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THE CURRENT GAIN ON THE STOCK OF PINE FOREST STANDS OF "LOGOISK FORESTRY" IN GIS "FOREST RESOURCES"

The parameter of the volume increment are added to the mock “The description of elements of a forest” standard form of the viewing attributive databases GIS “Forest resources”. For this, the mathematical model is destined for using in the geoinformation system “Forest resources” for assessing of the pine stands volume increment. The result was determined by volume increment of pine stands Logoisk forest enterprise. The distributions of the current volume increment of age classes, productivity classes, stand densities and forest site types are given. The thematic map of the distribution of the current volume increment of the pine stands Logoisk forest enterprise are compiled in the article**.**

Introduction. Questions of rational use of natural resources, conducting forestry activity, restoration of the woods and increase of their efficiency become an important state problem which effective decision is based on the modern theory of a structure of planting and improvement of modeling of conditions of forest stands in dynamics. There was a considerable intensification of knowledge of regularities of growth of a forest stand both in a statics, and in dynamics. With the development of the theory and practice of mathematical modeling and expansion of area of its application in studying of forest stands. Researches of productivity of plantings are based on collected skilled materials of real forest stands with the subsequent their processing by means of the regression analysis. The forest mensuration models received thus in general reflect average taxation values of forest stands.

One of the most important indicators characterizing efficiency of plantings is the gain, in particular for forestry a gain of forest stands on a stock. Information on a gain of forest stands provides control of a condition of the woods and efficiency of plantings at continuous and inexhaustible forest utilization [1].

Implementation of these tasks demands information support of forestry, increase of accuracy of valuation of the woods, receiving the staticized, reliable and certain information about a condition of forest fund productivity of the woods on the basis of which it could be possible to take a long-term maintaining forestry programs and to decrease in a prime cost of silvicultural and forest management works and increase of the income of forestry are possible.

Main part. National and global information systems which repeatedly accelerate and give new quality of work with the versatile, quickly replenish data on various objects, contribute a sustainable development of many branches of economy, including forestry.

In the Republic of Belarus since 1992 under the leadership of the prof. O. A. Atroshchenko the domestic specialized geographic information system (GIS) "Forest resources" is implemented in all forestries of the Ministry of Forestry . GIS "Forest Resources" has ample opportunities of input, control, editing and submission of various data on the woods and lands of forest fund. Geoinformation system is intended for obtaining reports on inquiries to information which is stored in cartographical and attributive databases, for development of annual working plans of cabins of the wood, programs of reforestation, the press of planned cartographic materials, etc. [2, 3].

In the conditions of intensive forestry activity GIS at the accounting of the current changes in forest fund, updating and the forecast of forest fund, rationing of the amount of use of the wood, regulation of pedigree and age structure of the woods is especially necessary.

In this plan geographic information systems can provide most quickly the information on the size of the current gain on a stock [4].

Modeling of a gain on a stock of forest stands consists of several stages:

– theoretical justification of methods of studying and an assessment of a gain on a stock of forest stands;

– collecting sufficient experimental material on valuation of a gain of forest stands; Modeling of a gain on a stock of forest stands consists of several stages:

– theoretical justification of methods of studying and an assessment of a gain on a stock of forest stands;

– collecting sufficient experimental material on valuation of a gain of forest stands; - Development of methods to assess growing stock increment of forest stands;

- Experimental investigations of increments, including accuracy assessment of different methods to determine increment of forest stands;

- Classification of growing stock increments of forest stands into a system of forest growth models, joint growth models and yielding capacity of forest stands;

- Up-to-date concept of a computer-based modeling of increments and yielding capacity of forest stands .

In order to develop forest stands growing stock increment models the following may be used:

1) Methods of repeated taxation of forest stands within stations;

2) Methods of forest stands taxation within temporary sample plots;

3) Methods to determine the forest stands increment according to models or volumetric tables [1, 4].

The most promising way to assess growing stock increment of forest stands is to define it in the form of computer models based on taxation indices of stands. It is appropriate to use models based on functions of the forest growth as the forest mensuration models of the growing stock increment.

The "Forest Resources" geo-information system makes it possible to obtain updated reliable information on each forest plot within the forestry every year given current changes in forest resources (forest felling, reforestation, forest fires, natural disasters). Updated reliable information on forest resources of the forestry is the basis information for the forest management planning according to forest groups and dominant species.

Consequently, an important issue is to solve the problems of using forest mensuration models of growing stock increment of forest stands in the "Forest Resources" geo-information system in order to assess growing stock increment of pine stands in every forest plot (taxation plot), dominant species and groups of forests. This will allow assessing increments according to yield classes and forest types, density and age groups, including suitable standardization of final and intermediate yield.

