The possibilities of remote sensing monitoring of Jun`Jaga coal open pit effects to tundra environment (Vorcuta region)

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Abstract – The RS methods were involved for estimation of Jun`Jaga pit influence to terrestrial and water ecosystems. For investigation of area the vegetation map (1: 25 000) was prepared with using of NDVI those can select different vegetation communities (five classes) and disturbed area (mechanical effects). Vegetation classes helped to separate the area to some zones of sensitivities and prediction the stability of area landscapes to anthropogenic influence. The differences of snow melt between polluted and natural districts were indicating stable pollution level halo around colliery (polygons forms) and roads (lines forms). The form of halo was related with intensively and directions of winds in could season and relief form of area.

Keywords: monitoring of mine influence, anthropogenic effect to tundra communities

1. INTRODUCTION

In modern practice the GIS approaches are the most important in spatial-temporal investigation of natural and antropogenically transformed ecosystems features in environmental monitoring. In that context remote sensing (RS) methods are the significant data source especially in thematically mapping aims (vegetation, soil, landscape, geomorphology maps) of model area. The discontinuous of data (spectral brightness) included to RS products do the possibility to estimate quantitative variation of features of individual natural components. The finding map materials to represent the "capacious graphic form of information about representative investigated area" (Sochava, 1978).

The main aim of this work was the investigation of tundra ecosystems exposure anthropogenic effects near Jun`Jaga coal open pit by RS and GIS methods and with application of field verification (fig.1). The Jun`Jaga coal open pit is first experiment of open coal mining over Polar circle. The intensive mine dynamic (2002 year– 200 thousand ton, 2003 – 300 and 2004 – get border of 500 thousand tons) generate environmental problems inevitable. The situation is complicate by effects of Vorcuta industrial junction and close related «traditional» coal mines.

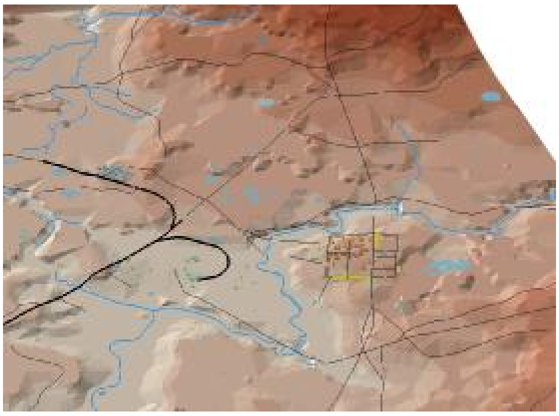

Fig. 1. The 3-D visualization of investigated area. Include relief, hydrology and transport layers.

1.1 Estimation of vegetation cover

For estimation of spatial distribution of vegetation cover on area the NDVI was used calculated for Landsat ETM+ image (168_12, 30.07.2000). The preliminary classification selected the five dominate types of communities. Low-shrub lichen community located on top of hills and up part of hill sides have most wide distribution in area (fig.2). This class had heightened drain facility and was formed on a peaty-glay soil. Class is more sensitive to mechanical impacts and demands the limitation of using conditions (transport roads, reindeer ways). Pollution substances are arrive mainly from atmosphere but low development of peat layer (organogenic accumulation) and high wash out rate. Precipitation, water of melt snow cover etc are reasons of low concentration of pollutants (heavy metals) in soils and they transportation to below conjugated landscapes.

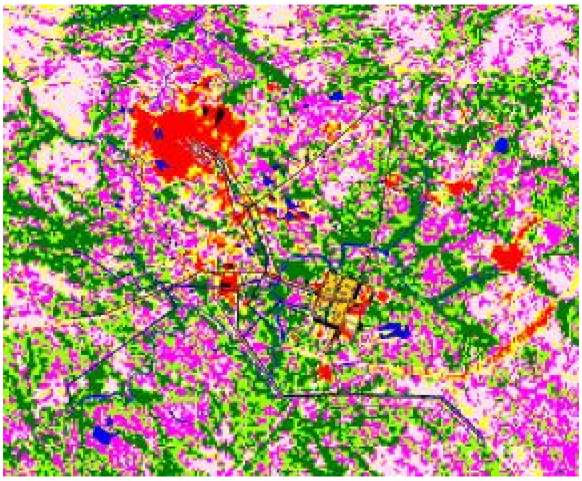

Fig 2. The vegetation classes in area.

- disturbed area and pioneer communities
- low-shrub lichen communities
- mossy shrubs communities
- rarefy grass willows (drain narrow)
- mossy willows (accumulating formations)

On hillsides and low parts of watersheds located mossy shrubs (mainly *Betula nana*) and mossy willows (*Salix* sp.) communities. In some parts of these communities we observed boggy processes (secondary hydromorphism) with formation of moss bogs (*Eriophorum* moss bogs). High stable of these communities to the accumulation of anthropogenic pollution (mainly dust and heavy metals) and location close to industrial objects (pit, roads, dumps) demonstrate of their important significance in vegetation cover of Jun`Jaga coal-field.

