Characteristics and Mechanism Analysis of Impacts of Different Land Management Types on Soil Carbon Sequestration

Sisi Yao¹, ², ³, ⁴, *
¹Shaanxi Provincial Land Engineering Construction Group Co., Ltd., Xian, China
²Institute of Land Engineering and Technology, Shaanxi Provincial Land Engineering Construction Group Co., Ltd., Xian, China
³Key Laboratory of Degraded and Unused Land Consolidation Engineering, the Ministry of Natural Resources, Xian, China
⁴Shaanxi Provincial Land Consolidation Engineering Technology Research Center, Xian, China

*Corresponding author e-mail: 415533048@qq.com

Abstract. As an important means to effectively optimize land use, land remediation projects need to be systematically analyzed for their qualitative and quantitative impacts on soil carbon retention. In this study, three types of land remediation project areas, namely sandy land, saline-alkali land, and abandoned residential land in Shaanxi Province, were selected as research objects, and the impact of land remediation years on soil carbon retention capacity was analyzed. The results of this study indicate that due to differences in basic soil properties and engineering implementation technologies, different types of land remediation have different effects on soil carbon retention characteristics. Aeolian sandy land, abandoned homesteads, and saline-alkali land remediation have certain effects on soil carbon retention.

1. Introduction
Land remediation directly affects soil organic carbon content by directly affecting the physical and chemical properties of the soil and related ecological processes. The impact may be positive or negative. Changes in land use have a significant effect on soil organic carbon density.

This article aims at the unclear ecological effects of the three types of land remediation projects currently being carried out in Shaanxi, saline-alkali land, and abandoned homesteads. The effects of three types of land remediation on soil carbon pools are investigated through field observation and indoor analysis and the mechanism was studied, and the research results provided a scientific basis for the development of future land remediation.

2. Experimental method
The methods were studied by field sampling and laboratory experiment analysis. The studied land remediation projects have been completed and cannot be achieved using long-term test methods, time series methods, and model methods. Therefore, this study uses the method of "space instead of time", that is, decomposing soil properties based on time series, and selecting In the project sites of land

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remediation projects, we selected pre- and post-remediation plots near the same terrain and soil type for comparison, and analyzed the impact of different types of land remediation projects on soil carbon pools. The results can be used to reflect the ecological effects of land remediation.

Three types of land remediation project areas, namely sandy land, saline-alkali land, and abandoned residential land in Shaanxi Province, were selected as research objects, and the effects of land remediation years on soil carbon retention capacity were analyzed. The selected three types of land remediation and 6 project areas have fulfilled the basic requirements for crop growth through the implementation of land remediation techniques, and cultivated agricultural land of different years. They are briefly described below.

2.1. Aeolian soil improvement project

The aeolian soil improvement project in Yuyang District of Yulin City aims at the problem of loose aeolian soil structure, poor water and fertilizer retention capacity, and easy leakage of fertilizers, which is difficult to meet the growth of vegetation. The technical means of combining the ratio of sand and soil to promote the reunion of sandy soil improves the physical properties of the cultivated layer, improves the water and fertilizer retention, and meets the basic needs for crop growth. The two selected test project areas were completed in 2010 and 2014, respectively, and the soil texture category belongs to tight sandy soil. It took 6 years and 2 years since the sampling period respectively, during which potato and corn were mainly planted, and very good economic and ecological benefits were obtained.

2.2. Saline-Alkali Land Improvement Project

The saline-alkali land improvement project in Dingbian County, Yulin City, aims at the low-lying terrain, high groundwater level, heavy water and salt damage, soil layer compaction, and extremely fragile ecological environment. Alkali engineering measures and ground sand-covering measures have achieved soil improvement projects such as reducing groundwater levels, improving the permeability of cultivated soils, inhibiting ground evaporation, and preventing resalts to meet crop growth needs. The two selected test project areas were completed in 2012 and 2014, respectively, and the soil texture category is light loam. After 4 years and 2 years, crops such as corn, forage and millet were planted.

2.3. Abandoned Homestead Land Remediation Project

Chengcheng County's hollow village abandoned house site land improvement project aimed at occupying the land of abandoned earth kilns and adobe houses in the arid terraced area of the Loess Loess Plateau. Land improvement such as soil fertilization is the main technical means. After the implementation of the project, the land use efficiency has been improved, and the original abandoned house site has the basic conditions for crop growth. The two selected test project areas were completed in 2009 and 2013, respectively, and the soil texture category belongs to middle loam. It took 7 years and 3 years to cultivate wheat, corn and other food crops.

