Forest Carbon Sinks and Its Economy Evaluation of State-owned Forest Region in Heilongjiang Province

LI Changsheng

School of Humanities and Social Sciences, Harbin Institute of Technology, Harbin, Heilongjiang, 150001, China. Email: lichangsheng100@yahoo.com.cn

Abstract: Forest carbon sinks has been paying much more attention to by worsening of greenhouse effect and climate warming. After studying the characteristics of forest carbon sinks, direct fixing carbon of forest was analyzed. The operational method of measurement of forest carbon sinks was suggested. Finely, forest carbon sinks of state-owned forest region in Heilongjiang Province was calculated. The forest carbon sinks of state-owned forest region in Heilongjiang Province is 0.895 billion ton. The value is 106.349 billion Chinese dollars.

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Key words: forest carbon sinks; economy evaluation; tree biomass carbon reserves

In terrestrial ecosystem, the forest is the largest carbon pool; the trees play an important and unique role in reducing greenhouse gas concentrations in the atmosphere and global warming by absorbing lots of carbon dioxide from the atmosphere during photosynthesis. In recent years, with increasing of the greenhouse effect and global warming, more and more attention is paid to the forest carbon sinks. Forest carbon sinks means the forest plants absorbing carbon dioxide from the atmosphere and fixing it in vegetation or soil, to reduce the concentration of the gases in the atmosphere. Although the area of forest takes up only 1 / 3 of the total area of land, but carbon storage in forest vegetation zone accounts for nearly half the total carbon pool of terrestrial. Currently, emissions of greenhouse gases of China accounted for 50% in developing countries, 15% in the global. China is rapidly shift from a state of low energy consumption to one state of high energy consumption, a large number of carbon dioxide emissions will be emitted. There is a very important theoretical and practical significance to establish a complete and science forest carbon sinks measurement system for measurement and dynamics of forest carbon sinks, and gradually integrate forest carbon sinks into the national forest ecological value statistics. This is to analyze direct fixing carbon of forest, identify the operational method of measurement of forest carbon sinks, and calculate and economic evaluation of forest carbon sinks of state-owned forest region in Heilongjiang Province.

Measurement methods of forest carbon sink

Method of calculating forest carbon sinks include carbon density, carbon balance of F-CARBON model method, CO_2FIX modeling, biomass conversion method, etc. , but these methods are basically belong to the pure category of natural, calculation is complicated. From social science, the purpose of this study is to carry out economic evaluation and implementation of carbon sinks trade, the current calculation is too complex to operate. Therefore, a calculating method of forest carbon sinks should be based on the calculation methods of the natural science and the research results, considering the calculating method of the practicality and operability, this paper proposes a set of economic measurement methods - forest volume conversion factor method.

1. The formula for all fixed carbon in forest

CF = the amount of fixed carbon of tree biomass + the amount of fixed carbon of Undergrowth + the amount of fixed carbon of forest

$$= \sum (Sij \times Cij) + \alpha \sum (Sij \times Cij) + \beta \sum (Sij \times Cij)$$

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

In the formula: CF—All the amount of fixed carbon of forest;

S_{ij}—The area of type-j forest in type-I areas;

C_{ij}—The biomass carbon density of type-j forest in type-I areas;

V_{ij}—the stock volume per unit area of type-j forest in type-I areas;

δ— biomass enlarge coefficient;
α—carbon transfer coefficient of undergrowth vegetation;
β—carbon transfer coefficient of woodland;
ρ—volumetric coefficient;
γ—carbon content rate.

2.The extension effect of the rate of wood fixed carbon. Solid wood carbon savings conversion based on considering the Utilization rate of harvesting and timber quality. Let λ be wood fixed carbon transfer coefficient, then the amount of wood fixed carbon.

$$CW = \lambda \sum (S_{ij} \times V_{ij}) \times \rho \times \gamma = Q \times \rho \times \gamma$$

Where: $\lambda = \gamma_1 \gamma_2$
CW—amount of wood fixed carbon;
Q—timber yield;
γ_1—utilization rate;
γ_2—outturn percentage。

3.The change of the formula

Allowing for alternate of woodland and current annual increment of understory vegetation playing a role in fixed carbon, when we investigate the release quantity of carbon dioxide with the expenditure of forest resources and gets, take tree biomass into account. In view of this, you can calculate the emissions of carbon dioxide from timber production.

