Problem Chosen	2022 MCM/ICM Summary Sheet	Team Control Number
E		2207670

Be the best forest manager

Summary

Climate change led to rising temperatures, extreme weather events, rising seas and many other impacts. Forests are essential to reducing the amount of greenhouse gases in the atmosphere. Therefore, it is desirable to develop a model to help forest managers make the best decisions and at the same time, mitigate the impact of greenhouse gases on the earth's environment.

To this end, we made the following main contributions:

First, we propose a Carbon Sequestration Model to simulate how much carbon dioxide forests and their products can sequester over time. CS Model mainly includes OCS Model and H-P Model. To be specific, taking into account the dominant species in different forests and the distribution of trees in different age groups, this model can get different suitable calculation schemes according to the composition characteristics of different forests. At the same time, it also considered the impact of harvest cycle T and felled area S_{cut} on the carbon storage of the target forest.

Secondly, in order to make forest managers better manage and make decisions on the forest, we establish a decision model. Specifically, based on the Analytic Hierarchy Process (AHP), we generally consider the impact of five factors on forest management, mainly as follows: Carbon sequestration, Product value/economy, Culture and entertainment, Conservation of biodiversity, Potential carbon sequestration. Forest managers can determine the different weights of the five factors according to different local conditions. Through the weights, combining the different conditions of the forest, we can get a management plan specific to each place, and can be applied globally.

Then, we applied the model to the specific forest, and finished carbon sequestration prediction and generalized model. For the Forests of The Lesser Khingan Mountains, when the period is unchanged, we use MATLAB to fit the model function and concluded that the optimal carbon sequestration rate can be achieved when the number of trees felled is 14%, that is, the best forest carbon sequestration scheme. The amount of carbon sequestration could add 3.7% to the total amount of carbon sequestration each year. While that may not seem like much, it adds up to a staggering 144,522 tons.

Finally, we wrote a newspaper article to convince forest managers of our decision to include logging in the management plan.

Keywords: Carbon sequestration, Forest management, AHP, Normal distribution

Contents

1. Introduction

1.1 Background

Current situation

From the catalog of USGCRP Indicator Platform, since the 1880's, the average global temperature has increased by 1.8°F. Since the late 1970's, average temperatures have exceeded the last century's average every year [1]. The Annual Greenhouse Gas Index (AGGI, a measure of capacity of Earth's atmosphere to trap heat as a result of the presence of long-lived greenhouse gases) shows that the warming influence of long-lived greenhouse gases in the atmosphere increased by 47% between 1990 and 2020 [3]. Climate change led to rising temperatures, extreme weather events, rising seas and many other impacts.

The importance of forests

Reducing the content of greenhouse gases in the atmosphere has become the key to improving climate change [4]. In addition to reducing greenhouse gas emissions, sequestration of carbon dioxide from the atmosphere through biosphere or mechanical means (carbon sequestration) also plays an important role. Research shows that [2], forests and harvested wood products uptake the equivalent of more than 14% of economy-wide CO2 emissions in the United States annually, and there is potential to increase carbon sequestration capacity by ~20% per year by fully stocking all understocked productive forestland.

Therefore, the contribution of forest carbon sequestration to climate improvement cannot be ignored.

Since wood products also have varying degrees of carbon sequestration capacity, a certain amount of logging into wood products, followed by planting of young forests, may allow for more carbon sequestration over time. This relates to the amount of carbon stored by trees at different ages and in different geographical environments, as well as the utilization and longevity of forest products.)

At the same time, forest managers need to consider other values of forests, including biodiversity, culture and recreation.

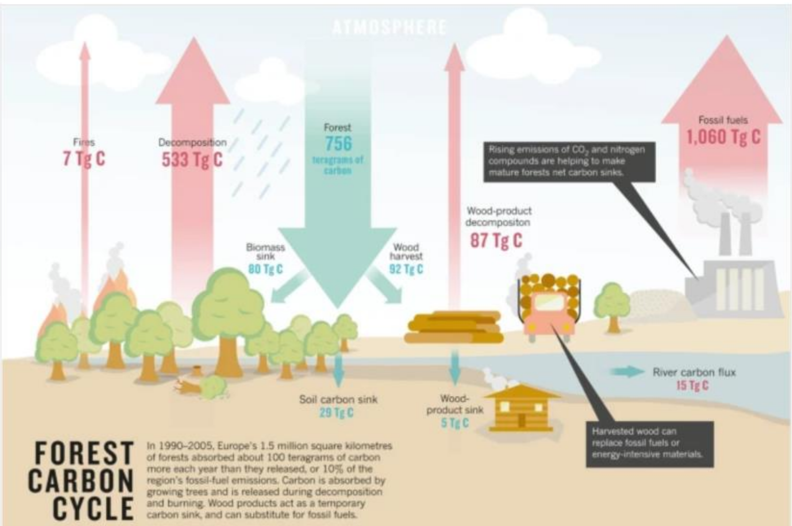

Fig.1 Forest carbon cycle[9]

What should we do now?

