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RESEARCH ARTICLE

Comparison and analysis of three estimation methods for soil carbon sequestration potential in the Ebinur Lake Wetland, China

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Abstract Based on soil under seven vegetation types, the carbon sequestration potential in the Ebinur Lake wetland was estimated using the maximum value method, the saturation value method, and the classification and grading method. Results indicated that: 1) Soil carbon sequestration results for the top 20 cm soil layer were about 1.88 Mt using the maximum value method; the middle level standard of the classification and grading method result was 1.71 Mt. 2) Soil carbon sequestration potential in the top 20 cm layer under different vegetation types, evaluated using the saturation value method and the classification-grading method, ranged from 0.45 to 0.67 Mt, accounting for about 5/16 of the ideal carbon sequestration potential. 3) Carbon sequestration potential calculated using the saturation method and the classification method (middle level standard), combining the soil organic carbon increment under different vegetation types in Ebinur Lake wetland, recorded an average growth rate of soil organic carbon around 0.7–1 kg/(hm^2·a). Time required to reach its carbon sequestration potential was 41 to 144 a. These results indicate that soil organic carbon content dynamically changes, and different forms of land use affect soil organic carbon content. The potential and ability of soil carbon sequestration and its mechanism of dynamic change are investigated, providing a scientific basis for understanding regional carbon cycle and climate change in wetlands.

Keywords Ebinur Lake, wetland, soil, carbon sequestration potential\

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1 Introduction

Soil is the largest carbon pool in the terrestrial ecosystem. The dynamic change of soil organic carbon content and soil carbon sequestration is an important role of the land carbon cycle and global change research (Liu and Zhou, 2012; He, 2013; Cao et al., 2016). Any change in environmental conditions will therefore significantly impact the carbon sequestration capacity of plants. By studying the potential of plant carbon sequestration, the reconstruction of past climate and the prediction of future climate can be better understood. Through determining the photosynthetic rate of *Phragmites australis* and *Tamarix chinensis* in the Ebinur Lake wetland, the carbon storage capacity and carbon sequestration capacity of the plant community can be calculated. Our results indicate that the average carbon sequestration capacity of *Phragmites australis* is 2.4 g/(m^2·h), and the carbon sequestration capacity of *Tamarix chinensis* is about 2.2 g/(m^2·h). Bo et al. (2009) recorded the carbon storage function of *Phragmites communis* in Baiyangdian to have a fixed carbon content of 0.82 to 1.65 kg/(m^2·a), and a carbon sequestration capacity 1.7 to 3.4 times the national average in China; the carbon sequestration potential was 2 to 4 times the global vegetation average. By examining the carbon sequestration potential of the main grassland vegetation in Xinjiang, alpine grassland recorded the highest carbon density and lowland meadow had the largest carbon sequestration potential density; stable desert grassland had the largest carbon content density and carbon sequestration potential (Li et al., 2016). Based on the measurement of typical steppe in Xilinguole enclosure grazing, Wang et al. (2013) highlighted that the soil carbon content of three grassland vegetations decreased with an increase in enclosure time on the local scale, results that were in accordance with those of Yan et al. (2014). The carbon and nitrogen storage of meadow grassland in Hulun Buir, Inner Mongolia, recorded a significant linear decline with an increase in grazing gradient (Yan et al., 2014). Findings by Duan et al. (2006) and Duan et al. (2008) showed that carbon sequestration in a wetland ecosystem recorded the highest sequestration rates in mangrove wetlands and coastal salt marshes; the area of the strongest carbon sequestration speed and function was in the Eastern Plain Wetland. The restoration of wetland ecology will therefore help to improve the carbon sequestration potential of terrestrial ecosystems in China (Duan et al., 2006; Duan et al., 2008). Compared with other types of ecosystems, wetland ecosystems have a higher carbon sequestration potential. On the basis of analysis of wetland carbon sequestration capacity and potential research results, as well as reviewing ecological mechanisms, influencing factors, and quantitative methods of carbon sequestration in wetlands, a mechanism for studying the dynamics and regulation of wetland carbon dynamics under the intervention of climate change and human activities is proposed. Song et al. (2011) have previously proposed the law and mechanism of carbon accumulation, as well as the interaction mechanism between climate change and human activities. By analyzing the composition and characteristics of organic carbon of soil over time in the Jujube yards, an arid area of Xinjiang, Du et al. (2016) found that the soil organic carbon content increased with increasing planting time. To some extent, the soil organic carbon pool content increased with time. Therefore, soil organic carbon content is dynamically changeable, and different land-use patterns affect soil organic carbon content (Chen et al., 2011; Chen et al., 2016). The content of soil organic carbon also records different performances on spatial and temporal scales (Sun et al., 2010; Xu et al., 2010; Jiang et al., 2013; Li et al., 2013; Fan et al., 2015; Cai, 2016; Wang and Jiao, 2016). Investigating soil carbon sequestration potential and its dynamic mechanism will provide an important scientific basis for understanding the global carbon cycle and climate change (Chen and Yao, 2016; Wang et al., 2017). The estimation method used to calculate soil carbon sequestration potential has always been an important yet difficult area of research (Sun et al., 2008). Based on different potential categories, there are different ways to estimate potential. At present, the maximum value method, the saturation value method, and the classification and grading method are widely used. The maximum value method takes the difference between the maximum values and the measured values as the increasing potential of the soil organic carbon at this point (Zhang et al., 2011). The saturation value method considers the increase potential of organic carbon in a soil based on the difference of organic carbon content and each measured content when the change of organic carbon content is zero (Qin and Huang, 2010). The classification and grading method divides organic carbon content into different levels; differences between the measured values are taken as the increase of soil organic carbon potential at the different levels. The three methods have been used by different scholars. Liu (2014) used the maximum value method to estimate carbon sequestration potential of an arable layer soil in the Songnen plains; Qin and Huang (2010) used the saturated model to estimate the carbon sequestration potential of soil in a national farmland; and Wang et al. (2014) estimated the carbon sequestration potential of an island land ecosystem. However, studies focusing on carbon sequestration estimation in different regions have used one specific method; studies using comparative methods are sparse. The study of carbon sequestration potential of soils under different vegetation coverage in Xinjiang is less concerned.

