AL-FARABI KAZAKH NATIONAL UNIVERSITY
FACULTY OF MECHANICS AND MATHEMATICS
DEPARTMENT OF MECHANICS

Development of the specialty *«Space engineering and technologies»* in al-Farabi KazNU

Rakisheva Z.B.
Head of Department on Mechanics

ALMATY, 2017

Department on Mechanics

One of the eldest in al-Farabi KazNU

Was established in **1935** (KazNU – in 1934)

Three levels of training in this specialty:

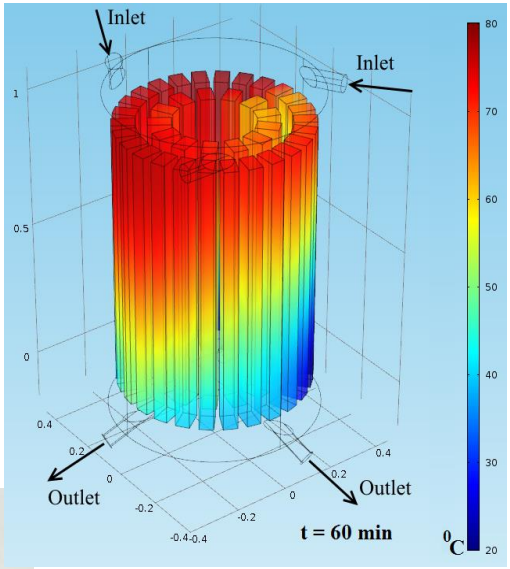
1. 5B060300 – Bachelor Program;
2. 6M060300 – Master Program;
3. 6D060300 – PhD Program.

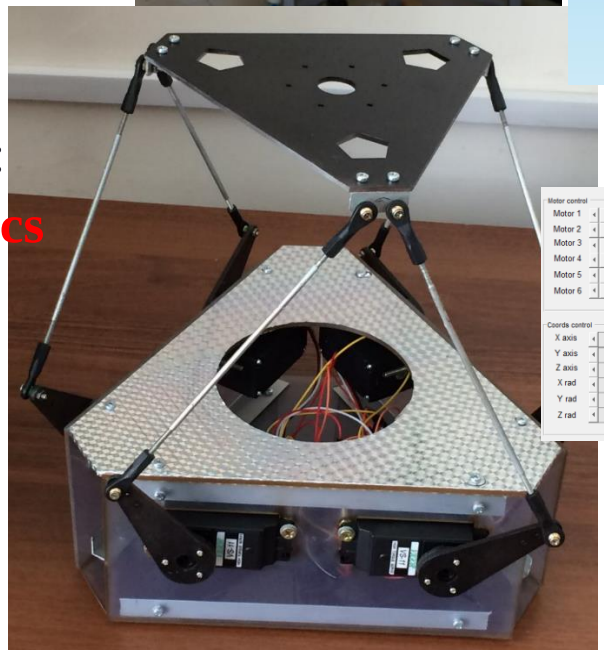
Main directions of development of educational and scientific activities:

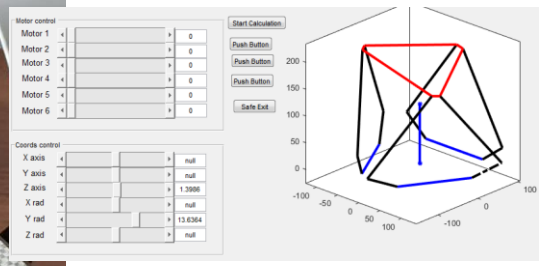
Theoretical and celestial mechanics

Fluid Mechanics (plus renewable energy)

Mechanics of machines and mechanisms (plus robotics)







Space engineering and technologies

In 2010 Department of Mechanics had opened the new specialty «Space engineering and technologies».

Now we implement three levels of training in this specialty:

1. 5B074600 – Bachelor Program;
2. 6M074600 – Master Program;
3. 6D074600 – PhD Program.

In 2015 by National Program of Innovative and Industry Development of RK (NPIID-2) new individual education trajectory had been opened «Information technology of space monitoring systems» within Master Program on specialty «Information systems». This IET is realized at the Department on Mechanics.

Subjects, studied on the specialties

«Information technology of space monitoring systems», enrollment - 2015, 2016:

- Satellite communications;
- Basics of computer-aided design;
- Space technologies for Earth observation;
- Applied microelectronics in space facilities;
- Applied sciences on Earth and ecological management;
- Treatment methods of satellite data;
- Ecological mathematical modeling;
- Application of GEONETCAST for monitoring of environment of industrial regions;
- Monitoring of transport system state;
- Monitoring and management of nature resources;
- City planning and building management.

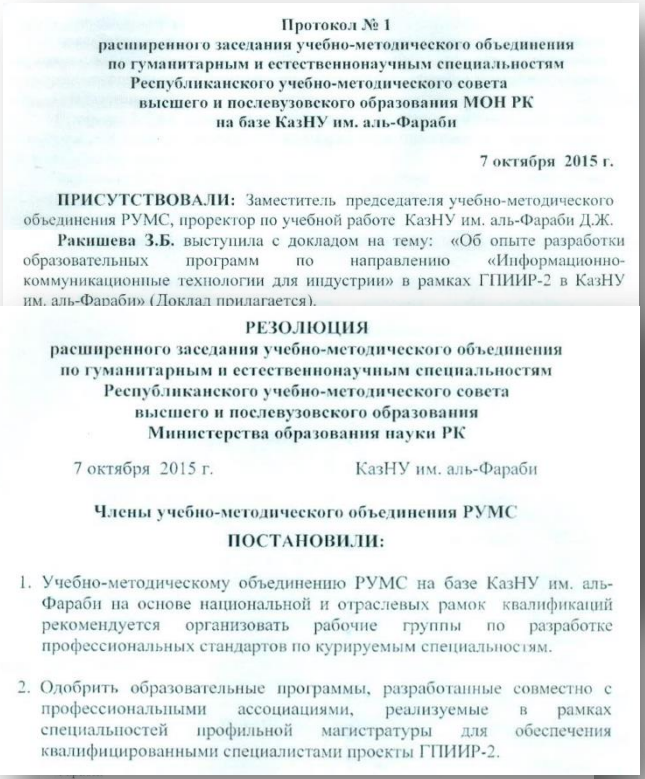
«Design of the spacecraft», enrollment - 2016:

- Structure and mechanisms of the university nano- and microsatellites;
- Basics of computer-aided design;
- Design and operation of the spacecraft ground automated control complexes;
- Ballistic and navigation support of the aerial vehicles;
- Spacecraft mission planning;
- CAD/CAM/CAE design at space applications;
- Spacecraft electrical system design;
- Thermo-mechanical design of the satellites of micro- and nano- type;
- Designing of the systems for spacecraft motion control and navigation;
- Applied microelectronics in space facilities.

QUALITY CONTROL

For new curricula the expert's positive conclusions were received from:

- Akira Iwasaki, Professor of Engineering Space Application Laboratory, University of Tokyo, Japan
- Arno van Lieshout, Professor of University of Twente, Netherlands (partner on Tempus)



Протокол № 1
расширенного заседания учебно-методического объединения
по гуманитарным и естественнонаучным специальностям
Республиканского учебно-методического совета
высшего и послевузовского образования МОН РК
на базе КазНУ им. аль-Фараби

7 октября 2015 г.

ПРИСУТСТВОВАЛИ: Заместитель председателя учебно-методического объединения РУМС, проректор по учебной работе КазНУ им. аль-Фараби Д.Ж. **Ракишева З.Б.** выступила с докладом на тему: «Об опыте разработки образовательных программ по направлению «Информационно-коммуникационные технологии для индустрии» в рамках ГПИИР-2 в КазНУ им. аль-Фараби» (Доклад прилагается).

РЕЗОЛЮЦИЯ
расширенного заседания учебно-методического объединения
по гуманитарным и естественнонаучным специальностям
Республиканского учебно-методического совета
высшего и послевузовского образования
Министерства образования науки РК

7 октября 2015 г. КазНУ им. аль-Фараби

Члены учебно-методического объединения РУМС
ПОСТАНОВИЛИ:

1. Учебно-методическому объединению РУМС на базе КазНУ им. аль-Фараби на основе национальной и отраслевых рамок квалификаций рекомендуется организовать рабочие группы по разработке профессиональных стандартов по курируемым специальностям.
2. Одобрить образовательные программы, разработанные совместно с профессиональными ассоциациями, реализуемые в рамках специальностей профильной магистратуры для обеспечения квалифицированными специалистами проекты ГПИИР-2.

Зам. председателя
учебно-методического объединения
по гуманитарным и
естественнонаучным специальностям
Республиканского учебно-методического совета
высшего и послевузовского образования МОН РК
на базе КазНУ им. аль-Фараби,
проректор по учебной работе Д.Ж. Ахмед-Заки

Ученый секретарь УМО РУМС А.С. Сыргакбаева

Univ. of Tokyo RCAST 東京大学先端科学技術研究センター Research Center for Advanced Science and Technology
東京大学 THE UNIVERSITY OF TOKYO

Research Center for Advanced Science and Technology
The University of Tokyo
4-6-1 Komaba, Meguro
Tokyo 153-8904
Japan

EXPERT CONCLUSION

The individual educational trajectory "Information technologies of space monitoring systems" of the main curriculum for "Information and communication technologies" direction of "6M070300 Information systems" specialty aims to educate highly qualified specialists in master course. Part of the subjects are taken from the International project Tempus-SESREMO, funded by European Union (2013-2016).

Monitoring form space has an ability to observe a wide area simultaneously and deliver valuable information for human life and industries in Kazakhstan.

The presented core curriculum convers knowledge, skills and abilities of space systems and information technologies in both hardware and software sides, such as satellite systems, satellite data processing, geographic information system, system modeling, environmental monitoring and management. Additional courses, such as industrial practice and research work, further accelerate the skills and experiences of graduates in this field. The master's thesis cultivates the independent research skills to find original application of acquired knowledge for solving production problems using information technologies.

Information from space is related to various kinds of key industries, such as mineral and oil/gas, agriculture, forest and water resources, by analyzing the present status and forecasting the future development in Kazakhstan. The competence acquired by the present curriculum is expected to demonstrate original approach in solving problems in a professional manner.

Sincerely,

Akira Iwasaki

Akira Iwasaki
Professor of Engineering
Space Application Laboratory

UNIVERSITY OF TWENTE.

FACULTY OF GEO-INFORMATION SCIENCE AND EARTH OBSERVATION

FROM: a.m.vanlieshout@utwente.nl
DATE: 21st August 2015
OUR REFERENCE: WRS-69.15/ak
PAGE: 1 of 2

SUBJECT
Topic Expert Conclusion

The documentation related to the individual educational trajectory (IET) **Information technologies of space monitoring systems** of the main curriculum for "Information and Communication Technologies –speciality - Direction "Information Systems" (6M070300) has been reviewed.

Many elements from this programme are taken from the SESREMO/Tempus project in which Technical University Berlin and University of Twente have developed several course elements related to Earth Observation.

Regarding the curriculum the following can be observed:

Competencies

The competencies, which are to be obtained after the programme has been taken, are well described. The list of competencies demonstrate that the curriculum designers have a good insight in the complex and divers working environment the graduates will encounter after graduation. The involvement of JSC "National Center for Space Research and Technology" and JSC "KAZGEOCOSMOS" for practical training ensures a direct link between future employees and graduates-to-be and the bringing in of real-life case study in the curriculum. Learning "Space monitoring techniques' require a lot of software related skills. The programme provides sufficient time for the students to acquire this during the 'laboratory works.'

Curriculum

The topics which been identified in the electives will give a wide exposure of the students on applications of Earth Observation (EO). The application of EO for ecology, natural resources and urban (city) planning have been given sufficient weight in the programme. Essential is good knowledge of spatial data acquisitions and image processing . These elements will be covered in the electives. Space technologies for Earth observation and Treatment methods of satellite data and Application of GEONETCast. After the principles of acquisition and analysis applications in different fields follows.

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7500 AE Enschede
The Netherlands

ITC
www.itc.nl

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ensure that the students have sufficient "System Earth" related background such as Ecology, Biology, Hydrology and/or Environmental Sciences. With students in the programme with this background the IET can focus directly on EO applications without the need to explain "System Earth" principles.

Kind regards,

Arno van Lieshout
Course Director Water Resources and Environmental Management (WREM)
University of Twente
Faculty of Geo-Information Science and Earth Observation (ITC)

RETRAIN ACADEMIC TEACHERS

INSTITUTE OF CYBERNETICS
at Tallinn University of Technology

Tallinn, 14 November 2014

This is to certify that

Ms. **Makpal Nogaibayeva**

has participated in the training on the new curricula:

COASTAL PROCESSES AND ENVIRONMENTAL MANAGEMENT

ENVIRONMENTAL MATHEMATIC MODELLING FOR WAVE DYNAMICS
and
PREVENTIVE METHODS FOR COASTAL ENVIRONMENTAL PROTECTION

organized within the SESREMO project jointly by the Institute of Cybernetics at Tallinn University of Technology and Klaipeda University on 01–14 November 2014.

Tarmo Soomere
Estonian Academy of Sciences,
Head of Division of Informatics and Engineering
Dr. Math., Leading Research Scientist
Head of Wave Engineering Laboratory

KLAIPEDA UNIVERSITY

Certificate

This is to certify that

Prof. Dr. Zaure Rakisheva

has participated in the training on the new curriculum
PROCESSES AND ENVIRONMENTAL MANAGEMENT
in the SESREMO project jointly by Tallinn University of Technology
University on 01–14 November 2014 in the amount of 72 contact hours

Academician Tarmo Soomere

Klaipeda
2014

Courses:

- COASTAL PROCESSES AND ENVIRONMENTAL MANAGEMENT;
- PREVENTIVE METHODS FOR COASTAL ENVIRONMENTAL PROTECTION;
- ENVIRONMENTAL MATHEMATIC MODELLING FOR WAVE DYNAMICS.

Organizer: Institute of Cybernetics at Tallinn University of Technology

Participants from KazNU (Faculty of Mechanics and Mathematics):

Zaure Rakisheva,
Makpal Nogaibayeva

31.10.2014-15.11.2014.

STAFF TRAINING

Teacher training in Moscow: course on software ENVI and SARscape, 30.11.2015-09.12.2015

Zaure Rakisheva, Makpal Nogaibayeva, Gulnara Mayemerova, Nazgul Kalieva, Zhanbolat Lyazat

MASTER CLASSES

KazNU has invited the lecturers

for master students:

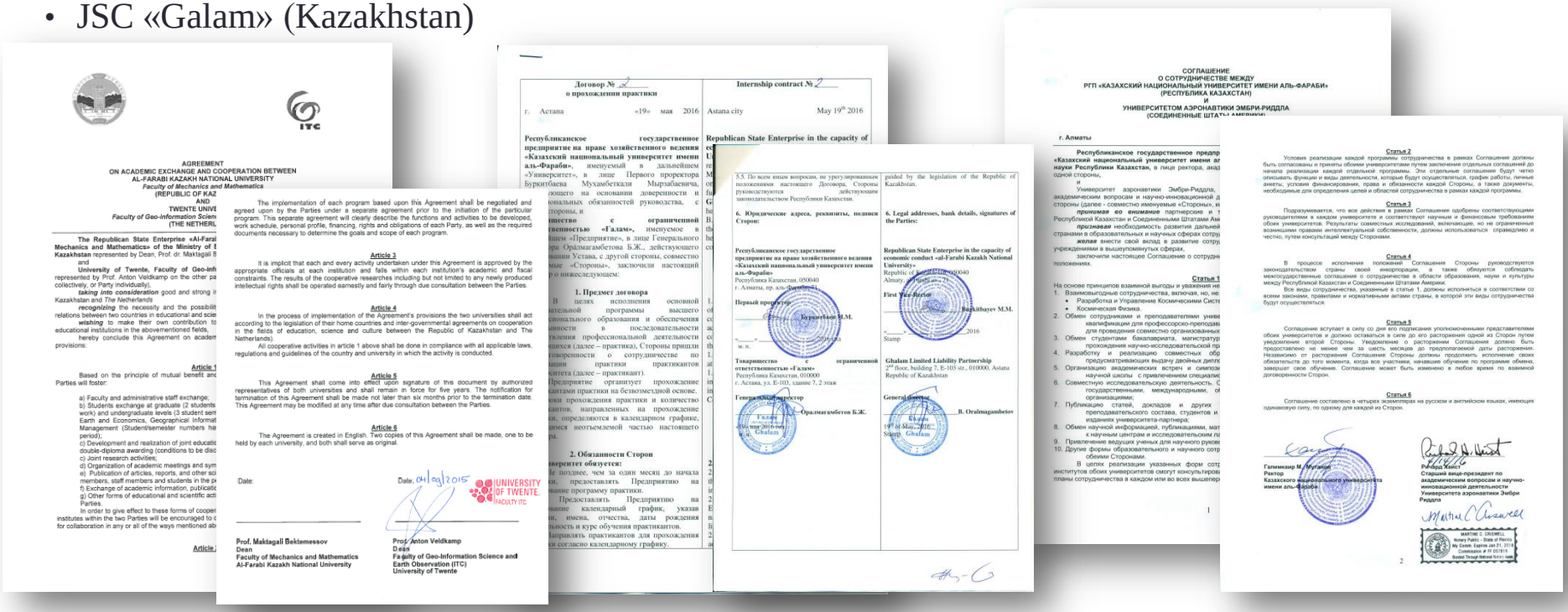
- Prof. Vasily Kopenkov from Samara State Aerospace University, Russia, read lectures on subject: “Basics of remote sensing” (December, 2015)
- Prof. Akira Iwasaki from Tokyo University read the subject “Satellite data processing” (March, 2016)

ECOLOGICAL MONITORING SERVICE OFFICE

Our department with the Faculty of Geography and Environmental Sciences had organized the **Center of Space technologies and RS**. It was approved by Academic Council of KazNU (prot. №3 from 26.12.2016

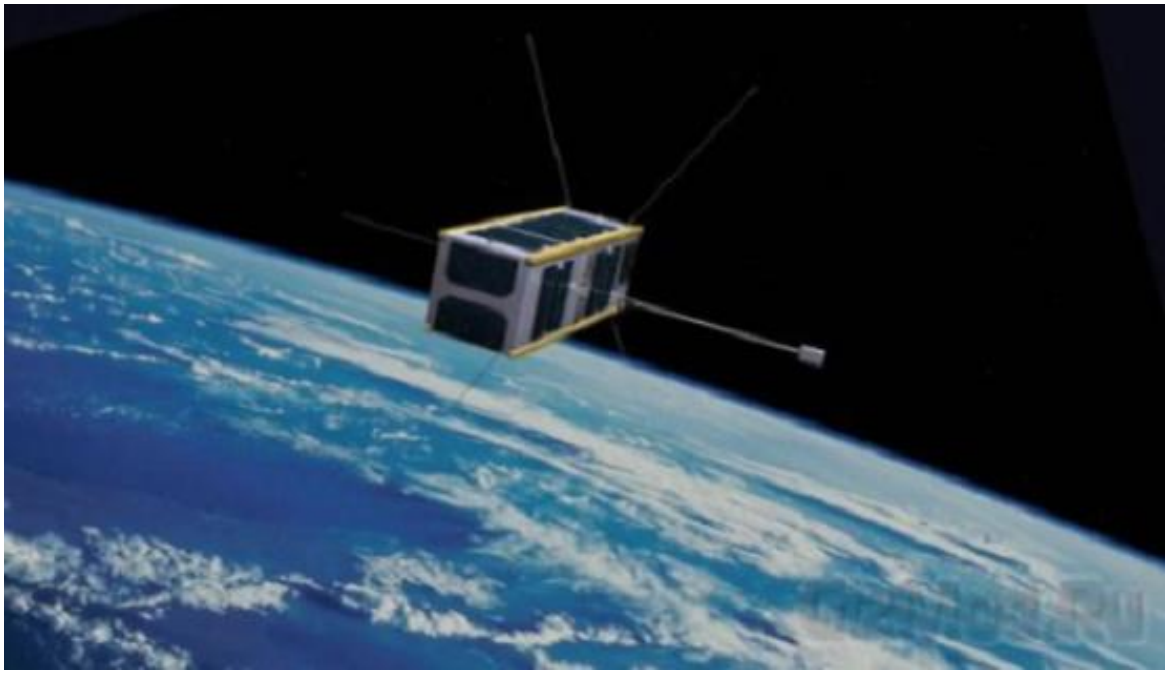
The MoU had signed with:

- University of Twente (Netherlands)
- Berlin Technical University (Germany)
- Embry-Riddle Aeronautical University (USA)
- Samara State Aerospace University (Russia)
- JSC «Galam» (Kazakhstan)



Nano-satellite «Al-Farabi-1»

The first student nano-satellite in Kazakhstan was developed by students of our specialty «Space engineering and technologies».



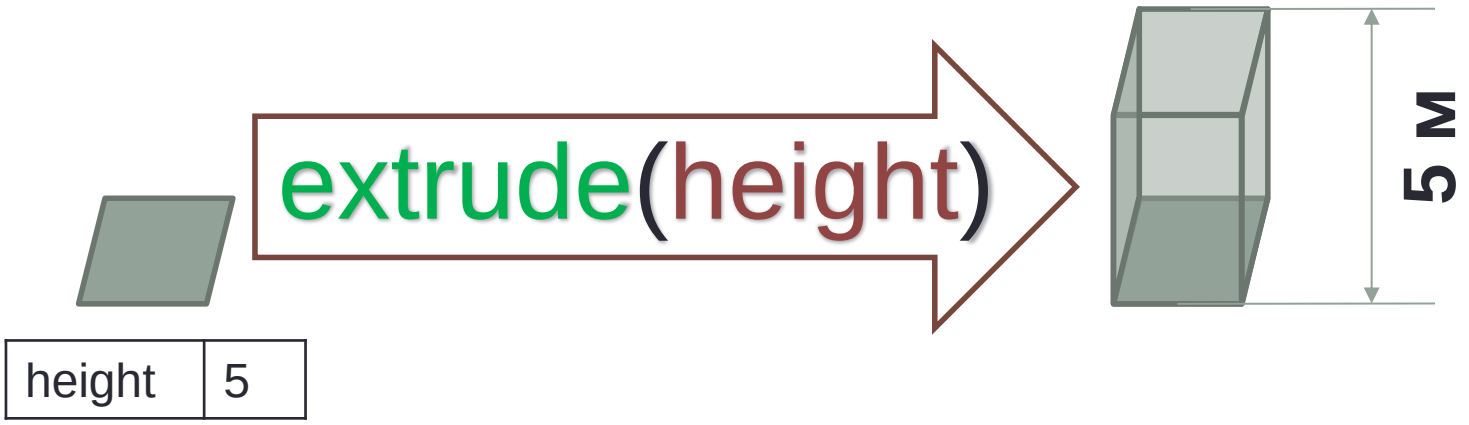
Research works of our master students in specialty «Information technology of space monitoring systems» (enrollment 2015)

CREATING THE THREE-DIMENSIONAL CITY MODELS BASED ON REMOTE SENSING DATA AND TOPOGRAPHICAL MAPS

Zhetpissov R.

Source Data / Procedural modeling

- **Remote Sensing Data:** very high-resolution orthoimagery from archive.
- **Topographical data:** 1:1000 scaled map of the city of Zhezkazgan.
- No stereo imagery / no lidar data.



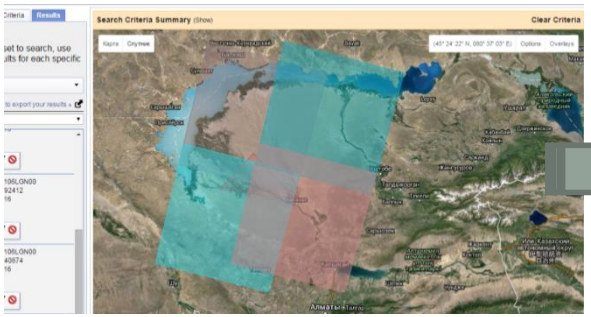
Model creation

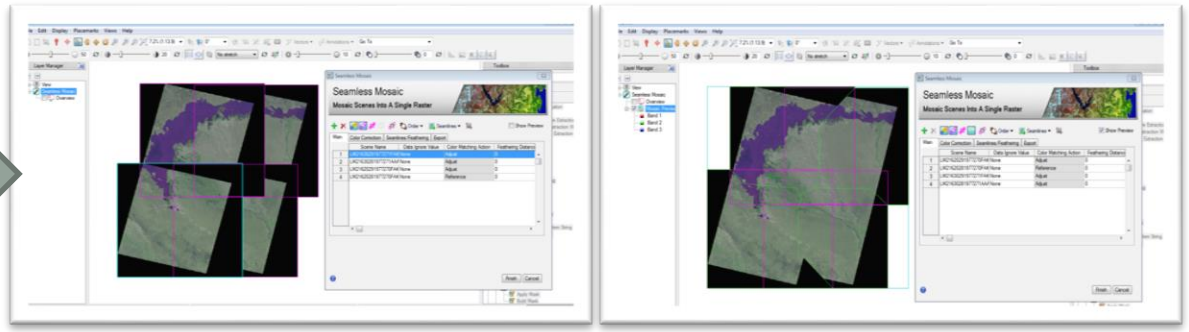
CITY 3D SCENES

GEOENVIRONMENTAL MONITORING OF CHANGES OF DELTAS OF RIVER ILY BY METHODS OF REMOTE SENSING

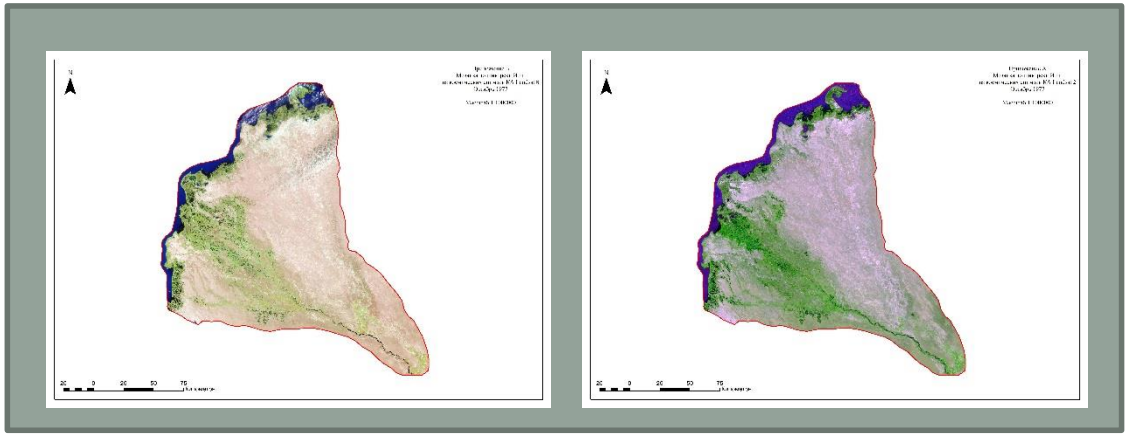
Ibrayeva A.