Thus, an accurate model is in urgent need to evaluate and predict current, and future carbon sequestrate situations, and to therefore provide reasonable plans to forest products.

1.2 Problem statement

We are first required to establish a model to determine how much carbon dioxide a forest and its products can be expected to sequester over time.

After that, we need to develop a further decision model, which considered other ways that forest valued, to inform forest managers of the best use of a forest.

Then the model me made will be applied to various forests and we need to analysis them.

At the final, we should write a technical newspaper article why our analysis identified including harvesting in the management of this forest rather than it being left untouched.

1.3 Our work

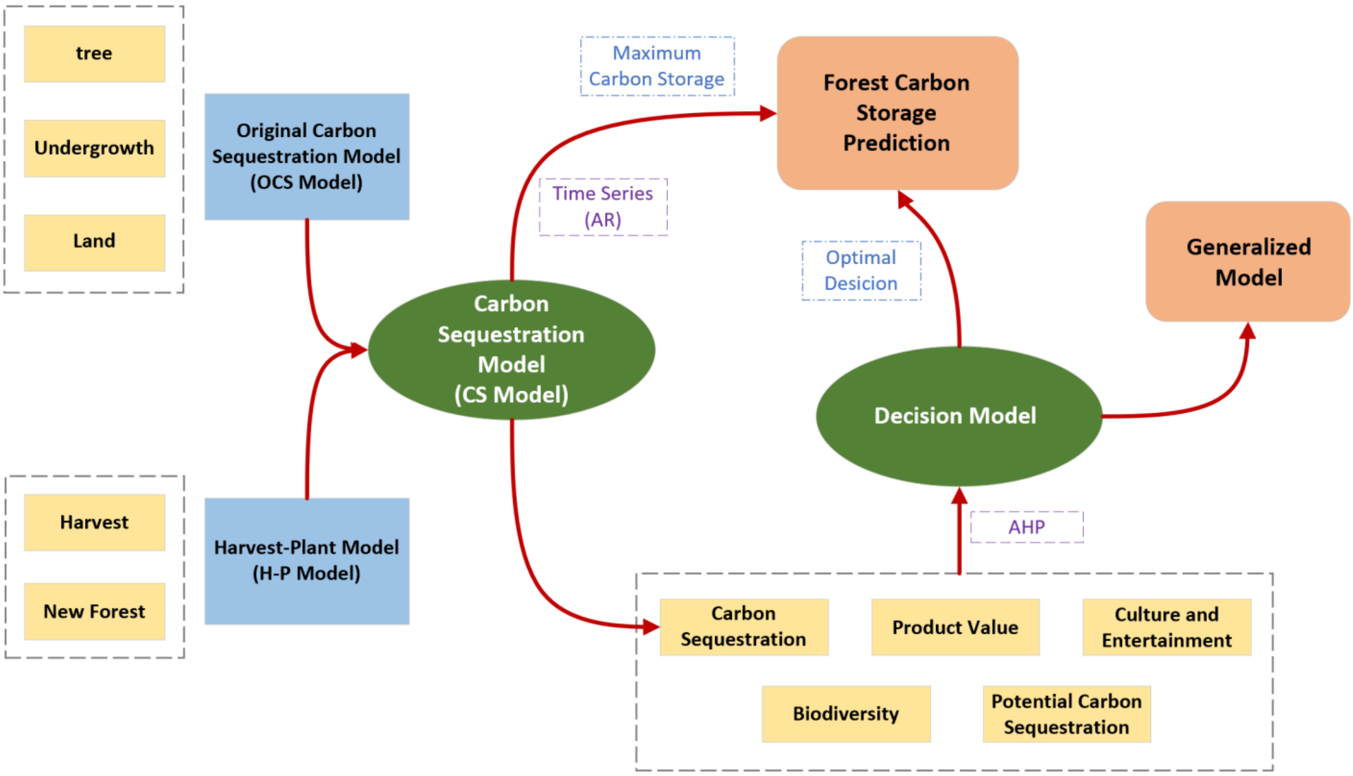

Fig.2 Whole modeling process of the paper

2. General assumptions

- The number of over-mature trees and natural deaths in forests is too small to be considered.
- Forests do not suffer from major natural disasters.
- Mainly consider the dominant tree species in the forest
- The loss of wood products is averaged yearly
- The economic value of wood products is basically stable

3. Notations

Tab.1 Variables and their meanings

Number	Symbols	Definition
1	C	The total amount of carbon sequestration in the forest
2	C_0	The total amount of original carbon sequestration in the forest
3	C_1	The total amount of carbon sequestration from deforestation
4	C_2	The amount of carbon sequestration of new trees in the forest
5	v_{ij}	Carbon sequestration rate of i tree species at j age after conversion
6	V_{ij}	Actual carbon sequestration rate of i tree species at j age
7	S_{ij}	The total area of i tree species at j age
8	S_{cut}	Area felled per cycle
9	$C_{mature\ and\ over\ mature}$	The amount of carbon sequestration per unit area of mature and over mature trees felled
10	T	Harvest cycle
11	S_k	The area of k tree when planting new trees
12	$\mathrm{v}_{\mathrm{k\ Average}}$	The average carbon sequestration rate of k tree species at different ages after conversion
13	α	The conversion coefficient of carbon sequestrated by undergrowth
14	β	The conversion coefficient of carbon sequestrated by forest land
15	r	Comprehensive utilization rate of wood

4. Carbon Sequestration (CS) Model

4.1 Analysis approach

We know that the carbon sequestration capacity of trees varies at different ages as they grow. At the same time, the distribution of tree species was different in different areas, and the dominant species were different. The carbon sequestration capacity of different tree species also varies greatly.

