

# Research on the Path of Comprehensive Land Improvement in the Whole Region under the Target of "Carbon Peak and Neutrality"

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## Abstract

Taking "carbon peak and carbon neutrality" as the goal orientation, this article analyzes the connotation and relationship of comprehensive land consolidation in the whole region and "carbon peak and neutrality", explores the potential of reducing carbon emission and enhancing carbon sink in the fields of agricultural land consolidation, construction land consolidation, rural ecological protection and restoration, and historical and cultural protection, points out the path of comprehensive land consolidation in the whole region remediation based on ecological remediation, optimizing space and industrial layout, increasing green (blue) carbon sink and soil carbon sink, and resource activation and reuse, and then puts forward relevant suggestions such as strengthening planning guidance, accelerating the development of standards and specifications, developing key technologies and improving public participation.

## Keywords

Comprehensive land consolidation in the whole region; "Carbon Peak and Neutrality"; Connotation; Path; Suggestion.

## 1. Introduction

Climate change caused by greenhouse gas emissions is one of the major challenges facing mankind [1]. In September 2020, China put forward the goal of "carbon emission will reach the peak by 2030 and achieve carbon neutralization by 2060", and incorporated the goal of carbon peak and carbon neutralization (hereinafter referred to as "double carbon" goal) into the overall layout of ecological civilization construction. According to the data jointly released by the World Resources Institute and climate watch in 2016, 73.2% of global greenhouse gases come from energy consumption and 18.4% from agriculture, forestry and land use. Admittedly, controlling energy consumption is the focus of carbon reduction, but agriculture, forestry and land use can not be ignored. The strategic plan for Rural Revitalization (2018-2022) clearly proposes to comprehensively carry out construction land consolidation and land reclamation in rural areas, optimize rural land use pattern and improve rural land use efficiency. Carry out the construction of demonstration villages and towns for comprehensive land improvement, 300 in 2020 and 1000 in 2022. The comprehensive land improvement in the whole region is a land improvement model guided by land spatial planning and village planning, with agricultural land improvement, rural construction land improvement and rural ecological protection and restoration as the main contents [2]. It is an important measure to optimize land spatial layout,

promote land intensive and economical utilization, protect and repair rural ecological environment and help rural revitalization, it is also an important starting point for high-level protection and efficient utilization of natural resources. Up to now, the Ministry of natural resources has approved 446 pilot projects for comprehensive land improvement in the whole region, and some provinces have launched provincial pilot projects. Obviously, comprehensive land improvement in the whole region is a long-term and sustainable work.

The implementation of the major decision-making and deployment of the "double carbon" goal requires extensive and in-depth participation of the whole society and all industries. The comprehensive land improvement of the whole region covers paddy field reclamation, land reclamation, forest quality improvement, mine vegetation restoration, etc. [3]. Studies have shown that changing land use mode and carrying out ecological protection and restoration have a positive impact on emission reduction and foreign exchange increase [4]. At present, the research on promoting the "double carbon" goal pays more attention to the adjustment of energy use structure and ecological restoration [5-7], while the research on the comprehensive land improvement in the whole region mainly focuses on the development path and model under different backgrounds [8-11]. The research on the combination of the comprehensive land improvement in the whole region and the "double carbon" goal has not been reported. Therefore, it is urgent to face the realistic needs of the "double carbon" goal and explore the direction and path of global comprehensive land improvement to help reduce carbon and increase foreign exchange. In view of this, on the basis of combing and analyzing the connotation and correlation of "double carbon" and global land comprehensive improvement, this paper takes "double carbon" as the goal guidance, and adopts the methods of field investigation, system analysis and expert consultation to start from the aspects of agricultural land consolidation, construction land consolidation, rural ecological protection and restoration and historical and cultural protection. Explore the implementation path of emission reduction and foreign exchange increase in the comprehensive land improvement in the whole region, and put forward relevant suggestions, in order to provide reference for the comprehensive land improvement in the whole region to promote "carbon peak and carbon neutralization".

