NELDA TEST SITE REPORT

Komi Site

Vladimir Elsakov[1], Olga N. Krankina[2], Peder Nelson[2]

[1] Institute of Biology, Komi Science Center, Russian Academy of Sciences, Kommunisticheskaja st., 28, 167610 Syktyvkar, Russia, elsakov@ib.komisc.ru
2 Oregon State University, Department of Forest Ecosystems and Society, 321 Richardson Hall, Corvallis, OR 97331, USA, krankinao@fsl.orst.edu, Peder.Nelson@oregonstate.edu

Table of Contents

	Page
1) Site location	
a) *Country, State, Province*	**2**
b) *Center Coordinates*	**2**
c) *General characteristics of terrain*	**2**
d) *Major types of vegetation disturbance and land cover change*	**3**
2) Satellite Imagery	**3**
3) Ground Data	**4**
4) Land Cover Map	
a) Map Legend	**6**
b) Imagery pre-processing	**7**
c) Masks	**8**
d) Supervised classification	**8**
e) Accuracy assessment	**9**
f) ***Mapping results***	**10**
5) Land Cover Change	**11**
6) Comparison with Coarse-resolution maps	**13**
a) Land cover maps	
7) Publications using site data	**14**
NELDA – other publications and presentations	
8) List of Contributors to Site Data and Report	**15**
9) Acknowledgements	**15**
Appendices:	
Table.1. The stages of revegetation in observation area	**16**
Fig. The land-cover classification of area accordance with LCCS legend. The three plots of field work are presented: 1 – Vozeiskoe oil deposit (Harjaha), 2 – Juznoe Shapkino, 3 – Srednaja Charjaha.	**17**
Table.2. Diagnostic table of vegetation communities gropes.	**18**

Formatted: English (U.S.)

1) Site location

a) ***Country, State, Province*** – Russian Federation, North-east part of European Russia, North part of Komi Republic (KR) and Nenets Autonomous District (NAD). Dominant natural landscapes are typical of taiga-tundra ecotone.

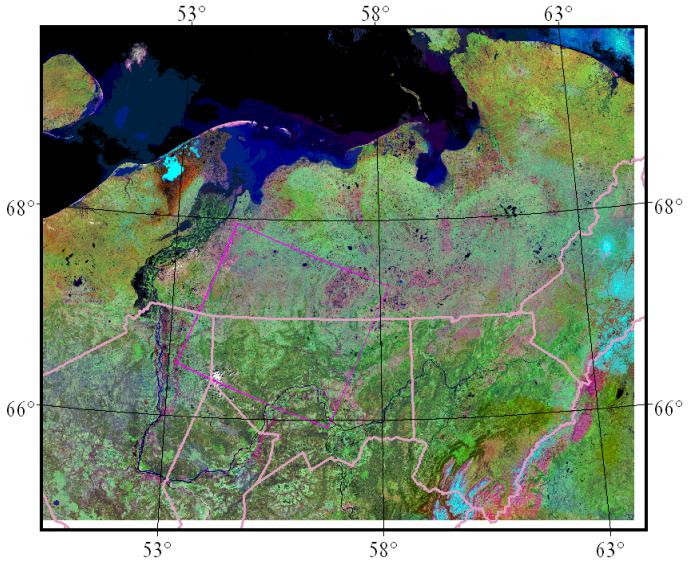


Fig. 1. The location of test site (Landsat TM image 172/13). The site boundary and administrative boundary of Komi Republic are presented.

b) ***Center Coordinates*** – 66°57'08.00"N, 55°37'39.5"E (Landsat 172/13)

c) ***General characteristics of terrain*** - The site is located in the Northern part of Pechora river basin. Almost one-fourth of that area is located at or above the Polar circle and this determines all natural features of ecosystems. For most of these landscapes the radiation balance is about 20-25 kcal/cm^2. For comparison, the northern-most part of Pechora river delta has the radiation balance of 15-20 kcal/cm^2 per year (Atlas of Arctic, 1985). Severe climate (the number of days with average temperature higher than 10 °C is about 40 per year), excessive humidity (the annual precipitation decreases from south to north from 500 to 360 mm), in combination with relatively flat relief and seasonally-frozen ground (permafrost), determine the high degree of water saturation and presence of many wetlands.

Current vegetation cover of territory was formed by a complex of local physical and geographical conditions and the development history of the region. Almost all ecosystems are characterized by low phytomass and slow rates of biogeochemical cycling as well as development of cryogenic processes. At the same time, despite rather poor overall species diversity, the vegetation-soil cover of tundra and forest-tundra communities has a remarkably high diversity and microrelief-dependent complexes. Low heat availability and excessive humidity on the significant part of territory account for slow mineralization processes of soil organic matter and, as a consequence -- peat accumulation and soil gleyzation. As a result, soils with shallow peat, peaty-glay soils, and also boggy soils are formed where peat layer includes different types of plant material decomposition.

Formatted: Portuguese (Brazil)
Formatted: Portuguese (Brazil)
Formatted: Portuguese (Brazil)
Formatted: Portuguese (Brazil)
Formatted: Portuguese (Brazil)
Formatted: Portuguese (Brazil)
Formatted: Portuguese (Brazil)
Formatted: Portuguese (Brazil)
Formatted: Portuguese (Brazil)
Formatted: Portuguese (Brazil)

The formation of flora and fauna began relatively recently (as evidence - absence of endemic and relicts species) and relates to the time of Pliocene-Pleistocene. In most cases fauna and flora formation depended on change of temperature conditions of territory and sea transgressions. Vegetation cover of today's communities was formed also under influence of reindeer grazing during several millennia. More than 20 reindeer-breeding farms exist in the region.

d) ***Major types of vegetation disturbance and land cover change*** **-** The main changes of ecosystem components in the study area relate to seasonal dynamics of vegetation, cryogenic evolution of landscapes and anthropogenic effects which have especially been increasing in recent years and are related to development of gas and oil industry.

