

The Assessment of the Forestry Carbon Sinks and the Effect on the Global Climate Change

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Abstract: The issue on the climate change is not only an ecosystem problem, but also closely associated with the economy and the political. The carbon stocks in forests are making a significant contribution to alleviating the green house effect. Generally speaking, the forestry effects on absorbing carbon can be classified into three categories: Absorbing carbon directly by the forests; Absorbing carbon indirectly by timbers and other wood products; The mitigation caused by wood substitution. Therefore, we should increase the carbon stocks in both aspects: the interior and the extensive. The activities are as follows: forestation, enhancing the forests management, and also, by substituting the fuel-based energy with the biomass-based energy. In this way, it's assumed that the forestry will make a great function in mitigating the green house effect.

Keywords: Assessment, Carbon sinks, Climate change, Kyoto Protocol

1. Introduction

1.1 The fact on the climate change

Since the year of 1900, the climate in both China and the world has been witnessing a significant change: the weather is becoming warmer and warmer, which made a great influence on the eco-system and the economy in China. What is more, the influence will continue. Nowadays, the issue of the climate change is being concerned by both government and the academy.

According to the study by IPCC, since 1861, the trend of the climate change is Obvious: It's becoming warmer and warmer. On average, the temperature of the earth surface increased by 0.6 °C. In the 21 centuries, the mean incensement of the global temperature is estimated to be 1.4 °C to 5.8 °C. The climate change is due to the emission of the GHG, which exceed the orientation ability of the eco-system. This will make more species in the danger of extinction. Meanwhile, a series of results will occurs. Even the emission of the GHG would be reduced to a certain extend, however, the negative influence of the climate change will last for a period of time.

1.2 The climate change and the forestry

(1) The climate change and the human activity

The green house effect results in the climate change, and the green house effect can be classified into two categories: the normal green house effect and the strengthen green house effect. The former one makes the earth become a star which is suitable for mankind to live, the later one, which is called the strengthen green house effect, has made the earth warmer and warmer. In other words, the carbon emission, which dues to the human activities, is making the more significant contribution to the climate change.

(2) The climate change and the carbon dioxide

In addition to other green house gas, the carbon dioxide makes the most important contribution to the green house effect. Based on several studies, the percentage is over 63%. However, plants serve to remove some of the carbon dioxide from the atmosphere by absorbing it through their leaves. Nowadays, the carbon dioxide that absorbed by plants accounts for half of the total carbon emission. The effect of the carbon sink will lower the speed of the climate change.

(3) Kyoto Protocol

From the UNFCCC (the United Nations Framework Convention on Climate Change) in 1992 till the Kyoto Protocol in 1997, and to the year of 2005, the Kyoto Protocol took effect finally. For the sake of decreasing carbon dioxide emissions and confirming the contribution of the forestry on mitigating the climate change, the international society has made hard efforts and investigates.

(4) The effect of the forestry carbon reserves on climate change

It's estimated that, the total carbon storage is about $75 \times 10^{15} \text{T}$, which stocked in the atmosphere, the sea, the rock and the land biosphere respectively. Meanwhile, the movement and the circulation of C, both in and out of the carbon pools is active, which meets all the demands on the nutrition and energy for all lives on earth. (See Fig. 1)

Based on the reports by IPCC, the total carbon storage in the land biosphere is amount to $2.47 \times 10^{10} \text{TC}$, 20% of which are stocked in plants, about $4.66 \times 10^{11} \text{TC}$, 20% of which are stocked in soil, about $2.01 \times 10^{12} \text{TC}$. About 27.6% of the land is covered by forests, the carbon reserves in forests is about 77% of the carbon reserves in all plants, and the carbon stocks in the form of forestry soil is about 39% of the carbon stocks in soil. The carbon reserves in the forestry eco-system accounts for about 46.6% of the total carbon stocks in the land eco-system. Forestry is the largest eco-system in the land, also, the largest carbon sink in the land eco-system. It takes a great part in absorbing the carbon dioxide and mitigating the green house effect.

