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**EFFICIENCY OF LAND USE IN CHINA IN THE CONTEXT OF THE
DEVELOPMENT OF A LOW-CARBON ECONOMY**

**ЭФФЕКТИВНОСТЬ ЗЕМЛЕПОЛЬЗОВАНИЯ В КИТАЕ В КОНТЕКСТЕ
РАЗВИТИЯ НИЗКОУГЛЕРОДНОЙ ЭКОНОМИКИ**



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Аннотация. В данной работе подчеркнута важное место и значение земельных ресурсов в современном общественном развитии Китая, исследованы некоторые аспекты повышения эффективности землепользования в условиях перехода к низкоуглеродной экономике. Методология данного исследования основана на всестороннем анализе исторических данных и существующих условий землепользования. При анализе современного состояния землепользования подчеркиваются изменения в структуре землепользования и их характеристиках. Обращаясь к существующим проблемам использования земельных ресурсов, в статье указывается на проблемы, связанные с сокращением пахотных земель в расчёте на одного человека из-за роста численности населения, а также влиянием климатических условий на устойчивое использование земельных ресурсов. В контексте низкоуглеродной экономики в этом документе обсуждается взаимосвязь между земельными ресурсами и низкоуглеродной экономикой, способы повышения эффективности землепользования для поддержки низкоуглеродной экономики и подчеркивается роль рационального землепользования в содействии низкоуглеродному экономическому развитию. В заключении предлагаются конкретные меры для устойчивого развития земельных ресурсов, включая научный подход к стратегическому планированию землепользования, усиление надзора за землепользованием, разработка действенных мер по охране и рациональному использованию земельных ресурсов.

Abstract. This paper are emphasized the important position and value of land resources in the modern social development of China, examines some aspects of improving the efficiency of land use in the transition to a low-carbon economy. The methodology of this

study is based on a comprehensive analysis of historical data and existing land use conditions. In analyzing the current state of land use, changes in the land use structure and their characteristics are emphasized. In view of the existing problems of land resource utilization, this paper points out the decreases of arable land per person due to population growth, the impact of natural disasters on the sustainable use of land resources, and the shortage of arable land reserve resources. In the context of low-carbon economy, this paper discusses the relationship between land resources and low-carbon economy, how to improve land use efficiency to support low-carbon economy, and emphasizes the role of reasonable land use in promoting low-carbon economic development. Finally, measures for the sustainable development of land resources are proposed, including scientific formulation of strategic land use planning, strengthening supervision of land use, and strengthening the protection and rational use of land resources.

Ключевые слова: *земельные ресурсы, землепользование, устойчивое развитие, низко-углеродная экономика, рациональное природопользование, эффективность землепользования*

Keywords: *land resources, land use, sustainable development, low-carbon economy, environmental management, land use efficiency*

Introduction. With the increasing severity of global climate change and environmental pollution, the development of low-carbon economy has become a common global pursuit [1]. Sustainable development of any country is impossible without solving the accumulated local economic, social and environmental problems [2, 3]. For China, which is rich in resources and has a large population, how to use land resources more effectively to meet the needs of sustainable social and economic development is particularly important [4].

The behavior of comprehensive utilization of land development is actually a kind of super-large protection and utilization of land resources, mainly for the new mode of land development and utilization, land transformation and vegetation restoration research and practice, is a direct reflection of a variety of human behavior factors such as the law of changes of the times, and is also one of the ways of human beings on land protection and

land resource reuse [5, 6]. Since the beginning of the 21st century, the rational use and management of land and natural resources have undergone tremendous changes, and these changes have profoundly affected the stability and sustainability of the green ecological environment. Advances in science and technology have driven changes in the functional form of land, which have brought good news to human development, but often also brought irreversible damage to land resources [7]. A large number of rare species are on the verge of extinction, their suitable living environment has been destroyed by humans, serious chemical pollution remains in the soil, resulting in a significant reduction in vegetation cover, obvious degradation of the soil's ability to store water, and uneven distribution of urban and rural land, although these problems have been noted, but are still intensifying. In the past experience, the dynamic optimization model of cultivated land quantity realized through regional spatial optimization of economic benefits is the most effective basic operation model of the original land optimization allocation mechanism in the region, but at the same time, it is related to strategic spatial transformation, regional industrial transformation and regional national economic development, the change of land use spatial pattern will be more prominent and rapid, and the contradiction between man and land will be more acute [8]. China has long been in a period of rapid and healthy development in the new period of socialist city construction, with the steady growth of the domestic economic situation, the profound changes in the social development model and the structural form of living consumption, etc., may cause a significant and rapid increase in the demand for construction land [9].

