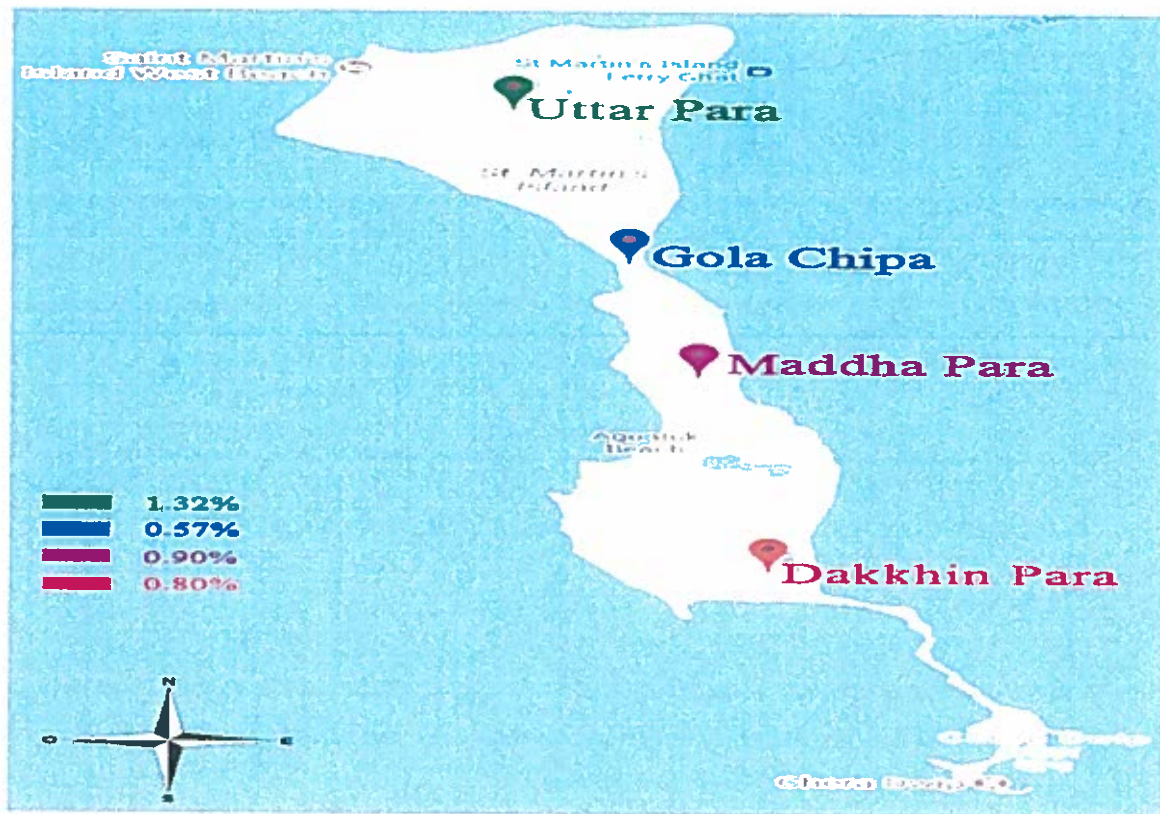
98 Our study was conducted in the Saint Martin coral island which is only one coral island of
99 Bangladesh. The mean annual temperature (MAT) ranges from 14 to 31°C, and the mean
100 annual precipitation (MAP) varies from approximately 150 to 400 mm. The typical landforms
101 in the study region are gently rolling plains, and floodplain region. The vegetation types
102 along the ESET region mainly include meadow steppe, typical steppe and desert steppe.

103 **Data collection**

104 Field sampling was performed from late January to mid-February 2017, when the grassland
105 community biomass was at its peak. Four field sites were established from the north to the
106 north along with the Saint Martin Coral Island (Fig 1). The position of each site was located
107 with a GPS (S1 Table). At each site, an area of 10 × 10 m was delineated, and three 1 × 1 m
108 quadrates were then randomly placed within this area. We harvested the aboveground parts of
109 the plants in each quadrat, and the dry weight of the plants was obtained by oven-drying at
110 60°C for 24 h until a constant weight was obtained. Three soil profiles were collected within
111 each quadrat. Each soil profile was extracted to a depth of 100 cm, and the samples were
112 divided into depth increments of 0-10, 10-20 cm, 20-40cm, 40-60 cm, 60-80 cm, 80-100 cm
113 and 100-120 cm

114 Each of these samples was collected using a standard container with a volume of 100 cm³
115 and a cloth pocket. All of the soil samples were air-dried and then oven dried at 105°C to
116 determine their bulk densities. Before the soil samples were further analyzed to determine the
117 soil organic carbon concentration and soil texture, visible plant roots and rock fragments were
118 manually removed by sieving the samples through a 2 mm screen [4].

