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# Research and Exploration of Ecological Highway Carbon Sequestration Forest Methodology

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**Abstract:** Based on the demand of ecological highway construction, this paper explores the research work of carbon sequestration forest. The introduction of forest carbon sinks and advanced concepts of the forestry carbon sequestration, and for the measurement of the highway in the carbon sink forest carbon sink monitoring and exploration on the aspects, such as, the forest carbon sinks and forestry carbon sink theory knowledge, used in highway transportation, implements the carbon sink forest methodology used in the field of traffic, road area change ever green landscape, the shrub tree species as the main design concept, put forward the concept of carbon sequestration in the road system and based on the neutral roadside greening design forestry carbon sequestration. On the basis of energy conservation and emission reduction, the construction of carbon sequestration forest is adopted to solve the carbon emission problem of the transportation industry from another perspective, so as to improve the quality of planting trees along the transportation lines of Jiangsu province and even the whole country, update the greening concept, enhance carbon sequestration and ecological efficiency, and open up a new path for building a green transportation environment.

## 1. The introduction

The global temperature rises due to the greenhouse gas emissions caused by the consumption of resources, and extreme and abnormal weather phenomena appear more and more frequently. Due to the close relationship between global climate change and the carbon cycle of the earth system, the carbon cycle and its process mechanism of the earth system have become the basic issues in the scientific research on the cause analysis, change trend prediction, mitigation and adaptation countermeasures of climate change, which have attracted wide attention from the scientific and technological community and the international community [1-2]. In the past 100 years, human beings have used a large amount of fossil fuels and changed land use, which significantly increased the concentration of CO<sub>2</sub> in the atmosphere, broke the original carbon balance between the biosphere and the atmosphere, and caused a series of major environmental problems such as global warming and sea level rise [3]. Ecosystem carbon sequestration is currently an economically feasible and environmentally friendly method to slow down the rise of atmospheric CO<sub>2</sub> concentration. As defined in article 3.4 of the Kyoto protocol, carbon storage in ecosystems can be increased to offset carbon emissions from economic development [4].

According to the United Nations framework convention on climate change (UNFCCC), a carbon sink is a process, activity or mechanism to remove carbon dioxide from the atmosphere; Carbon sources point to processes, activities, or mechanisms that release carbon dioxide or extreme climate carbon from



the atmosphere. Its function is to convert solar energy into effective energy for the earth, so as to maintain the survival and evolution of all life and ecosystem including human beings. Carbon sink is the basis and premise of the existence of human beings and their environment.

Globally, the transportation industry accounts for more than 20% of the world's energy consumption and greenhouse gas emissions, and it is still rising rapidly. It bears great responsibility for energy conservation and emission reduction. Countries around the world have taken developing green and low-carbon transportation as a strategic priority. The road transport system is still a large carbon source at present. The transport industry must accelerate the implementation of the green and low-carbon development strategy in line with the requirements of developing a green and low-carbon economy. In the planning and design of transportation infrastructure, efforts should be made to strengthen ecological protection, vegetation restoration and afforestation construction, and increase carbon sink capacity. In the process of highway construction and maintenance, we should vigorously promote the assessment and review of energy conservation, strengthen the organization and management of green construction, and strive to reduce energy consumption and emission levels.

Methods to reduce the amount of greenhouse gases in the atmosphere mainly include two aspects: reducing emission sources and increasing carbon sink absorption. Reducing emissions sources means investing heavily or improving energy efficiency through technological upgrading and retrofitting. But according to the current stage of China's economic development, will be subject to energy structure, capital technology. In addition, automobile industry emission reduction affects economic development, increases the cost of transportation, and restricts China's transportation and logistics economic development. However, measures of forestry projects such as afforestation and reforestation can increase CO<sub>2</sub> absorption at a much lower cost, which is about 1/30 of the former [5]. Therefore, through vigorously promoting afforestation, protecting forests, improving ecological environment, setting up forestry carbon sink projects and increasing carbon sink capacity are important measures for transportation departments to cope with climate change and make contributions to energy conservation and emission reduction. This is currently recognized by the international community as the most effective and fastest indirect way to reduce emissions.

## **2. Analysis and evaluation of the research status of carbon sequestration forest methodology at home and abroad**

At present, foreign carbon sequestration projects are developing rapidly. For example, the Chicago climate exchange has been established in the United States. France also puts forward "national plan for controlling greenhouse effect", etc. [6]. He Ying [7] mainly focused on the use of biomass method, accumulation method and other methods to calculate carbon reserves. Caldwell [8] et al. applied comprehensive evaluation method to evaluate the cost and benefit of carbon sink projects. Forests can absorb carbon dioxide, and through afforestation carbon sink projects, a large amount of money can be introduced for forestry development. For example, to offset 40 years of carbon dioxide emissions from a 400-mw coal-fired power plant in the Netherlands, the forest carbon absorption (FACE) foundation will invest \$180 million in afforestation projects around the world.

