FOREST MANAGEMENT, FOREST INVENTORY AND INFORMATION SYSTEMS IN FORESTRY

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THE SYSTEM AND METHODS OF FOREST FUND INVENTORY ON THE BASES OF INFORMATION TECHNOLOGIES PROVIDING SUSTAINABLE FOREST MANAGEMENT

The article is dedicated to introduction of new methods, means and techniques of forest growing, its protection, sustainable forest treatment, providing increase of forest productivity and resistance, development of forest resource and social-economic role, and rational multifunctional application of forest resources. The author describes newly introduced systems and methods of forest inventory fund on the bases of information technologies providing conversion of the Belarusian state forestry data base into the European one. Models of planning of forest stand growth and actualization are described. Also the article contains information on some mobile means of obtaining taxation data, indexes / indicators for inventory of forest fund with the help of new methods and technologies. The following aspects are under investigation: computer tablet sand forest taxation data input, system of taxation data transfer (by Internet), satellite navigation, and delimitation of forest areas. The author analyses forest growth forecast models and regression models.

Key words: taxation, forest, sustainability, inventory, information technologies, conversion of a model, actualization, accounting, system, program.

Introduction. Understanding the role and importance of the world's forests while providing stable environmental conditions requires a lot of efforts to create and maintain favorable conditions for development of ecosystems.

With this purpose, in 1998, in Lisbon (Portugal) the European Conference of Ministers of forestry adopted the criteria and indicators for sustainable forest management. In Belarus, in 2003 the Department of Forest Management of the BSTU adopted the criteria and indicators for sustainable forest management. Thus, conditions were created for the certification of Belarusian forests with the help of the PEFC and FSC system. Currently, 255.1 mln. ha of forests in 30 countries have been certified by the PEFC scheme including 87.0 mln. ha in North America. In Belarus, forest management and forest exploitation systems of 95 timber enterprises of the Ministry of Forestry in the area of 8 mln. ha of forest fund have been certified by the PEFC scheme. However, for a consistent solution of the problems of creating conditions for the achievement and implementation of sustainable forest management it is necessary to solve a number of technological problems [1, 2].

In our opinion, the first priority is to improve forest management system, as well as the accuracy of inventory and accounting of forest that is inseparably linked with the introduction and use of modern information technologies, the creation of new systems and methods of forest fund inventory.

The main components of this process include:

1) the development of the forecast system of-forest stands growth for forest inventory and updating the forest;

2) the creation of forest taxation data collection and transmission system using computer tablets and mobile equipment;

3) the improvement of the system of state accounting of forests in accordance with the European standards to be converted into a European system of accounting.

Main part. The forest stands growth forecast system should be based, in our opinion, on the model growth forecast of the stands and actualization of forest fund, providing the updating of the data bank for the preparation of the taxation description in the form of a taxotere card. This changes the indicators on the proposed taxation rules given below:

– the age and predominant constituent species: the number of years of the past period are added to the age determined by the previous forest management, thus at the age of 100 years, the result is rounded to the nearest five years, more than 100 years – upto 10 years;

– the height of the predominant and constituent cosmponent of the species is actualized on the updated formulas of O. A. Atroschenko for each component of the species. For young trees with actualized age of 30 years, the height is determined by the scale of the previous bonitetclass;

– diameter: its actualization is performed on the models drawn up using the tables of growth progress. For young trees up to 30 years old the diameter in centimeters is taken equal to the height in meters, the diameter up to 32 cm is rounded with the gradation of 2 cm, greater than 32 cm – up to 4 cm;

– the stock of 1 ha of one tier below the age of 30 years is determined by the standard tables of stocks at a density of 1.0 on the basis of the height of the predominant species;

– the completeness of tiers: the average height of the tier is. According to the standard tables the stock is determined by the predominant species at a density of 1.0. To determine the relative completeness the updated reserve of tiers is divided by the stock at a density of 1.0. The result is rounded to one decimal point. For the young trees under the age of 30 years the actualization of completeness is not performed;

– land category: non-closed crops (code 19) are replaced by forest crops (code 2). Other land category codes are not changed.

Regression models were developed according to the standard tables of stocks of the Central Research Institute of Forestry, the total bonitetscale of Professor M. M. Orlov (height) and the growth progress tables (diameters).

Regression models have the form:

$$\lg P_H = b_0 + b_1 \cdot \lg A + b_2 \cdot H + b_3 \cdot \lg;$$

$$\lg P_D = b_0 + b_1 \cdot \lg A + b_2 \cdot D + b_3 \cdot \lg;$$

$$\lg P_M = b_0 + b_1 \cdot \lg A + b_2 \cdot M + b_3 \cdot \lg,$$

where P_H, P_D, P_M – the average percentage of the periodic current rate (per year), respectively, height, diameter and the growing stock; A – the average age of the stand, years; H – the average height of the forest stand, m; D – the average diameter of the stand, cm; M – forest stock, m^3.

