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The Impact of Global Warming on China's Forest Resources in the 21st Century

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Abstract: Since the 21st century, the greenhouse effect caused by human activities and the resulting global climate change and ecological environment have attracted more and more attention. Among them, forest resources, as an important component of the global ecosystem, are the focus of people's attention. The author discusses various impacts of climate change on forest ecosystems in the 21st century, such as the frequency and extent of forest fires, forest biodiversity, forest distribution area, etc. Forest resources bring challenges and risks that may exist in the future, such as the destruction of several forest phenology, the reduction of future growth rates of forest productivity, and the frequent occurrence of forest disasters. Finally, in response to the various risks and challenges mentioned above, through preventive measures such as adjusting the length of the rotation period, improving forest disaster monitoring technology, and compensatory measures such as afforestation, it is expected that the future climate and forest ecosystem will be affected. develop better strategies.

Keywords: forest ecosystem, forest disaster, global warming

1. Introduction

Forest ecosystem is one of the most important types of ecosystems among the many ecosystems on the earth, and it is also the one with the most complex structure on land and the greatest impact on other ecosystems. It has high biological productivity and biomass and rich biodiversity. Although the forest area only accounts for 26% of the land area, its carbon storage accounts for more than 80% of the carbon storage of the entire terrestrial vegetation, and the annual carbon fixation of forests accounts for about 2/3 of the terrestrial biological carbon fixation[1]. Forest ecosystems not only provide humans with many by-products such as wood, starch and protein. Moreover, it has ecological functions such as water conservation, mitigation of natural disasters, climate regulation, breeding and preservation of biodiversity. Therefore, forests play an irreplaceable role in maintaining the balance of the earth's life system. Since the 18th National Congress of the Communist Party of China, the forest and grass construction in our country's has delivered excellent ecological performance. On September 19, 2022, at the press conference on “Development and Achievements of Natural Resources in the New Era” held by the Publicity Department of the Central Committee of the Communist Party of China, Li Chunliang, deputy director of the National Forestry and Grassland

Administration, introduced that China's forest coverage rate has reached 24.02%, contributing to the world a quarter of newly added forest area within ten years. From the overall situation, the forest area is 3.460 billion mu, ranking the fifth in the world, and the forest volume is 19.493 billion cubic meters, ranking the sixth in the world, the conservation area of artificial forest is 1.314 billion mu, ranking the first in the world; the grassland area is 3.968 billion mu, ranking the second in the world; wetland area of about 850 million mu, ranking the fourth in the world; China is also one of the 12 countries with the richest biodiversity in the world, covering almost all types of ecosystems in the world. The number of plant species and vertebrate species account for 10% and 13.7% of the world's respectively, all ranking the top in the world.

According to the sixth assessment report of IPCC (Intergovernmental Panel on Climate Change), the report pointed out that the current global average surface temperature is about 1°C higher than that before industrialization. From the projected average temperature change over the next 20 years, global warming is expected to reach or exceed 1.5°C[2]. Under the background of global warming, China's climate has also undergone significant changes, mainly manifested in: From 1951 to 2021, the annual average temperature warming rate of China's surface is 0.26°C/10 years (higher than the global average temperature rise in the same period: 0.15 ℃/10 years); extreme weather and climate events such as high temperature and heavy precipitation in China are becoming more and more intense; from 1981 to 2021, the sea level rise rate of China's coastal areas is 3.4 mm/year (higher than the global average level for the same period)[3-4]. The "Blue Book" shows that the global warming trend is still continuing, and in 2021, China's average surface temperature, coastal sea level, and thickness of permafrost active layers and other climate change indicators will break the observation record. The general trend of China's climate change scenarios forecast by different global climate models is consistent: China will continue to warm, precipitation will also increase, and China's extreme climate events such as extreme high temperature events will show an increasing trend.