Foreign scholar Kramer [10] believes that forest ecosystem has high productivity compared with other terrestrial ecosystems, and the fixed carbon amount accounts for about 2/3 of the total terrestrial ecosystem every year. Norby [11] believes that it is an urgent task to increase the carbon sink of terrestrial ecosystem and reduce and control the emission of greenhouse gases such as carbon dioxide. Oliver [12] used the permanent sampling method to estimate that about 40% of mature tropical forests could become carbon sinks. Some scholars believe that Brazilian tropical forests sometimes become carbon sinks in the atmosphere [13]. Pacala et al. [14] estimated that the carbon sink of forest soil in the United States accounted for about 2/3 of the carbon sink of forest vegetation. V. Whitford [15] et al., from the university of Manchester, UK, studied the carbon sink and carbon respiration of urban trees and proposed the calculation method. In 2001 Hyun. Kiljo from Kangwon National University, South Korea, obtained the carbon source and carbon sink values of three cities by measuring the carbon storage and respiration amount of trees and calculating the growth rate of trees [16]. In 2002, Australian national

university scholar C.L. Brack [17] established the economic value model of urban trees and developed the auxiliary decision support system, which input the data of more than 400,000 trees in the capital city into the management system and conducted dynamic management. In 2004, the Chicago climate exchange established a branch in Europe, the European climate exchange, and established a partnership with the Indian Commodity Exchange.

The UN framework convention on climate change (UNFCCC) resolution 17/ ce.7 defines a baseline for CDM project activities as a reasonable representation of anthropogenic greenhouse gas emissions in the absence of any project activities, which should cover all greenhouse gas source emissions and sink removal within the project boundaries. According to general characteristics, baselines can be divided into specific project aseline, regional baseline and national baseline. According to the dynamic characteristics can be divided into dynamic baseline and static baseline, according to the determination means can be divided into simple baseline and complex model baseline. Generally speaking, baselines of most projects are considered comprehensively. For example, CDM afforestation and reforestation projects in Huanjiang and Cangwu regions of Guangxi of China adopt project-based, simple and fixed baselines [19].

The determination of baseline should be based on four criteria: considering environmental effectiveness, cost effectiveness [20], transparency and conservatism. The determination of baseline should first consider the most likely land use scenario without project implementation, and secondly quantify the carbon storage changes caused by such scenario. After the successful application of CDM afforestation and reforestation project, it is necessary to know how many tons (t) of CO<sub>2</sub> fixed by the project can be used for trading in the international carbon market. Therefore, there must be a way to monitor the amount of CO<sub>2</sub> fixed by the project, which is called the monitoring methodology of carbon sink. Monitoring is to achieve transparent, measurable, verifiable and verifiable removal of anthropogenic net greenhouse gas source emissions or sinks resulting from project activities, minimizing uncertainty. Both the baseline methodology and the monitoring methodology actually fall into one problem; Calculation of carbon stocks. The main methods can be summarized into three types: sample inventory method, model simulation method and remote sensing estimation method [21].

So far, China's first approved methodology is Guangxi afforestation of the methodology of a degraded land reforestation reforestation project methodology, the methodology, led by Zhang Xiaoquan researcher, Chinese academy of agricultural sciences and Austrian energy research institute Bernard Schlamadinger Dr, Guangxi autonomous region forestry bureau, Guangxi forestry survey and design institute and the world bank cooperation development, is based on the project, simple and fixed the baseline. Led by institute of forest ecology environment, Chinese academy of agricultural sciences and protection, and the state forestry administration of desertification prevention and control center, and other department cooperation development, aohan combating desertification youth forestation project "with shrubs as auxiliary degraded land afforestation reforestation methodology" is one of the world's sixth methodology approved by the CDM executive board, is China's second approved similar methodology; The CDM afforestation and reforestation carbon sink project in Sichuan is based on the Albanian methodology approved under the Kyoto protocol.

The present methodology is still insufficient and need to be improved: (1) our country the diversity of potential CDM afforestation or reforestation project, lack of specific way of land use in CO<sub>2</sub> flux relationship of understanding and the limitations of currently available data, and the way to determine the baseline as the comparability and consistency requirements increasing, at present our country lacks, the standard model data base. (2) No matter what method is used, Chinese, foreign, national or regional studies are all measurement of quantity at a certain stage, and according to the Kyoto protocol, this quantity must be dynamic, that is to say, the annual change of quantity must be calculated, and the change of quantity is what we need to trade. At present there is little methodology for this. (3) at present, there are a total of 31 methodologies approved by CDM executive council at home and abroad, but they are concentrated in the fields of energy, industrial production, urban waste and agriculture, etc., and there is almost no green afforestation in the field of transportation.

### **3. Analysis of technical key points of implementing ecological highway carbon sequestration forest**

In view of the problem of air pollution caused by the exhaust emission of highway traffic vehicles, based on the domestic and foreign studies on the treatment effect of carbon sink forest, this paper proposes that the implementation of highway carbon sink forest mainly includes the following aspects:

#### **(1) Investigation and analysis of road traffic flow**

Combined with statistical data and measured video data, the section form, traffic flow, traffic composition, vehicle type and other data of the highway in the region to be studied were investigated and analyzed, and the production of vehicles on the road as carbon sources was considered from the aspects of traffic volume, vehicle type distribution and fuel consumption. Preliminary quantitative analysis of road area carbon emissions.

