

Capacity estimation of soil organic carbon pools in the intertidal zone of the Bohai Bay

Mao Tian-Yu¹, Shi Ting-Ting¹, Li Ya-Juan^{1*}

Laboratory of Environmental Protection Technology on Water Transport, Tianjin Research Institute for Water Transport Engineering, Ministry of Transport, Tianjin 300456, China

13323348832@189.cn

Abstract. Based on the data obtained from the field survey in the intertidal zone of the Binhai New Area of Tianjin Bay in October 2014, the distribution characteristics of soil organic carbon pool in intertidal zone were studied. The results showed that the highest organic carbon content of soil is 22.913g/kg; the average is 16.304g/kg. The soil organic carbon pool in the intertidal zone is in the 6.58-30.40kg/m³, almost close the level of forest soil in the Binhai New Area. Moreover, close to the surrounding wetland such as Yellow River Estuary or Liaohe River Estuary. In conclusion, the soil carbon storage of the beach tidal flats is higher in the coastal zone, and the carbon storage will be significantly reduced after artificial backfilling.

1. Introduction

Wetland is a special transitional ecosystem between land and water, saturated with water either seasonally or permanently, inhabited by shade plants and animals, and has the characteristic of soil gleization. Wetland is an interface on the Earth, linking the lithosphere, biosphere, hydrosphere, atmosphere and anthroposphere. It is also an intersection of various motion forms and material systems, performing as sources, sinks, and converters of carbon, nitrogen and phosphorus. ^[1] Wetlands play an important role in carbon storage, although global wetland area only covers 4~5% of total land area, less than other terrestrial ecosystems, its carbon storage is the highest, reaching 450 Gt, equivalent to 20% of total carbon amount in the terrestrial ecosystems.

As part of the researches on carbon cycle in wetland ecosystem, studies on organic carbon dynamics and distributions in the soil in wetlands have been attracting much attention. Systematic research on carbon cycling in coastal salt marshes is of great importance to scientific assessment of the role of coastal salt marsh in the carbon cycles in terrestrial and marine ecosystems. It is also crucial to enhance the terrestrial carbon sink and to relieve China's stress on international negotiations on the limit of greenhouse gas emissions ^[2, 3].

Tianjin Binhai New Area covers a large area of wetland. However, under the influence of human activities in recent years, large areas of coastal beaches have changed to artificial construction land, leading to significant losses of original soil carbon pools ^[4, 5]. As a result, a survey was carried out in 2014 to estimate the carbon reserves in intertidal wetland in Tianjin Binhai New Area.

2. Material and Methods

2.1. Collecting and processing methods

In mid-October 2014, we selected three locations for soil sampling in Tianjin Binhai New Area: Eco-city Tianjin, Dongjiang Harbor and DASHEN town beach. In each sample plot, samples were taken with 1.2 meters high and 0.1 meters in diameters, using special soil survey dedicated sampler. In Dongjiang Harbor Coast and DASHEN town beach, samples were taken from the sediments submerged in water level below high tide line. Set the sampling points in the high, middle, and low tide bits of each sampling point. Each sample was taken in triplicate. The interval between the sampling points was about 15m. In the Eco-city Tianjin sampling points around the sea due to the region has been part of the artificial with no tide, set two sampling points spaced 20 meters, each site sampling for three time. At all, 24 soil profiles were taken. Sampling depth to bedrock, the shallowest of about 45cm, and the deepest of about 60cm. Each sub-soil profile three levels: upper, middle, lower, and then the seal number bagged soil samples, and be send to the laboratory for processing.



Fig.1 Sampling points

Table.1 The co-ordinates of sampling points

	Dongjiang Harbor	DASHEN town	Eco-city Tianjin
Latitude N	39° 0' 56"	39° 12' 53"	39° 05' 56"
Longitude E	117° 49' 03"	117° 57' 31"	117° 46' 27"

Laboratory processing includes drying, sifting and determination. After removing the plant roots and gravel, the soil samples were dried, sifted and stored in plastic bags.

2.2. Determination

Determination method of soil organic carbon content is Potassium dichromate oxidation Spectrophotometry. Acidometer is used to measure the pH of the soil, and simultaneously salinity and other nutrients indicators.