In this study, soil organic carbon from seven different sampling sites with different vegetation types in Ebinur Lake wetland was determined. The potential of organic carbon was estimated using different methods to identify the accumulative law of soil organic carbon content in the study area. Results from this analysis will provide a scientific basis for assessing carbon sequestration in the Ebinur Lake wetland.

2 Research area overview, materials and methods

2.1 Sample collection and processing

2.1.1 Layout of sample points

Based on vegetation types, soil types, land use patterns, topography, and other factors around the Ebinur Lake wetland, as well as the principles of comprehensiveness, proportionality, and representativeness, a total of 107 soil sampling points were established under seven vegetation types. The vegetation types which best represent the basic situation of the surrounding soils in the study site (Fig. 1; Table 1) were: salinized meadow, small tree desert, alpine coniferous forest, dry lakebed, halophyte bush, desert riparian forest, and shrub desert,

2.1.2 Sampling method

A stainless steel auger with a depth of 100 cm was used to collect soil samples from sampling points around Ebinur Lake in 2006, 2011, and 2013. Samples were split into depths of 0–20, 20–40, 40–60, 60–80, and 80–100 cm. All soil samples were collected using a 5-point mixing method whereby samples collected at 5 points were evenly mixed into a 2 kg sample and brought back to the laboratory for physical and chemical analysis. GPS information was recorded at each sample location. In this study, shallow soil profile samples from 0 to 20 cm on the ground surface were also used.

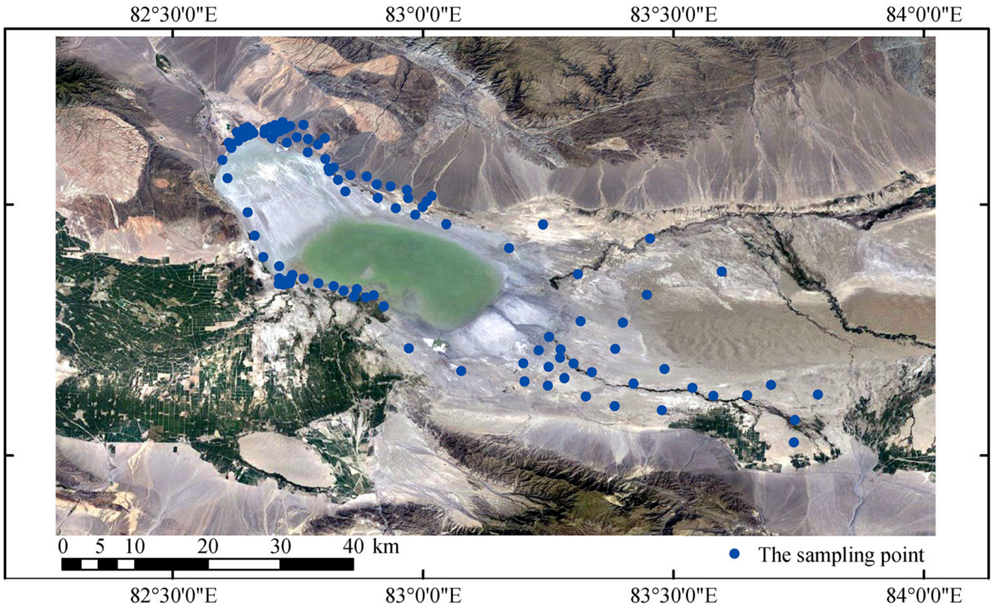


Fig. 1 Sample point distribution around Ebinur Lake

Table 1 Sampling point design

Vegetation	Section number
Dry lakebed	16
Desert riparian forest	5
Halophyte shrub	3
Saline meadow	10
Desert shrub	11
Alpine coniferous forest	5
Microphanerophytes desert	57
Total	107

2.2 Analysis method and data processing

2.2.1 Sample analysis

Organic carbon was calculated using the potassium dichromate external heating method. The physical and chemical indices of soil samples were determined after natural soil drying, grinding, and sieving.

2.2.2 Estimation method of soil carbon sequestration potential

Estimation of soil carbon sequestration potential was based on target value theory. The three methods used were:

1) Maximum value method: the difference between the maximum organic carbon content of soil under different vegetation types and the actual measured value is considered the increasing potential of soil organic carbon content with the vegetation type (Zhang et al., 2013; Shi et al., 2016).

2) Saturation value method: under different vegetation types, the amount of organic carbon in the soil is zero, and the saturated carbon sequestration potential of the soil under this vegetation type is calculated (Shi et al., 2016; Jiang et al., 2017).

3) Classification and grading method: the organic carbon content in the soil with different vegetation types is divided into different levels, and the difference between the organic carbon content and the measured value at different levels is considered an increasing potential in the organic carbon content of the soil under this vegetation type (Shi et al., 2016).