Large parts of the area are important for the oil supply of Russia (**www.ipieca.org**) and new dramatic changes of the landscape are expected in the near future. The importance of this region for Russian economy is related to vast resources of fossil fuels, concentrated in deposits within the Timano-Pechorsk oil-gas province. At the present time nearly 78 terrestrial oil and gas fields in Nenetz Region and 187 in Komi Republic are in use. Nearly 6,600 boreholes were drilled in the study area during the period of industrial development. The output of natural gas is 3.1-3.2 billion m^3 and 10.3 million tons of oil. The oil reserves in Komi are confirmed in 125 distinct oil deposits while nearly 50% of oil is concentrated in only 3 large deposits (Official report…, 2007) – two of them are presented in the study area (Usinskoe and Vozeiskoe). There is an urgent need for a system for monitoring future changes associated with oil and gas development. Due to the size of the area, remote sensing is the only realistic way to monitor these major changes. The landcover changes are related to large-scale oil extraction, transport system construction, establishment of temporary worker camps, and installation of flow tanks for storage. Legally 0.325 ha of native land is allocated for building of each oil well, but in practice the disturbed area is much bigger. The buildings and preparation of pipeline corridors (transforming native ecosystems) favor the expansion of ruderal flora (weed) and fauna species and limit the reindeer migration ways. The initial landcover disturbances occurred in the 1978-1988 period of preliminary exploration and preparation of oil deposits for extraction. The differences in time since disturbance is the main reason for the variation of stages of revegetation. The recently disturbed lands were classified as herbaceous vegetation and hardwood shrub «yernik» tundra. Revegetation includes 3 stages (Appendices, table 1; Gruzdev, Martynenko, 1994). Compared to other parts of Komi republic, the significance of fire activity is low.

2. Satellite Imagery

The selection of satellite images depended on presence/absence of clouds and seasonal vegetation development. The selection of imagery is constrained by high proportion of days with overcast sky. For example, the probability of overcast sky in observed region (Narjan-Mar meteorological station data) varies from 62% in July to 78% in September (Klimatologicheskii…, 1952).

The main source of images: http://glovis.usgs.gov; http://glcf.umiacs.umd.edu.

As basis for classification of land cover the Landsat images of 172/13 were mainly used. The total list of images for land cover dynamic analysis includes 11 images for time period from 1974 to 2007.

i. Landsat MSS (170/13), GeoTiff; 1974-Jun-22. The moderate cloud is only in lower left corner

ii. Landsat TM (171/13), GeoTiff; 1984-Jul-31. The 25% of image (upper left part) covered by cloud
iii. Landsat TM (170/12), 1988- Jul-11. GeoTiff; mainly clear from clouds, only upper left corner (<1%)
iv Landsat TM (171/13) GeoTiff; 1988-Aug-3, 2% of cloud cover
v. Landsat ETM+ (171/13), 2000-Jun-01, GeoTiff; 25% down left part with clouds
vi. Landsat ETM+ (171/13), 2000-Jul-19, GeoTiff; 2% cloud cover
vii. Landsat ETM+ (171/13), 2004-Jul-14, GeoTiff; 25% of lower part and 6% of the upper part with clouds.
viii. Landsat TM (172/13) GeoTiff; 1988- Aug-2, no clouds
ix. Landsat ETM+ (172/13) GeoTiff; 2000- Jun -8, no clouds.
x. Landsat TM (172/13) GeoTiff; 2007- July-18.
xi. Landsat TM (171/13) GeoTiff; 2007- July-15.

Google Earth was used for general reference for estimation of vegetation and changes and for accuracy assessment.

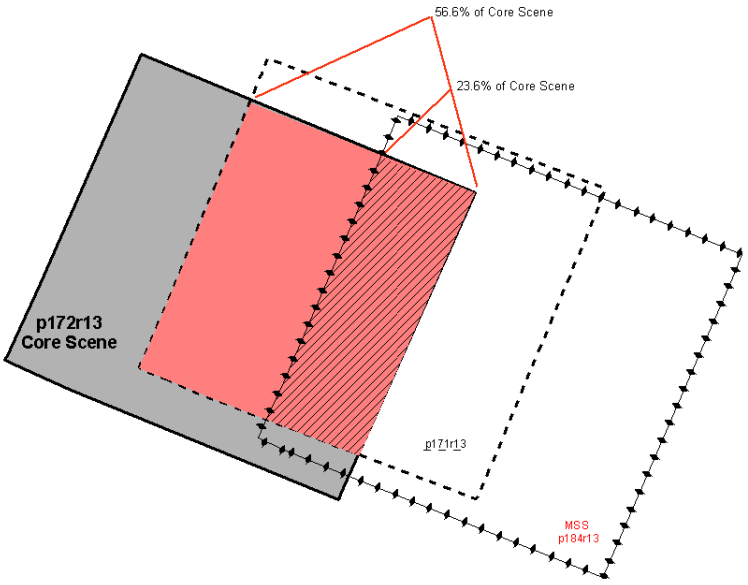


Fig.2. The Distribution of Landsat images

3. Ground Data.

a) forest-inventory data for Muntno-Materikskoe and Ust'-Usinskoje forestry units of Komi Republic. The digital map of forest polygons (woodlots) were combined with attributive data (forest types, dominant tree species, site conditions, tree age and density, etc.) (Fig.3). Forest Inventory was carried out by Northwestern Forest inventory Enterprise in 1990. The total number of map polygons obtained: Muntno-Materikskoe – 4288 polygons. Each polygon was assigned NELDA legend class based on their attributes.