Timber production discharge carbon into the atmosphere

$$= \Sigma(S_{ij} \times V_{ij}) - \lambda \Sigma(S_{ij} \times V_{ij} \times \rho \times \gamma)$$

Timber production discharge carbon dioxide into the atmosphere

$$= \{\Sigma(S_{ij} \times V_{ij}) - \lambda \Sigma(S_{ij} \times V_{ij} \times \rho \times \gamma) \} (44 \div 12)$$

However, in the actual production of timber, it is easier to get produced, but for reducing the number of forest biomass in the production process it is not concerned. Assuming we have mastered the wood production data, consumption of forest reserves can be derived based on the above formula, the emissions amount of carbon and carbon dioxide can be calculated in the logging and processing of timber.

When timber yield is Q, Timber production discharge carbon dioxide

$$= \left(\frac{Q}{\gamma_1 \times \gamma_2} \times \delta \times \rho \times \gamma - Q \times \rho \times \gamma\right) \times (44 \div 12)$$

These coefficients should be determined in order to accurately calculate the amount of forest carbon sinks, are different with areas and forest types. Reasonable regionalization for the national according to the theory of regionalization and forestry is a precondition for determined these coefficients, based on the regionalization to determine various conversion coefficients of forest types.

4.Determination of the average of various conversion coefficients

(1)The expansion coefficient of forest resources accumulation δ

Accumulation of trees can be converted into bio-volume with a tree as Main part by using the coefficient. The average biomass of the leaves of China conifer and broadleaf trees accounted for about 6.75% of the total tree biomass, branches accounted for 15.75%, roots accounted for 25.0%, tree trunk accounted for 52.5% according to the measured tree, hence it is not difficult to calculate that the expansion coefficient of tree bio-volume is 1.9. The Measurement coefficient of conifers and broadleaf is 1.7 and 1.8 from Japan. The research Result from France show that tree trunks and branches accounted for about 78% of the total biomass, leaves accounted for 6%, root biomass accounted for 16%, we can see that The French coefficient is much lower. The coefficient is 1.90 during this study (The default value Intergovernmental panel on climate change (IPCC) is 1.90).

(2)Volume density ρ

Accumulation of the forest biomass can be converted into dry weight conversion factor by using the coefficient. The average volume density of dominant tree species in Japan was about 0.45 (coniferous was about 0.38 t / m3, hardwood was about 0.49 t / m3). We have taken universal IPCC's default value to 0.5.

(3)Carbon content rate γ

Biomass dry weight can be converted into the amount of fixed carbon by using the coefficient. In our country carbon content rate of hardwood is less than 0.5, while the average carbon content rate of conifers generally is equal to or above 0.5, the result of calculated the tree layer reserve in forest is objective and impartial as the average carbon content rate with 0.5. IPCC's default value is 0.5.

(4)The conversion coefficient of fixed carbon of Undergrowth α α is 0.195, by which fixed carbon of undergrowth (including litter) would be calculated based on forest biomass.

(5)The conversion coefficient of fixed carbon of forest β

β is 1.244, by which fixed carbon of forest would be calculated based on fixed carbon of forest biomass.

(6)The conversion coefficient of wood fixed carbon

It is the product of forest harvesting percentage of outturnmultiplying by wood processing utilization rate. After a certain amount of forest having been harvested, the amount of wood fixed carbon would be calculated by this coefficient.

The coefficient value would reach the maximum when maximize the forest harvesting percentage of outturn and wood processing utilization rate. Assume that percentage of outturn is 70%, utilization rate is 80%, and then conversion coefficient of wood fixed carbon is 0.14.

The coefficient value would reach the minimum when minimize the forest harvesting percentage of outturn and wood processing utilization rate. Assume that percentage of outturn is 70%, utilization rate is 80%, and then conversion coefficient of wood fixed carbon is 0.10.

This formula could calculate existing forest fixed carbon as well as fixed carbon caused by forest stock volume increasing. Relevant standard coefficient value of forest carbon sinks in different regions, different forest species and forest types could be set by state to guide the calculation and evaluation of forest carbon sinks.