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121 **Figure 2: The sampling point of Saint Martin coral Island into the Bay of Bengal.**

122 The soil organic carbon concentration was measured via wet combustion with $K_2Cr_2O_7$ [40].
 123 A Master size S3500 instrument (Microtrac Incorporated, USA) was employed to measure
 124 the soil texture, including the clay content (<0.002 mm), silt content ($0.002-0.02$ mm), and
 125 sand content ($0.02-2$ mm). For each soil layer, the soil organic carbon concentration, soil
 126 bulk density and soil pH were represented by the average of the values from three spatially
 127 random profiles. The soil texture was measured using a composited sample for each soil layer
 128 from the three soil profiles. The MAP and MAT were obtained at a 30 arc-second (~ 1 km²)
 129 resolution from the World Clim database. ?

130 / Human is turbaned is the main human activity in the region. The spatial distribution of human
 131 density was used as an indicator of the grazing intensity in the region. Sheep density data
 132 from the year 2012 were provided by the Food and Agriculture Organization of the United
 133 Nations and were extracted with respect to each site's location.

134 Data analysis

135 The soil organic carbon storage was assessed using the SOCD in the three soil layers of 0-10,
 136 10-20 cm, 20-40cm, 40-60 cm, 60-80 cm, 80-100 cm and 100-120 cm and the sum for the
 137 three layers. We employed an ordinary least squares regression to examine the relationships
 138 between the SOCD of four soil layers (of 0-10, 10-20 cm, 20-40cm, 40-60 cm, 60-80 cm, 80-
 139 100 cm and 100-120 cm and each of the different controlling factors (MAT, MAP, Sand, Silt
 140 and clay content) along there region.

The climatic variables in the framework included the MAT and MAP. In this framework, we hypothesized that climate, soil texture and grazing would directly influence the SOCD and that climate and grazing would affect the soil texture. Furthermore, climate, soil texture and grazing would indirectly influence the SOCD through community productivity.

Results and Discussions

The storage of soil organic carbon was assessed in various depths of four sites named Uttar Para, Golachipa, Maddha Para and Dakkh in Para in the Saint Martin Island, Cox's-Bazar. The amount of organic carbon is changeable accompanied with the variations of depth in each location. In Uttar Para, the percentage of carbon is high (0.82%) in 0-10 cm depth than any other depths in that location.

Table 1: Amount of soil organic carbon (kg C/ha) of Uttar Para, Saint Martin Island, Cox's-Bazar.

location	Depth(cm)	Carbon Percentage(%)	Organic matter (%)	Wet soil mass (g)	dry soil mass (g)	Moisture Content	Bulk Density (g/cm ³)	Soil organic carbon(kg C/ha)
138	0-30	0.76	1.32	154.45	118.67	23.17	1.45	33060
138-1	0-10	0.82	1.41	153.29	116.42	24.05	1.42	29820
138-1	0-20	0.76	1.32	155.67	119.45	23.27	1.46	21580
138-1	20-40	0.5	0.87	180.97	151.86	16.09	1.85	18500
138-1	40-60	0.39	0.68	127.76	106.98	17.05	1.29	10060
138-1	60-80	0.34	0.59	126.34	103.47	18.10	1.26	8570
138-1	80-100	0.31	0.54	173.27	142.61	17.69	1.40	7564

The organic matter percentage is also high in the same depth. This condition is also same for the other sites that are Golachipa, Maddha Para and Dakkhin Para because all these locations are high in carbon percentage and organic matter percentage at 0-10 cm depth. On the contrary, the wet soil mass and dry soil mass varies from each locations to other with their depths. The climate and soil texture of each location varies from depths to depths and it indirectly affects the soil mass. In Uttar Para, the wet soil mass and the dry soil mass both are high in 20-40 cm depth and lowest in 60-80 cm. In Golachipa Para, they are both high in 80-100 cm. But in Maddha Para, the wet soil mass is high in 80-100 cm and dry soil mass is high in 40-60 cm depth. In Dakkhin Para, the wet soil and dry soil both are high in 20-40 cm depth.