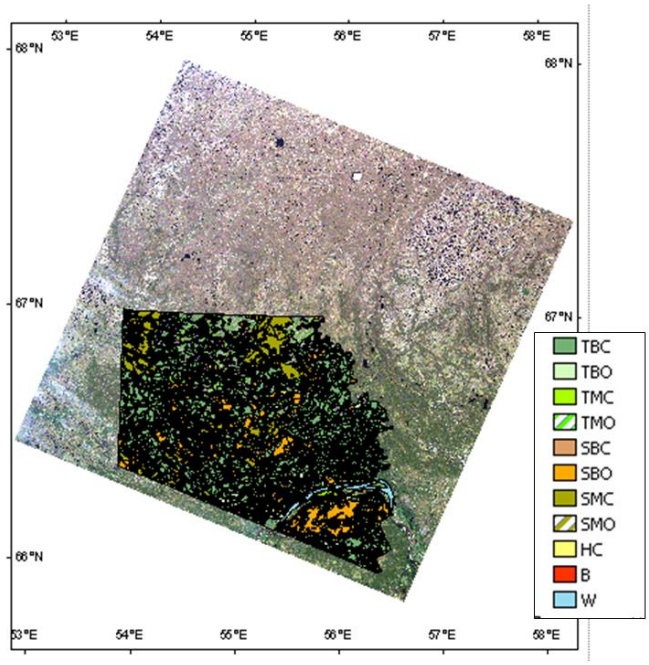


Fig. 3. The combination of inventory contours and satellite image.

b) For three additional sites detailed field observations were performed (Appendices, Fig 2). The species composition of vascular and spore plants, total and projective coverage was measured in 25 m^2 plots. The herbarium material was collected for further analysis in lab. The total number of description was 78. The analysis of flora of this area allowed finding 107 species of vascular plants and 67 species of lichens. The low reindeer grazing intensity (the pasturs of biggest European reindeer farm «Izemskii olenevod») on the studied area was noted, it occurs in shrub-tundra communities (20% of area). At the same time ecotopes of eluvial groups of landscape located on watersheds with spotted dwarf-shrub tundra (4.2%) are the most sensitive to grazing damages. Decrease of abundance of common prevailing lichens (*Cladonia arbuscula, C.rangiferina)* is observed in these communities. The main producers of biomass are *Cladonia uncialis*, *C.amaurocraea*, *Flavocetraria nivalis*. The destruction of moss cover and increase of portion of lichens with poor nutrient quality (*Bryocaulon divergens*, *Alectoria ochroleuca*, *A.nigricans*, *Sphaerophorus globosus*, *Thamnolia vermicularis*) are observed on sites exposed to most intensive influence of reindeers (grazing). The presence of disturbed vegetation is mainly related with oil-gas fields and activity of extraction and transportation companies.

c) Quickbird images (from Google Earth) were used to supplement ground points for land cover classes poorly represented by other data sources(2005-Sep-5; 2003-Jun-3; 2007-June-28).

4) Land Cover Map

Formatted: English (U.S.)

Class	Code	Definition
Tree.Broadleaved.Deciduous .Closed	TBDC	Vegetation height greater than 3m with the main layer consisting of broadleaved deciduous woodland with crown cover greater than 65%.
Tree.Broadleaved.Deciduous .Open	TBDO	Vegetation height greater than 3m with the main layer consisting of broadleaved deciduous woodland with a crown cover 15-65%.
Tree.Mixed.Closed	TMC	Vegetation height greater than 3m with no dominant woodland type and crown cover greater than 65%.
Tree.Mixed.Open	TMO	Vegetation height greater than 3m with no dominant woodland type and crown cover 15-65%. Tree-stands dominated by *Picea obovata* (10-30%); verage height 8-15 m mixed with *Betula pendul*, shrubs (*Salix* sp., *B.nana*), low-shrub (*Vaccinium myrtillus, V. uliginosum*) and lichen-moss levels are developed. On sand soils dominated lichens *Cladonia stellaris, C. rangiferina,C.arbuscula* and other. The moss cover close. It composite *Pleurozium schreberi* и *Hylocomium splendens* and *Polytrichum commune.*
Shrub.Broadleaved.Closed	SBC	Vegetation height 0.5-3m with main layer of shrub species with less than 15% tree crown cover. The height of *Betula tortuosa* trees – 1.5-2.5 m with dwarf-shrub layer (*Arctous alpina, Empetrum hermaphroditum, Vaccinium vitis-idaea, V. uliginosum).* Grasses and herbs are xero-mesophytic: *Achillea millefolium, Antennaria dioica, Armeria scabra, Eremogone saxatilis, Festuca ovina, Tanacetum bipinnatum.* In the soil cover lichens dominate - *Cladonia arbuscula, Cetraria islandica, Stereocaulon paschale.*
Shrub.Broadleaved.Open	SBO	Projective cover of shrubs (*B.nana*) 40-60%, height 0.3-0.7 m. In dwarf-shrubs level mainly *V. myrtillus* and *V. uliginosum*; In grass several species of herbs and grasses – *Bistorta major, B. vivipara, Calamagrostis lapponica, Chamaenerion angustifolium, Chamaepericlymenum suecicum, Solidago virgaurea, Veronica longifolia.* In the ground cover dominate mosses – *Hylocomium splendens* and *Pleurozium schreberi.* Occurs on slopes.
Shrub.Mixed.Open	SMO	In shrub level (0.3-0.5 m, projective coverage 30-60%) are presented the *Salix* sp. and *Juniperus communis. Sparse* tree-stand consists of *Picea obovata and Betula* sp.The mosses and dwarf-shrub layer had high projective cover. The dwarf-shrub layer with *Arctous alpina, Empetrum hermaphroditum, Vaccinium vitis-idaea, V. uliginosum.* In the soil cover lichens dominate - *Cladonia arbuscula, Cetraria islandica, Stereocaulon paschale.*
Herbaceous.Closed	HC	The species composition is mono dominated (2-9 species). Total projective coverage is 70-90%. The composition includes Carex *aquatilis* (mainly), *Eriophorum* sp. (*E.vaginatum*, E. *E.scheuchzeri*, *E.russeolum*), *Comarum palustre*. Mainly found in littoral zone (5-10 m near border of lakes) and wetland depressions. Also on watershed areas on peat substrates includes herbaceous: *Carex* sp., *Eriophorum* sp. and dwarf-shrubs (*Vaccinium* sp., *Rubus shamaemorus*). The cover of lichens is low.

