

Forest vector of development of DPW Photomod

FROM IMAGERY TO MAP: digital photogrammetric technologies
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Saint Petersburg
Director of Development

The target of forest inventory

Forest compartment

Unique geographic location



Unique forest inventory description

Уч. л-во: Кривешное
Эксплуатационные леса

Квартал : 54

N	Состав	Яр	В	Д	Кл	Во	П	Запас	К	Запас на		
вып	порода	--	м	и	во	ни	о	р	с	р	а	р
возр.	ср	с	а	зр	те	л	и	в	куб	ометрах	.	куб
пл	пдр	о	м	--	т	и	ж	--	т	---	---	---
га	пдр	вы	т	е	гр	+	---	на	по	о	сухо	закл.
год	пкр	со	а	т	во	Т	ип	l	га	сос	в	сто
учета	пчв	та	р	зр	леса	---	---	тав.	а	---	---	---
	выдела	ар			ТЛУ	деле	пор.	н	д	и	ли	ж

1	SE	-110	1	21	26	6	3	0.8	312	2262	1	СПР
14.50	40с	-80	--	25	32	--		ЧР	---	1810	3	Сохр.пдр
2016	1Б	-80	23	21	20	4		В2	4524	452	2	
+С	-140											
+Е	-70											
Подрост: 10Е 20 лет, высота 2.0 м, 2.0 тыс.шт/га												
2	6Е	-110	1	22	26	6	3	0.7	239	3126	1	СПР
21.80	2Е	-75	--	16	20	--		ЧР	---	1042	1	ЛК РТК 5
2016	2Б	-75	21	22	20	4		В2	5210	1042	2	
+Ос	-75											
Целевая порода Е												
3	5Е	-110	1	21	26	6	3	0.8	291	1586	1	СПР
10.90	3Б	-75	--	20	20	--		ЧР	---	952	2	Сохр.пдр
2016	20с	-75	22	26	32	4		В2	3172	634	3	
+Е	-75											
Подрост: 10Е 20 лет, высота 2.0 м, 2.0 тыс.шт/га												
4	4Б	-15	1	5	4	2	4	0.7	20	346		ПРЧ
43.30	40с	-15	--	6	6	--		ЧР	---	346		выб.35 %
2016	1С	-15	5	4	4	1		В3	866	87		
1Е	-15									87		
+Б	-80											
5	5Б	-15	1	6	6	2	3	0.8	39	361		
18.50	50с	-15	--	8	6	--		ЧР	---	361		
2016	+Е	-15	7					В2	722			
6	7Б	-65	1	20	20	7	3	0.8	182	408	2	СПР
3.20	10с	-65	--	22	24	--		ЧР	---	58	3	ЛК РТК 5
2016	2Е	-85	20	20	24	4		В2	582	116	1	
Целевая порода С												
7	40с	-85	1	25	32	9	2	0.7	260	530	3	СПР
5.10	2Е	-85	--	21	20	--		КС	---	265	2	ЛК РТК 4
2016	3С	-110	24	25	32	5		С3	1326	398	1	
1Е	-90									133	1	
Целевая порода Е												

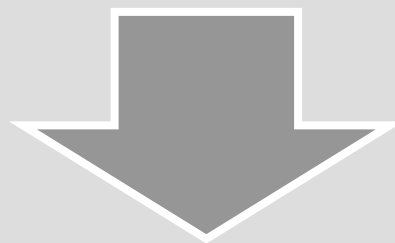
Total number of forest compartments – 50 millions

The problem

The total demand to actual results of forest inventory according expert assessments is about 300 mln. ha every year. This demand is



Unsatisfied



Growing

Decision of the problem

1. Transition to modern high-performance and relative cheap remote sensing technologies of forest inventory
2. Education of specialists (personnel training).

Technology of stereoscopic forest inventory

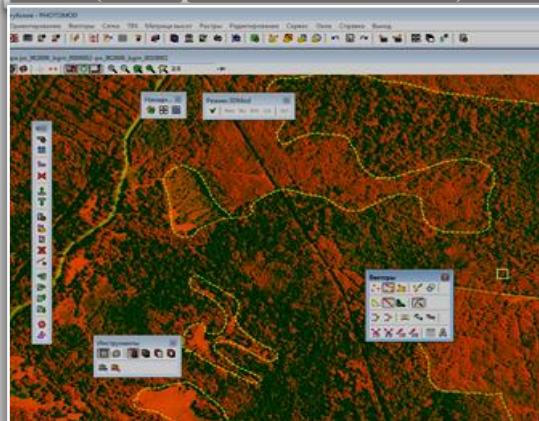
MAIN STAGES

1. AERIAL or satellite SURVEY



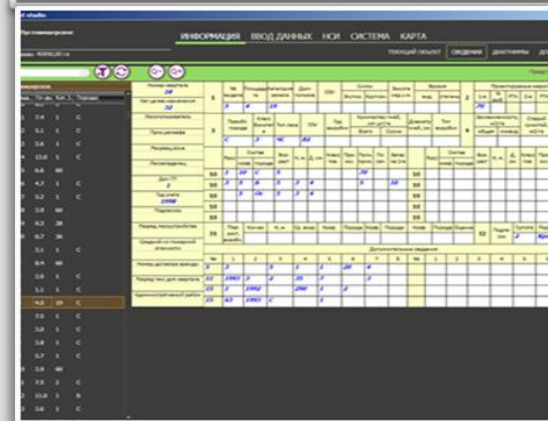
- Planning, ordering, implementing, receiving materials of the aerial digital aerial survey
- Making ortho-photo-maps

2. INVENTORY (interpretation method)



- Making digital cartographic base
- Making contour, analytical and metrical interpretation
- Digitizing the borders of forest compartments (by means of «Photomod StereoMeasure» module)

3. GIS FORMATION



- Entering the inventory cards
- Forming the GIS database
- Printing the standard forest maps, sheets and reports (by means of «PLP-2015», WinGIS etc.)