2.3. Data Processing and Analysis

The index is the average content of soil organic carbon layers. To compare the differences of soil organic carbon contents between the natural beaches, artificial beaches and artificial land area. According to upper, middle, lower classification.

MS EXCEL 2013 software is used for data processing, correlation analyzing and graphing.

3. Results

The analyzed data are shown in table.2 and fig.2.

Table.2 Descriptive statistics of soil properties

Sampling position	Lever	AVG. density(g/cm ³)	Bulk Content (%)	Water pH	AVG. Soluble salt (%)	AVG. OC (g/kg)
DASHEN town	Upper	1.251	4.143	7.95-8.58	1.403	16.52
	Mid	1.792	3.757	7.98-8.57	1.301	15.25
	Lower	-	3.800	8.21-8.4	1.563	17.14
DongJiang Harbor	Upper	-	1.085	8.05-8.37	0.820	10.49
	Mid	-	1.070	7.77-8.15	0.909	9.49
	Lower	-	1.550	7.89-8.29	0.944	9.83
ECO-city	Upper	1.769	1.836	8.43-8.44	1.734	5.42
	Mid	1.826	0.154	8.27-8.57	0.633	5.85
	Lower	1.931	0.271	8.11-8.61	0.739	6.51

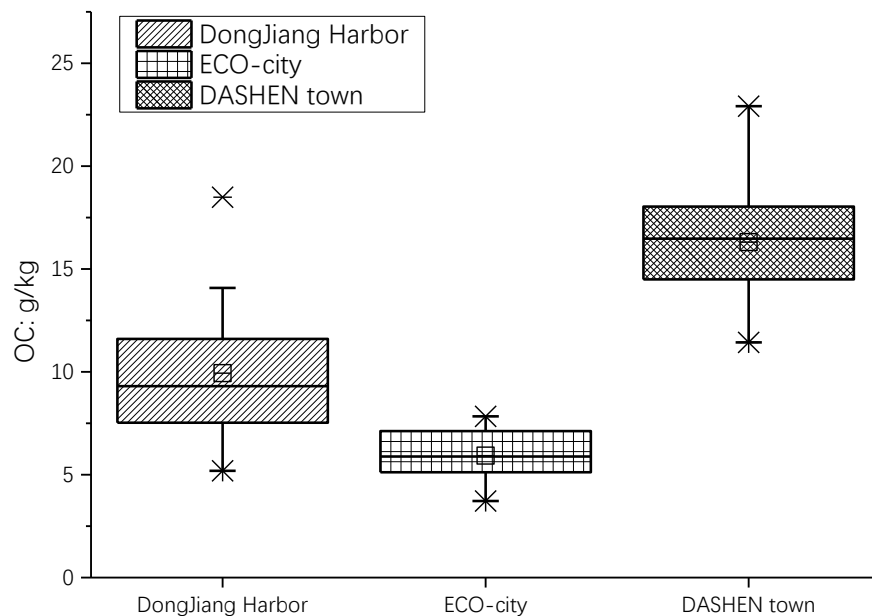


Fig.2 Distribution of OC according to sampling point

In this survey, Upper-level soil bulk density has an average of 1.424g/cm³; average moisture content after drying is 2.503%; average salt content is 1.201% and average organic carbon content is 12.35g/kg. Middle-level soil bulk density has an average of 1.803g/cm³; average moisture content after drying is

2.091%; average salt content is 1.038% and average organic carbon content is 11.44g/kg. Low-level soil bulk density has an average of 1.931g/cm³; average moisture content after drying is 2.331%; average salt content of 1.18% and average organic carbon content is 12.49g/kg. Organic carbon contents in upper, lower and middle level in DASHEN town intertidal wetlands are 19.25g/kg, 22.91g/kg and 17.72g/kg respectively. It is apparent that the organic carbon contents in DASHEN town intertidal wetlands are relatively higher than the average.

