Research Journal of Applied Sciences, Engineering and Technology 4(19): 3675-3679, 2012
ISSN: 2040-7467

Submitted: February 21, 2012 Accepted: April 07, 2012 Published: October 01, 2012

Study on Timber Volume Accounts system for Rapid-growing and High-yield forest based on WebGIS in Northeast China

[1]Li Dan,[1]Li Yuchong and [2]Cao Yukun
[1]School of Information and Computer Engineering, Northeast Forestry University, Harbin 150040, China
[2]School of Economics and Managemenet, Northeast Forestry University, Harbin 150040, China

Abstract: A management system was developed with the aim of improving decision-making by analyzing the current process of forest production, manual searching of the tree volume mode table method is the primary method in forest resources inventory. A new method to calculate the stock accumulation for single tree was proposed in this study. It has been established individual timber volume of forest trees accounted for web systems based on Heilongjiang local standards in china, and Linkou Forestry Bureau was selected as the demonstration plot. A feasible method that gets individual timber volume can be provided for forest production. The system is using J2EE and ArcGIS Server technology, it can offer the visualization of geographic service for forest recourse management.

Keywords: Computer simulation forest resource system, modeling, stand tree volume, WebGIS

INTRODUCTION

Information management of forest resource is the core of the forest industry; it is also the most important basis to make decisions on forestry development. Decision methods for forest resource management focus on decision making for forests that are managed for both ecological and economic objectives (Vacik and Lexer, 2001). Traditional methods of forest monitoring and management had many shortcomings, such as the difficulties in data renew, lack of spatial information, lack of real-time data updates difference, excessive manual work, difficulty in data transmission (Li and Zhao, 2006). Forestry enterprises and forestry administrative departments hoped to strengthen the interdepartmental communication on the data information foundation of every department of their units, to realize data sharing, to improve official business efficiency, to optimize management means, and to offer scientific decisions and methods for the country (Wu *et al*., 2003).

And in the process of forest resource management, Forest Stand volume is an important indicator of forest inventory. The calculation of standing volume is an important step during the whole process of forest resource calculation, especially during the forest resource investigation, the first-level resource checking, wood cutting and other forest production can not be done without the calculation of standing volume (Li and Zhao, 2006). At the present stage, the calculation of standing volume mainly concludes the normal tables of stand volume investigation in china, such as one-variable forest volume table, binary volume table and local collection, etc. The relevant outcomes can be gained by using variable related parameters to calculate standing volume. However, during the actual process of production, in many forest areas, people are still using manual research. It was wasting time, but also easily causing mistakes.

This research, according to the local standard of the DB/T 482-1998 Heilongjiang forest stand volume table in China, we developed Timber Volume Accounts system for Rapid-growing and High-yield forest based on WebGIS in Northeast China to reinforce the application of model integration for forest production. The system can be divided into two modules. The first module is the forest stock volume calculation system; the other is the WebGIS module. First of all, according to the forest stock volume calculation system, it is easily to calculate the accumulation of changes. Secondly, the WebGIS can show the intuitive changes on the electronic map.

The one-variable forest volume table and binary volume table are two main calculation method of timber volume. One-variable forest volume table do not consider the influence from height and sharp of a tree to the model. The volume maybe varied significantly due to the different height of trees with the same Diameter PERLINK"app:ds:at"\t""at Breast Height (DBH); so the one-variable forest volume table is only applicable in some specific area of the same condition, it was also

Corresponding Author: Li Dan, School of Information and Computer Engineering, Northeast Forestry University, Harbin 150040, China

called as the local volume table. On the basis of the one-variable forest volume table, binary volume table introduced the tree height to the calculation of the volume. Its precision is highly improved than the one-variable forest volume table. But this method has great localization. Because gauging the height of the tree is a time consuming and hardly work in forest, so this method can't meet the demand of actual use in implementation. So in the volume of investigation, it is usually measuring the DBH firstly, and then uses the one-variable forest volume table to calculate Timber Volume. To solve the issue mentioned above, this paper proposed a new method that dividing the tree into different groups based on the ratio relationship between DBH & height, and it divided the same DBH and different tree height into several height class degree, and proposed a new height class standing volume table. This method is an integration of one-variable forest volume table and binary volume table, first use the idea of binary volume table differentiate the trees and then use the one-variable forest volume for calculation, strengthening the merit and weakling the drawbacks. The specific model will be introduced later.

