APPLICATION OF REMOTE SENSED DATA FOR STUDYING OF TUNDRA AND TAIGA ECOSYSTEMS TRANSFORMATIONS

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KEY WORDS: Remote Sensing Environmental monitoring, Ecosistems Dynamic, Technogenic influence.

ABSTRACT:

The extending of mine areas in the Russian North leads to increase of technological influence on environment. As a result there occurs transformations of Tundra and Taiga Ecosystems which may be irreversible. Therefore monitoring is needed to control the development of negative processes. Realization of monitoring is maximum effected on basis of Remote Sensed Data (RSD). RSD allows to make follows : 1) to record and to analyze the types intensity, relationships of different influences on environment with enough accuracy and quickness over large areas; 2) to predict trends of Ecosystems development to finish future by analysis of the Earth's space image obtaining at different times. RSD are based on system approach to environmental monitoring as they imagine the decreasing spatial model of Earth's surface for depicted on their territory. The scale row of RSD provides possibility of diverse level ecosystems studying. Knowledge acquisition and aero-space and geological-landscape data are formed to provide complex investigations. They are basis of Integrated Geographical Information Systems which allows to operate and analyze various information. Dynamic of Tundra and Taiga Ecosystems influenced from of large metallurgical and mine enterprises is observed on example of sites in the Western Siberia and the Kolsky Peninsular.

1. THE NORILSK AREA

At present natural environment of the Norilsk area is subjected to intensive anthropogenic forces. The result of this influence is the natural landscape disturbance, which makes bad ecological situation for living organisms and vegetation. The technogenic influence leads to destruction of surface covers, disturbance of thermal region of thawing layers in different seasons, the intensive development of bad cryogenic phisical/geological processes, which proceeds very slowly in ordinary conditions.

The main sources of technogenic forces to natural environment at the Norilsk area are: 1) activity of the powerful Norilsky integrated mining and metallurgical plant for extraction and refining of mineral resources; 2) landscape transformations due to launching of Khantaiskaya hydroelectric power station and filling of reservoir which was not prepared to flooding. This fact led to rotting of flooded vegetation and to increase of fenol contents in the water.

Gas and smoke erruptions of Norilsky mining and metallurgical plant play the vital importance for creation of bad ecological situation. These erruptions contain compounds of oxygen and hydrogen with

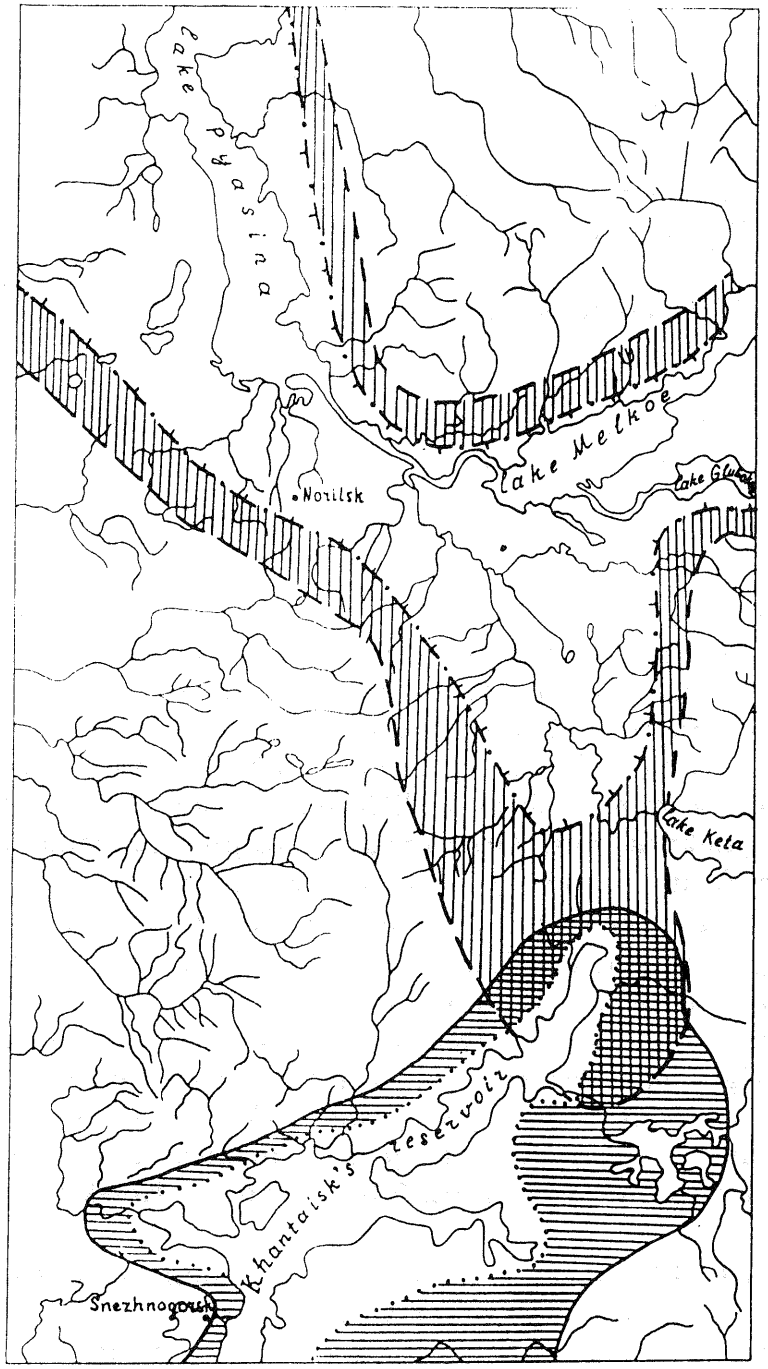
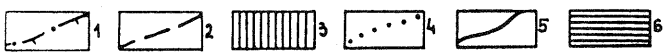