## **2. Connotation and Internal Relationship Between "Double Carbon" Goal and Comprehensive Land Improvement in the Whole Region**

### **2.1. Connotation of "Double Carbon" Goal**

The special report on global warming of 1.5 °C issued by the United Nations Intergovernmental Panel on climate change (IPCC) points out that if the global warming range cannot be stabilized at or below 1.5 °C, the indicators and impacts of global climate change will continue to deteriorate. At that time, many natural system structures and functions will degrade beyond the critical value and lead to permanent changes. Existing studies show that if the current independent emission reduction contributions submitted by countries are followed, the long-term objectives set out in the Paris Agreement may not be achieved. In this context, China has made a commitment to the "double carbon" goal, which aims to contribute to global climate governance. Relevant functional departments and academic circles quickly reached consensus and work plans on reducing emissions and increasing foreign exchange, such as adjusting energy structure, transforming industrial structure, improving energy efficiency, R & D and promotion of low-carbon technologies, improving low-carbon development system and mechanism and increasing ecological carbon sink. The goal of "double carbon" was clearly put forward in 2020. In fact, since the 18th National Congress, China has begun to comprehensively promote the construction of ecological civilization, the concept of green development, the strategy of rural revitalization, land greening and the modernization of harmonious coexistence between man and nature. Guangdong Province has also simultaneously carried out the

construction of a demonstration province for high-level protection and efficient utilization of natural resources (hereinafter referred to as "double high" demonstration province construction). These strategic decisions have made clear the requirements for resource conservation and low-carbon development (Table 1). It can be seen that the "double carbon" goal is unified with the vision of the above strategic decisions.

**Table 1.** Statements related to "double carbon" objectives in relevant strategic decisions

Strategic Hierarchy	Name	Source	Related Expressions
National level	Ecological civilization construction	2012 The 18th National Congress of the CPC incorporated the construction of ecological civilization into the general layout of the "five in one" strategy	Put forward the basic national policy of saving resources and protecting the environment, requiring the ecological mode of production, green lifestyle and high-quality natural environment
	Green development concept	2015 The Fifth Plenary Session of the 18th CPC Central Committee put forward the development concept of innovation, coordination, green, openness and sharing	It is proposed to develop green economy and promote green development, low-carbon development and circular development, in which green low-carbon cycle is the main principle
	the rural revitalization strategy	2018 National strategic plan for Rural Revitalization (2018-2022)	It is proposed to improve the carbon emission trading system, form an effective way for ecological restoration projects such as forests, grasslands and wetlands to participate in carbon sink trading, and improve the ecological protection compensation mechanism,
	Land greening	2018 Opinions on actively promoting large-scale land greening action	Improve the forest area and quality through forest tending and restoration
	Harmonious coexistence between man and nature and modernization	2020 The Fifth Plenary Session of the 19th CPC Central Committee proposed to promote green development and promote the harmonious coexistence between man and nature	Respect, comply with and protect nature, support ecological priority and green development, promote green and low-carbon development and practice a green and low-carbon lifestyle
Provincial level	Construction of "double high" demonstration Province	2021 In, Guangdong Province proposed that during the "14th five year plan" period, it will improve the protection level and utilization efficiency of natural resources and strive to create a demonstration province for high-level protection and efficient utilization of natural resources	We will promote total resource management, scientific allocation, comprehensive conservation and recycling, and comprehensively improve the protection level and utilization efficiency of natural resources

## 2.2. Connotation of Comprehensive Land Improvement in the Whole Region

Following the principle of giving priority to ecology and protection, and in accordance with the general requirements of overall protection, systematic restoration and comprehensive treatment, the comprehensive land improvement of the whole region carries out agricultural land consolidation, construction land consolidation, rural ecological protection and restoration and historical and cultural protection, in order to help rural revitalization. Compared with the traditional land regulation, the comprehensive land regulation in the whole region has been expanded and extended in terms of objectives, contents and measures. In terms of objectives, the comprehensive land improvement in the whole region has gradually changed from the single protection of cultivated land to the integration of new urbanization, poverty alleviation, new rural construction, ecological civilization and beautiful China. In terms of content, from a single agricultural land consolidation to covering construction land consolidation, mine ecological restoration, forest quality improvement, water ecological restoration, coastal island ecological restoration, residential environment improvement [3], rural historical and cultural protection, rural style improvement and other fields. In terms of measures, the overall land comprehensive improvement has changed from a single project implementation to the integration of land and space planning, village planning, multi-channel funds, industrial

integration and development, with the help of a number of land policies, industrial optimization and upgrading, and the integration of multi sectoral resources and forces.