The carbon sequestration potential (SOCP) of Ebinur Lake wetland was achieved by multiplying the difference between the soil organic carbon density target (SOCD_b) and the soil organic carbon density (SOCD_o) of the soil type under different vegetation types by the area of the vegetation type. The equation for SOCP was:

$$\text{SOCP} = \sum S_i \cdot (\text{SOCD}_{\text{b}i} - \text{SOCD}_{\text{o}i}) \quad (1)$$

where i represents several different vegetation types; $\text{SOCD}_{\text{o}i}$ represents the present status of soil organic carbon density under the cover of this vegetation type; and $\text{SOCD}_{\text{b}i}$ represents the organic carbon density target of the soil covered by this vegetation type. The target value was calculated using the maximum value method, the saturation value method, and the classification method.

2.2.3 Calculation of soil organic carbon density

Soil organic carbon density was calculated as:

$$\mathrm{SOCD} = \sum (1-\theta\%) \times P_i \times C_i \times T_i/100, \quad (2)$$

where θ_i represents the volume fraction of coarser particles of soil greater than 2 mm under this vegetation type; SOCD represents the organic carbon density of the soil under this vegetation type (kg/m^2); P_i represents soil bulk density under this vegetation type (g/cm^3); T_i represents soil thickness under the vegetation type (cm); and C_i represents the organic carbon content of soil under the vegetation type (g/kg).

2.2.4 Calculation of soil organic carbon storage

Soil organic carbon storage in the Ebinur Lake Wetland was calculated as:

$$\mathrm{TC} = \sum S_i \cdot \mathrm{SOCD}_i, \quad (3)$$

where TC represents the total amount of soil organic carbon which is covered by this vegetation type (t); S_i represents the area of the soil under which the vegetation type is covered (hm^2); and SOCD_i represents the organic carbon density of soil which is covered by this vegetation type (t/hm^2).

3 Results

3.1 Maximum value method

The carbon sequestration potential of surface soil around Ebinur Lake was estimated using the maximum value method. For this method, the soil organic carbon content value under the different vegetation types with a cumulative frequency greater than 99% were removed. Next, the extreme value was removed to reduce error. After removing the extreme value, the maximum value recorded using this method was taken as the maximum value of soil organic carbon content under the vegetation type (Fig. 2).

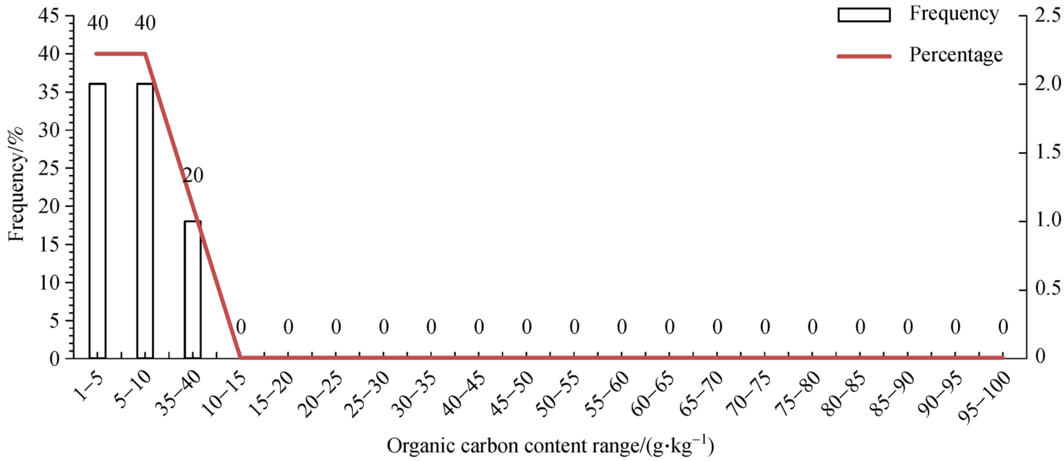
The difference between the maximum organic carbon content value of soil under each vegetation type and each actual measured value was considered the increment of soil organic carbon content under each vegetation type. The average organic carbon density increment of soil under each vegetation type was then calculated. According to the soil area under the different vegetation types, the soil organic carbon potential increment of the vegetation type was also calculated. From the distribution of organic carbon content in the dry lakebed (Fig. 3), identified in 16 profile sampling points, the number of sampling points with a soil organic carbon content of 1 to 5 g/kg was 33% of the total sampling points; 5 to 10 g/kg accounted for 20% of sampling points; 10 to 15 g/kg accounted for 7% of sampling points; and 25 to 30 g/kg accounted for 7% of sampling points. Sampling points with a cumulative frequency greater than 99% fall into those with an organic carbon content of 20 to 25 g/kg. Therefore, the number of valid sampling points is 14, and the number of effective sampling points of other vegetation forms was chosen using a similar method.

The maximum organic carbon content in the different vegetation types was in the order of: salinized meadow (322.8 g/kg) > small tree desert (84.82 g/kg) > shrub desert (25.92 g/kg) > dry lakebed (19.86 g/kg) > alpine coniferous forest (7.82 g/kg) > desert riparian forest (7.59 g/kg) > halophyte bush (3.29 g/kg) (Table 2). The average organic carbon density increment was in the order of: salinized meadow (42.60 t/hm^2) > small tree desert (17.53 t/hm^2) > shrub desert (4.04 t/hm^2) > dry lakebed (3.87 t/hm^2) > alpine coniferous forest (0.69 t/hm^2) > desert riparian forest (0.50t/hm^2) > halophyte bush (0.11t/hm^2) (Table 2). According to the soil area under the different vegetation types and using the maximum value method, the carbon sequestration capacity of the seven vegetation types around Ebinur Lake was 1.88 Mt. Carbon sequestration potential of organic carbon was mainly concentrated in shrub desert (31.84%), alpine coniferous forest (31.43%), and salinized meadow (26.23%) (Table 2).