The system of growth modeling and productivity of forest stands for bonitet classes is developed based on their classification according to the general bonitetscale suggested by Professor Orlov as a common table to evaluate the productivity of the country's forests. On the basis of the data of a general bonitet scale the following indices of bonitet class (Table 1) were adopted. Mobile data acquisition and transmission means are based on the use of computer equipment. At present, computer tablets and smartphones are widely-used. Tablet PC is a full-sized IBM-PC-compatible laptop, equipped with a touch screen that allows you to work with a stylus or a finger in the field. The main distinguishing feature of this family of PCs is hardware compatibility with IBM PC. Full-fledged operating systems installed on them are also used on desktop computers.

The most used operating system for tablets when used in the field is ArcPad – it is a software oriented for forest management specialists working in the field and is used for the collection of attributive data and mapping the terrain. ArcPad offers a variety of STS-sharing and GPS for fast and efficient data collection, editing and displaying geographic information.

With this program you can fill out an electronic form of the inventory cards in the field directly on the tablet PC. This operation allows you to avoid loading the data of a sample inventory into the computer. The program ArcPad makes it possible to load a sample inventory of the past forest management. The transmission system can be carried out directly in the computer center of Belgosles [1].

The improvement of the state forest inventory system in accordance with European standards is based on new methods and technologies in the inventory of forest fund.

The implementation of the state forests of Belarus to the European records system should be performed taking into account three main forest accounting methods [2].

Data on forests and forest resources are provided in the form of distribution areas and reserves stands for age classes. Mainly the 10 years age classes are taken. For each tree species age class forest area in hectares, the total growing stock, average stock per 1 ha and the current increase in cubic meters per 1 ha per year are given.

The information on areas and reserves stands for diameter classes is provided.

For the countries with low forest resources aggregated total data of plantations and reserves are given, as well as the current growth for the year on 1 ha.

The domestic system of the state registration of forests is very detailed. It needs to be corrected. It may be recommended to add the following sizes of taxation rates given in Tables 2 and 3.

Table 1

Indices of Site Classes

Woodspecies	Site class								
	I^b	I^a	I	II	III	IV	V	V^a	V^b
Pine	37	33	29	25	21	17	13	9	5
Spruce	37	33	29	25	21	17	13	9	5
Birch	28	25	22	19	16	13	10	7	4

Table 2

Diameter indicators, height, volume and growth, recommended for the addition to the state accounting system

Indicators	Age groups (10 years old)						
	1	2	3	4	5	6	7
$D_{average}$, cm	–	5.7	8.4	11.2	14.0	16.7	19.5
$H_{average}$, m	–	5.6	8.6	11.3	13.8	16.2	18.5
V, m^3	–	0.019	0.024	0.070	0.110	0.160	0.200
Z, m^3/ha	–	7.0	8.7	8.4	7.3	6.3	5.6

Table 3

Taxation indicators ofthe age groups, area, total reserve and reserve per 1 ha, recommended to the addition to the state accounting system

Indicators	Age groups (10 years old)						
	1	2	3	4	5	6	7
Age	to 10	11–20	21–30	31–40	41–50	51–60	61–70
S, thousand ha	3	2	3	2	10	10	5
Reserve, thousand m^3	60	100	180	1,401	900	1,000	600
Reserve per1 ha, m^3/ha	20	50	60	70	90	100	120

Conclusion. Mobile data collection and transfer can be effectively used in forest management at the forest inventory and forest fund, aerospace monitoring of forests, while organizing ecotourism, and tourism resources. When updating the forest fund the forecasting models of diameter growth, height and growing stock, designed according to the local growth Tables are used. The indicators of growth forecast of stands systems are used for actuzlization of forest. Operative can be taken into account the current changes in the forest reserve associated with acceptance and transfer of forest land. The current changes in the forest reserve connected with the acceptance and transfer of forest fund lands, tourism planning can be rapidly taken into account.

The improved system of the State forest inventory in accordance with the European standards in the complex will allow to solve the problem of increasing the efficiency of forest management, as well as its profitability by increasing productivity of forests, improving their species and age structures. It is planned to increase the economic efficiency by raising revenue from improved pricing mechanism for timber, cost optimization by carrying out non-continuous felling and replacement of planting by natural regeneration, increasing the volume of the main use.

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