

Analysis of Forest Management Planning--Based on carbon sequestration model

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Abstract. This paper develops a carbon sequestration model to calculate forests' maximum carbon sequestration stock. The purpose is only to consider the ecological benefits and explore whether deforestation is needed based on maximizing the ecological benefits. In the model, we insert the forest growth model, consider the carbon sequestration of forest and forest products, and use the traversal algorithm to calculate the cutting cycle under the maximum ecological benefit. The result is that the best ecological benefits will be obtained if the tree is cut down in about 25 years. It proves that deforestation is also needed in forest management planning regardless of economic factors and only considering ecological benefits.

Keywords: Carbon sequestration; Logistic tree growth model; Forest management planning.

1. Introduction

Global climate change caused by the continuous rise of greenhouse gases such as CO₂ in the atmosphere is a global issue of universal concern in the international community. It will affect the human living environment and affect world economic development and social progress.

In order to mitigate the impact of climate change, reducing greenhouse gas emissions is far from enough. It requires another way to isolate carbon dioxide reserves outside the atmosphere: carbon sequestration.

2. Model: Carbon Sequestration Model

2.1 Forest Carbon Sequestration Accounting Model

According to IPCC 2016, we get the forest carbon sequestration formula as follows:

$$C = A \times V \times BEF_s \times D \times (1 + R) \times CF \quad (1)$$

Where

C represents regional forest carbon sequestration. A represents regional forest area. V represents regional storage volume. It is a function of time 't' for a single tree. BEF_s represents biomass expansion coefficient. D represents basic wood density. R represents the root shoot ratio. CF represents the carbon content of dry matter.

For the forest with certain tree species, the forest is defined as arbor forest, bamboo forest, and shrub forest. We can assume that the main body of the forest is composed of arbor forests. For the forest with certain tree species, the forest is defined as arbor forest, bamboo forest, and shrub forest. We can assume that the main body of the forest is composed of arbor forests. Then, there can be a certain value to calculate for most parameters. Only 'V' is used as a function of growth years, which greatly influences the calculation of carbon sequestration. At the same time, a physical quantity, forest carbon density, is introduced 'ρ'. The amount of carbon sequestration can be expressed as the product of forest carbon density and forest area. Therefore, we get the following formula:

$$C = \rho \times A \quad (2)$$

Remarks: $\rho = V \times BEF_s \times D \times (1 + R) \times CF$.

Therefore, for the carbon sequestration model developed above, it is necessary to model and analyze the function 'p' to obtain the maximum carbon sequestration stock. Considering that 'p' is a function of the number of growth years, and considering the problem of forest cutting time, the problem is transformed into the problem of finding the optimal tree growth years or determining the cutting time.

2.2 Logistic Tree Growth Model

The maximum carbon sequestration decision is to consider the benefits of forest products and the selection of the age of felled trees to achieve the maximum carbon sequestration stock. In short, the primary purpose of this model is to calculate the cutting time of trees under the condition of maximum carbon storage.

The tree growth model adopts the representative 'Logistic model' in biology. Select parameters based on assumptions and the formula as follows:

$$\rho = \frac{y_{max}}{1 + c'e^{-r(t-10)}} \quad (3)$$

Where

y_{max} represents the maximum value of tree growth. c' represents the initial value. r represents the potential maximum growth rate

We can get the tree growth model, as shown in Figure 1. We can get the tree growth model, as shown in Figure 1. It can be seen that the growth process of trees is to grow rapidly, then slow down, and finally stop growing.

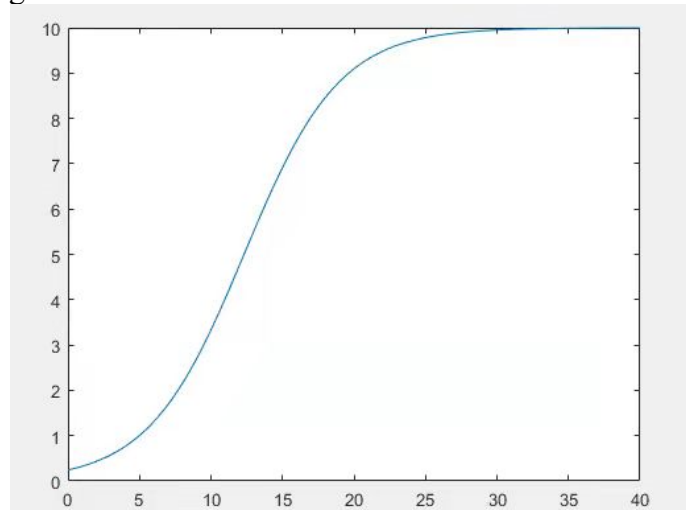


Figure 1. The logistic tree growth model

2.3 Maximum Carbon Sequestration Model

In the maximum carbon sequestration model, the problem of forest harvesting is considered to determine whether to cut down the forest or not under the condition of maximum carbon sequestration. If it is cutting down the forest, the maximum benefit of carbon sequestration can be obtained under what age of trees.

