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**To the question of the environmental education:  
how Landsat TM, ETM+ and MSS images  
can be processed by GIS-techniques  
for geospatial research**

Trends and Perspectives in Creating  
Regional Systems of the Additional Education of Adults

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## Introduction

- Research Summary

- Study Area

## Yamal Peninsula: Geographic Settings

- Climate and Environment

- Landscapes

## Methodology

- Minimum Distance Method

- Workflow

- Data Import and Conversion

- Data Georeferencing

- Supervised Classification

## Results

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- Mapping

- Comments

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## Discussion

## Conclusion

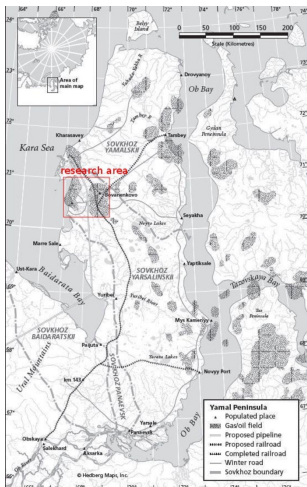
## Thanks

## Literature

## Bibliography



- ▶ GIS and RS application for environmental studies of Yamal
- ▶ Calculation of NDVI
- ▶ Monitoring vegetation changes in tundra landscapes
- ▶ Analysis of the vegetation dynamics in the past two decades (1988-2011).
- ▶ Data: Landsat TM scenes for 1988, 2001 and 2011
- ▶ Originality: Application of ILWIS
- ▶ GIS spatial analysis tools and Landsat imagery
- ▶ Area: Bovanenkovo region in Yamal Peninsula, Russian Extreme North



Geographic location: Yamal Peninsula, north Russia. (a) Geographic location of Yamal (b) Location of the study Peninsula  
Map source: google.com area on Yamal (western coast).

Source: B. Forbes

Yamal Peninsula: geomorphology : flat geomorphology, elevations lower than 90 m

Processes:

- ▶ seasonal flooding,
- ▶ active erosion processing,
- ▶ permafrost distribution,
- ▶ cryogenic landslides formation

Landslides affect local ecosystem structure.

Landslides change vegetation types recovering after the disaster.

Landscapes of Yamal.



Source: <http://pixtale.net/>



Yamal shrub tundra.

Source: [www.novaonline.nvcc.edu/](http://www.novaonline.nvcc.edu/)



Dwarf willows. Source:  
[www.travelanguist.com](http://www.travelanguist.com)



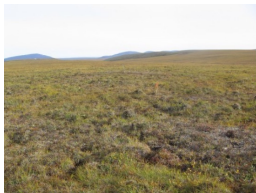
Arctic willows:

Source: <http://nature-plants.com>



Sparse short shrub

Source: [www.polarfield.com](http://www.polarfield.com)



Dry grass heath tundra (left). Sedge grass tundra (center). Dry short shrub tundra (right)



Landscapes of Yamal (left). Sphagnum moss (right)



Dry short shrub sedge tundra (left). Wetlands (right)



Short shrub tundra



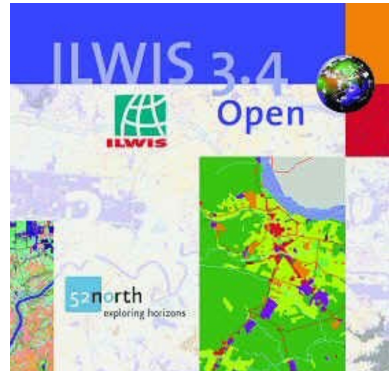
Technical tools: The RS data processing was performed in ILWIS GIS software.

Research Methods:

- ▶ Image interpretation (Landsat TM scenes).
- ▶ Supervised classification

Following working steps summarize research scheme used in this research:

- ▶ Data pre-processing
- ▶ Creation of image composites of several bands
- ▶ Supervised classification using various classifiers
- ▶ Spatial analysis and interpretation of the results
- ▶ Time series analysis for detecting changes
- ▶ Final GIS mapping



ILWIS GIS:

<https://52north.org/software/software-projects/ilwis/>



Calculation of vegetation indices, especially and in this case Normalized Difference Vegetation Index (NDVI), has become one of the most successful, popular and traditional attempts in biogeographical research methods.

