Research on Integrated Ecological Management Engineering Model of Soil Organic Reconstruction

Juan Li¹,²,³,⁴,*, Yangjie Lu¹,²,³,⁴, Chendi Shi¹,²,³,⁴

¹Shaanxi Provincial Land Engineering Construction Group Co. Ltd., Xi’an 710075, China
²Institute of Land Engineering and Technology, Shaanxi Provincial Land Engineering Construction Group Co., Ltd., Xi’an, China
³Key Laboratory of Degraded and Unused Land Consolidation Engineering, the Ministry of Natural and Resources, Xi’an, China
⁴Shaanxi Provincial Land Consolidation Engineering Technology Research Center, Xi’an 710075, China

*Corresponding author e-mail: 2644816206@qq.com

Abstract. In view of the comprehensive problems of soil erosion and soil structural instability in the shoal land, in the process of remediation of Bailongjian in Huayin County, Shaanxi Province, the land reclamation and overburden were comprehensively designed using land leveling, river treatment and overburden comprehensive treatment techniques. Engineering, irrigation engineering, roads and shelterbelts; the implementation of the project model, the total rectification scale is about 67.94hm², and the newly added cultivated land is about 61.93hm². The utilization rate and output rate of land have been improved, agricultural production conditions and farmers’ living environment have been improved. At the same time, it is of great significance to prevent soil erosion, continuously establish farmland ecosystems, and promote the improvement of comprehensive agricultural production capacity.

1. Introduction
Agriculture is the basis of the national economy, arable land is the basis of agricultural production, and the most basic natural resource for human survival and social development [1]. China has a large population and relatively scarce cultivated land resources. At the same time, China is also in a period of rapid economic development. Various economic constructions will inevitably occupy cultivated land, resulting in a sharp reduction in cultivated land area[2]. With the development of urbanization and industrialization and the implementation of the strategy of western development, the demand for construction land has increased year by year, and the contradiction between economic development and cultivated land protection has become very prominent [3-5].

At present, the main way to replenish cultivated land is to develop and remedy the cultivated land reserve resources through various land remediation techniques to make it reach the standard of agricultural cultivated land. Tidal flats are also important reserve resources [6-8]. The development and utilization of this type of land is mainly concentrated in coastal cities [9-11], and the methods of
development and utilization are also diverse, and the technology is relatively mature [12-14]. For Shaanxi Province, the existing reserve resources of cultivated land mostly belong to hard-to-use land, mainly including barren rock beaches, bare rock gravels, saline-alkali lands, sandy land, and tidal flats in old river channels. Among them, the barren beach on the old river has an area of about 200,000 mu. It is mainly distributed in the upstream of alluvial fans such as the Nanshan tributary, Weihe tributary and Beiluo tributary of the Qinling Line. Type [15]. These old river barren beaches consist of pebbles, sand, and soil of varying sizes, with vegetation coverage of less than 5%, and poor land conditions.

As an important cultivated land reserve resource, barren beach land has important development value and huge development potential to alleviate the shortage of cultivated land resources in the region. Although the objective soil method has become a common method for the construction of cultivated layers on the barren beach, the determination of the thickness of the cultivated layer and its suitability and economic efficiency, the construction of the profile structure of the cultivated layer and its rationality, and the stability of the newly-built cultivated layer Technology and method systems such as improving safety and comprehensive evaluation of newly-built plows have always been the focus and difficulty of remediation and development of barren beaches. Therefore, for this special type of cultivated land reserve resources, research and development of a complete set of remediation technologies and comprehensive remediation are important issues that we urgently need to resolve.

2. Engineering technical indicators

The project construction is centered on the construction of square field, which comprehensively controls fields, water, roads and forests, basically controls soil erosion, comprehensively improves agricultural production conditions and ecological environment, and achieves dry energy irrigation, waterlogging energy drainage, field changed square, and road energy. Forest changed network, changed low-yield fields to high-yield fields, thereby greatly improving the quality of cultivated land and achieving the overall goal of coordinated development of cultivated land quantity, quality, and ecology.

(1) River course design. Fully consider the planning and construction of the land along the river in the regional governance section, and carry out the overall layout of the project; reasonably consider the interests of the upstream, downstream, left and right banks, coordinate and handle the relationship between flood prevention and environmental protection; The riparian line is smooth, avoiding large river crests.

(2) Farmland design. Reasonably plan the field, merge the field ridges locally, level the field surface, reduce the number of field ridges, increase the effective arable land area, and make the earthwork movement smaller.