Education of specialists

The set of the tutorials for training of specialists on forest interpretation (developed in conjunction with Saint Petersburg State Forest Technical University and Volga State University of Technology):

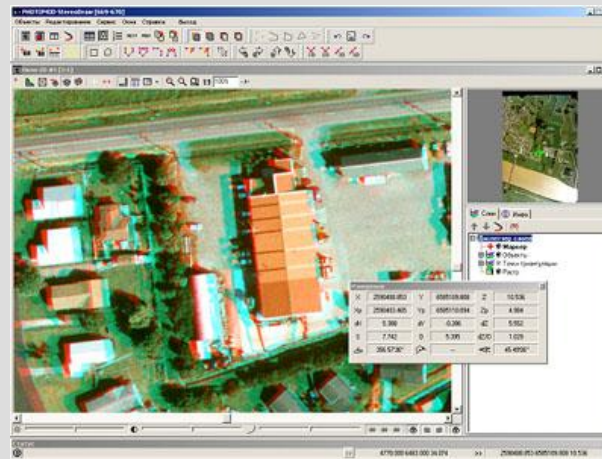
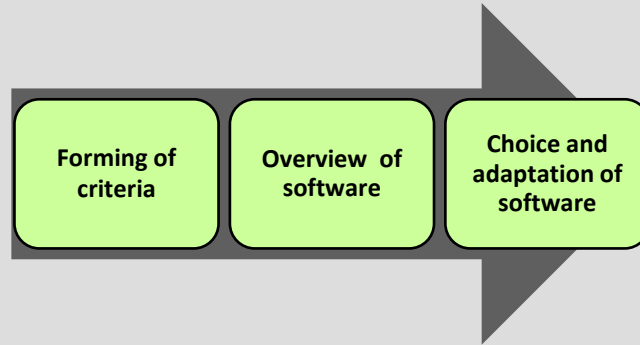
1. Lectures (32 hr., 10 themes)
2. Laboratory studies (64 hr., 12 themes)
3. Training practice at the special training polygon (96 hr., 4 themes)
4. Set of the visual tutorials (classifications, standards and samples, blanks and special sheets) for practical lessons
5. Programme of professional training

Photomod – the keys software in chain of forest inventory stereoscopic interpretation

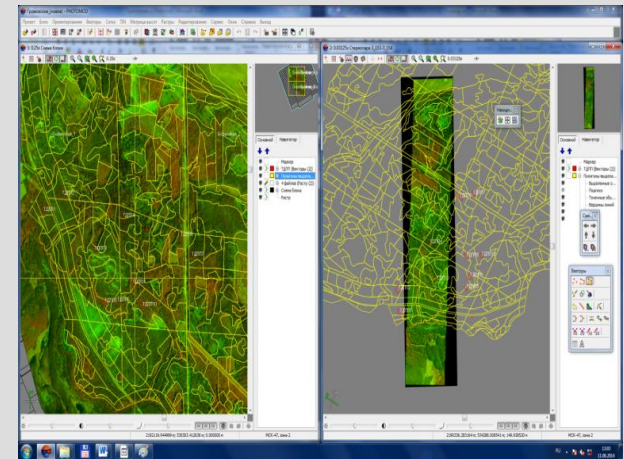
PHOTOMOD – from StereoDraw to StereoMeasure

Criteria for choice:

- Forming of stereo pairs from remote sensing data;
- Possibility of work with multizonal images in stereo regime (analysis, mensuration of heights, digitizing);
- Possibility execute of analysis features of interpretation and definition of forest inventory characteristics of compartments;
- working in local nets;
- russification;
- acceptable price



«PHOTOMOD StereoDraw»
(module for stereo drawing)



«PHOTOMOD StereoMeasure»
(module for forest interpretation)

The choice of software and hardware for forest interpretation

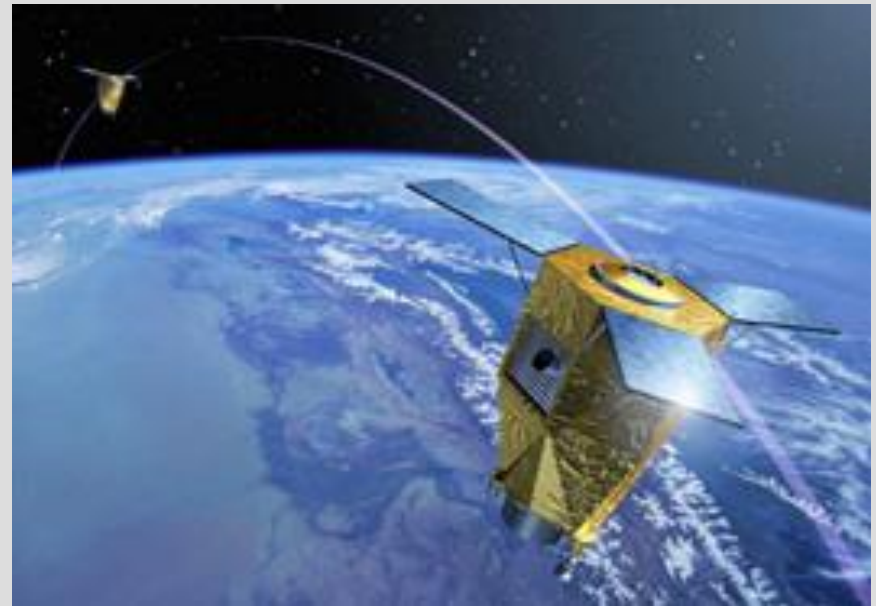
Technical requirements for remote sensing data

