Federal State Autonomous Educational Institution for Higher Education
PEOPLES' FRIENDSHIP UNIVERSITY OF RUSSIA NAMED AFTER PATRICE LUMUMBA
(RUDN University)

Institute of Environmental Engineering

COURSE SYLLABUS

REMOTE SENSING TECHNICS FOR CLIMATE CHANGE ASSESMENT

Recommended by the Didactic Council for the Education Field of:

05.04.06 "Ecology and Nature Management"

The course instruction is implemented within the professional education programme of higher education:

Climate Projects Management

2025

1. COURSE GOAL(s)

The course is designed to study methods of remote sensing of the Earth and the features of its application to solve climate problems.

The course is designed to provide knowledge on the application of basic Earth remote sensing technologies to assess the environmental impacts of climate change.

Know:

theoretical foundations of Earth remote sensing;
mechanisms and principles of obtaining remote sensing images,
basic techniques for interpreting Earth remote sensing images;
basic principles of geoinformatics;

Be able to:

use methods for interpreting aerial and space images to solve practical climate problems;
use GIS software to solve practical problems;
use spectral indices to solve practical problems;
use spatial analysis of the territory to solve practical problems;

Own:

skills in working with design and construction documentation;
skills in working with regulatory documents

2. REQUIREMENTS FOR LEARNING OUTCOMES

The process of studying the discipline is aimed at the formation of the following competencies:

Competence code	Competence descriptor	Competence formation indicators
PC-6	Able to develop projects based on existing methods for solving geoinformation problems, use modern cloud services and analytical tools to update climate data	**PC-6.1** is able to perform GIS analysis to analyze and predict regional climate changes
		PC-6.2 has the skills to assess ecosystem services for climate regulation using remote sensing

3. COURSE IN HIGHER EDUCATION PROGRAMME STRUCTURE

Course **Remote Sensing Technics for Climate Change Assessment** refers to the **Variable component** of the block 1 of the curriculum.

Within the higher education programme students also master other disciplines (modules) and / or internships that contribute to the achievement of the expected learning outcomes as results of the course.

Table 3.1

The list of the higher education programme components that contribute to the achievement of the expected learning outcomes

Competence code	Competence descriptor	Previous courses/modules, internships*	Subsequent courses/modules, internships*

PC-6	Able to develop projects based on existing methods for solving geoinformation problems, use modern cloud services and analytical tools to update climate data	No	Low-carbon Economy Ecosystem Services for Climate Change Mitigation Master's Thesis Defence

4. COURSE WORKLOAD AND ACADEMIC ACTIVITIES

The total workload of the course is **5** credit units.

Table 4.1. Types of academic activities during the period of the HE program(me) mastering

Types of academic activities	**Total hours**	**Semester(s)**			
		1	**2**	**3**	**4**
Contact academic hours					
Lectures	18		18		
Lab works					
Seminars (workshops/tutorials)	18		18		
Self-study	*117*		*117*		
Evaluation and assessment (exam; pass/fail grading)	*27*		*27*		
The total course workload hours	**180**		**180**		
credits	**5**		**5**		

5. COURSE CONTENTS

Table 5.1. The content of the discipline (module) by type of educational work

Title of Course Modules	**Content**	**Types of academic activities**
Module 1. Introduction	Topic 1.1. The study of the physical basics for Earth Remote Sensing, the study of types and means for remote sensing.	L, S
	Topic 1.2. Remote sensing data processing software: a variety of GIS	L, S
	Topic 1.3. QuantumGIS interface, loading raster data, vector layers creation	L, S
	Topic 1.4. Satellite images – types of satellites and missions, Open sources for images	L, S
Module 2. Basic principles of remote sensing, classification of remote sensing methods	Topic 2.1. Photointerpretation. photointerpretation signs. Features of recognition of artificial and natural objects	L, S
	Topic 2.2. Semi-automatic classification.	L, S
Module 3. RSE methods to solve Climate assessment tasks	Topic 3.1. Spatial analysis of GIS, a method for analyzing hierarchies. Cluster analysis, Geoecomarketing	L, S

	Topic 3.2. Vegetation indices, groups of vegetation indices. Landscape indices	L, S
	Topic 3.3. Landfills. The main deciphering signs of unauthorized dumps. Methods for determining unauthorized dumps.	L, S
	Topic 3.4. Web GIS, Google Earth Engine.	L, S

6. CLASSROOM EQUIPMENT AND TECHNOLOGY SUPPORT REQUIREMENTS

Table 6.1. Classroom equipment and technology support requirements

Classroom for Academic Activity Type	**Classroom equipment**	**Specialized educational / laboratory equipment, software and materials for mastering the course (if necessary)**
Lecture	Classroom, equipped with a set of specialized furniture; whiteboard; a set of devices includes portable multimedia projector, laptop, projection screen, stable wireless	Classroom, equipped with a set of specialized furniture; whiteboard; a set of devices includes portable multimedia projector, laptop, projection screen, stable wireless Internet connection. Software: Microsoft Windows, MS Office / Office 365, MS Teams, Chrome (latest stable release), Skype. Microsoft Windows 7 corporate. License No. 5190227, date of issue March 16, 2010 MS Office 2007 Prof , License # 6842818, date of issue 09/07/2009
Seminars	Classroom, equipped with a set of specialized furniture; whiteboard; a set of devices includes portable multimedia projector, laptop, projection screen, stable wireless	
For Self-Study	Classroom for self-study (can be used for seminars and consultations), equipped with a set of devices includes laptop, stable wireless.	No

7. RESOURCES RECOMMENDED FOR COURSE STUDY

Main reading:

1. Martin Wegmann, Jakob Schwalb-Willmann , Stefan Dech An Introduction to Spatial Data Analysis: Remote Sensing and GIS with Open Source Software (Data in the Wild) 1st Edition, Kindle Pelagic Publishing, 2020
2. E.O. Wilson, Dawn J. Wright, Christian Harder GIS for Science, Volume 3: Maps for Saving the Planet. Esri Press, 2021
3. Jindong Li Satellite Remote Sensing Technologies Springer, Singapore, Space Science and Technologies, 2021

4. Remote Sensing and Image Interpretation, 7th Edition, Thomas Lillesand, Ralph W. Kiefer , Jonathan Chipman

Additional reading:

1. Otto Huisman and Rolf A. de By Principles of Geographic Information Systems An introductory textbook The International Institute for Geo-Information Science and Earth Observation (ITC), webapps.itc.utwente.nl
2. Jonathan Campbell, MIchael Shin, UCLA Essentials of Geographic Information Systems, Publisher: Saylor Foundation https://open.umn.edu/opentextbooks/formats/249

Internet-based sources

1. ELS of RUDN University and third-party ELS, to which university students have access on the basis of concluded agreements:

- RUDN Electronic Library System - RUDN EBS http://lib.rudn.ru/MegaPro/Web
- ELS "University Library Online" http://www.biblioclub.ru
- EBS Yurayt http://www.biblio-online.ru
- ELS "Student Consultant" www.studentlibrary.ru
- EBS "Lan" http://e.lanbook.com/
- EBS "Trinity Bridge"

2. Databases and search engines:

- electronic fund of legal and normative-technical documentation http://docs.cntd.ru/
- Yandex search engine https:// www .yandex.ru/
- Google search engine https://www.google.ru/
- abstract database SCOPUS http:// www .elsevierscience.ru/ products / scopus /

8. ASSESSMENT TOOLKIT AND GRADING SYSTEM FOR EVALUATION OF STUDENTS' COMPETENCES LEVEL UPON COURSE COMPLETION

The assessment toolkit and the grading system to evaluate the level of competences (competences in part) formation as results of mastering the discipline are specified in the Appendix to the syllabus.

DEVELOPER:

Associate Professor of the EM Department		**Kapralova D.O.**
Position	Signature	Name, Surname

HEAD OF DEPARTMENT:

Director of EM Department		**Kucher D.E.**
Position	Signature	Name, Surname

HEAD OF PROGRAMME:

Director of ES&PQM Department		**Savenkova E.V.**
Position	Signature	Name, Surname

Federal State Autonomous Educational Institution for Higher Education PEOPLES' FRIENDSHIP UNIVERSITY OF RUSSIA NAMED AFTER PATRICE LUMUMBA (RUDN UNIVERSITY)

Institute of Environmental Engineering

ASSESSMENT TOOLKIT

Remote Sensing Technics for Climate Change Assesment

Recommended by the Didactic Council for the Education Field of:

05.04.06 "Ecology and nature management"

The course instruction is implemented within the professional education programme of higher education:

Climate Project Management

2025

Passport to Assessment Toolkit for Course Remote Sensing Technics for Climate Change Assesment

Education Field / Speciality 05.04.06 "Ecology and nature management"/ «Climate Project Management» Course: Remote Sensing Technics for Climate Change Assesment

Competences (competences in part) under assessment	Course module under assessment	Course topic under assessment	Oral/written survey	Tools to assess higher education programme mastering level							Points for topic	Points for module
				Class work			Self-studies					
				Test	Lab work topic	Lab work	Report	Research essay/ Library research paper	Calculation and graphic work	Exam/Pass -fail assessment Course		
PC 6	Introduction	The study of the physical basics for Earth Remote Sensing, the study of types and means for remote sensing.	0.5	1	QGIS interface	5				1	7.5	29
		Remote sensing data processing software: a variety of GIS	0.5	1	Working with raster images	5				2	8.5	
		QuantumGIS	0.5	1	Working with vector images	5					6.5	

		interface, loading raster data, vector layers creation										
		Satellite images – types of satellites and missions, Open sources for images	0.5	1	Thematic maps	5					6.5	
PC 6	Basic principles of remote sensing, classification of remote sensing methods	Photointerpretation. photointerpretation signs. Features of recognition of artificial and natural objects	0.5	1	Photointerpretation of natural and anthropocentric objects	5				2	8.5	22
		Semi-automatic classification.	0.5	1	Controlled/uncontrolled classification	10				2	13.5	
	RSE methods to solve Climate assessment tasks	Spatial analysis of GIS, a method for analyzing hierarchies. Cluster analysis, Geoecomarketing	0.5	1	Network analysis	5				2	8.5	48
		Vegetation indices, groups of vegetation indices. Landscape indices.	0.5	1	Spectral indices. NDVI computing. Landscape indices	10				2	13.5	
		Landfills. The main deciphering signs of unauthorized dumps. Methods for determining unauthorized dumps.	0.5	1	Buffer zones, Landfill sanitary zone	10				2	13.5	

		Web GIS, Google Earth Engine.	0.5	1	LST and spatio-temporal dynamic with GEE	10				1	12.5	
		Total	**5**	**10**		**70**				**15**		**100**

Course Remote Sensing Technics for Climate Change Assessment

QUESTION CARD No 1

QUESTION 1. Application of Earth remote sensing data for climate change assessment QUESTION 2. 19. Vegetation indices.

3 * …….

Developer_____(Kapralova Daria)
signature

Head of Educational Department_____(Kutcher Dmitryi)
signature

_____
day, month, year

Note * Practice case/task inclusion is subject to the teacher's discretion.

The set of exam question cards is complemented by the assessment criteria developed by the teacher and approved at the department meeting.