(3) Design of irrigation and drainage benefits. Determine the number, location and various parameters of irrigation facilities engineering projects to ensure that irrigation work can be performed normally at any time. Under the premise that the future water consumption remains unchanged and the water intake conditions do not deteriorate, irrigation can be achieved in dry conditions. It can be drained when waterlogged to ensure the safety of farmland.

(4) Road design. Construct and improve the field road system, connect with roads outside the area, determine the type and location of the traffic roads in the project area, make sure the roads are reasonably allocated, make large and medium-sized agricultural machinery accessible to each plot, and facilitate mechanized farming and agricultural product transportation.

(5) Protection forest design. According to other points and geographical elements in the project area, the layout, scale and structure of the farmland shelter forests are determined, and appropriate plant species are selected to increase biodiversity and improve local microenvironment.

3. Research area overview

Bailongjian is located in Mengjing Town, Huayin City. It belongs to the foothills of the Qinling Mountains. The terrain is generally high in the south and low in the north. It is a strip alluvial zone. The area is a river channel trough. Alluvial strata of the Quaternary Neogene, the lithology of the
embankment mainly includes sandy loam, silty loam, silty clay (muddy) and sand; the surface water system is abundant and the rainfall is abundant, which provides a rich source of groundwater recharge. The climate of the project area is a warm temperate monsoon climate. The average annual precipitation is 599mm and the annual average evaporation is 1261mm. The annual average temperature is 13.5 °C, the annual extreme maximum average temperature is 40.2 °C, and the annual extreme minimum temperature is -13.1 °C. The annual vegetation evaporation is 968.3mm, the dryness is 1.4-1.8, and the maximum depth of frozen soil is 0.6m. The texture is good, suitable for the growth of grain, cotton and cash crops. It is a high-quality growth place for crisp pears, and the forest resources are also very rich. The original cultivated land in the zone was mainly planted with crops such as wheat, corn and cotton, with a multiple crop index of 1.8. Tree species include poplar and willow.

Figure 1. Schematic diagram of project location
4. Limiting factor analysis
(1) Natural factors.
The soil structure in the area is unreasonable. The presence of most of the sand and gravel in the soil brings great obstacles to soil cultivation. In rainy seasons, it is prone to septic water attack, and the fields are easily washed away. The nutrients required for crop growth cannot be guaranteed. The growth is hindered; large water can also easily cause slope instability, and there are frequent natural disasters such as frost, hail and heavy rain, which is also an important limiting factor affecting land use in the region.

(2) Socio-economic factors.
The current land management in the zone is still based on the household co-production contract responsibility system. Under the influence of production conditions, economic conditions, knowledge levels, business concepts, etc., modern agricultural production facilities and equipment have not been promoted and applied. Intensive cultivation and intensive production and operation. Due to the lack of sufficient funds, the land utilization rate is extremely low, and unused wasteland suitable for cultivation accounts for more than 99% of the total land area, and the productive potential has not been effectively realized.

5. Engineering Design and Implementation

5.1. River design
The Bailongjian River is a natural scoured underground river. The width of the river bed is 135~430m, and the river bed ratio is 4.6%. The ground on the left and right banks is 2~12m higher than the riverbed. The Puyu reservoir is built at the upper mouth of the river. Once in 50 years, the standard for checking floods is once in 500 years. At present, the main channel of the river channel swings left and right on the river beach, the main channel is extremely unstable, the river beach is divided into pieces, and it is not suitable for integrated cultivation. The goal of the governance project is to channelize the river channel, so that the water from the upstream river flows in the planned river channel, and the planar layout should be arranged along the side of the slope as far as possible to ensure the integrity of the cultivated land. Facilitate future cultivation and other infrastructure construction. The technical standard is once in a flood in 10 years, the width is 20-30 meters, the specific ratio is 4.6%, the two sides of the bank are built with mortar, the foundation is 50cm, the thickness is 30cm, and the slope is 1: 1.5. The river channel design mainly includes linear river channels and curved river channels, which is beneficial to resist the impact of the water flow on the river channels and can effectively extend the service life. The design of composite trapezoidal flume can reduce the engineering volume, engineering investment, safety and security. The ornamental aspect is higher than a single trapezoidal section. The rolling dam can first intercept the upstream sediment, gravel and water flow, and secondly it can reduce the kinetic energy of the flow and reduce the erosion of the river bed. The
reservoir can assist the rolling dam to make short-term adjustment of the water flow. Provide a certain guarantee for the safe growth of crops.