Considering the carbon sequestration stock of forest products, we assume that there are two main categories of forest products: paper and wood products. According to the National Bureau of statistics, paper products account for 52.6% of forest products, and wood products account for 47.4%. According to the national data, we assume that the service life of paper products is 3 years and that

of wood products is 30 years. We can get the proportion array $K[x]$ of forest products and the life Array $D[x]$ of forest products.

According to the age of the forest, every ten years is a tree growth period, which can be divided into young forest, medium-aged forest, near mature forest, mature forest, and over-mature forest. Thus, we can determine the relevant parameter values in equation (3). According to model 4.2, we define a new forest carbon density function density (t) and select the parameters through the relevant calculation to obtain the following formula:

$$\text{density}(t) = \frac{10}{1+2e^{-0.3(t-10)}} \quad (4)$$

At the same time, we define the annual cutting area as:

$$Y = \frac{A}{T} \quad (5)$$

From this, we can get the calculation formula of carbon sink of living standing wood as follows:

$$F = \sum_1^{T-1} Y \times \text{density}(t) \quad (6)$$

Meanwhile, the total carbon sequestration of forest products is as follows:

$$W = \sum_1^2 Y \times \text{density}(t) \times K[x] \times D[x] \quad (7)$$

Thus, the total amount of carbon sequestration is:

$$C=F+W \quad (8)$$

Where

Y presents the annual cutting area. t presents the age of a tree. T presents the cutting age of trees. F presents carbon sink of living standing wood. W presents total carbon sequestration of forest products.

It assumed that the forest area is 1000 hectares, using the traversal algorithm, we can get the carbon sequestration curve of the forest, as shown in Figure 2. In Figure 2, the abscissa is the age of harvested trees, and the ordinate is the amount of carbon sequestration. We can get that the curve is the trend of the first decline, then rise and then tend to decline, and the maximum value is obtained when the tree age is 26 years. The initial downward trend of the curve is that there will be a downward trend in the early curve because the direct conversion of trees into tree products will last longer. Through the analysis of the whole curve, we can get that compared with no deforestation at all, deforestation will get a better carbon sequestration benefit, and the best deforestation age is the 26th year.

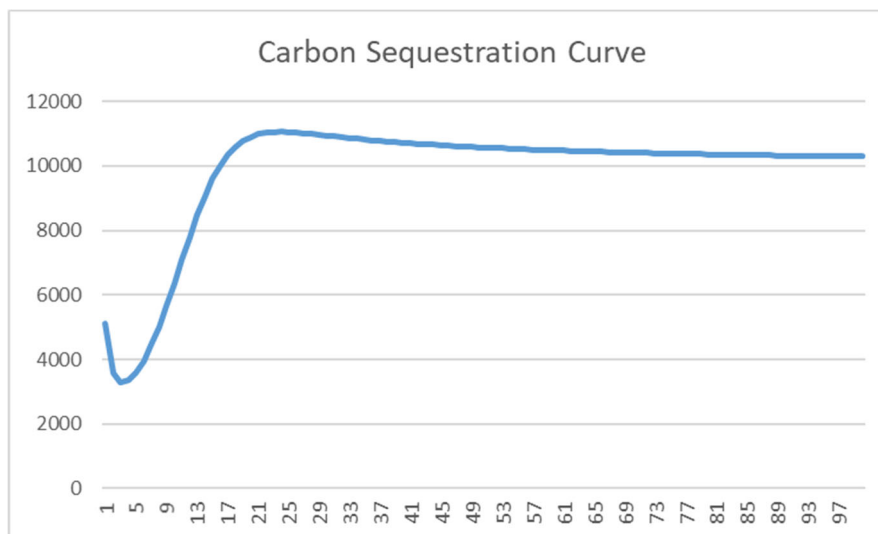


Figure 2. Carbon sequestration curve

3. Conclusion

Overall, optimal forest management planning requires deforestation. For the forest carbon sequestration and forest growth model, the service life of forest products primarily affects the cutting cycle of trees. If the life span of forest products is short enough, forests that may not be cut down will harvest the largest carbon sequestration stock. For the forest management planning model that comprehensively considers economic and ecological benefits, it is largely the process of obtaining the optimal solution of the linear regression equation. It can also consider more factors, such as temperature, terrain, etc, which obtains the optimal solution of the cutting cycle.

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