Purpose and significance of the research. With the increasing prominence of global climate change and environmental problems, low-carbon economy has become an important development direction for countries to explore. China, as the world's largest carbon emitter, is particularly concerned about the development of a low-carbon economy and the sustainable use of land resources. In addition, land resources are the foundation of economic development, and their utilization efficiency directly affects economic growth and environmental protection. This study aims to explore the relationship between land resource use efficiency and low-carbon economic development in China, provide

policymakers with scientific decision-making basis, and promote China's development path towards a more sustainable development path.

Research methods and materials.

Research Methods. Make full use of the information network resources and various library materials of the current CNKI, Weipu, China Government Network and other relevant information construction, carefully and systematically study relevant scientific research papers and monographs at home and abroad, based on the existing academic research results of predecessors, pay attention to absorbing foreign achievements and studying the latest trends in domestic research on various latest technologies and papers on similar topics, and deepen researchers' deep understanding of their future research goals and problems. On the basis of summarizing and drawing on the existing domestic research and the characteristics of the results, the new key content of the future undergraduate research paper to continue the research and what breakthroughs may be achieved in the future are determined. Inductive summary analysis method: a large number of relevant text materials collected and queried in ordinary times, on the basis of further induction or collation of research methods, comprehensive analysis and summary.

Research materials. With the continuous development and progress of modern society, science and technology continue to improve, and the modernization process of information productive forces is gradually accelerating, which undoubtedly has good development prospects for human society. But at the same time, it has also brought new problems to human beings, and will face more difficult challenges, such as uncontrolled resource exploitation, destruction of the ecological environment, decreasing forest area year by year, and countless rare animals on the verge of extinction. In this context, this paper analyzes the efficiency of land resource use as a condition for the development of low-carbon economy in China.

Results and discussion.

China is a country with a complex terrain and diverse climate, which has a clear impact on land use. For example, in mountainous areas such as the southwest, land is more used for woodland and pasture; in rice-growing areas such as the Jianghuai Plain, land is mainly used for agricultural cultivation. Specific natural conditions, such as deserts,

grasslands and wetlands, also determine how land is used in the region [10]. Located in the Taklamakan Desert, the Gobi and most of Inner Mongolia in northwest China, due to low precipitation and dry land, it is mainly suitable for pastoralism and the cultivation of some drought-tolerant plants. In these areas, there are also a series of projects to combat desertification, such as afforestation, wind and sand barriers, etc., in order to protect and improve the land so that it will not be degraded. In the northeast, due to the cold climate, the land is mostly used to grow crops such as corn, soybeans, and rice. In winter, large areas of land are covered with snow, and some areas become popular for snow tourism and snow sports [11]. The southern coasts of China, such as the Pearl River Delta and Yangtze River Delta regions, are suitable for growing a variety of fruits and vegetables due to their fertile land and mild climate. These places are economically developed and land use is more inclined to industrial and urbanized. Then come to central China, such as the Loess Plateau, where the land has been affected by over-cultivation, and there has been a certain degree of soil erosion. But in recent decades, the government and local residents have worked together to carry out extensive afforestation work, which has succeeded in alleviating the problem. In addition, such as the Qinghai-Tibet Plateau, the high altitude and cold climate make the land mostly used for grazing. In such an environment, there are also abundant wildlife resources, which has become a hot spot for ecotourism. In general, China's land use is diverse, influenced by a combination of geography, climate and economic development. With the development of economy and the strengthening of environmental protection awareness, land use strategies are constantly optimized and adjusted [12].