### 2.3. Analysis on the Relationship Between Global Land Comprehensive Improvement and "Double Carbon" Goal

IPCC's special report on global warming of 1.5 °C points out that agriculture, forestry and other land use activities can play an important role in achieving the goal of stable global warming of 1.5 °C and below. Eco-system function restoration, land degradation mitigation, biodiversity protection and sustainable agriculture development are effective measures to deal with climate change [12]. According to statistics, the total amount of soil organic carbon (SOC) is three times that of atmospheric carbon, and 80% of the total carbon involved in the terrestrial carbon cycle of the earth exists in the form of soil organic carbon [13]. In 2017, the Nature Conservation Association (TNC) found that effective protection, restoration and sustainable management of forest, farmland, grassland and wetland ecosystems will contribute 37% of the climate change mitigation potential to achieve the goal of controlling the global temperature rise below 2 °C in the Paris Agreement by 2030 [14]. Land use patterns and land management measures are important factors affecting greenhouse gas emissions [15]. Yang Qingyuan and others found that the conversion of agricultural land to construction land will increase carbon emissions [16], and the reduction of cultivated land area is the main factor leading to the decline of ecosystem carbon sequestration capacity [17]. As shown in Figure 1, the comprehensive land improvement in the whole region can increase the area of cultivated land, increase the content of soil organic carbon, reduce high energy consumption materials such as cement, sand and gravel, improve energy utilization efficiency and increase ecological carbon sink by using mud stone pavement through ecological improvement and cultivated land quality improvement. Through the transfer and transformation of construction land, optimize land space and industrial layout, strictly control and reduce the development space of high-energy consuming industries, intensively and economically use land, and slow down the reduction of cultivated land caused by the expansion of construction land, which can indirectly reduce carbon emissions and promote the transformation of industrial structure. Forests and other ecosystems have the functions of absorbing, storing, replacing and adapting to greenhouse gases such as carbon dioxide [18]. It is found that soil animal earthworms can improve the stability of soil organic carbon and the ability of soil carbon fixation through feeding activities [19]. Relevant data show that about 55% of the carbon captured by the global natural ecosystem through photosynthesis is contributed by marine organisms, especially mangroves, seagrass beds and coastal salt marshes [20]. The rural ecological protection and restoration in the comprehensive land improvement of the whole region can systematically improve the ecosystem function, improve the soil carbon sequestration capacity and increase the green carbon sink by coordinating the forest stand transformation, forest quality improvement, mine vegetation restoration, rural residential environment improvement, biodiversity protection and other means. The blue carbon sink can be increased by taking measures such as coastal zone regulation, construction and restoration of mangroves and protection of seagrass bed. On the basis of protecting ancient buildings, ancient villages and ancient post roads, activate and utilize buildings and other sites, develop low-carbon tourism and leisure industry, avoid energy consumption in the process of demolition and construction, and use green energy-saving materials, which will help to improve energy efficiency.

By combing and analyzing the relevant contents of comprehensive land improvement in the whole region (agricultural land consolidation, construction land consolidation, rural ecological protection and restoration, rural historical and cultural protection) and the key tasks to achieve the "double carbon" goal (adjusting energy structure, industrial structure transformation, improving energy utilization efficiency, R & D and promotion of low-carbon technologies,

improving low-carbon development system and mechanism and increasing ecological carbon sink) It can be concluded that among the measures for comprehensive land improvement in the whole region, the protection and quality improvement of cultivated land can reduce carbon emissions, the intensive and economical use of land can improve land use efficiency, the efficient utilization of resource recycling can reduce energy consumption, the optimization of industrial layout can promote the development of low-carbon industries, and the optimization of industrial layout can strictly control the access of high-energy consuming industries, ecological protection and restoration can improve the carbon sequestration capacity of the ecosystem. Therefore, the development direction and overall goal of comprehensive land remediation in the whole region are highly consistent with the connotation of "double carbon", which can help to achieve the "double carbon" goal.