Technical requirements for remote sensing data

- color spectrozonal stereoscopic digital images (RGB + NIR channels)
- **the presence of stereoscopy is mandatory**
- spatial resolution - 0.3-0.5 m
- longitudinal overlap of images - 56-60%;
- transverse overlap of images - 10-15%;
- The height of the Sun during the survey is at least 25 degrees.

Output materials

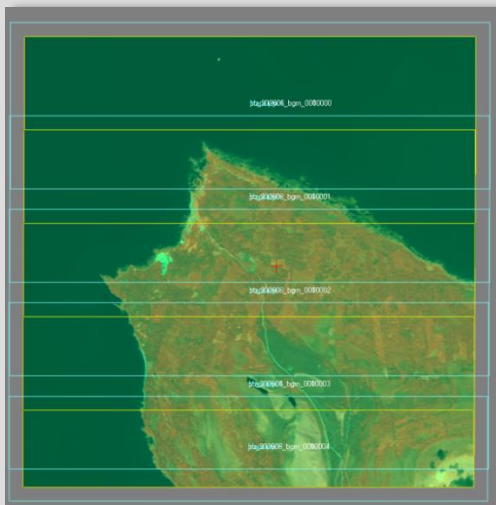
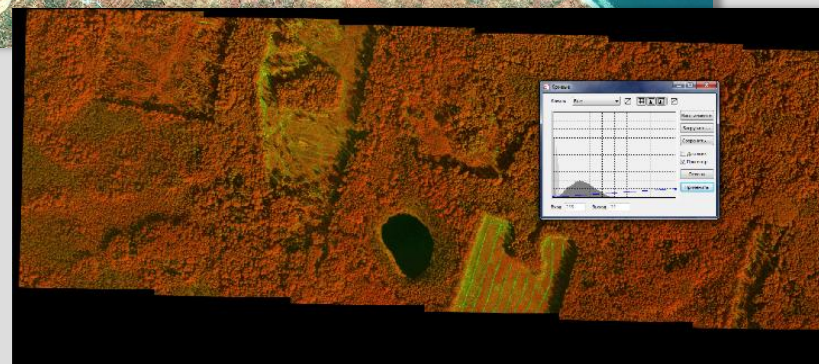
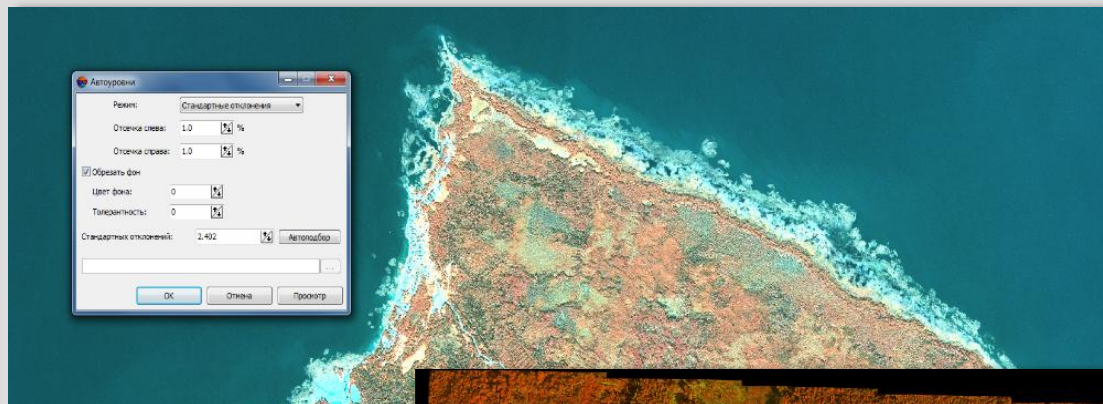
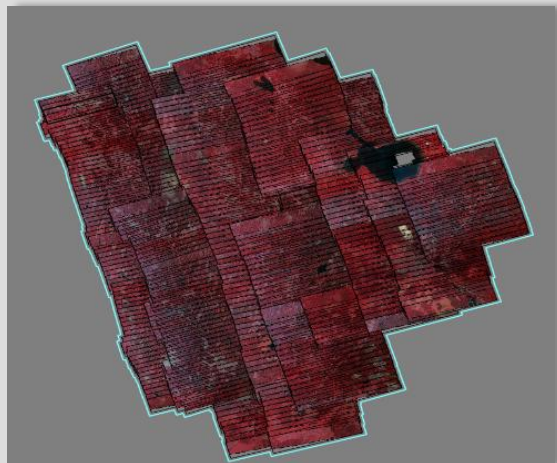
- high-precision orthophotos
- sets of stereopairs



Interpretation of forests taking into account methodology and technology aspects of work is divided to

- Contour interpretation
- Forest inventory interpretation
 - analytical interpretation
 - measuring interpretation

Preparing images for forest interpretation in PHOTOMOD StereoMeasure



- Forming of projects by objects of work with sets of vector and raster layers, remote sensing data
- Improving of images (making pseudocolour images, radiometric correction, setting of histograms)