Herbaceous.Open	HO	The communities are developing in slopes, flood-lands or in places with lately melting snow. The height of herb layer is 0.3-0.7 m. The Herbaceous are absolutely dominant and include: *Achillea millefolium, Antennaria dioica, Armeria scabra, Bartsia alpina, Bistorta major, B. vivparum, Campanula rotundifolia, Dianthus superbus, Equisetum arvense, Festuca ovina, Filipendula ulmaria, Galium boreale, Hieracium alpinum, Myosotis palustris, Rubus arcticus, Rumex acetosa, Saussurea alpina, Solidago virgaurea, Stellaria palustris, and others.*
Bare Land	B	Primarily non-vegetated areas containing less than 5% vegetation cover during at least 10 months per year.
Bare Land with Sparse Vegetation	BSV	Sparsely Vegetated (Vegetation < 15% and > 5%) during at least 10 months per year.
Water	W	Perennial natural water bodies where water is present over 11 months per year.

Wetland was included in land cover classification as an additional distinction in all classes except tree closed and water; " W " was used as a code for this additional distinction.

Tundra was included as an additional distinction in the following Herbaceous Open and Shrub Mixed Open classes. Tundra plant communities of dwarf-shrub type are dominated by *Empetrum hermaphroditum* and *Arctous alpinaand* are most common in this region. This type occurs on hills, usually on sand. In this tundra common species are *Arctous alpina, Ledum decumbens, Salix numullaria, Vaccinium vitis-idaea, V. uliginosum, Festuca ovina.* Dominating mosses are *Aulacomnium turgidum and Polytrichum.* There are many lichen species – *Alectoria nigricans, Al. ochroleuca, Bryocaulon divergens, Bryoria nitidula, Cetraria islandica, C. nigricans, Flavocetraria cucullata, Fl. nivalis, Cladonia arbuscula, C. rangiferina, C. amaurocraea, etc*.

b) Imagery pre-processing

The landscapes and vegetation distribution analysis was based on Landsat ETM+ satellite image (path 172, row 13 for dates Aug-2-1988, Jun-8-2000, UTM projection, zone 40). The geographical, radiometric and atmosphere correcting were done in accordance with common procedure (Kennedy & Cohen, 2003; Chavez, 1996; Canty et all, 2004).The 3, 4 and 5 channels of Landsat images of 172/13 (1988-Aug-2 and 2000-Jun-8) are used for land cover classification.

The pre-processing methodic references:

Kennedy, R.E., & Cohen, W.B. 2003. Automated designation of tie-points for image-to-image coregistration. International Journal of Remote Sensing, 24: 3467-3490.

Chavez Jr., P.S. 1996. Image-based atmospheric corrections – revisited and improved. Photogrammetric Engineering & Remote Sensing 62: 1025-1036

Canty, M.J., Nielsen, A.A., & Schmidt, M. 2004. Automatic radiometric normalization of multitemporal satellite imagery. Remote Sensing of Environment, 91: 441-451.

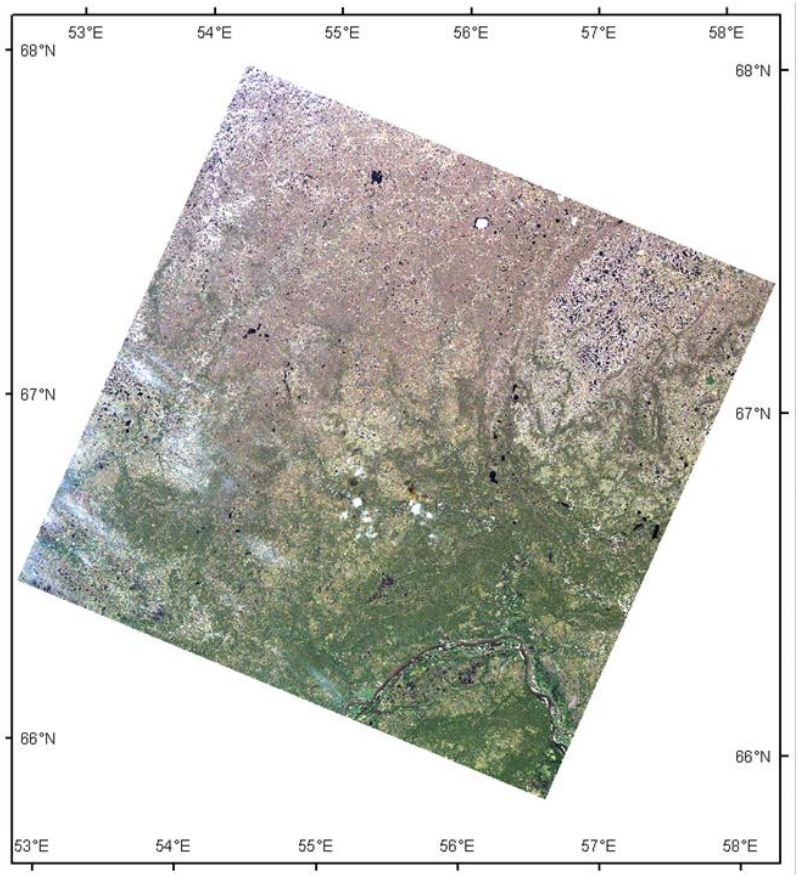


Figure. 4. The preview of Landsat ETM+ 8- June- 2000 (R:Band3, G: Band2, B: Band1), UTM projection, zone 40

c) Masks. Clouds/Shadows

In Jun-8-2000 image (path 172, row 13) there are we have only few clouds in central part – for this area we used inserts from Aug-2-1988 images.

d) Image classification For classification the channels of images were combined (Layer Stack operation); supervised classification method was performed (Erdas Imagine 8.5) using the detailed maps from field sites (Attachment Figure 2) to guide the classification. The evaluation of results showed that supervised classification failed to adequately identify several tree-dominated classes that were in fact present at the test site (Tree Broadleaf Closed, Tree Broadleaf Open, Tree Mixed Closed). We used unsupervised classification of pixels previously assigned to shrub and tree classes to identify the missing tree-dominated classes. The labeling of "wet" distinction was retained from the initial map. The resulting map had 13 classes; adding "wet" distinction results in 25 classes total.