### 3. Path Discussion

#### 3.1. Agricultural Land Consolidation

The notice on carrying out the pilot work of comprehensive land improvement in the whole region (NZF [2019] No. 194) issued by the Ministry of natural resources clearly puts forward two 5%, that is, the newly added cultivated land area in the regulation area is not less than 5% of the original cultivated land area, and the newly added permanent basic farmland area is not less than 5% of the adjusted area. Under the condition of completing the above two basic requirements of 5%, the fragmented cultivated land shall be intensively renovated and the cultivated land area shall be increased. By "combining small fields with large fields", promoting the concentration and connection of cultivated land can improve the large-scale operation level and production efficiency of agriculture. Studies have shown that reducing tillage [21], applying organic fertilizers such as green manure [22] and returning straw [13] can help to improve soil organic carbon content and reduce soil carbon emission. Compared with traditional land remediation, the application of ecological facilities, such as ecological ditches, ecological bricks, ecological slope protection, purification ponds, mud stone pavement and buffer belt [23], can reduce cement, gravel and other materials by about 40% and energy consumption by about 30% [12]. In addition, the comprehensive land improvement in the whole region can also promote the carbon reduction and foreign exchange increase in agricultural space through the development of technologies such as circular agriculture, smart agriculture and low-carbon land improvement.

#### 3.2. Construction Land Consolidation

The adjustment of energy structure is an important part of realizing the goal of "double carbon". By ensuring the construction of green and low-carbon projects such as clean energy, new industries and rail transit, and strictly controlling the access of projects with high energy consumption and high emissions, it is an effective means to force the optimization and upgrading of the energy industrial structure from the source. Foshan, Guangdong Province, strictly restricts industrial projects with high pollution, high energy consumption and backward technology, prohibits the introduction of projects explicitly eliminated by national and local environmental protection, promotes the transformation of village level industrial parks and helps to do a good job of "double carbon" work. Not increasing the scale of construction land is the basic requirement of the pilot work of comprehensive land improvement in the whole region. Studies have shown that every 1% increase in the total amount of construction land will increase net carbon emissions by 3.99% [24]. Under the premise of strictly controlling the scale of construction land, the comprehensive land improvement of the whole region can promote the landing of industrial projects through the transfer and transformation of construction land. In this process, we should take into account industrial development and the goal of "double carbon", study and formulate industrial project

access system and strictly control high-energy consumption industries. Land space optimization can provide effective solutions for energy conservation and emission reduction. On the one hand, we can optimize the layout of community supporting facilities such as residential buildings, schools, parks and transportation, optimize the non motorized design of traditional roads, improve the convenience and safety of non motorized travel and walking, and improve the green travel rate. On the other hand, the building orientation can be reasonably arranged to induce wind direction, so as to realize heat protection in summer and thermal insulation in winter, so as to achieve energy-saving effect. In addition, studies have shown that simple building shape and reasonable window wall area ratio can also improve energy-saving effect. The implementation of comprehensive land improvement in the whole region may involve the demolition of old houses, reconstruction and renovation of reserved plots, dam demolition, river regulation, road reconstruction and other activities, and will produce waste building materials including stones, bricks, concrete blocks, building slag, wood, metal, glass and so on [25]. On the basic premise of ensuring the quality of project construction. The slag body of buildings shall be utilized as much as possible. Green space has ecological functions such as regulating climate, purifying environment, reducing waterlogging and maintaining biodiversity. According to the research, the average daily absorption of green space per hectare is 1.767 tCO<sub>2</sub> and the release of 1.23 t O<sub>2</sub> [26]. Therefore, it is particularly necessary to carry out green space construction in the comprehensive land remediation of the whole region to improve the carbon sink capacity of the remediation area.