Dynamic changes of state-owned forest in Heilongjiang Province

Dynamic changes of the area, stock in past 24 years of state-owned forest resources in Heilongjiang Province are shown in Figure 1 to Figure 2 respectively.

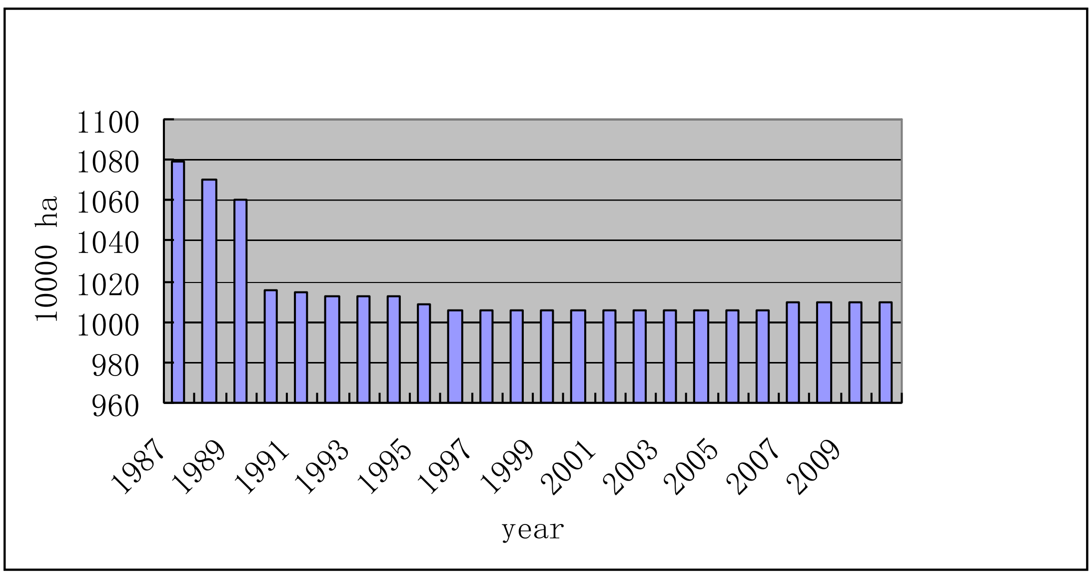

Fig 1 Dynamic changes of the area of state-owned forests in Heilongjiang Province

It is shown that the forest area declined fast in 1988, 1989 and 1990. From 1991 to 2004, it declined slowly, and since 2005, forest area has begun to rise in Figure 1.

Figure 2 shows that stock declined fast in 1988, 1989 and 1990, and from 1991 to 2000 it showed some fluctuations, while declining was the general trend. Until 2002, it had reached the bottom point, and it began to rise since 2003. During recent 4 years, forest stock rises rapidly, and develops very well.