Assessment criteria:

(*in compliance with the legal regulations in force*)

EXAM QUESTIONS

1. Direct photointerpretation signs.
2. Factors affecting the tone (brightness) of the image.
3. Calculating the size of an object from its shadow.
4. Ways to determine the scale of the image.
5. Types of object shape.
6. Classification of objects by image contrast.
7. The concept of the structure of the image. Structure types.
8. The concept of image texture. Image texture types.
9. Generalization during decryption.
10. Application of Earth remote sensing data for climate change assessment 11. Name the groups of decryption features.
12. On identifying what patterns is the use of indirect decoding signs based?
13. What is the object of landscape mapping?
14. The concept of remote sensing.
15. Satellites for remote sensing.
16. Active remote sensing
17. Passive remote sensing.
18. Spectral, spatial, radiometric resolution.
19. Vegetation indices.
20. Landscape indices.
21. The main technical factors influencing the information content of satellite images are
22. Supervised/unsupervised classification 23. Concept of GEE. Possibilities 24. Definition of LST.
25. What is meant by remote sensing?
26. What are the main advantages of using remote sensing

27. Describe the main stages in the development of remote sensing technology. Name the main trends in the development of remote sensing technology.
28. Describe the steps involved in remote sensing and data analysis.
29. What are the transparency windows of the earth's atmosphere?
30. What are the methods of transmitting remote sensing data to Earth?
31. What data formats are mainly used by remote probing?
32. What are the main elements of the ground and orbital segments remote sensing systems.
33. What are the main characteristics of remote sensing data?
34. What characteristics of the COP depend on the height of the satellite?
35. How is computer interpretation of images made?
36. Describe the steps for interpretation of images.
37. What equipment is used for interpretation?
38. What are the automated interpretation methods?
39. What is image correction and restoration used for?
40. What is the difference between improving the visual perception of pictures and image conversion? What are they used for?
41. In what areas can remote sensing data be used?
42. How is the area under crops can be estimated?
43. How can remote sensing data be used to study urban growth?
44. How can remote sensing data be used to study landfills and illegal dumps?
45. How remote sensing can be used to prevent and combat consequences of emergencies?
46. In what main areas are remote sensing data used in solving problems of assessing natural resources and the environment?
47. What are the requirements for software solutions in the field of remote sensing of the Earth?
48. What are the stages of primary processing of remote sensing data?
49. What is an orthorectified image and orthomosaic?
50. Define the concept of interferometry.
51. Describe the process of building digital elevation models using radar survey materials.
52. In what areas are remote sensing radar equipment mainly used?
53. What are the advantages of remote sensing radar?
54. What tasks is the geocoding processor intended for?
55. What is georeferencing, geocoding and orthorectification?

Tentative list of assessment tools

п/п	Assessment tool	Brief features	Assessment tool representation in the kit
		Class work	
1	Survey/Quiz	A tool of control, organized as a special conversation between a teacher and students on topics related to the course under study, and designed to clarify the amount of students' knowledge in a particular section, topic, problem, etc.	Questions on the course topics /modules
2	Test	A system of standardized tasks that allows the teacher to automate the procedure for measuring the student's level of knowledge and skills	Tests bank
3.	Colloquium	A tool for monitoring the acquisition and mastering of educational material on a topic, section or sections of a discipline, organized as a training session in the form of an interview among the teacher and students.	Questions on the course topics /modules
4	Control work	A tool of control organized as a classroom lesson, at which students need to independently demonstrate the acquisition and mastering of the educational material of the course topic, section, or sections.	Questions on the course topics /modules
5	Lab work	The system of practice tasks aimed at the students' practical skills formation	Practice tasks bank
6.	Round table, discussion, polemic, dispute, debate, (class work)	Evaluation tools that allow the teacher to engage students in the process of discussing controversial issues, problems and assess their ability to argue their own point of view.	List of themes for round tables, discussions, polemics, disputes, debates.
7	Business game and/or role play	Joint activities of a student group under the teacher's control to solve educational and professionally oriented tasks through the simulation of a real-world problem; this activity allows the teacher to assess the students' ability to analyze and solve typical professional challenges.	Topic (problem), concept, roles and expected results for each game
8.	Essay	A tool that allows the teacher to assess the student's ability to express in writing the essence of the under study, to independently analyze this issue using the concepts and analytical tools of the relevant discipline, to draw conclusions that summarie his/her position on the issue under consideration.	Themes for essays

9.	Presentation (defence) of	A tool for monitoring the students' ability to present the work results to the audience.	Themes for projects/reports/
	project/report/ Library research paper /briefs *		Library research paper/ briefs
10	Pass/Fail assessment	A tool for checking the quality of students' performance of laboratory work, acquisition and mastering of the practice training and seminar educational material, successful completion of the advanced field internship and pre-graduate internship and fulfillment of all training assignments in the course of these internships in accordance with the approved programme.	Tasks examples
11	Exam	The evaluation of the student's work during the semester (year, the entire period of study, etc.); it is designed to identify the level, soundness and systematic nature of theoretical and practical knowledge gained by the student, formation of independent work skills, development of creative thinking, ability to synthesize the acquired knowledge and apply it to solve practice tasks.	Examples of tasks/questions/exam question cards
12	Internship and research and development (R&D) report	A form of written work that allows the student to generalize his/her knowledge, skills and abilities acquired during the introductory and advanced field internships, scientific and industrial internships and R&D activities.	
13	Case	A problem-solving task in which the student is asked to comprehend the real work-related (occupational) situation necessary to solve the problem.	Assignments to solve the case
14	Multi-level tasks and assignments with varying difficulty	The tasks and assignments differ in terms of the following levels: a) reproductive level allows the teacher to evaluate and diagnose the students' knowledge of factual material (basic concepts, algorithms, facts) and the students' ability to correctly use special terms and concepts, recognize objects of study within a certain section of the discipline, b) reconstructive level allows the teacher to evaluate and diagnose the students' abilities to synthesize, analyze, generalize factual and theoretical material and formulate specific conclusions, establish cause-and-effect relationships, c) creative level allows to evaluate and diagnose students' skills to integrate	Set of multi-level tasks and assignments with varying difficulty

		knowledge of various fields, argue their own point of view.	
Self- studies			
1	Calculation and graphic work	A tool for checking students' skills in applying the acquired knowledge according to a predetermined methodology in task solving or fulfilling assignments for a module or discipline as a whole.	Set of tasks for calculation and graphic work
2	Course work/project	A type of independent written work aimed at the creative development of general professional and specialized professional disciplines (modules) and the development of relevant professional competences	Course assignment themes
3	Project	The final "product" that results from planning and performance of educational and research tasks set; it allows the teacher to assess the students' ability to independently shape their knowledge in the course of solving practice tasks and problems, navigate in the information environment and the students' level of analytical, research skills, skills of practical and creative thinking; it can be implemented individually or by a group of students.	Themes for teambased or individual projects
4	Research essay (Library research paper)	The student's independent work in writing that summarizes the results of the theoretical analysis of a certain scientific (educational and research) topic, where the author reveals the essence of the problem under study, considers different points of view, as well as argues his/her views on the material under consideration.	Themes for research essay (library research papers)
5	Reports, briefs	The product of the student's independent work, which is a public performance on the presentation of the results of solving a specific educational, practical, research or scientific topic.	Themes for reports, briefs
6	Essay and other creative assignments	A partially regulated assignment that has a non-standard solution and allows the teacher to diagnose students' skills in integrating knowledge from various fields and arguing their own point of view; it can be prepared individually or by a group of students.	Themes for teambased or individual creative assignments

7	Standard calculations	A tool to test skills in applying the acquired knowledge, according to a predetermined methodology, solving tasks or fulfilling assignments for a module or discipline as a whole.	Set of tasks for standard calculations
8	Homework	The tasks and assignments differ in terms of the following levels: a) reproductive level allows the teacher to evaluate and diagnose the students' knowledge of factual material (basic concepts, algorithms, facts) and the students' ability to correctly use special terms and concepts, recognize objects of study within a certain section of the discipline, b) reconstructive level allows the teacher to evaluate and diagnose the students' abilities to synthesize, analyze, generalize factual and theoretical material and formulate specific conclusions, establish cause-and-effect relationships, c) creative level allows the teacher to evaluate and diagnose students' skills to integrate knowledge of various fields, argue their own point of view.	Set of multi-level tasks and assignments with varying difficulty

Department Nature management

Set of tasks for calculation and graphic work, simulator training

For the course **Remote Sensing Technics for Climate Change Assessment**

Task (assignment) 1 QGIS interface.
Task (assignment) 2 Working with raster images.
Task (assignment) 3 Working with vector images
Task (assignment) 4 Thematic maps
Task (assignment) 5 Thematic maps
Task (assignment) 6 Photointerpretation of natural and anthropocentric objects
Task (assignment) 7 Buffer zones, Landfill sanitary zone
Task (assignment) 8 Network analysis
Task (assignment) 9 Spectral indices. NDVI computing, Landscape indices
Task (assignment) 10 Controlled/uncontrolled classification
Task (assignment) 11 10 LST and spatio-temporal dynamic with GEE

Assessment criteria:

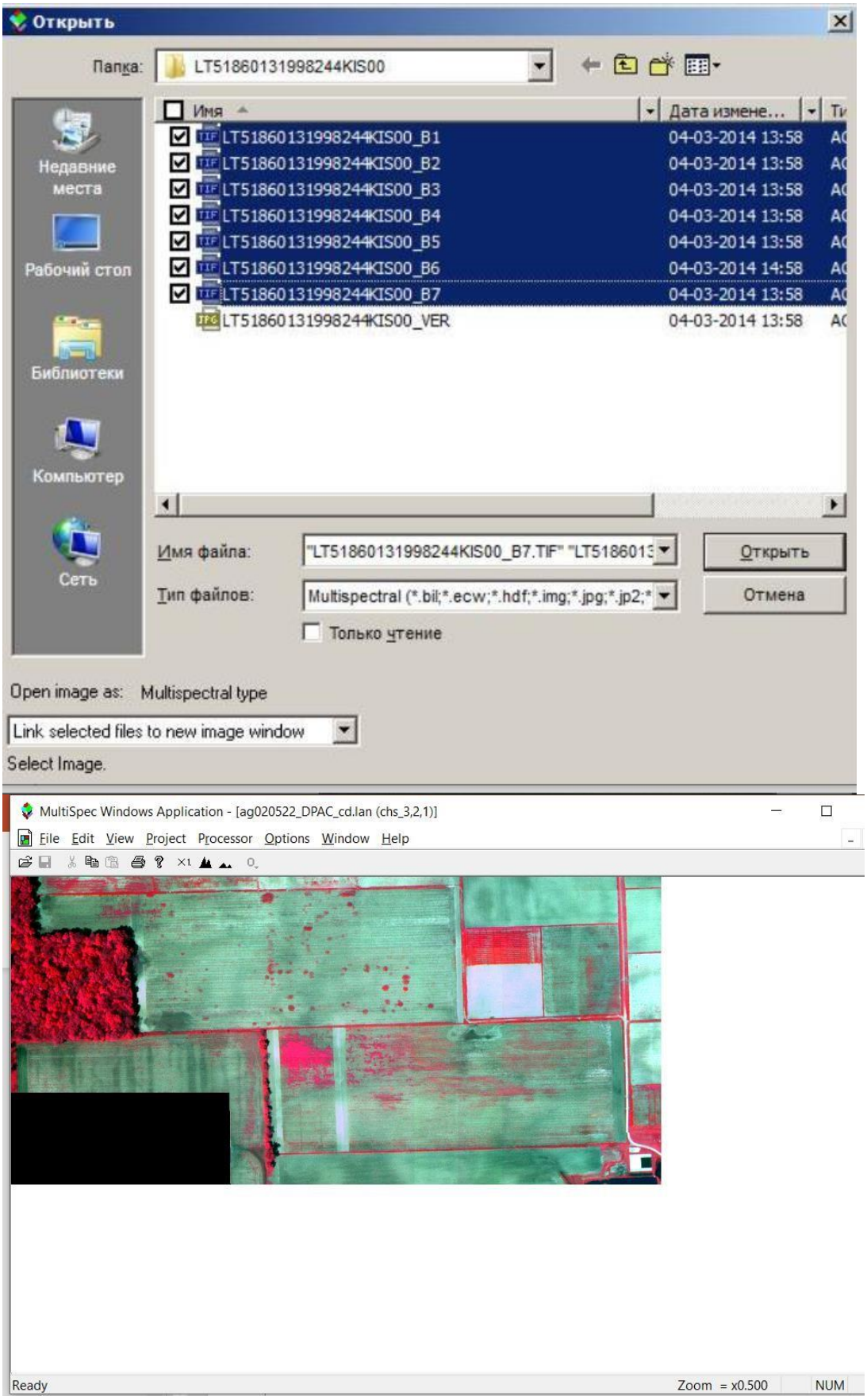
Table 2.1. Scale and criteria for evaluating laboratory reports

Scale	Evaluation criteria
The grade is "passed" (all points planned for a specific laboratory work of the BRS are awarded)	The work is completed. The required results have been achieved, visualization is sufficient.
"Failed" grade (no points awarded)	The work has not been completed