The collected soil samples are air-dried and ground, and stored after passing through a 2mm sieve for analysis and determination of organic carbon. A total organic carbon analyzer (Multi N / C®3100) was used to determine the total soil carbon content and total organic carbon content, and the inorganic carbon content was obtained. In order to study the soil reserves of each project, the undisturbed soil samples were collected by the ring-knife method using the excavation profile method, and the soil bulk density of the corresponding soil layer was measured. The collected plant samples are washed with water, and then air-dried and dried in a constant temperature oven at 80°C to a constant weight. The dry weight is weighed, and the plants are crushed and mixed to determine the plants by potassium dichromate oxidation and external heating Carbon content.
3. Results and analysis

3.1. Effects of land remediation on soil carbon sequestration in saline-alkali soils

The content of total carbon, organic carbon, and inorganic carbon in the soil profile (0 ~ 100cm) before and after land remediation in the saline-alkali area of Dingbian County, Yulin City are shown in Figure 1. Among them, the soil profile is 0 ~ 10cm, 10 ~ 20cm, 20 ~ 40. The total carbon content of soil at 40, 60 cm, 60 to 80 cm, and 80 to 100 cm increased by 84.72%, 111.17%, 199.32%, 149.62%, 210.45%, and 87.18%, respectively. The differences in total soil carbon content within the profile range are obvious; although the organic carbon content in the soil profile varies between the soil layers, especially at the surface layer of 0 to 10 cm, it does not reach a significant difference standard after analysis of the differences; The carbon content increased significantly by 111.18%, 156.88%, 267.24%, 186.68%, 227.58%, and 110.51% at 0 ~ 10cm, 10 ~ 20cm, 20 ~ 40, 40 ~ 60cm, 60 ~ 80cm, 80 ~ 100cm, respectively.

After the saline-alkali soil in Dingbian area was rehabilitated and cultivated for 4 years, the total carbon content of the soil in each layer of the soil profile increased significantly, which was mainly due to the improvement of soil inorganic carbon, rather than the increase of organic carbon. The amount of fine sand containing carbonate is directly related to carbonate leaching during planting and utilization. The overall organic carbon content of the soil in each section of the profile has an increasing trend, but it has not reached a significant difference for the time being. This is directly related to the short vegetation planting time and the small amount of organic fertilizer input. It also reflects that it is difficult to increase organic carbon. After land remediation, the content of inorganic carbon in each layer of the soil profile increased significantly, and there was a significant increase with the increase of the depth of the soil layer. This shows that the measures of covering the surface with fine sand during the land consolidation also implanted a large amount of inorganic carbon into the soil. The deep leaching process of calcium carbonate was also obvious during the 4-year cultivation period.
3.2. Impact of land remediation on soil carbon sequestration in aeolian sandy land

The total carbon, organic carbon, and inorganic carbon content of the soil on the 0-100 cm section of the Yuyang District in Yulin City before and after remediation are shown in Figure 2. Among them, the soil section is 0 to 10 cm, 10 to 20 cm, 20 to 40, 40 to 60 cm, 60 to 80 cm, 80 to 100 cm. The total soil carbon content of 0 to 80 cm and 80 to 100 cm increased by 101.86%, 103.83%, 115.56%, 104.40%, 85.89%, and 84.96% respectively; the organic carbon content of the soil profile was 0 to 10 cm, 10 to 20 cm, 20 to 40 cm, 40 to 60 cm, 60 to 80 cm, 80 to 100 cm have increased by 163.52%, 146.78%, 143.21%, 101.89%, 104.88%, 102.96% respectively; after land consolidation within the range of 0 to 100 cm, the total soil Both the carbon content and the total organic carbon content reached significant levels, but there was no significant difference in the inorganic carbon content of the soil from 0 to 100 cm, both of which varied from about 0 to 5 g / kg. It shows that from inorganic remediation to the entry point, the accumulation of organic carbon in the soil is achieved, and the goal of organic reorganization of the soil is achieved.