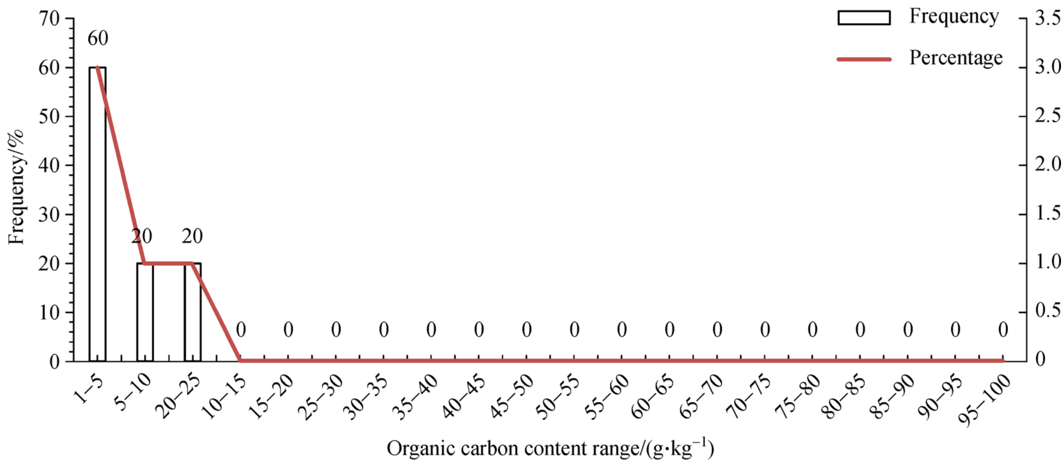
3.2 Saturation value method

The soil carbon content of the different sampling sites (from 0 to 20 cm) under different vegetation coverage was determined. Because of the different number of sampling points, different vegetation types, and different years, the average value of soil organic carbon density was calculated as the soil organic carbon density under the vegetation type. According to the calculation method of organic carbon storage, the carbon storage of soil under different vegetation types (in 2006, 2011, and 2013) was estimated, respectively. The soil organic carbon value of the different vegetation types in 2006 was used as the initial carbon content for the different vegetation types. The variation of soil organic carbon was the difference of soil organic carbon content in soil samples under the different vegetation types in 2011 and 2006. The soil organic carbon value for the different vegetation types in 2011 was used as the initial carbon content for the different vegetation types. The variation of soil organic carbon was then the difference between soil organic carbon content in soil samples under different vegetation types in 2013 and 2011.

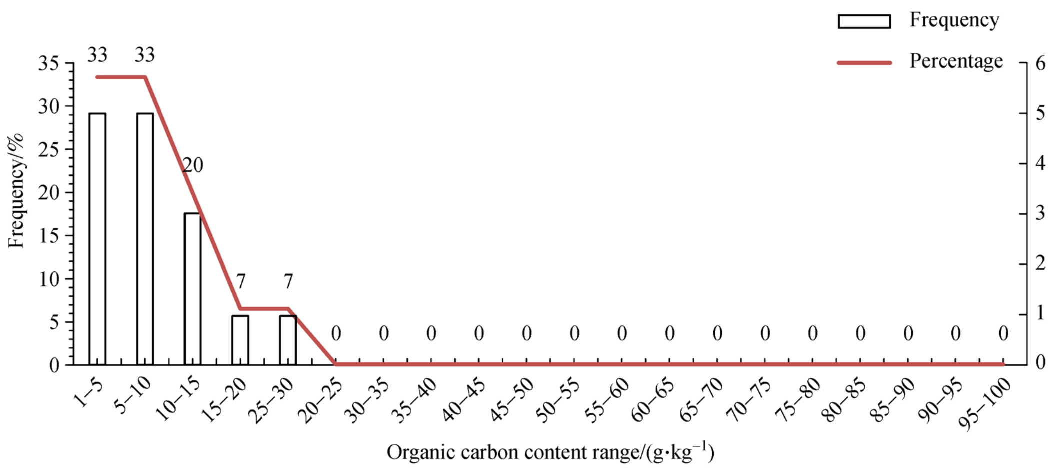
By plotting soil initial organic carbon against its variation under the different vegetation types (Fig. 3), various fitting curves were established. When the variation of soil organic carbon under a vegetation coverage was zero, the soil organic carbon value corresponding to the soil type reached saturation. Saturated organic carbon was considered as the saturated carbon sequestration potential of the soil under this vegetation type. Then, according to the soil area of different vegetation types, the average