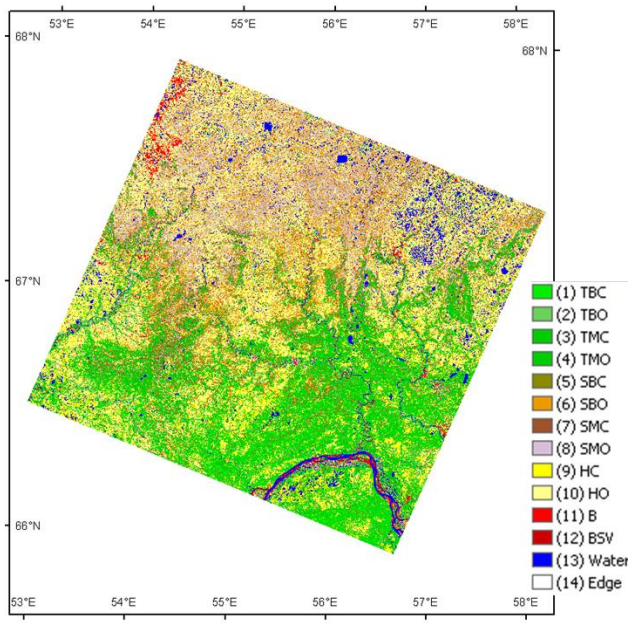


Figure 5. The classified Landsat image (172_013, 8- June- 2000).

Peder, please add maps for wet classes only and for tundra.

e) Accuracy assessment. The total number of accuracy points needed was determined based on area distribution by legend classes:

Table 1

Legend Classes*	% area	Percent of 300 points	Minimum number of points needed	Total Points Selected
TBC	5.02	15.05	30	34
TBO	3.77	11.31	30	59
TMC	2.38	7.14	30	33
TMO	18.35	55.05	55	171
SBC	4.59	13.78	30	18
SBO	12.11	36.34	36	14
SMC	4.71	14.14	30	19
SMO	9.23	27.70	30	35
HC	6.78	20.33	30	32
HO	26.59	79.76	80	
B	1.49	4.47	30	57
BSV	0.32	0.96	-	
WATER	4.66	13.97	30	39
TOTAL		300	441	524

*See class definitions in legend description

For purposes of accuracy assessment, we combined “Bare” and “Bare-Sparse Vegetation” classes in a single class and tested the distinction between “wet” and “non-wet” types separately from the rest of the legend using additional 60 points.

Accuracy points were derived from two sources: forest inventory polygons and Google Earth Quickbird imagery. First, the forest inventory polygons of Mutno-Materikskii leskhoz were registered to the Landsat imagery. Second, very small polygons (<1 ha) were eliminated to avoid registration problems and very large ones (>100 ha) were eliminated as well since class labeling for these polygons is ambiguous. We also removed from the dataset the polygons for which available information was insufficient to define a specific NELDA legend class. The resulting forest inventory dataset contained 320 polygons with "observed" class derived from forest inventory data and "predicted" class determined based on map labels of pixels within the polygon. The predicted label reflects the proportion of different cover types based on NELDA hierarchical classification system rather than the majority rule. One additional polygon with ambiguous "predicted" label was eliminated. Accuracy points derived from forest inventory were weighed heavily towards "tree-mixed-open" class, and these were supplemented by 204 random points within Google Earth Quickbird imagery to ensure proportional representation of map classes.

Formatted Table

Formatted: Centered

		Observed Class (Accuracy Points)						
		B	H	S	T	W	Sum	Comission
Map Class	B	**41**	10			1	52	21.2%
	H	15	**14**	1	12	3	45	68.9%
	S	1	8	**39**	8		42	40.5%
	T			22	**289**	1	303	4.6%
	W				2	**34**	36	5.6%
	Sum	57	32	39	311	39	**524**	
	Omission	28.1%	56.3%	35.9%	7.1%	12.8%		

Agreement = 417 / 524 = 79.6%

kappa 0.686192

		Observed Class (Accuracy Points)												
		B	HC	SMO	SMC	SBO	SBC	TBC	TBO	TMC	TMO	W	Sum	Comission
Map Class	B	**41**	10									1	52	21.2%
	HC	15	**14**	7				6		6		3	51	72.5%
	SMO	1	4	**15**				8					28	46.4%
	SMC				**19**								19	0.0%
	SBO					**10**							10	0.0%
	SBC		4				**13**						17	23.5%
	TBC			13			5	**18**		6		1	43	58.1%
	TBO					4			**48**		8		60	20.0%
	TMC								**11**	**21**			32	34.4%
	TMO										**171**		171	0.0%
	W							2			5	**34**	41	17.1%
	Sum	57	32	35	19	14	18	34	59	33	184	39	**524**	
	Omission	28.1%	56.3%	57.1%	0.0%	28.6%	27.8%	47.1%	18.6%	36.4%	7.1%	12.8%		