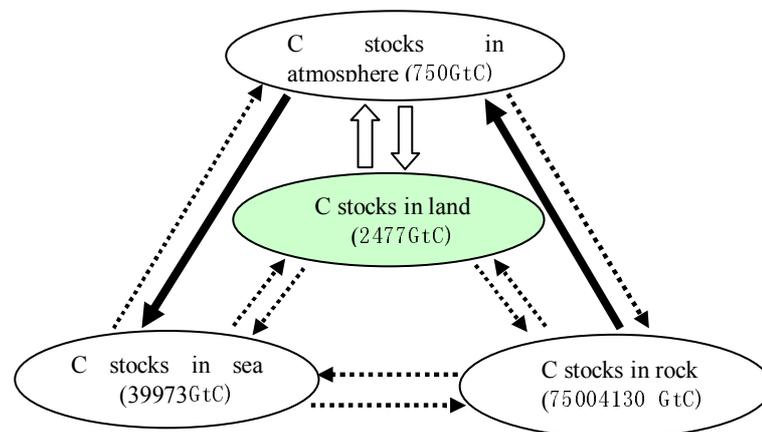


Fig. 1 The C circulation in C stocks

2. Methodology

In general, the contribution of the forests to mitigate the climate change involves two aspects: forestry carbon sink and the wood using. However, at most of the situations, the carbon mitigation caused by wood using is neglected, as the matter of fact, the effect of forests on climate change was under-estimated.

2.1 The assessment on the carbon sinks mechanism

The forestry effects on absorbing carbon can be classified into two categories: Absorbing carbon directly by forests; Absorbing carbon indirectly by timbers and other wood products. (See Fig.2)

(1) Absorbing carbon directly by forests

This form deals with the carbon absorption and the carbon stocks by the woods, the plants under the forests and the forest soil, which makes the most important part of the forestry carbon sink.

(2) Absorbing carbon indirectly by forests

After exploitation, the timber and other forest products can maintain the carbon, which is stored in the woods. In this way, the effect on absorbing carbon will last, in addition to the carbon stocks that caused

directly by forests.