The sites we selected differed in many ways such as local climate, species composition, soil characteristics, variation among sites; history of land uses on those sites sometimes directly affects the amount of soil organic carbon per hector. The amount of soil organic carbon in these four sites are related with the depths, soil masses, organic matter, carbon percentage, bulk density, moisture content etc. The values of bulk density in each location represent the different composition from every random layer which helps to measure about the carbon storage in that area. In the Uttar Para and Dakkhin Para, Saint Martin Island, the highest bulk

171 density is at 20-40 cm depth which is 1.85 g/cm^3 and 1.79 g/cm^3 respectively. In GolaChipa
 172 Para, the bulk density is high at 80-100 cm depth and lowest at 40-60 cm depth. In Maddha
 173 Para, the bulk density ranges from 1.19 to 1.40 g/cm^3 in various depths.

174 **Table 2: Amount of soil organic carbon (kg C/ha) of Gola Chipa, Saint Martin Island,**
 175 **Cox's-Bazar.**

location	Depth(cm)	Carbon Percentage(%)	Organic matter(%)	Wet soil mass (g)	dry soil mass (g)	Moisture Content	Bulk Density (g/cm^3)	Soil organic carbon(kg C/ha)
139	0-30	0.33	0.57	156.82	146.18	6.78	1.78	17620
139-1	0-10	0.35	0.61	145.46	134.14	7.78	1.64	5740
139-1	0-20	0.32	0.55	144.65	132.85	8.16	1.63	10430
139-1	20-40	0.28	0.49	142.34	130.75	8.14	1.60	8960
139-1	40-60	0.24	0.42	140.30	129.04	8.03	1.58	7580
139-1	60-80	0.24	0.42	150.45	141.95	5.65	1.74	8350
139-1	80-100	0.22	0.38	180.73	154.75	16.03	1.86	8180

176

177 } Apart from the bulk density, the soil moisture content and organic carbon are also variable at
 178 } different depths. It is a well-known fact that the chemical composition of the moisture in the
 179 } pores of the soil is important for the prevention of future groundwater pollution and
 180 } agriculture. The proper measurement of soil moisture content helps to maintain the plants and
 181 } soil and to manage the nature. Besides the relation with organic carbon storage, soil moisture
 182 } value is an important parameter for geo engineering.

soil?

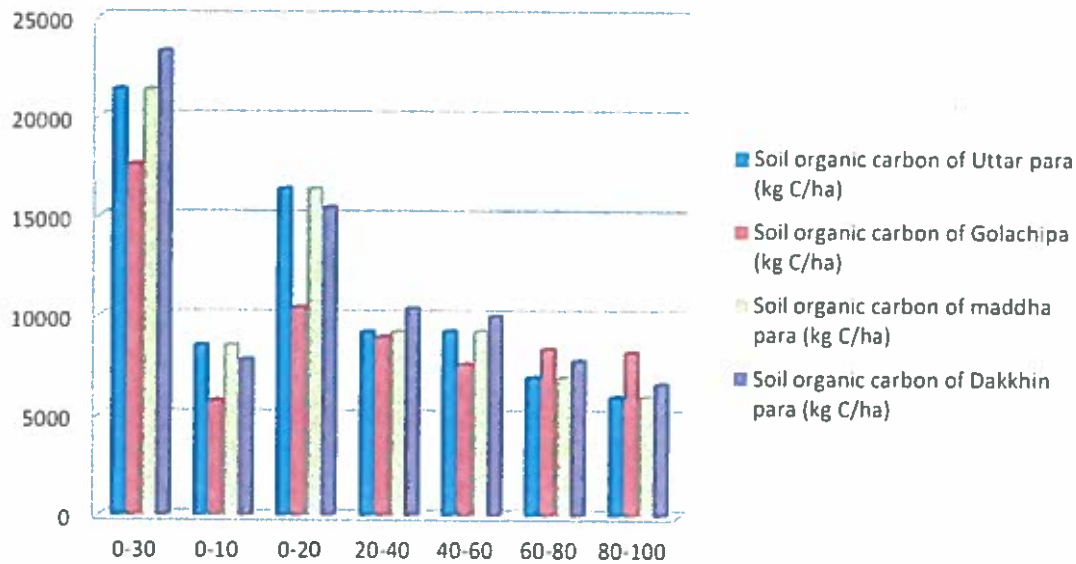


Fig 3: The soil organic carbon storage variation with the vertical depth of soil profile at four different sampling point of the coral island.