(a) Alpine coniferous forest



(b) Desert riparian forest



(c) Dry lakebed

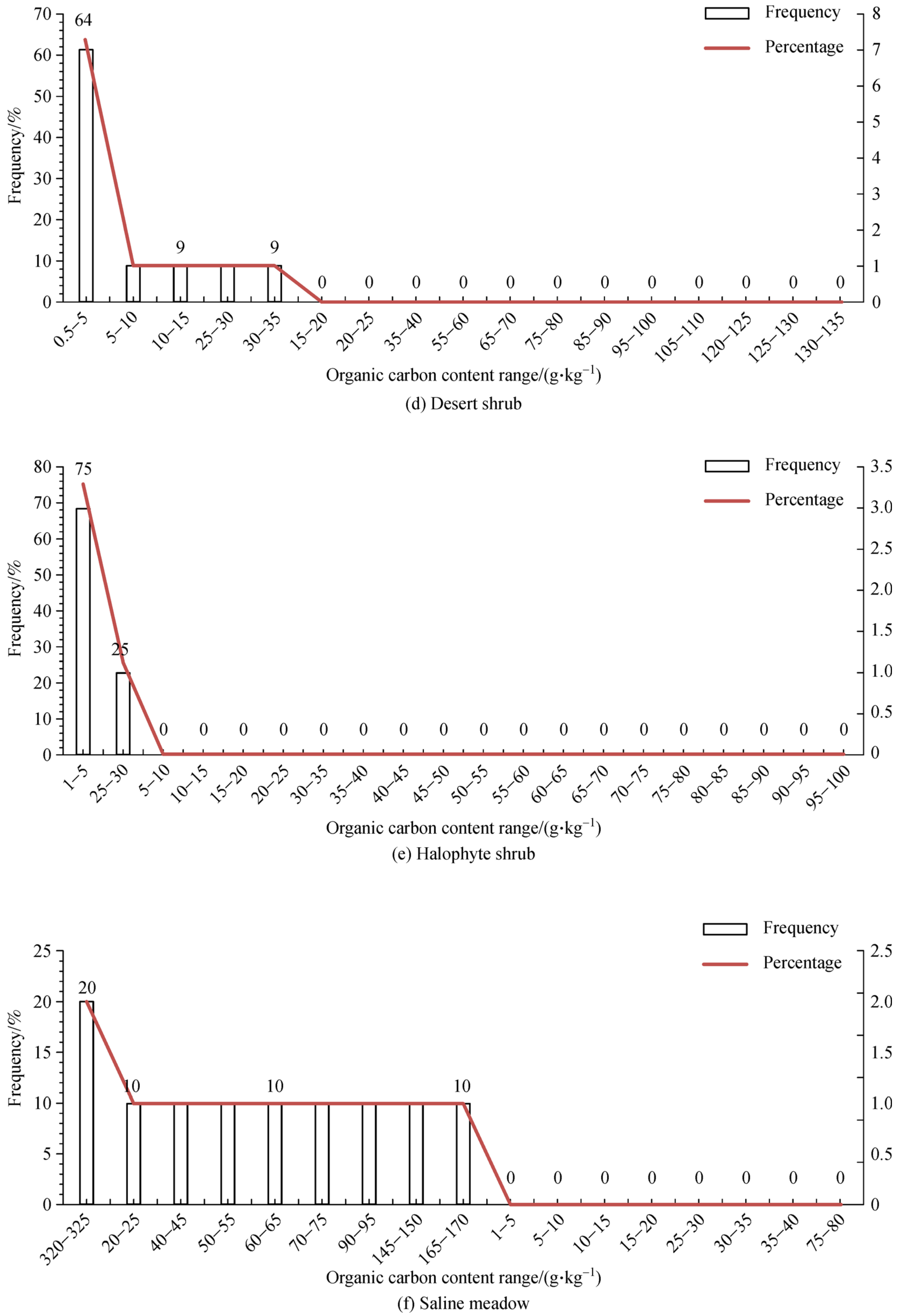


Fig. 2 Interval distribution of organic carbon content in the different vegetation types.

Table 2 Carbon sequestration potential in the different vegetation types

Vegetation	Sample	SOC Max/($g \cdot kg^{-1}$)	C density increment/($t \cdot hm^{-2}$)	Area/(hm^2)	SCS/t
Dry lakebed	14	19.86	3.87	41464.33	160466.96
Desert riparian forest	4	7.59	0.50	44851.19	22425.60
Halophyte shrub	3	3.29	0.11	637.85	70.16
Saline meadow	9	322.8	42.60	11571.05	492926.73
Desert shrub	10	25.92	4.04	148134.24	598462.33
Alpine coniferous forest	4	7.82	0.69	20614.47	14223.98
Microphanerophytes desert	56	84.82	17.53	33699.9	590759.25
Total	100		69.34		1879335.01

organic carbon density of surface soil (from 0 to 20 cm) under the different vegetation types was calculated, and the organic carbon increments of the different vegetation types were also calculated (Table 3). Our results indicate that the content of saturated organic carbon in soil varied with different vegetation types. The increment of organic carbon was ranked in the order of: salinized meadow (34.89 g/kg) > small tree desert (9.59 g/kg) > dry lakebed