For a natural forest, its carbon sequestration contribution is important. In this model, we divide the carbon sequestration model of a forest into two parts. As shown below:

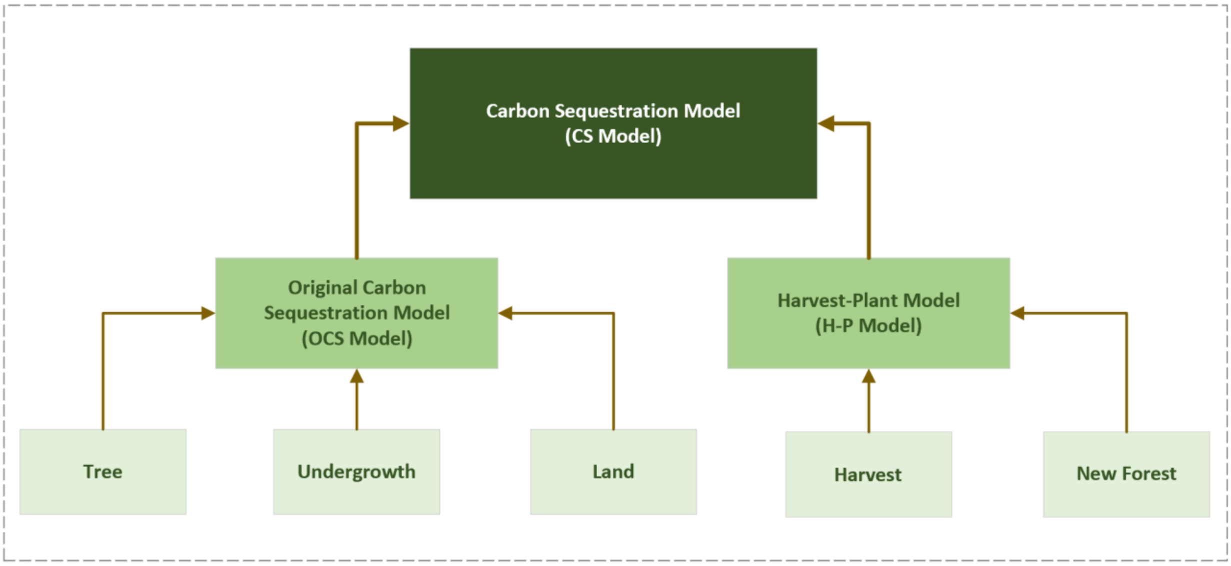

Fig.3 CS Model flowchart

The first part is the **Original Carbon Sequestration Model** of forest itself. In this model, we calculate the amount of carbon stored by the forest itself under ideal conditions. We will consider primarily the trees of the forest, the animals and other small plants of the forest, and the water and land of the forest.

The second part is the **Harvest-Plant Model** after deforestation. In this model, for effective and reasonable logging, we consider the loss caused by cutting down trees to produce wood products, and the carbon sequestration supplement brought by planting new trees on the logged land.

The processing technology that wood is made wood product is different, and the anticorrosion means is different also. According to the specific needs of the product, the processing plant will use different anticorrosive treatment means, therefore the life of some wood products is very short, about three to four years; and also there will be some wood products have a long life span of several decades, even longer than the life of the tree itself. Therefore, the carbon sequestration of wood products cannot be determined solely simply based on the reduction of carbon sequestration caused by natural wood decay. According to the survey[], the average life of wood products is 10-50 years. So the life of wood products should also need to be taken into account when calculating the carbon sequestration of products made from trees cut down in a forest.

In order to maximize the preservation of carbon sequestration, we should make as much as possible to make wood products to get the best treatment, so that the number of years of wood products to rot as long as possible, so that the protection is very beneficial for the entire environment.

Therefore, in order to discuss the maximization of forest carbon sequestration over time, the core of our model is to calculate the total forest carbon sequestration by using the amount of deforestation, the amount of carbon sequestration of new tree seedlings and the carbon storage fixed by the forest itself, and then choose a combination that can reach a maximum value in a certain period of time.

The model can also be used to calculate the maximum amount of carbon sequestration over time between deforestation and restoration without damaging the forest's environment.

4.2 Model establishment

4.2.1 OCS Model

According to existing studies, there are many methods to estimate forest carbon sequestration, including CO2FIX model, carbon balance F-CORRON model, biomass conversion method, vortex correlation method, box method, etc. [5]. However, the above calculation methods are complicated and tedious. Considering operability, long-term measurement, accuracy and other factors, forest stock conversion factor method is adopted to calculate forest carbon storage [6].