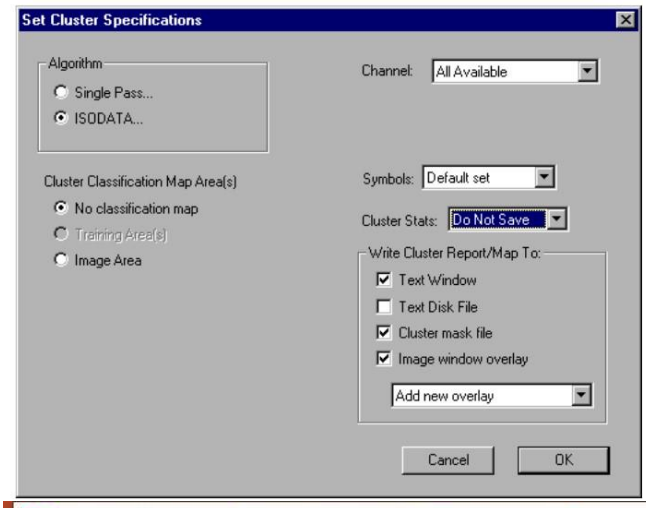
Example of the task for calculation and graphic work, simulator training

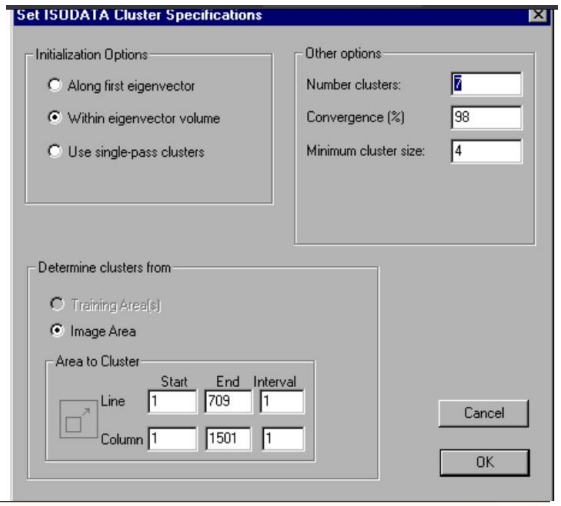
Task (assignment) 1 QGIS interface.

- Creation of a multispectral image is performed in the MultiSpec program as follows[2]:
- 1. Execute the command from the main menu File/Open Image... or click the Open button on the toolbar. The Open Image File dialog box appears.
- 2. Select in the window those channel files that should be included in the multispectral image (Fig. 1).

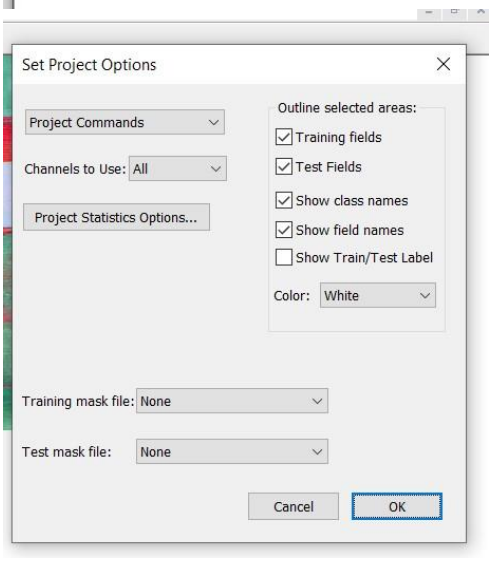


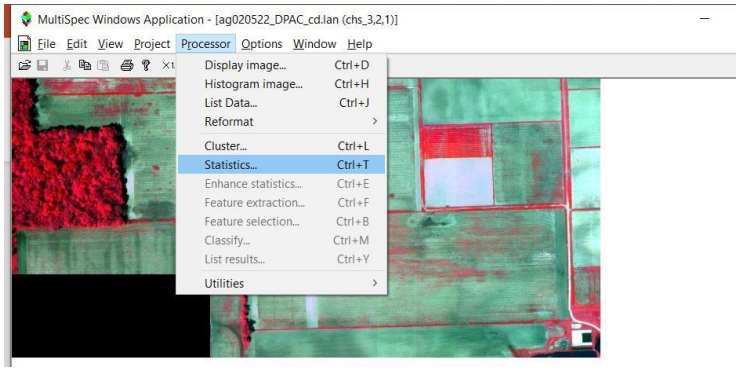
- From Processor menu, select Cluster.
- Next “Do Not Save”
- in Cluster Stats: Select “Cluster mask file” and “Image window overlay”
- from the “Write Cluster Report/Map To” drop-down list.

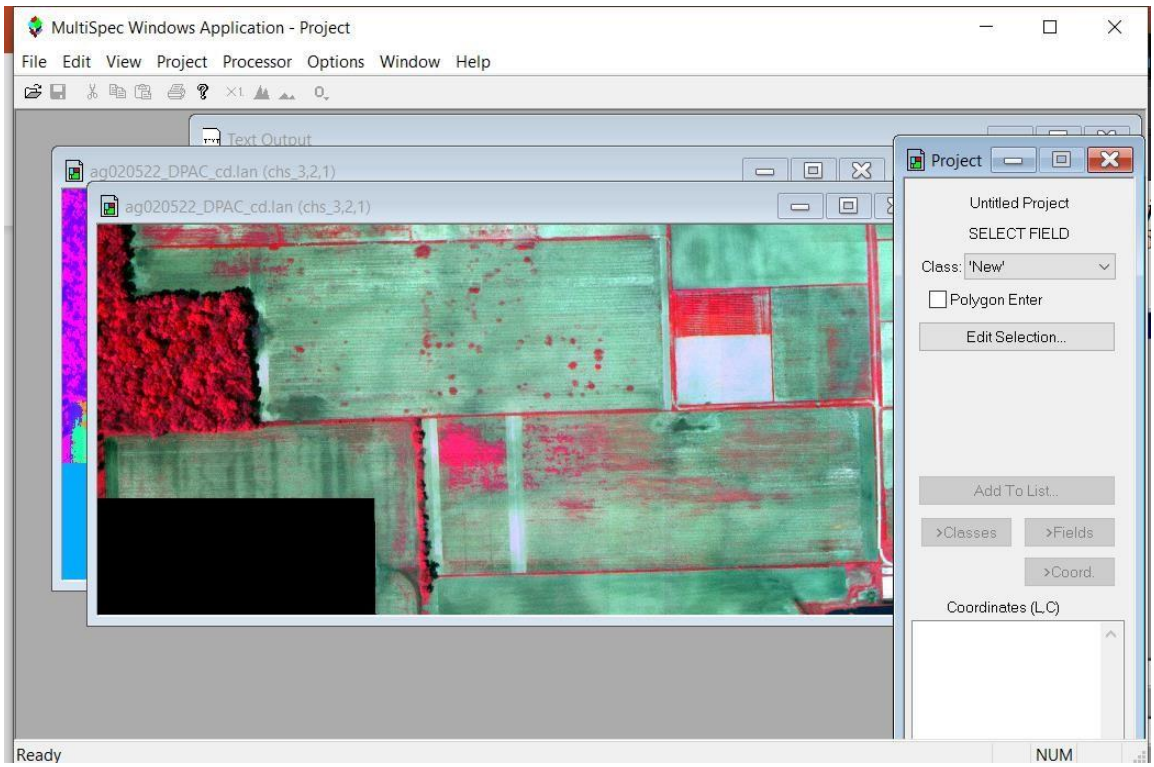

Set Cluster Specifications
Algorithm
Single Pass...
ISODATA...
Channel:
All Available
Cluster Classification Map Area(s)
No classification map
Training Area(s)
Image Area
Symbols:
Default set
Cluster Stats:
Do Not Save
Write Cluster Report/Map To:
Text Window
Text Disk File
Cluster mask file
Image window overlay
Add new overlay
Cancel
OK

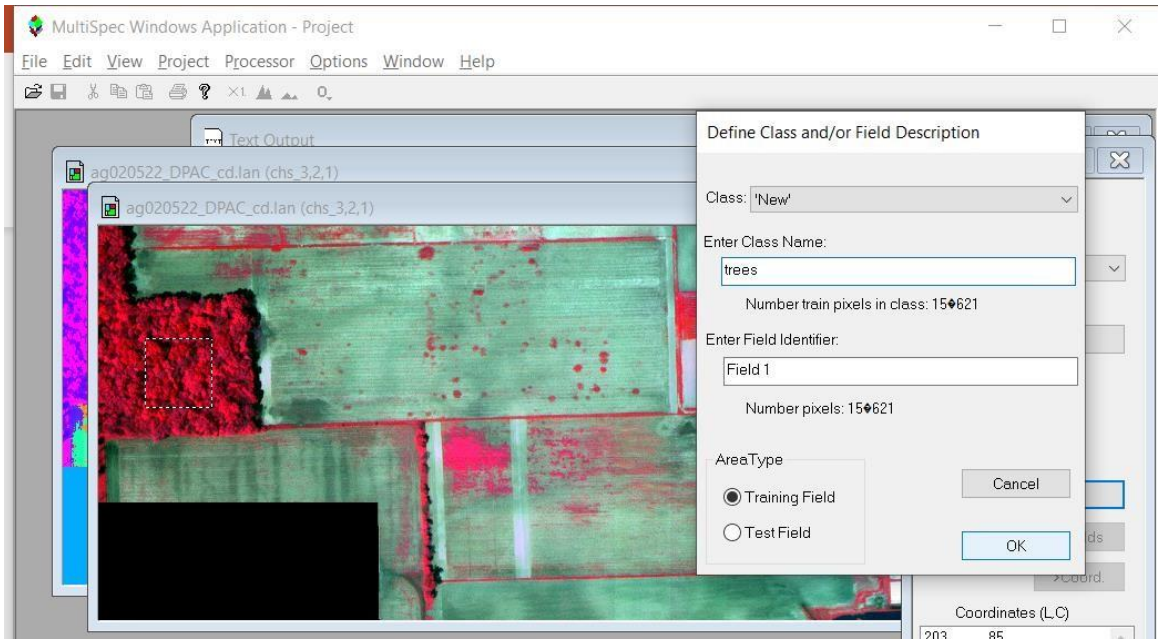

Set ISODATA Cluster Specifications
Initialization Options
Along first eigenvector
Within eigenvector volume
Use single-pass clusters
Other options
Number clusters:
7
Convergence (%)
98
Minimum cluster size:
4
Determine clusters from
Training Area(s)
Image Area
Area to Cluster
Start
End
Interval
Line
1
709
1
Column
1
1501
1
Cancel
OK


MultiSpec Windows Application - [ag020522_DPAC_cd.lan (chs_3,2,1)]
File Edit View Project Processor Options Window Help


Set Project Options
Project Commands
Channels to Use:
All
Project Statistics Options...
Outline selected areas:
Training fields
Test Fields
Show class names
Show field names
Show Train/Test Label
Color:
White
Training mask file:
None
Test mask file:
None
Cancel
OK


MultiSpec Windows Application - [ag020522_DPAC_cd.lan (chs_3,2,1)]
File Edit View Project Processor Options Window Help
Display image... Ctrl+D
Histogram image... Ctrl+H
List Data... Ctrl+J
Reformat
Cluster... Ctrl+L
Statistics... Ctrl+T
Enhance statistics... Ctrl+E
Feature extraction... Ctrl+F
Feature selection... Ctrl+B
Classify... Ctrl+M
List results... Ctrl+Y
Utilities