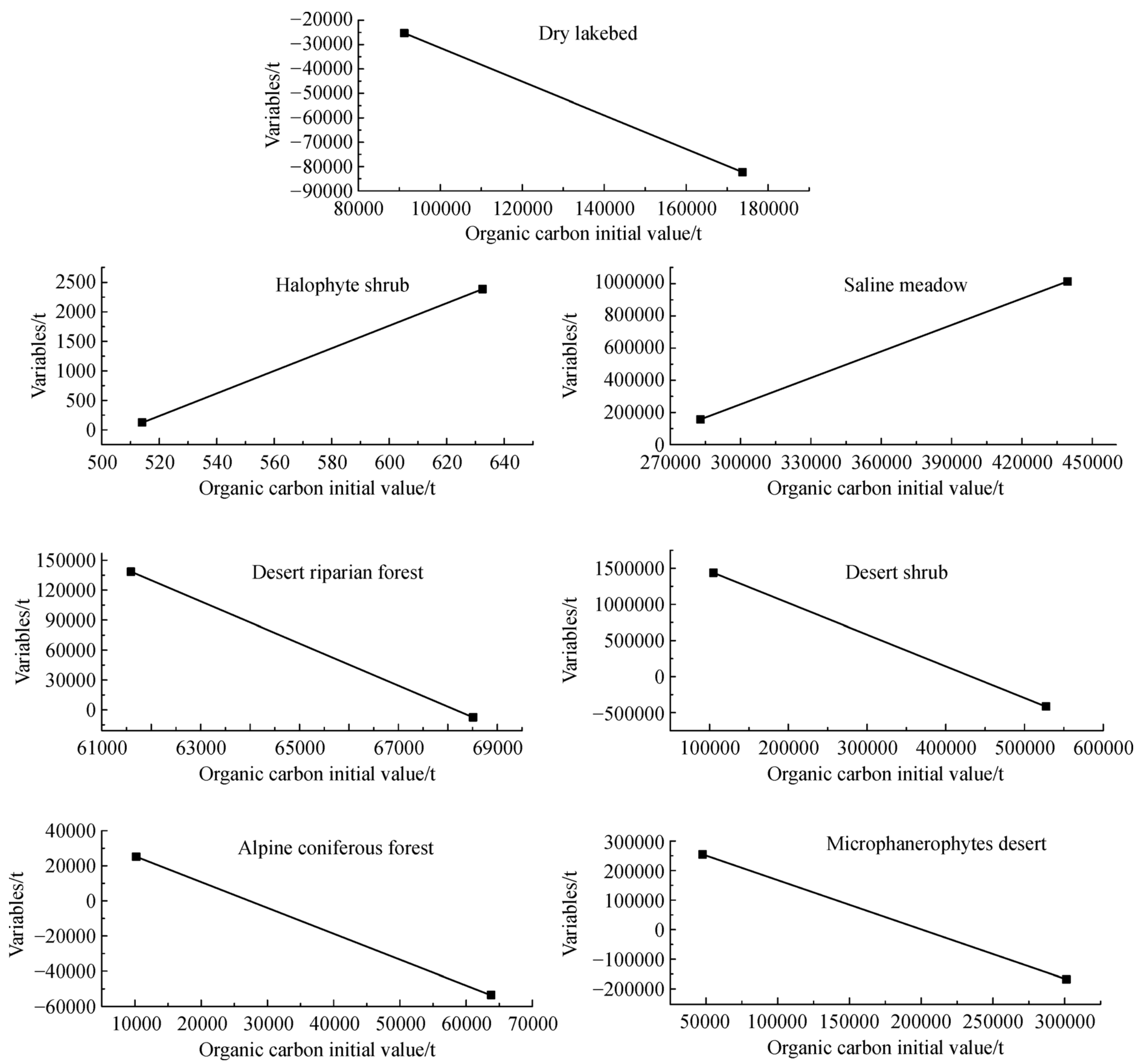


Fig. 3 Organic carbon content and variables in the different vegetation types.

Table 3 Estimation of different vegetation types using the saturation value method

Vegetation types	Sample	Area/hm^2	SOC increment/$g \cdot kg^{-1}$	C density increment/$t \cdot hm^{-2}$	SCS/t
Dry lakebed	15	41464.33	4.26	1.31	54318.27
Desert riparian forest	5	44851.19	3.04	1.06	47542.26
Halophyte shrub	4	637.85	2.42	0.8	510.28
Saline meadow	10	11571.05	34.89	15.83	183169.72
Desert shrub	11	148134.24	0.32	3.07	454772.12
Alpine coniferous forest	5	20614.47	3.87	1.32	27211.10
Microphanerophytes desert	57	33699.90	9.59	5.02	169173.50
Total	107	300973.03	58.39	28.41	936697.25

(4.26 g/kg) > alpine coniferous forest (3.87 g/kg) > desert riparian forest (3.04 g/kg) > halophyte bush (2.42 g/kg) > shrub desert (0.32 g/kg). Organic carbon density increment was ranked in the order of: salinized meadow (15.83 t/hm^2) > small tree desert (5.02 t/hm^2) > shrub desert (3.07 t/hm^2) > alpine coniferous forest (1.32 t/hm^2) > dry lakebed (1.31 t/hm^2) > desert riparian forest (1.06 t/hm^2) > halophyte bush (0.8 t/hm^2). Carbon sequestration potential was ranked in the order of: shrub desert (454772.12 t) > salinized meadow (183169.72 t) > small tree desert (169173.50 t) > dry lakebed (54318.27 t) > desert riparian forest (47542.26 t) > alpine coniferous forest (27211.10 t) > halophyte bush (510.38 t). Among them, shrub desert had the largest carbon sequestration potential, accounting for about 48.55% of the total, and halophyte bush had the minimum carbon sequestration potential, accounting for about 0.05% of the total.

