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The Role of Wetlands in Achieving the Carbon Neutral Goal

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Abstract: Climate change is closely related to the global carbon cycle, and the carbon cycle of terrestrial ecosystems and its driving mechanism is of great significance to the study of the global carbon cycle. This paper puts forward suggestions to realize the goal of carbon neutrality from three aspects: to carry out wetland carbon accounting, to increase the area of wetlands, and to strengthen the research on wetland carbon enhancement technology.

Keywords: Wetland; Carbon Sink; Carbon Neutral

1. Introduction

Wetland is a unique ecosystem that has an irreplaceable role in the development of human history. However, until today many people have not really recognized the great value that wetlands bring to human beings. With the rapid development of the global economy, wetland areas have been substantially degraded due to the transformation of land use patterns caused by human production and life. It was not until the middle of the 20th century that people gradually realized the importance of wetlands to human production. Wetland ecosystems store much more carbon than the atmosphere[1], but there are different views on the impact of climate change on the global soil carbon pool. It is widely recognized that the reasons for the lack of consensus are mainly from two aspects. On the one hand, there are insufficient basic observations, immature in-situ observation techniques for wetland carbon exchange in different geographic regions, and insufficiently in-depth long-term positional observation studies; on the other hand, there is a lack of in-depth understanding of the dynamics of the wetland carbon cycle. Although many studies have been carried out on greenhouse gas emissions from wetlands worldwide, there is a lack of research on the observation of wetlands in Asia, especially in China.

2. Role of Wetland Ecosystems in Achieving Carbon Neutral Goals

Global climate change is a common challenge facing mankind and has evolved from a scientific issue to a global economic and political issue of widespread concern to the international community. Temperature rise, sea level rise, extreme weather, and climate events caused by climate change are becoming increasingly prominent. The international community's scientific understanding of climate change has been deepening, and the IPCC has further reinforced that more than 95% of human-induced climate change can be attributed to greenhouse gases emitted by human activities. The UN Climate Change Summit held in September 2014 pointed out that climate change is a threat to the hard-won peace, prosperity, and opportunities for all humankind, and that no one and no country is exempt from it. Containing global warming within 2°C is an urgent and serious challenge for mankind to address climate change. Awareness of climate change issues is also increasing in various countries. In 2015, the Sustainable Development Goals (SDGs) and the Paris Climate Agreement launched a global initiative, but most countries are still struggling to achieve the proposed carbon-neutral goal of achieving a sustainable, low-carbon economy with the lowest CO2 emissions[2]. Therefore, the concepts of carbon neutrality and peak CO2 emissions have become a global concern in the current decade. Peak carbon refers to the total amount of carbon emissions that have peaked in a certain timeframe since industrialization within a certain spatial scope; carbon neutral refers to the measurement of the total amount of greenhouse gas emissions by an enterprise, group, or individual within a certain period of time, and at the same time, offsetting its CO2 emissions through afforestation, energy conservation, and emission reduction to ultimately achieve zero CO2 emissions. In September 2020, the President of China proposed in the general debate at the 75th United Nations General Assembly that "China will continue to reduce its emissions of greenhouse gases, including carbon dioxide, in order to achieve zero carbon dioxide". In September 2020, the President of China proposed in the General Debate of the 75th session of the UN General Assembly that "China will increase the strength of its national autonomous contribution, adopt more vigorous policies and measures, strive to peak CO2 emissions by 2030, and make efforts to realize carbon neutrality by 2060" (i.e., the dual-carbon target). The

"dual-carbon" goal is an integral part of China's strategic layout for ecological civilization, as well as our solemn commitment to global climate governance.

The twenty-sixth Conference of the Parties, to be held in Glasgow, United Kingdom, in November 2021, urged all countries to strive to reduce carbon emissions by 2030 and to achieve "zero emissions" by 2050 or so. Consequently, addressing climate change has become a shared goal of all nations and a pressing necessity for all peoples. At present, the reduction of greenhouse gas emissions (represented by CO2) has become a global consensus. In addition, researchers in various fields around the globe are exploring related issues. The first study to examine routes to carbon neutrality was Ma et al. (2020)[3], who used dynamic emission scenarios to simulate peak emissions and assessed past CO2 emission reductions. Hepburn et al. (2019) [4]reviewed 10 pathways with limited potential to reduce CO2 emissions, showing that each of these pathways could improve CO2 utilization efficiency, thereby reducing CO2 emissions.

Ecosystem carbon capture and carbon utilization and sequestration are considered to be more feasible in achieving carbon neutrality. However, studies have pointed out that some of the carbon utilization and sequestration technologies not only do not reduce emissions but also increase carbon emissions. In addition, the technology is costly, has a long technology chain, is policy-dependent, and cannot be used on a wide scale. Ecosystem carbon sequestration is currently the most cost-effective and operational way and is also the inevitable choice to achieve the goal of carbon neutrality.