Relations between the current growing stock increment and other taxation indices has been studied by many researchers, such as I.M. Naumenko, F.P. Moiseeenko, A.S. Babakin, M.L. Dvoretsky, P.V. Voropanov, P.M. Verkhunov , P.V. Yakas, O.A. Trull, V.S. Miroshnikov, V.E. Ermakov, N.N. Svalov, O.A. Atroshchenko, V.F. Baginsky and others [1, 6]. Extensive work to identify logical connections between the current increment and other taxation indices has been carried out by V.V. Antanaitis and V.V. Zagreev [1, 6].

Using computer processing of taxation results in the forest science has led to active usage of multiple regressive analysis, including development of simple regression equations (one explanatory variable), as well as multiple regression equations (two or more explanatory variables).

As a rule, researchers are testing not a single, but several models in their works on modeling of the forest stand increment, and the best one is then selected out of them. Increment is, in fact, the derivative of the growth function, the detailed analysis of which has been carried out by A.K. Kiviste [7].

The selection of variables for the regression analysis is limited by available items in the attribute base of the "Forest Resources" GIS. Undoubtedly, one of the variables must be the age, as it delimits the growth process into timeslots. The other variables are growth indicators in space: diameter, height and volume (stock). The important indicator – the total basal area – is limited for using, as the Formap is calculated in GIS for mature stands only. Introduction of the intermediate indicator to calculation (of the same radial growth), which is not available in the attribute database, leads to an inevitable increase in the systematic error [3, 5].

The Finnish scientist K. Kuusela [8] presented a percentage of the current growing stock increment as a function of stock and age PM = f(M, A). Regression equations to calculate the percentage of the current changes of stock were developed by the Prof. O.A. Atroshchenko [9]. Lithuanian scientists researches confirmed this pattern, although they also indicated that the practical importance of the said relation is not significant, as the radial growth was not taken into account, which considerably improves the accuracy of the model (correlation coefficient can reach 0.99) [10].

The forest growth modeling is largely dependent on the availability of sufficiently reliable and complete silvicultural information. It is quite a time-consuming process to collect such information.

As contrasted with the widely-spread opinion, a massive bank of long-term observations on permanent sample plots is not mandatory. The relatively small number of samples, which is especially useful to create a decision-making system, may provide data for the development of adequate functions of the stand growth in conjunction with temporary random samples (random forest inventory), as well as reduce subjectivity in mathematical modeling, and increase the reliability of results in the case of statistical analysis [6]. The main advantage that is unattainable when using other method.

The main advantage unattainable at other methods of collecting primary data is the highest representativeness and strict objectivity because of statistical selection of units from population. Experimental material for studying of stock increments and productivity of pine forest stands is presented in a form of data of selective valuation of plantings by results of a selective forest inventory of the woods of the Grodno IFA (4801 circular trial platforms) and 71 temporary trial areas [5]. Belonging to one natural number of growth and development was checked according to the method by N. V. Tretyakov where the average height and average diameter of a forest stand is accepted as the dependent variable in regressions. Regressions

of communication of these works of forest stands explain the age 85–95% of a variation of works, reliable on Fischer's F-criteria on a 5% significance value [5].

A number of the regression equations with several variables (R^2 = 0,71–0,96) was estimated on the basis of the literature review of the calculations of size of the current increment of forest stock . As a result of the multiple regression analysis the model of the current increment of stock in dependents from a stock of M and age A [5] is received:

$$\overline{Z}_M^n = 10^{b_0} M^{(b_1 + b_2 \lg(A))}.$$

For the obtaining of the current increment on of stock of SFE "Logoysky Forestry" models of the current increment of stock of pine forest stands of Ia-III of classes of site class were taken, for other classes of site class the general forest valuation model of a increment was taken [5].

For a increment assessment of pine forest stand stock of the forestry it is necessary to add the model to the standard attributive database "Forest Resources" which is received according to the basic forest management 2010 [5, 11]. For this purpose it is necessary to use a database management system (for example, Ms Access) or to use specialized program for working with tables of databases in the Paradox format (for example, DataBase Desktop, DataBase Workshop etc.). For calculation of increment of a stock with the use of GIS changes to the following files of the GIS

а) <GIS>\Bases\Logoisk forestry\Logoiski.db;

б) <GIS>\Bases\Logoisk forestry\Logoiski SOST.db;

в) <GIS>\Bases\Logoisk forestry\Sprav\ spfield.db;

г) <GIS>\Bases\Name of the forestry\Sprav\ sptab.db [11].