Because of the close relationship between forest and climate, climate change will inevitably have some impact on forest. First, the distribution of forests in China may change significantly in the future. For example, Zhang Xinshi[5], former director of the Institute of Botany, Chinese Academy of Sciences, predicted that the boundaries of major vegetation belts in China would generally shift northward by 2.5° to 4.5 ° in the last century. In 2018, a large number of monitoring data showed that global warming has caused the forests in the eastern and central Qilian Mountains to climb upwards, which also confirmed the prediction of Academician Zhang Xinshi. As the global climate changes, China's plant phenology has also undergone significant changes. The increase in winter and early spring temperature makes spring come earlier, causing them to bloom and release leaves earlier, resulting in changes in the structure and species composition of forest ecosystems. In addition, global warming has led to warmer temperatures in winter and earlier spring, providing a better living temperature environment for pests and diseases, which has also led to the gradual expansion of forest pests in China, and the area of forest damage remains high. According to data from the National Bureau of Statistics, as of by

2019, the area of forest pests in China will reach 8.1146 million hectares, more than five times that of 10 years ago. Therefore, analyzing the impact of global warming on China's forest resources from multiple perspectives and exploring the response of forest ecosystems to climate change not only is of scientific significance, but also provide a scientific basis for formulating measures to mitigate and adapt to climate change.

2. Methods

This section contains technical and detailed information of procedure or working method that is prepared systematically.

2.1 Data

In countries where the data analysis industry is mature, 90% of market decisions and business decisions are determined through data analysis research. Using data to speak and attaching importance to quantitative analysis has gradually become an important consideration in scientific research, business management, government decision-making and other processes. First, data analysis can completely and correctly reflect the objective status quo of China's forest resources; second, after analyzing the status quo, the reasons for the status quo can be analyzed, summarized and concluded; finally, after the above analysis, it is necessary to predict the future development trend and provide scientific basis for formulating effective control measures. In addition, in order to better reflect the role of data analysis, the data used for analysis must be authoritative and up-to-date. Therefore, the sources of data collected in this paper are from the National Bureau of Statistic and the IPCC.

2.2 Chart method

The description method of column chart is more clear and specific than any simple text description. Explain complex things clearly, make up for the lack of expressing in words alone, and explain some things more directly and concretely. It is both intuitive and clear and it is not easy to miss information.

2.3 Contrast method

Data in isolation is meaningless, and there are differences that make a difference. Some variables that directly describe things, such as frequency, number, height, width, etc. By comparing the ratio data, growth rate, efficiency, benefit and other indicators, this is one of the functions of data analysis.

3. Results and Discussion

This section present result, either in text, tables, or figures. Each of figures and tables are number sequentially and must be referred.(Fig. 1)

Because of their slow adaptability to climate change, forests may be the most vulnerable ecosystems to the adverse effects of climate change. The impact of climate change on forests is multifaceted, including tree species phenology, forest productivity, and forest disasters in forest ecosystems.

3.1 The impact of global warming on Chinese forest ecological tree species and phenology

Phenology refers to the rhythm of plant development formed by plants in order to adapt to the rhythmic changes of climatic conditions, and is a comprehensive biological indicator of the impact of climate change on plant developmental stages. The flowering phenology of trees is affected by factors such as temperature, sunshine and precipitation. Temperature had the strongest influence on the flowering period of trees, followed by sunshine and the weakest precipitation. The temperature rises and the sunshine hours

increases, and the first flowering period is advanced, while the precipitation increases, the first flowering period is delayed. The effect of temperature on the beginning of flowering is mainly concentrated in spring and late winter. The increase in temperature in winter and early spring makes spring come earlier, affecting the phenology of plants, making them bloom and release leaves earlier. This would have adverse effects on under-story plants that complete their life history in early spring and could even make them unable to complete their life cycle and perish, thus causing changes in the structure and species composition of forest ecosystems. The increase in temperature will also lead to the increase of ground evapotranspiration, the reduction of soil water content, and the serious loss of water in the growing season of plants, which will inhibit the growth of plants, and even lead to the decline of leaves and dead ends. Zheng Jingyun[11], director of the China Climate Professional Committee, and others analyzed the phenological changes of woody plants in China in the past 40 years and their response to climate change, as well as the response relationship of changes in the geographical distribution of phenological periods to climate change under the current climate warming background. The results showed that the increase in temperature would lead to the advance of the spring phenology of woody plants in China. After the 1980s, the phenological period in Northeast China, North China and the lower reaches of the Yangtze River was advanced, and the phenological period in the eastern Southwest and the middle reaches of the Yangtze River was delayed, and the phenological period changed with latitude decreased.