The class of grass willows located on narrow strip drain was relatively stable to anthropogenic effects. Compeering analysis of images and data from early maps demonstrate extension area of communities related with bogy processes.

Antropogenically transformed classes are presented by bare grounds and plots with initial stages of forming vegetation cover (pioneer communities of dumps, roadsides, embankments). As a rule these classes are selected near industrial objects and transport infrastructure. Re-growing of that area is more intensively on peripheral zone border with low disturbed area. Species composition of communities is mainly presented by annual ruderal species: *Chamaenerion angustifolium, Tripleurospermum hookeri, Barbarea vulgaris*.

1.1 Analysis of pollution halo.

Using RS methods for analysis of pollution halo around industrial objects allow indicating the “chronic” polluted zones (Struman, 2003). More favourable conditions for they observation are created in spring time. In that period the ratio of spectral brightness (ρ) between disturbed and undisturbed area are more distinct. Also in that period the processes of snow melting are more intensive on antropogenically influenced area (Vinogradov, 1984; Procacheva et all, 1988). Optical and reflection effects of snow in that period are most great. In optical interval (0.4-0.7 mkm) the next regularity have place: ρ of old clear snow variable in interval 0.5-0.7, old low polluted snow – 0.4-0.5, vastly polluted snow – 0.2-0.3 mkm. Correlation between dust concentration in snow (g) and ρ have nonlinear exponential dependence (Vasilenko et. all, 1981). Selected pollution halo demonstrate an area of constant polluted and have original geochemical background.

The Jun`Jaga pit area feel the dust pollution from the beginning of exploitation underground coal mine and with the advent of settlement Sovetskiy. The image Landsat 7 TM for 3.06.1988 year (166_13, 03.06.1988, RGB = 4, 7, 1) was used for selection of pollution halo (Fig.3). Analysis of that area is more important with two causes. First, it help to select the relatively clear (native) area those can used as «background» in geochemical compeering. Second, combination images with data of vector layers of relief and hydrogeology allow to modeling the ways of reallocation and mark places of accumulation of pollutions on area. The late chemicals investigations demonstrate that the concentration of main contaminant elements (mainly heavy metals) in soils depends from landscape position and distance from emission source.

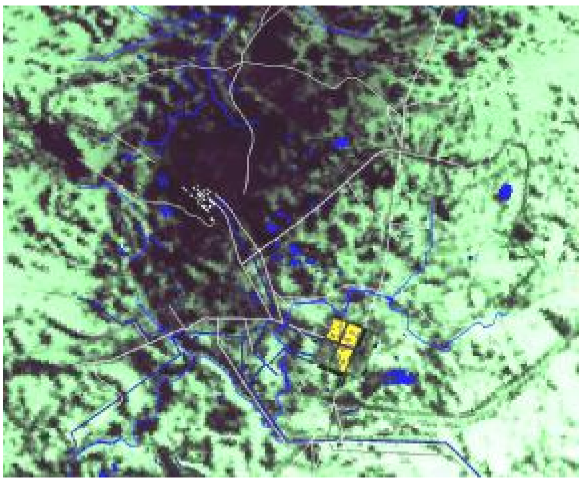

Fig.3. RGB image of pollution halo around Jun`Jaga pit area.

The snow melt and dust area (black and grey collar) related with polluted and industrial zones and nicely contrast with buffer and native area (Fig 3). Maximal disturbance area is located near emission source. Pollution halo around Jun`Ja mine have long length to north (2.8 km) and north-east (4.3 km) direction. Mainly it related with domination of winds from south and south-west direction in cold season (Atlas of climate…, .1977) (fig.4). The direction of halo in south and south-west direction is less show and spread on 1.8 and 1.4 km, respectively. The halo of pollution demonstrate presence a mixing complex of impacts from early exploit mine and modern exploit open pit.

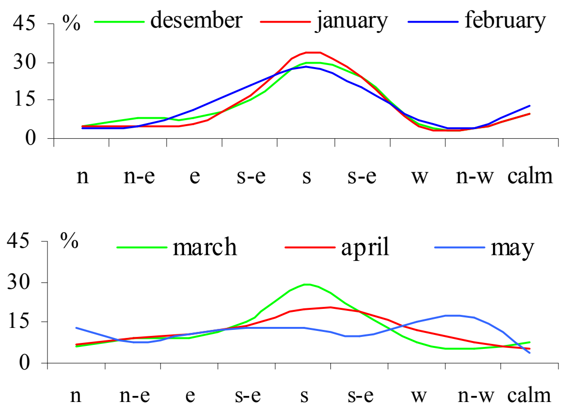

Fig.4. Dominant wind direction in investigation area in cold season

Analysis of RS materials with combination of field verification data separated area of Jun`Jaga coal-field on some zones and measured area of anthropogenic effects: coal pit area (9.8 ha), impact area (17.7 ha), buffer zone (23.8 ha) and relatively native communities.

2. REFERENCES:

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