Contour interpretation in PHOTOMOD StereoMeasure



STAGES

A. AN OVERVIEW OF THE TERRITORY

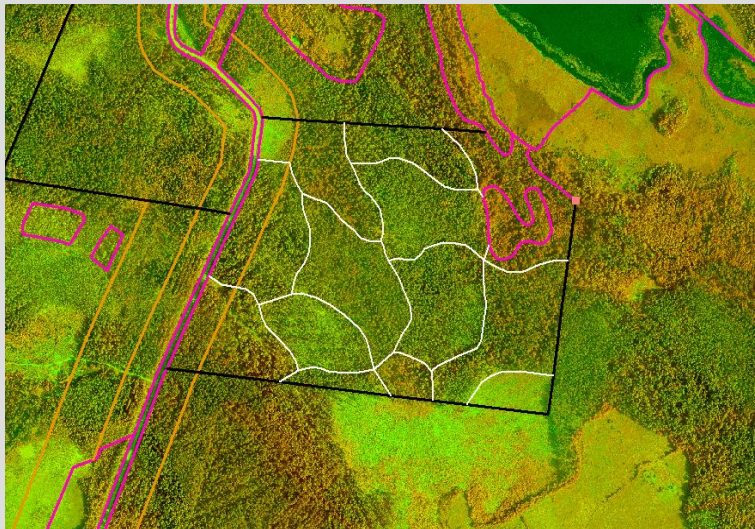


B. ADDING OF VECTOR LAYERS WITH DIGITAL
CARTOGRAPHIC BASE

Contour interpretation in PHOTOMOD StereoMeasure

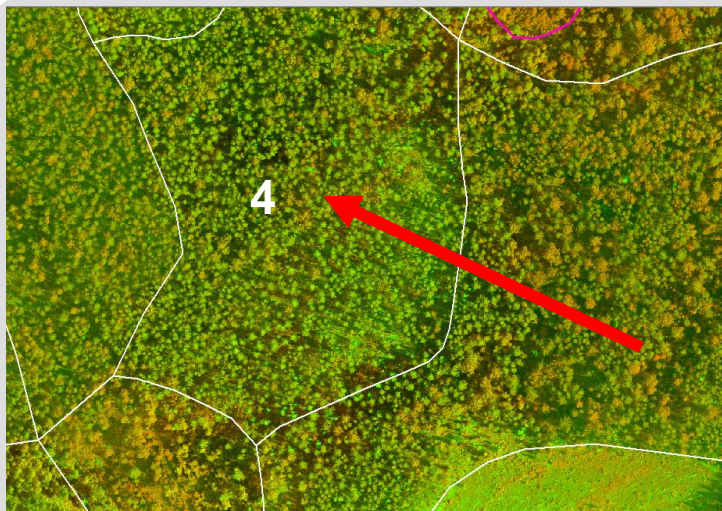


C. TOPOGRAPHY INTERPRETATION

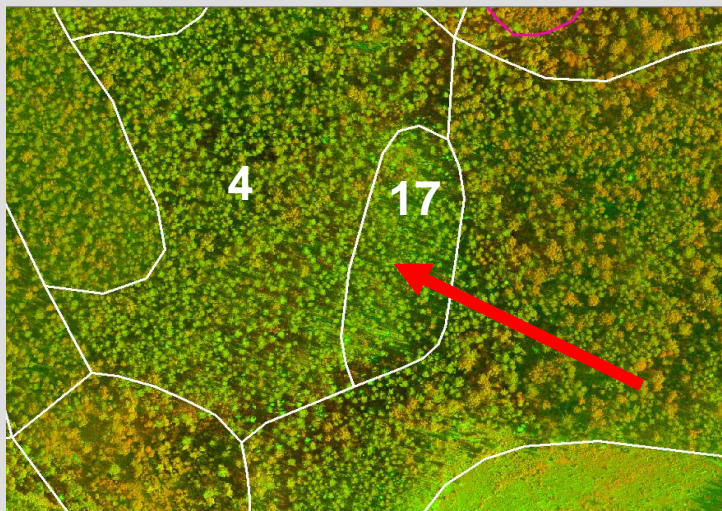


D. DIVIDING OF FOREST BLOCKS TO LARGE (GENERALIZED) PLOTS

Contour interpretation In PHOTOMOD StereoMeasure



E. THE ENLARGED PART OF GENERALIZED PLOT



F. DIVIDING OF THE GENERALIZED PLOT TO SEPARATE FOREST COMPARTMENTS

Number of compartment	Composition	Age	Height	Basal area	Growth class	Forest type	Volume, m ³ /ha
№ выдела	Состав	А, лет	Н, м	Полнота, ед.	Класс бонитета	Тип леса	Запас, м ³ /га
4	7C2E1Б	100	25	0.7	2	С-ЧС	305
17	10С	100	22	0.5	3	С-БР	190