Figure 3. Schematic diagram of the river channel (top) and cross section of the river channel (bottom)

1-bottom plate, 2-first side plate, 3-second side plate, 4-second bottom plate, 5-third bottom plate, 6-third side wall, 7-fourth side wall, 8-river bed, 9-Cistern, 10-roll dam.

5.2. Farmland design
(1)Leveling works. Land leveling plays an important role in rational irrigation and drainage, water conservation, soil improvement, water and fertilizer conservation, scientific farming, and improvement of labor productivity and efficiency of mechanized operations. Generally speaking, the land leveling should meet the requirements of artesian irrigation in the project area, and the farmland leveling should be as internally balanced as possible. Each field is used as a leveling unit to perform leveling in the field. Considering the large amount of leveling works in the field, the slope ratio of the field surface is controlled within 2%. The project area is divided into a total of 142 fields, and 107.2962 hectares of new cultivated land have been added through leveling development, and the new cultivated land rate has reached 79.64%.

Figure 4. Plan of the project area

(2) Covering works. There are soil sources in the east of the project area. Considering economic
and scientific feasible soil extraction, there are 6 soil extraction points planned, one soil extraction point at 1km. After the soil is taken, the borrow field will be renovated to Taitian, which not only increases the area of cultivated land, stabilizes the slope, but also prevents soil erosion. The calculation of the thickness of the overlying soil after the tidal flat is leveled provides scientific data through experiments to provide technical support. Comprehensive long-term positioning simulation experiments, combined with the relationship between crop growth indicators, yield, soil physical and chemical properties, and engineering costs, propose that the suitable thickness of the soil for organic reconstruction of the barren beach soil is 50 ~ 60cm. After combining the engineering costs, the thickness of the covering soil is selected as 50cm.

![Figure 5. Simulation monitoring test chart](image)

Tidal flat leveling is calculated by the amount of earth moving in each field. Before this earthwork calculation, five fields were selected to calculate the earthwork volume using the DTM method, the 20m grid method, and the regional earthwork balance method. The average error of the three calculation results was less than 1%. Since the grid is simple and intuitive, the drawing is clear, and it is very practical in actual work, so the earthwork calculation of the project uses the 20m × 20m grid method. After calculation and block by block calculation, a total of 402,400 m3 of moving earthwork was obtained. Covering engineering can effectively improve the soil mechanism and physical structure, not only play a role in water and fertilizer retention, but also prevent soil and water loss to a large extent.

![Figure 6. Engineering drawing](image)

5.3. Irrigation Engineering Design

According to local conditions, the original channel irrigation was changed to low-pressure water pipeline diversion irrigation, and the cisterns, main pipes, main pipes, branch pipes, gate valve wells, drain wells, and water outlet piles were scientifically set to achieve buffering effects on water flow and save later use Of irrigation water. Adopt low-pressure water pipeline diversion irrigation to
scientifically set up supervisors, main pipes, branch pipes, gate valve wells, drain wells, and outlet piles. One outlet pile is set up every 3 acres of land. The radiation radius of the outlet pile is controlled within a range of about 50m, and adjacent outlet piles The distance is not less than 70m. If it is more than 130m, a water outlet pile needs to be added. According to GB50288-99, "Irrigation and Drainage Engineering Design Code", the irrigation design guarantee rate is 75%, the pipe water utilization factor is 0.95, and the field water utilization factor is 0.9.

5.4. Road and shelter design
Based on the premise of ensuring agricultural production and convenient living for the masses, minimizing the occupied land area is conducive to improving the level of agricultural mechanization and other principles, and achieving the integration of east, west, and south. New trunk roads, field roads and production roads will be built to form a transportation network connecting the study area with roads outside the area and connecting the residential areas in the area with the labor in the field to facilitate field operations and the transportation of agricultural materials. Field roads are designed to facilitate large-scale mechanical operations. The roads are all designed as concrete roads. The trunk road is designed to have a road surface width of 4m and a surface layer thickness of 18cm. The field road is designed to have a road surface width of 3m and a surface layer thickness of 15 cm. Widen the wrong lane of the original road by 1m. Road edges are added on both sides of the road.