As a result we got the following data:

Table 1

Distribution of growth in reserves of pine stands SFE "Logoiski forestry" by site classes

Indicator	Age class								Total
	1	2	3	4	5	6-	7-	8-	
Area, hectare	2953.6	8786.7	20600.2	18825.1	6622.9	1711.7	80.7	8.5	59589.4
Area, %	5.0	14.7	34.6	31.6	11.1	2.9	0.1	–	100
Stock, m^3	100 647	1 205 015	4 942 505	5 199 319	1 806 622	459 749	20 068	2 226	13 736 151
Stock on 1 ha, m^3	34	137	240	276	273	269	249	262	231
Iincrement, m^3	10937.6	69810.6	164216.2	115631.9	27926.5	5683.2	193.2	17.0	394416.2
Increment, %	2.77	17.70	41.64	29.32	7.08	1.44	0.05	–	100
Increment on 1 ha, m^3	3.70	7.95	7.97	6.14	4.22	3.32	2.39	2.00	6.62

Table 2

Distribution of growth in reserves of pine stands SFE "Logoiski forestry" by growth classes

Indicator	Growth class									Total
	Iб	Ia	I	II	III	IV	V	Va	Vб	
Area, hectare	1.5	5348.3	3355.3	17303.6	2219.4	732.1	293.1	116.9	21.5	59589.4
Area,%	–	9.0	56.3	29.0	3.7	1.2	0.5	0.2	–	100
Stock, m^3	510	1 613 055	8 499 097	3 161 525	307 709	109 457	34 897	8 397	1 504	13 736 151
Stock on 1 ha, m^3	340	302	253	183	139	150	119	72	70	231
Iincrement, m^3	22.5	46117.2	240709.2	94259.5	9561.2	2689.3	808.8	227	21.5	394416.2
Increment, %	–	11.7	61.0	23.9	2.4	0.7	0.2	0.1	–	100
Increment on 1 he, m^3	15.0	8.62	7.17	5.45	4.31	3.67	2.76	1.94	1.00	6.62

Table 3

Distribution of growth in reserves of pine stands SFE "Logoiski forestry" by density

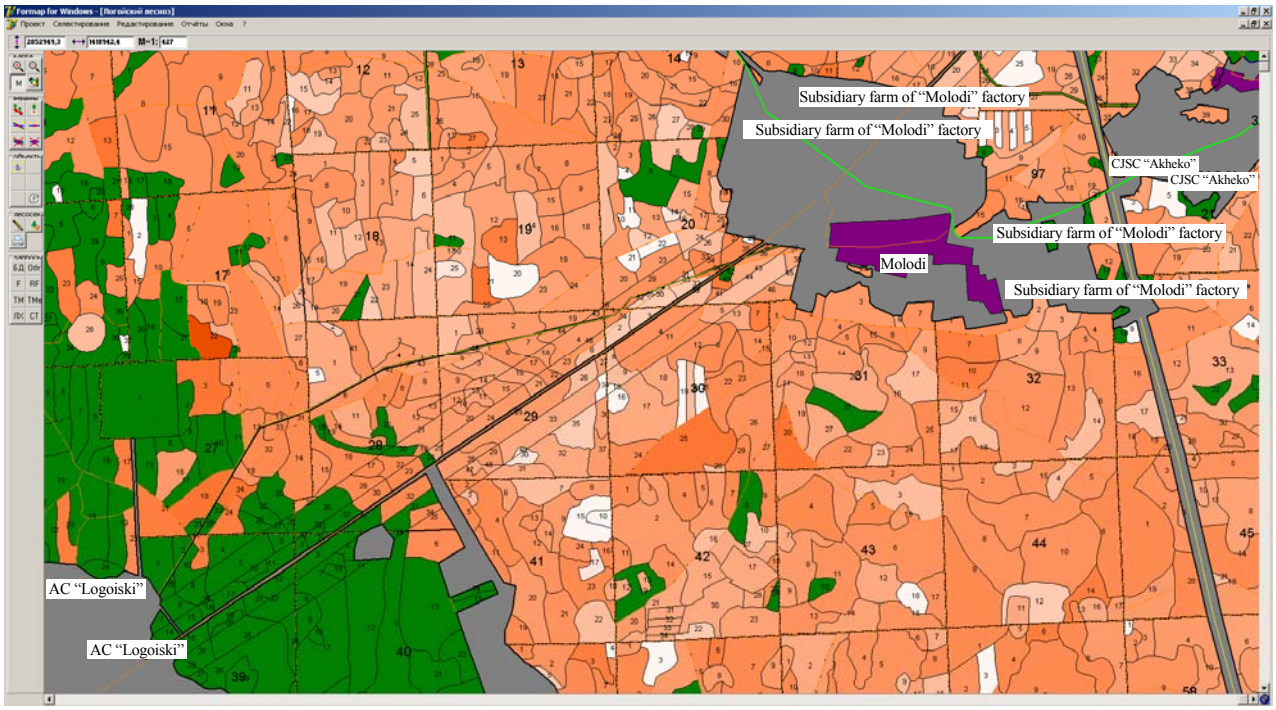
Indicator	Density								Total
	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	
Area, hectare	109.8	457.2	2560.9	11541.1	29312.4	10867.8	4277.9	462.3	59589.4
Area,%	0.2	0.8	4.3	19.4	49.2	18.2	7.2	0.8	100
Stock, m^3	14 391	76 617	518 251	2 719 729	7 201 446	2 387 052	751 637	67 028	13 736 151
Stock on 1 he, m^3	131	168	202	236	246	220	176	145	231
Iincrement, $м^3$	229.8	1239.1	9693.7	58587.4	196336.5	87971.2	36288.6	4069.9	394416.2
Increment, %	0.1	0.3	2.5	14.9	49.8	22.3	9.2	1.0	100
Increment on 1 he, m^3	2.09	2.71	3.79	5.08	6.70	8.09	8.48	8.80	6.62

