

Innovations in the Geoscience Research: Classification of the Landsat TM Image Using ILWIS GIS for Geographic Studies

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Summary

Research Aim

Analysis of the vegetation dynamics in the past two decades (1988-2011).

Research Goals

Calculation of NDVI. Monitoring vegetation changes in tundra landscapes

Data

Landsat TM scenes for 1988, 2001 and 2011.

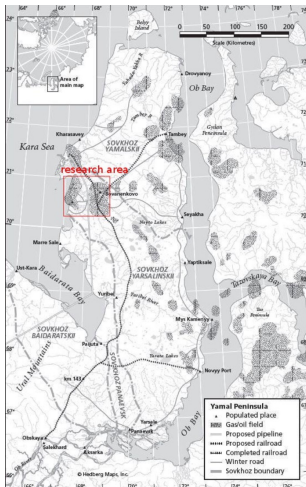
Approach

GIS spatial analysis tools and Landsat TM imagery. GIS and RS application for environmental studies of Yamal. Application of ILWIS GIS.

Examples

Area: Bovanenkovo region in Yamal Peninsula, Russian Extreme North

Study Area



Geographic location: Yamal Peninsula, north Russia.

- Geographic location of Yamal Peninsula (western part)
 - Study area: Yamal Peninsula.
- Map source: Web.

Source: B. Forbes

Yamal Peninsula:

Examples

Specific Problems: Seasonal flooding, seasonal flooding, permafrost distribution, cryogenic landslides formation

Geomorphology

Flat relief, elevations < 90 m.

Landslides

Affect local ecosystem structure. Landslides change vegetation types recovering after the disaster.

Landscapes of Yamal.



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

Landscapes of the Yamal Peninsula - I



Yamal shrub tundra.

Source: www.novaonline.nvcc.edu/



Dwarf willows. Source:
www.travelanguist.com



Arctic willows:

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



Sparse short shrub

Source: www.polarfield.com

Landscapes of the Yamal Peninsula - II



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



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

Landscapes of the Yamal Peninsula - III



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



Short shrub tundra

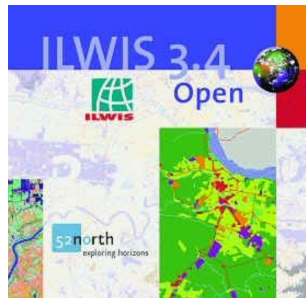
Methodology: ILWIS GIS

Technical tools: ILWIS GIS software. Methods:

- Landsat TM images interpretation
- 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 results interpretation
- Time series analysis for detecting changes
- GIS mapping



ILWIS GIS:

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

Minimum Distance Method

Calculating Indices

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.

Examples

Drawbacks: 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.

Conceptual Principle

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.

Examples

Misclassification: The misclassification of pixels 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.

Workflow

Data Processing

Data Import

Import .img into ASCII raster format (GDAL). After converting, each image contained collection of 7 raster bands

Data Pre-processing

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)

Data Selection

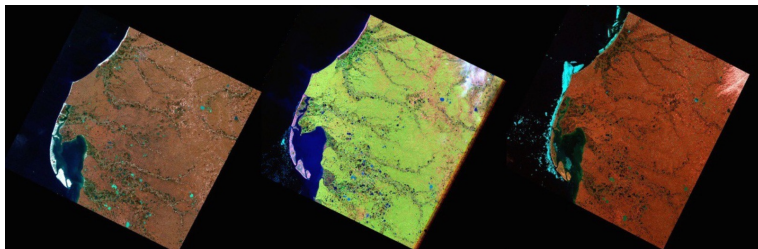
Crop of study area: the area of interest (AOI) was identified and cropped on the raw images. This area shows Bovanenkovo region in a large scale and best represents typical tundra landscapes.

Data Classification

Supervised Classification via GIS visualization and mapping

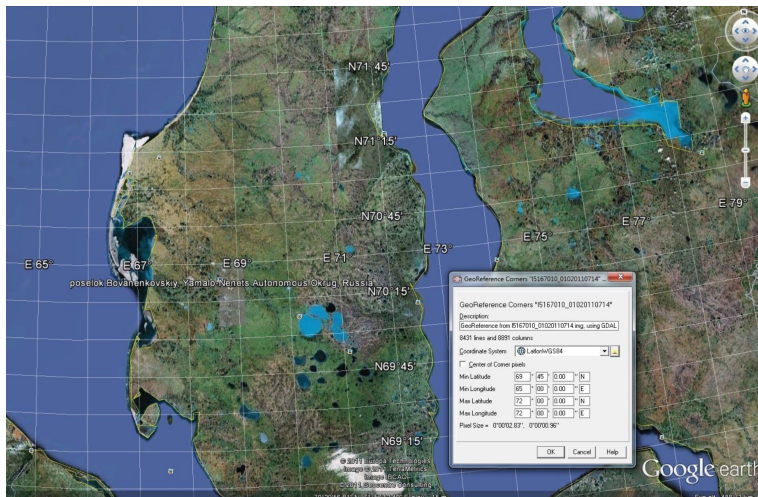
Data Import and Conversion

- Data Import and Conversion
- Test area selection (Mask): 67°00' - 72°00' E - 70°00' - 71°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.