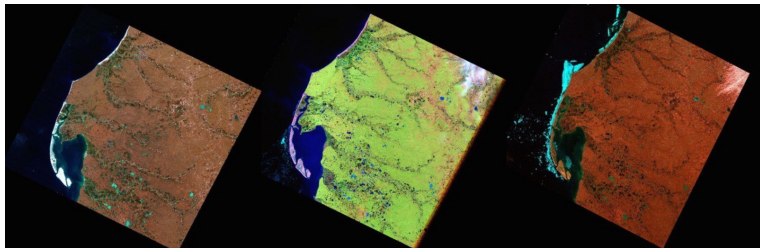
- ▶ The principle of Minimum Distance method used for classification is based on the calculating of the shortest straight-line distance in Euclidian coordinate system from each pixel's DN to the pattern pixels of land cover classes.
- ▶ The main weakness of the supervised classification method is caused by modeling approach and technical details of image recognition, i.e. errors in pixels classification.
- ▶ The misclassification by the Minimum Distance method may occur due to the ambiguity and erroneous recognition of some of the pixels as well as insufficient representation of classes.



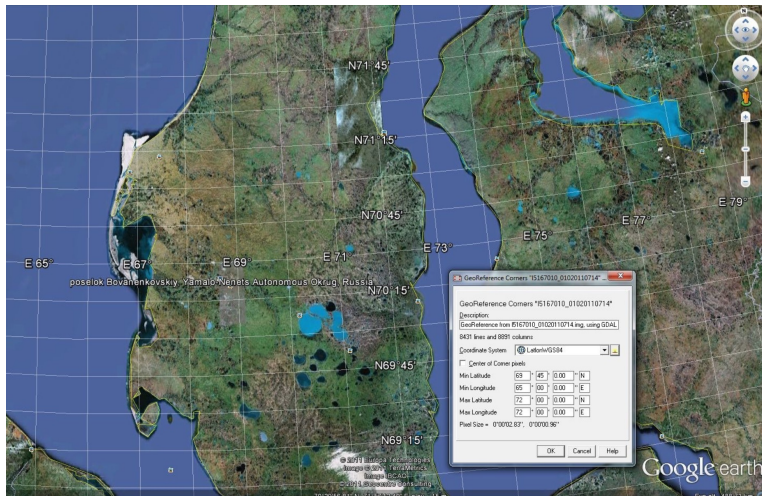
## Data pre-processing

- ▶ import .img into ASCII raster format (GDAL). After converting, each image contained collection of 7 raster bands
- ▶ Pre-processing (visual color and contrast enhancement)
- ▶ Geographic referencing of Landsat scenes, initially based on WGS 1984 datum: UTM (Universal Transverse Mercator) Projection, Eastern Zone 42, Northern Zone W, (Georeference Corner Editor)
- ▶ Crop of study area: the area of interest (AOI) was identified and cropped on the raw images. This area shows Bovanenkovo region in a large scale and best represents typical tundra landscapes.
- ▶ Supervised Classification vi.GIS visualization and mapping

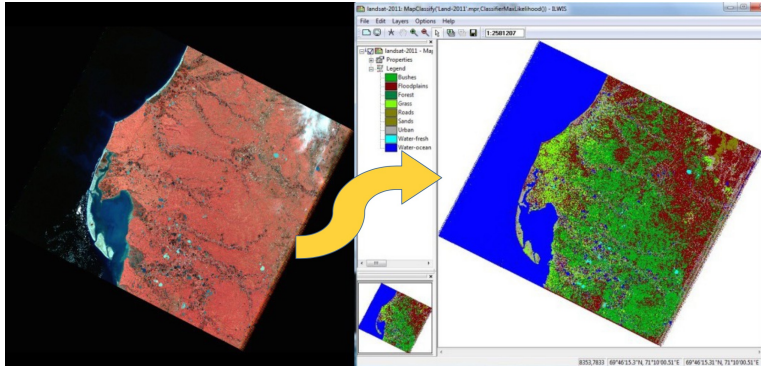
- ▶ Test area selection (Mask):  $67^{\circ}00'$  -  $72^{\circ}00'$  E -  $70^{\circ}00'$  -  $71^{\circ}00'$  N.
- ▶ 3 selected Landsat TM satellite images show Yamal region in 1988, 2001, 2011.
- ▶ Time span: 23 years (1988, 2001, 2011).
- ▶ Summer months selected for vegetation assessment.
- ▶ Data conversion / original images in format .TIFF converted to Erdas Imagine .img.



Initial remote sensing data, left to right: Landsat TM 1988, bands 7-3-1; Landsat TM 2011, pseudo natural colors composite; Landsat ETM+ 2001 bands 6-3-1.