### 3.3. Rural Ecological Protection and Restoration

The increase of ecosystem sinks and the emission reduction in the fields of electricity, industry, transportation and construction are equally important to promote the realization of carbon neutralization goals [6]. The comprehensive land management of the whole region involves many elements such as forests, grasslands, oceans, farmland, mines and so on [3]. On the premise of protecting various ecological elements and ecosystems, the comprehensive land remediation in the whole region should tap the carbon sink potential in the fields of forest, ocean and soil, and carry out low-carbon land remediation [12] and water ecology, mining. Marine protection, restoration, demolition and reclamation to further improve the carbon sequestration capacity of the ecosystem. We should learn from the existing practical experience, strengthen the ecological concept and promote the application and promotion of innovative technology. For example, the wetland in Haizhu District of Guangzhou makes full use of earth roads, earth canals and wooden piles. Cobbles, stones and triad are selected for some pavement of Guyi road in Zhuhai to minimize the damage and impact of excessive pavement hardening on the environment [23]. TNC research found that natural based solutions (NBS) have the ability to contribute about 30% of the emission reduction potential to achieve the objectives of the Paris Agreement, and more than 2 / 3 of them are likely to control climate warming within 2 °C in 2030 [27]. According to the NBS concept, relying on natural forces, through the protection, sustainable management and restoration of ecosystems, improve the quality and stability of ecosystems, and enhance the ability of ecosystems to regulate climate, fix carbon and release oxygen, reduce emissions and increase foreign exchange. It is also one of the options to help achieve the "double carbon" goal and improve the response to climate change [12, 28].

### 3.4. Rural Historical and Cultural Protection

There are often a large number of ancient towns, ancient villages, ancient buildings, ancient bridges, ancient post roads and other resources that can show the local historical and cultural connotation in the countryside. When repairing and transforming the above resources, we should reduce large-scale demolition, large-scale integration and large-scale development to maintain the original historical appearance to the greatest extent. In rural reconstruction, we should encourage the use of green and efficient energy-saving technologies such as solar energy,

energy-saving lamps and new thermal insulation materials to reduce carbon emissions. Value transformation and activation utilization are effective ways to protect rural historical and cultural resources. We should carry out low-energy transformation and repair of ancient towns, ancient villages, old buildings and old industrial areas through market-oriented means, make maximum use of the original facilities, save resources and reduce energy consumption. In addition, relying on historical and cultural resources, we can carry out low-carbon publicity activities such as mountaineering, ancient post road hiking [29], ancient town cycling, stimulate people's feelings of being close to and loving nature, and guide people to travel green.

## 4. Relevant Suggestions

### 4.1. Strengthen Planning Guidance

Township Land Spatial Planning and village planning are the planning basis for the implementation of comprehensive land improvement in the whole region. Taking Guangdong Province as an example, the land and space planning of Guangdong Province (2020-2035) (Draft for comments) proposes to form a resource recycling system of "saving, intensive, green and low-carbon". Based on the principle of "keeping the boundary, green and low-carbon", facing the goal of carbon neutralization, improve the ecological carbon sink capacity, effectively give play to the carbon sequestration role of forests, wetlands, oceans and soils, and improve the carbon sink increment of the ecosystem. Village planning is the legal basis and effective means to carry out land and space development and protection activities, implement land and space use control, issue planning permission for rural construction projects, and carry out various construction. At present, the requirements and contents of "double carbon" have not been involved in the village planning. How to transfer the "double carbon" requirements to the level of township land spatial planning, integrate the realization of "double carbon" objectives into village planning, and turn them into relevant binding indicators and requirements will be one of the key points of township land spatial planning and village planning in the next stage. Next, by integrating the concept of NBS, the concept of low-carbon planning and carbon emission control measures into the relevant planning, the contents related to emission reduction and foreign exchange increase, such as ecological remediation, optimizing the land spatial pattern, strictly controlling the access of high-energy consuming industries, increasing green (blue) carbon sink and soil carbon sink, resource activation and reuse, and the use of green energy-saving materials, can be included in the planning index system. It also makes differential assignment according to regional functional zoning, economy, population and other factors, so as to provide technical support for the effectiveness evaluation of "double carbon" assisted by comprehensive land improvement in the whole region.

### 4.2. Development of Enhanced Standards and Specifications

As of June 2021, there are more than 400 current and planned revised standards related to ecological restoration in China [30]. However, it covers the work sequence of comprehensive land improvement investigation and evaluation, planning and design, project implementation, acceptance evaluation, management, protection and protection, including agricultural land consolidation, construction land consolidation, rural ecological protection and restoration the standard system for the functional categories of rural historical and cultural protection has not been established, and the standards supporting the systematic and integrated development of comprehensive land improvement in the whole region are still blank. The research on construction standards of land and space ecological restoration projects in Guangdong Province launched in 2020 covers the topics of construction standards of agricultural land consolidation, construction land consolidation, mine ecological restoration, water ecological restoration and coastal island ecological restoration projects. The results of the project can provide services for the construction standardization of comprehensive land remediation projects in Guangdong

Province. At present, the subject has passed the acceptance and is in the standard development stage. Next, we should refine and decompose the "double carbon" goal, face the three major spaces of agriculture, town and ecology, build a standard system covering the whole process of comprehensive land improvement around the ecological elements of mountains, rivers, forests, fields, lakes and grasses, increase the consideration of "double carbon" in zoning, engineering system and engineering mode, and study and formulate taking into account "double carbon". Relevant standards and specifications for goal oriented comprehensive land improvement.