Contour interpretation in PHOTOMOD StereoMeasure



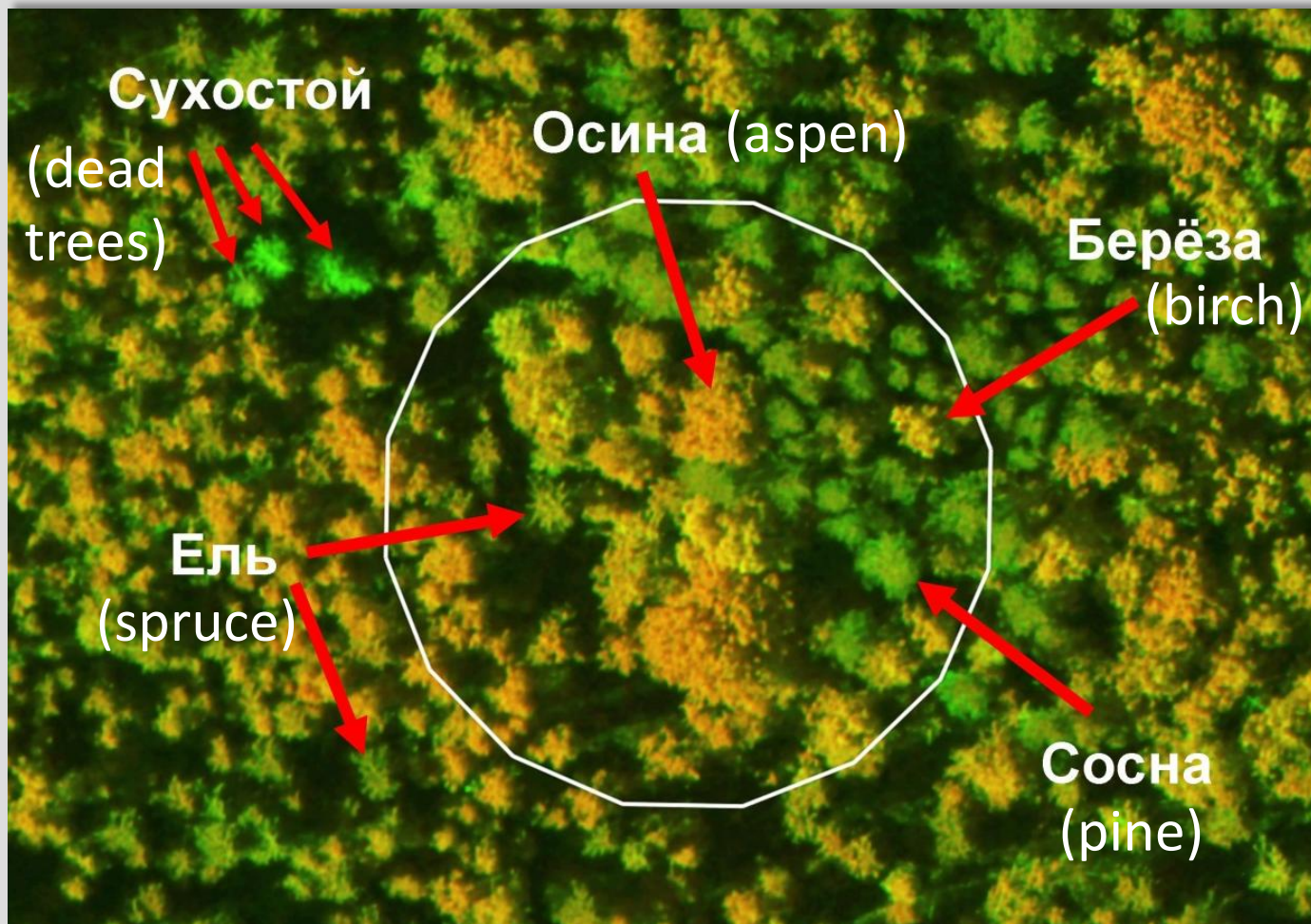
Generalized plots



Forest compartments

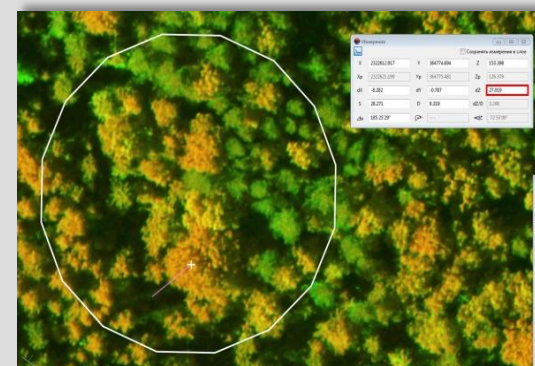
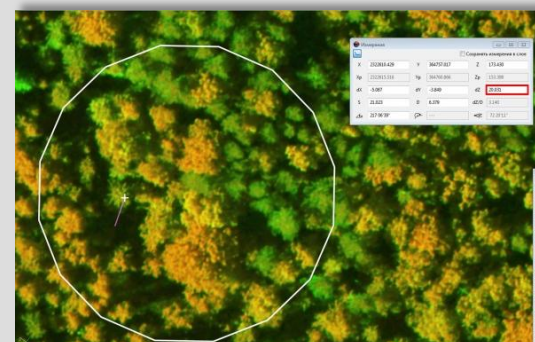
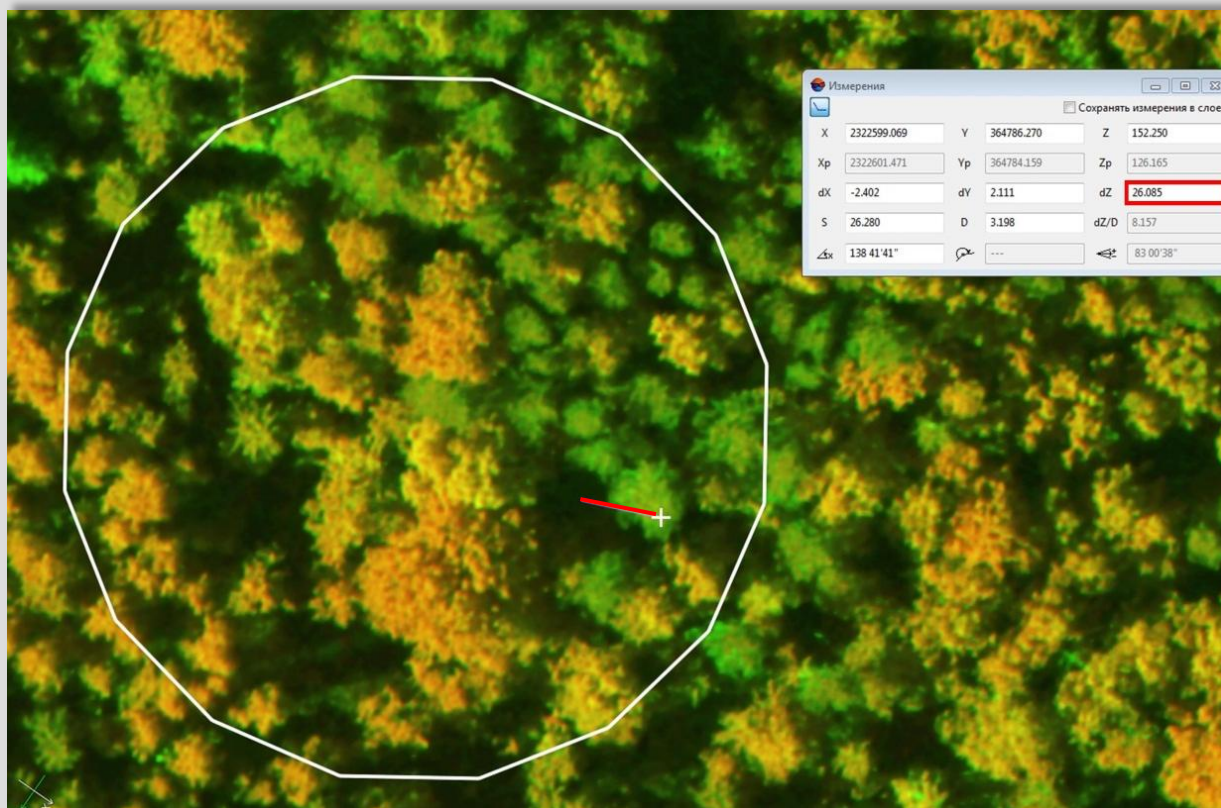