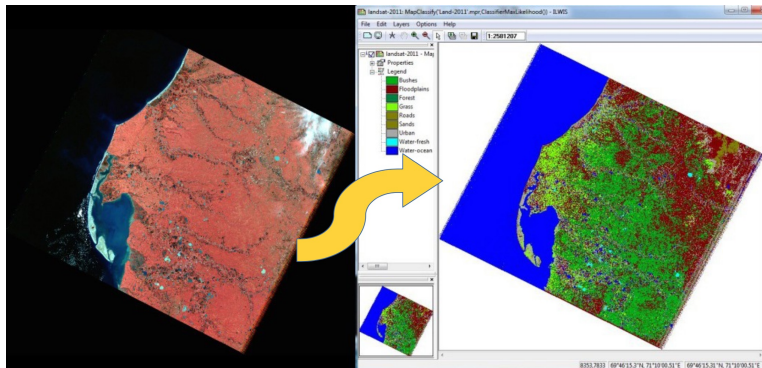


Initial remote sensing data, left to right: Landsat TM 1988, bands 7-3-1; Landsat TM 2001, pseudo natural colors composite; Landsat ETM+ 2001 bands 6-3-1.

Georeferencing: Google Earth



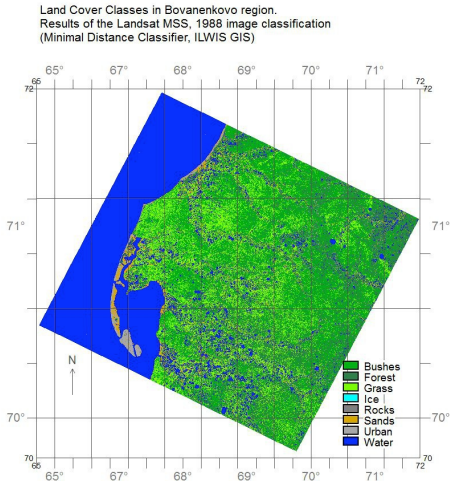
Supervised Classification of the Landsat TM Image



Computing Pixels on Various Land Cover Classes

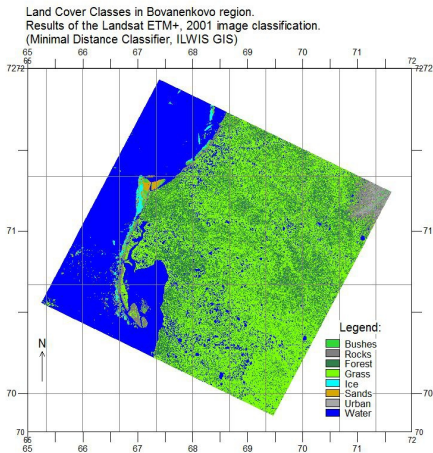
Land Cover Class	Brief Description	No of Pixels	Landsat TM: natural color composite	Landsat TM: false color composite
Grass	Sparse vegetation with low density	22	Light greenish	Light dull bordeaux to dark pinkish
Bushes	Dense vegetation coverage	16	Green, smooth texture	Dull red
Forest	Forest canopy	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

Map: 1988



Results show classified maps of the selected region of Bovanenkovo on 1988. GIS mapping is performed using image classification.

Map: 2001

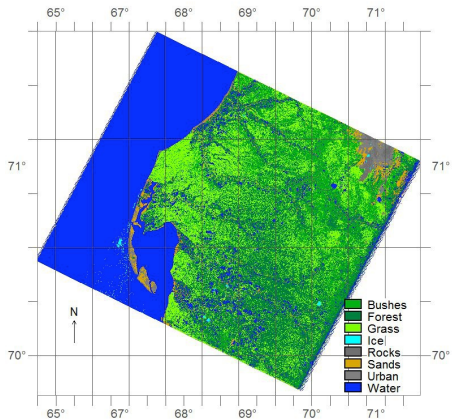


Results show classified maps of the selected region of Bovanenkovo on 2001.

Results of the supervised classification show preliminary dynamics of the vegetation distribution: 2001.

Map: 2011

Land Cover Classes in Bovanenkovo region.
Results of the Landsat TM, 2011 image classification
(Minimal Distance Classifier, ILWIS GIS)



Results show classified maps of the selected region of Bovanenkovo on 2011.
Results of the supervised classification show final stage of the land cover classes dynamics.

Explanations

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

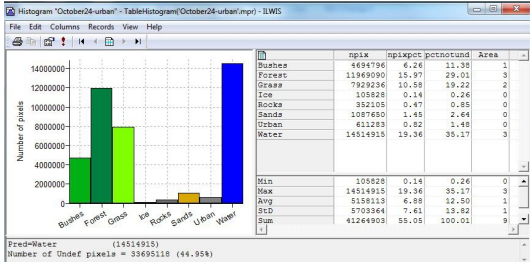
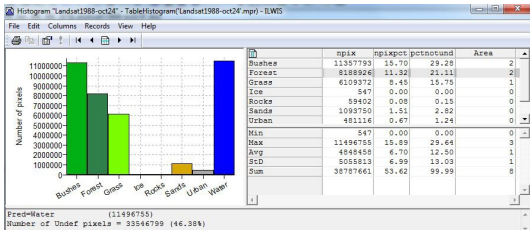
For year 2011, the percentage of the shrubland decreased down to 6,26%, while area of forests increased from 11,32 to 15,97%.

Examples

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

Histograms

Histogram for data on supervised classification of the Landsat TM image, 2011 (below) and 1988 (above).



Discussion

Spatio-Temporal Variations

This research presented GIS based studies of the environment of Yamal Peninsula. Calculated land cover changes indicated vegetation dynamics in years 1988, 2001 and 2011.

Actuality

Application of the RS data is especially important for studies of the northern ecosystems, because it enables studying remotely located areas of Arctic. The results show successful use of ILWIS GIS software for spatio-temporal classification of the satellite images aimed at ecological mapping.

Tools

Technically, the study is based on ILWIS GIS, effective tool for spatial analysis. GIS-based processing of the RS data (Landsat TM) improves technical aspects of the landscape studies and monitoring

Examples

Application: The results of the spatial analysis are presented as 3 GIS maps illustrating changes in vegetation based on the image analysis using Landsat TM.

Conclusion

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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