Height class standing volume calculation model: The height class standing volume calculation model is calculated as bellows:

Parameter DBH: DBH ($\overline{D}$ --) is calculated with the method in formula (1).

$$\overline{D} = \sqrt{\frac{\sum_{i=1}^{n} D_i^2}{n}} \qquad (1)$$

In formula (1), D_i is the actual measurement DBH of dominant species (cm), n is the actual measurement number of samples. When the average DBH of dominant tree species $\geq$12 cm, the average tree diameter at breast height to allow error ± 1 cm; The average breast height of dominant tree species <12 cm, the average tree diameter at breast height to allow error ± 0.5 cm.

It will be usually set n = 3 in the survey of forest resources, so in the system n = 3, then calculate the parameter of H_{theory}:

Parameter *H*-- is in formula (2).

$$H = \frac{\overline{D}}{1.681422 + 0.5657354 * \overline{D} + 0.02997197 * \overline{D}^2} \qquad (2)$$

Parameter tree height: According to average breast height of dominant species to determine the average tree height, Use altimeter device to determine the tree height

Table 1: *B.platyphylla Suk* height grade and $k_{\text{ÖÐÖµ}}$classification table

Height class	k	$k_{\text{ÖÐÖµ}}$
1	$k\geq$1.278614	1.330824
2	1.278614>$k\geq$	1.1741931.226403
3	1.174193>$k\geq$	1.0697721.121982
4	1.069772>$k\geq$	0.96535111.017562
5	0.9653511>$k\geq$	0.86093020.9131406
6	0.8609302>$k\geq$	0.76650950.8087119
7	0.7665095>k	0.7042991

Table 2: *B.platyphylla Suk* height grade and $k_{\text{ÖÐÖµ}}$classification table

Height class	k	$k_{\text{ÖÐÖµ}}$
1	$k\geq$1.218525	1.267572
2	1.218525>$k\geq$1.120431	1.169478
3	1.120431>$k\geq$1.022337	1.071384
4	1.022337>$k\geq$0.9242430	0.9732899
5	0.9242430>$k\geq$0.8261490	0.8751959
6	0.8261490>$k\geq$0.7280551	0.7771021
7	0.7280551>k 0.6790081	

Table 3: *Larix Mill* height grade and $k_{\text{ÖÐÖµ}}$ classification table

Height class	k	$k_{\text{ÖÐÖµ}}$
1	$k\geq$1.336353	1.392413
2	1.336353>$k\geq$1.224233	1.280293
3	1.224233>$k\geq$1.112113	1.168173
4	1.112113>$k\geq$0.9999929	1.056053
5	0.9999929>$k\geq$0.8878727	0.9439328
6	0.8878727>$k\geq$0.775727	0.8318126
7	0.775727>k	0.7196926

Table 4: *Q.mongolicus Fisc* height grade and $k_{\text{ÖÐÖµ}}$ classification table

Height class	k	$k_{\text{ÖÐÖµ}}$
1	$k\geq$1.280905	1.34309
2	1.280905>$k\geq$1.156536	1.21872
3	1.156536>$k\geq$1.032167	1.094351
4	1.032167>$k\geq$0.9077972	0.9699819
5	0.9077972>$k\geq$0.7834810	0.8456127
6	0.7834810>$k\geq$0.6590589	0.7212435
7	0.6590589>k	0.5968743

of the three strains average tree and used the arithmetic average method to calculate the average tree height *H*-- which is formula (3):

$$H = \sum_{i=n}^{n} h_i \qquad (3)$$

(*H*--) is the average height (m) of dominant tree species, n is the actual measurement number of samples, h_i is the measurement of tree height per plant (m) with the same DBH in formula (1).