Figure 1

Scheme of natural environment dynamics under affect of the Norilsk mining/metallurgical plant and the Khantaiskoe water reservoir.



1,2. boundaries of dead forests, 1-1978, 2-1990.

3. zone of dead forest at the period of 1978-1990.

4,5. boundaries of intensive irrigation and flooding of the Khantaiskoe water reservoir environs, 4-1974, 5-1990.

6. zone of increasing of irregated and flooded areas at the period of 1974-1990.

S, Se, Te, heavy others as well as light metal and organic compounds transfered to thousands kilometers. The acid rains badly influence for the man's health and to natural landscapes around the Norilsk. The strong disturbance of vegetation cover (wood, as well as moss and lichen) is observed in the zone of the Norilsky plant influence (near 150 km). In some parts it is destroyed (basin of Ribnaya river) and over this zone the moss and lichen cover is partially disturbed. The pollution of soils by the salts of heavy metals prevents rehabilitation of vegetation cover so the process of disturbance have irreversible character. Rare grass cover can not slow down the process of landscape transformation. In this area the process of thaw depression formation and other thermokarst phenomena take place due to increase of frozen and thawed layers thickness within large areas without vegetation cover was heat-insulating layer. The solifluction processes on the slopes, the processes of landslides formation on the cliffs became more active. The large quantity of silt, clay and sand substances is brought to the basin of Ribnaya river due to the destruction of shores composed by glacial and fluvioglacial deposits. At some parts of Ribnaya river basin the processes of wind erosion become active, and the hydrogeological regime of tributaries is changing. Besides Norilsk's plants and Khantaiskaya hydro-electric station the factors caused by intensive building of houses and construction for transport as well as the caring out of different geological and geophysical investigations influence to natural environment. But this influence is less intensive and it may be regulated. For this area the middle-scale schemes of natural environment dynamics and landscape/indicational has been created by using the results of visual and interactive interpretation of remotely sensed data observed in different years as well as geological and geophysical data from databank.

2. THE KOLSKY PENINSULA

The integrated mining, metallurgical and other plants for processing of raw materials strongly influence to ecological situation of the Kolsky peninsula western part. The deserts are formed around industrial centers. For example, at the Monchegorsk region the vegetation is destroyed at the area near 300 square kilometers. Approximately 30 000 kg of sulfur is fallen to every square kilometer during the year in this region. And the quantity of Cu and Ni is near 6000 kg.

At the area of city Nikel the desert is moved with speed 1-2 km during the year. The plants of Kirovsk and Apatity throw out near 180 million cubic meters of wastages the main part of which gets into the Imandra lake - the largest lake of the Kolsky peninsula.

The formation of gigantic dumps deep quarries, reservoirs, slag storage and other constructions is the result of exploitation of mineral deposits. The area of these construction is increasing and they are the source of dust transferred by wind to large distance. Other sources of air pollution are the erruptions of sulfur gas influenced to soil and vegetation. So, at the Laplandian preserve, which is situated to the south of "SeveroNikel" plant, the influence of this plant is spreading to the distance near 60 km. There is increased acidity at the lakes of the Laplandiya. It is due to acid rains. At the Inary area the North Finland the increased concentration of heavy metals in the moss is observed.

