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DEVELOPMENT OF ELECTRONIC MODEL AND DATABASE OF ARBORETUM

This article presents the issue of work optimization, which deals with the arboretum in forestry agencies. A reduction to practice an electronic model and database of dendrological park in the engineer of forest regeneration's job is proposed for this purpose. The article describes the technology of field data collection and methods of processing, presents characteristics of objects, which are displayed on the electronic map. The item of the product's fundamental functionality and directions for its improvements is addressed.

Introduction. According to the State Programme for Forestry Development of the Republic of Belarus for 2011-2015, among the main targets of reforestation there are restoration and preservation of biodiversity and improvement of ecological situation. For the solution of this task it is planned to expand the chain of arboretums, available in the silvicultural organizations, for the purpose of ecological education of the population by creation of 50 objects of this kind with a total area not less than 135 hectares. Arboretums will become gradually the objects of ecological education, the vacation spot for the population, will get cultural and experimental value [1].

Since 2011 in the government forestry institutions the work on establishment of arboretums was actively developed, their area varies from 2 to 4 hectares, the species composition of wood and shrubby vegetation constantly enriches. Besides plants, in the territory of arboretums there is a developed road and path network with different types of surface, small architectural forms, fences and many other things.

For the organization of works in arboretums technical officers spend considerable part of working time, because all the materials are on papers and often projects of arboretums don't correspond with the real situation. The latter is connected with the difficulties arising at the time of purchasing of planting material, and, as a result, with the use of a planting material of proper nurseries of forestry stations.

Main part. For the purpose of optimization of the works connected with arboretums, the idea of development of electronic model and a database of dendrology objects was put forward. The idea was realized in IV quarter of 2012 in the project of the arboretum of Skidelsky forestry station, and it was successfully introduced in the work of the engineer on reforestation.

For this a free Quantum GIS software – free cross-platform geoinformation system was used. The main reason why it was chosen, were: simple and clear interface, wide toolbox with high functionality, a free program code that allows to develop additional modules if necessary [2].

Originally at the time of the map creation, object location shooting is necessary. During the work in an arboretum the data gathering was divided into two stages: the first – mapping of location of all available objects on the studied territory, the second – studying of characteristics of all objects and measurement of their parameters.

The first stage was in turn divided into two substages: laying a compass traverse and actual mapping of all objects.

The fact that mapping was carried out on a sizable territory increases an inaccuracy of determination of objects location. Therefore for minimization of mistakes before field works the analysis of available cartographic materials (the arboretum project, cartographic materials of the territory of arboretum location approved by land management) and life-size object was carried out. The purpose of works was definition of an optimum route for running of the closed theodolite traverse, and objects of intermediate control, for example borders of the arboretum, crossing of roads, power lines, etc. The theodolite traverse served as "framework" to which all mapped objects referenced.

The coordinates of location of objects were defined by a method of angles and distances in polar system of coordinates [3] (Fig. 1). In field conditions for angle measurement there were used T5 theodolite (observation error – 6"), and for measurement of distances an ultrasonic range finder Haglof DME 201 (accuracy of 1%) was used. The foregoing gives a ground to consider the obtained data to be correct.

The obtained cartographic materials were referenced to the site plan approved by the land management.

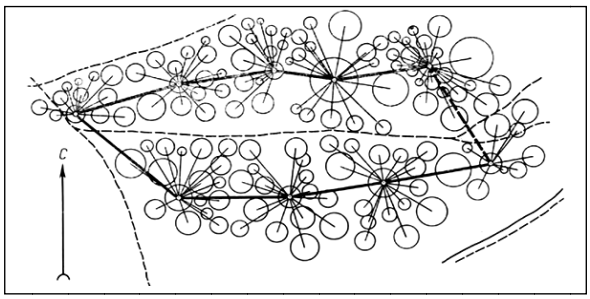

Fig. 1. Polar mapping
and theodolite closed traverse

Further the process of collecting characteristics of objects was carried out. For objects “trees” the following characteristics were defined: wood species, condition, tree height and crown diameter. Since the arboretum was established in 2012, the average age of wood and shrubby vegetation doesn't exceed 5 years. Therefore measurement of two and more crown diameters is considered to be not rational at this age, because trees were planted wide apart. Measurement of trunk diameter at this age is also considered to be not expedient, because diameter varies in the range of 3–5 cm. The latter parameter can be included in the characteristic of trees later, for example, after reaching 10-15-year age. With trees aging process such indices as crown spring height and crown-area can be included in a database.

Objects “shrubs” are represented by two types: point-type – the single ones, and areal-type – located in groups or creating a green hedge. Therefore, their characteristics will differ: the point-typed were defined by species, height and diameter, and areal-typed were defined by species, mean height and number of pieces in a group or green edge.

Hardscaping includes arbors, benches, litter bins etc. They can be displayed both as point-type objects, and areal-type ones with the attached photos of objects (Fig. 2).

Also one of the main types of objects is “road and path”, which main characteristics include area and surface type. The object “fence” is characterized by length and a production material. In some arboretums there can be “water objects” which are characterized by area, mean depth and width if it is a water course.