Parameter height class: Determine the tree height class: obtain k = *H*--/*H*--, and determine the height class according to k and tree species information, with parameter k can confirm parameter k--, which *B.platyphylla Suk* is shown in Table 1, *Populus davidiana Dode* is shown in Table 2, *Larix Mill* is shown in Table 3, *Q.mongolicus Fisch* is shown in Table 4.

Parameter H: H is shown in formula (4).

$$\text{H = H-- × k--} \qquad (4)$$

Table 5: Parameters of C_0 to C_6 for *B. platyphylla Suk*

Parameter	*B. platyphylla Suk*
C_0	5.20419694E-05
C_1	1.25678768
C_2	2.81389920E-02
C_3	7.32533761E-02
C_4	1.58404013
C_5	-5.21950700E-02
C_6	-0.04745274

Table 6: Parameters of C_0 to C_6 for *Populus davidiana Dode*

Parameter	*Populus davidiana Dode*
C_0	23309.09239057
C_1	171.89356193
C_2	0
C_3	0
C_4	0
C_5	0
C_6	0

Table 7: Parameters of C_0 to C_6 for *Larix Mill*

Parameter	*Larix Mill*
C_0	6.97027264E-05
C_1	1.52867068
C_2	4.55840261E-02
C_3	8.03372437E-02
C_4	1.21009185
C_5	-0.08334350
C_6	-0.03863249

The formula to estimate the single\stand tree volume for *B.platyphylla Suk*, *Populus davidiana Dode*, *Larix Mill* and *Q.mongolicus* is shown in formula (5):

Table 8: Parameters of C_0 to C_6 for *Q. mongolicus Fisch*

Parameter	*Q. mongolicus Fisch*
C_0	5.03070855E-05
C_1	1.14994462
C_2	2.1552763E-02
C_3	8.00807760E-02
C_4	1.81246965
C_5	-0.04181624
C_6	-0.06348562

$$V_i = C_0 * D_i^{(C_1+C_2*D_i+C_3*H)} * H^{(C_4+C_5*D_i+C_6*H)} \quad (5)$$

Parameters of C_0 to C_6: for *B.platyphylla Suk* is shown in Table 5, for *Populus davidiana Dode* is shown in Table 6, for *Larix Mill* is shown in Table 7, for *Q.mongolicus Fisch* is shown in Table 8.

Parameter H: At last we can calculate the whole standing volume accounts for a certain Demonstration Plot, which is shown in formula (6):

$$V = \frac{\sum_{i=1}^{n} V_i * S}{S} \quad (6)$$

(V--) is total accounts volume for the fixed area, V_i is individual plant volume of actual measurement in the sample plot,(S--) represents the acreage of the actual measurement sample plot; (S--) represent the area in an administrative division which will be estimated.