Making mosaics for 1977 and 2015

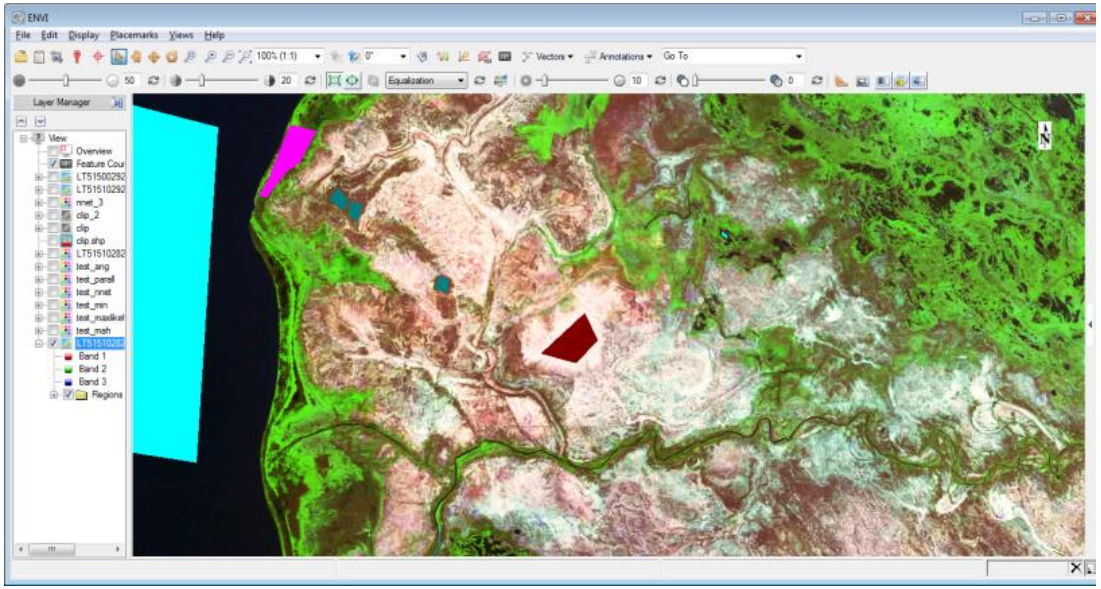




Seamless Mosais Tool (on the left - to add images to create a mosaic, on the right - automatic construction of stitching line and image preview)

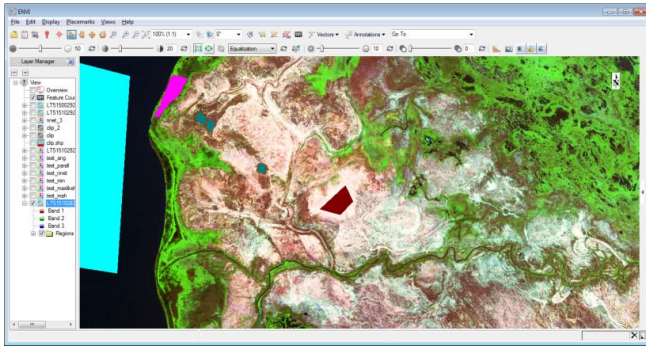


Identification areas of interest for learning

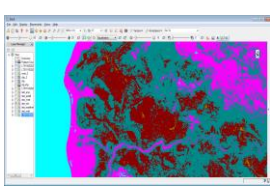
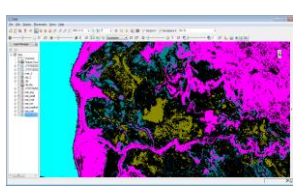
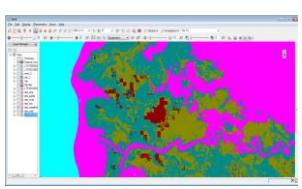
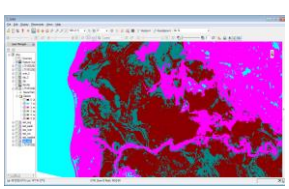
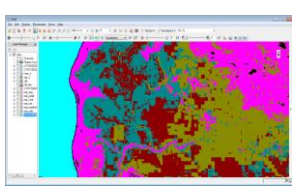
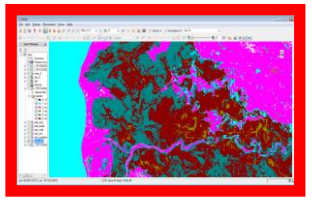


№ ROI	Краткий идентификатор	Наименование	Описание
1	Water	Гидрография	Объекты гидрографии - реки, соленые и пресные озера, водное зеркало р.Балхаш
2	Solon	Такыровидные и песчано-такыровидные и аллювиально-песчанные ландшафты, пустынные солонцы	Территории, относящиеся к древней дельте реки Или со следами ранее повышенного увлажнения
3	Wetland	Заболоченные, лугово-болотные ландшафты	Территории повышенного увлажнения, покрытые соответствующей растительностью
4	Sand	Песчаные ландшафты	Территории с минимальным количеством пустыни без следов увлаженения в геологическом прошлом

Selection of the most appropriate method for the classification

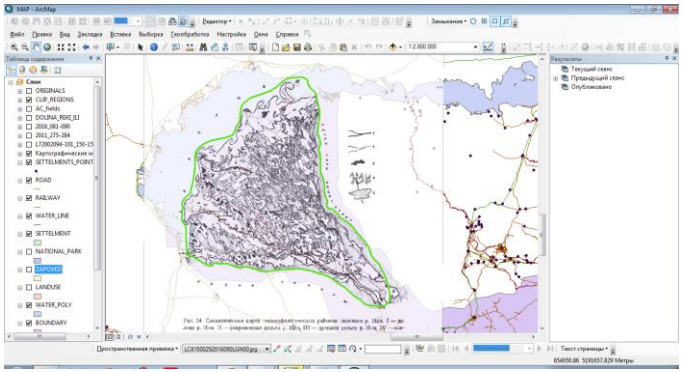


- Method of parallelepipeds (Parallelepiped)
- Minimum spectral distance algorithm (Euclidean metric, Minimum distance)
- Algorithm of Mahalanobis distances (Mahalanobis Distanse)
- The method of maximum likelihood (Maximum likelihood)
- Classification by the method of spectral angle (Spestral Angle Mapper)
- Classification using neural networks

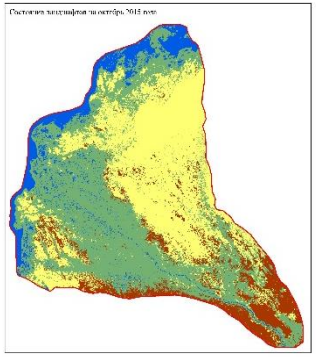







The best results were shown by using neural network algorithm, which is the most progressive and modern of image processing.

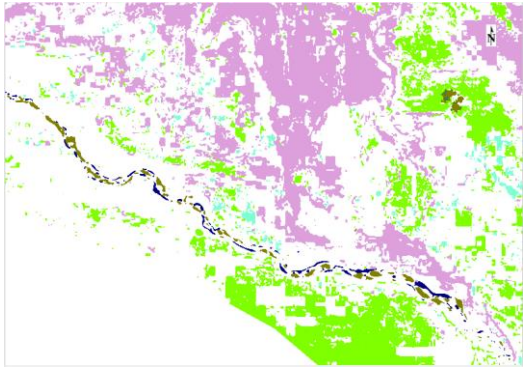
Map construction
"Integrated card of dynamics of delta landscapes of river Ily for 1977-2015"



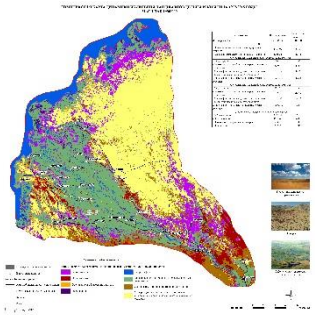
•Topographic base
•Digitized data

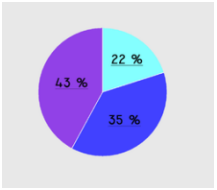


•Classified image
of landscapes for 2015



The results of the
detection of changes





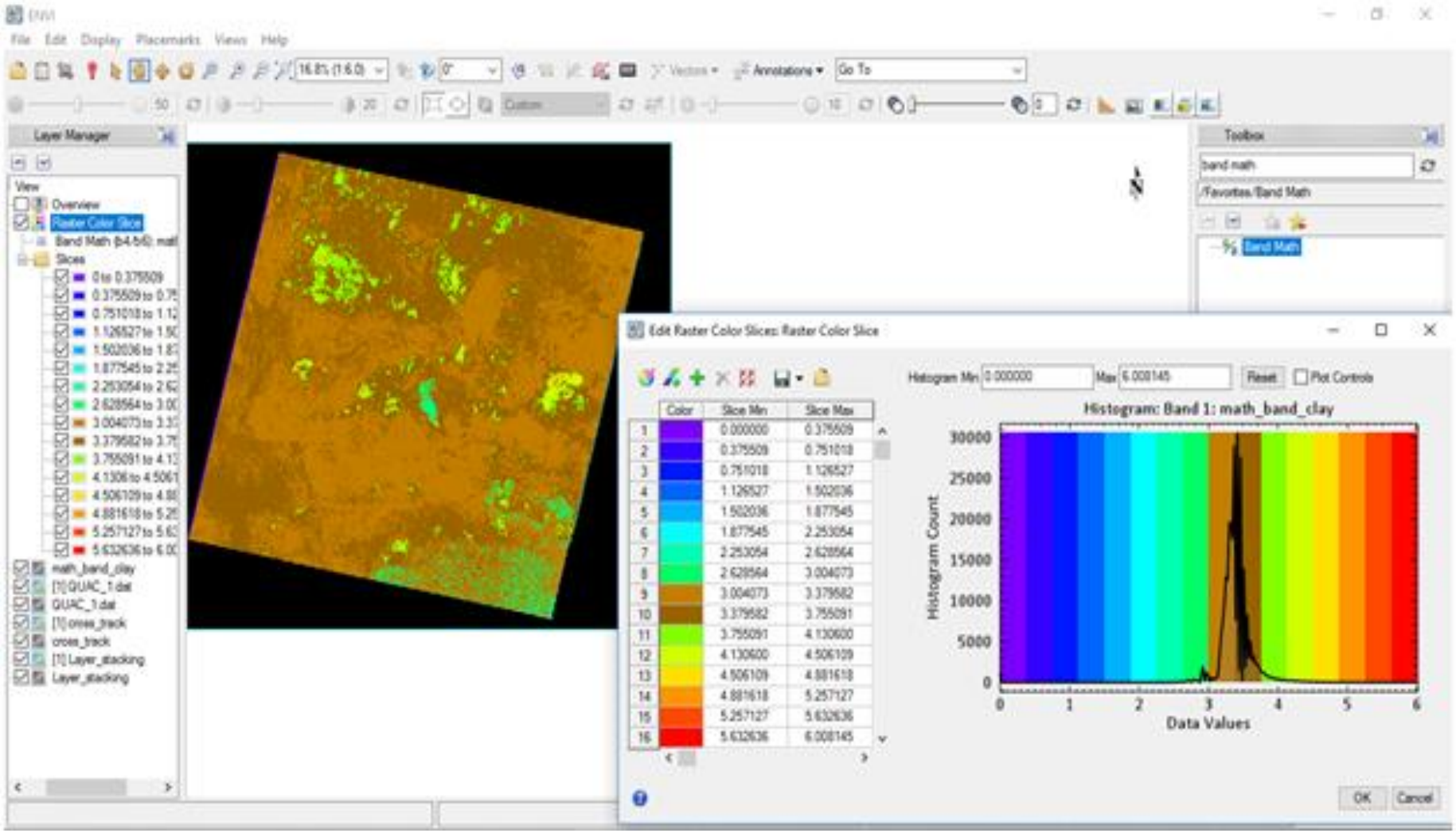
•A set of statistical data

•Integrated card of dynamics of delta landscapes of river Ily for 1977-2015

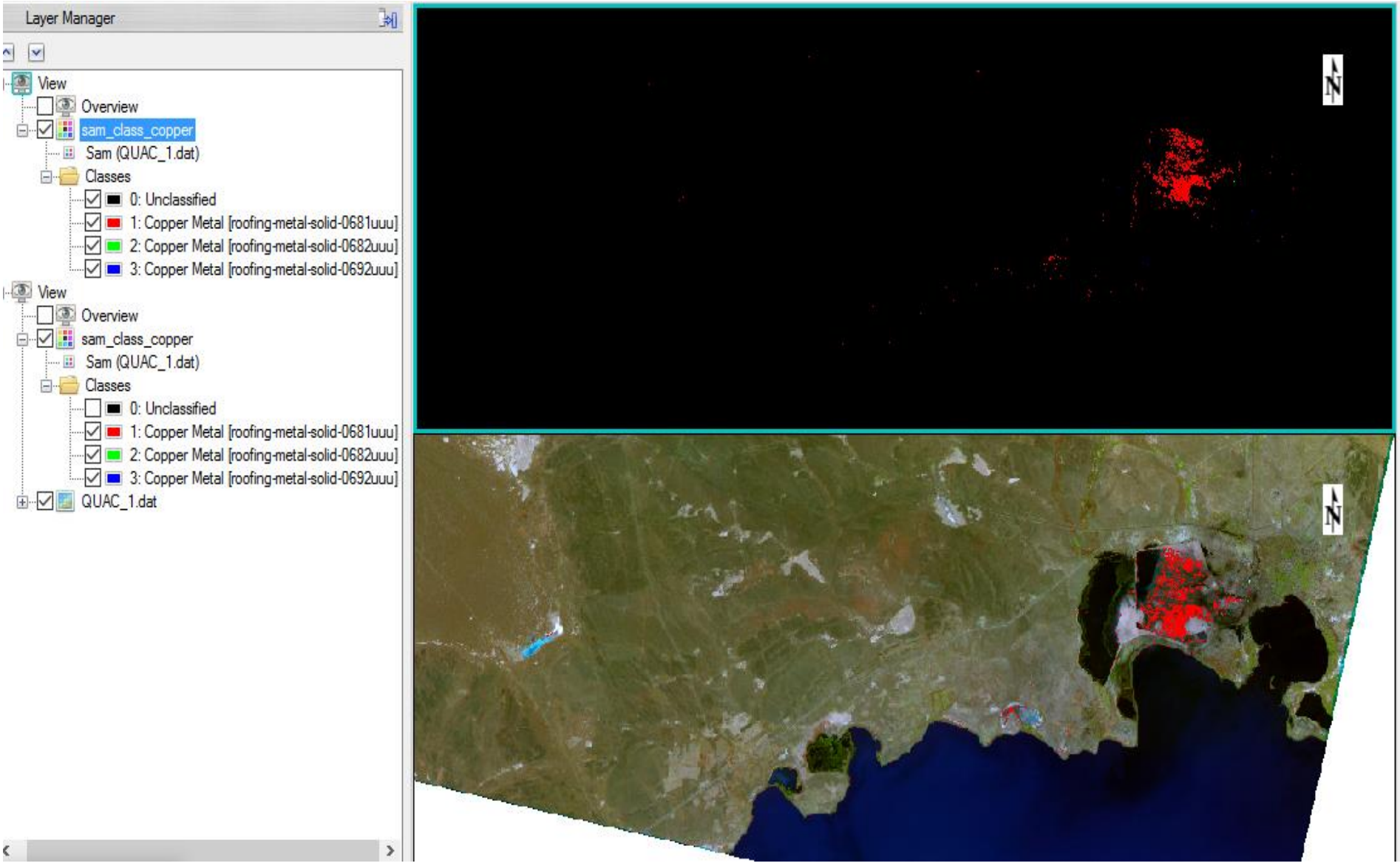
THE POSSIBILITY OF USING OF THE SPECTRAL SIGNATURE LIBRARIES FOR THE ANALYSIS OF MULTIBAND IMAGES FOR THE TERRITORY OF THE REPUBLIC OF KAZAKHSTAN

Sydyk N.

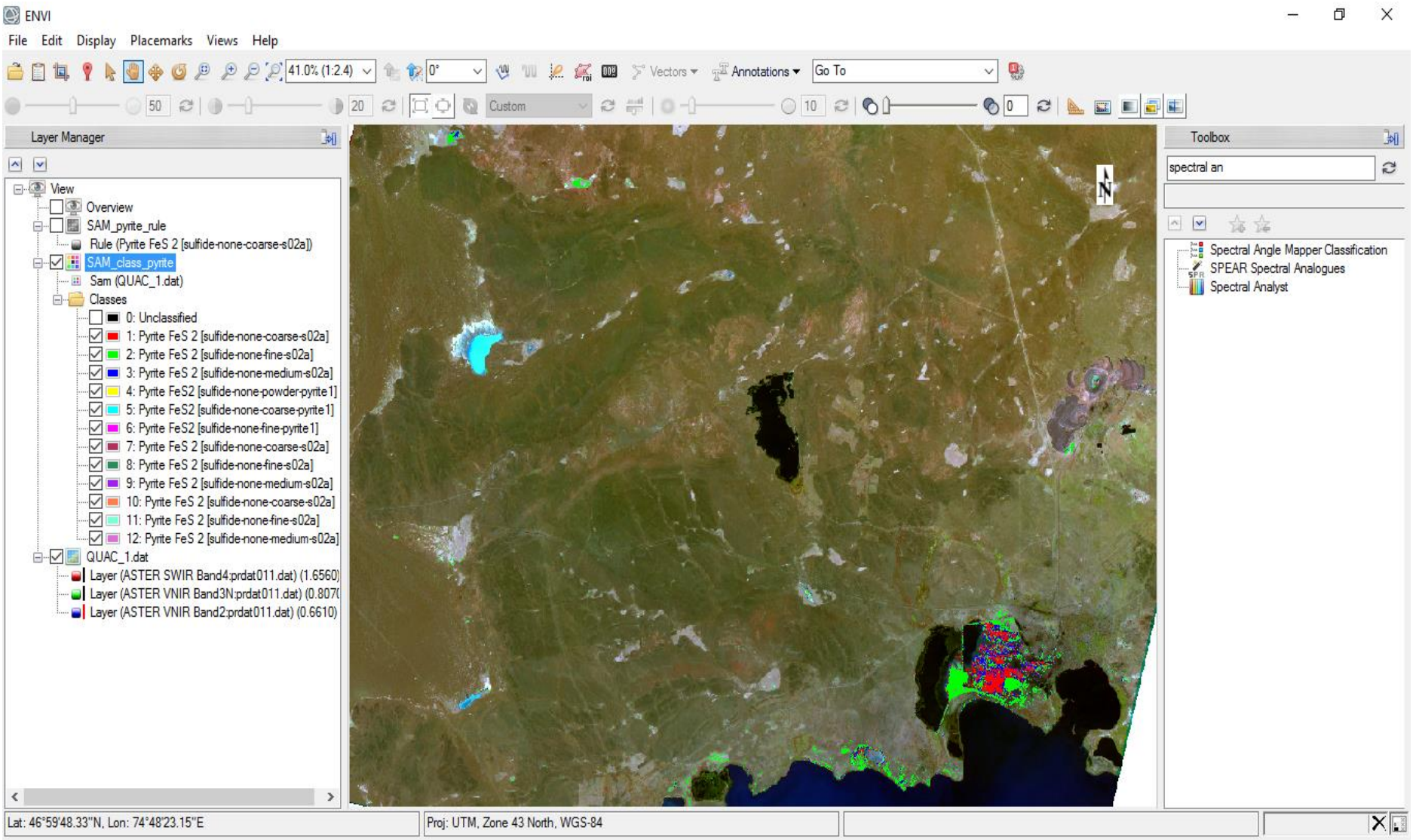
Discovering clay minerals by Band Math tool



Copper deposits by Spectral Angle Mapper



Pyrite deposits



Растровая подложка-ASTER, R=4, G=3, B=2

Conclusion

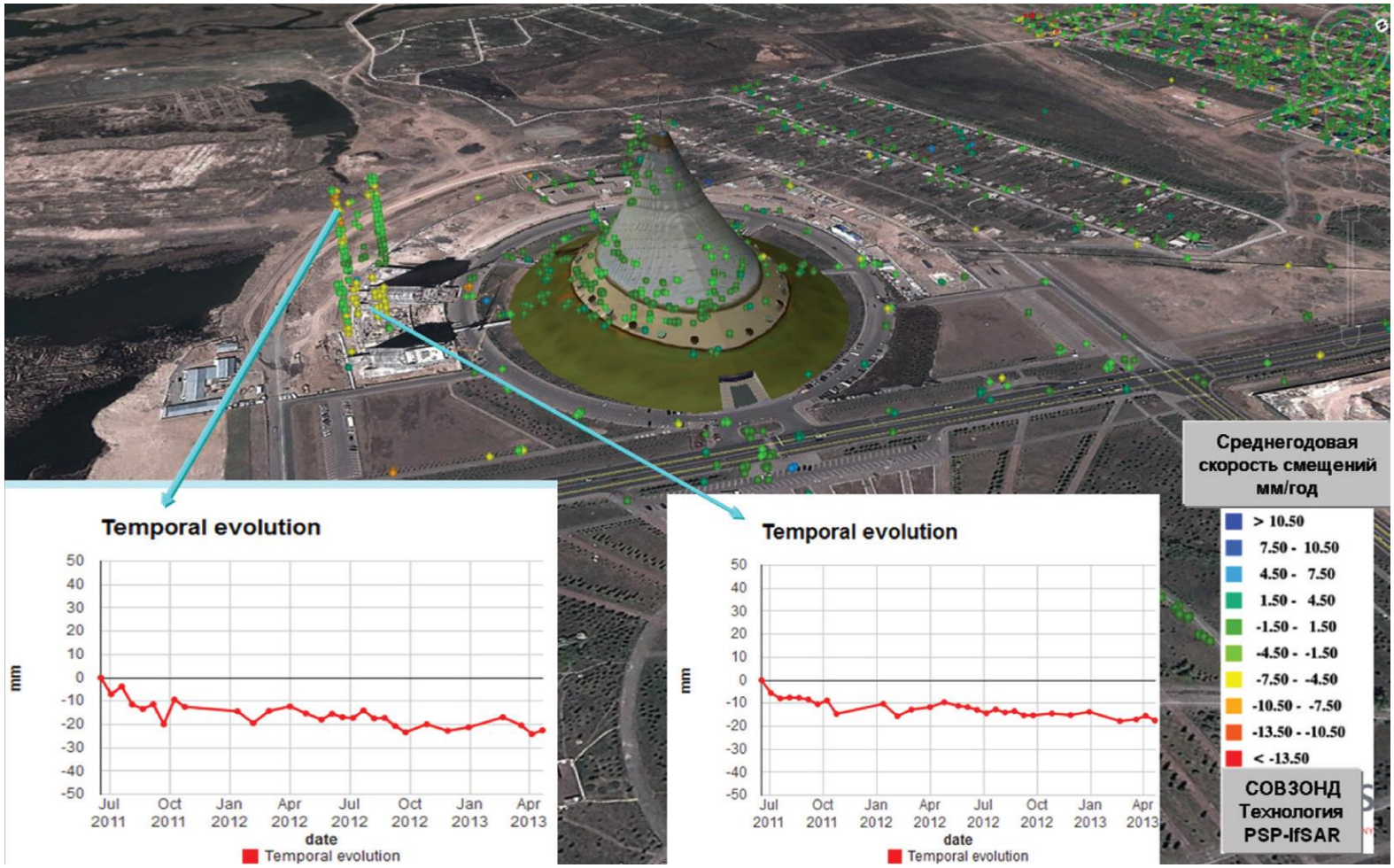
- The north-western part of Lake Balkhash has a large concentration of different types of minerals;
- Methods of spectral angle is more effective to search for specific ores;
- The use of spectral signatures libraries for the analysis of territories is one of the most reliable and advanced methods of exploration;
- Most of the ore was found in a certain square area near the lake. This is due to the fact that there is a large amount of recycled waste Balkhash Mining and Metallurgical Combine.
- The ability to use remote sensing data for exploration of deposits would greatly expand the possibilities of geological and intelligence services with less material and moral means.