At the last two or three years the ecological situation of the Kolsky peninsula became worse due to discord of economic mechanism and decreasing of technological discipline that leads to erruptions of polluted

substances to atmosphere and water reservoirs. All disturbances of vegetation cover clearly observed on the satellite images. The comparison of images obtained in different years have allowed to trace the dynamics of natural environment changes at the Kolsky peninsula Western part.

3. THE LENINGRADSKAYA REGION

One task of the research project was to solve one of actual problem for Russia, namely revision of maps by optical sensor data (JERS-1).

The test site is located in the north of Leningrad's district. This territory is characterised by an atlantic-continental climate: relatively mild winter, cool and humid summer. Annual precipitation ranges from 550 to 850 millimeters. Western and southern winds predominate. The test site is located within the south taiga subzone. The fir and pine forests with small areas of broad-leaves forests are extensive here. Geomorphological structures includes denudative, accumulative, glacial and glaciofluvial forms of earth's surface. The geological basement is in the form of AR- and PR-igneous rocks namely granites, granitogneisses, gabbro, diorites, granodiorites. These rocks are covered with an almost continuous layer of Q-sedimentary rocks which are mainly moraine and glaciofluvial deposits.

The following factors influence the environment of the researched territory: industrial and agricultural activity, forest clearing, mine industry, irrigation and etc.

The influence of peoples has led to the development of negative exogenous processes as well as chemical pollution of soils, air and water reservoirs. These processes result in the transformations of natural landscapes and the formation of a artificial landscapes. The most effective methods of environmental monitoring and mapping are those based on remotely sensed data.

The project involves VNIR and SVIR data. In addition topographical maps (scale 1:50,000) and data from an aerial survey for the test site were used. Computerized processing and interpretation of remotely sensed data have been carried out by specialists on the basis of software developed at VNIIKAM such as the Classification Program based on Standard Samples (CPSS).

The layers of computerized interpretation were as follows:

- forests; - clearing forests;- plains; - swamps; - water bodies; - arable lands; - artificial surfaces.

The object classes were identified on appropriate aerial survey images. Then they were used for computerized classification as standard samples for the researched territory. The CPSS uses simultaneously 3 information layers as input data. To reveal the objects by means of computerized processing the following combinations of spectral bands were used: - forests: 137; - clearing forests: 2357; - plains: 137; - swamps: 268; - water bodies: 357; - arable lands : 137; -artificial surfaces: 127.

The analysis has proven that computerized interpretation of OPS-data may be used for the revelation of non vectorial and vectorial objects in landscape mapping and monitoring and revision of maps of scale 1:200,000 and less.

The accuracy of computerized interpretation for non vectorial objects is 70%.