Agreement = 404 / 524 = 77.0%

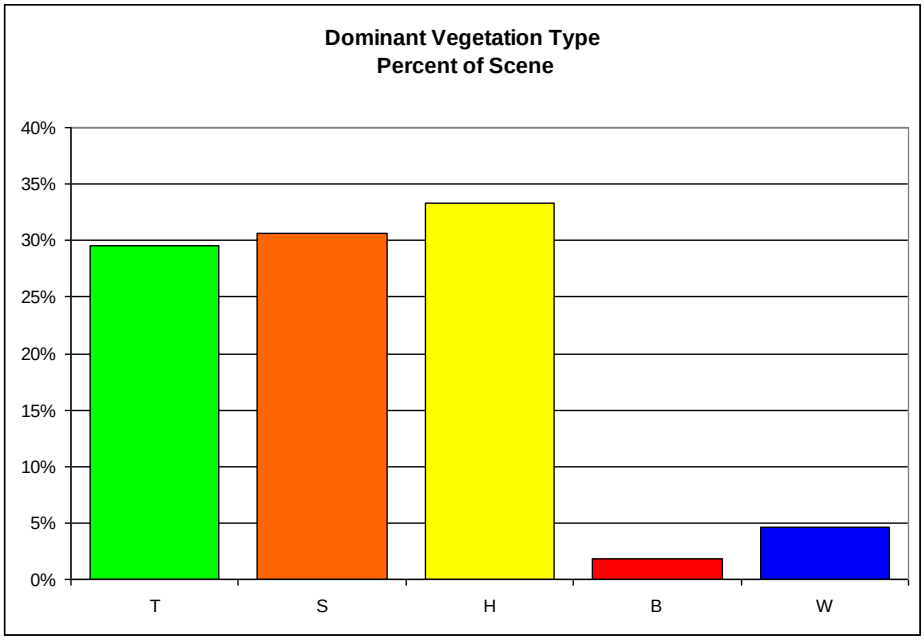
		Forest Inventory			
		Wetland	non-Wetland	sum	Comission
	Wetland	81	10	91	11.0%
	non-Wetland	5	239	244	98.0%
Map	sum	86	249	335	
	Comission	5.8%	96.0%		

Agreement =
320/ 335 = 95.50%
kappa = 0.91

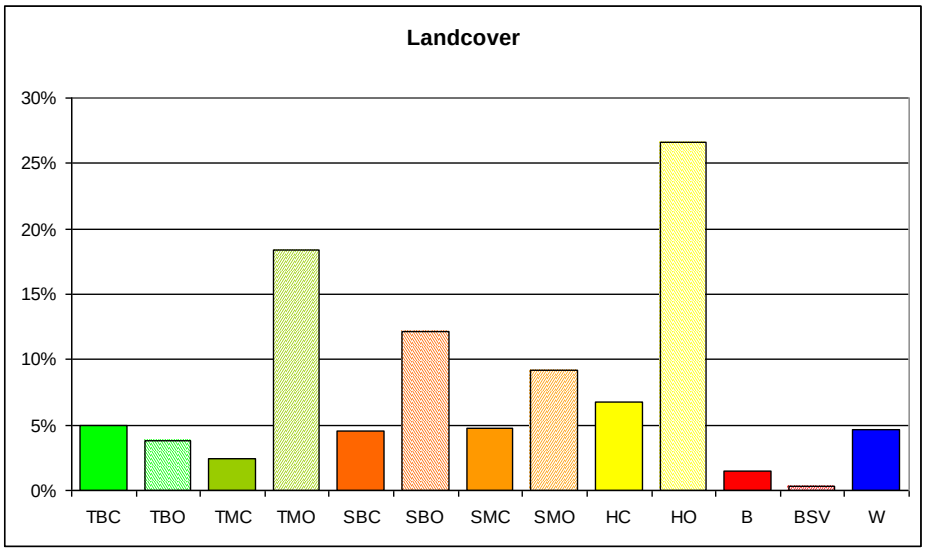
Formatted Table

Formatted: Right

*f) **Mapping results***



Distribution of dominant vegetation type.



Distribution of NELDA legend classes.

5) Land Cover Change

Land cover change was examined over 3 time periods (1988-2000, 2000-2004 and 2004-2007) for the intersection of the imagery.

To detect changes in ecosystems per observation period the *Disturbance Index, DI* was calculated (Healey et.al., 2005):

$DI = B_r - (G_r + W_r)$. (1),

where the B_r, G_r, W_r – scaled values of Brightness, Greenness и Wetness, after transformations:

$B_r = (B - B_m) / B_\sigma$

$G_r = (G - G_m) / G_\sigma$ (2),

$W_r = (W - W_m) / W_\sigma$,

and B, G, W – values pixels; B_m, G_m, W_m – average 'tree' values and B_σ, G_σ, W_σ – standard deviation of 'tree' values. The values of B, G and W are derived after standard Tasseled Cap procedures (King et.al., 2001; Huang et.al., 2001).