Forest inventory interpretation in PHOTOMOD StereoMeasure

Determination of the species composition of forest stands



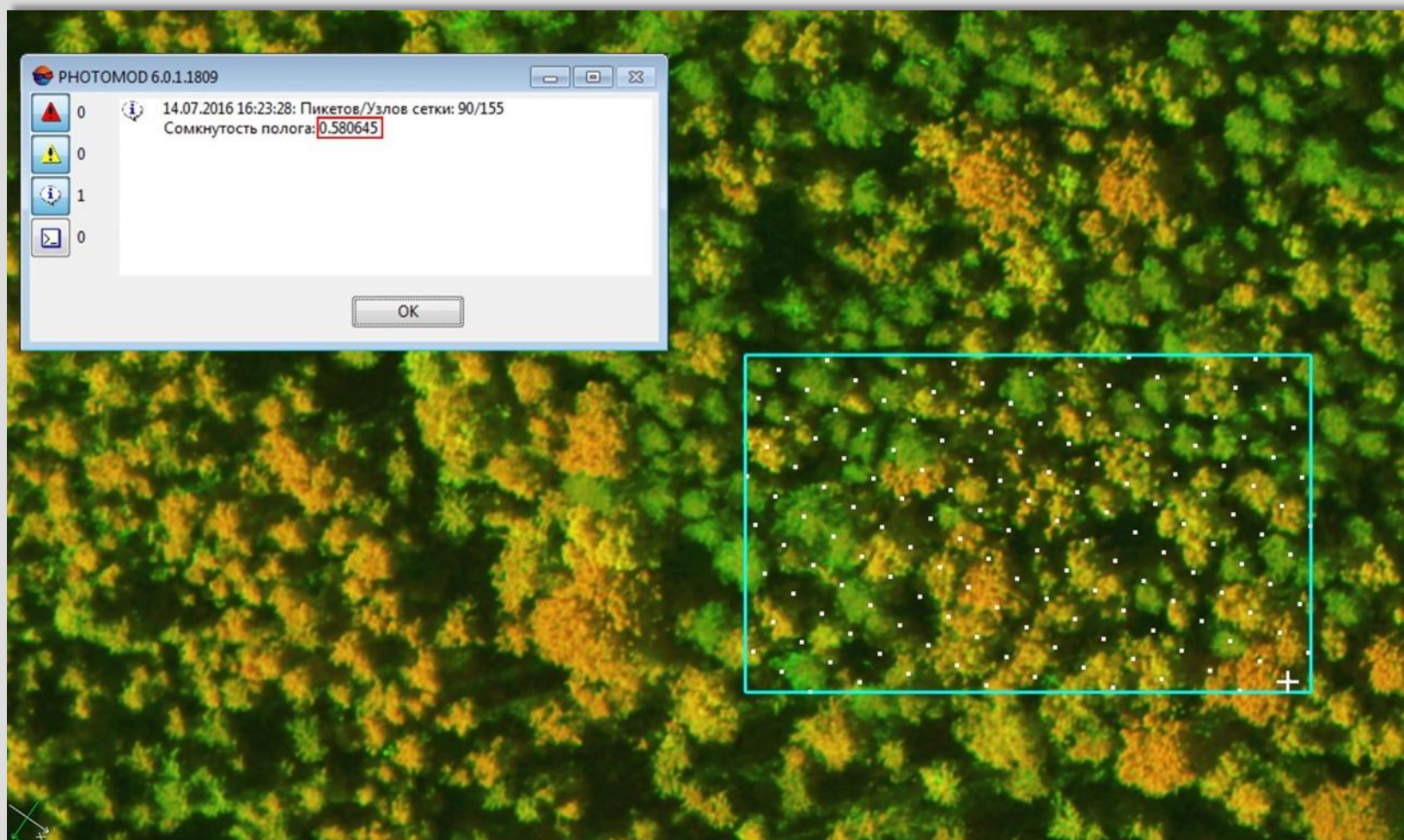
Forest inventory interpretation in PHOTOMOD StereoMeasure