MONITORING OF VERTICAL DISPLACEMENTS OF POINTS OF THE EARTH SURFACE OF THE ASTANA CITY

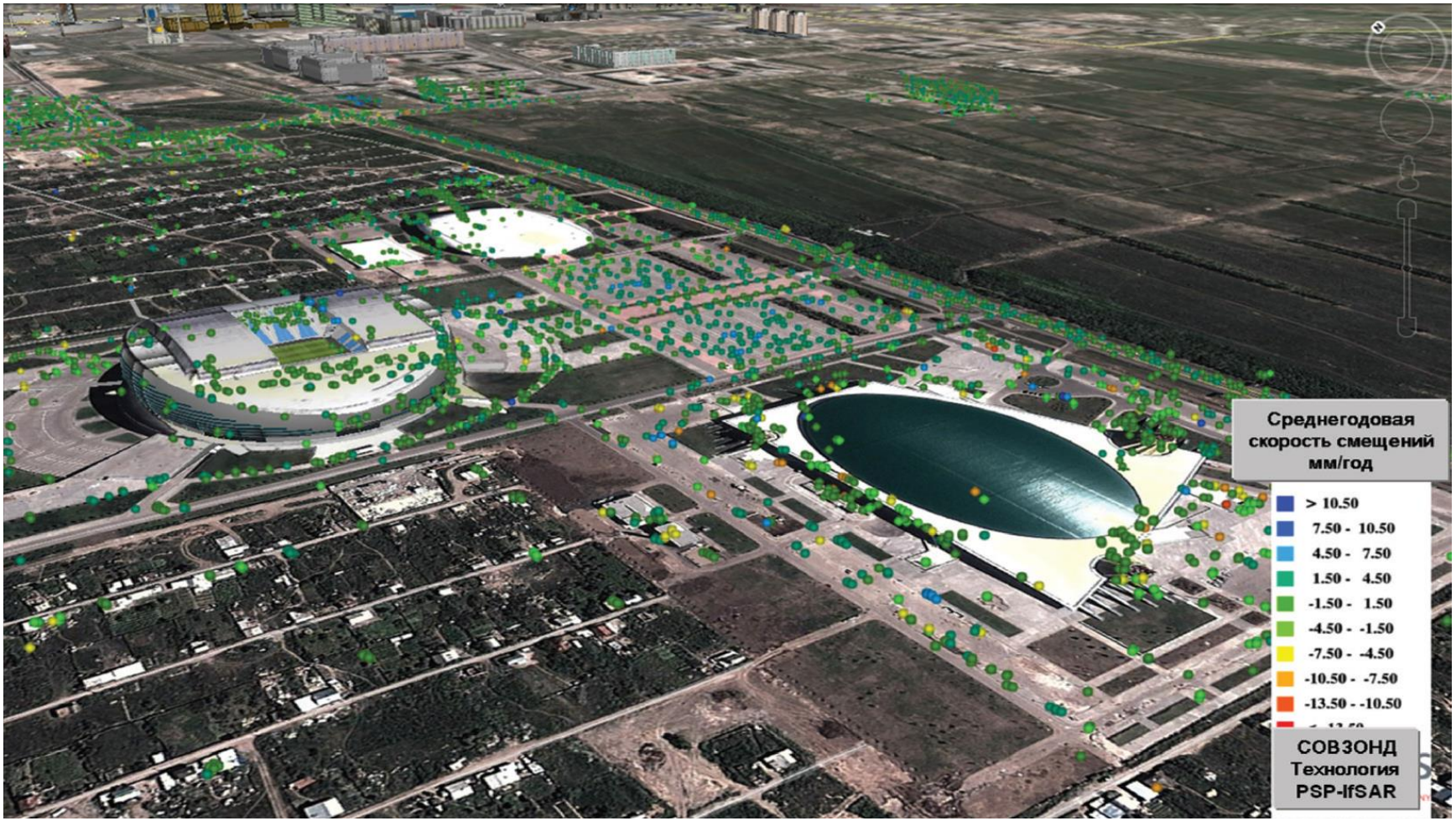
Baimenov E.

Stable scatterers of the House of Ministries (center), the Supreme Court (top left), the parliamentary complex and the presidential administration (high-rise buildings in the background) and the residence of the President of the Republic of Kazakhstan (in the background). Stable reflectors along the waterfront

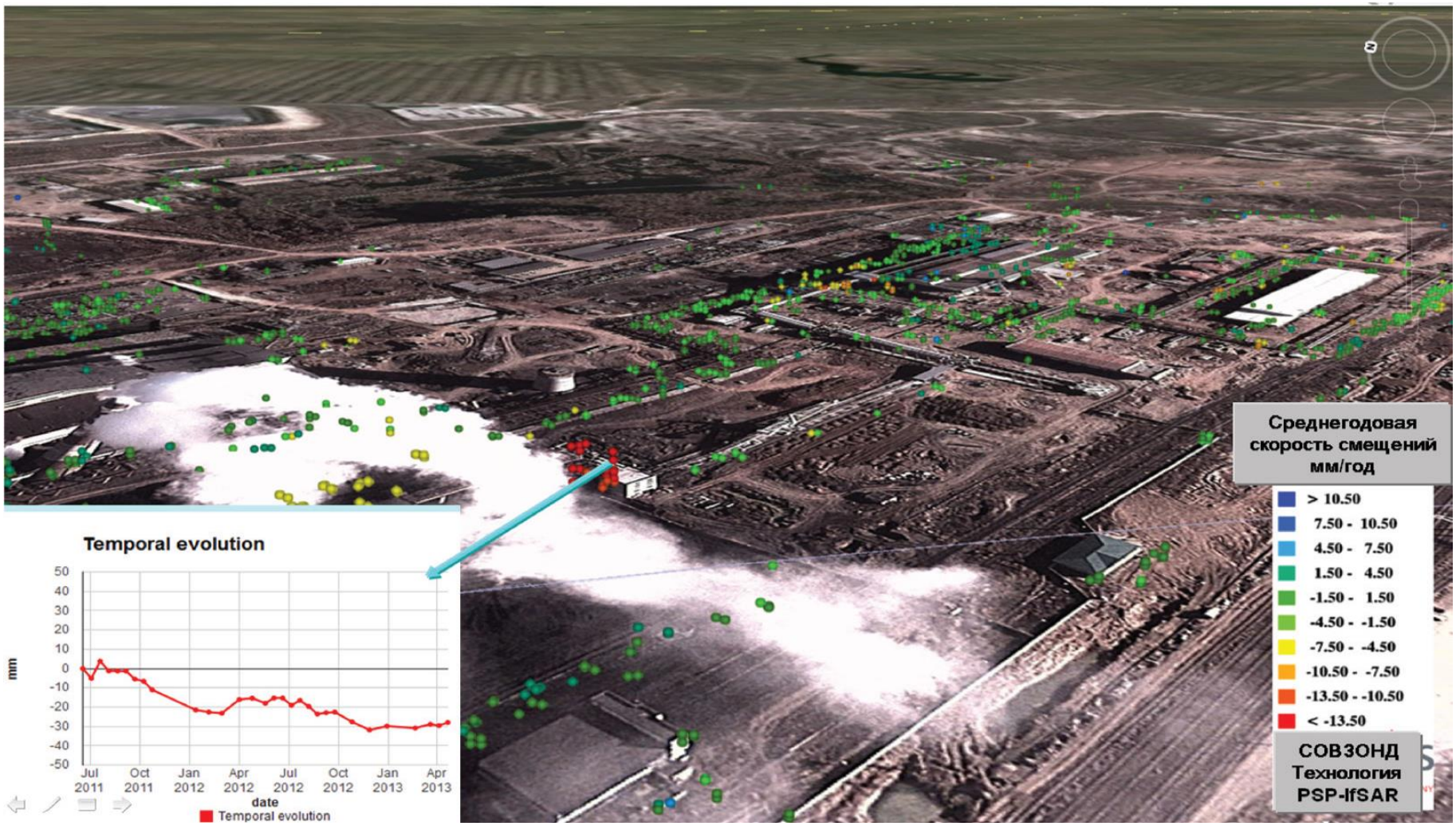
Stable building the shopping center "Khan Shatyr" and dynamics of settling skyscrapers buildings to the south of it



Stable scatterers on building the Ice Palace "Alau" (right), football stadium "Astana Arena" (left) and cycle track "Sary-Arka" (background)



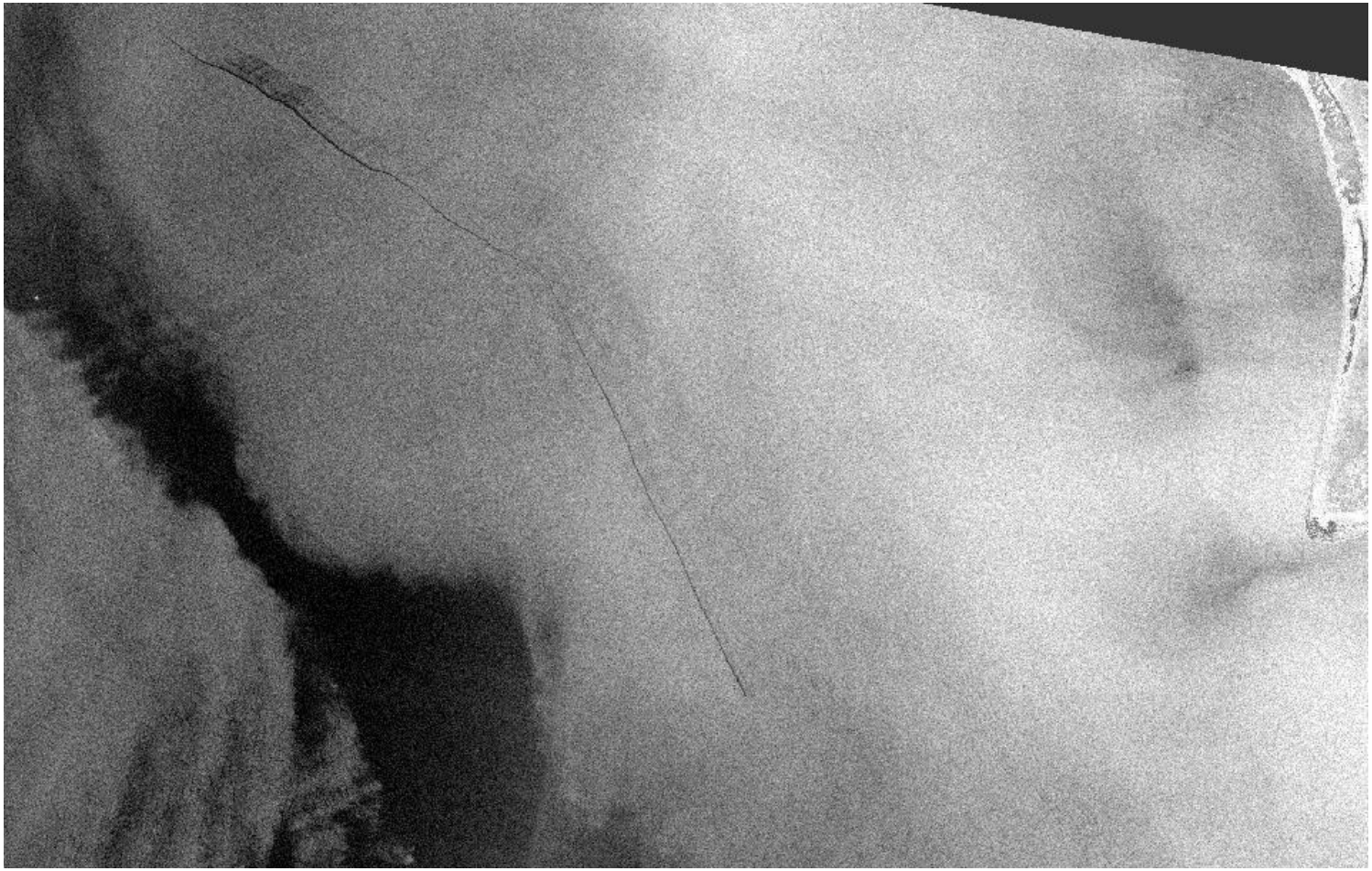
Dynamics of subsidence of a building in Akmola CHP (combined heat and power) -2 - up to 4 cm in 2 years. The most intensive building settles on all the considered area of 10x10 km in Astana

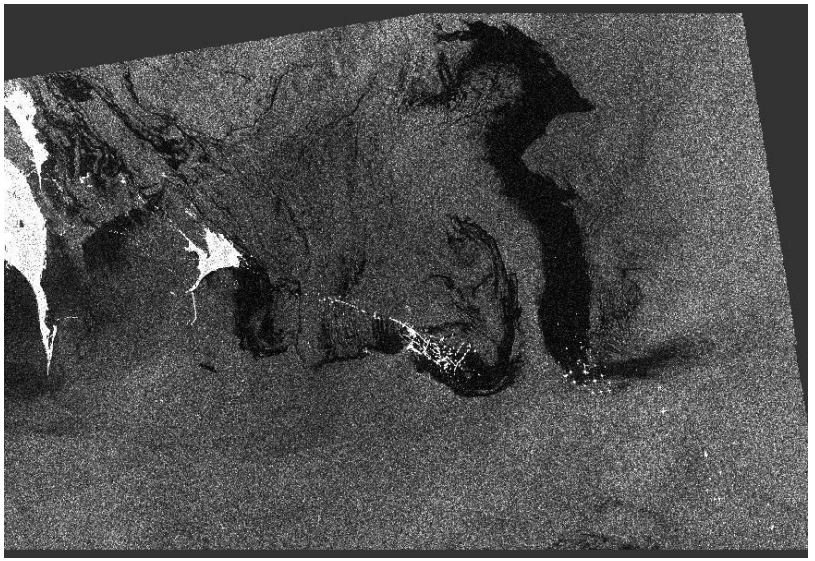


SATELLITE MONITORING OF OIL IN WATER RESERVOIRS

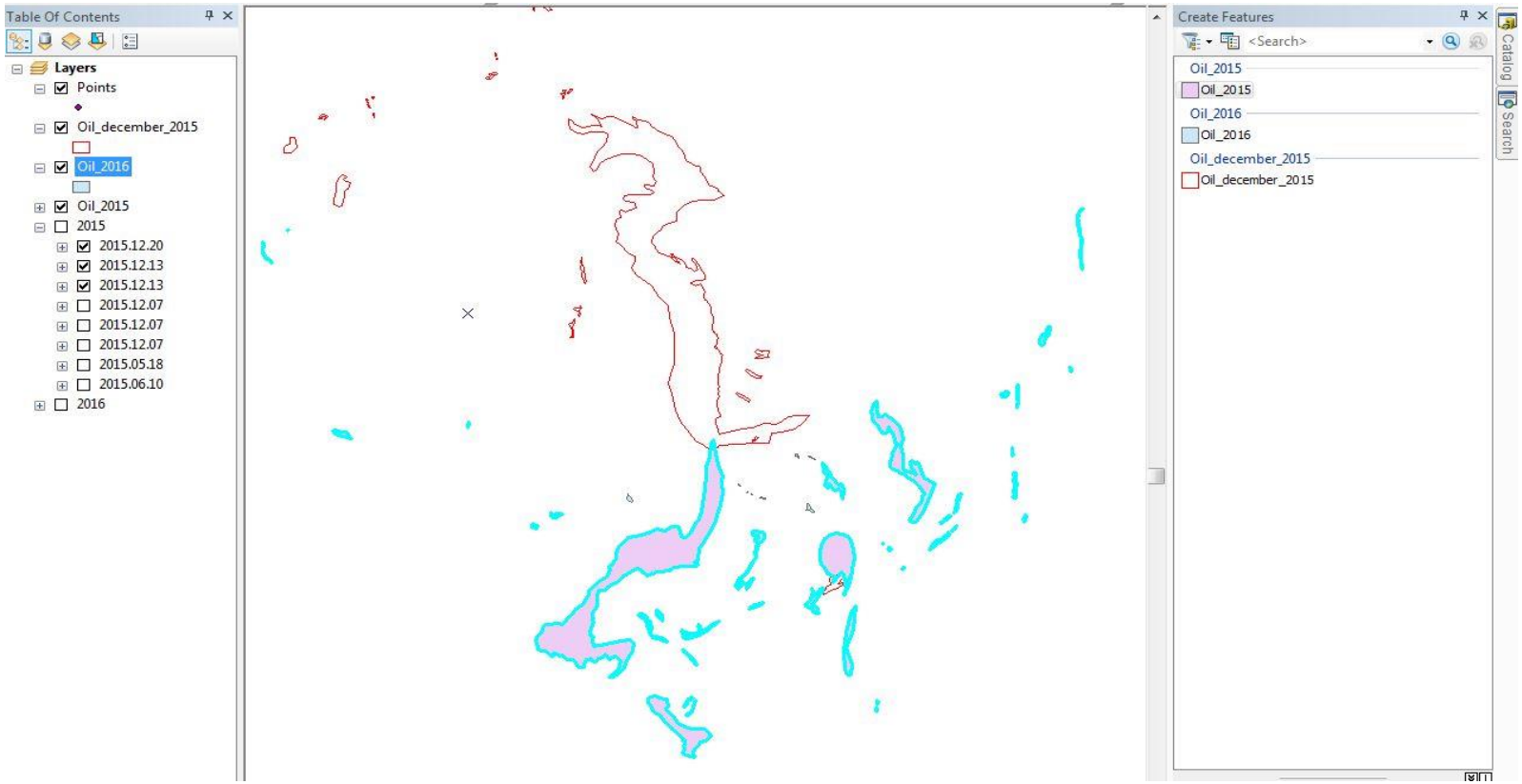
Kyrbay B.

This oil spill was detected in the Kazakhstan sector near the port of Aktau in 06/10/2015. its length composes more than 95 km. The area of the oil spill is 20.5 km^2





Pictures oil spill after the fire on the platform Guneshli in the Azerbaijani sector of Caspian Sea Sentinel-1A for 12/07/2015 (left) and 13/12/2015 (right)



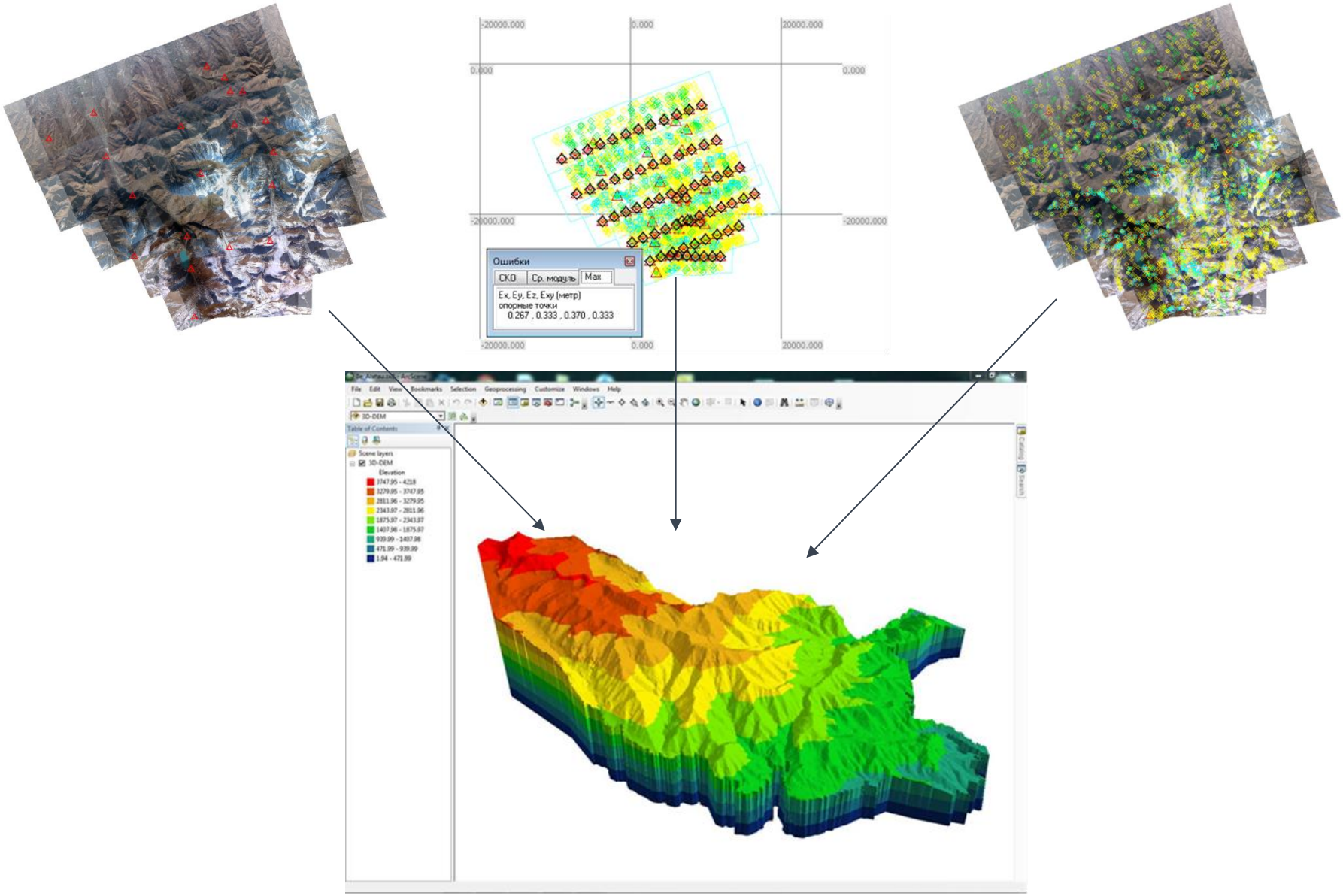
December 7, 2015 near the platform Guneshli large number of oil spills were detected. The maximum area of the spill is 104 km2. The total area of the oil spill on this day amounted to more than 350 km^2.

at 13 December 2015 this figure increased. The maximum area of the oil spill is 231.8 km2. The total area of the oil spill on this day amounted to more than 490 km^2

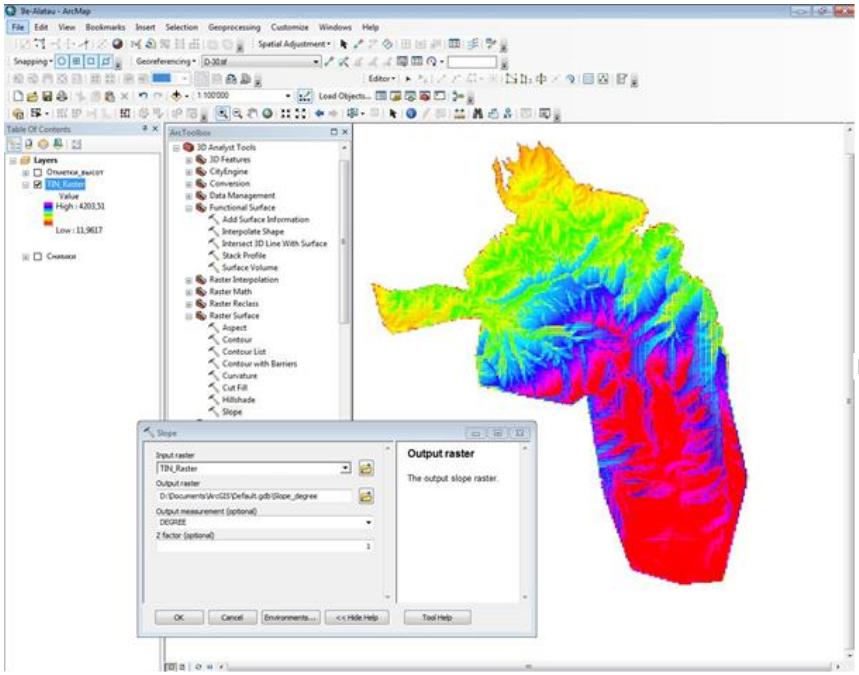
SPACE MONITORING TO PREDICT AND ASSESS THE SITUATION OF MUDFLOW IN ILE-ALATAU

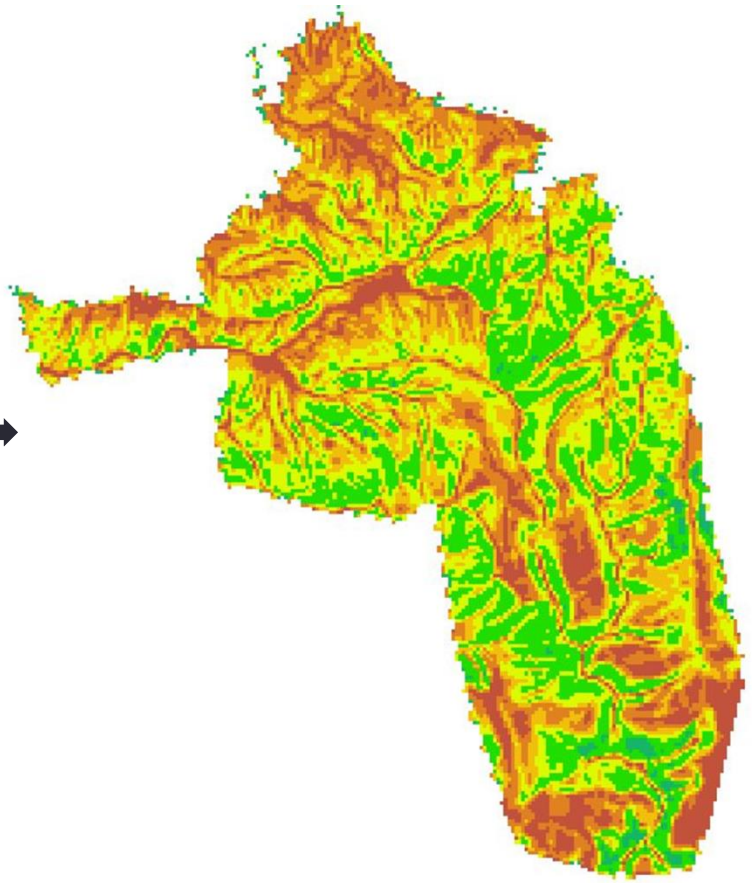
Nazyrova D.