- **conversion factor method**

We checked the Intergovernmental Panel on Climate Change (IPCC) and get the default universal value,

α =0.195， β =1.244， δ =1.9， ρ =0.5， γ =0.5.

Where, α is the carbon conversion coefficient of understory plants; β is the carbon conversion coefficient of forest land; δ is biomass expansion coefficient; ρ is the volume coefficient; γ is the carbon content.

From this method to this model, it can be obtained:

$$C_0 = C_{tree} + \alpha C_{tree} + \beta C_{tree}$$

C_{tree} is the amount of carbon sequestration of forest trees;

αC_{tree} is the amount of carbon sequestration of undergrowth in forests;

βC_{tree} is the amount of carbon sequestration of forest woodland.

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

V_{ij} represents the carbon sequestration rate of i tree species at j age after conversion;

v_{ij} represents the actual carbon sequestration rate of i tree species at j age.

- **Considering the species of trees**

According to the research, the tree age mainly includes five age ranges: Young forest, middle-aged forest, Near Mature forest, Mature forest and Over Mature forest.

Combining with the age interval of different tree species in five age stages, we can use normal distribution to fit the age distribution density of each tree species in unit area. Because the carbon sequestration amount of over-aged trees decreased significantly compared with the previous four stages, the amount of carbon dioxide absorbed and released was basically equal, equivalent to the two offset. It is not necessary to include over-aged trees when considering the sum of total carbon sequestration of tree age, that is, only the first four stages are considered.

$$\sum_{\mathrm{j=1}}^{\mathrm{n}} \mathrm{v_j} S_j t + \alpha \sum_{\mathrm{j=1}}^{\mathrm{n}} \mathrm{v_j} S_j t + \beta \sum_{\mathrm{j=1}}^{\mathrm{n}} \mathrm{v_j} S_j t$$

Among them, n=4; $S_j$is the total land area of a certain age, which is obtained by integrating the corresponding segment of the fitted normal distribution.

- **Considering the age of trees**

The total amount of original carbon sequestration in the forest:

$$C_0 = \sum_{\mathrm{i=1}}^{\mathrm{m}} \sum_{\mathrm{j=1}}^{\mathrm{n}} \mathrm{v_{ij}} S_{ij} t + \alpha \sum_{\mathrm{i=1}}^{\mathrm{m}} \sum_{\mathrm{j=1}}^{\mathrm{n}} \mathrm{v_{ij}} S_{ij} t + \beta \sum_{\mathrm{i=1}}^{\mathrm{m}} \sum_{\mathrm{j=1}}^{\mathrm{n}} \mathrm{v_{ij}} S_{ij} t$$

4.2.2 H-P Model

In each round of cutting, a certain area of adult trees is made into products and a certain area is planted with young trees (for maximum carbon sequestration, the area of trees is assumed to be planted with young trees).

- **Forest products derived from harvesting**

First, we need to consider the age at which trees are felled. Similar to restricted ecological fishing, we also do not cut down too many young trees, but instead target mature and overripe trees. Therefore, the carbon sequestration of the trees themselves in each cycle can be approximately the average of the carbon sequestration of mature and overmature trees.

In each cycle, harvested wood continues to sequester carbon. However, there is a utilization rate of wood that is actually made into products, and there is also a product life. Through literature review, we know that the comprehensive utilization rate r of wood is about 60%[5]. Thus, we can get the wood loss.

Since time T may be in different felling cycles, we can round t/ t to get the cycle h in which the current time is in the felling cycle.

$$h = \left[\frac{t}{T}\right]$$

Based on the above discussion, we can get the loss of carbon sequestration over the harvest cycle in the process of felling trees for products:

$$C_1 = S_{cut} C_{mature\ and\ over\ mature} \left[\frac{t}{T}\right] (1-r) \quad , r = 60\%$$

- **New Forest**

Considering the variety of trees newly planted, the first round of tree cutting should consider planting new trees in proportion to the existing tree species in the forest. The area of each newly planted tree is:

$$S_k = S_{cut} \frac{S_i}{S},$$

Among them,

$$S_i = \sum_{j=1}^{m} \mathrm{v_{ij}} S_{ij}$$

Then, if the first cut is made at time T, the carbon sequestration of all newly planted trees is:

$$\sum_{k=1}^{m}(\mathrm{t}-\mathrm{T})S_k \mathrm{v}_{\mathrm{k\,Average}}$$

The amount of carbon sequestration should be an iterative process, given the subsequent rounds of tree chopping.