Fig. 1: Input parameters interface

Fig. 2: Result of advisory

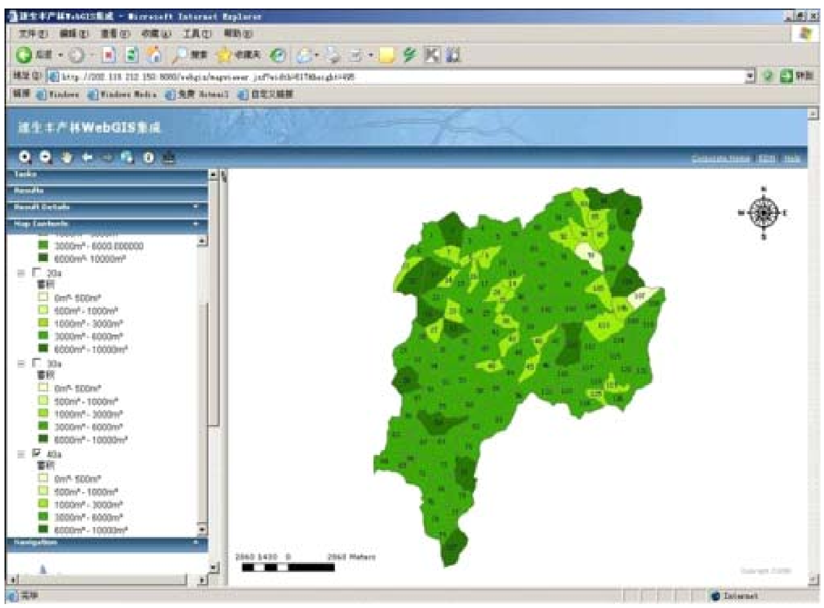

Fig. 3: WebGIS integration

Table 9: Standard of forest resources

Weight factor	Color	Forest resources
1		0 m^3<500 m^3
2		500 m^3<1000 m^3
3		1000 m^3<3000 m^3
4		3000 m^3<6000 m^3
5		6000 m^3<10000 m^3

System implementation: The interface of the system is shown in Fig. 1 and 2. The user can simply get the result by input some data collected from target area. The steps are as follows:

- Input three sets of data (height & diameter) of dominant tree species. For example, input 16.3, 17.2 and 15.7 cm, 12.4, 12.1 and 13.0 m separately. The system will call "SGJ()" function to get the result. In this case, the result for the parameter of the height class is 6.

- Select the tree species. We choose Larix Mill input the target DBH as 12.0 cm and the system will call "XUJI()" function to get 0.056 m^3. By this way, the user only needs to record the measurement information like height and diameter; the user can calculate the stock accumulation for a single tree through the system.
- In addition, the user can integrate the model components above with the demonstration plot's attribute information; every subcompartment's height class can be stored in the property database, very year the system can calculate the accumulation of forestry resources for inventory.

WebGIS integration: Geographical Information System (GIS) is a collection of computer hardware, software, and geographic data for capturing, managing, analyzing, and displaying all forms of geographically referenced information. With the GIS technology, we can obtain spatial information easily, and represent and process the data effetely. After we got the Timber Volume Accounts for one area, the system can update the volume in the database. With this method, the information management of forest resources and the WebGIS are combined to provide direct-viewing bases of resource investigation, analysis, and management for the users in decision-making.

Forest subcompartment is the basic unit for forest resources management. In WebGIS map, volume of the subcompartment is divided into five degrees; it is marked with different color, and gives weight factor for each degree which is shown in Table 9. On the basis of the parameter volume in database, the system can automatically carry on classification for the subcompartments' forest resources. The WebGIS is shown in Fig. 3.

CONCLUSION

This study discussed the specific process of research and the establishment of timber volume accounts system or Rapid-growing and High-yield forest based on WebGIS in china. The height class standing volume calculation model was researched, and this method integrated the advantage of one-variable forest volume table and binary volume table. With this method, a web consultation system was constructed to calculate individual timber volume and for a regional overall accumulation of situation. The system can prove a convenient and efficient interface with specific method.

ACKNOWLEDGMENT

This work is supported by Fundamental Research Funds for the Central Universities Nos.DL12BB05, Heilongjiang Natural science fund in China Nos.F201116 and Heilongjiang scientific and technological project in China Nos.GZ11B304.

REFERENCES

Li, F.R. and Y.H. Zhao, 2006. Development of a GIS-based decision-support system of forest resource management. Sci. China, 49(S1): 76-85, DOI: 10.1007/s 11431-006-8109-x.

Vacik, H. and M. J. Lexer, 2001. Application of a spatial decision support system in managing the protection forests of Vienna for sustained yield of water resources. Forest Ecol. Manag., 143(1-3): 65-76, DOI: 10.1061/50378-1127(00)00506-5.

Wu, S.L., Q.S. Lou, Z.J. Quan and X.J. Li, 2003. Study of setting up the forest resources management information system based on WebGIS. Chinese Geogr. Sci., 13(1): 56-61.