Table 4

Distribution of growth in reserves of pine stands SFE "Logoiski forestry" by forest type

Forest type	Area		Stock, m^3		Increment		
	he	%	total	1 he	m^3	%	1 he, m^3
Lichenous	6.3	–	275	44	16.6	–	2.63
Vaccinium	249.2	0.4	52 657	211	1119.6	0,3	4.49
Calluna	3001.5	5.0	386 754	129	15034.3	3,8	5.01
Mossy	28217.2	47.4	6 021 437	213	180423.8	45,7	6.39
Bracken	15344.6	25.8	4 072 645	265	118503.4	30,0	7.72
Wood-sorrel	4983.4	8.4	1 446 507	290	34633.9	8,8	6.95
Moss	9.1	–	2 730	300	72.8	–	8.00
Myrtillus	5486.8	9.2	1 353 531	247	35437.8	9,0	6.46
Долгомошный	1036.4	1.7	223 495	216	4956.8	1,3	4.78
Приручейно-травяной	99.4	0.2	22 249	224	492.6	0,1	4.96
Ledum	886.9	1.5	124 866	141	3091.9	0,8	3.49
Sedge	111.5	0.2	16 786	151	338.2	0,1	3.03
Sedge-sphagnum	135.6	0.2	10 715	79	273	0,1	2.01
Sphagnum	21.5	–	1 504	70	21,5	–	1.00
Total	59589.4	100	13 736 151	231	394416.2	100	6.62

Conclusion. From these results it is clear that the current increase in the stock of pine stands SFE "Logoiski forestry" is 394.416.2 m^3 and 1 ha - 6.62 m^3.This is due to the fact that the pine forests of the 2nd and 3rd class age (where the current gain is maximal - 7.95 and 7.97 m^3 respectively) make up 49.3% of the total area of the pine stands. Highly pine stands Ib- I yield classes make up 55.3% of the total area of the pine forest, they exhibit a high current gain in the stock on 1 ha 7.17-15.0 m^3. Pine plantations of high density (relative completeness 0.8-1.0) make up 26.2% of the total area of the pine forests and provide the maximum increase in the stock 8,09-8,80 m^3. Distribution of pine forests forestry in completeness in a certain way due to their age structure, site conditions. The optimum fullness of 1.0, which corresponds to the maximum current gain over stock. Among the groups of forest types pine stands to gain the most current stock have fern forest types and wood sorrel - 7.72 and 6.95 m3 respectively. The value of the current gain on a stock green moss forest type is not entirely reliable because of its small area (9.1 ha). Using GIS "Forests" can also receive maps showing the distribution of the value of the stock at current growth pine stands SFE "Logoiski Forestry" (Figure).



Spatial assessment of the current growth pine stands on the stock "Logoiski Forestry"

Information about the growth in demand for the stock at a high intensity of forest management, particularly in the precinct forest management methods, which is planned to gradually introduce in forestry of our country in accordance with the Strategic Plan for Forestry Development in Belarus.

In this respect, GIS provides a unique opportunity, allowing instantly calculate a gain on a stock Mark all represented in the database. The effect on the final result will have the actual data accuracy and taxation, the main method which is now the visual with its characteristic for him significant and systematic errors [12].

Valuation current growth pine stands in GIS "Forests" can also be used to determine the potential productivity of pine stands for the economic evaluation of forest land and forest inventory, sustainable forest management and forest department forest certification forestry enterprises.

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