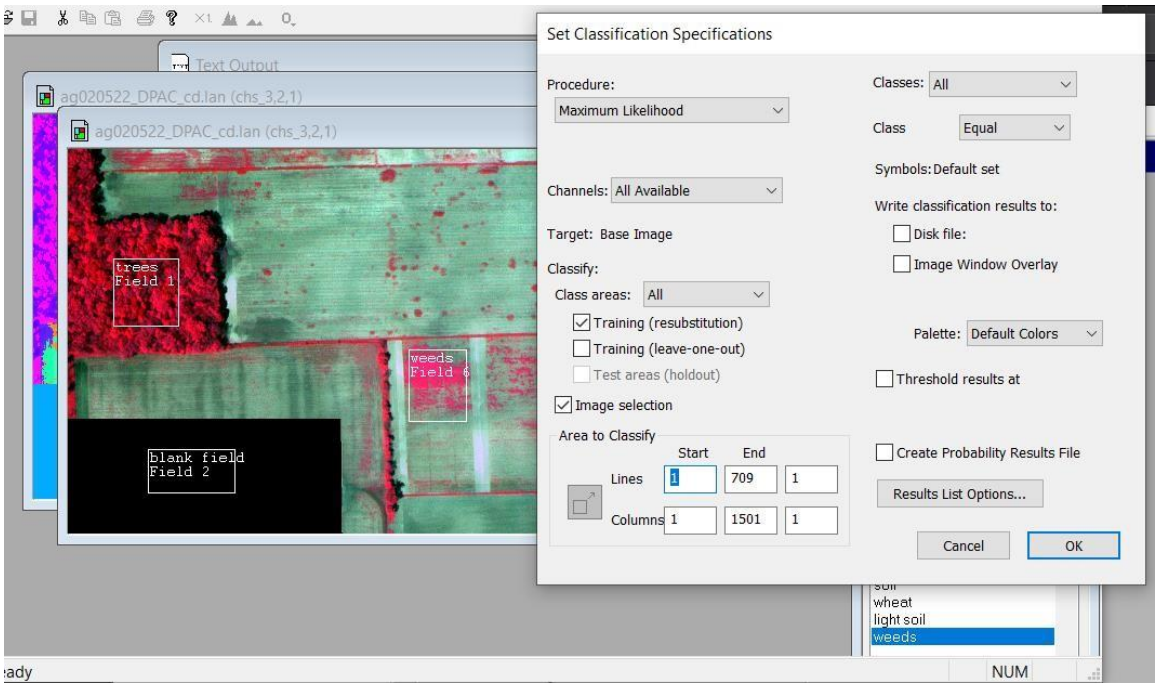


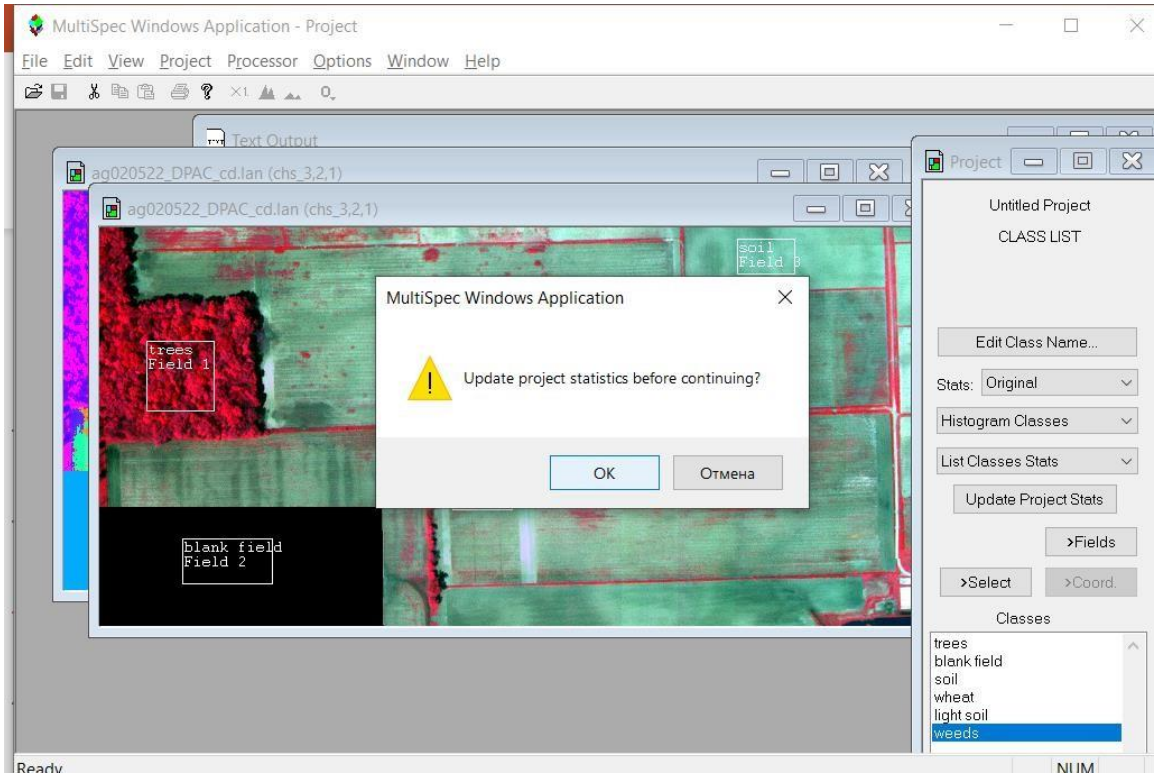
•

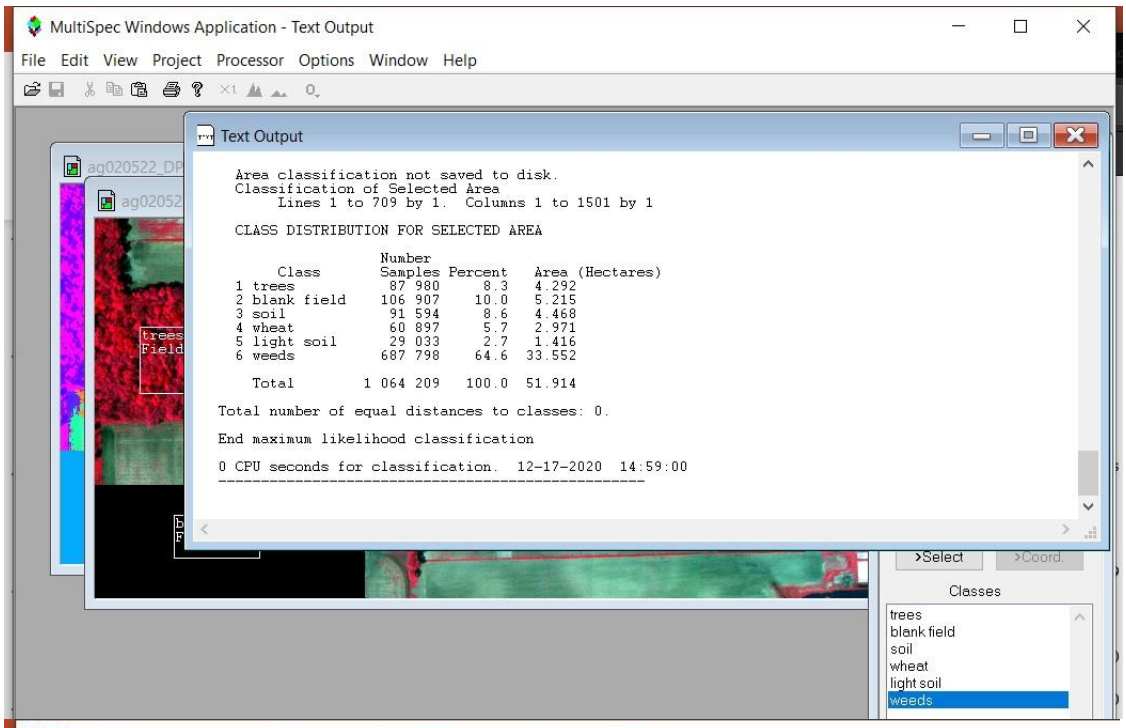
The project window can have four different modes - training field selection mode, class list mode, field list mode and coordinate list mode.

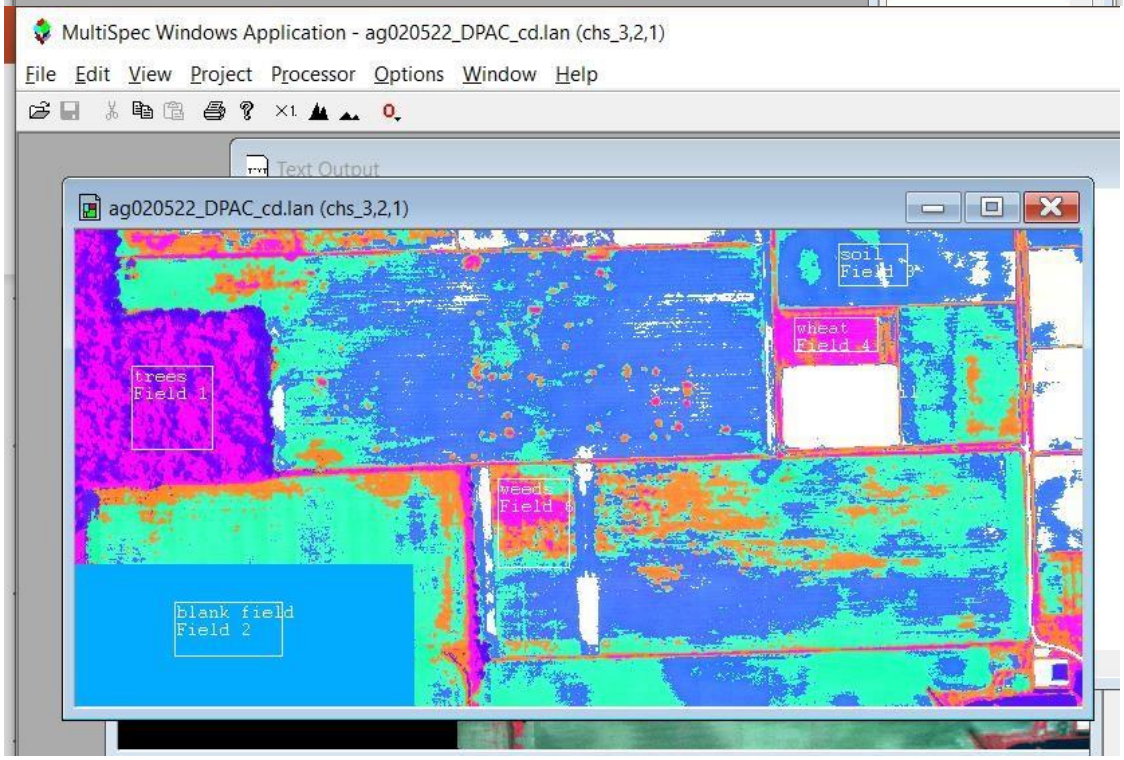
- Modes are controlled by four buttons just above the list at the bottom of the project window. • The "> Select" button switches the project window to selection mode.
- The "> Classes" button displays the project classes.
- The ">Fields" button displays the fields for the selected class. Button "> Coord." • The button displays the coordinates of the selected field.
- You can remove a class by selecting it in the class list and then choosing Cut Class from the Edit menu.
- The same can be done to delete a specific field. You can also use polygon fields to define classrooms.
- To do this, check the "Polygon input" checkbox in the project window in selection mode.
- Click in the image window to define each corner of the polygon.

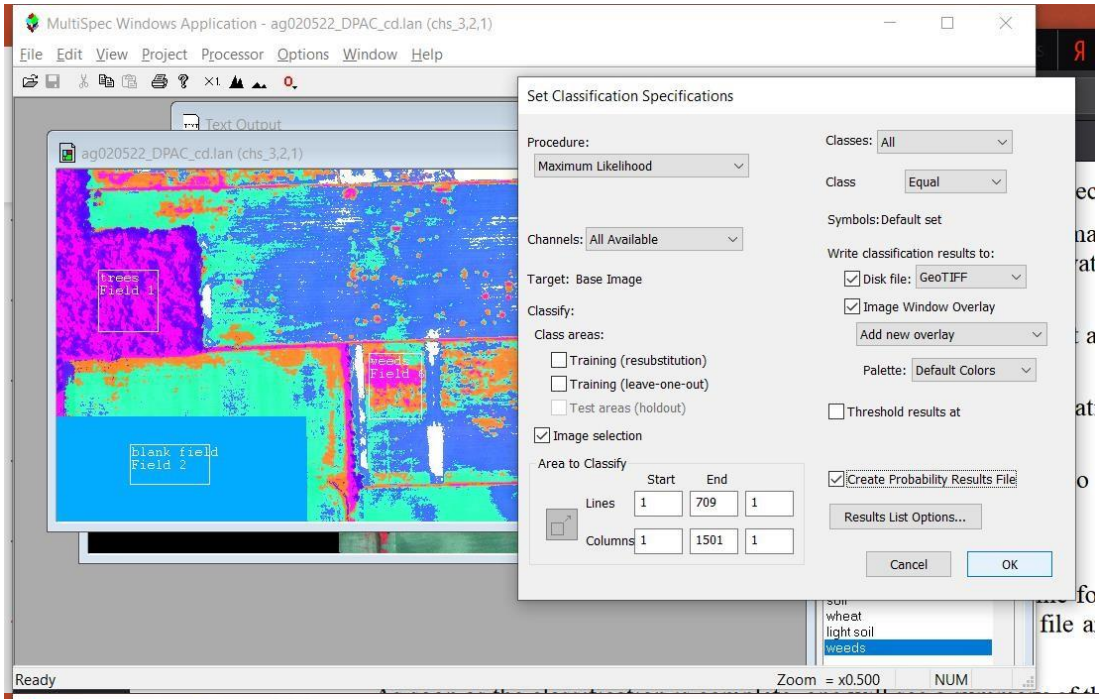
- Double-click the last point. To disable polygon type selection, simply check the Polygon Input checkbox to clear it.