Photogrammetric processing



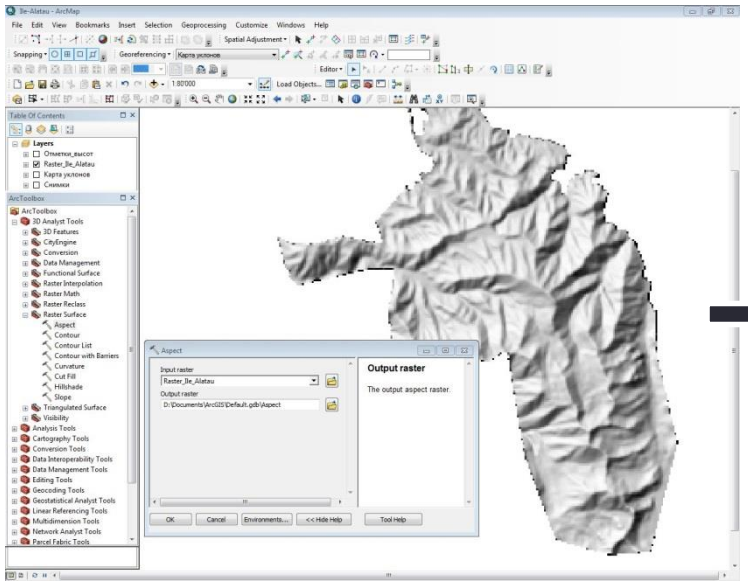
Ile-Alatau Slope Map

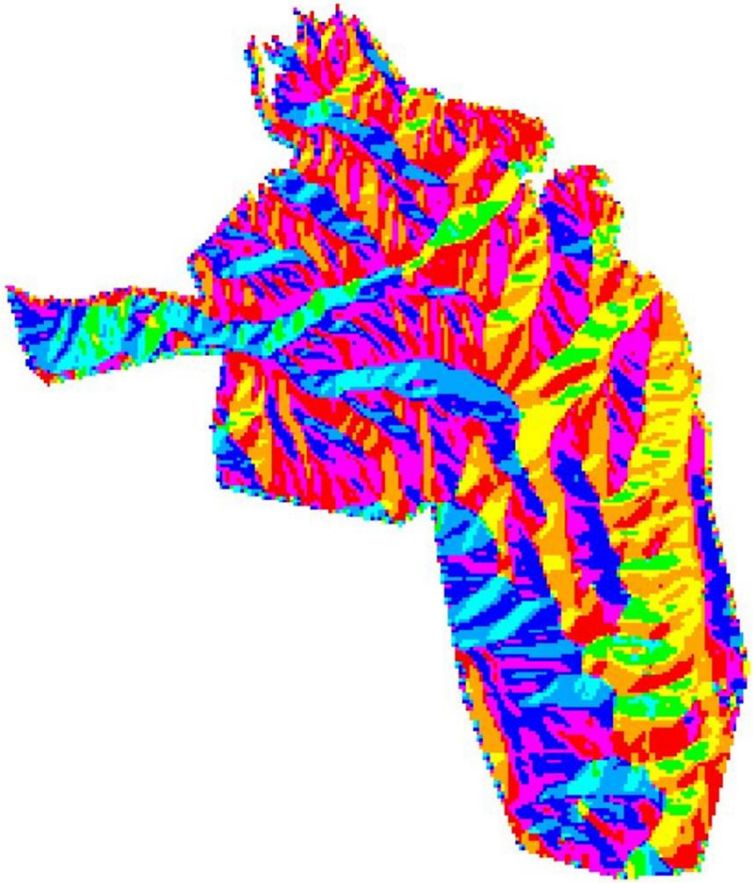


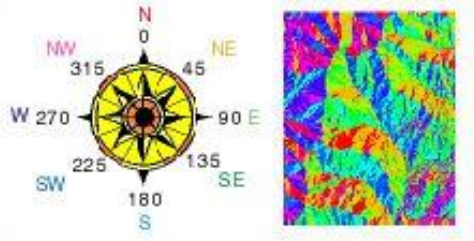


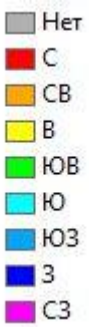
0 - 12
13 - 18
19 - 25
26 - 30
31 - 35
36 - 42
43 - 56
57 - 69

Ile-Alatau Aspect Map

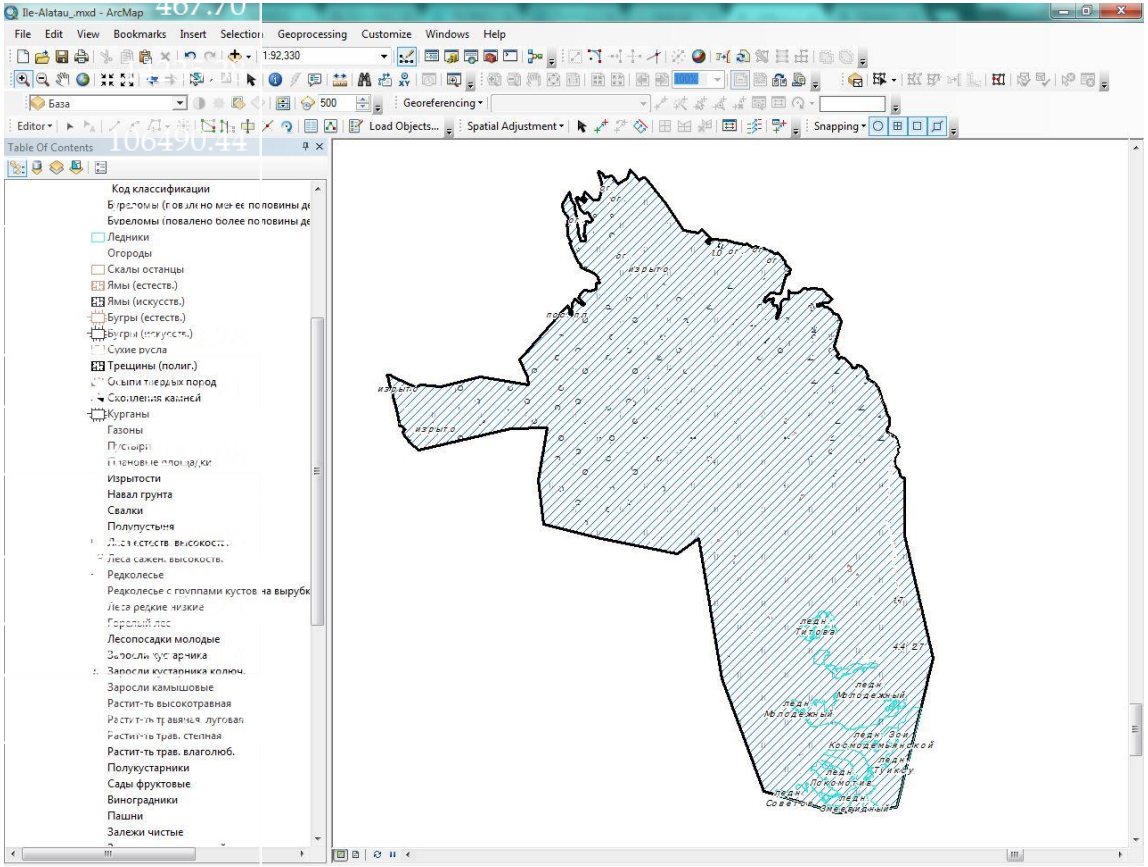




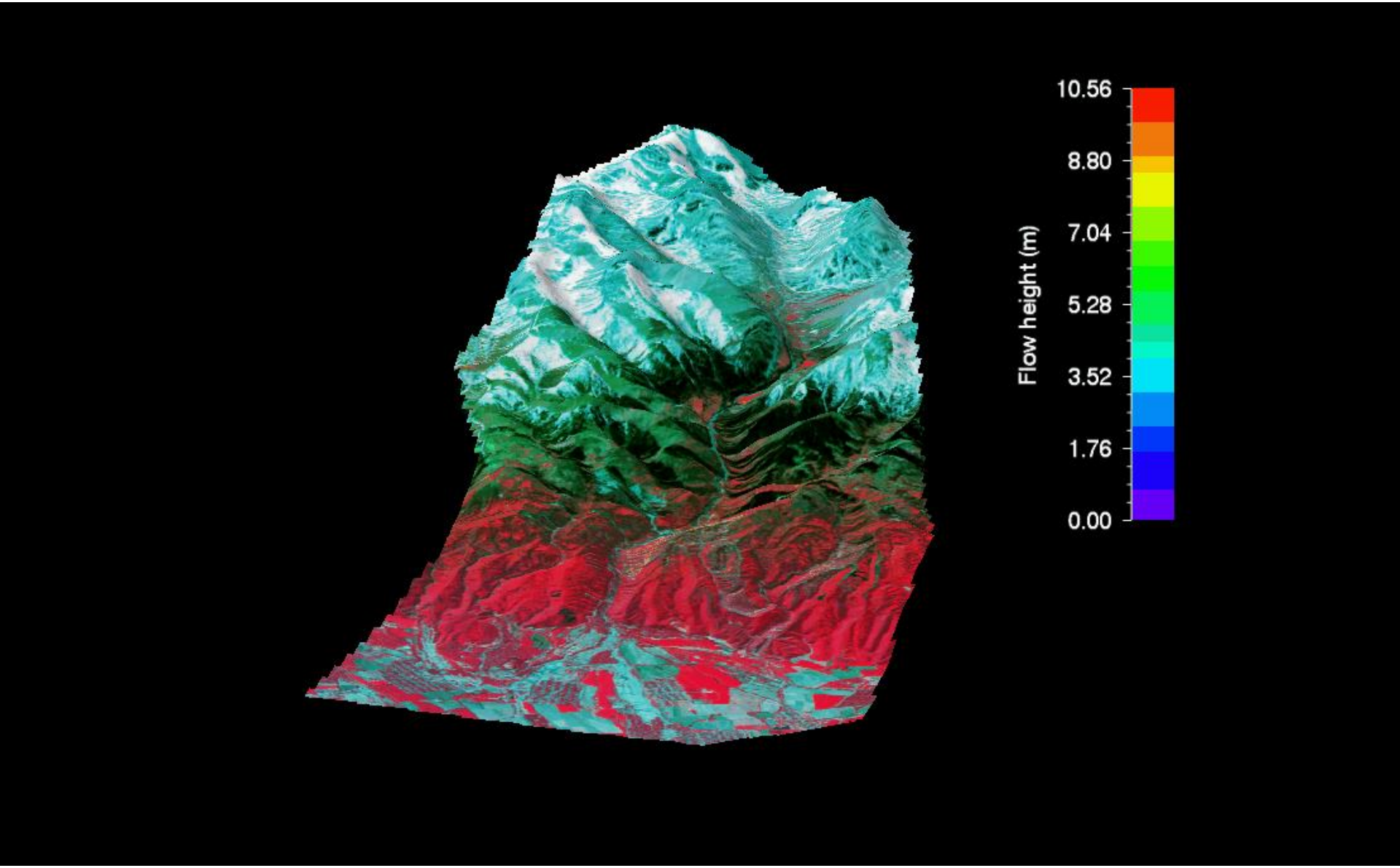




Ile-Alatau Geobotanical Map



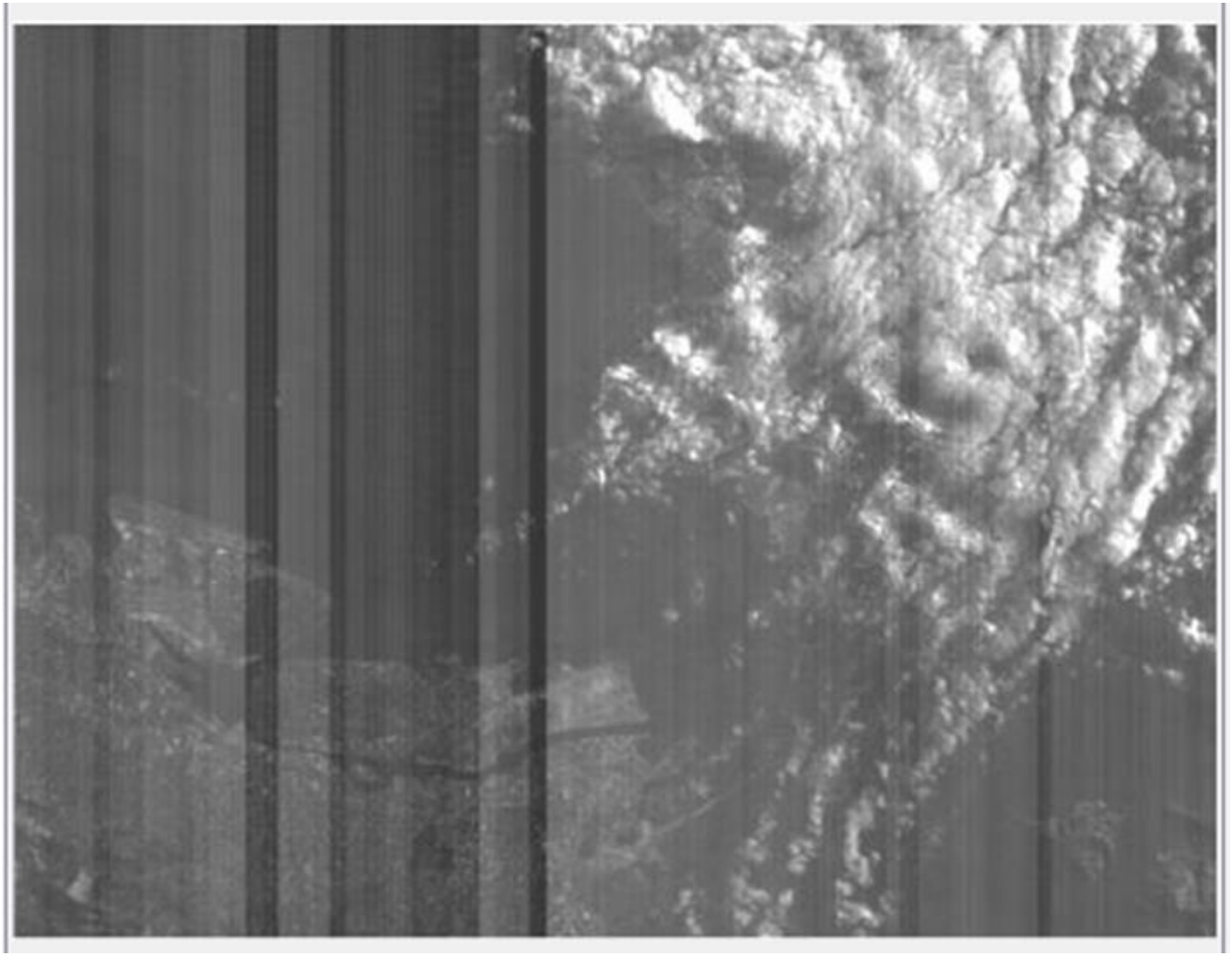
Modeling of Debris Flow



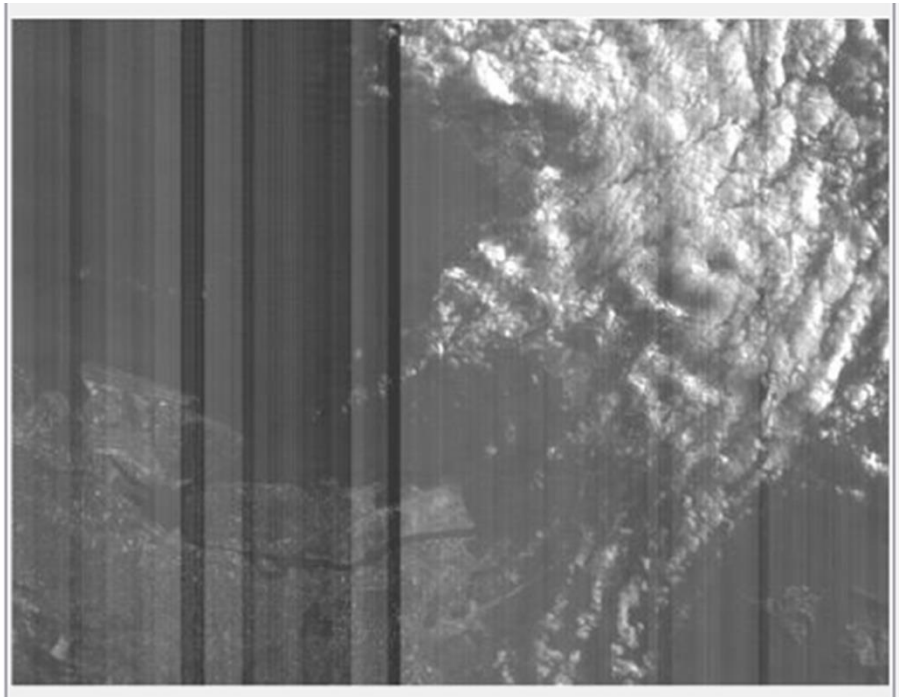
METHODS OF IMPROVEMENT OF RADIOMETRIC AND GEOMETRICAL PARAMETERS OF ERS IMAGES

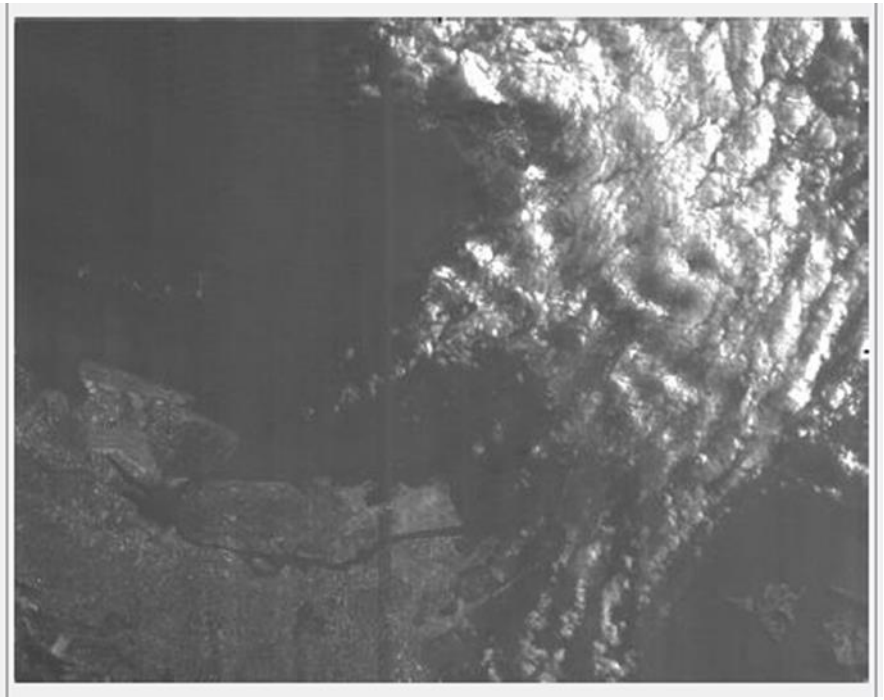
Menkhan R.

Taken the satellite image for the pre-processing from the Resurs-DK satellite (Russia) with the distortions (in the form of vertical stripes) across the image height.

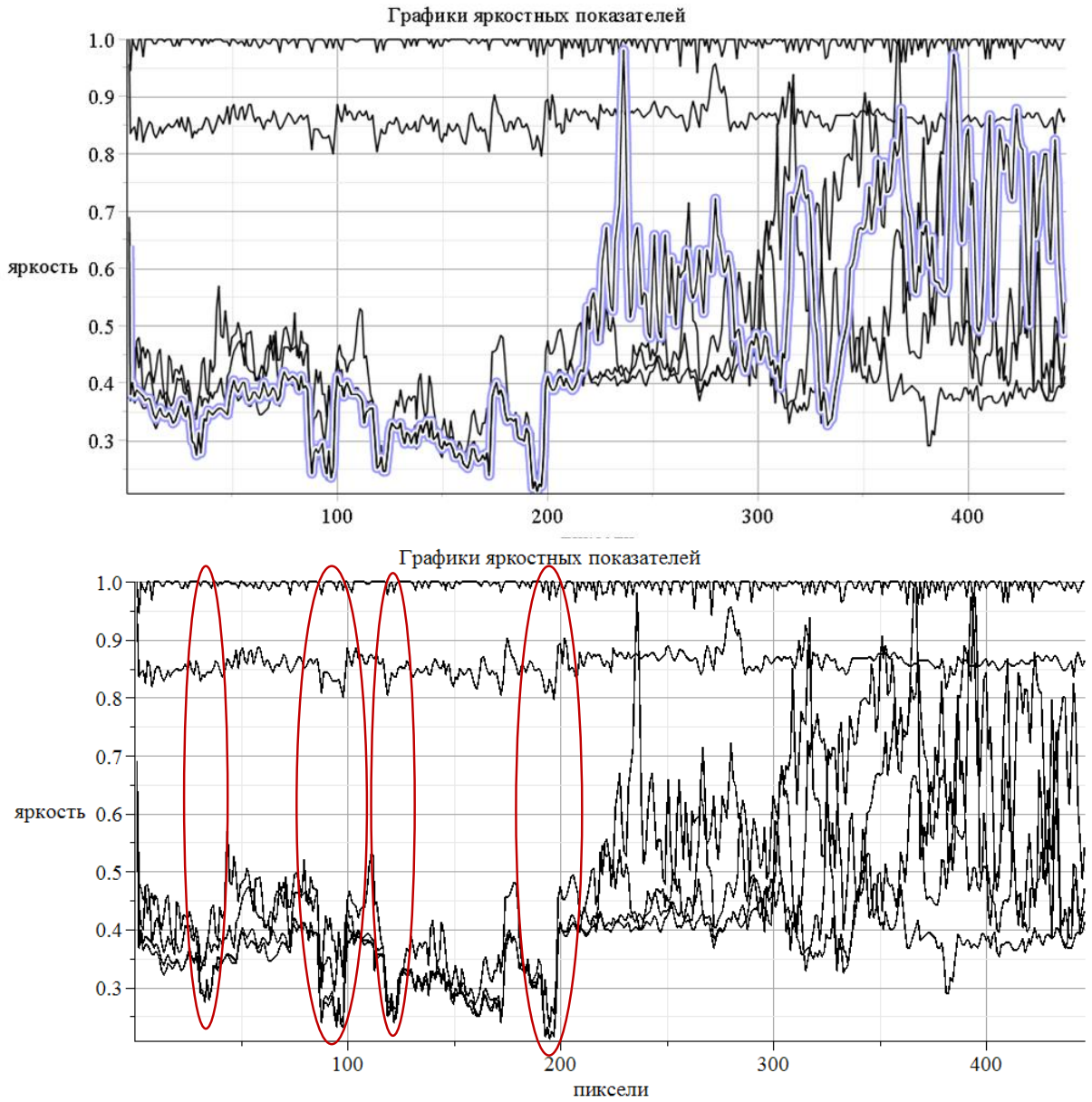


Processing is performed existing combined method, by adding the pixel brightness values of neighboring columns.

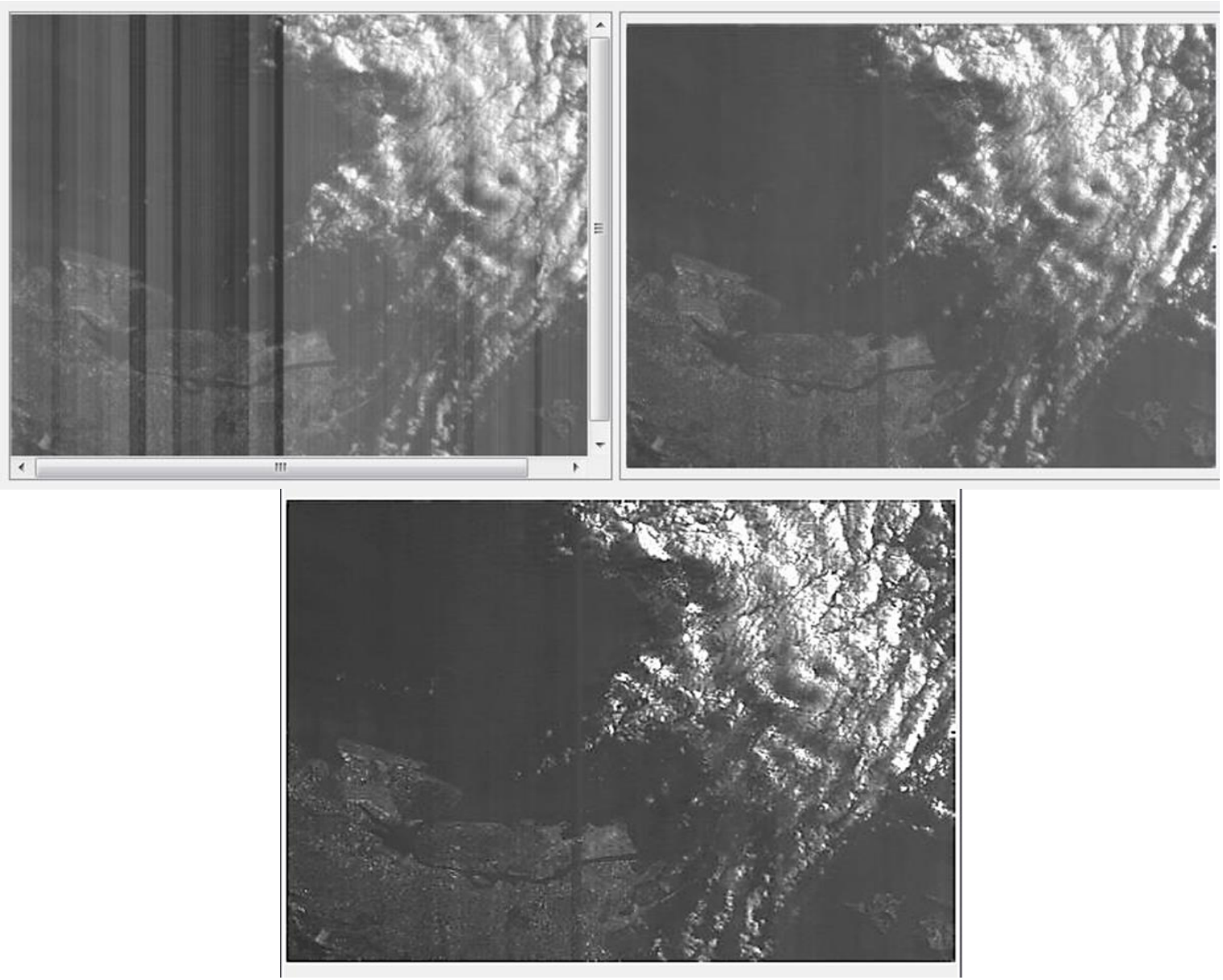




Made a modification of the above algorithm.