If the total amount of time is first used to represent the total amount of carbon sequestration (since the average carbon sequestration rate of different tree species is constant), a model similar to the sum of arithmetic sequences can be obtained:

$$f(t)\begin{cases} t-T, t\in[0,T] \\ 2t-3T, t\in(T,2T] \\ 3t-6T, t\in(2T,3T] \\ 4t-10T, t\in(2T,3T] \\ \vdots \\ ht-\left[\dfrac{h(h+1)}{2}\right]T, t\in(hT,(h+1)T] \end{cases}$$

Combining this iterative model represented by time with the carbon sequestration of all tree species, we can obtain the carbon sequestration of the total area of new species of young trees:

$$C_2=\sum_{k=1}^{m}\left[ht-\frac{h(h+1)}{2}T\right]S_k \mathrm{v}_{\mathrm{k\,Average}}$$

Among them,

$$h=\left[\frac{t}{T}\right]$$

- **H-P Model**

CS(Carbon Sequestration) model should consider OCS (Original Carbon Sequestration) model and H—C(Harvest-Plant) model mentioned above together.

Thus, we can give the following expression:

$$\mathrm{C}=C_0-C_1+C_2$$

$$=\sum_{\mathrm{i=1}}^{\mathrm{m}}\sum_{\mathrm{j=1}}^{\mathrm{n}}\mathrm{v_{ij}}S_{ij}t+\alpha\sum_{\mathrm{i=1}}^{\mathrm{m}}\sum_{\mathrm{j=1}}^{\mathrm{n}}\mathrm{v_{ij}}S_{ij}t+\beta\sum_{\mathrm{i=1}}^{\mathrm{m}}\sum_{\mathrm{j=1}}^{\mathrm{n}}\mathrm{v_{ij}}S_{ij}t$$

$$-S_{cut}C_{mature\ and\ over\ mature}\left[\frac{t}{T}\right](1-r)+\sum_{k=1}^{m}\left[ht-\frac{h(h+1)}{2}T\right]S_k \mathrm{v}_{\mathrm{k\,Average}}$$

4.3 Model accuracy

We compared the known carbon sequestration amount and the calculated amount of the model in the Lesser Khingan Mountains in the past 20 years, and found that the function curves of the two are basically consistent, and the error can be controlled within the acceptable range of about 2%. It is proved that the precision of this model is good.

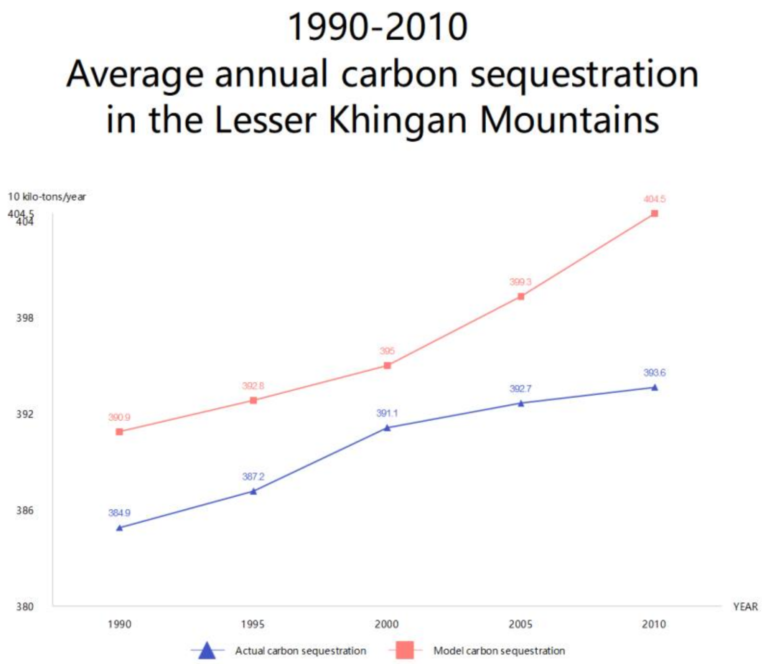

Fig.4 Comparison of model accuracy

5. Socially appropriate decision-making model

5.1 Problem analysis

We have found the most suitable carbon sequestration management scheme in the previous model, but it does not mean that this scheme can be applied to every forest in the world for different environments. In real life, we may consider the location of different forest, including environment, terrain, climate conditions and policy (for a forest is used as a commercial use) and forest value in different ways (including solid carbon and forest products not only, still have the potential of carbon sequestration, biodiversity conservation, entertainment culture purpose, etc.).

For different forests, we use AHP to establish the most suitable comprehensive forest management scheme.

5.2 Model preparation

For different forests, we first divide them into two categories according to their policies and nature, namely commercial forests and non-commercial forests.

- **For commercial forest**

The value of it is more emphasis on the economic benefits of forest products and the existing cultural entertainment purposes, of course, in the pursuit of economic benefits at the same time, we also want to ensure it will not lower than the original amount of carbon sequestration (namely the lowest also to ensure the sustainable development of the forest is not destroyed, not in pursuit of economic benefits to abandon environment).

- **For non-commercial forests**

Its value focuses on carbon sequestration and the protection of biodiversity and potential carbon sequestration, more for the protection of the earth's ecological environment. While maintaining carbon sequestration growth, we should also consider that it is not planned for maximum carbon sequestration (i.e. mature and over-mature trees should be preserved, not cut down for maximum carbon sequestration), but for the overall value of the forest.