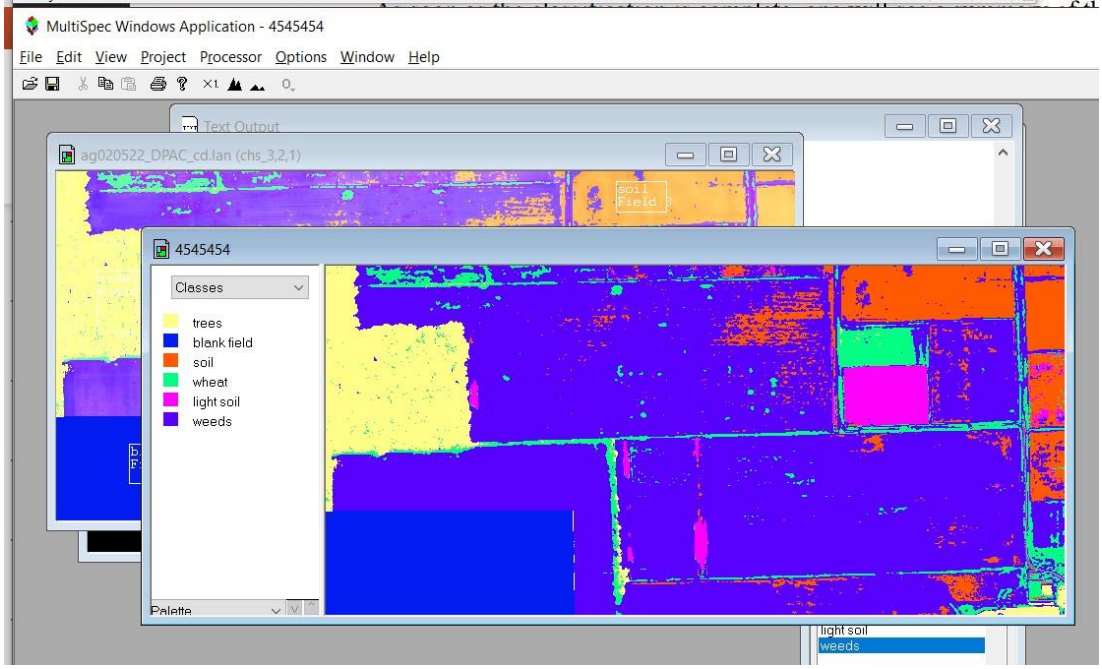


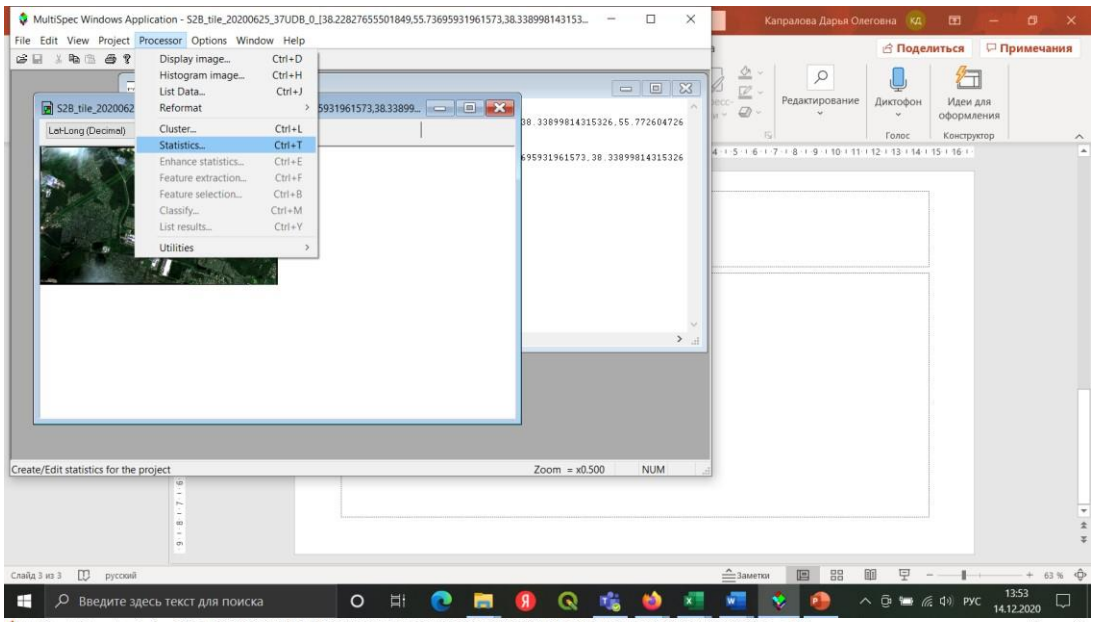


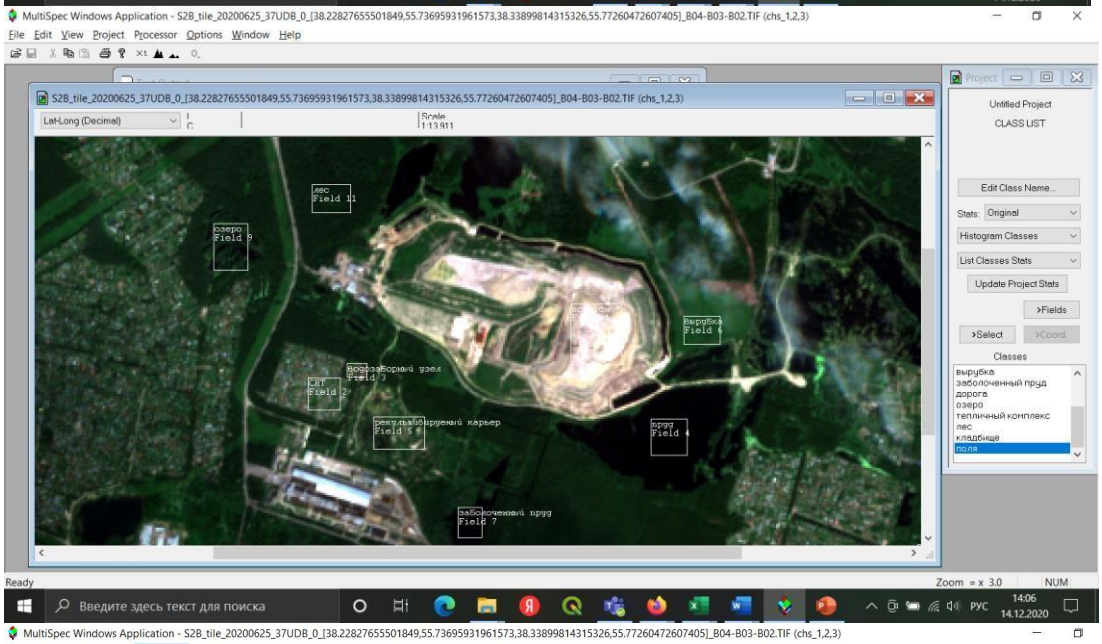

MultiSpec Windows Application - Text Output
File Edit View Project Processor Options Window Help
Text Output
Area classification not saved to disk.
Classification of Selected Area
Lines 1 to 709 by 1. Columns 1 to 1501 by 1
CLASS DISTRIBUTION FOR SELECTED AREA
Number
Class Samples Percent Area (Hectares)
1 trees 87 980 8.3 4.292
2 blank field 106 907 10.0 5.215
3 soil 91 594 8.6 4.468
4 wheat 60 897 5.7 2.971
5 light soil 29 033 2.7 1.416
6 weeds 687 798 64.6 33.552
Total 1 064 209 100.0 51.914
Total number of equal distances to classes: 0.
End maximum likelihood classification
0 CPU seconds for classification. 12-17-2020 14:59:00
>Select
>Coord.
Classes
trees
blank field
soil
wheat
light soil
weeds

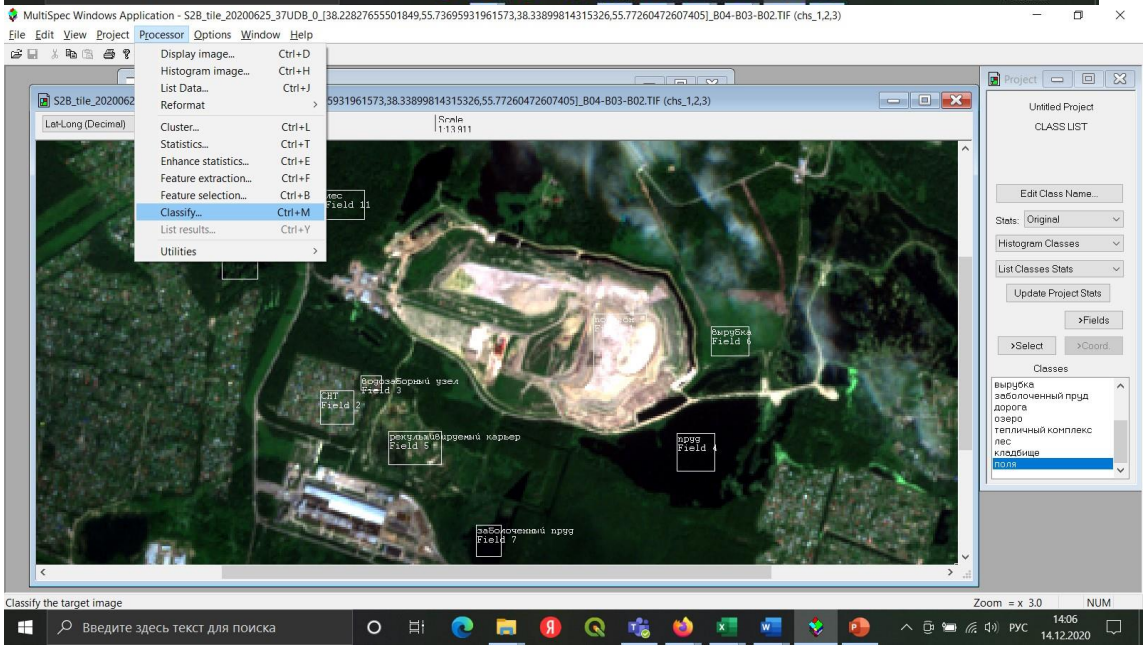

MultiSpec Windows Application - ag020522_DPAC_cd.lan (chs_3,2,1)
File Edit View Project Processor Options Window Help
Text Output
ag020522_DPAC_cd.lan (chs_3,2,1)
soil
Field 3
wheat
Field 4
trees
Field 1
weeds
Field 5
blank field
Field 2