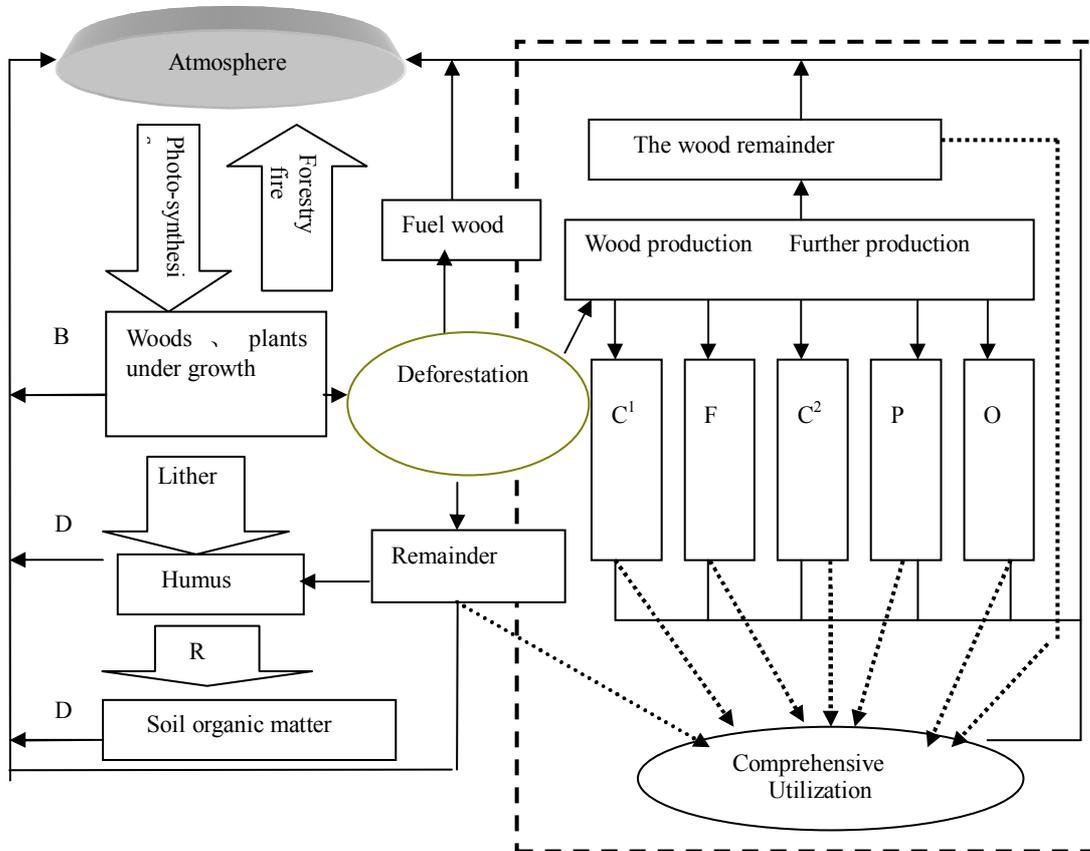


Fig.2 The mechanism on the forests carbon sink

2.2 The wood using and the carbon mitigation

(1) Assessment on the mitigation effect which caused by energy substitution

Compared with the fossil fuel-based energy, the energy in the form of forests biomass is renewable; therefore, the advantages are as follows: (1) Supposed that the energy in the form of biomass can be continuable, the carbon dioxide, which generated in the process of the energy consumption will be fully absorbed during the next period. Thus, taking the processes as a whole, the carbon emissions caused by the biomass energy is little. (2) By substituting the use of fuel-based energy with biomass-based energy, the carbon mitigation effect will be accumulated for the long run.

Notes:

① B is for the breath process of the trees. ② D covers the decomposition process. ③ C¹ Deals with the construction woods. ④ C² is the composite board. ⑤ F tracks the Furniture. ⑥ P is about the paper and board carton. ⑦ O means other wood products.

(2) Assessment on the mitigation effect which caused by raw materials substitution

The energy-intensive products, such as steels, plastic, cement and aluminum material, will release a mass of carbon dioxide and other green house gas. To some extend, these raw materials could be substituted with woods. Thus, the carbon emission will be reduced accordingly. Based on several studies, it's estimated that the energy consumption in producing different materials is quite different. The energy for making plastic is 35-45 times of the woods, and the energy for producing aluminum is 100-130 times

of the woods. We can draw a conclusion that the mitigation caused by raw materials substitution is quite obviously.

3. Results

3.1 The pressure on carbon mitigation in China

(1) The pressure from the development of the economics

With the reform and the opening up policy, the growth of the GDP (Gross Domestic Price) reached a high level of 7 % (even more than 10%). The development of the economy in China is extroverted, in other words, the development is at the cost of the mass energy consumption. Adhere to the society development and the policy of human rights, developing the economy and enhancing the welfare, both are first and prime in china. In the future, the economy in China will keep increasing, and the economic scales will attain a higher level. Therefore, the demand for energy and the carbon emission will extend to a large degree.

(2) The pressure from the carbon emission

Based on “the Assessment on the energy demand in China” and the EIA reports, it’s assumed that the carbon emission will amount to 17-18*10⁹ TC by the year of 2020, which is about 18% or 19% of the carbon emission

Tab. 1 The national carbon stocks in forests

Statistics	Periods.	Forest coverage (%)	Forest Areas (*10 ⁸ ha)	The forests Volume (*10 ⁸ m ³)	C stocks in biomass (TC)	The total C stocks in forests (TC)
1	1973-1976	12.70	1.22	86.56	4.11*10 ⁹	10.03*10 ⁹
2	1977-1981	12.00	1.15	90.28	4.29*10 ⁹	10.46*10 ⁹
3	1984-1988	12.98	1.25	91.41	4.34*10 ⁹	10.59*10 ⁹
4	1989-1993	13.92	1.34	101.37	4.82*10 ⁹	11.74*10 ⁹
5	1994-1998	16.55	1.59	112.67	5.35*10 ⁹	13.06*10 ⁹
6	1999 -2003	18.21	1.75	124.56	5.92*10 ⁹	14.43*10 ⁹

in the world. As the second largest emission source, China is getting more and more attention. According to the development of the economy, and the growth of the energy consumption, the carbon emissions in China will be about 50% of the world annually.