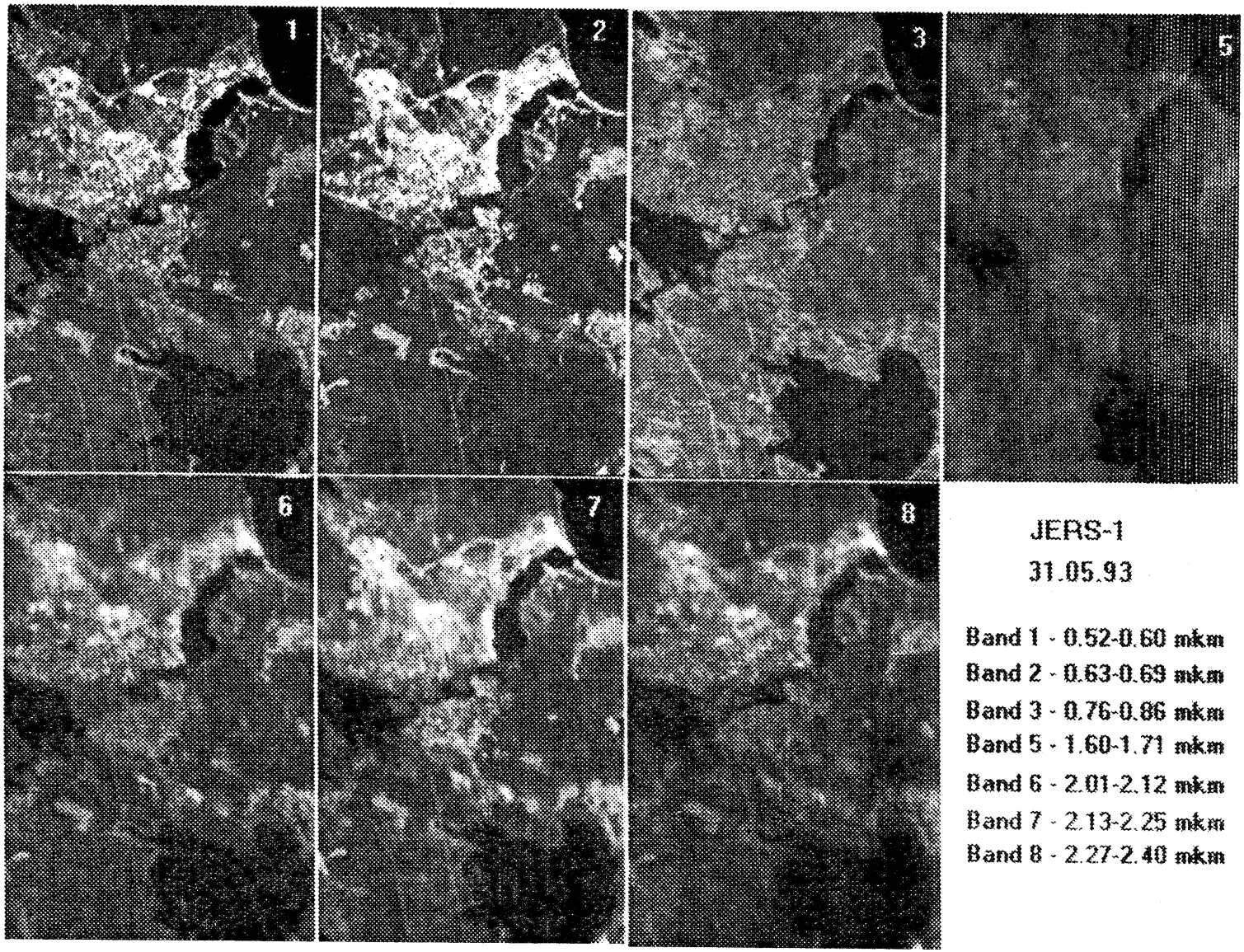

1
2
3
5
6
7
8
JERS-1
31.05.93
Band 1 - 0.52-0.60 mkm
Band 2 - 0.63-0.69 mkm
Band 3 - 0.76-0.86 mkm
Band 5 - 1.60-1.71 mkm
Band 6 - 2.01-2.12 mkm
Band 7 - 2.13-2.25 mkm
Band 8 - 2.27-2.40 mkm