Pre-processing is performed.

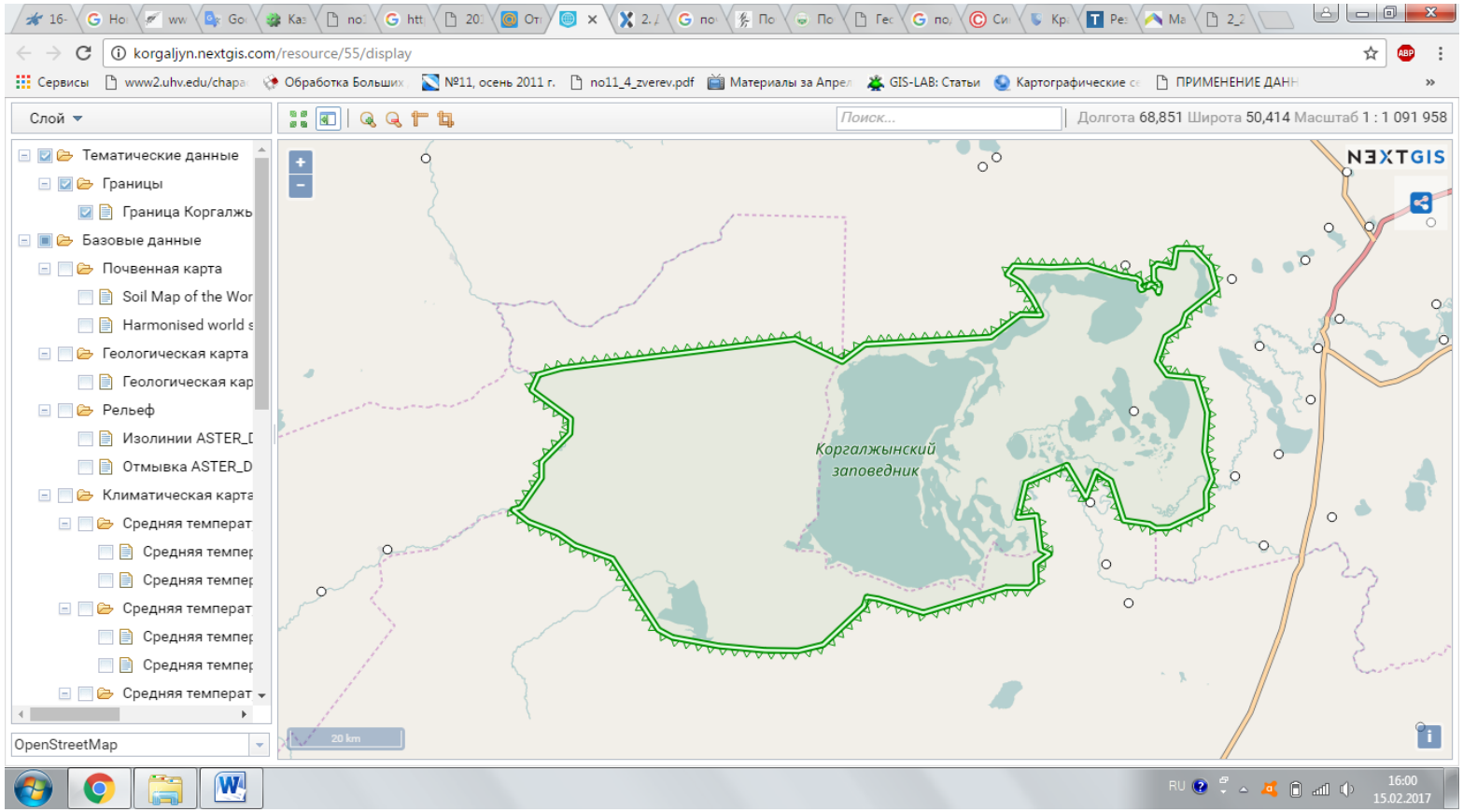


The possibility of using open data for space monitoring problems

Beisenbinova L.

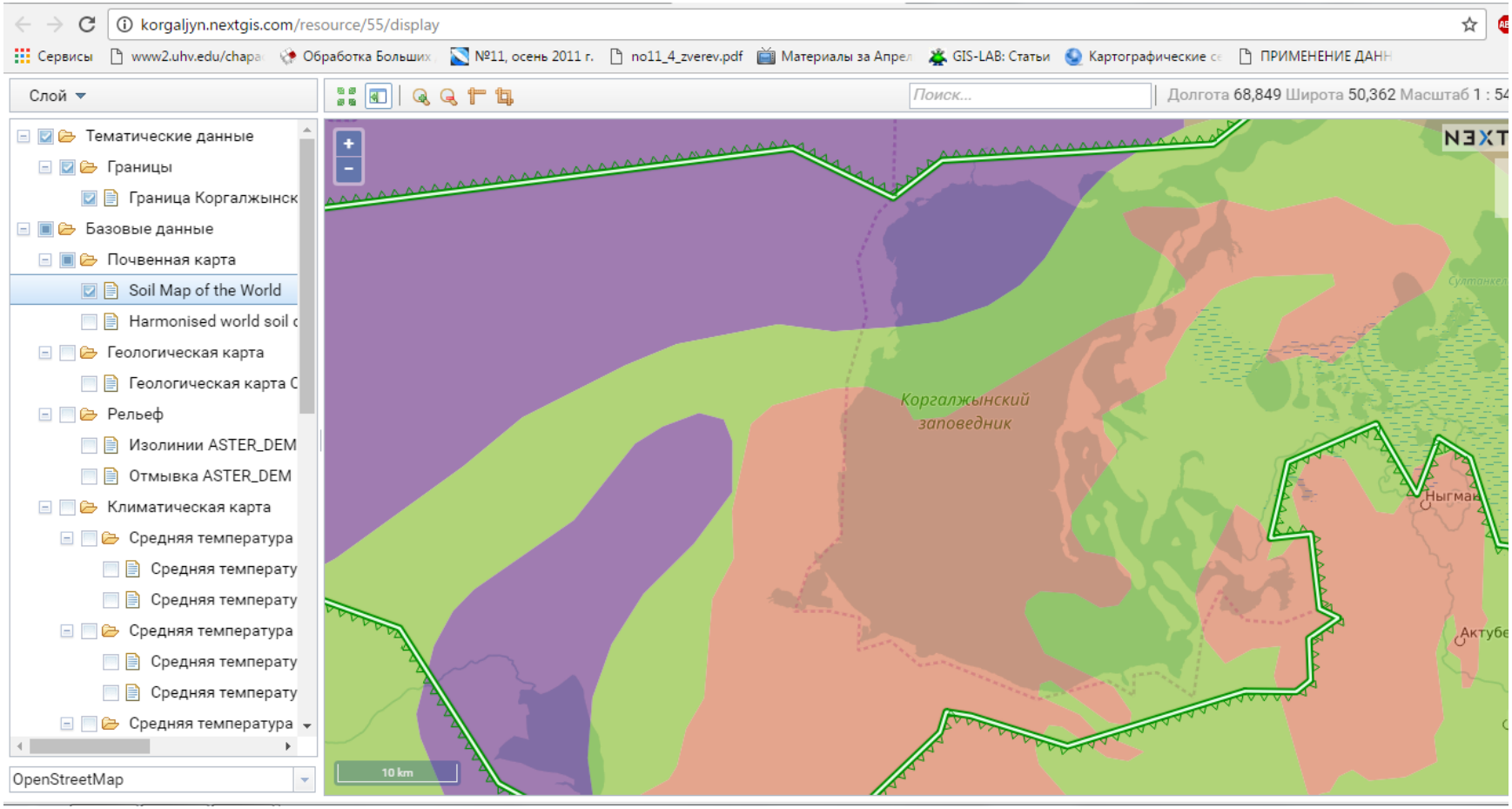
Geoportal Korgalzhyn Reserve was developed NEXTGIS open platform. Geoportal is available here http://korgaljyn.nextgis.com/resource/55/display

Appearance UI Geoportal published a web map is shown in Figure · The boundary of the reserve. Vector data from Openstreetmap, http://www.openstreetmap.org

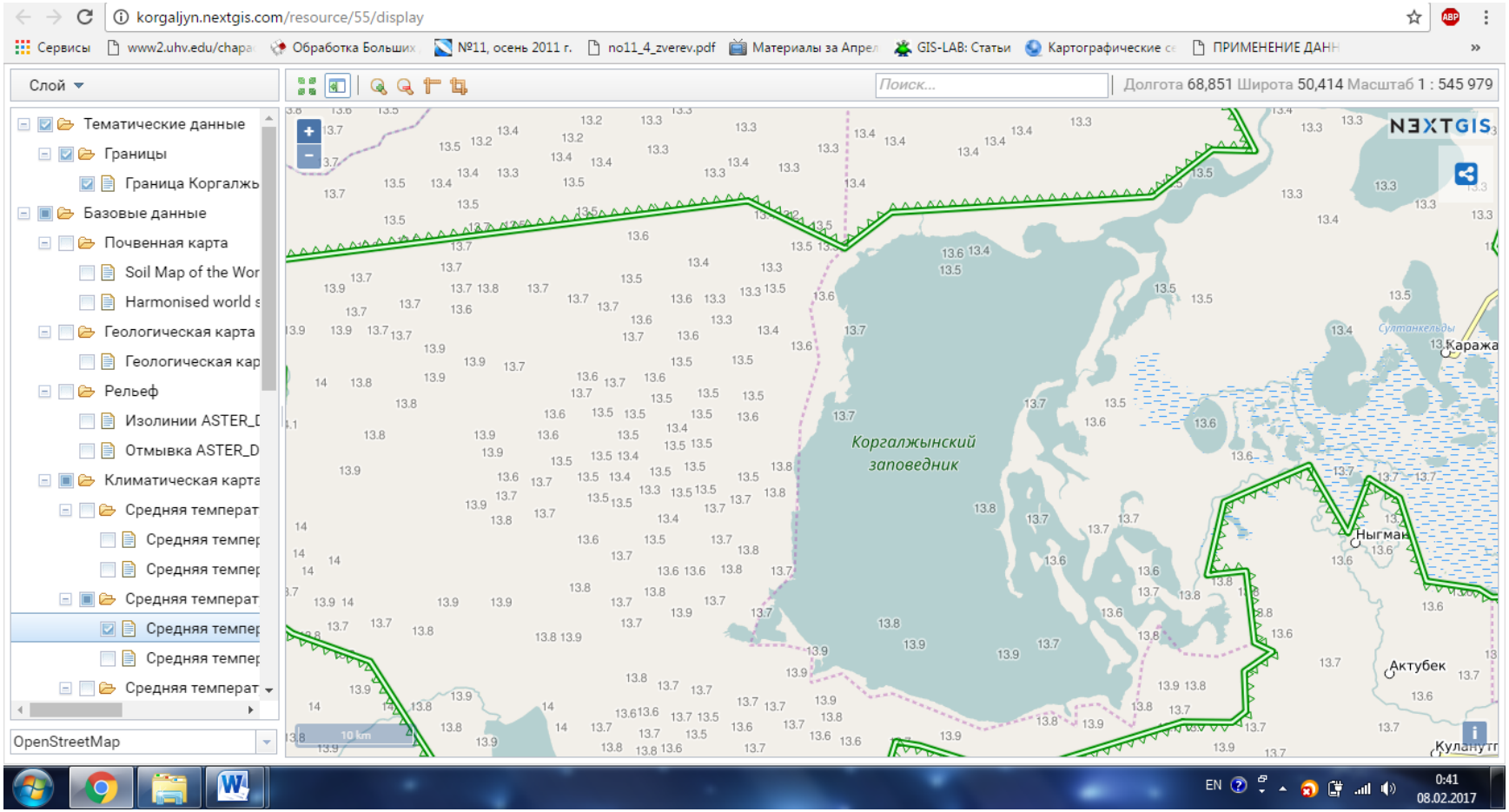


Soil map showing the distribution of soils on the Earth's surface, their characteristics and properties.
Soil map of UNESCO Soil Map of the World –

http://gis-lab.info/qa/world-soil-maps.html

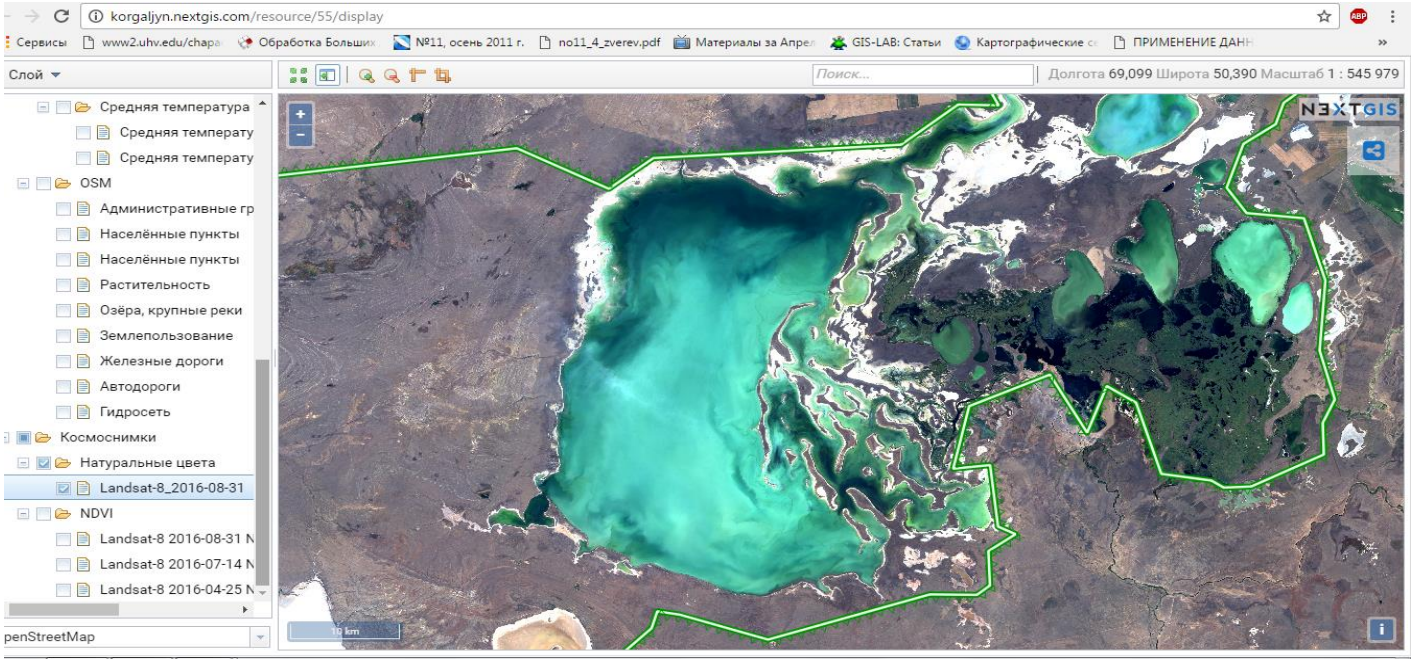


Climatic map Korgalzhyn Reserve



Climatic map: WorldClim: https://wiki.gis-lab.info/w/WorldClim

Thus, the Geoportal Korgalzhyn reserve allows any interested party to obtain a comprehensive set of information about the reserve

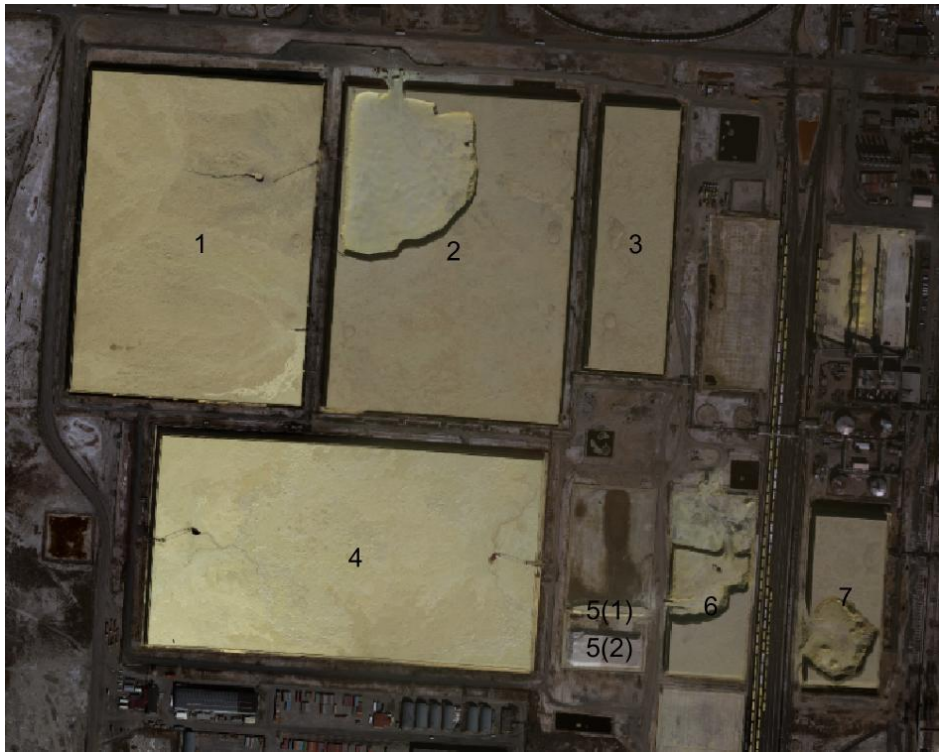


Satellite image of the reserve from the Landsat-8 satellite

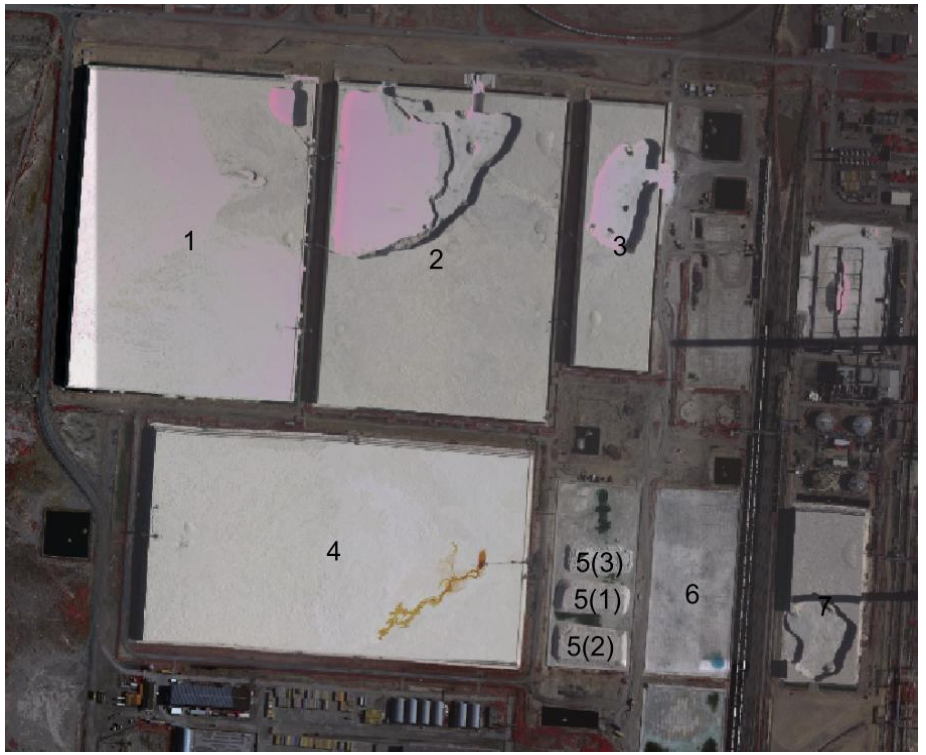
Methods of construction and use of the DEM (digital elevation model) solutions for monitoring problems

Akhmetkarimkyzy A.

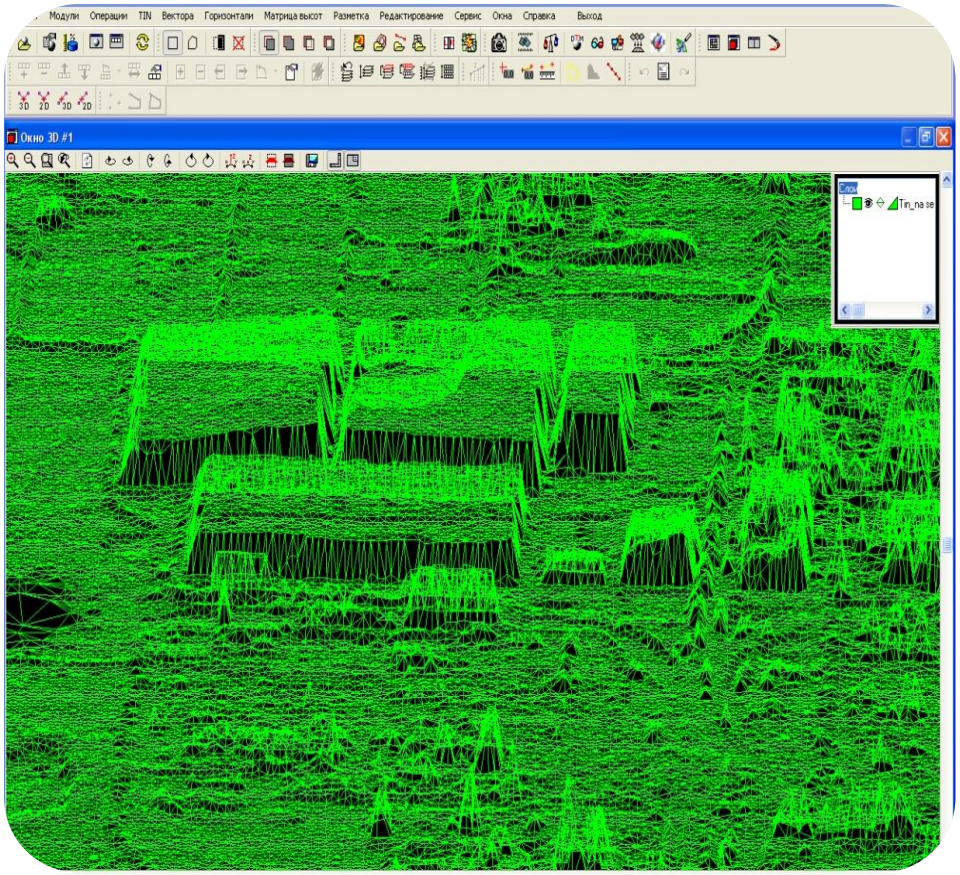
Fields of GMW (granular mineral waste) in the field of minerals