With socio-economic development, the way and purpose of land use is also changing. In ancient times, the land was mainly used for agriculture. With the process of industrialization, many lands have been converted into industrial land, residential land, etc. In recent years, with the development of the economy and the advancement of urbanization, the demand for land for business, entertainment and tourism has also increased. Not only that, the emphasis on the ecological environment has gradually increased the area of green spaces and parks on the land, and the city has begun to pursue green development and sustainability. In the 21st century, with the revolution in

information technology, land use has become more diversified [13]. For example, some land is used as data centers, cloud computing bases, and 5G towers. At the same time, due to the pursuit of health and leisure by modern people, many urban and rural areas have also begun to develop ecological agriculture and rural tourism, making land not only an economic carrier, but also a space for culture and leisure. The finite nature of land resources has made people use it more and more sophisticated. In order to better meet the various needs of society, many countries and regions have begun to implement comprehensive land planning and management, striving to meet the needs of economic development while protecting the ecological environment and cultural heritage. This implies not only the physical use of land, but also the importance of the cultural, historical and social values of the land. With the process of globalization, land-use trends are also influenced by international factors. For example, changes in global supply chains have led to increased demand for land in some regions, while some traditionally industrial areas are facing land replanning challenges. For another example, the development of international tourism has greatly increased the land value of certain scenic spots. In the future, with the further development of science and technology, economy and society, the pattern and purpose of land use will continue to change. For decision-makers, how to balance various needs to ensure the rational and sustainable use of land will be an eternal topic [14].

In 2020, the global agricultural land area was 4.74 billion hectares (ha), down 3%, or 0.13 billion ha compared with 2000. Asia had the largest share of the global cropland area in 2020 (38%). In 2020, 12% of global permanent meadows and pastures belonged to China and 9% of global cropland was in China. Cropland area per capita decreased in all regions between 2000 and 2020 as population increased faster than the cropland area. In 2020 compared to 2000 the world average declined by 18% to 0.20 ha per capita, the Asia declined by 15% to 0.13 ha per capita, the China declined by 10% to 0.09 ha per capita (Table 1).

The object of our research is Wuhan City, Hubei Province. According to the survey on land use status changes in Wuhan City in 2022, the total land area of the city is 9,456,200 hectares, and the land use structure and changes are shown in Table 2.

Table 1. Cropland area per capita (ha per capita) [15]

	World	Asia	China
2000	0.24	0.15	0.10
2005	0.23	0.14	0.10
2010	0.22	0.14	0.10
2015	0.21	0.13	0.09
2020	0.20	0.13	0.09
2025*	0.19	0.12	0.09
2030*	0.18	0.12	0.08

* The authors' forecast

From the area structure of the rational land utilization degree in the province, it can also be clearly seen that the agricultural land reached 7,431,000 hectares, accounting for 78.5% of the total area occupied by the land use right. The land used for construction is about 1,004,900 hectares, accounting for 10.6% of the total area of the total land ownership rights. The total amount of unused land is 520,300 hectares, accounting for about 5.5% of the total equity area occupied by land development in Hubei Province.

Compared with the same period from ten years ago to 2011, in the calculation table of the total land area of the city at the end of the year, the total cultivated land area increased to 3200 hectares, the number of garden land decreased to only 1300 hectares, the total grassland area also decreased to only 1200 hectares, the total area of village green space and surrounding rural industrial and mining land in towns and suburbs increased to 7600 hectares, and the area of transportation and business land increased by 2900 hectares. The area of water areas and other land used for water conservancy facilities were reduced by 400 hectares of farmland respectively, and the cumulative reduction of other operational land was 9,000 hectares.

The characteristics of land use in "big cities and large rural areas" cities are also very obvious. The rapid development of the urban economy will inevitably lead to the common and rapid development of the urban economy in rural areas and between cities in this other large rural area, and the road to development is heavy and long.

Table 1. Current status of land use in Wuhan in 2022

Type	Area hectares)	Year-over-year growth (%)
Cultivated land	2752000	0.4%
Garden	320900	-0.2%
Woodland	3904100	0.2%
Grassland	360800	-0.3%
Towns and villages and industrial and mining land	605200	1.6%
Land for transportation	134300	2.6%
Land for water and water conservancy facilities	290600	-0.05%
Other lands	520300	-1.5%

There are obvious differences in the spatial distribution of the quality of guaranteed land resources. In general, occupy better quality guaranteed land resources; however, the coastal districts belong to the main urban area and urban expansion function area, the land quality is relatively poor, and the proportion of medium and low-yield land is large [16].