#### **(2) Baseline survey and data analysis**

According to the results of road flow analysis and the guidelines of carbon sink measurement and monitoring for afforestation projects, the land qualification and carbon pool selection were carried out. Determine the number of stratified and sample sites in the project area, predict the size of carbon storage through literature research, field survey and expert opinions, and select the carbon storage through comprehensive analysis of the proportion of total carbon storage and the change with time. It is planned to determine the above-ground part, underground part and soil carbon storage as the selection of measurement carbon storage.

#### **(3) Research on measurement and monitoring methods of carbon sequestration forest**

To study the relationship between plant biomass, timber collection and carbon sequestration, investigate the carbon storage of trees on both sides of existing roads, and analyze and quantify the carbon sink function of plants within the range of road land. The methodology of carbon sink monitoring and metrology monitoring for highway green belt is studied.

#### **(4) Study on optimal allocation model of several kinds of carbon sink forest**

According to the measurement and monitoring methods of carbon sequestration forest, according to the idea of giving priority to native seedlings and the principle of maximum carbon sequestration, the tree species are optimized, and the corresponding optimal allocation model is established to determine 5 ~ 10 tree types.

The key point of highway carbon sequestration is the application of carbon sequestration methodology, namely monitoring and measurement. As the monitoring work lasts for a long time and there are many species, the monitoring and measurement of the project, as well as the stratification and boundary definition of the project are the key points of this project.

### **4. Analysis of economic and social significance of highway carbon sequestration forest construction**

In the process of afforestation of carbon sequestration in strict accordance with the China green carbon fund carbon sink project management method ", "China green carbon fund interim provisions on the carbon sink project afforestation technology, the China green carbon fund forestation project measurement and monitoring guide" carbon sink, "carbon sink afforestation technology sets" (trial), the carbon measurement and monitoring of afforestation project guide to determine the requirements of the relevant baseline, and the afforestation of woodland forest stratification, forest tree growth process implementation of carbon measurement and monitoring, ensure the forestation project carbon sinks are accurate and reliable and verifiable. By using the method of scientific planting and monitoring of soil characteristics, soil organic carbon sequestration, and the carbon sequestration capacity of different tree species for research and monitoring, in high carbon tree species selection and afforestation tending management, carbon sinks and exploration on the measuring and monitoring carbon sinks, accumulation of technical experience, form and perfect a set of highway afforestation of carbon sequestration and carbon sink metering technology and monitoring system. Will increase carbon sink as the main ecological and environmental protection, concept into highway landscaping design and construction, in the guide to assure the safety of driving and traffic principle, to ensure that the functional requirements

under the premise, change in the past is given priority to with vegetation, landscape design principles, the carbon sequestration capacity of trees as a leading indicator of tree species selection, maintenance cost is low, carbon absorption ability, green landscape beauty. In addition to driving function and aesthetic effect, the traditional concept of highway area greening design should be changed, so as to enhance carbon absorption effect in this area and open up a new path for green traffic construction. What is more important is that at present, we should not only develop the economy, but also save energy and reduce emissions; Under the dilemma of protecting cultivated land and carrying out industrial and urbanization construction, it is undoubtedly of great social significance to transform the afforestation along the highway into carbon sequestration forest, which can not only protect the environment, reduce carbon emissions and slow down the greenhouse effect, but also alleviate the contradiction between land supply and demand and free up limited land for economic construction.

By pursuing the balance between carbon emission and carbon absorption, we can find the most reasonable and effective method to reduce the harm of carbon emission to traffic environment by analyzing and calculating all aspects of road traffic. On the one hand, this achievement will provide theoretical basis for the construction of carbon sequestration forests on both sides of roads in China; on the other hand, it will provide technical support for the construction of road engineering infrastructure and environmental protection, and reduce and eliminate the damage of transportation system to the carbon circulation system of the earth.

At present, Jiangsu province is working with the ministry of transport to build a green, circular and low-carbon transport demonstration province. Saving resources, improving energy efficiency, controlling emissions and protecting the environment will be the core of transport development, and will be integrated into all aspects and the whole process of ecological civilization construction. The scale, speed and average density of road network construction in Jiangsu province are in the forefront of the country. At present, every highway that has been built and opened to traffic has implemented greening and beautification measures to varying degrees, but the main points are landscape greening and anti-dazzling, wind, dust and noise prevention, etc., ignoring the ecological protection of vegetation and the carbon sink function of trees. Research of this paper will introduce in the advanced concept of forest carbon sinks and forestry carbon sink, for the measurement of the highway in the carbon sink forest of Jiangsu province and exploration on the aspects, such as carbon sink monitoring, accumulation of technical experience, to improve the quality of traffic along the tree-planting afforestation in the province and the state, to renew the idea of green, enhancing carbon sequestration and ecological efficiency, realize the traffic low carbon and energy conservation and emissions reduction is of great significance.

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