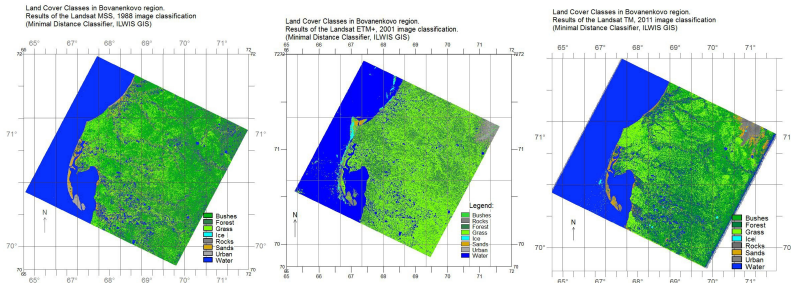
# Supervised Classification of the Landsat TM Image



# Computing Pixels on Various Land Cover Classes



Land Cover Class	Brief Description	No of Pixels	Landsat TM: natural color composite	Landsat TM: false color composite
Grass	Sparse vegetation with low density	22	Light greenish	Light dull bordeaux to dark pinkish
Bushes	Dense vegetation coverage	16	Green, smooth texture	Dull red
Forest	Forest canopy	73	Camouflage green	Dark bordeaux
Urban areas	Human settlements (towns, villages)	10	Grey and greenish grey	Violet and lilac
Fresh water	Rivers and lakes	332	Navy blue	Soft-to dark blue
Salt water	Ocean	5295	Dark blue	Almost black
Flood plains	River flood areas, alluvial land	4	Dark grey	Brownish red
Roads	Road network	3	Steel grey, slightly purple	Dark brown
Sands	Exposed sands, rocks & soils without vegetation	114	Light aquamarine	Light rose, pink



Results show classified maps of the selected region of Bovanenkovo on 1988, 2001 and 2011 yr (from left to right). GIS mapping is performed using image classification. Results of the supervised classification show 3 maps of the vegetation distribution (above).





Classification is based on the relationship between the spectral signatures and object variables, i.e. vegetation types. Water areas are defined as “no vegetation” class.

## 1988

For year 1988 “forest” class covered 8,188,926 pixels, which is 11,32% from the total amount.

## Examples

1988: Maximal area, except for water, is covered by the shrubland (15,29% from the total).

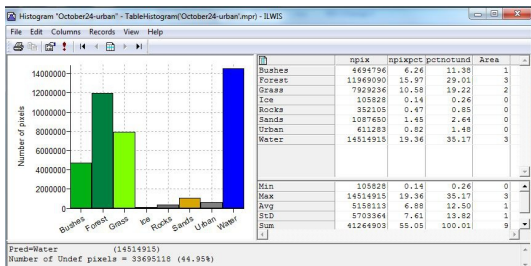
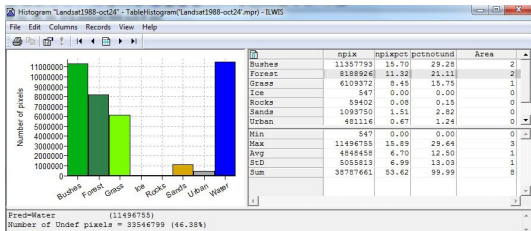
## 2011

For year 2011, the percentage of the shrubland decreased down to 6,26%, while area of forests increased from 11,32 to 15,97%.

## Examples

2011: The area of grass remained relatively stable with values slightly increasing to about 2%

Histogram for supervised classification of Landsat TM image, 2011.





- ▶ This research presented GIS based studies of the environment of Yamal Peninsula
- ▶ The study is technically based on ILWIS GIS, effective tool for spatial analysis
- ▶ The results of the spatial analysis are presented as 3 GIS maps illustrating changes in vegetation based on the image analysis using Landsat TM.
- ▶ Calculated land cover changes indicated vegetation dynamics in years 1988, 2001 and 2011.
- ▶ Application of the RS data is especially important for studies of the northern ecosystems, because it enables studying remotely located areas of Arctic
- ▶ GIS-based processing of the RS data (Landsat TM) improves technical aspects of the landscape studies and monitoring
- ▶ The results show successful use of ILWIS GIS software for spatio-temporal classification of the satellite images aimed at ecological mapping.

## Time-Series Analysis

Remote sensing plays important role in land use studies and serves as a valuable source of spatial information for the time series analysis.

## ILWIS GIS

Using enhanced ILWIS GIS tools to analyze and process satellite imagery contributes to the environmental analysis of the land cover changes. The classification used in the current work is pixel-based aimed to allocate and categorize pixels on the image to the created classes.

## Examples

Remote Sensing: While traditional methods for vegetation monitoring are fieldwork and ground surveys, usually performed in large-scale areas, the use of remote sensing techniques enables to monitor extended areas in a small scale, as well as to assess temporal changes.



*Thank you for attention !*

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