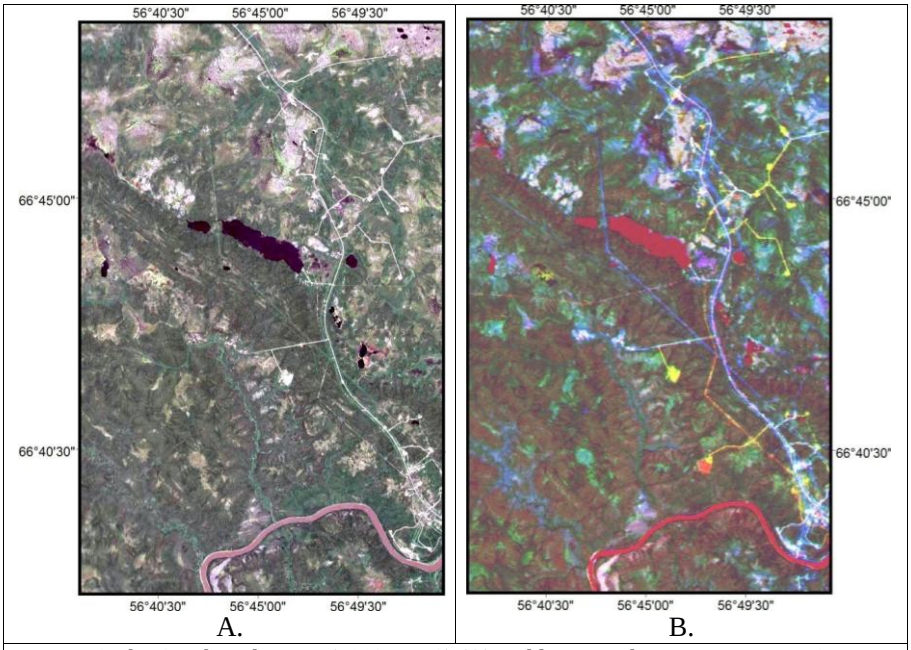


Fig 8.The QuickBird image (2003-Jun-3) (A) and layer stack images DI into RGB-synthesis R: DI 2007-Jul-6 G: DI 2004-Jul-14 B: DI 1988-Aug-3 (B).

The main part of disturbances was done in period of 2004-2007 year (1.1km^2) and was related with gas-oil drilling sites construction, organization the transport infrastructure. For the small oil deposits the changes was not so strong and main effect was related with transport infrastructure development. Main part of disturbances was related with creeper tractor or land cars using. In non snow time the using of that machine are limiting by administration. The single passage of most light machine GAS-71 is effect to soil cover with pressure 0.47 kg/cm^2 (Gruzdev, Umnjachin, 1984). Three-four passages are absolutely destroying the vegetation-soil cover. Sometimes the tracks are initiated the termocarst processes developing. In the forest ecosystems (North taiga zone) timber harvest is restricted and very small areas were harvested.

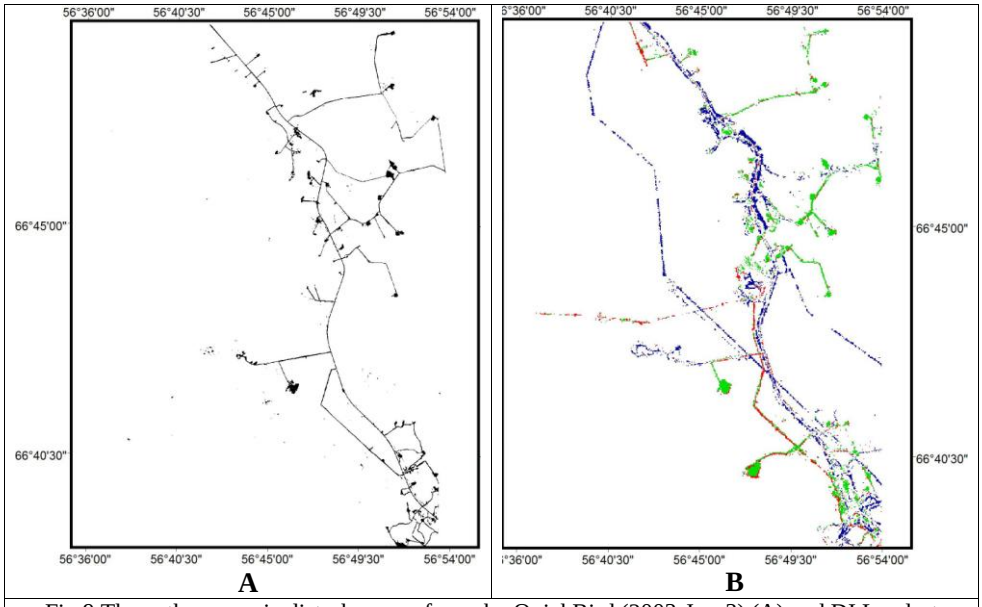


Fig 9.The anthropogenic disturbances of area by QuickBird (2003-Jun-3) (A) and DI Landsat image (1988-2007). The blue collar disturbances in all years, green - 2004, red – 2007 (B).

Total comparison of changes maps of Landsat and QuickBird data demonstrated high level of covariance (86%) (Table 2).

Table 2. The Accuracy assessment of changes map

	QuickBird 2003			
Landsat DI	Undisturbed	Disturbed	Sum	User's accuracy
Undisturbed	95.9	24.5	120	79.6
Disturbed	3.5	72.8	76	95.5
Sum	99	97	197	
Producers's acurracy	96.5	74.8	total =	85.8%
			kappa =	71.5%

The accuracy could not be evaluated by individual time interval using a single QuickBird scene.

7) Publications using site data

NELDA – other publications and presentations

i) Elsakov V.V. 2005 Remote sensing monitoring of plant cover disturbances in oil deposits // Modern problems of Remote sensing Earth from Space. Articles of conference. Moscow, Institute of Space research, 2005. Pp. 152-155.

Formatted: English (U.S.)

ii) Elsakov V.V., Taskaev A.I. Geoinformation technology in fundamental and applied investigation of ecosystems of Timan-Pechora oil-gas province // Article of VIII Scientific conference of thematically mapping: «Geoinformation mapping for balanced territorial development». Novosibirsk, 2006. Pp. 128-129.

iii) Elsakov V.V. 2007 Satellite monitoring in investigation of spatial and temporal changes of phytosystems of European tundra communities // Articles of international conference «Modern plant physiology: from molecules to ecosystems». Part 3. Syktyvkar, 2007. Pp.27-28.

iv) Elsakov V.V., Deneva S.V. Estimation of spatial distribution of polluting substanses in technogenic landscapes of Srednecharjaginskoe oil field // Modern problems of soil pollution. V2. Moscow, 2007. Pp. 52-55.

v) Elsakov V.V. Satellite monitoring in ecological research of Komi Republic oil deposits // Articles of IV scientific conference « Return aims and information technology of rational nature management». Chanty-Mansiisk, 2008. Pp. 164-167.

