Coastal blue carbon ecosystems in China

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Citation: Fa-ming Wang, Jing-fan Zhang, Si-yuan Ye, Ji-hua Liu, 2022. Coastal blue carbon ecosystems in China, China Geology, 5, 193-194. doi: 10.31035/cg2022007.

View online: https://doi.org/10.31035/cg2022007

China Geology 5 (2022) 193−194

China Geology

Journal homepage: http://chinageology.cgs.cn
https://www.sciencedirect.com/journal/china-geology

News and Highlights

Coastal blue carbon ecosystems in China

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1. What are blue carbon ecosystems?

Coastal blue carbon ecosystems (BCEs) consists of salt marshes, mangroves, and seagrass bed. Its function as carbon (C) sink is an important pathway to reduce atmospheric carbon dioxide (CO_2) concentration and mitigate global change. Coastal wetlands have a great carbon sequestration capacity. The annual C sequestration rate per area of BCEs is expected to reach 0.22 Gg/km^2, which is equivalent to the CO_2 emitted from the consumption of 1.12×10^6 L gasoline, and tens to hundreds of times that of terrestrial forest ecosystems. The protection and restoration of BCEs are an important ocean-based climate change governance method, which is also a "nature-based solution". Therefore, accurate assessment of the coastal BCEs C stock, C sequestration potential and ecosystem services is critical for enhancing C sinks and reducing the CO_2 emission. Strengthening the scientific research on coastal wetlands not only provides the theoretical basis for governments to draw up action plans to tackle climate change, but also is a solid foundation for China to achieve "carbon neutrality".

2. Blue C sequestration mechanisms

The C sequestration of BCEs is mainly through the vertical sedimental C burial and the lateral C flux of dissolved inorganic C (DIC), dissolved organic C (DOC) and particulate organic C (POC) by tidal seawaters (Fig. 1). The preliminary C burial rate of salt marshes and mangroves at the global scale is estimated to be 53.65 Tg/a, equivalent to CO_2 196.71 Tg/a. In addition, this value is only the vertical C burial rate, and some research showed that the inorganic C input into the ocean by lateral tidal flow from coastal wetlands is far more than the sedimentation of organic C. Thus, the actual annual C sequestration capacity of coastal wetlands far exceeds the rate estimated by the conventional vertical C sequestration.

3. China coastal wetlands

Salt marshes are the largest type of coastal BCEs in China. The latest national scale remote sensing of wetlands found that the salt marsh area was 2979 km^2. The authors' previous study estimated that C burial rate of salt marshes in China was 1.19 Tg/a by combining remote sensing data and measured data of C burial rate in these coastal wetlands. This data was greater than the previous estimate of 0.26–0.75 Tg/a, mainly because the salt marsh area (5448 km^2) used was larger than other data sources. If using a relatively conservative wetland area (2979 km^2) for calculation, the annual C burial capacity of salt marshes in China is about 0.50 Tg/a (Table 1).

China's mangroves are located in the northern margin of the global mangrove distribution, mainly in Guangdong, Guangxi, Hainan and Fujian provinces. The authors estimated that the total C burial rate of mangroves in China is about 0.05 Tg C/a, which is close to other studies, but far less than that of salt marshes in China, mainly due to the small area of mangroves in China. According to the remote sensing, China's mangroves covered a total area of 259 km^2 in 2015. The National Forestry and Grassland Administration 's data indicated that Chinese mangroves have recovered rapidly over the past decade, with an area of 289 km^2 in 2020, with more than 70 km^2 of which were newly built and recently restored. However, even according to the latest mangrove area, the current mangrove area in China is only about ten percent of the highest area in history (about 2500 km^2), leaving a huge space for restoration.

Tidal flats are also an important type of coastal ecosystem, which mainly includes mudflat, sandy beach, and bedrock coast, among which mudflat has a strong C burial capacity. China 's tidal flats occupy a large area, even exceeding the total area of salt marshes and mangroves. Moreover, the tidal

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Literary editor: Xi-jie Chen
doi:10.31035/cg2022007