5.3 Model establishment

5.3.1 Influencing factors of model

- **Carbon sequestration**

This is an important indicator for us to measure the combined value of a forest. Historically, about 25 percent of our carbon emissions have been captured by the earth's forests, farms and grasslands. Scientists and land managers are working to keep landscape vegetation and soil water differentiated for plant growth and carbon sequestration. [6]

- **Product value/economy**

This is one of the factors used to measure indicators and is of different importance to commercial and non-commercial forests. We also discuss the different economic values of tree types in different regions.

- **Culture and entertainment**

Professor K. Mantel said, The main conditions for determining forest sites are not the economic point of view that focuses on wood production and market distance, but the cultural point of view that people live a safe and healthy life. This is the basis of forest management, and forest sites should be determined not simply for economic reasons such as transportation costs and production costs, but for cultural reasons such as environmental protection and good physical and mental health of human beings. Thus, a good forest is not only used for carbon sequestration and production, but also of great significance to human society.

- **Conservation of biodiversity**

climate change has affected forest ecosystem functioning in both negative and positive ways, and has led to shifts in species/functional diversity and losses in plant species diversity which may impair the [7] Excessive deforestation leads to a decrease in biodiversity, so biodiversity must be taken into account when cutting down trees for production and other loss of forest area.

- **Potential carbon sequestration**

The potential carbon sequestration is related to the ecological environment of forests, the surrounding and even the global ecological environment and forest degradation. Therefore, potential carbon sequestration is also a factor worth considering. And the importance of this factor will change in the future, depending on how much effort we make to improve the environment in the future, such as human factors and various environmental factors.

5.3.2 Establish Model matrix according to different influencing factors

Each region determines the importance of the corresponding factors to the other factors according to various influencing factors and policies (measured by a 1-10 index, namely the analytic hierarchy Process (AHP)).

Based on the above influencing factors, a 5×5 matrix is established, and the value on the diagonal is 1, that is, the influence value of factors on themselves is 1.

Then check the consistency of the matrix.

Consistency index (CI) of the matrix A(5-times-5)

$$CI = \frac{\lambda_{max} - n}{n - 1}$$

Because it's the fifth order, n here is 5;

Another parameter RI can be acquired by using random method to construct 500 5-times-5 sample matrices: Convincing numbers from 1 − 9 and its reciprocal to construct a positive matrix, And obtaining the average value of the largest eigenvalue λ0 Max, then

$$RI = \frac{\lambda'_{max} - n}{n - 1}$$

And then we have consistency ratio. (CR)

$$CR = \frac{CI}{RI}$$

If CR value is less than 0.1, the condition is satisfied.

$$CR<0.1$$

this matrix is acceptable.

At the same time, the weight of each factor in this environment can be calculated.

6. Case study

6.1 The Lesser Khingan Mountains CS Model Test

We used model I to analyze the relationship between total carbon sequestration and felled area, respectively, to calculate the area of felled trees when the optimal co2 sequestration rate was achieved over time. Management is the most effective way to sequester co2.

The fitting function graph of MATLAB obtained is as follows:

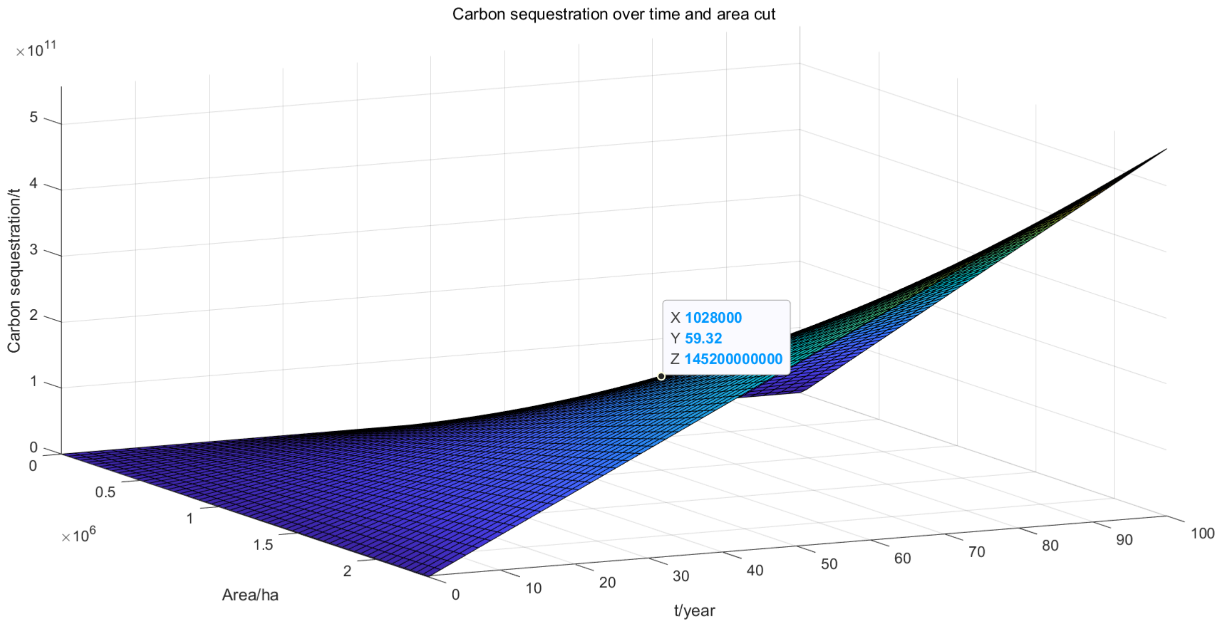

Fig.5 Model I MATLAB Fitting Plot

It is not difficult to find that there is a convex surface on this growth curve, and on this surface there is the point with the maximum curvature in the image (marked in the figure), which is the point with the fastest carbon fixation speed, and that is the optimal carbon storage plan we need to work out.

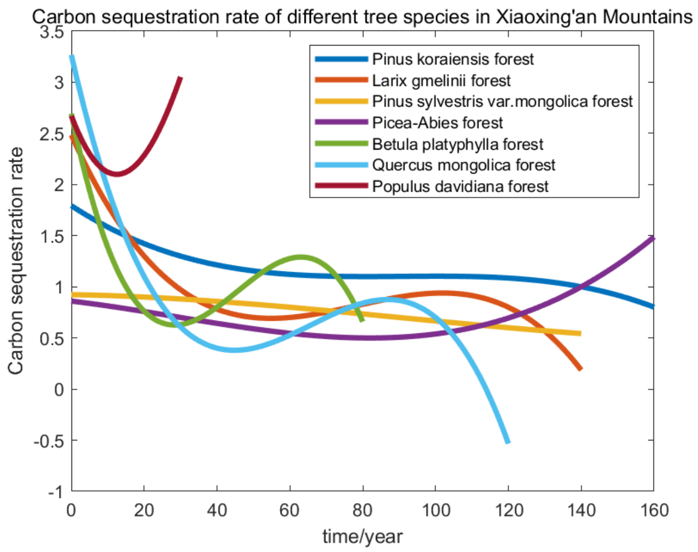

Fig.6 Carbon sequestration rates of different tree species at different ages(t • hm^{-1}/year)[8]

By calculation, we find that the number of felled trees at this point accounts for 14% of the number of middle-aged and old trees, and the rate of this point is 3.7% higher than that of other points. This means that we control 14% of the total amount of slash to achieve the maximum carbon sequestration rate in the same cycle time.

In this way, the total amount of carbon sequestration can be higher than:

$$\Delta = 3.7\% C_f S$$

That is, 144,522 tons of carbon dioxide can be fixed more.

In the same way, if the maximum carbon sequestration rate remains basically unchanged, and the decay amount of wood products is calculated based on the average value, we infer based on the time series model (AR) that after 100 years, this forest is estimated to be able to store 388.647 million tons carbon dioxide.

6.2 Socially appropriate decision-making model Test

Here we consider the Lesser Khingan Mountains as a non-commercial forest, and according to the above five factors and combined with the survey materials and forest policy situation, we will make a discretionary score. We take the five factors into a matrix horizontally and vertically in order, and fill in the scored values. First, conduct consistency analysis on them and pass. Then perform AHP (Analytic Hierarchy Process) to decide where the focus of the forest is.

$$A = \begin{pmatrix} 1 & 7 & 3 & 4 & 8 \\ \frac{1}{7} & 1 & \frac{1}{3} & 2 & 5 \\ \frac{1}{3} & 3 & 1 & 2 & 4 \\ \frac{1}{4} & \frac{1}{2} & \frac{1}{2} & 1 & 2 \\ \frac{1}{8} & \frac{1}{5} & \frac{1}{4} & \frac{1}{2} & 1 \end{pmatrix}$$

From one to five are carbon sequestration, wood products, potential carbon sequestration, biodiversity and recreational culture.

$$CI=0.0737 \quad ; \quad CR=0.0658<0.1;$$

Through AHP calculation, we obtain their weights as:

$$0.5240 \quad 0.1277 \quad 0.2133 \quad 0.0908 \quad 0.0442$$

That is to say, for this forest, the weight of carbon sequestration accounts for 75% of the total, so carbon sequestration is still the main consideration when considering forest use decisions, but wood products account for almost 13% and also need to be considered.

If we want to update a new cycle of a multi-decade period, we need to find a new balance, that is, in the new cycle, the fixed amount of new and old trees must at least supplement the loss of the previous cycle. At the same time, according to the different weights of various factors in the location of the forest, we should focus on the goals required for development.

6.3 Result analysis

Maybe the forest we analyzed is relatively small, but this is still representative, and because the model accuracy is not low, the data generated by it is also more valuable. Among them, for the actual forest, it is almost impossible for us to have a forest with 0% deforestation. Because it is impossible to completely close the weight of carbon sequestration to 0, which is contrary to our concept of sustainable development. At the same time, with the development of time, the age of trees continues to increase, and the amount of carbon sequestration will gradually increase in value. Replant A downward trend occurs after withering and dying.