8.) Acknowledgements

a.NASA LCLUC Program (NAG5 – 11250)

b.US NASA and of START secretariat

c.«The development of remote sensing methods for monitoring of biodiversity and productivity of reindeer pastures in Northeast European Russia» (2004-2006) Funding: Russian Found of Fundamental Research (04-04-96014).

APPENDICES

Table.1 The stages of revegetation in observation area (According: Gruzdev, Martynenko, 1994).

stages	Stages and, period after disturbances, year	Main characteristic	Images
1	Pioneer stage, 2-6	Revegetation by separate specimen of *Tripleurospermum perforatum, Equisetum arvense, Senecio congestus, Chamerion angustifolium,* in wet tracks - *Eriophorum scheuchzeri. In peat area the revegetation process has some specific. More active in that places Polytrichum species of mosses,* ***Rubus chamaemorus*** *in depressions - Eriophorum scheuchzeri, Carex aquatilis* S. congestus.	
2a	bunch-grasses stage, 8-12	The grass cover form mainly grasses: *Poa pratensis, Calamagrostis lapponica, Deschampsia cespitosa, Festuca ovina* and other.	
2б	Densely – grasses stage, 12-16		
3	Shrubby stage, above 16 years	*The* shrubby *cover formation from Salix species (S.phylicifolia, S.lanata end other.), Betula nana,* in lower layer - epigeous grass-moss cover.	

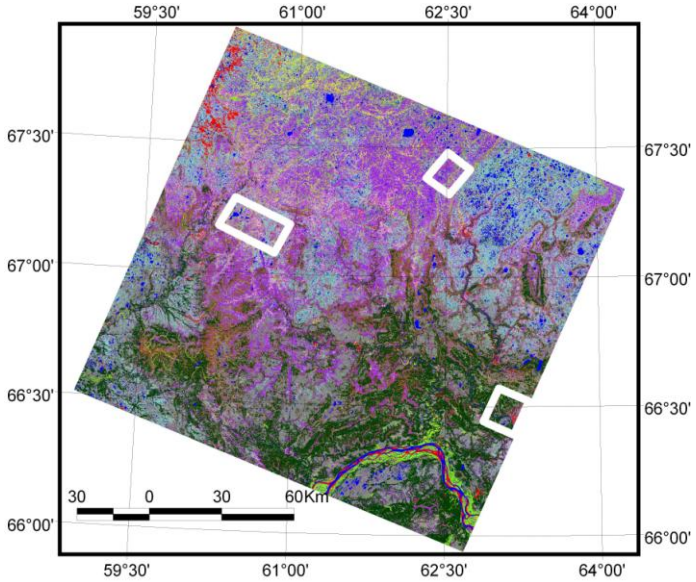


Fig. The land-cover classification of area accordance with LCCS legend.
The three plots of field work are presented: 1 – Vozeiskoe oil deposit (Harjaha), 2 – Juznoe Shapkino, 3 – Srednaja Charj

Table 3. Diagnostic table of vegetation communities groups.

	HCW		HOS	HCNW	SBCNW	B	HO	SBO	SBCW	TNEO	SMO
Species/code of communities.	A	B									
Total coverage, %	90	100	80	100	95	0-40	90	100	90	100	100
Trees	-	-	-	-	40					50	40
bushes	-	-	5	10	20			50	75	20	40
Low dwarf-shrub	-	-	20	30	20	<3	5	10		15	10
Grass	50-90	50	10	10	15	5	60	5	10	5	5
Mosses	50-10	50	20	60	40		5	10	10	15	30
Lichens			30	5	10			10	5	10	20
Picea obovata Ledeb.										3	2a
Betula tortuosa L. or *B.pubescens*					3					2b	
Salix sp.					1	+			4		3
Ledum decumbens (Ait.) Small			r	r-2b	2a						
Betula nana L.			1-2a	1-2a	2a			1		2a	1
Vaccinium uliginosum L.		r	r-1	5	2a			1		2a	2a
Andromeda polifolia L.		+		r	1				1		
V.vitis-idaea L.			1	1	2a			1		1	1
Empetrum nigrum L.			2a	2b	2a			1		1	
Carex aquatilis Wahl.	4-5	3					2	+	2a		
Comarum palustre L.	2a								1		
Caltha palustris L.	1										
Eriophorum sp.	+	1			1	1	1	1	1		
C.rotundata Wahl.		1									
C.rariflora (Wahl.) Smith		2b		+							
Calamagrostis purpurea (Trin.) Trin.			+		1	1-2b	4				
Chamaenerion angustifolium (L.) Scop						2a					
Rubus chamaemorus L.			r-1	[r]-2a		+					
Sphagnum sp	1	3		r-2a					3		
Drepanocladus sp.			1-3	2a-3	3			3			
Polytrichum sp.			2b-3	1-2b	3	+					
Dicranum spadiceum Zett.			1-3	3-4	2						
Sphagnum.capillifolium (Ehrh.)Hedw.			2b	1-2b							
Flavocetraria cucullata (Bellardi) Ach.			1	r-+							
Cetrariella delisei (Bory ex Schaer.)			+	+-1							
Cladonia arbuscula (Wallr.)Flot.			r-+	r-1							
Cetraria islandica (L.)Ach.				r-+							
Cladonia amaurocraea (Florke)Schaer.				r-1							

The percent coverage of plant species (%) in these plots was estimated in the middle of vegetation season. Diagnostic (or synoptic) table for the vegetation classes is in Appendices **(**table 4). Roman numbers indicate classes of cover: I – <20 %, II – 21-40%, III – 41-60%, IV – 61-80%, V – 81-100%. Arabic numbers indicate range of cover values. Percentage cover of each taxon was estimated using the following variant of the Braun-Blanquet scale: “r” << 1%, “+” < 1%, “1” 1-5%, “2a” 6-12.5%, “2b” 12.6-25%, “3” 26-50%, “4” 51-75%, “5” 76-100%.