Stereoscopic measuring the heights of trees



Forest inventory interpretation in PHOTOMOD StereoMeasure

Stereoscopic measurement of closeness of forest canopy

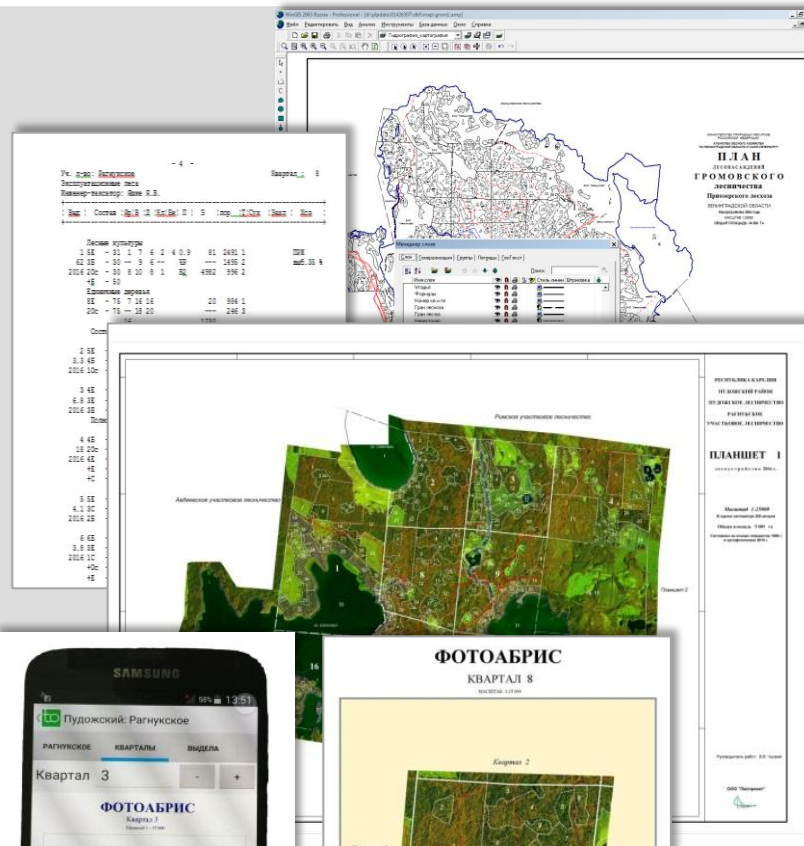


Inventory indicators, classes of interpretation attributes and methods of their definition

№	Inventory indicators	Class of interpretation attributes and methods for defining the inventory indicators	Methods for defining the inventory indicators under the stereo interpretation
1	Land category	Photometric & morphological	Analytical interpretation
2	Predominant tree species	Photometric, morphological and landscape	Analytical and metrical interpretation
3	Forest stands composition	Photometric, morphological and landscape	Analytical and metrical interpretation
4	Age (class or group)	Morphological & photometric	Analytical interpretation using interrelations
5	Forest growing type	Landscape, morphological & photometric	Analytical interpretation
6	Productivity class	Landscape and morphological interrelations with the other indicators	Analytical and metrical interpretation using interrelations
7	Average height (story, forest element)	Mensuration methods, ocular estimation, interrelations with the other indicators	Metrical and analytical interpretation using interrelations
8	Average diameter of the forest element	Mensuration methods, ocular estimation	Metrical and analytical interpretation using interrelations
9	Canopy density	Mensuration methods, ocular estimation	Metrical and analytical interpretation using interrelations
10	Diameter of the crown projection	Mensuration methods, ocular estimation	Metrical and analytical interpretation using interrelations
11	Number of the crowns projections	Mensuration methods	Metrical interpretation
12	Relative wood stocking	Interrelation with the canopy density, ocular estimation	Metrical and analytical interpretation using interrelations, ocular estimation
13	Volume per a hectare	Interrelation with the other indicators	Metrical and analytical interpretation using interrelations, reference tables