7. Non-technical newspaper articles

As one of the greenhouse gases, carbon dioxide will lead to global warming, which will lead to the rise of sea level. In recent years, human beings have paid more and more attention to the management of carbon dioxide. Many countries have proposed the concept of carbon sequestration to deal with the global climate crisis.

In addition to scientific means, afforestation is the most economical way of carbon sequestration. As the "lung of the earth", forests have the ability to naturally absorb carbon dioxide. With the development and utilization of forests by human beings, the management of forests is particularly important. The region's forests have lost economic and environmental benefits due to improper management

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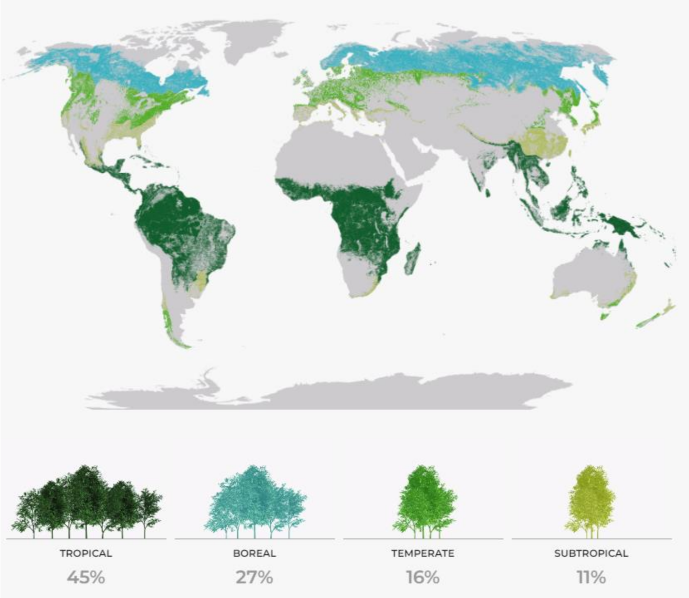

Fig.7 Schematic diagram of global forest distribution

Today, many people still think that forests should not be cut down and that keeping them as they are will fix more carbon, which seems reason-able, but the truth is that many older trees have reached a state of equilibrium between photosynthesis and respiration, and no longer Carbon sequestration, so there is no more environmental benefit than appreciation.

Fortunately, these trees without carbon sequestration can also promote economic development, that is, they can be made into wood products, which can not only provide convenience for human beings, but also sequester part of the carbon element in them. The carbon sequestration of old trees and planting of small saplings can generate more carbon cycle benefits and bring more value to the environment because the average carbon sequestration rate of small saplings is much higher than that of old trees.

Moreover, modern forest management models must not only weigh the environmental and economic benefits brought by forests, but also pay attention to the contribution of forests to biodiversity conservation and the impact of forests on culture and recreation. The carbon sequestration capacity has increased, and the economic benefits of forests have increased. There are countless examples of this around the world. For example, after the management reform of the Lesser Khingan Mountains in China, the carbon cycle efficiency has increased by 3.7%. Compared with before the reform, its carbon sequestration efficiency The average annual increase in volume is 144,000 tons, which is equivalent to a reduction of about 460,000 tons of garbage pollution.

At present, human beings are in a stage of rapid development of science and technology.

The development of science and technology will bring a lot of unnecessary pollution and carbon emissions at the same time. It is particularly important for the harmonious development between man and nature and sustainable development. Improving the forest management model is a time when mankind has Forest breakthrough.

Fig.8 Soil carbon sequestration[10]

Of course, managing forests is not a simple matter. Managers need to consider the economic and environmental value of forests from multiple dimensions. Management based on local needs, culture and the environment is often the most effective management method. Only in this way can sustainable development be achieved. Only with development can the earth's environment be slowly improved, and protecting forests is by no means not cutting down any trees. This kind of management effect is a failure, because over time, when all the trees are aging, the entire forest will be harmful to the environment. The benefits will no longer exist or even be negative, so for sustainable development, it is necessary to cut down some old trees with no cultural value and plant new saplings while carrying out management. We believe that with the improvement of forest management level If it increases, the concentration of carbon dioxide in the atmosphere will decrease, and human beings will successfully cope with the global climate crisis, so as to achieve sustainable development.

8. Evaluation and Spread of the Model

8.1 Evaluation of the Model

Strength:

• The model we built fully considers the problem of small tree update and iteration, and also takes into account the corruption of wood products, which is more realistic.

• The model has a high degree of freedom, and can decide a variety of forest management plans corresponding to different goals according to the environment of different locations, so that each different area can generate an exclusive plan.

Weakness：

• The model may be distorted occasionally, because the values we bring in are basically averages, which can lead to strange deviations if the data needs to be subdivided.

8.2 The Extension of Models

Our model is universal, because considering the problem of periodic iteration, if the focus is determined according to the local situation, we can use a general but partial model to adapt to the world situation.

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