3.3 Classification and grading method

The carbon sequestration potential of soil under different vegetation types differed. According to the different vegetation types, the profile sampling points and soil organic carbon content was classified and graded. Under the different vegetation types, organic carbon content was set at 5 levels: low, relatively low, middle, high, and relatively high. Differences between the five levels of organic carbon content and the measured organic carbon content can be used to obtain the average soil organic carbon increment under the vegetation type. The soil potential of organic carbon under different vegetation conditions at different levels was also obtained. Under different carbon sequestration levels, the potential of soil carbon sequestration under different vegetation types differed (Table 4). Under the high level, total carbon sequestration potential was about 5.37 Mt. Carbon sequestration potential was ranked in the following order: small tree desert (38.06%) > shrub desert (28.61%) > salinized meadow (15.96%) > desert riparian forest (6.29%) > dry lakebed (5.98%) > alpine coniferous forest (5.00%) > halophyte bush (0.10%). Under the middle level standard, total carbon sequestration potential was about 1.71 Mt, and carbon sequestration potential was ranked as: shrub desert (39.32%) > salinized meadow (28.93%) > desert riparian forest (13.69%) > small tree desert (6.92%) > alpine coniferous forest (6.60%) > dry lakebed (4.32%) > halophyte bush (0.22%). Under the low level standard, total carbon sequestration potential was about 0.78 Mt and carbon sequestration potential was ranked as: small tree desert (33.55%) > shrub desert (32.24%) > salinized meadow (21.68%) > Aapine coniferous forest (4.81%) > desert riparian forest (4.32%) > dry lakebed (3.35%) > halophyte bush (0.04%). Soil organic carbon increment and organic carbon density increment differed under different vegetation types. The different vegetation types under the middle level standard were taken as an example (Table 5). Organic carbon increment was ranked in order of: salinized meadow

Table 4 Carbon sequestration potential of the vegetation types under different carbon sequestration levels/t

Level	Low	Lower	Middle	Higher	High
Dry lakebed	26227.66	42657.61	73849.88	253729.39	321360.87
Desert riparian forest	33866.92	118236.19	233750.43	311667.24	338038.32
Halophyte shrub	309.99	2522.17	3783.25	5044.33	5333.12
Saline meadow	169813.83	232814.79	494174.88	676096.41	858017.93
Desert shrub	252510.46	653875.34	671487.45	1243015.91	1538013.22
Alpine coniferous forest	37652.13	56399.64	112799.29	162148.98	268497.19
Microphanerophytes desert	262751.62	706493.52	118116.3	1438343.95	2045644.73
Total	783132.61	1812999.26	1707961.48	4090046.21	5374905.38

Table 5 Carbon sequestration potential of the different vegetation types at the moderate level

vegetation	Area/hm^2	Bulk density/($g \cdot cm^{-3}$)	Sample	SOC increment/($g \cdot kg^{-1}$)	C density increment/($t \cdot hm^{-2}$)	SCS/t
Dry lakebed	41464.33	1.54	16	5.78	1.78	73849.88
Desert riparian forest	44851.19	1.74	5	15.00	5.21	233750.43
Halophyte shrub	637.85	1.65	3	18.00	5.93	3783.25
Saline meadow	11571.05	2.27	10	94.13	42.71	494174.88
Desert shrub	148134.24	1.62	11	14.00	4.53	671487.45
Alpine coniferous forest	20614.47	1.98	5	16.00	5.47	112799.29
Microphanerophytes desert	33699.90	1.68	57	66.89	35.05	118116.30
Total	300973.03	12.48	107	229.8	100.68	1707961.48

(94.13 g/kg) > small tree desert (66.89 g/kg) > halophyte bush (18.00 g/kg) > alpine coniferous forest (16.00 g/kg) > desert riparian forest (15.00 g/kg) > shrub desert (14.00 g/kg) > dry lakebed (5.78 g/kg). The increment of organic carbon density was ranked in the order of: salinized meadow > small tree desert > halophyte bush > alpine coniferous forest > desert riparian forest > shrub desert > dry lakebed (Table 5).

3.4 Soil organic carbon and standard deviation with different vegetation types

Average soil organic carbon values under the seven different vegetation types ranged from 8.11 to 131.2 g/kg, with the order of: saline meadow (131.12) > microphanerophytes desert (21.41) > alpine coniferous forest (11.16) > halophyte shrub (8.53) > desert riparian (8.42) > dry lakebed (8.41) > desert shrub (8.11). Standard deviation, reflecting the dispersion degree of soil organic carbon, ranged from 6.54 to 110.97 (Fig. 4), with the order of: saline meadow (110.97) > microphanerophytes desert (24.94) > alpine coniferous forest (15.38) > halophyte shrub (11.23) > desert shrub (11.08) > desert riparian forest (7.57) > dry lakebed (6.54).

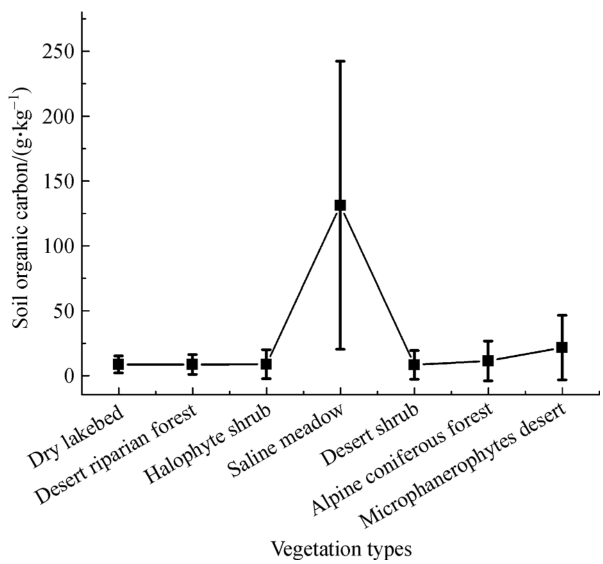


Fig. 4 Soil organic carbon and standard deviation with the different vegetation types.