Problems in the use of land resources:

1. *Arable land decreases, population increases, and the contradiction between people and land is prominent.* Due to the rapid adjustment of the city's agricultural industrial structure, ecological forest reclamation and the occupation of some non-agricultural production and construction, the area of cultivated land in the country is shrinking and decreasing in recent years, although in recent years the centralized development and consolidation of agricultural land has been carried out to sort out and supplement rural cultivated land, and the implementation of more strict and specific national cultivated land protection and policies, but China the growth rate of arable land ownership, total land area and per capita actual arable land area still shows a gradual downward trend. The long-term trend of continuous reduction of the total amount of arable land and the long-term sustained and rapid growth of the total number of working people have made the contradiction between the rich land of Chinese and many more prominent.

2. *Natural disasters affect the sustainable use of land resources.* These irrational production behaviors of human production eventually lead to serious forest and soil erosion in China, and the intensification of global desertification, which may then evolve into global natural disasters such as global droughts and floods and mudslides. Natural disasters can also directly damage agricultural ecosystems, and in turn, the ability of severely damaged agricultural ecosystems to withstand the impact of major natural disasters will become weaker and weaker [17]. According to the author's survey, at present, the national land reclamation index is relatively high, reaching 31%, and the reclamation index similar to mountainous areas in the southern region of the high-yield zone is about 6% to close to 8%. In recent years, secondary geological disasters such as floods, landslides, debris flow disasters and land collapse geological disasters in western China have continued continuously, and over-reclamation of land is an important factor leading to these disasters. The sediment entering the Yangtze River in western China is as high as 140 million tons every year, accounting for 1/5 of the sand content in the upper reaches of the Yangtze River. Such a serious and large-scale mountain soil erosion has caused serious destruction of a very limited range of native soil resources in hilly areas, increasing gravel content year by year, softening and thinning soil layer year by year, and even leading to complete exposure of bedrock, which directly leads to the reduction of cultivated land quality. At the same time, the frequent occurrence of natural disasters will reduce the efficiency of ensuring sustainable land use, resulting in a decrease in the ecological carrying capacity of land.

3. *The reserve resources of cultivated land are insufficient, and it is difficult to develop and utilize.* According to the relevant statistics of the Ministry of Land and Resources, most of the rural cultivated land used is already high-quality, high-yield and low-yield facility farmland that can achieve the benefits of increasing income through drought and flood, and the degree of land replanting of these newly added areas of peasant households is obviously not enough, the overall quality is poor, and comprehensive comparison, land productivity has begun to decrease. Moreover, it is very difficult to develop unused land in western China, and the terrain in western China is dominated by mountains and hills, and the crisis of reserve resources is quite serious. Due to the advancement of

urbanization, in the future development, new construction land is an inevitable trend, so agricultural land on the outskirts of the city will also be reclaimed into urban land as a construction land reserve [18].

The relationship between the development of low-carbon economy and land resources. A low-carbon economy is an economic model in which efforts are made to reduce carbon emissions and promote economic development in production, consumption and various other activities. In order to achieve this, we need to make rational use of land resources. As urbanization accelerates, large amounts of land are used for construction and industrialization, resulting in large amounts of carbon emissions. How to rationally use land in urbanization and ensure green space and public space will affect the carbon footprint of cities. Traditional agricultural practices can lead to land degradation and large amounts of carbon emissions [19]. Sustainable, environmentally friendly agricultural practices, such as organic farming and conservation tillage, can reduce carbon emissions and increase land productivity.

How to improve land use efficiency to support a low-carbon economy? By building green buildings, overuse and waste of land can be effectively reduced, while also reducing carbon emissions. For example, a piece of land can be used for agriculture, recreation and ecological conservation at the same time, which can achieve multiple functions and improve the efficiency of land use. Land that has been degraded can be restored to its productive and ecological functions again. Scientific planning and management of land resources can ensure that land is used rationally, efficiently and sustainably.

Rationally bring into play the benefits of land use and promote the development of a low-carbon economy. Using suitable land for the production of renewable energy such as solar and wind energy can not only provide clean energy, but also reduce overexploitation of land. Measures such as afforestation and restoration of degraded forests can improve the carbon sink efficiency of the land, while also providing wood and other ecological services to society. Agroecology not only reduces the use of fertilizers and pesticides, but also increases the productivity and ecological benefits of the land.

Measures for sustainable development of land resources.