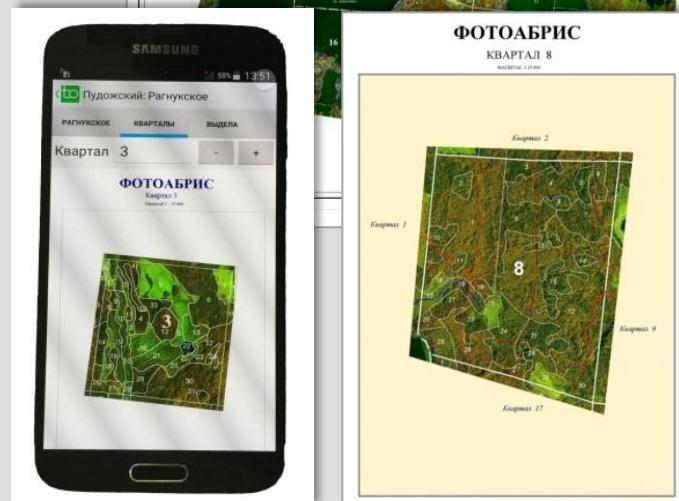
FULL SET OF OUTPUT DOCUMENTS (according Russian Forest Inventory Instruction)

1. Forest inventory descriptions
2. Map-schemes of forest management enterprises
3. Forest management tablets
4. Plans of forest stands for districts



ADDITIONAL SET OF OUTPUT DOCUMENTS

1. Forest inventory GIS-database
2. Photo tablets (paper-based and digital form) on the scale from 1:500 to 1:25000
3. Mobile applications for smartphones
4. Forestry regulations (for forest management enterprise or park)
5. Forest management plans



Accuracy of evaluation the main forest inventory characteristics

Characteristics	Forest interpretation method («From survey – to the project»)	Forest interpretation method (Forest Inventory Instruction)	Forest inventory by the visual method(Forest Inventory Instruction)
Coefficient of composition of predominant tree species	$\pm 1,5$ units	$\pm 1,5$ units	$\pm 1,5$ units
Average height of main forest layer, %	$\pm 10\%$	$\pm 15\%$	$\pm 10\%$
Basal area, units	$\pm 0,1$ units	$\pm 0,2$ units	$\pm 0,1$ units
Volume per ha, %	$\pm 20\%$	$\pm 30\%$	$\pm 20\%$

Implementation in production

№	Objects of work		Total area, thousand hectares	Source of financing	Executor of work	Term implementation of work
	The subject of the Russian Federation	Forest enterprise				
1	Republic of Karelia	Пудожское (арендованный лесной участок)	500, 0	Lease holder of the forest plot	ООО «Леспроект»	2015-2016 гг.
2	Leningrad region	Лодейнопольское	400,0	Budget resources – 50% Lease holder of the forest plot– 50%	ФГБУ «Рослесинфорг» ООО «Леспроект»	2016-2017 гг.
3	Republic of Karelia	Пудожское (арендованный лесной участок)	259, 0	Lease holders of the forest plot	ООО «Леспроект»	2016-2017 гг.
4	Leningrad region	Лужское	367,0	Budget resources – 50% Lease holders of the forest plot – 50%	ФГБУ «Рослесинфорг» ООО «Леспроект»	2017-2018 гг.
5	Leningrad region	Северо-Западное (арендованный лесной участок)	112,0	Lease holder of the forest plot	ООО «Леспроект»	2017-2018 гг.
6	Novgorod region	Новгородское Чудовское	447,0	Budget resources	ФГБУ «Рослесинфорг»	2017-2018 гг.
7	Arhangelsk region	Красноборское (арендованный лесной участок)	50,0	Lease holder of the forest plot	ООО «Леспроект»	2017-2018 гг.
	TOTAL		2135,0			

Number of objects of works: 2015-2016 – 1, 2016-2017 – 2, 2017-2018 - 4

Implementation in production

The comparison of values of main forest inventory characteristics, received by interpretation method with results of forest inventory by selectively-measuring method

Forest inventory characteristics	Number of forest compartments for comparison	Minimal number of compartments with tolerance in the definition of the indicator – 68% from compartments for comparison (item 69 Forest Inventory Instruction)	Number of compartments with correct determination of the indicator / %	Number of compartments with incorrect determination of the indicator / %	Systematic error, ±%
Predominate tree species	77	52	$\frac{77}{100}$	$\frac{0}{0}$	0
Age group	77	52	$\frac{77}{100}$	$\frac{0}{0}$	0
Coefficient of composition of predominant tree species	77	52	$\frac{64}{83}$	$\frac{13}{17}$	+2,3
Average height of forest layer	77	52	$\frac{66}{86}$	$\frac{11}{14}$	-3,2
Basal area, units	77	52	$\frac{69}{90}$	$\frac{8}{10}$	-2,8
Volume, cub. m per ha	77	52	$\frac{67}{87}$	$\frac{10}{13}$	-4,3

Systematic errors of receiving of forest inventory characteristics are not exceed the allowable values (± 5, item 69 Forest Inventory Instruction)

The advantages of remote inventory compared to the terrestrial inventory

1. The accuracy of remote inventory accuracy \geq taxation by terrestrial method.
2. Seasonal productivity of labor in 2-3 times higher.
3. Cost per 1 ha of forest inventory (taxation) 2-3 times lower.
4. A more efficient and transparent system of quality control.
5. Getting additional outputs (visual photographs).

Potential directions of development Photomod (StereoMeasure) for tasks of forest accounting

1. Extension of functional possibilities of Photomod StereoMeasure for solving production problems of forest stereoscopic interpretation of remote sensing data.
2. Assessment of possibilities of the execution of forest stereoscopic interpretation on base different remote sensing data.
3. Study of possibilities of relief and terrain modeling for forest inventory and forestry planning problems.
4. Study of possibilities automation for assessment of separate forest inventory characteristics (closed forest canopy, height, diameter)



«Lesproekt», LLC

**THANK YOU FOR
YOUR ATTENTION!**