Obviously, after sand remediation and only 5 years of cultivation, the total carbon content of the soil in the aeolian sandy land increased significantly at 0 to 10 cm, 10 to 20 cm, 20 to 40, 40 to 60 cm, 60 to 80 cm, 80 to 100 cm. This is due to the increase in soil organic carbon. Although a certain proportion of sandstone was added during the land consolidation, the content of inorganic carbon minerals in the sandstone was not enough to change the inorganic carbon pool of sandy soil. The addition of sandstone was mainly to implant the lack of inorganic clay mineral colloid in the sandy land. The fact that the total soil carbon and organic carbon content has increased significantly confirms that after the land is rehabilitated, the inorganic colloids and sand in the sandstone are introduced to make it preliminary planting conditions, and crop root exudates and plant root residues accumulate year by year. Will inevitably promote the growth of the number of soil microorganisms. The increase of the soil organic carbon in the sandy land indicates that the sandy land has started a weak soil formation and soil formation process from the inherent parent material properties. Inputting a certain amount of inorganic colloids into the sandy land, creating a foundation for vegetation growth, achieving the accumulation of soil organic colloids, and gradually improving the quantity and quality of soil colloids are the scientific basis and feasible technical route for sandy land improvement.

![Figure 2](image_url)

**Figure 2.** Changes in total carbon content a, organic carbon content b, and inorganic carbon content c in aeolian sandy soil profile in Yuyang District, Yulin
After the saline-alkali soil in Dingbian area was rehabilitated and cultivated for 4 years, the total carbon content of the soil in each layer of the soil profile increased significantly, which was mainly due to the improvement of soil inorganic carbon, rather than the increase of organic carbon. The amount of fine sand containing carbonate is directly related to carbonate leaching during planting and utilization. The overall organic carbon content of the soil in each section of the profile has an increasing trend, but it has not reached a significant difference for the time being. This is directly related to the short vegetation planting time and the small amount of organic fertilizer input. It also reflects that it is difficult to increase organic carbon. After land remediation, the content of inorganic carbon in each layer of the soil profile increased significantly, and there was a significant increase with the increase of the depth of the soil layer. This shows that the measures of covering the surface with fine sand during the land consolidation also implanted a large amount of inorganic carbon into the soil. The deep leaching process of calcium carbonate was also obvious during the 4-year cultivation period.

The total carbon density, organic carbon density, and inorganic carbon density of soil profiles (0-100cm) before and after remediation in the sandy land of Yuyang District, Yulin City, increased by 83.27%, 96.30%, 113.40%, 104.89%, 91.03%, 83.71%; the density of soil organic carbon increased by 139.25%, 137.67%, 140.79%, 102.39%, 110.54%, 101.61% at 0 ~ 100cm; The increase and decrease also did not reach significant levels. The increase of the organic carbon density in each layer of soil is significantly higher than the increase of the total carbon density. This is because the inorganic carbon density has decreased in some soil layers, especially in the 0-20 cm cultivated soil layer, with the accumulation of soil organic carbon. There is a decrease in inorganic carbon. The total soil carbon density and organic carbon density increased exponentially in the entire soil layer range from 0 to 100 cm. Although the inorganic carbon density also increased, it did not reach a significant level. The thickness of the mixed soil layer of sandstone and sand is only 30cm, but the organic carbon content and carbon density of the soil from 0 to 100cm increase significantly after cultivation, reflecting the basic characteristics of the deeper extension of the crop root system in the sandy land. It is good.

3.3. Effects of land remediation on soil carbon sequestration in abandoned residential land on the dryland of the Loess Plateau

Abandoned house site in Chengcheng County, located in the Weibei dryland of the Loess Plateau. The total carbon, organic carbon, and inorganic carbon content in the soil profile at 0 to 100 cm before and after land remediation are shown in Figure 3, of which only at 0 to 10 cm, 40 to 60 cm, and 60 to 80 cm The total soil carbon content of 80cm and 80 ~ 100cm increased significantly by 21.64%, 11.56%, 7.24%, and 11.20%, and the increase in other soil layers was not obvious; the soil organic carbon content was only at 0 ~ 10cm, 10 ~ 20cm, 40 ~ 60cm, 60 ~ 80cm, 80 ~ 100cm increased significantly by 79.11%, 77.89%, 39.20%, 89.07%, 99.71%, the other soil layers did not increase significantly; the inorganic carbon content of the soil profile increased significantly by only 12.05% at 0 ~ 10cm It decreased significantly by 10.56% at 10-20cm, and the other soil layers did not change significantly. The variation of total carbon, organic carbon, and inorganic carbon in the soil profile is inconsistent, reflecting the landfill traces of land consolidation.
After 7 years of farming, the soil type of the abandoned house site renovation type has a significant increase in the total soil carbon content at only 0-10cm and 40-100cm, and the increase in the total soil carbon content at 0-10cm is a combination of organic carbon and inorganic carbon. As a result, although the organic carbon content increased significantly at 10-20cm, the soil layer in the dryland region is a relatively stable soil layer with soil moisture, which is the main distribution of the crop root system. The crop root system accumulates respiration and the soil air accumulates high concentration of CO2, which promotes the transformation of poorly soluble inorganic carbonic acid into a soluble, migratable carbonate. This layer of soil inorganic carbonate moves to the surface layer with the evaporation of water, which causes the surface layer to increase from 0 to 10 cm of inorganic carbon. The infiltration moved to the deep layer, and as a result, the inorganic carbon content in the layer decreased significantly. The above processes are normal biogeochemical processes of the soil.