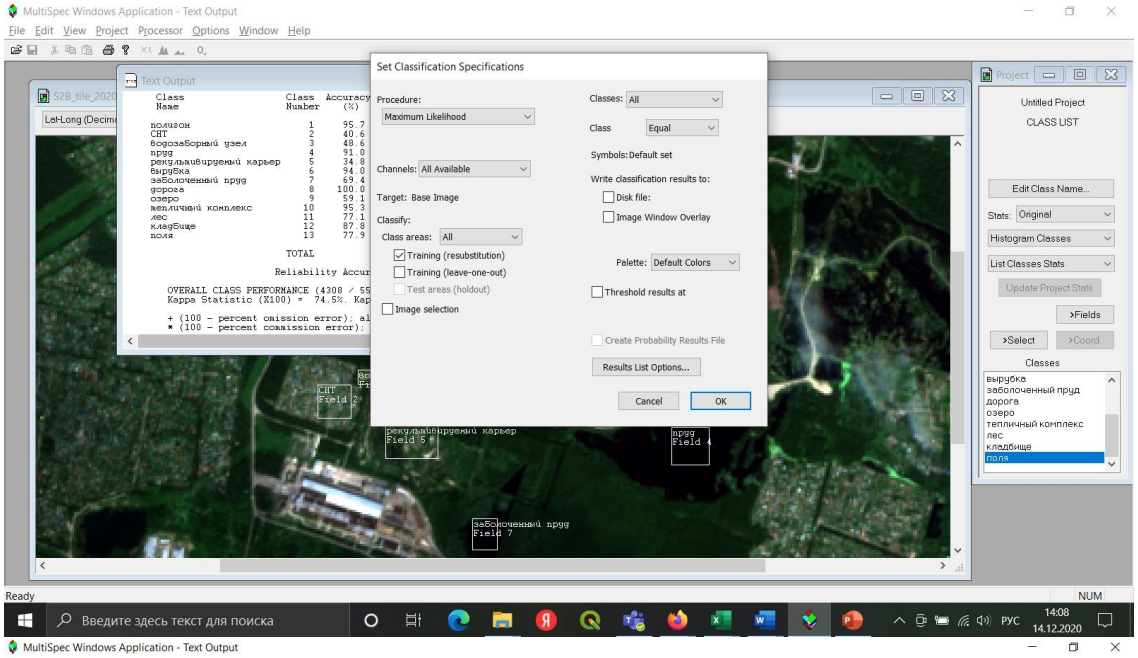

MultiSpec Windows Application - ag020522_DPAC_cd.lan (chs_3,2,1)
File Edit View Project Processor Options Window Help
Text Output
ag020522_DPAC_cd.lan (chs_3,2,1)
trees
Field 1
blank field
Field 2
Set Classification Specifications
Procedure:
Maximum Likelihood
Classes: All
Class Equal
Symbols: Default set
Channels: All Available
Write classification results to:
Target: Base Image
Disk file: GeoTIFF
Image Window Overlay
Classify:
Add new overlay
Class areas:
Palette: Default Colors
Training (resubstitution)
Training (leave-one-out)
Test areas (holdout)
Threshold results at
Image selection
Area to Classify
Start End
Create Probability Results File
Lines 1 709 1
Results List Options...
Columns 1 1501 1
Cancel
OK
wheat
light soil
weeds
Ready
Zoom = x0.500
NUM

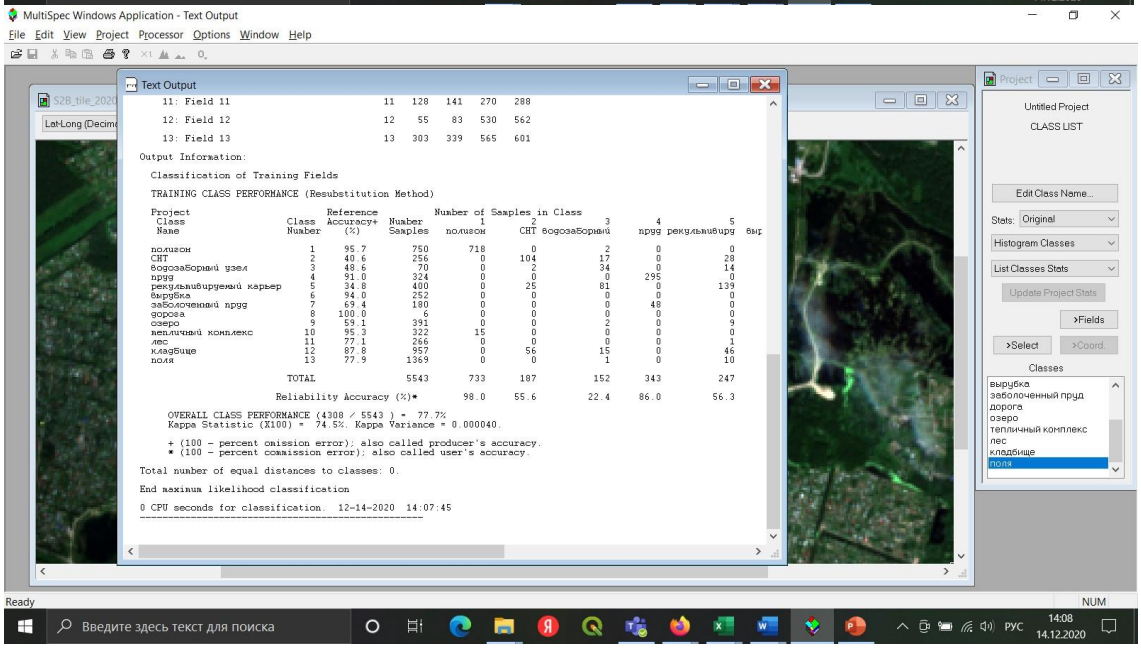

MultiSpec Windows Application - 4545454
File Edit View Project Processor Options Window Help
Text Output
ag020522_DPAC_cd.lan (chs_3,2,1)
soil
Field 3
4545454
Classes
trees
blank field
soil
wheat
light soil
weeds
Palette
light soil
weeds

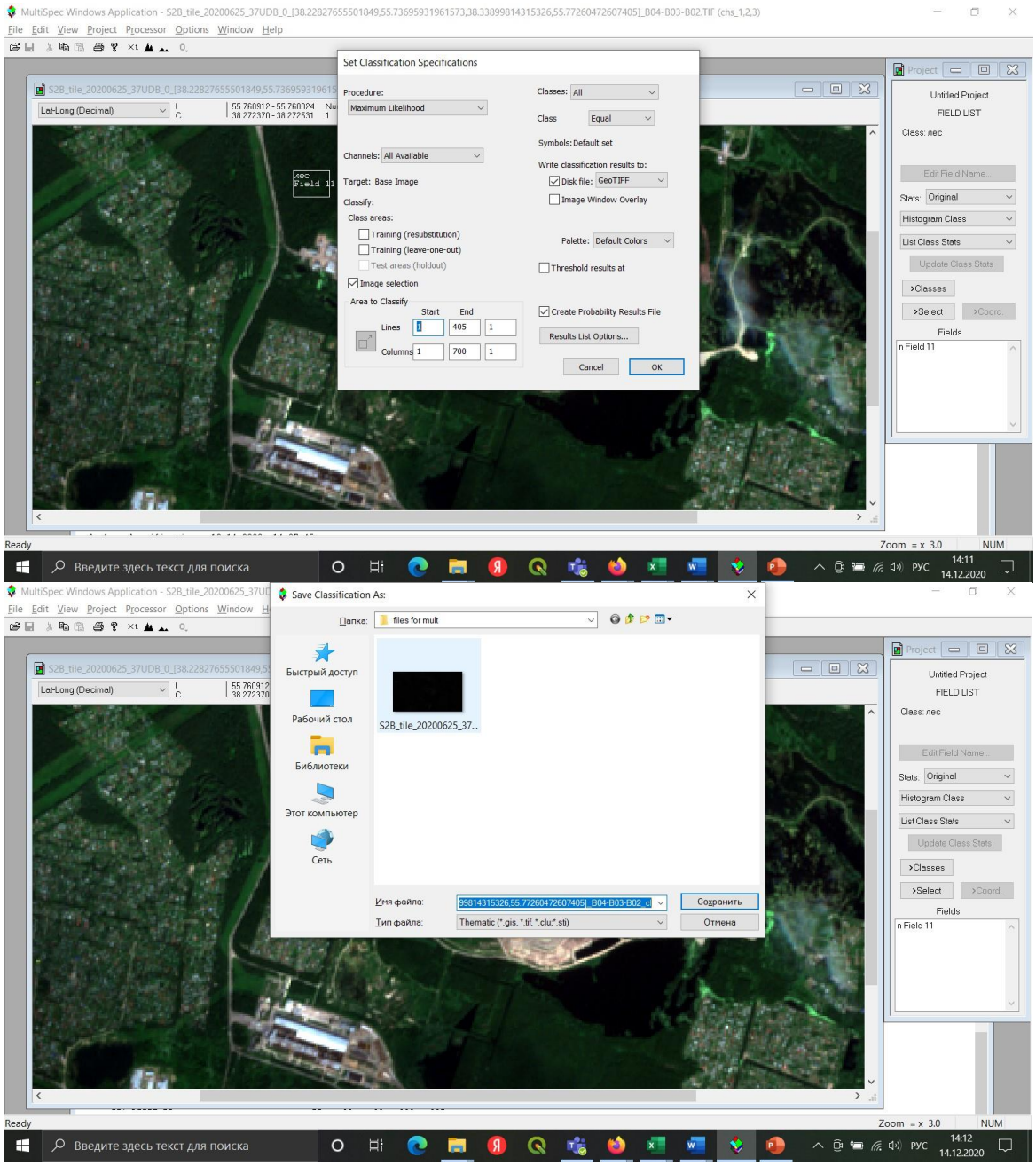

MultiSpec Windows Application - S2B_tile_20200625_37UDB_0_[38.22827655501849,55.73695931961573,38.338998143153...
File Edit View Project Processor Options Window Help
Display image... Ctrl+D
Histogram image... Ctrl+H
List Data... Ctrl+J
Reformat
Cluster... Ctrl+L
Statistics... Ctrl+T
Enhance statistics... Ctrl+E
Feature extraction... Ctrl+F
Feature selection... Ctrl+B
Classify... Ctrl+M
List results... Ctrl+Y
Utilities
Lat-Long (Decimal)
Create/Edit statistics for the project
Zoom = x0.500
NUM
Каралова Дарья Олеговна
Поделиться
Примечания
Редактирование
Диктофон
Идеи для оформления
Голос
Конструктор
Введите здесь текст для поиска
РУС
13:53
14.12.2020


MultiSpec Windows Application - S2B_tile_20200625_37UDB_0_[38.22827655501849,55.73695931961573,38.33899814315326,55.77260472607405]_B04-B03-B02.TIF (chs_1,2,3)
File Edit View Project Processor Options Window Help
Lat-Long (Decimal)
Scale
1:13,911
Project
Untitled Project
CLASS LIST
Edit Class Name...
Stats: Original
Histogram Classes
List Classes Stats
Update Project Stats
>Fields
>Select
>Coord.
Classes
вырубка
заболоченный пруд
дорога
озеро
тепличный комплекс
лес
кладбище
поля
Field 11
Field 9
Field 6
Field 3
Field 2
Field 5
Field 4
Field 7
Ready
Zoom = x 3.0
NUM
Введите здесь текст для поиска
РУС
14:06
14.12.2020