Shelterbelt engineering is one of the indispensable and effective means in land governance, and it is a favorable way to improve the local fragile habitats. The choice of plant species is mainly local species, and the main choice is willow tree, which ensures fast and low cost of material collection and high survival rate. The forest belt follows the direction of the road and is planted on both sides of the road to more effectively control soil and water loss and has certain ornamental properties. The line spacing of the tree is marked by the white and gray lines after the theodolite is put out. After the exact position of the tree is determined, the tree is planted according to the planting requirements of the tree. After planting, the seedlings are managed by a special person to ensure its survival rate.

![Trunk road cross-section](image1)

![Field Road Cross Section](image2)

**Figure 7. Schematic diagram of road works and protective works**

6. Engineering promotion and application value
After finishing the implementation of the project, the first is to control the river channel and strengthen the river embankment to ensure the smooth and safe river channel to avoid flooding the farmland; the second is to improve the soil structure by covering the soil; the third is to construct water diversion pipes and improve the irrigation facilities in the project area; On the basis of river management, the
river tidal flats are developed to increase the area of arable land, while improving the ecological environment of the area, promoting local farmers' production, increasing farmers' income, and improving the living standards of local farmers. The implementation of the project has transformed the land use structure; increased farmers' income, promoted agricultural development, improved farmers' living standards, and played a significant role in building a new socialist countryside.

7. Conclusion
For the study of the comprehensive ecological management model of the tidal flat, Shaanxi Bailongyu, which is representative of geographical location, climate, and hydrology, was selected as the project demonstration project site. In 2014, comprehensive land improvement and development was implemented for the project, and the land was levelled. The construction of roads and irrigation systems has improved the land utilization rate and output rate, improved agricultural production conditions and farmers' living environment, and transformed the former tidal flats into modern standard farmland. The improvement effect is significant, and can be similar to other conditions. Regional promotion; at the same time, it is of great significance to prevent soil erosion, continue to establish farmland ecosystems, and promote the improvement of comprehensive agricultural production capacity.

Acknowledgments
This study is financially supported by The Fund Project of Shaanxi Key Laboratory of Land Consolidation (2019-JC07), Fundamental Research Funds for the Central University, CHD (300102279503) and Shaanxi Provincial Land Engineering Construction Group Internal Research Project (DJNY2019-13, DJNY2020-16).

References
[1] Lian Jinqing. Economic benefits of farmland development and management in different regions[J]. Natural resources, 1990, 11(4) : 1-5.
[2] Yu Na. Study on Ecological Benefit Evaluation of Land Development and Consolidation: A Case Study of Dafeng City, Jiangsu Province[D]. Nanjing Agricultural College,2008, 15-19.
[3] Sun Ge. A study on land use in China's urbanization process[M].China Agriculture Press,2005.22-29.
[4] Zhang Lijuan. Study on the countermeasures of land use in the urban fringe of underdeveloped areas[J]. Value Engineering, 2012, 31(1):311-311.
[5] Tang Rentian. Land use and institutional innovation in the process of urbanization [J]. Knowledge Economy. 2014(9):50-50.
[6] Pengqian,Wang Yangling,et al. Study on coastal shoals in China[J]. Journal of Peking University (natural science edition), 2000, 36(6):832-839.
[7] Yang Baoguo,Wangying, Zhu Dakui. Marine resources in China[J]. Journal of natural resources, 1997,2(4) : 307-316.
[8] Zhu Dakui. The exploitation and utilization of the resources in China[J].Geographical Science,1986,6(1):34-40.
[9] Lu Guoqing, Gao Fei. Research on development and utilization of coastal beach resources [J]. Land science in China, 1996, 10(2) : 118-14.
[10] Wang Nan. Strategic choice of sustainable development and utilization of coastal shoal resources in yancheng city[D], Nanjing Agricultural College 2014.25-30.
[11] Zhang Zhenke. Implications of the beach maintenance project on the east coast of the United States on the development and protection of sandy beach tourism resources in China [J]. Marine geology dynamics, 2002, 18(3):23-27.
[12] Shen hui, Wan Xihe, He Peimin. Progress in bioremediation of eutrophication beach [J]. Marine science, 2016, 40 (10):160-169.
[13] Li Xizhi. Simulation of wetland vegetation change in changjiang estuary and its ecological
effect [D]. East China normal university, 2015, 14-18.

[14] Zhao Guofeng. Research progress on reclamation and development of coastal shoals [J]. Journal of yancheng institute of technology (social science edition), 2012, 25 (1): 24-28.

[15] Li Juan, Zhang Yang, Han Jichang, et al. Effects of different overburden thickness on soil chemical properties and spring maize yield in open rock and gravel fields [J]. Agricultural science in anhui province.