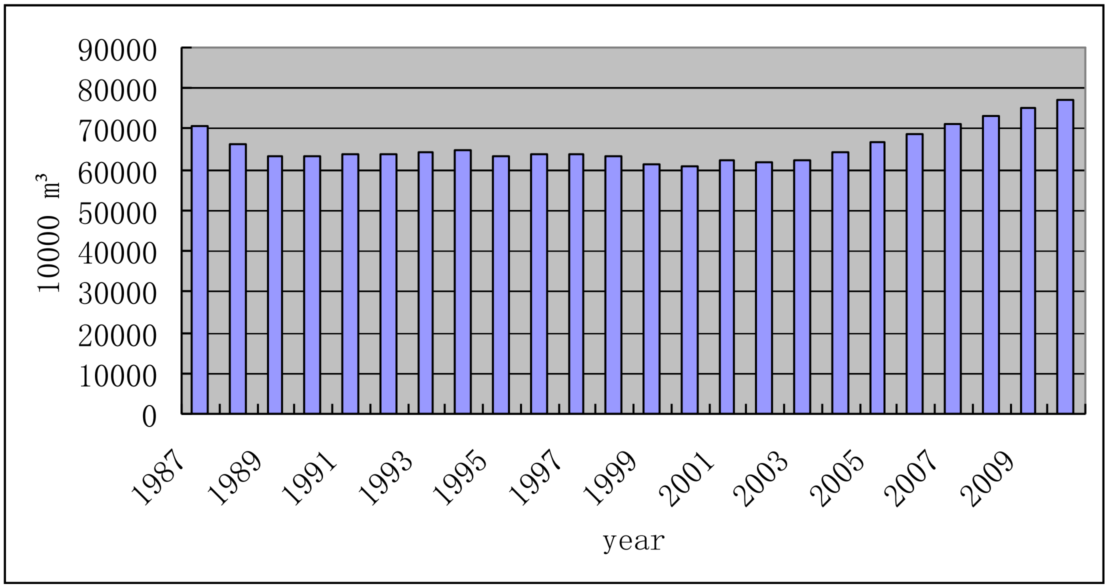

Fig 2. Dynamic changes of the stock of state-owned forests in Heilongjiang Province

Table 1 Forest carbon sinks of state-owned forest in Heilongjiang Province

Age	Forest area /million hectare	Forest reserves/million m^3	Tree biomass carbon /million ton	forest carbon reserves /million ton
1987	10.79346	705.213	334.9762	817.0069
1988	10.70520	663.457	315.1421	768.6315
1989	10.60633	633.119	300.7315	733.4842
1990	10.15850	632.228	300.3083	732.4519
1991	10.14421	635.830	302.0193	736.6250
1992	10.12395	636.615	302.3921	737.5344
1993	10.12300	645.269	306.5028	747.5603
1994	10.12496	645.928	306.8158	748.3237
1995	10.08555	635.246	301.7419	735.9484
1996	10.05999	636.300	302.2425	737.1695
1997	10.06004	638.505	303.2899	739.7240
1998	10.05295	631.632	300.0252	731.7615
1999	10.05402	615.591	292.4057	713.1776
2000	10.05405	610.141	289.8170	706.8636
2001	10.05403	622.812	295.8357	721.5433
2002	10.05456	615.970	292.5858	713.6166
2003	10.05437	622.930	295.8918	721.6800
2004	10.05437	643.646	305.7319	745.6800
2005	10.05653	667.532	317.0777	773.3525
2006	10.05582	684.959	325.3555	793.5421
2007	10.09777	711.303	337.8689	824.0623
2008	10.09777	731.865	347.6359	847.8839
2009	10.09777	752.149	357.2708	871.3834
2010	10.09777	772.295	366.8401	894.7231

Forest carbon sinks of state-owned forest in Heilongjiang Province and evaluation

(1) Tree biomass fixed carbon

Tree biomass carbon reserves=forest stock × enlarge coefficient×volumetric coefficient × carbon content rate= V×1.9×0.5×0.5

(2) Total forest carbon sinks

Total forest carbon reserves=tree biomass fixed carbon+ fixed carbon of Undergrowth+ fixed carbon of forest

$$=\sum(Sij\times Cij)+\alpha\sum(Sij\times Cij)+\beta\sum(Sij\times Cij)$$

=V×1.9×0.5×0.5+0.195(V×1.9×0.5×0.5)
+1.244(V×1.9×0.5×0.5)
=2.439(V×1.9×0.5×0.5)

According to the above tow formulas, Table 1 shows tree biomass fixed carbon and total forest carbon sinks of state-owned forest in Heilongjiang Province based on forest stock.

It is shown that forest carbon sinks of state-owned forest in Heilongjiang Province was 895 million tons.

The value of forest carbon sinks equals to the product of the amount of forest carbon sinks multiply by unit price of forest carbon sinks.

The value of forest carbon sinks $V_t = CF \times P$

In the formula: Vt—the value of forest carbon sinks;

CF—the amount of forest carbon sinks;

P—price of forest carbon sinks，Yuan/ton

We adopt the international carbon price 5 dollars/ton, the price of carbon is 3 × (44/12) = 18.33 dollars/ton. The value of forest carbon sinks of state-owned forest in Heilongjiang Province is 16.400 billion dollars. We calculate at 1 dollar = 6.4846 Yuan, the value of forest carbon sinks of state-owned forest in Heilongjiang Province is 106.349 billion Yuan.

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