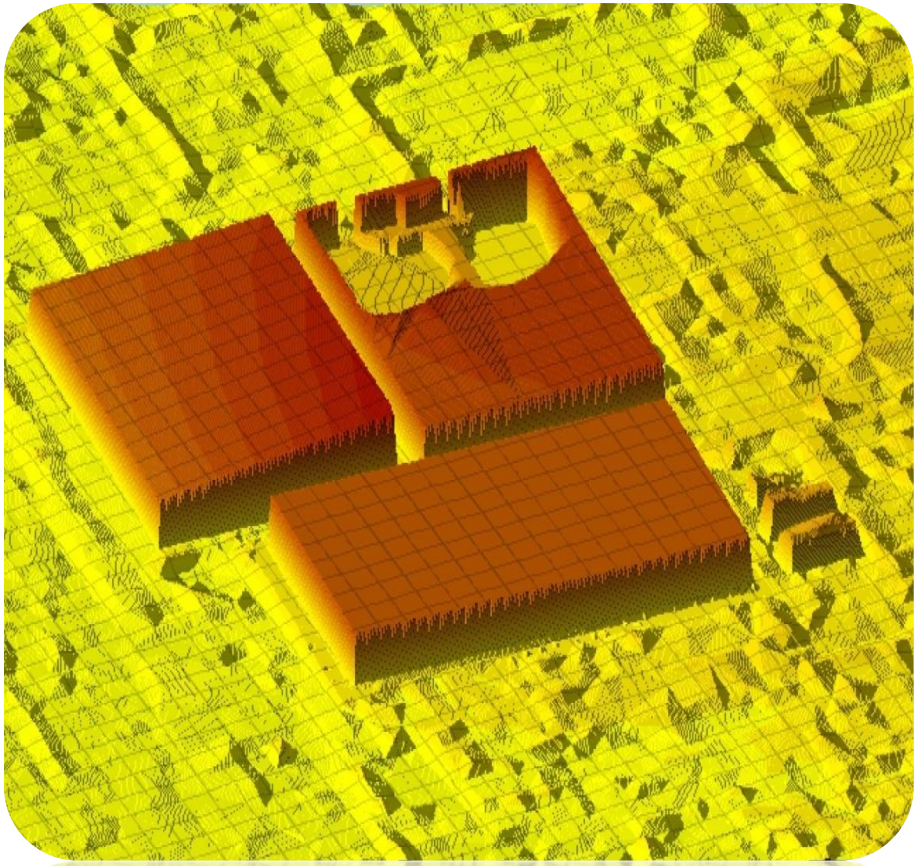
Aerial Photo, 4 October 2007



Aerial Photo, 19 May 2008

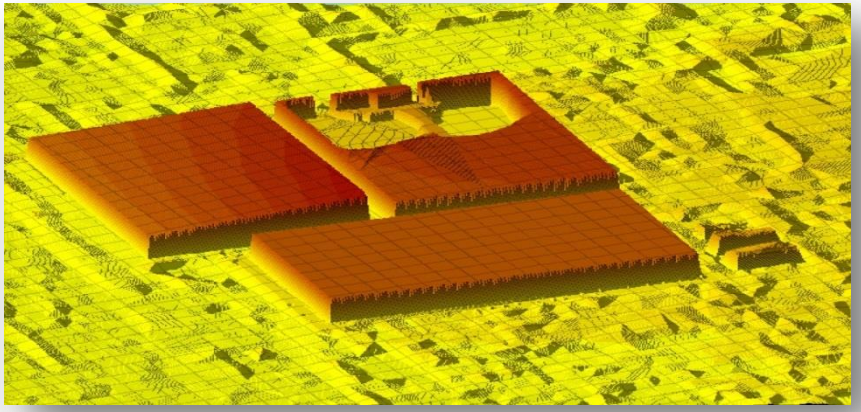


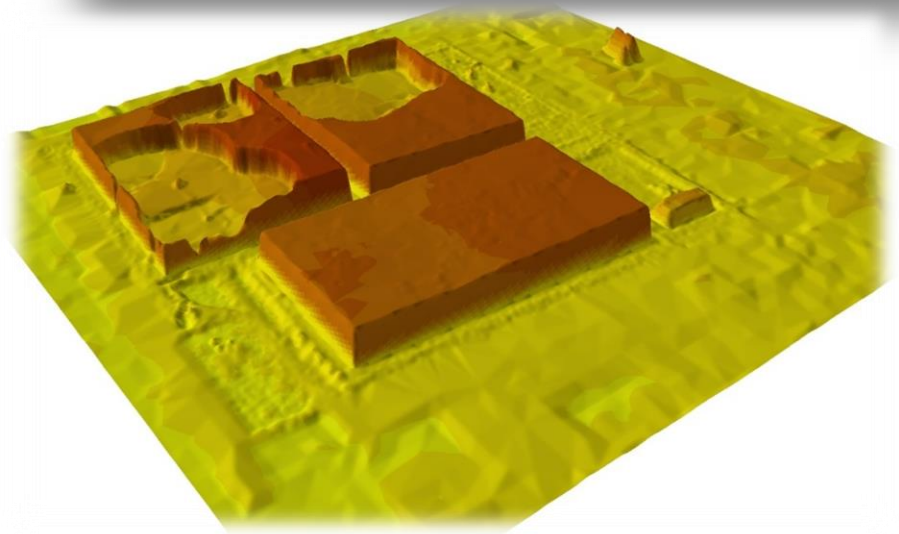
3D model of maps of grained industrial waste in 2008

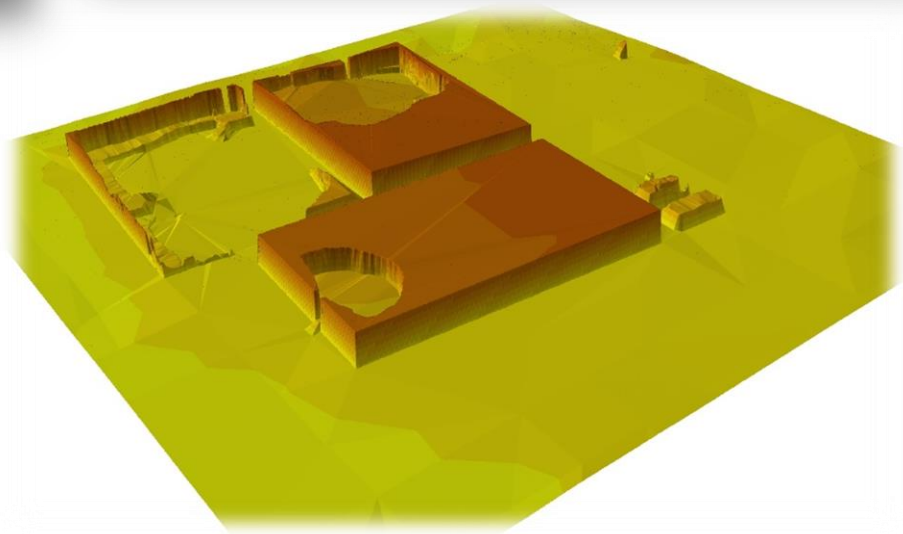


3D model of maps of grained industrial waste in 2009

Comparative analysis with the use of quantitative indicators from 2009 to 2011







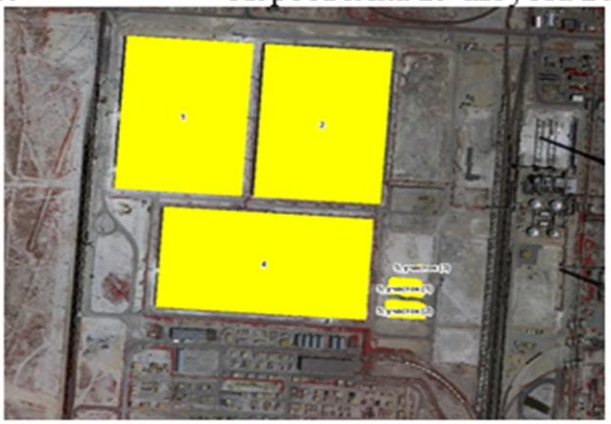
Maps of granulated production waste in the field of mineral resources for the period 2007 to 2011

Аэросъемка 4 октября 2007 г.

Аэросъемка 19 мая 2008 г.

Аэросъемка 29 августа 2009 г.

Аэросъемка 26 августа 2010 г.



Аэросъемка 24 июля 2011 г.

№ карты	Масса гранулированных производственных отходов (т)				
	2007	2008	2009	2010	2011
карта №1	2 647 608,7	2 616 290,8	2 704 112,5	1 709 362,6	365 439,8
карта №2	2 336 115,3	2 145 310,1	1 797 793,7	1 850 393,3	2 145 991,2
карта №3	816 727,6	633 266,6	12 700,7	2 543,8	0,0
карта №4	2 413 956,6	2 555 225,6	2 679 534,0	2 932 034,5	2 823 333,2
карта №5, участок (1)	7 241,3	32 594,2	36 954,6	1 472,6	37 256,3
карта				41 358,0	40 213,0
				200,3	276,1
				0,0	0,0
				0,0	0,0
				6 537	5 412
				5,2	509,7

The filtered differential interferograms on area of underground developments and open-cast mining's

Issin D.

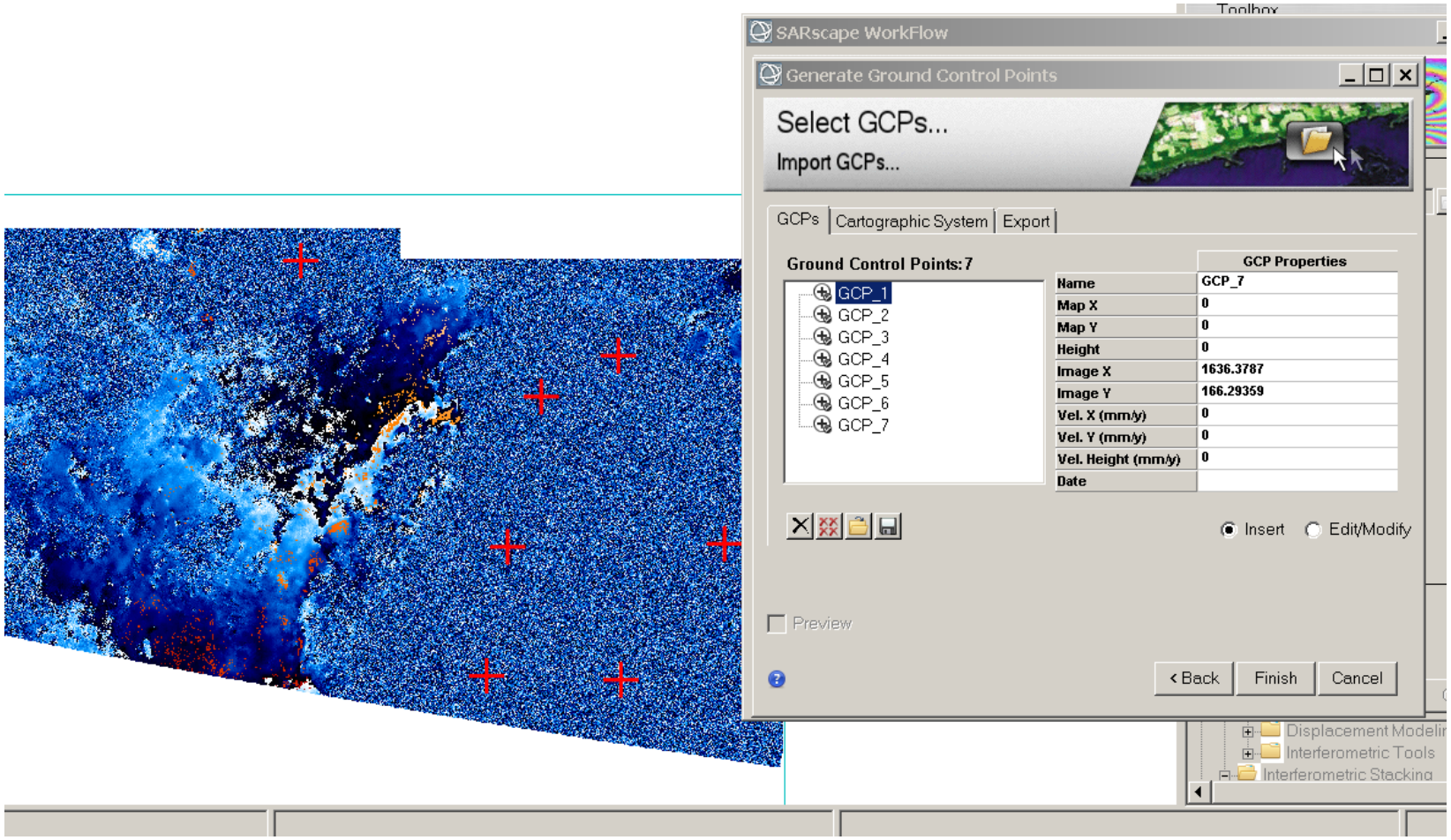
Evaluation of the dynamics of ground subsidence in Zhezkazgan

Dates of images from Sentinel 2

- **1) 05.07.2016**
- **S1A_IW_SLC__1SDV_20160705T023340_20160705T023407_012007_012898_C127**

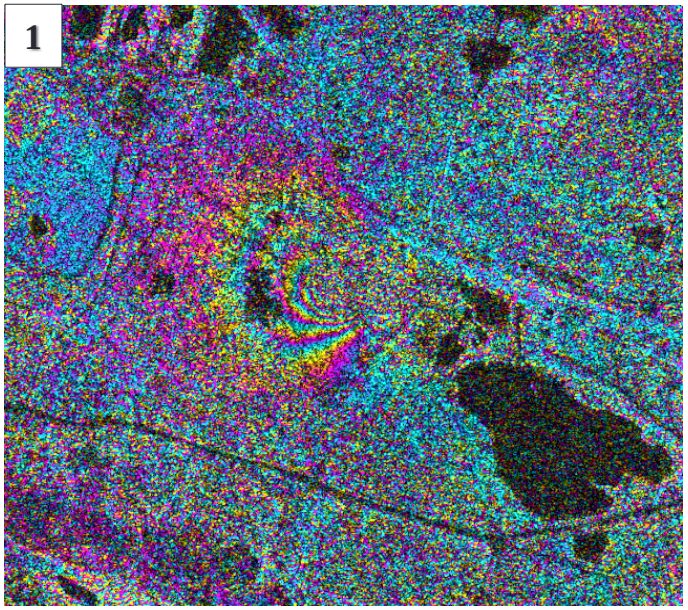
- **2) 15.09.2017**
- **S1A_IW_SLC__1SSV_20160915T023400_20160915T023429_013057_014B31_6903.SAFE**

GCP-GROUND CONTROL POINT



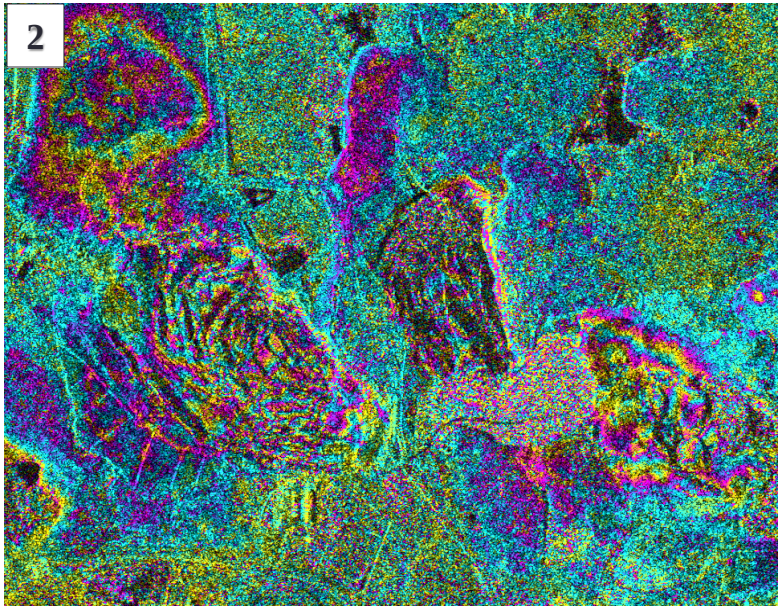
Filtered differential interferrogram in the area of underground workings (1) and opencast mining (2) - the territory of the city of Karaganda

Figure 1 clearly stands out of the intensive subsidence of the earth's surface.



date pictures : 2015-04-30/2015-05-20
time base– 20 days

Figure 2 is detected not only the relief of surface pits, but decorrelation visible changes associated with the deformation of boards.

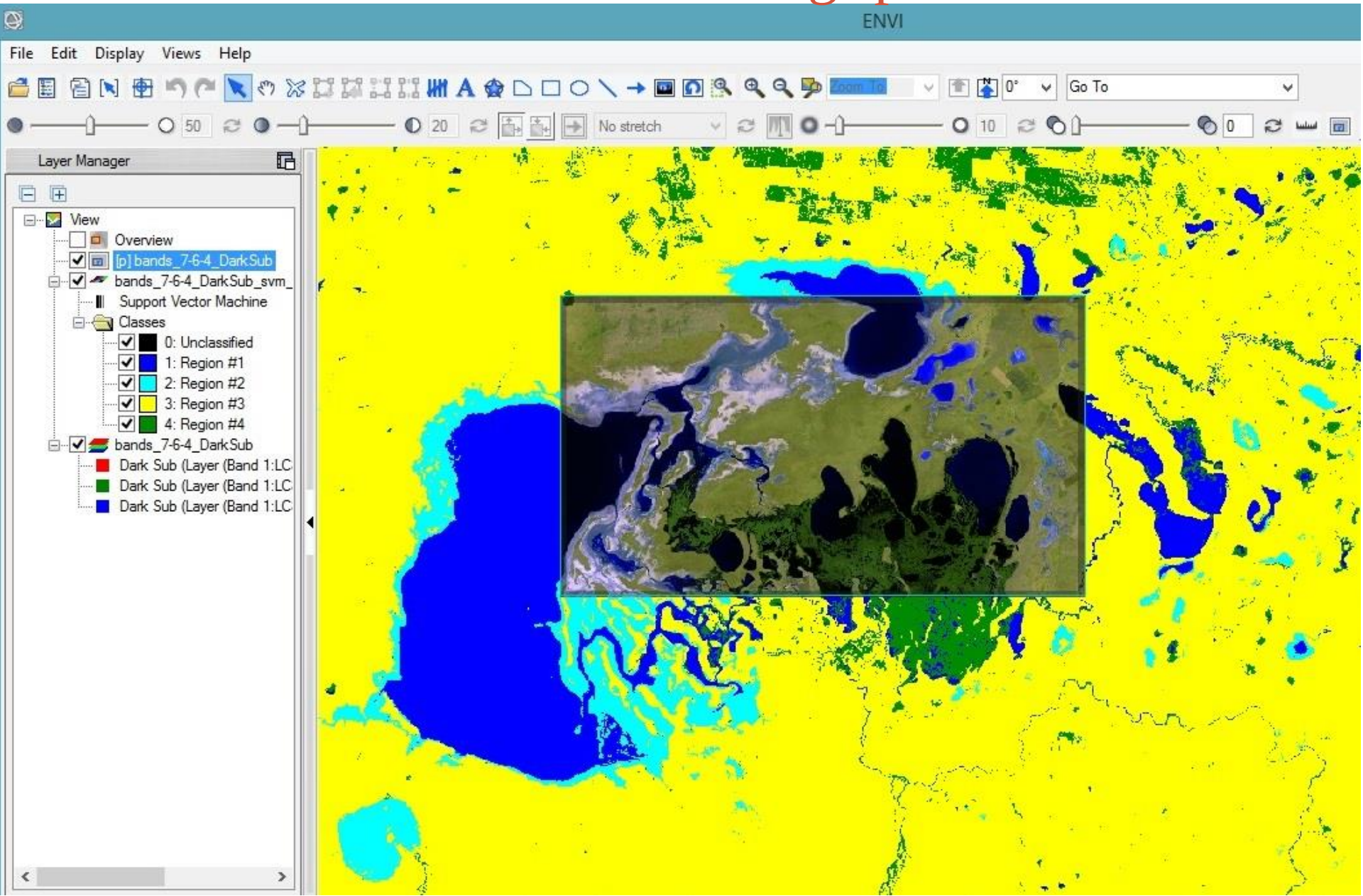


date pictures : 2015-04-30/2015-05-12
time base– 12 days

Space monitoring of water resources

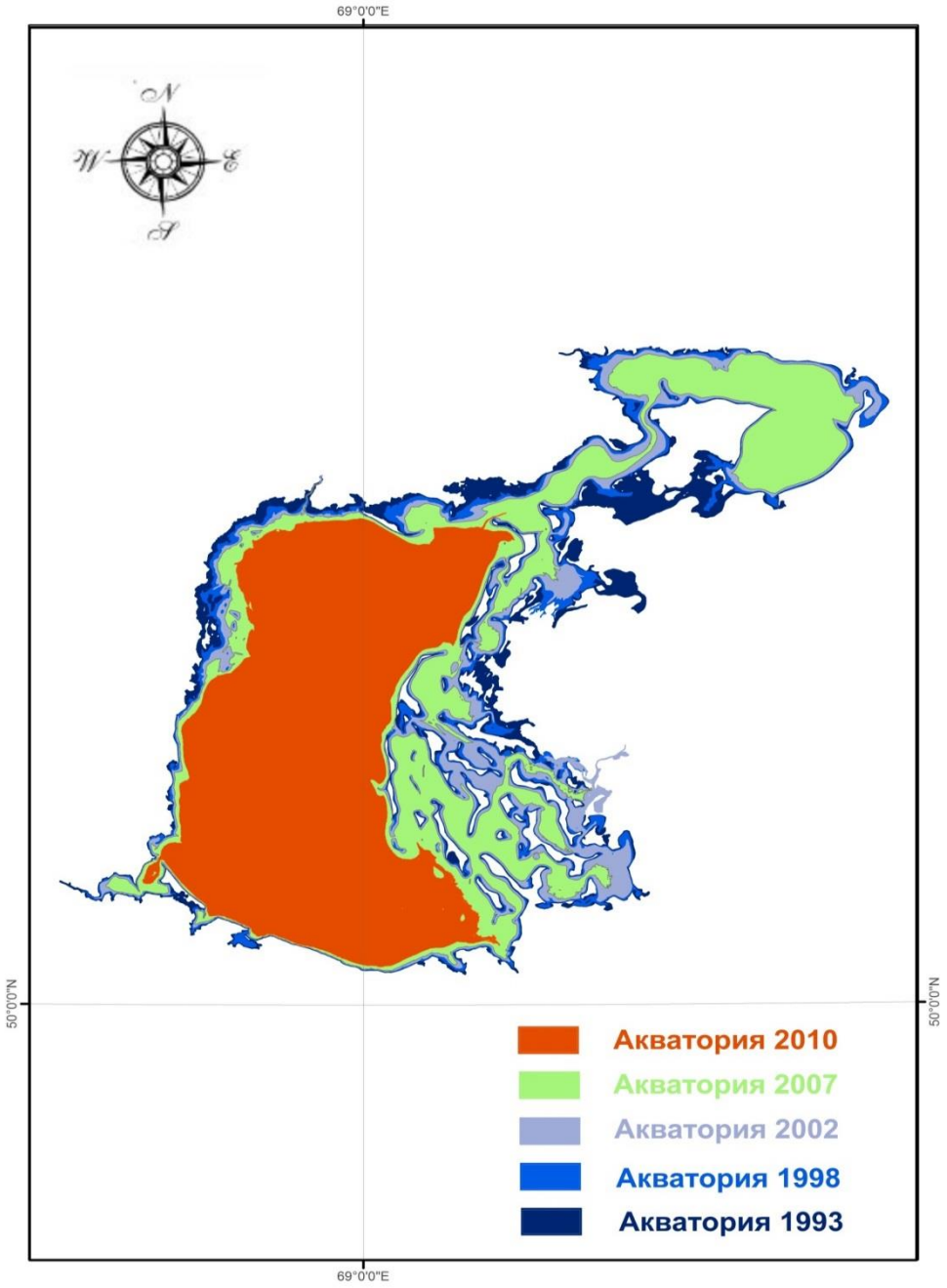
Chepashev D.