Along with the above mentioned, the following types of objects can be used in electronic model: “lawn”, “flower garden”, “roads”, “power lines”, “forest area”, “meadow”, “tillage” etc.. Some of them aren't in the arboretum territory, don't enter in silvicultural establishments and in electronic model have only information function for displaying more complete spatial pattern.

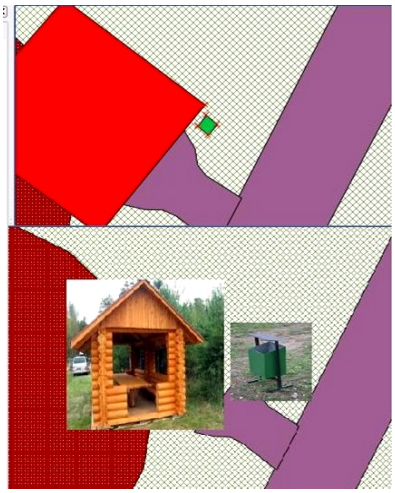

Fig. 2. Objects «small architectural forms»

The cartographic materials concerning the arboretum can be displayed in different ways depending on the targets. Trees and single bushes for descriptive reasons can be shown as multi-colored circles corresponding to the crown sizes and color of wood species. This way of the objects image allows to estimate spatial allocation of wood and shrubby vegetation. This information can be used for improvement of an arboretum landscape. The cartographic material on the arboretum of Skidelsky forest station is showed on the Fig. 3.

Additional advantage of electronic model is that such index as a crown radial increment can help to construct time-space models that can display a state of the arboretum in 5-10-year prospect.

The second variant of the vegetation image on the electronic map is a representation by various markers for bushes, coniferous and deciduous trees.

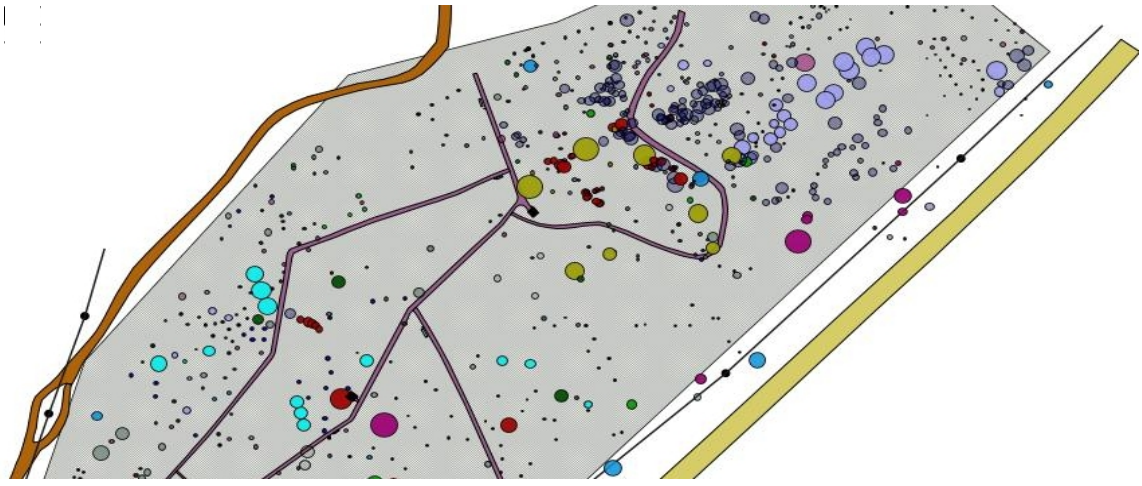

Fig. 3. Graphic map of the arboretum of Skidelsky forestry

Besides, digital map allows to display wood and shrubby vegetation by means of photos of real objects.

A large toolbox of QGIS gives ample opportunities for the analysis of the constructed model. The electronic model allows to measure the areas of objects – this function can be used when planning the arboretum cutting, paths arrangement, etc. The database gives the chance to create by means of standard inquiries the reports, displaying various information (at the present time specialists have to make this type of works by hand). In Fig. 4 there is an example of a database inquiry which contains wood species, object number, X and Y coordinate, tree height and crown radius.

No	SPECIES	X	Y	HEIGHT	CROWN DIAMETER
4	Spruce	512.95	–2146.54	1.4	0.8
5	Spruce	550.19	–2158.58	1.1	0.8
6	Small-leaved linden	514.92	–2095.16	1.2	0.4
9	Spruce	512.71	–2034.72	1.2	1
10	Common plum	536.12	–2033.78	0.7	0.4
11	Spruce	531.86	–1996.78	1.2	1
13	Spruce	625.23	–1993.96	1	0.6
14	Small-leaved linden	610.12	–2083.47	1.1	0.4

Fig. 4. Database enquiry

Conclusion. Inquiries allow to create the following types of the reports: sheets of wood and shrubby vegetation, sheet of a material and monetary assessment of the whole arboretumas well as of separate small architectural forms etc. From a database it is easy to receive the sheet of certain species of trees or shrubs which, for example, need top-dressing. Having made space request, it is possible to obtain the map of allocation of definite trees, and by means of such tool as “calculator”, to calculate necessary amount of fertilizers.

The convenient interface allows the engineer to make easily any changes to a database and cartographic materials if those occurred actually.

Further it’s planned to complete a model to display of volumetric objects, i.e. 3D models of all objects of the arboretum with the relief display.

References

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