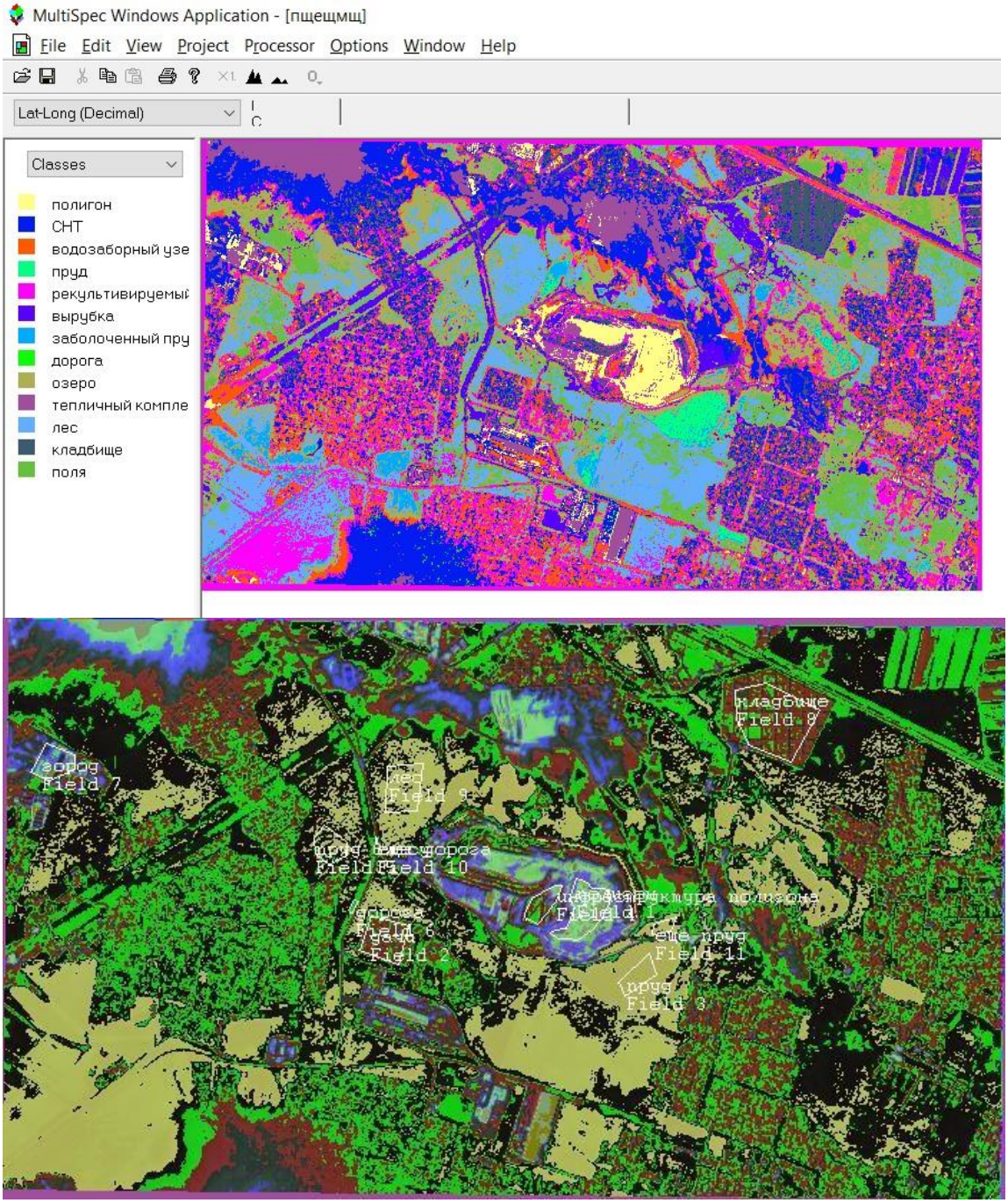

MultiSpec Windows Application - S2B_tile_20200625_37UDB_0_[38.22827655501849,55.73695931961573,38.33899814315326,55.77260472607405]_B04-B03-B02.TIF (chs_1,2,3)
File Edit View Project Processor Options Window Help
Display image... Ctrl+D
Histogram image... Ctrl+H
List Data... Ctrl+J
Reformat
Cluster... Ctrl+L
Statistics... Ctrl+T
Enhance statistics... Ctrl+E
Feature extraction... Ctrl+F
Feature selection... Ctrl+B
Classify... Ctrl+M
List results... Ctrl+Y
Utilities
Lat-Long (Decimal)
Scale
1:13,911
Project
Untitled Project
CLASS LIST
Edit Class Name...
Stats: Original
Histogram Classes
List Classes Stats
Update Project Stats
>Fields
>Select
>Coord.
Classes
вырубка
заболоченный пруд
дорога
озеро
тепличный комплекс
лес
кладбище
поля
Classify the target image
Zoom = x 3.0
NUM
Введите здесь текст для поиска
РУС
14:06
14.12.2020


MultiSpec Windows Application - Text Output
File Edit View Project Processor Options Window Help
Text Output
Set Classification Specifications
Procedure: Maximum Likelihood
Classes: All
Class Equal
Symbols: Default set
Channels: All Available
Write classification results to:
Target: Base Image
Disk file:
Image Window Overlay
Classify:
Class areas: All
Training (resubstitution)
Training (leave-one-out)
Test areas (holdout)
Palette: Default Colors
Threshold results at
Image selection
Create Probability Results File
Results List Options...
Cancel
OK
Project
Untitled Project
CLASS LIST
Edit Class Name...
Stats: Original
Histogram Classes
List Classes Stats
Update Project Stats
>Fields
>Select
>Coord.
Classes
вырубка
заболоченный пруд
дорога
озеро
тепличный комплекс
лес
кладбище
поля
Ready
NUM
Введите здесь текст для поиска
РУС
14:08
14.12.2020


MultiSpec Windows Application - Text Output
File Edit View Project Processor Options Window Help
Text Output
11: Field 11 11 128 141 270 288
12: Field 12 12 55 83 530 562
13: Field 13 13 303 339 565 601
Output Information:
Classification of Training Fields
TRAINING CLASS PERFORMANCE (Resubstitution Method)
Project Class Name | Class Number | Reference Accuracy (%) | Number Samples | Number of Samples in Class: 1 полигон | 2 СНТ | 3 водозаборный | 4 пруд | 5 рекультивиру
полигон 1 95.7 750 718 0 2 0 0
СНТ 2 40.6 256 0 104 17 0 28
водозаборный узел 3 48.6 70 0 2 34 0 14
пруд 4 91.0 324 0 0 0 295 0
рекультивируемый карьер 5 34.8 400 0 25 81 0 139
вырубка 6 94.0 252 0 0 0 0 0
заболоченный пруд 7 69.4 180 0 0 0 48 0
дорога 8 100.0 6 0 0 0 0 0
озеро 9 59.1 391 0 0 2 0 9
тепличный комплекс 10 95.3 322 15 0 0 0 0
лес 11 77.1 266 0 0 0 0 1
кладбище 12 87.8 957 0 56 15 0 46
поля 13 77.9 1369 0 0 1 0 10
TOTAL 5543 733 187 152 343 247
Reliability Accuracy (%)* 98.0 55.6 22.4 86.0 56.3
OVERALL CLASS PERFORMANCE (4308 / 5543) = 77.7%
Kappa Statistic (X100) = 74.5% Kappa Variance = 0.000040
+ (100 - percent omission error); also called producer's accuracy.
* (100 - percent commission error); also called user's accuracy.
Total number of equal distances to classes: 0.
End maximum likelihood classification
0 CPU seconds for classification. 12-14-2020 14:07:45
Project
Untitled Project
CLASS LIST
Edit Class Name...
Stats: Original
Histogram Classes
List Classes Stats
Update Project Stats
>Fields
>Select
>Coord.
Classes
вырубка
заболоченный пруд
дорога
озеро
тепличный комплекс
лес
кладбище
поля
Ready
NUM
Введите здесь текст для поиска
РУС
14:08
14.12.2020


MultiSpec Windows Application - S2B_tile_20200625_37UDB_0_[38.228276555501849,55.736959319615 73,38.338998143153 26,55.772604726074 05]_B04-B03-B02.TIF (chs_1,2,3)
File Edit View Project Processor Options Window Help
Set Classification Specifications
Procedure: Maximum Likelihood
Classes: All
Class Equal
Symbols: Default set
Channels: All Available
Write classification results to:
Disk file: GeoTIFF
Image Window Overlay
Target: Base Image
Classify:
Class areas:
Training (resubstitution)
Training (leave-one-out)
Test areas (holdout)
Palette: Default Colors
Threshold results at
Image selection
Area to Classify
Start End
Lines 1 405 1
Columns 1 700 1
Create Probability Results File
Results List Options...
Cancel OK
Project
Untitled Project
FIELD LIST
Class: nec
Edit Field Name...
Stats: Original
Histogram Class
List Class Stats
Update Class Stats
>Classes
>Select >Coord.
Fields
n Field 11
Lat-Long (Decimal)
Ready
Zoom = x 3.0
NUM
Введите здесь текст для поиска
РУС
14:11
14.12.2020

MultiSpec Windows Application - S2B_tile_20200625_37UD
File Edit View Project Processor Options Window H
Save Classification As:
Папка: files for mult
Быстрый доступ
Рабочий стол
Библиотеки
Этот компьютер
Сеть
S2B_tile_20200625_37...
Имя файла: 99814315326,55.772604726074 05]_B04-B03-B02.c
Тип файла: Thematic (*.gis, *.tif, *.clu,*.sti)
Сохранить
Отмена
Project
Untitled Project
FIELD LIST
Class: nec
Edit Field Name...
Stats: Original
Histogram Class
List Class Stats
Update Class Stats
>Classes
>Select >Coord.
Fields
n Field 11
Lat-Long (Decimal)
Ready
Zoom = x 3.0
NUM
Введите здесь текст для поиска
РУС
14:12
14.12.2020



Task (assignment) 9 Spectral indices. NDVI computing

Normalized relative vegetation index, which takes positive values for vegetation, and the greater the green phytomass, the higher it is. Index values are also affected species composition of vegetation, closeness, state, exposure and surface angle, the color of the soil under sparse vegetation. Calculated using the following formula:

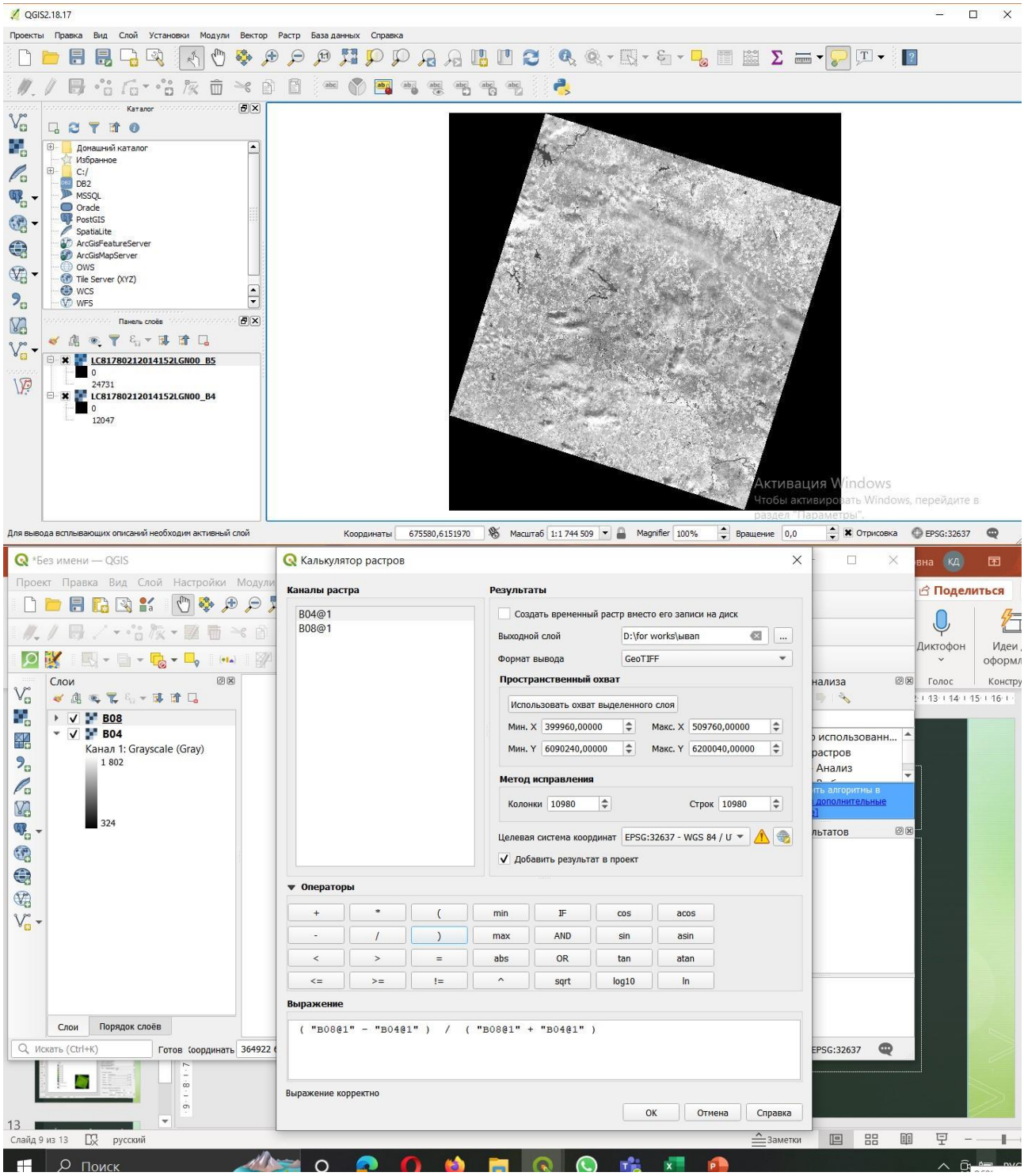
$$NDVI = \frac{\rho_{NIR} - \rho_{RED}}{\rho_{NIR} + \rho_{RED}},$$