Classification of image pixels

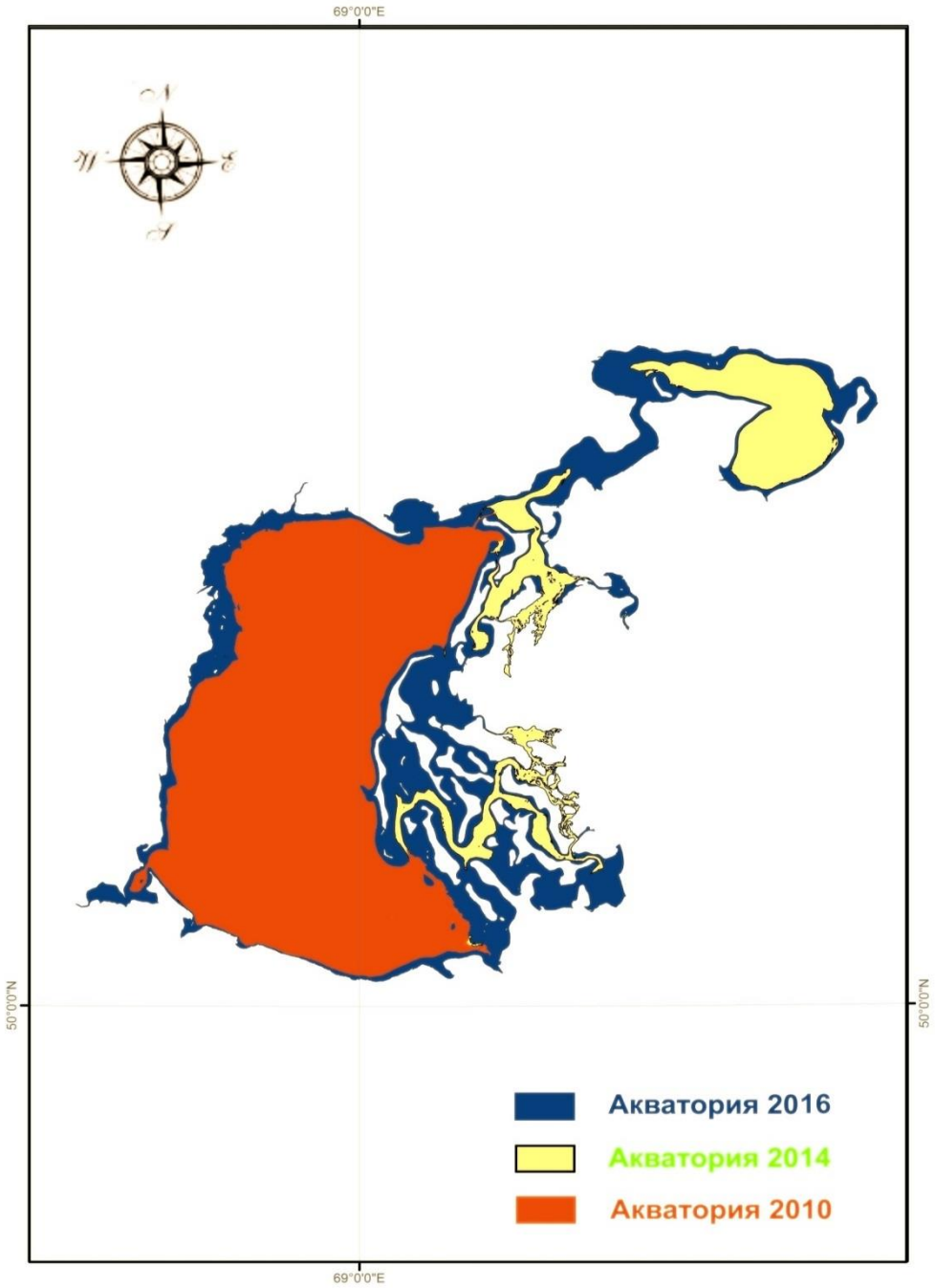


Lake square changes

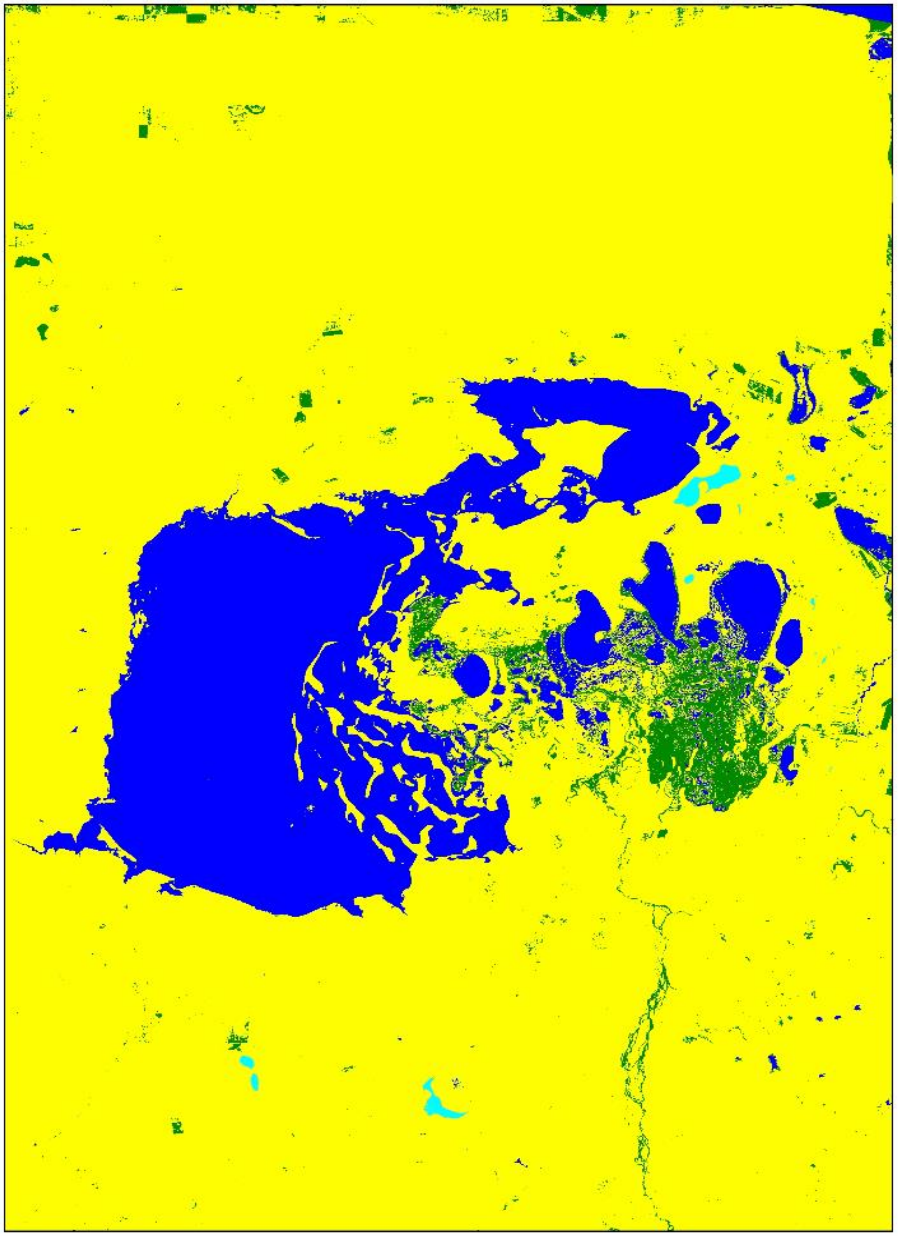
YEAR	SQUARE OF TENGIZ LAKE, sq.km
1993	1597,2
1998	1470
2002	1364,8
2007	1202,13
2010	782,127
2014	927,9
2016	1376,8



Drying of Tengiz lake since 1993 till 2010



Recovery of Tengiz lake since 2010 till 2016



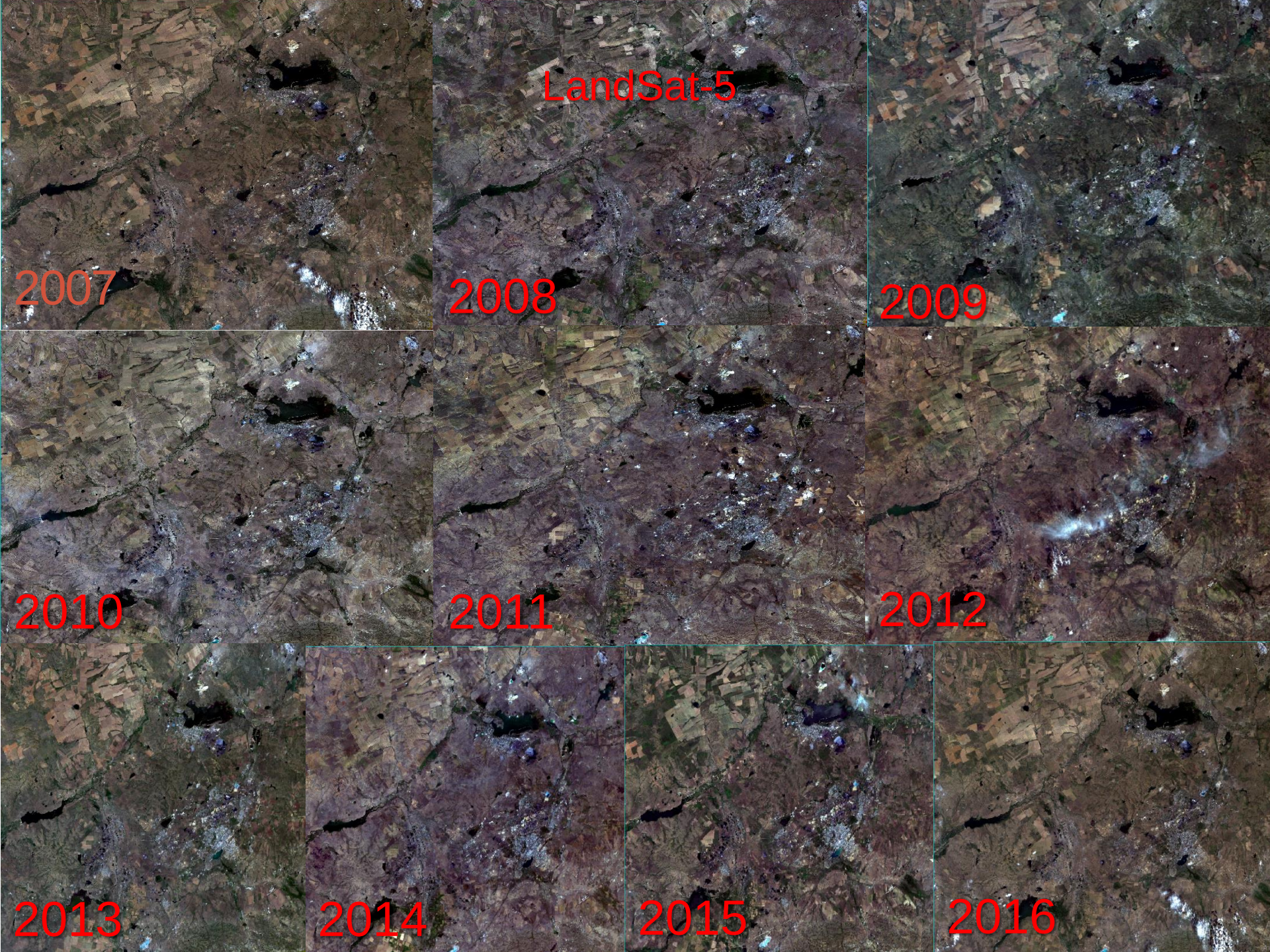
Visualization of Tengiz lake square changes from 1993 to 2016

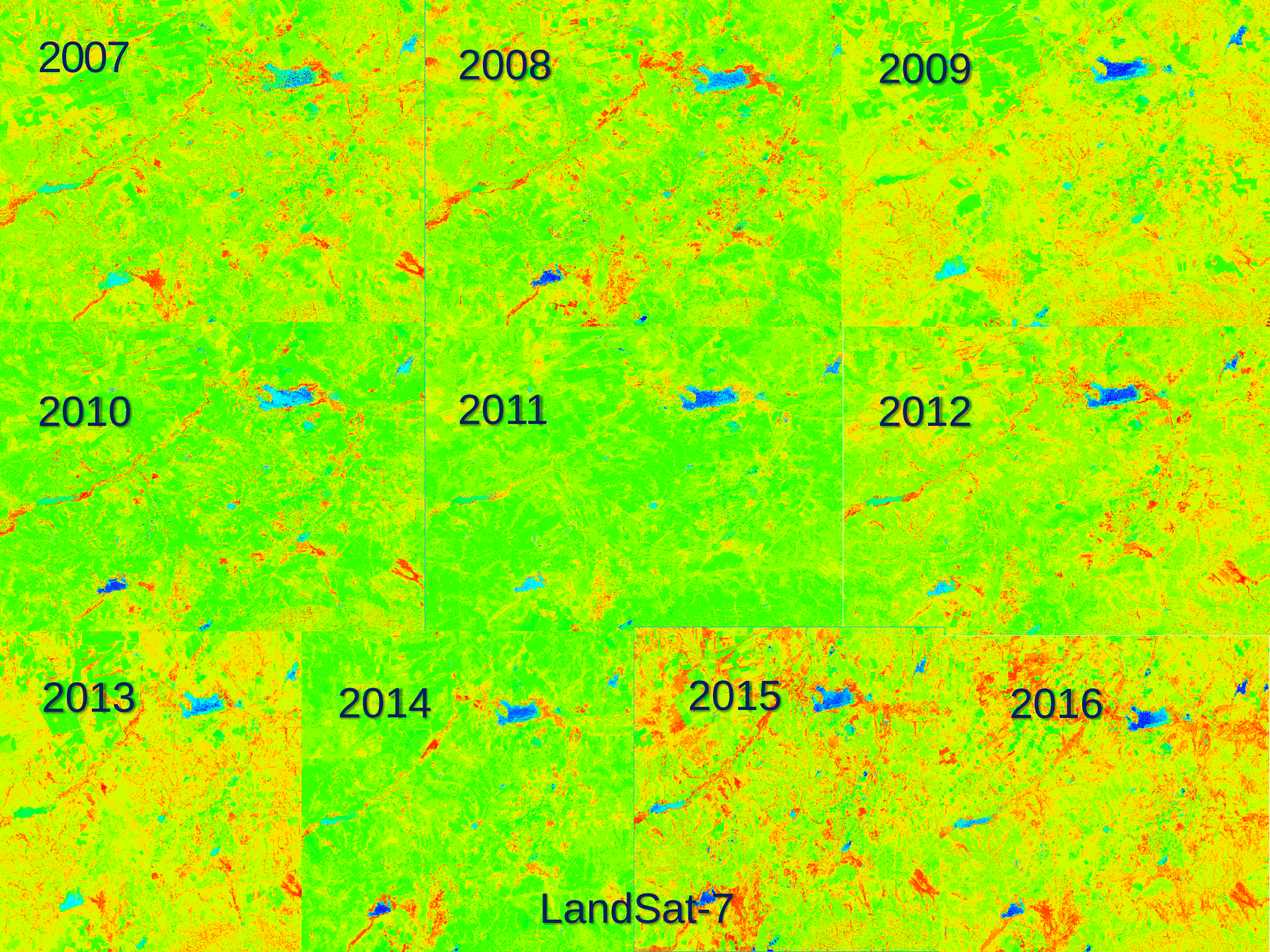
Remote monitoring of the geo – environmental state of the district of the Karaganda coal basin

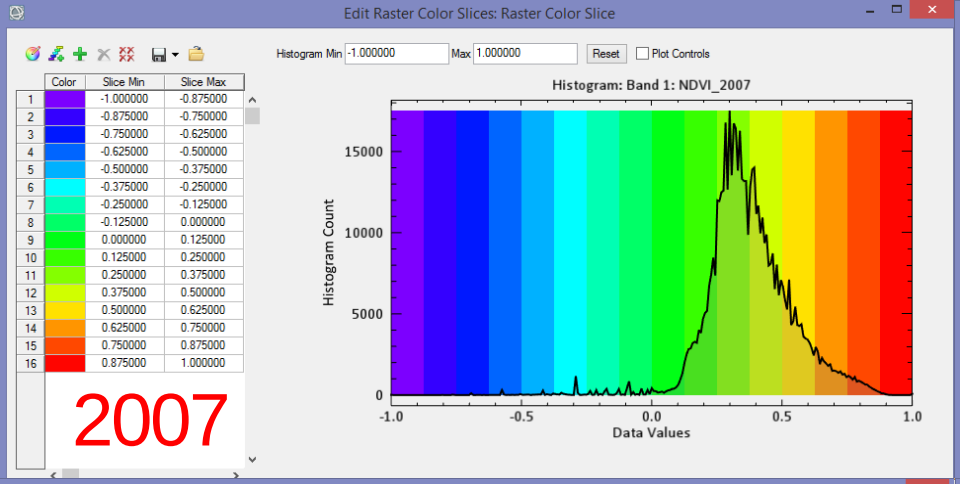
Imangaliyeva B.

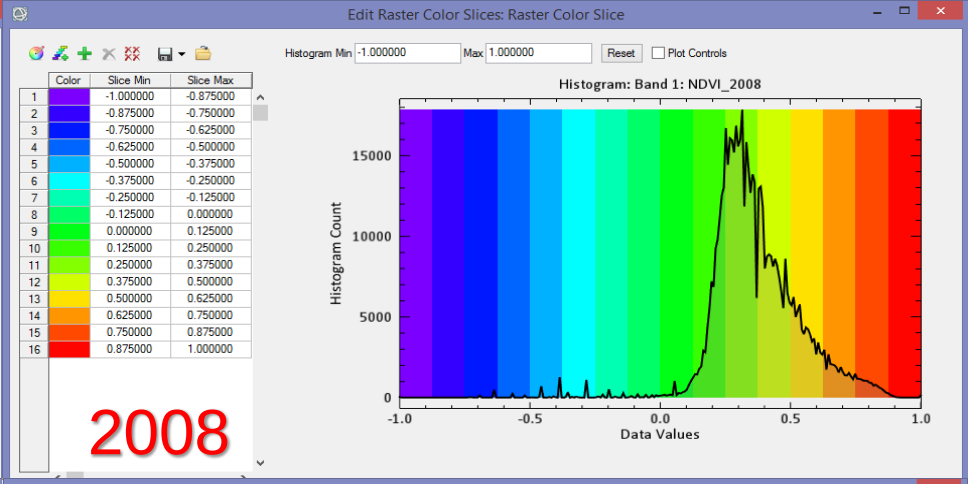
Aim of the work

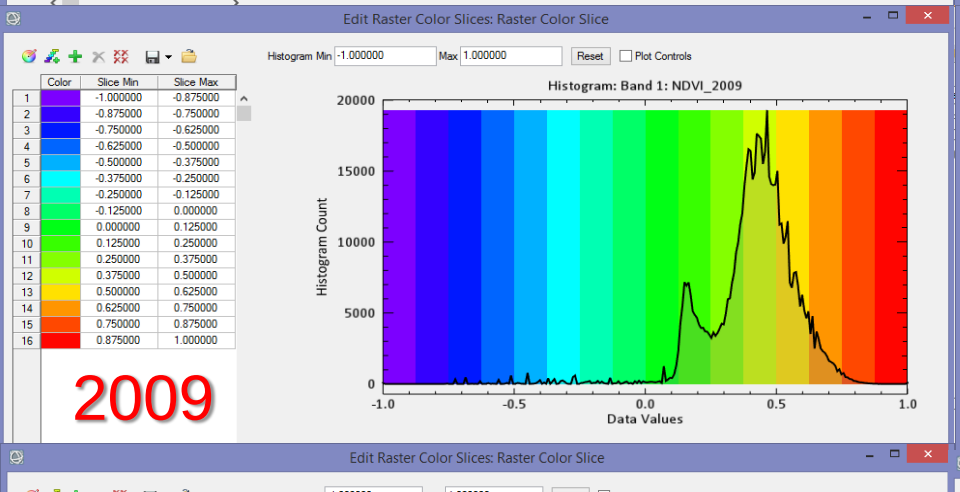
ENVI through software to process the data obtained from the satellite Landsat 5 and 7 of the last 10 years, and to observe the change of vegetation and to make the analysis.

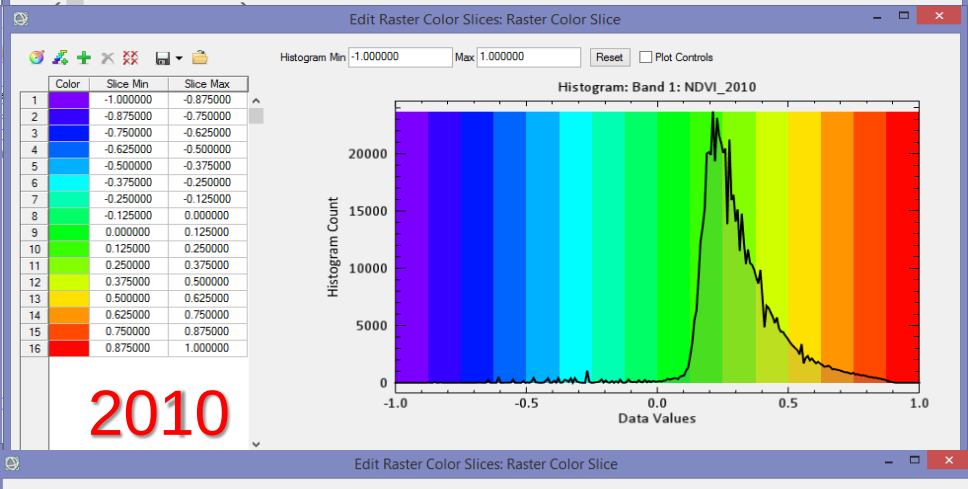

LandSat-5
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016

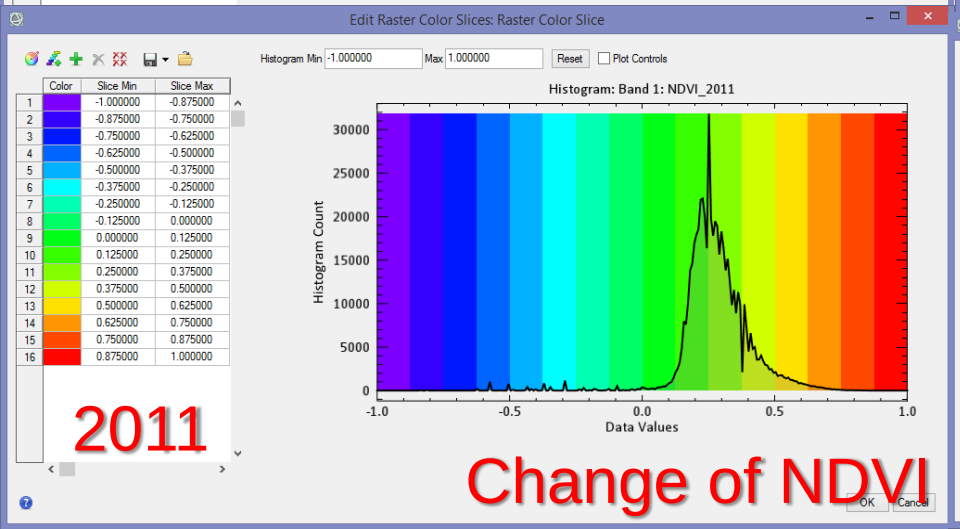

2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
LandSat-7

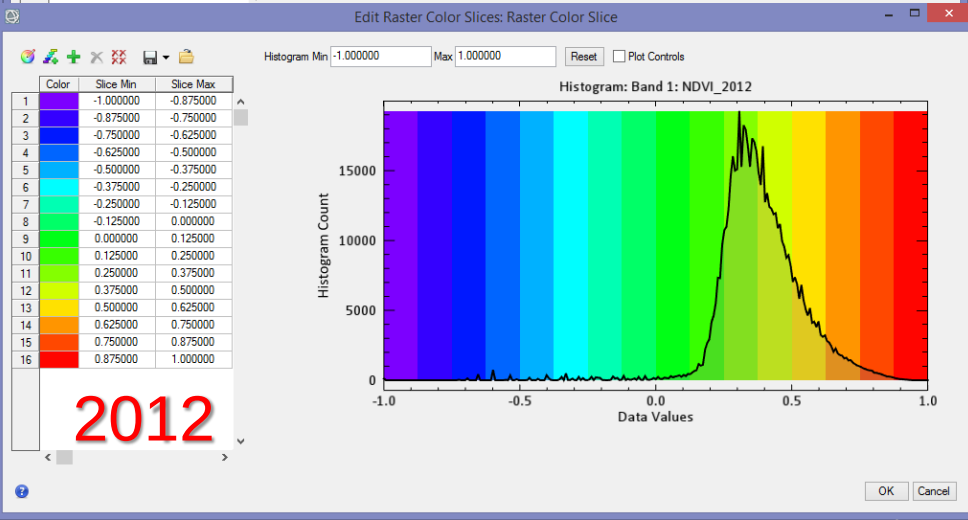

Edit Raster Color Slices: Raster Color Slice
Histogram Min -1.000000 Max 1.000000 Reset Plot Controls
Histogram: Band 1: NDVI_2007
Histogram Count
Data Values
2007


Edit Raster Color Slices: Raster Color Slice
Histogram Min -1.000000 Max 1.000000 Reset Plot Controls
Histogram: Band 1: NDVI_2008
Histogram Count
Data Values
2008


Edit Raster Color Slices: Raster Color Slice
Histogram Min -1.000000 Max 1.000000 Reset Plot Controls
Histogram: Band 1: NDVI_2009
Histogram Count
Data Values
2009


Edit Raster Color Slices: Raster Color Slice
Histogram Min -1.000000 Max 1.000000 Reset Plot Controls
Histogram: Band 1: NDVI_2010
Histogram Count
Data Values
2010