Firstly, scientifically formulate land use planning. In the National Economic and Social Development Plan, key tasks and indicators should be included in the plan and strictly implemented. Planning for cities, rural areas, transportation, water conservancy, energy, tourism, ecology and other aspects should be combined with territorial spatial planning. It must meet the requirements of cultivated land protection and concentrated land use, and be suitable for the general layout delineated by the land plan and the master plan. Strictly follow the general plan of land and space, strictly review the scale and standards of various lands, and strictly implement the land use control system [20]. Where it is inconsistent with the master plan for land use, it is necessary to make timely adjustments and changes, reduce the land area, and adjust the layout of land use.

The scientific and perfect planning scheme for the rational use of regional land should be reflected in the systematic integrity, authority, scientificity, rationality of the overall structure of regional planning, and the high degree of coordination of technical and economic market policies [21]. This shows that the fairness and authority of the land use planning documents must also be ensured by national legal means and procedures, any institution should first fully follow the principles of the national rational land utilization regional overall planning to make good use of land in accordance with the law, land use management and other departments should take the initiative to fully cooperate with the use of the planning content, so that all regions can jointly ensure that the sustainable development and utilization of China's land resources can be established on such a more scientific and reasonable unified policy platform framework in an orderly manner.

Secondly, strict supervision of land use. The principle of land use control is that the government ultimately realizes the scientific and optimal utilization, allocation arrangement and sustainable and rational development and utilization of guaranteed land resource elements. It requires strict control over the gradual conversion of original agricultural land into permanent land for non-agricultural construction projects, the protection and occupation of cultivated land resources, and the rational use of compensation fees for state-owned construction projects, and strict and supervised planning for the development of new land projects in various localities. Standardize and uniformly manage land for urban planning and construction projects, and promote the

efficiency and comprehensive coordination of land utilization indicators and resource output in the city. In line with accelerating China's urbanization development and the development of pilot projects for new rural development and construction in the county, on the basis of reasonably improving the indicators of the intensive utilization of each piece of land occupied in the city, the development period, scale and resource potential, while continuing to give play to the social functions of the land itself, so as to better ensure and guarantee the long-term sustainable intensive utilization of the development of existing land resources.

Strictly control urban and rural construction land. It is necessary to delineate urban industries and rural settlements in strict accordance with the indicators of urban and rural construction land, strictly control the residence of urban industries and rural residents, clarify management responsibilities, management rules and supervision and management methods, and comprehensively use economic, administrative and legal means to effectively curb the excessive exploitation of development and utilization.

Thirdly, strengthen the protection and rational use of land resources. While strengthening the research of scientific land use planning, paying attention to land reclamation and sorting out is also of great importance and scientific practical application significance. Land reclamation and consolidation refers to a kind of re-study, planning and zoning adjustment of the current or long-term use of land, the purpose is to gradually reduce and affect the unfavorable factors of rational land reuse in the future, and increase the exploitable area of more effective use of land. The overall direction of its development should include further improving the current environmental conditions of agricultural land development and production land to ensure the improvement of future agricultural land quality, rationally optimizing the layout of land to effectively promote the significant improvement of land efficiency indicators in the production and construction process, scale control of intensive land to significantly strengthen the space utilization index and intensive output rate of intensive industrial land area and efficient agricultural land space, and at the same time, the central government should also reserve a considerable part of its land area as an emergency reserve resource to achieve continuous and efficient land

supply. In order to effectively realize and guarantee the long-term sustainable use of land in China.

Conclusions and proposals.

With the development and change of the trend of the times, people's lifestyle, the concept of consumption culture and the changes of the global economic and social pattern continue to deepen and develop, the sustainable and effective use of land in the development of new scientific and technological concepts are also constantly being injected into the field of real social construction and development, in today's global advocacy of low-carbon emission reduction economic development strategy macro trend background, green and healthy living environment life concept more deeply rooted in the hearts of the people. Sustainable land development has become an inevitable trend of China's future social development strategy, further in-depth study of the international advanced new concept of effective land utilization, and use science and technology to guide the current effective guarantee of human land sustainable use, promote intensive utilization development, promote and guarantee long-term sustainable intensive utilization of idle land. Based on the above analysis, this paper argues that only by scientifically and effectively controlling land use behavior, implementing scientific, standardized and legal strict management of land use in a planned manner, and rationally allocating existing guaranteed land resources on the basis of protecting resources, ecology and environment can we promote the goal of sustainable regional land use and achieve sustainable economic and social development.

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