Carbon Density and Its Distribution Pattern in Salt Lake Area Ecosystems: Postprint

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Abstract

Due to the lack of understanding of carbon storage in soils and vegetation of terrestrial ecosystems, there are considerable discrepancies in climate change predictions; therefore, it is essential to investigate carbon distribution patterns in different ecosystems. This study focuses on arid saline lakes to explore the characteristics of carbon distribution in saline lake ecosystems. The results show that soil organic carbon density decreases with increasing soil depth, whereas soil inorganic carbon exhibits an irregular distribution. Within the 100 cm soil layer, organic carbon density ranges from 7.55 to 15.75 $kg \cdot m^{-2}$, averaging 12.54 $kg \cdot m^{-2}$, which accounts for 97.84% of the total organic carbon density of plant communities and soils. *Lycium ruthenicum* and *Halimodendron halodendron* are the dominant species in halophytic communities, with an average aboveground biomass of 261.38 $g \cdot m^{-2}$, representing 70.49% of the total biomass, while the average biomass of herbaceous plant communities is only 109.45 $g \cdot m^{-2}$. The aboveground biomass of shrub and herb layers is significantly higher than that of the litter layer $(84.81 \pm 9.22) g \cdot m^{-2}$ and $(79.76 \pm 8.61) g \cdot m^{-2}$. The belowground biomass of halophytes decreases with increasing soil depth, with a total belowground biomass of 77.74 $g \cdot m^{-2}$ in the 0–100 cm soil layer. The total biomass carbon density of halophytes is 276.48 $g \cdot m^{-2}$, with aboveground, litter, and belowground biomass accounting for 62.09%, 25.75%, and 12.16%, respectively. The carbon density of aboveground vegetation and litter is significantly higher than that of herbaceous plants, and root biomass carbon density is unevenly distributed in the profile, with 96.55% concentrated in the 0–50 cm soil layer. The average carbon content of aboveground, belowground, and litter components of halophytes is 43.09%; the carbon density calculated using the empirical coefficient (50%) overestimates the actual value by 13.80%, which would introduce substantial bias into the estimation of vegetation carbon stocks.

Full Text

Carbon Density Distribution Characteristics of Saline Vegetation and Soil in Arid Areas: A Case Study of Dabancheng Saline Lake in Xinjiang

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Abstract

Saline vegetation in arid regions is widely distributed and species-rich, playing a crucial role in ecosystem carbon balance and regional climate regulation. This study investigates the carbon density distribution characteristics of saline vegetation and soil in arid areas using a combination of field surveys and laboratory analysis, with Dabancheng saline lake in Xinjiang as the research site. Results demonstrated that soil organic carbon density decreased with soil depth, ranging from 7.55 to 15.75 $\text{kg}\cdot\text{m}^{-2}$ within the 0–100 cm profile, with a mean value of 12.54 $\text{kg}\cdot\text{m}^{-2}$, which accounted for 97.84% of the total organic carbon density of the plant-soil system. Black fruit wolfberry and bell thorn were the dominant species in saline communities, with aboveground biomass of 261.38 $\text{g}\cdot\text{m}^{-2}$, comprising 70.49% of total biomass. Herbaceous community biomass was 109.45 $\text{g}\cdot\text{m}^{-2}$, significantly higher than shrub aboveground biomass (84.81$±9.22)g · m^{-2}$ and herb layer biomass (79.76$±8.61)g · m{-2}.Halophyteundergroundbiomassdecreasedwithsoildepth, withtotalundergroundbiomassof77.74g · m{-2}$ in the 0–100 cm soil layer. Total halophyte biomass carbon density was 276.48 $\text{g}\cdot\text{m}^{-2}$, with aboveground, litter, and underground components accounting for 62.09%, 25.75%, and 12.16%, respectively. Aboveground vegetation and litter carbon densities were significantly higher than herbaceous components. Root biomass carbon density exhibited vertical stratification, with 96.55% concentrated in the 0–50 cm soil layer. The average carbon content of halophytes (including aboveground, underground, and litter) was 43.09%. Using an empirical conversion coefficient of 50% overestimated carbon density by 13.80% compared to actual measurements, potentially introducing substantial bias in vegetation carbon estimation. This exploration of carbon density distribution in arid saline vegetation and soil provides data support for plant conservation and enhancing carbon sequestration potential in arid regions.

Keywords: soil organic carbon; inorganic carbon; soil carbon density; biomass carbon density; saline ecosystem; distribution pattern

2.2 Biomass Characteristics

The aboveground biomass of dominant species was (261.38$±21.69)g · m{-2}, whileherbaceouscommunitybiomasswas(109.45±14.58)g · m{-2}$. The root-to-shoot ratio of aboveground biomass showed significant differences among community types, with values of 0.12 (0.10–0.14) and 0.11 (0.09–0.12). The root-to-shoot ratio of underground biomass was 0.35 (0.24–0.53) and 0.26 (0.19–0.34) respectively, indicating significant differences between vegetation types ($P<0.05$).

2.3 Carbon Density Distribution

Carbon density varied significantly among different community types, ranging from 17.68 to 289.38 $g \cdot m^{-2}$, with an average of 81.46 $g \cdot m^{-2}$. The ranking of carbon density among community types was: black fruit wolfberry (261.38 $g \cdot m^{-2}$) > *Suaeda* community (56.75 $g \cdot m^{-2}$) > *Kalidium* community (40.59 $g \cdot m^{-2}$) > *Halostachys* community (27.95 $g \cdot m^{-2}$) > *Phragmites* community (20.63 $g \cdot m^{-2}$), showing significant differences between vegetation types ($P<0.05$, n=14).

[Figure 2: see original paper]

Discussion

Soil organic carbon density in the 0–100 cm profile exhibited clear vertical distribution patterns, decreasing consistently with depth. The distribution characteristics of soil organic carbon density varied among different vegetation communities. Soil organic carbon density ranged from 7.55 to 15.75 $kg \cdot m^{-2}$, accounting for 97.84% of the total ecosystem carbon density, indicating that soil represents the primary carbon pool in saline ecosystems.

The average carbon content of halophytes was 43.09%, significantly lower than the commonly used empirical conversion coefficient of 50%, which overestimated carbon density by 13.80%. This finding suggests that applying a uniform conversion coefficient for carbon density estimation in saline vegetation may lead to substantial errors. The carbon content of saline vegetation differs markedly from that of terrestrial ecosystems, necessitating species-specific and region-specific conversion factors for accurate carbon accounting.

Root biomass carbon density showed pronounced vertical stratification, with 96.55% concentrated in the 0–50 cm soil layer. This distribution pattern reflects the adaptive strategies of halophytes in arid saline environments, where shallow root systems facilitate access to surface moisture and nutrients. The aboveground biomass carbon density (62.09%) was significantly higher than underground components, contrasting with patterns observed in some other ecosystems.

Comparative analysis revealed that carbon density distribution patterns in this study align with previous research on arid ecosystems, where soil carbon dominates ecosystem carbon stocks. The significant variation in carbon density among community types highlights the importance of vegetation composition in determining ecosystem carbon storage capacity. Black fruit wolfberry communities exhibited the highest carbon density, suggesting their potential importance for carbon sequestration in saline environments.

These findings provide critical data for assessing carbon storage potential and developing conservation strategies for saline ecosystems in arid regions. Accurate quantification of carbon density distribution is essential for modeling regional carbon cycles and evaluating the effectiveness of vegetation restoration efforts in enhancing carbon sequestration.

[Figure 5: see original paper]

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Note: Figure translations are in progress. See original paper for figures.