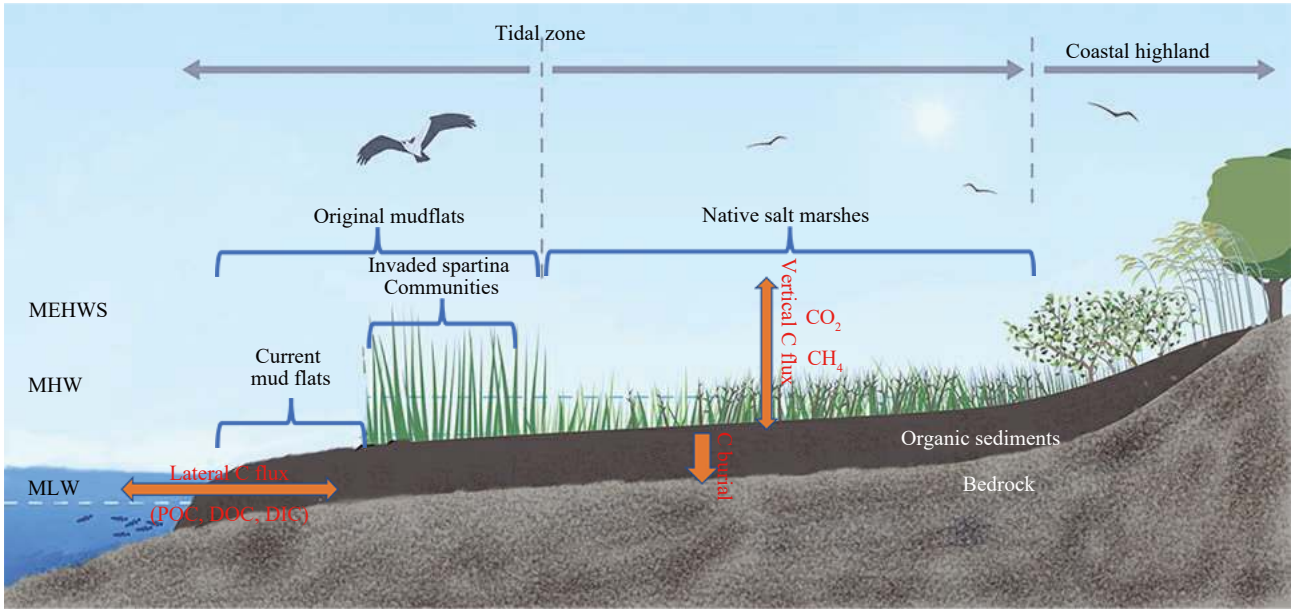

Fig. 1. The vegetation communities and carbon sequestration in Chinese coastal wetlands (Modified from Wang Fa–ming et al. 2021. Bulletin of Chinese Academy of Science, 36, 241–251).

Table 1. The distribution and carbon (C) accumulation rate of coastal wetlands along the coastlines of China (Source from Wang Fa–ming et al. 2021. Bulletin of Chinese Academy of Science, 36, 241–251).

Province	Area/km^2				C burial rate/(Gg/a)			
	Salt marshes	Mangroves	Mudflats	Total	Salt marshes	Mangroves	Mudflats	Total
Liaoning	974.73	0.00	0.01	974.73	162.78	0.00	0.00	162.78
Hebei	103.47	0.00	83.05	186.51	17.28	0.00	13.95	31.23
Tianjin	189.69	0.00	0.00	189.69	31.68	0.00	0.00	31.68
Shandong	421.34	0.00	342.08	763.42	70.36	0.00	57.47	127.83
Jiangsu	465.98	0.00	62.77	528.75	77.82	0.00	10.55	88.36
Shanghai	602.66	0.00	109.81	712.47	100.64	0.00	18.45	119.09
Zhejiang	76.60	1.06	217.40	295.06	12.79	0.21	36.60	49.60
Fujian	51.21	8.27	282.85	342.34	8.55	1.60	48.54	58.70
Guangdong	53.61	92.05	348.07	493.73	8.95	17.86	64.19	91.00
Guangxi	8.98	112.51	697.32	818.81	1.50	21.83	133.94	157.27
Hainan	15.67	36.30	50.31	102.28	2.62	7.04	9.37	19.02
Taiwan	15.41	7.36	180.75	203.53	2.57	1.43	31.89	35.89
Hongkong	0.02	1.04	0.02	1.09	0.00	0.20	0.00	0.21
Macau	0.00	0.00	0.07	0.07	0.00	0.00	0.01	0.01
Total	2979.36	258.60	2374.51	5612.47	497.55	50.17	424.96	972.68

flats in China are dominated by mudflat, characterized by high burial rate of sediment and strong C sequestration potential. The sedimentation rate and C sequestration capacity of mudflats are comparable to those of nearby salt marshes and mangroves. Based on the most conservative coastal mudflats distribution data and C burial rate of nearby salt marshes and mangroves, the lower limit of C burial rate of coastal mudflats in China is estimated to 0.42 Tg/a, which is much higher than that of mangroves and second only to salt marshes in China (Table 1). In addition, China's tidal flats are threatened by *Spartina alterniflora* invasion (Fig. 1). In the past 30 years, nearly 467 km^2 of mudflats have been transformed into *Spartina alterniflora* salt marshes. After *Spartina alterniflora* invaded, it not only increased the input of plant biomass and organic litter, but also slowed down the tidal flow, accelerated the sediment deposition, and improved the sedimentation rate. Generally, the total C sink of mudflats increases after *Spartina alterniflora* invasion, which favors the ecosystem C sequestration. However, the invasion has led to the changes of methane emission and other ecosystem functions, like biodiversity, its comprehensive ecosystem impactions after *Spartina alterniflora* invasion thus need to be further evaluated.

4. Implications for China "carbon neutrality"

Considering the relatively high sedimentation rate of coastal wetlands in China, if there 's no disturbance to the natural shoreline, the total area of coastal wetlands will increase substantially till the end of the 21st century, and the overall C sink and ecosystem services are expected to be further enhanced. However, the total area of coastal wetlands in China is relatively small. In the past few decades, land development activities such as tidal flat reclamation, fish and shrimp aquaculture, urbanization and industrialization have led to a sharp decrease in coastal wetlands, as well as their C sequestration function. Therefore, how to effectively restore and build coastal wetlands, reduce the damage to the natural coastline around wetlands, improve their natural resilience, and enhance the ecosystem service of existing coastal wetlands is of great importance to the improvement of the "blue carbon" function of coastal wetlands in China.