It influences the soil shear strength, soil mass and dust formation. To provide a proper knowledge about total carbon sequestration of Saint Martin Island, the determination of moisture content of these four sites has been done. In GolaChipa Para and Maddha Para, the moisture content is both high at 80-100 cm depth and low at 60-80 cm depth. In Uttar Para, soil moisture is high at 0-10 cm and in Dakkhin Para it is high at 0-30 cm depth. The amount of soil moisture determines when certain earth related activities can be carried out. In agricultural aspects, a key pathway of carbon sequestration is from plant biomass. The soil carbon sequestration also helps to build soil fertility and protects from soil compaction. In addition, besides helping in the mitigation of greenhouse gas emissions, soil carbon sequestration has many other benefits that are important to the society. In the degraded soils the conservation tillage impact of organic carbon sequestration generally appears greater than fertile soil. From the data of the four sites of Saint Martin Island, we can see that each of the four sites are high in soil organic carbon at 0-30 cm depth. In Uttar Para the soil organic carbon ranges from 33060 to 8570 kg C/ha. In GolaChipa Para it is from 17620 to 5740 kg C/ha and in Maddha Para 21387.32 to 5933.028 kg C/ha. And lastly, the soil organic carbon in Dakkhin Para ranges from 23320 to 6570 kg C/ha.

↓
Convert to Tons

207 **Table 3: Amount of soil organic carbon (kg C/ha) of Maddha Para, Saint Martin**
 208 **Island, Cox's-Bazar**

location	Depth(cm)	Carbon Percentage(%)	Organic matter(%)	Wet soil mass (g)	dry soil mass (g)	Moisture Content	Bulk Density (g/cm ³)	Soil organic carbon(kg C/ha)
140	0-30	0.52	0.90	150.56	139.98	7.03	1.37	21387.32
140-1	0-10	0.63	1.09	150.23	138.26	7.97	1.35	8531.057
140-1	0-20	0.59	1.02	149.41	141.92	5.01	1.39	16401.79
140-1	20-40	0.34	0.59	151.36	138.32	8.62	1.35	9212.121
140-1	40-60	0.33	0.57	149.67	142.84	4.56	1.40	9233.355
140-1	60-80	0.29	0.50	127.25	121.65	4.40	1.19	6910.442
140-1	80-100	0.23	0.40	159.68	131.69	17.53	1.29	5933.028

209

210 ~~There are many reasons for being variables in the amount of soil organic carbon distributions~~
 211 ~~in each location.~~ Variation in soils in different location at Saint Martin Island is somehow
 212 influenced by the soil depth, climatic condition and various external factors. As the soil types
 213 and local climate condition of this area is different from other areas of the country, this
 214 directly affect the total carbon storage.

215 All this factors directly or indirectly influence the agricultural condition and economic
 216 solvency of this island. ~~But recently slow erosion is occurring in the northwest part of the~~
 217 ~~island.~~ It should be a matter of concern, ~~because of the betterment of the agricultural purposes~~
 218 ~~and scopes of this island.~~ Although there are few works that highlights the soil types and soil
 219 conditions of this island, we tried to include about the soil carbon estimation and the carbon
 220 sequestration into these research works. For this work, the carbon percentage, wet and dry
 221 soil mass, moisture content and other things have been experimented. This experiments
 222 shows charts where we can see that in every layer of soil depth these properties are variables.
 223 The carbon storage in Saint Martin are less than other areas of the country because of the soil
 224 type. The dominant soil in this part is sandy type which is less capable of storing organic
 225 matter. This sandy soil generally cannot ~~able to~~ hold organic carbon. Organic carbon in soil
 226 prefers adhering to clay soil which is unavailable in this island. *? which*

227 Moreover, the tourism sector nowadays is getting upgraded and it has a ~~great negative impact~~
 228 ~~on~~ the soil fertility and soil structure. Soil organic matter is the key point for any type of soil
 229 fertility which is low in Saint Martin Island. It plays a vital role in nutrient absorbance, crop
 230 productivity, physical, chemical and biological properties of soil which improves the quality
 231 of the soil. [20, 21]. ~~But~~ due the various reasons the soil organic matter in Saint Island is