Edit Raster Color Slices: Raster Color Slice
Histogram Min -1.000000 Max 1.000000 Reset Plot Controls
Histogram: Band 1: NDVI_2011
Histogram Count
Data Values
2011
Change of NDVI
OK Cancel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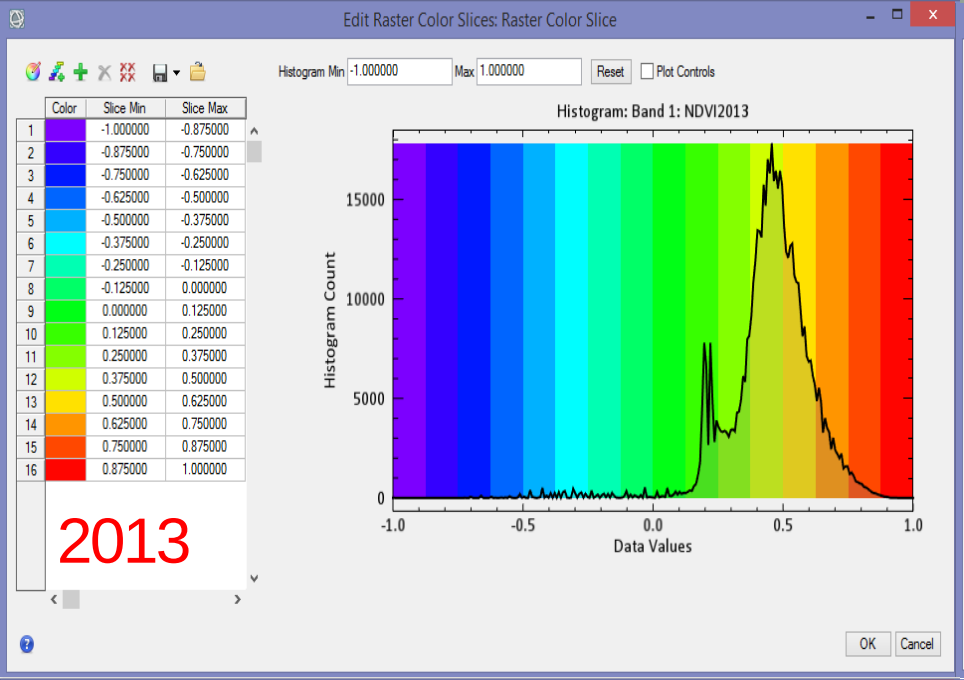
Histogram Min -1.000000 Max 1.000000 Reset Plot Controls
Histogram: Band 1: NDVI_2012
Histogram Count
Data Values
2012
OK Cancel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Histogram Min -1.000000 Max 1.000000 Reset Plot Controls
Color Slice Min Slice Max
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2 -0.875000 -0.750000
3 -0.750000 -0.625000
4 -0.625000 -0.500000
5 -0.500000 -0.375000
6 -0.375000 -0.250000
7 -0.250000 -0.125000
8 -0.125000 0.000000
9 0.000000 0.125000
10 0.125000 0.250000
11 0.250000 0.375000
12 0.375000 0.500000
13 0.500000 0.625000
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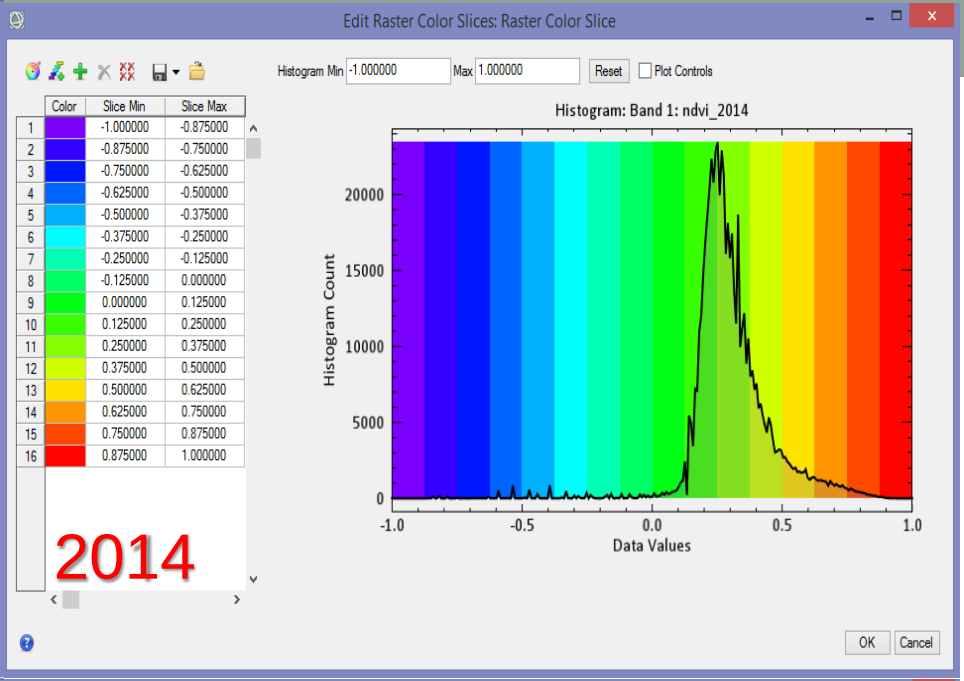
Histogram Count
Data Values
2013
OK Cancel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12 0.375000 0.500000
13 0.500000 0.625000
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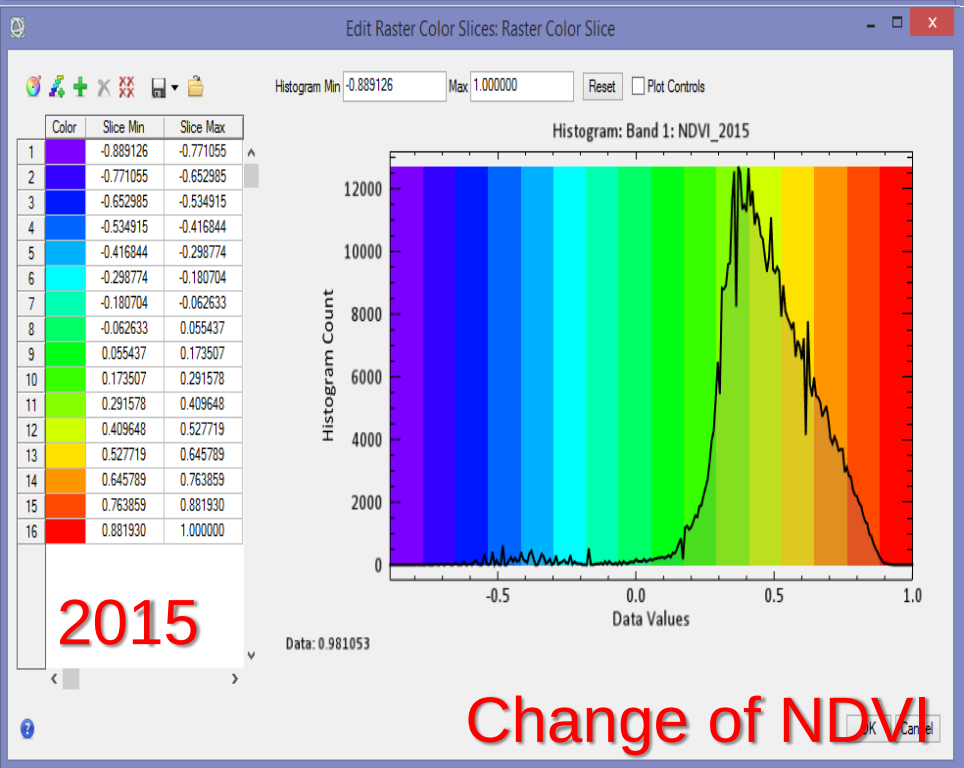
Histogram: Band 1: ndvi_2014
Histogram Count
Data Values
2014
OK Cancel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Color Slice Min Slice Max
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4 -0.534915 -0.416844
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6 -0.298774 -0.180704
7 -0.180704 -0.062633
8 -0.062633 0.055437
9 0.055437 0.173507
10 0.173507 0.291578
11 0.291578 0.409648
12 0.409648 0.527719
13 0.527719 0.645789
14 0.645789 0.763859
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16 0.881930 1.000000
Histogram: Band 1: NDVI_2015
Histogram Count
Data Values
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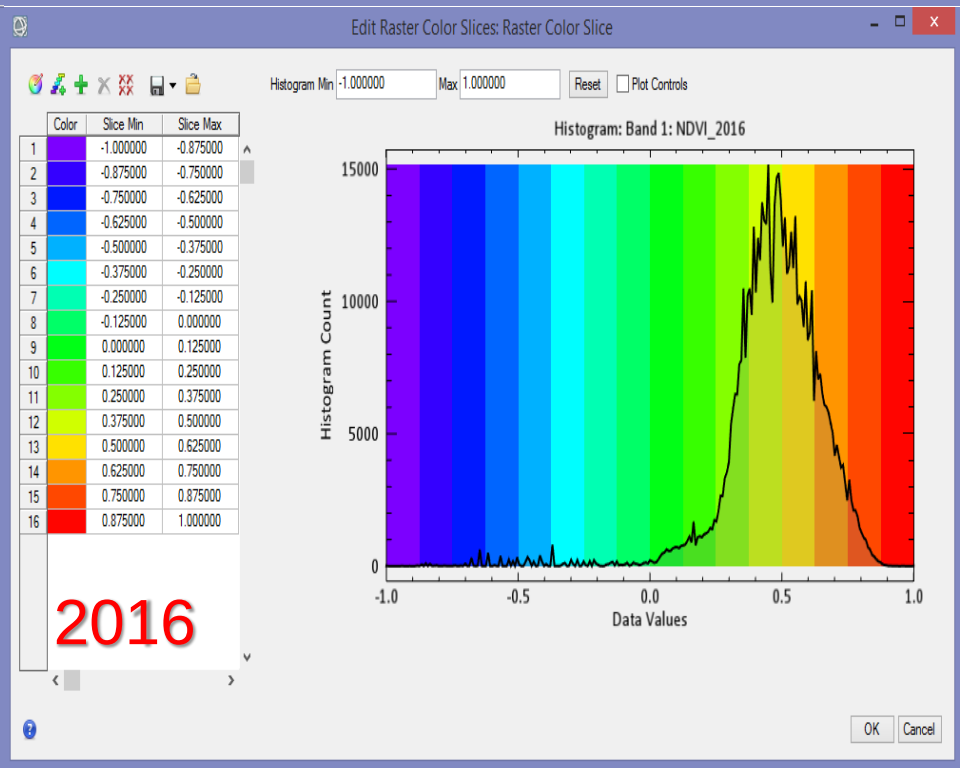
2015
Change of NDVI


Edit Raster Color Slices: Raster Color Slice
Histogram Min -1.000000 Max 1.000000 Reset Plot Controls
Color Slice Min Slice Max
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2 -0.875000 -0.750000
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13 0.500000 0.625000
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15 0.750000 0.875000
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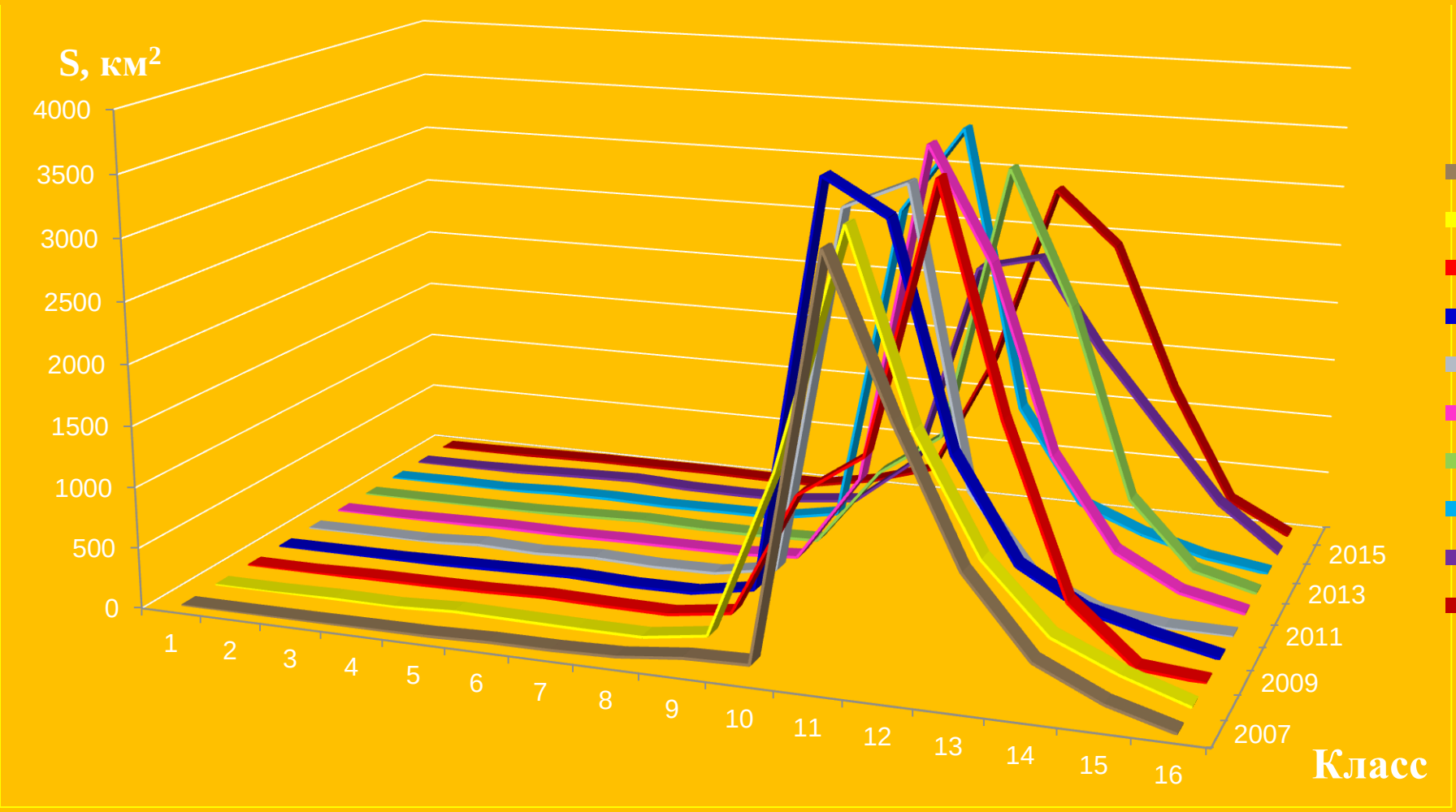
Histogram: Band 1: NDVI_2016
Histogram Count
Data Values
2016
OK Cancel

Schedule of classes a ratio of NDVI, vegetation state for 10 years, and the volume of space

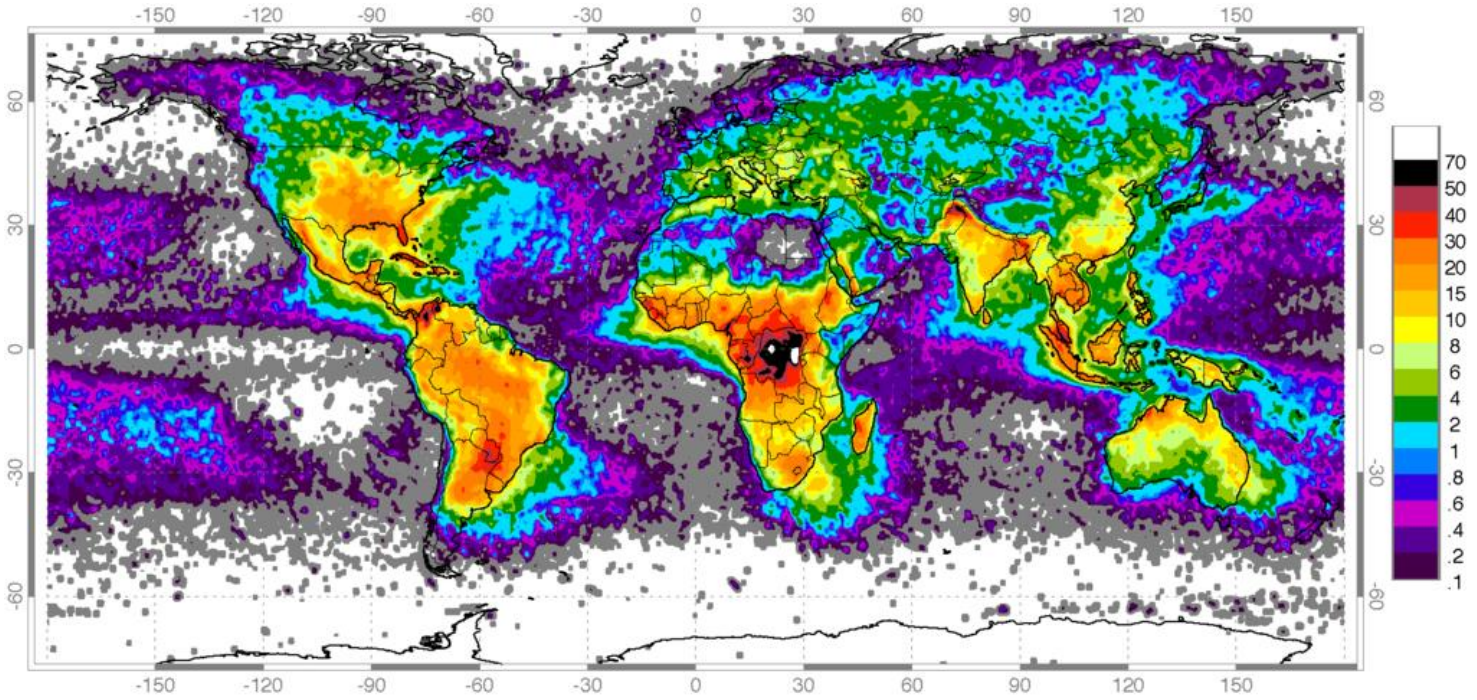


The analysis leads to the conclusion that the positive growth trend observed in the ecological status of the vegetation cover. Increased vegetation areas due to climatic factors for 2015 and 2016, when there was a significant increase in precipitation during the spring and summer.

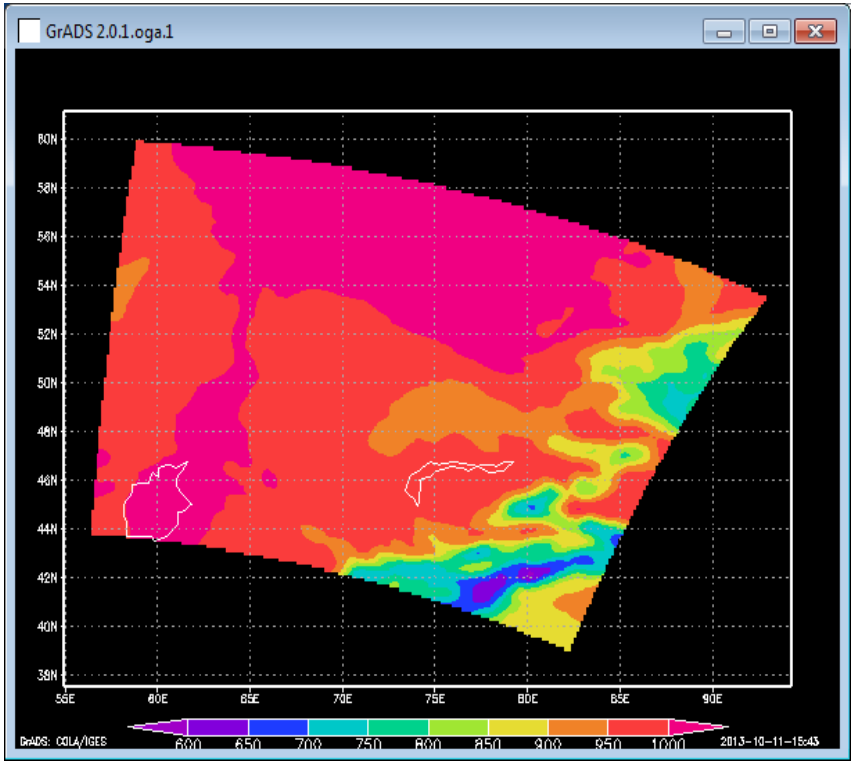
The numerical forecast of weather and storm activity in Almaty with WRF

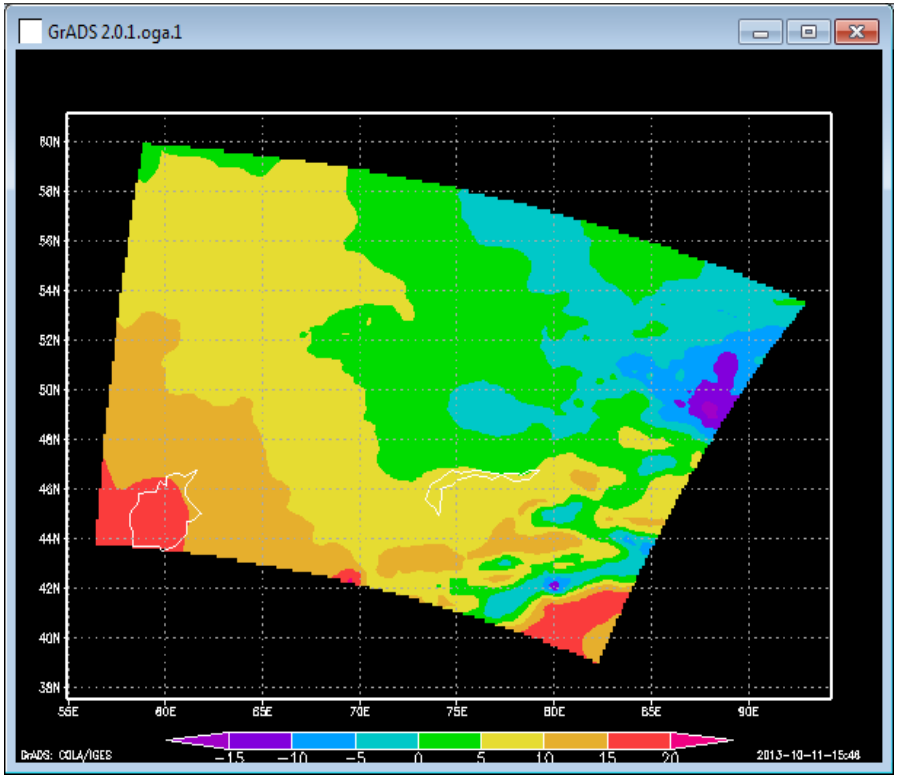
Shaltykova Zh.

Geography Thunderstorms

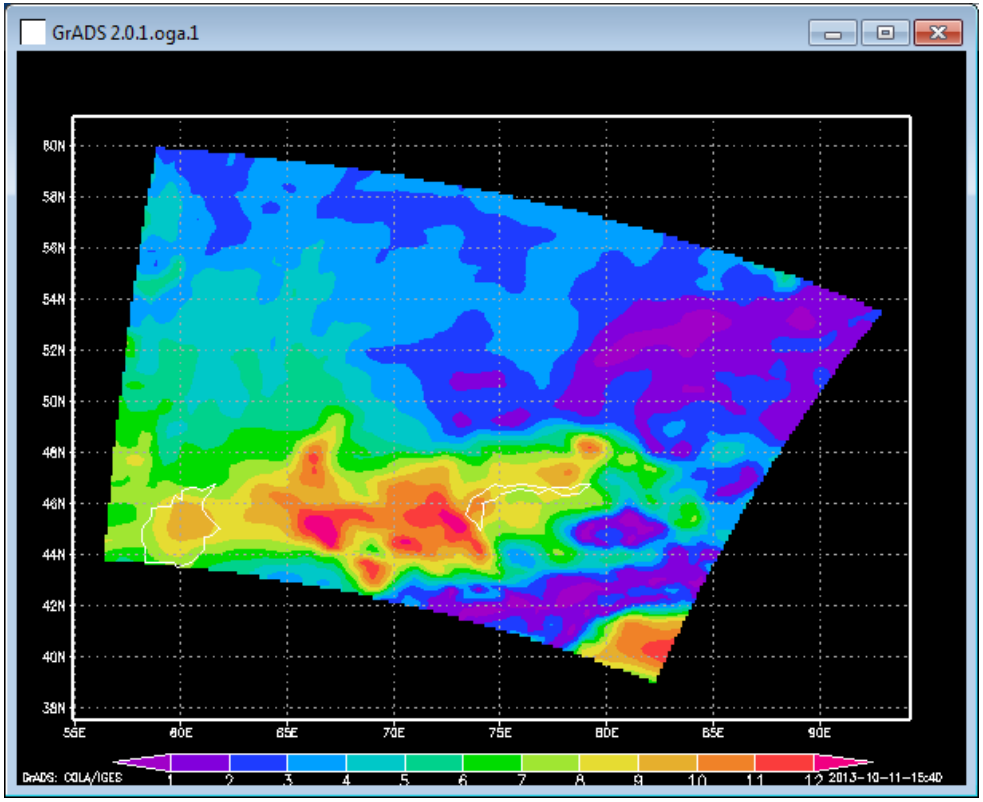


The pressure and temperature in Almaty





Wind speed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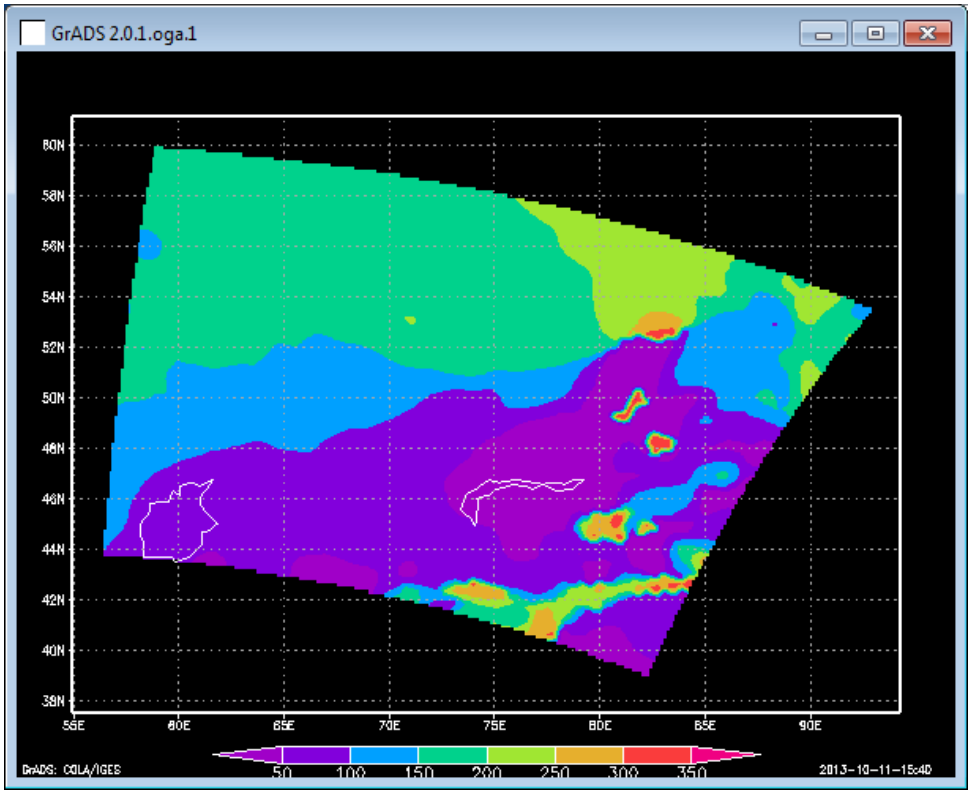
58N
56N
54N
52N
50N
48N
46N
44N
42N
40N
38N
55E
60E
65E
70E
75E
80E
85E
90E
GrADS: COLA/IGES
1
2
3
4
5
6
7
8
9
10
11
12
2013-10-11-15:40

Wind direction



THANK YOU
FOR YOUR ATTENTION!