3.2 The impact of global warming on forest productivity in China

Forest productivity is one of the important indicators to measure tree growth status and ecosystem function, and climate warming will adversely affect forest productivity. The indices for evaluating forest productivity include Net Primary Productivity (NPP), Net Ecosystem Productivity (NEP), Net Biome Productivity (NBP)[6-9], etc. Based on the Lund-Potsdam-Jena (LPJ) model, Zhao Dongsheng[10] et al. simulated the NPP of natural vegetation in China from 1991 to 2080 under the B2 climate scenario. The results show that the total amount of natural vegetation NPP from 1991 to 2080 showed a fluctuating downward trend, and the spatial pattern will be obvious change.(Fig. 1)

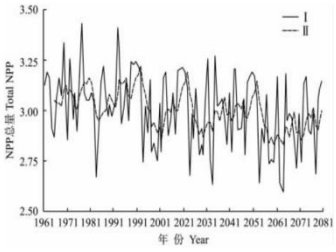

Figure. 1 Interannual variations of total NPP in Chinese natural vegetation during 1961-2080.

3.3 The impact of global warming on forest disasters in China

In recent years, the number of forest diseases and insect pests has gradually become an upward trend, which is inseparably related to climate change. Before the climate warmed in the last century, the temperature in Northeast China in winter could reach minus 40 degrees Celsius. Because the temperature is relatively cold, the chances of pests and diseases surviving in winter are small. Since the beginning of this century, with the warming of temperature, it has provided opportunities for pests and

diseases to survive, and to a certain extent, the area of forest pests and rodents has been expanded. Global warming is not only manifested in winter, but the weather from winter to late autumn also has great changes for the other three seasons. For example, When the real spring comes, because of the warmer temperature, the pests and diseases become active before the spring planting. The resuscitated pests absorb the nutrients irrigated into the soil, and the spread and speed of pests and diseases are also expanding. After the trees are infected by the diseases, their ability to resist the diseases and insect pests will decrease, and the forest resources and the ecological environment will be affected and destroyed. Therefore, the occurrence of pests and diseases has a great negative impact on the sustainable development of national forest resources.(Fig. 2)

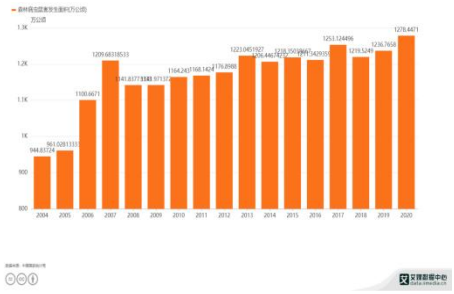

Figure 2: 2004-2020 National Forest Diseases, Pests and Rodents Occurred Area

4. Conclusions

Forest ecosystems have strong adaptability to climate change and can maintain stability within a certain range of changes, but they lag behind climate change. To sum up, the impact of global climate change on China's forest ecosystem is multifaceted. Under the background of global warming, the tree species phenology, productivity and function of forest ecosystems have been greatly affected, and the occurrence of forest disasters will affect human survival and social and economic development. Since there are still many uncertainties in the current research on the impact of global warming on forest ecosystems, and the impact of climate warming on forest ecosystems is complex, it is necessary to have a comprehensive and full understanding of the interaction between forest and climate, other environmental factors and forest, and to strengthen the study of forest ecosystem response to climate change. Therefore, this requires us to carry out some long-term observations to clarify the impact mechanism of climate warming on forest ecosystems, and to strengthen the multi-level scientific management of the forest ecosystem by adjusting the length of rotation period, improving forest disaster monitoring technology, and afforestation and other compensatory measures, so as to improve their ability to cope with climate warming.

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