Figure 2

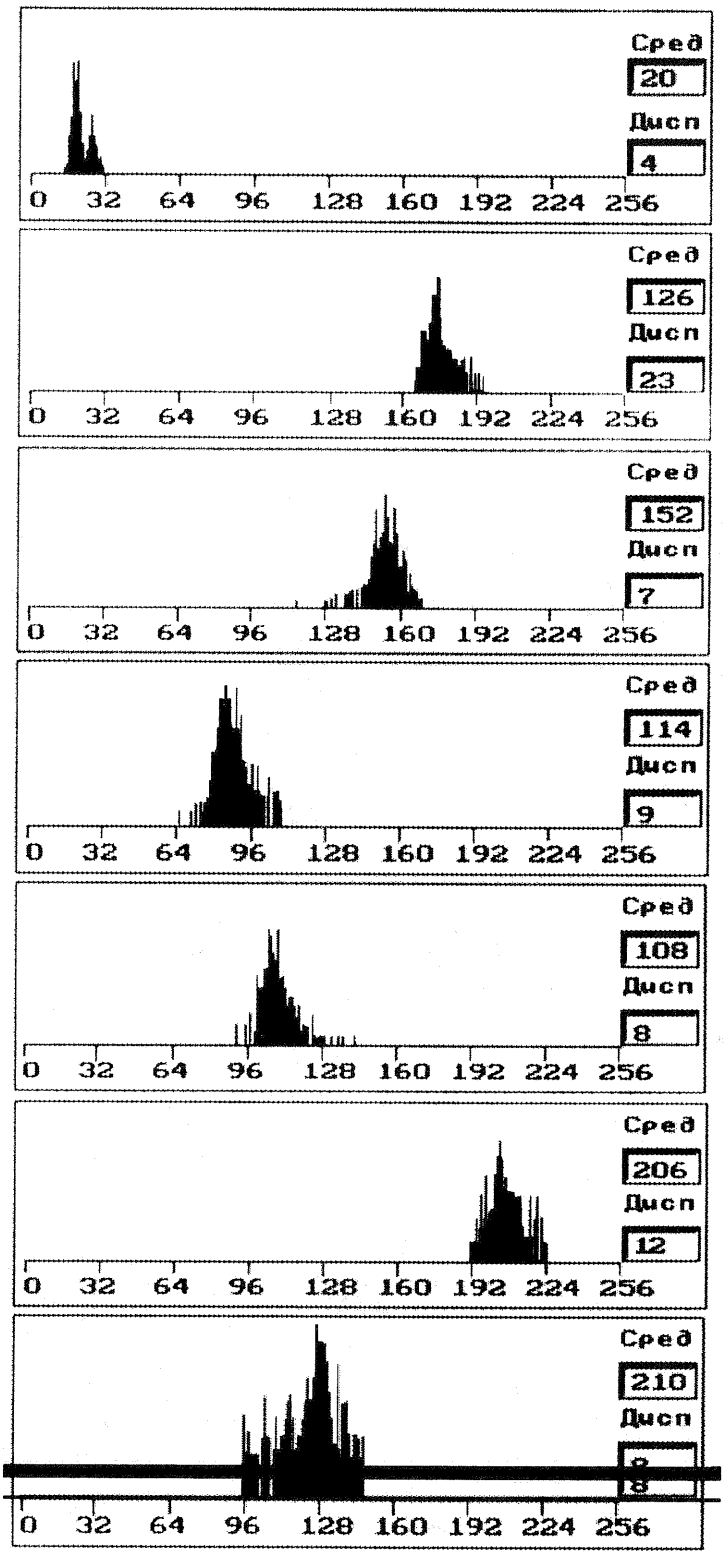


Figure 3 Histograms shawins the brightnesses characteristics of objects in computerized interpritation of JERS-1 spectral band combinations

Graph of forest area variations

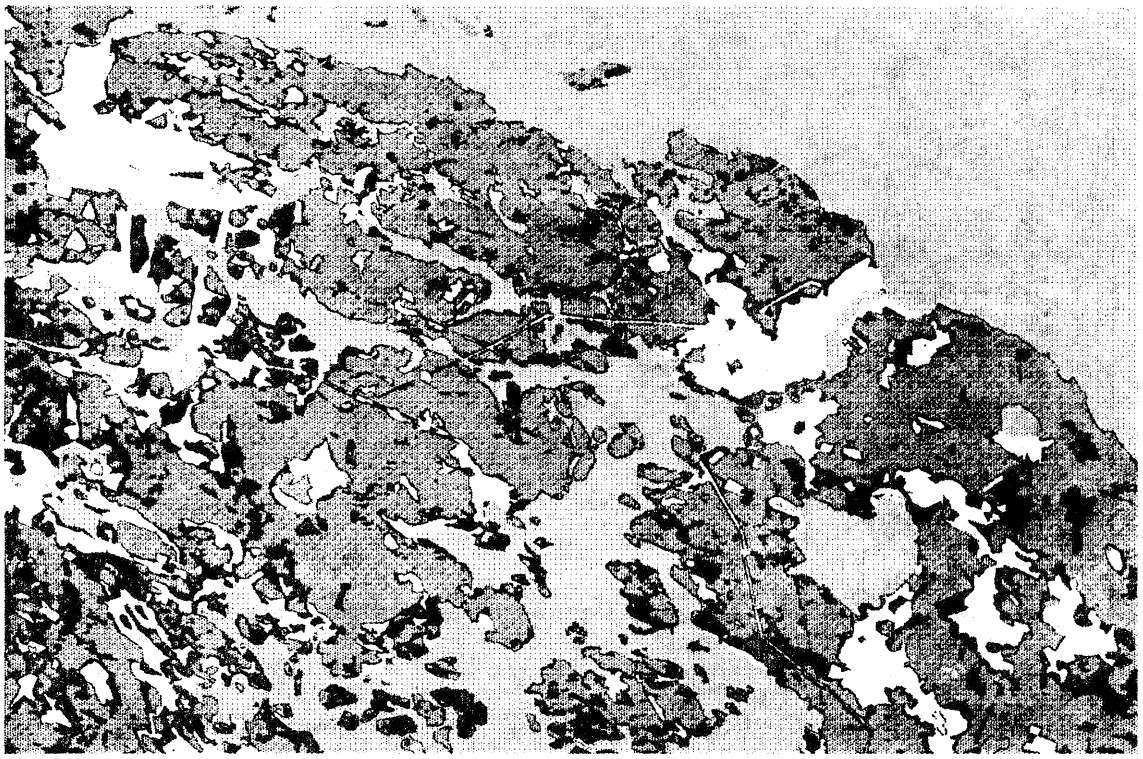


Figure 4

Legend

forests determined by computerized interpretation

borders of forests taken from the topographical map

decrease in forest area for the period of 1974-1993

regions of forest vegeneration reneval

water bodies