Soil carbon pool needs to be a number of representative soil organic carbon content and bulk density as the basis. The formula of Soil carbon pool estimation is as follows [6]:

$$T_i = TOC_i \times D_i \quad (1.1)$$

In this formula, D means soil bulk density (g/cm³); TOC_i means soil organic carbon content (g/kg). The results of soil carbon pool are as follows:

Table.3 Distribution of soil carbon pools

	Mean (kg/m ³)	S.D.	Min (kg/m ³)	Median (kg/m ³)	Max (kg/m ³)
DASHEN town	20.93	9.91	10.02	21.65	30.40
DongJiang Harbor	17.75	7.03	6.58	19.91	24.97
ECO-city	19.27	10.19	9.34	18.67	30.39

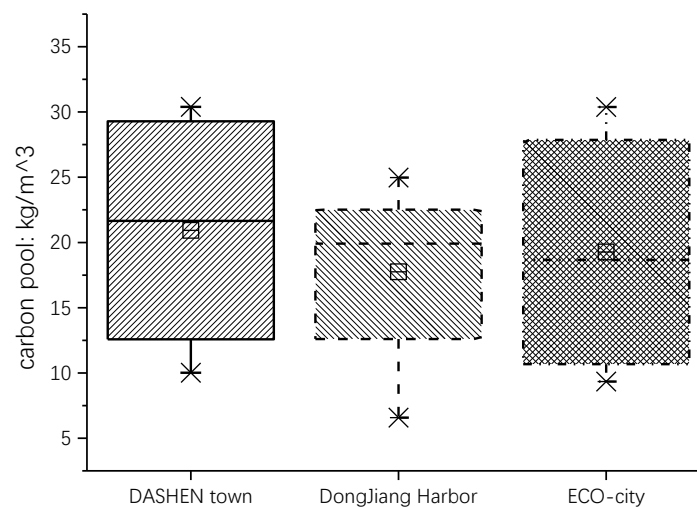


Fig.3: Soil carbon pools in sampling points

4. Discussion

4.1. Distribution analysis of soil organic carbon pools

In this investigation, soil samples were derived from three different environmental sites. DASHEN town station represents the original topography of intertidal wetland zone; ECO-city station represents the artificial land and Dong-Jiang Harbor represents the area between artificial land and natural wetland area, that impacted by the ocean natural tides or currents. In comparison, the observation results in DASHEN town are the highest. There is a close relationship between soil organic carbon pool and

ecological system. The organic carbon pool is maintained at the highest level in the condition that the tidal flat wetland of the original terrain is preserved.

4.2. Comparison with the other soil of Binhai New Area

The SOC of surface soil (0-30cm) at Binhai New Area is (8.55 ± 3.98) g/kg; the Bulk density of the soil is (1.87 ± 0.17) g/cm³, and the carbon density of soil is (4.70 ± 1.91) kg/m². In comparison, the soil organic carbon content in the intertidal zone of DASHEN town (15.25-17.14g/kg) in this investigation is much higher than the SOC in other Binhai New Area. The soil organic carbon content in ECO-city region (5.42-6.51g/kg) is slightly lower than others. It is found that the organic carbon content in the intertidal zone is very high, and it is an important carbon pool in the Binhai New Area.

4.3. Comparison with other soil of north China estuaries

China's Yellow River estuary and Liaohe estuary are close to the study area. The surface soil organic carbon content in Liaohe estuary in October is 23.91mg/g on average. The surface soil organic carbon content in Yellow River Estuary in October is 10.68mg/g on average. The results in this investigation reveal that the surface soil organic carbon contents in the study area are comparable to those in Yellow River estuary intertidal zone or Liaohe estuary soil [6], but higher than Yellow River estuary wetland, and lower than Liaohe estuarine wetland. Compared with other estuarine wetlands in China, the soil organic carbon contents in this survey also same with Minjiang estuary and in Yangtze River estuary [7, 8].

5. Conclusion

Under the same conditions, the stock of backfill is lower than that of natural soil. In all stations, the DASHEN town station is at a natural tidal flat and is artificially low and its soil organic carbon reserves remain at the highest level. Compared with other land in the surrounding Binhai New Area, the organic carbon reserves of natural tidal flats are at a high level. Compared with the Yangtze River, Liaohe River and other estuarine wetlands, the SOC of DASHEN town beach are the same order of magnitude. In conclusion, the soil carbon storage of the beach tidal flats is higher in the coastal zone, and the carbon storage will be significantly reduced after artificial backfilling.

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