Although wetlands cover only 5-8% of the total land surface, they provide habitats for 20% of the species on Earth. Wetland ecosystems play an important role in regulating climate, purifying wastewater, preserving biodiversity, replenishing groundwater, and containing water as a powerful carbon-neutral base. Our country has a full range of wetland types, including all those defined in the Convention on Wetlands, such as riverine wetlands, swampy wetlands, peat wetlands, lake wetlands, and so on. With carbon stocks that range from 3.67 to 16.9 Pg C, wetlands are among the world's greatest carbon reservoirs. They contribute significantly to the global carbon cycle and have higher carbon stocks than the combined carbon stocks of agricultural areas, temperate forests, and tropical rainforest ecosystems. Furthermore, many wetland ecosystems have acted as carbon sinks since the last glacial melt, and wetlands have a persistent potential to sequester carbon. Thus, it is crucial from both a theoretical and practical standpoint to fully use, preserve, and enhance the carbon sink capacity of wetland ecosystems in order to achieve China's aim of carbon neutrality.

3. Recommendations for wetland ecosystems in achieving the carbon neutrality target

3.1 Carry out wetland carbon sink accounting and build a carbon sink measurement, monitoring and reporting system

Carbon accounting is a prerequisite for promoting the sustainable development of ecosystem carbon sinks. For wetlands, it is necessary to monitor and account for carbon stocks and inter-annual changes in aboveground biomass, soil and litter, improve the basic database and parameter modeling library, and prepare technical specifications for monitoring, accounting and reporting on wetland carbon sinks, and regularly update the data and accounting reports. These efforts can grasp the temporal and spatial changes of carbon sinks in wetland ecosystems in real time, and provide a scientific basis for accurately improving the carbon sink capacity of wetland ecosystems. Since wetland ecosystems are of various types, the measurement and accounting of carbon sinks are complicated and easily interfered by the external environment, it is necessary to carry out an all-round accounting of wetland ecosystems' carbon sinks, set up a dynamic monitoring system for wetland carbon sinks, speed up the exploration of the establishment of a wetland carbon sinks trading system in line with China's national conditions, and push forward the integration of wetland carbon sinks into the national carbon emission right trading system.

3.2 Increase wetland area and restore wetland ecosystem services

Wetlands have strong ecosystem service functions and carbon sink potential, as well as strong self-resilience[5]. The total area of wetlands in China ranks first in Asia and fourth in the world. However, the per capita wetland area in China is far below the world average, only 20% of the world's per capita wetland area. In particular, irrational development in recent years has caused serious degradation of 50% of the coastal wetlands and 78% of the natural marsh wetlands in the Sanjiang Plain, leading to the transformation of some wetlands from carbon

sinks to huge carbon sources. Therefore, the government needs to prohibit all behavioral activities that damage wetland ecosystems to avoid the rapid decline of their carbon sink function, promote wetland restoration, rebuild and build new wetland ecosystems, and restore and enhance their carbon sink function. Secondly, wetland resources should be incorporated into important public resources for protection, and laws and regulations related to the management of carbon resources in wetland ecosystems should be introduced. Increased carbon sinks in wetland ecosystems while protecting nature, allowing wetlands to make a greater contribution to the goal of carbon neutrality.

3.3 Strengthening research on wetland carbon sequestration techniques and improving the capacity of wetlands to sequester carbon

Carbon source and sink functions of wetland ecosystems will be analyzed quantitatively and scientifically from multiple scales and perspectives, and the size of carbon income and expenditure in different regions and their influencing factors will be judged scientifically. Based on the comprehensive analysis of carbon sources and sinks, we will actively carry out research on the integration of key technologies to increase sinks and reduce emissions, and develop a comprehensive model of eco-friendly utilization. For example, based on the relationship between net carbon balance and environmental (climate, soil, etc.) factors, the most suitable plant species for a particular location can be identified, and plants can be planted without artificial management such as fertilization and irrigation so that the suitable plants can grow in the most suitable environment. This approach increases carbon sequestration by improving species, controlling the composition and structure of plant communities, and improving the environment in which plants grow, thereby increasing their photosynthetic capacity. At the same time, the decomposition process of apoplastic material is regulated by regulating the autotrophic respiration of plants as well as the heterotrophic respiration of animals and microorganisms to control CO2 emissions.

In addition, the oceans have a huge carbon sink potential (blue carbon), providing ample opportunities for the implementation of various abatement technologies. For example, organic carbon stocks in coastal areas, mangrove wetlands, and salt marsh wetlands are 1.3 million tons per year. Exploring the carbon sink regulation mechanism of these wetlands will be conducive to accelerating the formation of a blue carbon sink assessment system and responsive carbon sequestration and sink enhancement technologies for such wetlands, and to promoting the development of a management plan for maximizing the ecosystem service function of wetlands. Therefore, it is necessary to increase the investment of scientific researchers and research funds to improve our understanding of the mechanism of blue carbon enhancement in wetlands as well as our ability to predict the intensity of carbon sinks in the future.

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