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THE INFLUENCE OF SILVICULTURAL AND FOREST INDICES ON THE ACCURACY OF A GPS-SURVEY OF THE FOREST AREAS

The intensive development of space geodesy leads to more active implementation methods of global satellite positioning in various spheres of the person's activity, including forestry. Such surveying methods enable the computer collection process and navigation binding of forest measurements data, eliminate the need to create line visibility between points, allow you to perform surveillance in any weather, both day and night-time measurements and data processing are almost completely automated. However, the use of GPS-equipment under the canopy of the forest has its own characteristics. To study the influence of the habitat conditions, silvicultural and biophysical parameters on the accuracy of a GPS survey of the forest areas satellite measurements are made in the Negoreloye experimental research training forestry. For the measurements we used another set of single-frequency satellite receivers Trimble R3. A GPS-survey was carried out in the kinematic regime of „stop & go" in combination with the regime „on the fly". When conducting the research such silvicultural and inventory indices, as forest type, age, class, the fulness, etc., were taken into account. It was found out that a key indicator affecting the accuracy of a GPS-survey is a species composition.

Key words: GPS-surveying, satellite measurements, kinematic regime, accuracy, measurement error, forestry valuation indicators.

Introduction. An effective forest management, rational use of forest resources, forest monitoring, inventory and accounting of the forest fund – all this requires accurate and precise topographic and geodetic information. At the present stage topographic and geodetic works are impossible without the introduction of new technologies, devices and software. The application of methods of satellite positioning (GPS-methods) allows you to quickly solve tasks with a completely new principle of collecting information about the spatial location.

However, the application of satellite positioning when working under the canopy of the tree stand has its own characteristics, as forest stand itself is a factor hampering the passage of signals from the satellites to the GPS-receiver, which affects the positioning accuracy.

Main part. Relative definitions of the coordinate points and boundaries of forest areas in the territory of Negoreloye experimental forestry were performed with the help of single-frequency satellite equipment Trimble R3 (Figure).

Satellite receiver Trimble R3 enables measurements on the L1 carrier in the frequency mode "statics", "fast statics" and "kinematics", and also operate in DGPS. To control the GPS, Trimble R3 GPS System uses field software Trimble Digital Field Book [1].

GPS-survey of forest areas was done in the kinematic mode. A special feature of this mode is the ability to quickly observe a large number of points, but this requires that the receiver should keep the grip of satellites at all times during the movement between points. In this mode several species are distinguished.

During the kinematic mode "stop & go" two or more receivers are used. At least one receiver is a support and remains stationary during filming. All baselines during the session are determined consistently with respect to the reference receiver. The rest of the receivers move making observations on the points, the coordinates of which are unknown.

Aerial Trimble A3

Receiver Trimble R3

Set of single-frequency satellite equipment Trimble R3

The kinematic mode “on the fly” (in the air) is used when there is confidence that the reception of signals of a sufficient number of satellites will not be interrupted for 20–30 min. During this time, at continuous running of the receiver it will accumulate enough information for further post-processing.

To study the effect of habitat conditions and silvicultural-taxation parameters on the accuracy of GPS-survey of forest areas the actual shooting of pine, spruce, birch and black alder allotments was performed.

The boundaries of departments were coordinated in the mode “on the fly”, which allows you to quickly perform field measurements compared to conventional terrestrial geodetic survey.

However, its major shortcoming when measuring on in forested areas was a permanent loss of signals from the satellites, and the time required to re-initialize. Therefore, the combined method of shooting of forest areas where the boundary allotment was determined in the mode “on the fly”, but at the same time in several places of the trajectories of motion of the receiver the points were coordinated in the mode “stop & go”. This enabled to periodically initialize the receiver on the ground and thus increase the positioning accuracy at low time costs.

GPS-survey results were processed in the program Trimble Geomatics Office [2–4].

In conducting the research the following forestry and taxation parameters were taken into account: type of forest, tree species, composition, age, yield class, fullness, edafotop, height. The results are presented in the Table.

As seen from the Table, the accuracy of determination of forest areas in the kinematic mode ranges from 1.3 to 1.9 m.

The main forestry and taxation parameter affecting the accuracy of the coordinate boundaries of the plot is the species composition. Thus, the best accuracy of position was achieved in pure pine stands (1.3 m) with the fullness of 0.9. In the pine stands with an admixture of birch the error of coordination in the plan was 1.36 m.

The results of the coordination of spruce and birch stands (1.55 and 1.62 m, respectively) had similar accuracy.

The results of evaluation of the accuracy of GPS-survey of forest areas

Forest type	Species composition	Age, years old	Yield class	Fullness	Edafotop	Height, m	The measurement error in the plan, m
Sour	10P	67	Ia	0.9	B_2	27	1.30
Fern	7P, 3B	67 60	Ia	0.8	B_2	26	1.36
Sour	10S	85	I	0.6	D_2	25	1.55
Bilberry	7S, 1P, 1B, 1AlB	75 60 50	I	0.8	C_3	24	1.59
Sour	9B, 1P	65 60	Ia	0.9	D_2	27	1.60
Fern	7B, 3P	65 60	I	0.8	B_2	27	1.64
Sedge	7AlB, 2B, 1S	60 50	II	0.7	C_5	20	1.85

The lowest accuracy of the areas was obtained in black alder forests (about 1.85 m). Another factor affecting the accuracy of the coordinate of forest areas is edafotop. The richer the soil in its nutrition, the lower the accuracy of satellite findings.

Conclusion. The studies show that, when using the single-frequency GPS-receivers to capture the forest areas in the kinematic mode, you can obtain an accuracy in the range of 1.3–1.9 m according to the results of the post-processing. The error in determining the boundaries of forest areas will depend mainly on the species composition at the site of the shooting. To improve the reliability of the results of GPS-measurements in the kinematic mode it is recommended to use the combined method of shooting of forest areas.

The boundaries of allotments can be determined in the mode “on the fly”, but at the same in several places of the trajectory of motion of the receiver it is necessary to coordinate the points in the mode “stop & go”. This enables the receiver to periodically initialize on the area and increase the positioning accuracy at low time costs.

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