(3) the pressure from the energy consumption

China is one of the few countries, which the means of the energy consumption is simple. To the total energy consumption, the percentage of the coal is over 70%. Compared with other energy, the carbon emission caused by coal is the most. Thus, the pressure due to the energy consumption structure is obvious.

(4) the pressure from the international politics and diplomacy

According to the IPCC, it’s the target to keeping the climate system from human activities. In order to meet the GHG mitigation, one of the tasks is to imply the carbon mitigation measures in China. In the late 20 years, by enhancing the utilization and the energy saving, the growth of the energy consumption is lower to that of the carbon emission. However, with the last increasing of the GHG, the developed countries, including America and EU, is taking China as the source of the green house gas. This added to the pressure in the international climate negotiation.

3.2 Analyses on the forests carbon sink capacity in China

(1) The total amount of the forests carbon stocks

In this study, two methods are being used as below:

$$C_{ij} = V_{ij} \times \delta \times \rho \times \gamma$$

(2) Estimate the carbon stocks only in the form of biomass

Notes:

① C_{ij} covers the carbon density of certain forests category. ② V_{ij} Deals with the wood volume for certain forests category. ③ δ is the parameter about biomass. ④ ρ is the parameter about cubage. ⑤ r is the rate of C sequestration.

(b) Estimate the carbon stocks only in the form of biomass, the plants undergrowth and the wood lands. The total carbon stocks = the carbon stocks in the form of biomass + the carbon stocks in the form of plants undergrowth + the carbon stocks in the form of wood lands. As mentioned in the table above, it's showed that, nowadays, the carbon stocks in forests biomass is about 5.92×10^9 TC, which is equal to 2.07×10^{10} TC, in the form of carbon dioxide. Well, taking the carbon stocks in the form of plants and the wood lands into account, the total carbon stocks would seem to be much higher, about 14.43×10^9 TC, which is 5.05×10^{10} TC in the form of carbon dioxide.

(2) The increment of the forests carbon stocks

According to the statistics Information on forests Resources (1999-2003), the annual resources consumption is about 3.65×10^8 TC. With the wood volume increasing, about 5×10^8 m³ per year, the net increment of the forests is amount to 1.78×10^8 m³. Based on this assumption, it's expected that the net increment of the forests will be 0.85×10^8 TC. However, if the wood utilization rate reaches a level of 80%, the stocks capacity in the form of forests and wood will go up to 1.2×10^8 TC, in other words, 4.5×10^8 T of the carbon dioxide.

4. Conclusion

With the new development concept, the issue on carbon mitigation, which is included in the Tokyo Protocol, is not only a challenge but also a good opportunity. We should take the great change to promote the forestry development in China.

4.1 Setting up the production forestry concept

The results of the analysis show that the optimum carbon absorption happened to be the stage, which the logs grow exuberantly. Based on the concept of the forests carbon sink, it's necessary to justify many unilateral forestry ideas which are still accepted widely. From this point of view, the productive forestry is not opposite to the ecology protection. What's more, the wood products and the eco-products can both increase at the same time.

4.2 Enhancing the forests management

The unit wood volume is low, which is the fact in China. While by enhancing the unit volume and the forests growth, the forests carbon sink is indicated to be increased.

4.3 Forestation

The forests coverage and the forests productivity are low. On one hand, it indicated the deficiency; on the other hand, it means a great chance to enhance the forests carbon sink. Forestation, protecting the forests and enhancing the forests management, are all the practical means.

4.4 Enhancing the wood utilization

Plenty of timbers are consumed, but most of them are raw productions, which leads to an obvious effect on C conservation. Therefore, in order to reduce the C emissions, the government should promote the

science research of timber, raise the utilization and circulating utilization rate, and prolong the life-span of the wood products.

4.5 Developing the biomass energy

It's a good option to substitute the use of fuel-based energy with the biomass energy. The mitigation effect is so significant that more attention should be paid to.

4.6 Establishing the reasonable compensate mechanism for forests

Forestry makes a considerable contribution to the national ecology and the ecology security. In view that the eco-service should be remunerative, it's necessary to set up the ecology compensate mechanism, which closely associated with the carbon trade. At the mean time, the forestry development will be continuable.

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