#### **4.3. Research and Development of Technologies for Reducing Carbon and Increasing Foreign Exchange**

Energy saving and emission reduction technology research and development is the key support to achieve the "double carbon" goal. On the one hand, we should strengthen the application and promotion of the existing research results of emission reduction and exchange enhancement technologies in the field of comprehensive land remediation in the whole region, and actively carry out the research and development of key technologies such as NBS, low-carbon land remediation, improving forest quality, creating and repairing mangroves, improving soil carbon sink, biodiversity protection and optimizing the spatial layout of carbon sink. On the other hand, we should strengthen the research and development of key technologies such as zero energy and zero carbon building design, green community construction, green low-carbon urban planning and design, energy-saving new materials and waste resource utilization, promote the integration of carbon reduction and foreign exchange increase technologies, and strengthen the application, demonstration and promotion in the field of construction land consolidation and rural historical and cultural protection. In addition, based on the big data survey, the carbon emission and carbon sink inventories at different spatial scales of agriculture, town and ecological space in the region where comprehensive land improvement is carried out can be obtained, the multi-dimensional carbon emission assessment model can be constructed, the carbon emission and carbon sink can be quantified with the help of formulas and parameters, and the intensity and spatial distribution characteristics of carbon emission and carbon sink can be described through scenario analysis. Build an intelligent carbon emission dynamic monitoring, assessment and early warning information management platform for comprehensive land improvement, realize the monitoring and supervision of all elements of carbon reduction and foreign exchange increase in comprehensive land improvement, and provide decision-making basis for comprehensive land improvement to help achieve the "double carbon" goal.

#### **4.4. Enhance Public Participation**

According to statistics, the carbon emissions generated by residents' consumption account for more than half of the total carbon emissions of the whole society. Coping with climate change requires the joint participation of multiple social subjects such as the government, for-profit enterprises, public welfare organizations and the public. The comprehensive land improvement in the whole region is to improve the production and living conditions and development level in and around the treated area through land spatial layout optimization, industrial introduction and ecological restoration. In addition to following the wishes of the masses, there are less requirements for "human" behavior. Different from the comprehensive land improvement in the whole region, the realization of the "double carbon" goal is inseparable from the key element of "people", which also puts forward clear requirements for people's clothing, food, housing and transportation. The inclusion of the "double carbon" goal enriches the connotation of the comprehensive land remediation in the whole region to a certain extent and widens the application scope of the concept of man land coupling in land remediation. On the one hand, we should continue to strengthen low-carbon publicity, innovate publicity forms, guide the public to pay attention to the practical benefits brought by low-carbon life, deepen the public's

awareness of low-carbon environmental protection, and promote the transformation of low-carbon awareness into practical emission reduction actions. On the other hand, we should establish a comprehensive, sustainable and market-oriented incentive mechanism with policy guidance, commercial incentives and emission reduction transactions, and build an environmental governance system dominated by the government, dominated by enterprises, and participated by social organizations and the public. In addition, in order to truly implement the "double carbon" goal of comprehensive land improvement in the whole region, in addition to the Department of natural resources, it also needs the coordination and linkage of housing and construction, agriculture and rural areas, ecological environment, water conservancy, culture and tourism, transportation and other departments.

## 5. Epilogue

Reducing carbon and increasing foreign exchange is an inevitable choice to deal with climate change. How to achieve the goal of "double carbon" has become a research hotspot in various fields. Comprehensive land improvement in the whole region can boost carbon reduction and sink increase through cultivated land protection, ecological improvement, optimization of space and industrial layout, increase green (blue) carbon sink and soil carbon sink, resource activation and reuse, etc. of course, the role of these paths and measures in helping to achieve the goal of "double carbon" needs further scientific verification.

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