The infiltration moved to the deep layer, and as a result, the inorganic carbon content in the layer decreased significantly. The above processes are normal biogeochemical processes of the soil. Although the cultivation time is only 7 years, the research results show that after land remediation, the soil's biogeochemical evolution and development process has started under the action of vegetation. The change of the total carbon content of the soil at each soil layer below 30cm completely depends on the content of organic carbon, and the irregular change is characterized by engineering measures during the reclamation of abandoned old villages.

4. Conclusion
As an important means to effectively optimize land use, land remediation projects need to be systematically analyzed for their qualitative and quantitative impacts on soil carbon retention. The results of this study indicate that due to differences in basic soil properties and engineering implementation technologies, different types of land remediation have different effects on soil carbon sequestration characteristics, and the trend of soil carbon sequestration varies with the duration of land remediation.

Quantitative analysis found that:
1. After 2 years of remediation in aeolian sandy land, the total carbon density of 0 ~ 20cm in the soil surface decreased by 17% ~ 31%, and the density of organic carbon decreased by 29% ~ 31%;
years after remediation, the total carbon, organic carbon, and inorganic carbon density were lower than before remediation. After two years of remediation, there was a significant upward trend, and the increase of each soil layer was more than 30%. Due to the effective improvement of cementite and other cementitious substances in agglomerated sandstone on the agglomeration ability of aeolian sandy soil, and the accumulation of crop root exudates and residues on the soil profile year by year, the carbon retention capacity of the compound soil is significantly improved. The compound soil technology effectively increased the carbon content and carbon density in the aeolian sandy soil, enhanced the carbon sink function of the aeolian sandy land, and the increase in carbon reserves increased with the increase in planting years after remediation. Moreover, the deep roots of crops in arid regions prompt this carbon sequestration effect to penetrate into the middle and deep soil layers of aeolian sands with a depth of 0 to 100 cm, achieving good ecological benefits.

2. There is no significant difference in the total soil carbon density after 3 years of remediation of the abandoned house site, and the overall organic carbon density is generally on the rise, increasing by 17% to 38% at 10-80 cm. Afterwards, the total carbon density increased by 34% -40% at 0-20 cm; the organic carbon density increased by 53% -83% at 0-20 cm. The basic conditions of the soil before the remediation of the abandoned house site are relatively good. Therefore, as the remediation period increases, the overall soil carbon retention capacity, especially the carbon content, is not significantly different. However, due to the relatively stable humidity of the 0-40 cm soil layer in the drylands, it is mainly distributed in the soil layer after remediation. Crop root respiration causes high concentrations of CO2 to accumulate in this layer of soil air. Therefore, the surface layer can be increased as the remediation period increases Organic carbon content. In addition, with the increase of the treatment period, the change in bulk density is greater than the change in carbon content. Therefore, the carbon content of the profile of the abandoned house site is relatively stable, but the carbon storage has increased with the increase of the treatment period;

3. With the increase of the treatment period, the total carbon and inorganic carbon in the saline-alkali land showed a downward trend and then an increase in the surface layer, and continued to increase in the deep layer. After 2 years of treatment, the total carbon density decreased by 46% to 61% between 0 and 20 cm. After 4 years of treatment, the total carbon density rose by 40% -130% from 0 to 20 cm compared with the 2 years of treatment. During the treatment of saline-alkali land, because the surface sand-covering effect promoted the downward migration of inorganic carbon, the inorganic carbon in the surface layer of the soil decreased and the inorganic carbon in the deep layer increased during the early stage of the treatment. However, with the continuous increase of the treatment period and the continuous improvement of the soil, the surface inorganic carbon has picked up, and the inorganic carbon reserves in the profile have increased significantly, and the total reserves have increased significantly.

The research results show that aeolian sandy land, abandoned homesteads, and saline-alkali land improvement all have certain effects on soil carbon retention.

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