However,
Soil organic matter

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Soil organic matter

232 relatively low than rest of the country. As there are no previous records of the amount of
 233 carbon storage and sequestration of this Island, it is a little bit difficult to compare about the
 234 carbon storage ratio. Information on carbon percentage and soil carbon balance of this Island
 235 is needed to be estimated for the benefits of upcoming research work which will lead to gain
 236 a vast knowledge about the environmental statistics and carbon cycle of this Island. RR
 237 Moreover, one of the reasons of being short in amount of carbon storage is excessive erosion
 238 in these areas. RR

239 Due to the heavy winds and unique structure of coral reefs of this Island, soil is getting
 240 heavily eroded and making the Island less fertile. Also, to ensure food security and
 241 supplement for the people and tourists of his Island, soils are cultivated at a wide range. As
 242 the cultivable land of this Island is not much, mixed and excessive cultivation is common.
 243 This excessive cultivation is destructive for soil fertility. So, it results a huge negative impact
 244 on the soil carbon storage and carbon sequestration. From the four sites of this Island we
 245 collected the data which shows that the carbon percentage and organic matter are very low
 246 than the average range [20]. RR

247 **Table 4: Amount of soil organic carbon (kg C/ha) of Dakkhin Para, Saint Martin**
 248 **Island, Cox's-Bazar.**

location	Depth(cm)	Carbon Percentage(%)	Organic matter (%)	Wet soil mass (g)	dry soil mass (g)	Moisture Content	Bulk Density (g/cm ³)	Soil organic carbon(kg C/ha)
141	0-30	0.46	0.80	148.71	138.19	7.07	1.69	23320
141	0-10	0.47	0.81	147.67	137.65	6.79	1.66	7800
141	0-20	0.46	0.80	147.09	136.98	6.87	1.68	15460
141	20-40	0.29	0.50	154.35	146.04	5.38	1.79	10380
141	40-60	0.28	0.49	152.86	145.08	5.09	1.78	9970
141	60-80	0.22	0.38	151.99	144.04	5.23	1.76	7740
141	80-100	0.19	0.33	145.98	141.56	3.03	1.73	6570

249

250 In Uttar Para the percentage of carbon is 0.31-0.82 % and organic matter is 0.54-1.4%
 251 whereas the average organic matter percentage in Bangladesh is 5%. In GolaChipa Para and
 252 Maddha Para the carbon percentage is 0.22-0.35% and 0.23-0.63% respectively. The organic
 253 matter of these two sites ranges from 0.38-0.61% and 40-1.09%. The rest one site is Dakkhin
 254 Para and it carries carbon percentage 0.19-0.47% and organic matter 0.33-0.81%.

255 These all amounts are much lower than other parts of the country. So it is experimentally shown
 256 that the carbon stock in this area is extremely low which affects the all over agricultural and
 257 environmental conditions. There also exists temperature imbalance which affects the carbon
 258 sequestration. Temperature above the sea level remains high at days and at night the
 259 temperature falls down. This high temperature may have some effects on SOC stock. There
 260 are some studies show that loss of carbon stock occurs in the high temperature areas has an
 261 impact on soils of that area. Besides, all these factors, grazing intensity is one of the most

262 important factors determining the SOC of any area. This factor has a negative effect on soil
263 carbon sequestration in Saint Martin Island. The overall climatic conditions and soil texture
264 both play a vital role controlling soil carbon storage. Each of the four sites of this Island
265 represents an overview of total carbon stock which ~~will lead to~~ determine ~~about~~ the
266 agricultural and vegetation probability and knowledge on environmental consequences [20].

267 Conclusion

268 The relationship among integrated nutrient management and carbon storage systems should ^{was}
269 ~~be~~ evaluated. From many experiments it is proved that intensive crop cultivation may reduce
270 the soil organic carbon through oxidation process. As Saint Martin Island is facing a large
271 number of populations, agricultural and human activities have been increased a lot. Not only
272 natural phenomenon, but also manmade activities are the reasons of less carbon storage in
273 this Island. The carbon cycle and carbon sequestration has a potential effect on the
274 environmental consequences which ~~lead to~~ determine ~~about~~ the carbon rating of ~~that~~ ^{The} area for
275 further research and analysis.

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