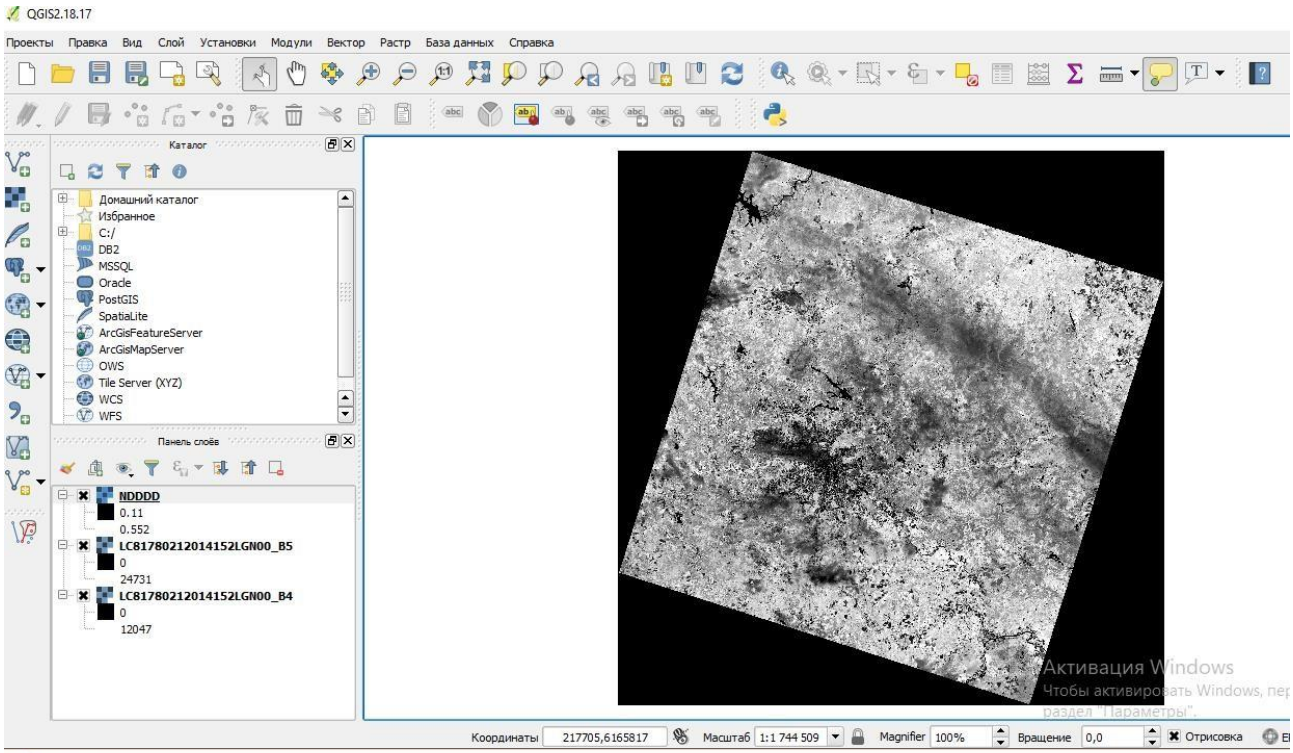
where pNIR is reflection in the near-infrared region of the spectrum, pRED is reflection in the red region of the spectrum.

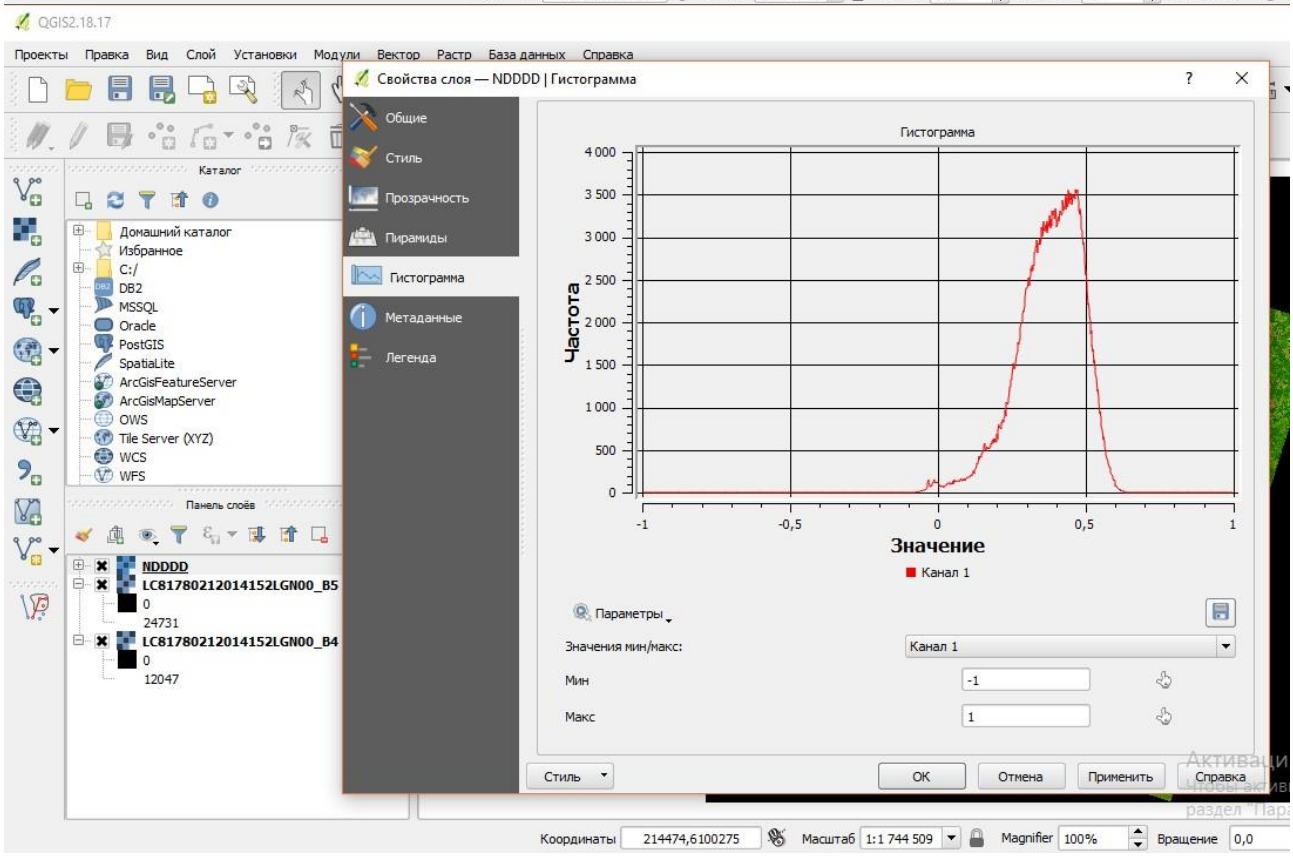
NDVI can be calculated based on any high, medium or low resolution imagery that has spectral channels in the red and near-infrared ranges.

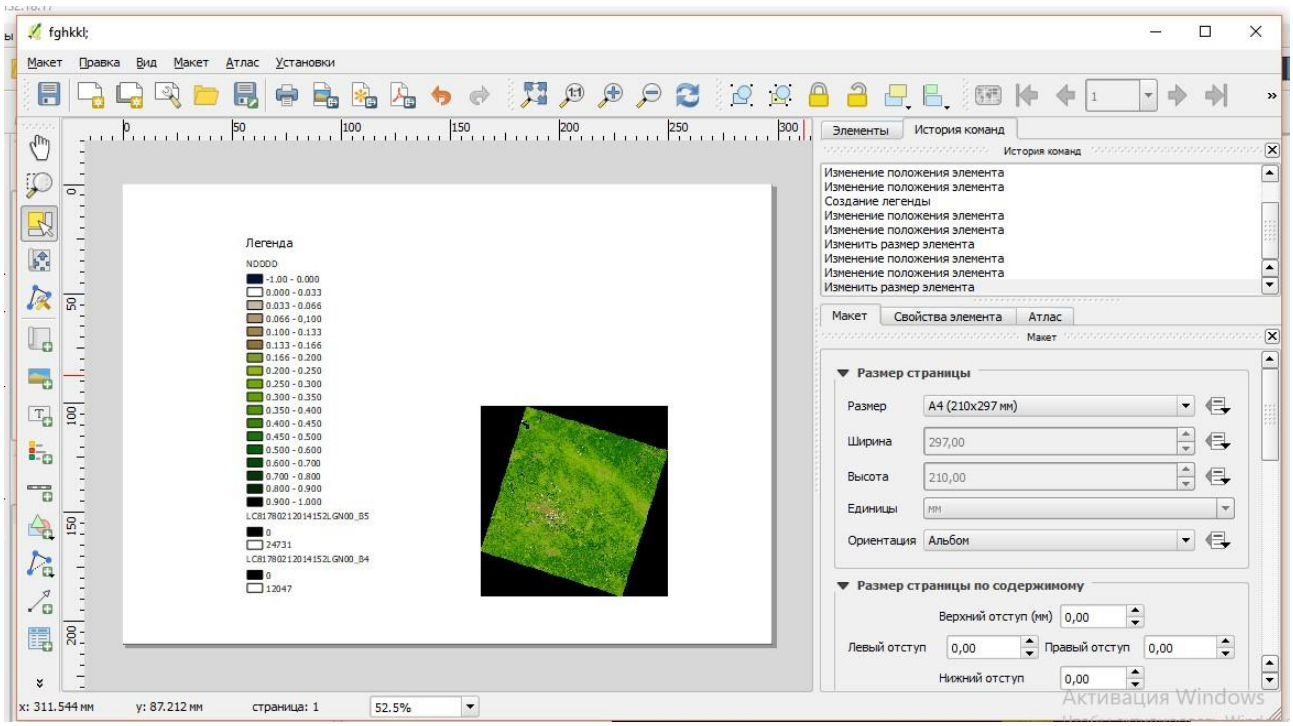
The NDVI calculation algorithm is built into almost all common software packages related to the processing of remote sensing data. The NDVI index can take values from –1 to 1. For green photosynthetic vegetation, the NDVI index takes positive values, usually from 0.2 to 0.8.

NDVI can provide numerical data used for assessment and forecasting yield and productivity, biological diversity, the degree of disturbance and damage from various natural and man-made disasters, accidents, etc.
NDVI allows you to identify problem areas of oppressed vegetation, making it possible to make the most correct decisions in the long term aimed at increasing productivity.
Using statistical processing of NDVI maps, in addition to determining the amount of phytomass, it is possible to identify the areas sown with various crops.




QGIS2.18.17
Проекты Правка Вид Слой Установки Модули Вектор Растр База данных Справка
Каталог
Домашний каталог
Избранное
C:/
DB2
MSSQL
Oracle
PostGIS
SpatiaLite
ArcGisFeatureServer
ArcGisMapServer
OWS
Tile Server (XYZ)
WCS
WFS
Панель слоёв
NDDDD
0.11
0.552
LC81780212014152LGN00_B5
0
24731
LC81780212014152LGN00_B4
0
12047
Координаты 217705,6165817
Масштаб 1:1 744 509
Magnifier 100%
Вращение 0,0
Отрисовка


QGIS2.18.17
Свойства слоя — NDDDD | Гистограмма
Общие
Стиль
Прозрачность
Пирамиды
Гистограмма
Метаданные
Легенда
Гистограмма
Частота
Значение
Канал 1
Параметры
Значения мин/макс:
Канал 1
Мин
-1
Макс
1
Стиль
OK
Отмена
Применить
Справка
Координаты 214474,6100275
Масштаб 1:1 744 509
Magnifier 100%
Вращение 0,0



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DEVELOPER:

Associate Professor of the EM Department		**Kapralova D.O.**
Position	Signature	Name, Surname

HEAD OF DEPARTMENT:

Director of EM Department		**Kucher D.E.**
Position	Signature	Name, Surname

HEAD OF PROGRAMME:

Director of ES&PQM Department		**Savenkova E.V.**
Position	Signature	Name, Surname