3.5 Comparison of carbon sequestration potentials

As a result of different land use patterns, carbon sequestration in soils also differs (Zhu et al., 2016; Zhou and Wang, 2017). Results using different methods to estimate the carbon sequestration potential of the seven vegetation types in the Ebinur Lake wetland indicated that significant differences in sequestration potential exist between the methods (Table 6). The maximum value of carbon sequestration potential estimation (2.05 Mt) was recorded in the high-level standard of the classification and grading method. The minimum estimate of carbon sequestration potential (70.16 t) was recorded using the maximum value method. The maximum (42.60 t/hm^2) and minimum (0.11 t/hm^2) values for the estimated increment

Table 6 Comparison of carbon sequestration potential under the different estimation methods

Method	C density increment/($t \cdot hm^{-2}$)		SCS/t	
	Max	Min	Max	Min
Maximum value method	42.60	0.11	598462.33	70.16
Saturation method	15.83	0.8	454772.12	510.28
Classification grading method (H)	74.15	7.54	2045644.73	5333.12
Classification grading method (M)	42.71	1.78	671487.45	3783.25
Classification grading method (L)	14.68	0.49	262751.62	309.99

of organic carbon density were recorded using the maximum value method and the maximum value method. Carbon sequestration potential using the maximum value method was estimated to be about 1.88 Mt, this being the closest result to that gained using the middle level standard of the classification and grading method (1.71 Mt). Results for the saturation value method, based on saturation theory, had a high level of accuracy, accurately reflecting the carbon sequestration potential of the seven different vegetation types in the Ebinur Lake wetland. Total carbon sequestration potential using this method was about 0.94 Mt, and the average increment of organic carbon density was 28.41 t/hm^2 in total. Using results from the saturation value method and the classification and grading method, carbon sequestration potential in Ebinur Lake wetland was identified to range from 0.45 to 0.67 Mt, this being about 5/16 of the ideal carbon sequestration potential. According to the increment of organic carbon under the seven different vegetation types around the Ebinur Lake wetland area, the average growth rate of organic carbon was about 0.7 $kg/(hm^2 \cdot a)$. The time required to reach its carbon sequestration potential therefore ranged from 41 to 144 a.

4 Discussion

The maximum value method is a simple and quick way to estimate the carbon sequestration capacity of a soil. This method is predominantly used to estimate the ideal carbon sequestration potential. Results gained using the saturation value method are based on saturation theory, and they have a high level of accuracy. The classification and grading method divides the organic carbon content in a soil into different levels under different vegetation types, based on the maximum value. The difference between the organic carbon content and the measured values at different levels is regarded as the potential for increasing soil organic carbon content (Liu et al., 2014). Due to natural conditions forming each soil sample, environmental factors, farming management methods, and other attributes differ; it is impossible for all soil samples to reach the highest level of organic carbon content. Therefore, although the potential obtained using the maximum value method is a theoretical value, it still has a certain reference value. The potential of carbon sequestration estimated using the maximum value method was about 1.88 Mt, a value similar to that obtained by Zhang et al. (2011). This result can provide data for the ecological restoration of Lake Abbey. The estimated maximum carbon sequestration potential in Abigail Lake wetland using the level standard in the classification method was approximately 1.71 Mt, and the ideal carbon sequestration potential value using this method was slightly lower than the maximum method. The difference was derived from the difference in the target value. This finding is consistent with those of Shi (2016) and others. At present, the most widely used method for estimating soil carbon sequestration potential is the saturation value method. This method, however, has difficulty in accurately determining the saturation level (Shi, 2016). In our study, the total carbon sequestration potential of seven vegetation types in Lake Abigail wetland was estimated to be 0.94 Mt. The saturation value method needs to meet two conditions: first, it satisfies a certain number of spline points, and the number of spline points determines the level of saturation; secondly, sufficient input of exogenous organic matter needs to be ensured. According to the dynamic changes of soil organic carbon highlighted by, for example, Izaurralde et al. (2001), Campbell et al. (1998), and Campbell et al. (1996), the stability of soil organic carbon will occur during the input of exogenous organic carbon. When the soil organic carbon content no longer increases with the input of exogenous organic carbon, the true saturation level of soil organic carbon is achieved. Due to the uncertainty in determining the saturation value of organic carbon, this method is still difficult to undertake in practice. Based on these results, the classification and grading method was found to be simpler and more operable than the saturation value method. In the estimation of the ideal carbon sequestration potential of a soil under different vegetation cover types, results obtained from the level standard estimates in the maximum value method and the classification and grading method were relatively close. Therefore, when estimating soil carbon sequestration potential values, it is necessary to select according to different conditions to ensure that accurate estimates are obtained.

5 Conclusions

1) In the Ebinur Lake wetland, the carbon sequestration potential of seven different vegetation types was estimated using the maximum value method. The carbon sequestration potential of soil under the different vegetation cover (from 0 to 20 cm) was about 1.88 Mt. This result was the closest to the result estimated using the middle level standard of the classification and grading method.

2) The soil carbon sequestration potential (from 0 to 20 cm) under different vegetation types was calculated using the saturation value method and the classification and grading method. The carbon sequestration potential of Ebinur Lake wetland was about 0.45 to 0.67 Mt, this being about 5/16 of the ideal carbon sequestration potential.

3) The carbon sequestration potential of the surface soil (from 0 to 20 cm) under different vegetation types was estimated using the saturation value method and the classification and grading method (middle level standard). According to the increment of organic carbon under the seven different vegetation types, the average growth rate of organic carbon was about 0.7 $kg/(hm^2 \cdot a)$. The time required to reach its carbon sequestration potential was calculated to be between 41 and 144 a.

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