



Modelling Landscape Changes and Detecting Land Cover Types by Means of the Remote Sensing Data and ILWIS GIS

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Research Summary

Application

GIS and RS application for environmental studies of Yamal Peninsula, Russian North

Data

Landsat TM scenes for 1988, 2001 and 2011

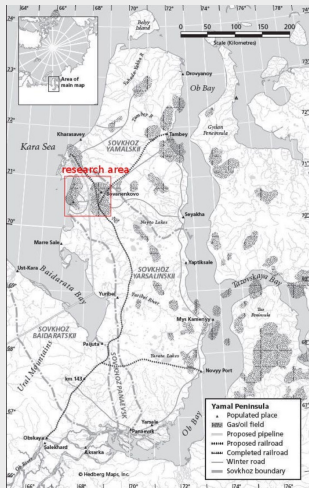
Aim

Analysis of the land cover change dynamics in the past two decades (1988-2011).
Mapping vegetation in tundra landscapes

ILWIS GIS

GIS spatial analysis tools and Landsat imagery, calculation of NDVI by ILWIS GIS

Study Area



Location

Yamal Peninsula, north Russia.

Map source: Web.

Source: B. C. Forbes

Climate and Environment

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/>

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

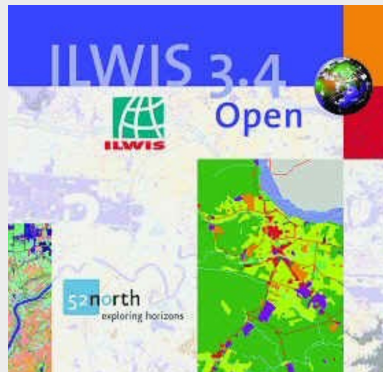
Technical tools: The RS data processing was performed in ILWIS GIS software.

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

Minimum Distance Method

NDVI

Calculation of vegetation indices, e.g. Normalized Difference Vegetation Index (NDVI), is one of the most useful attempts in biogeographical research methods.

Examples

Disadvantages: Technical details in modeling approach of image recognition: errors in pixels classification due to the ambiguity

Concept

The principle of Minimum Distance method used for classification is based on calculating the shortest straight-line distance in the Euclidian coordinate system from each pixel's DN to the pattern pixels of the land cover classes.

Examples

Misclassification: The misclassification by the Minimum Distance method may occur: erroneous recognition of some pixels, insufficient representation of classes.

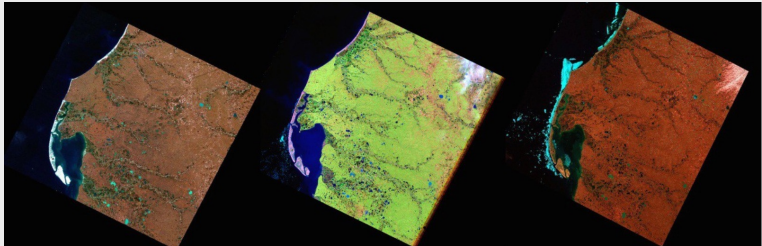
Workflow

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

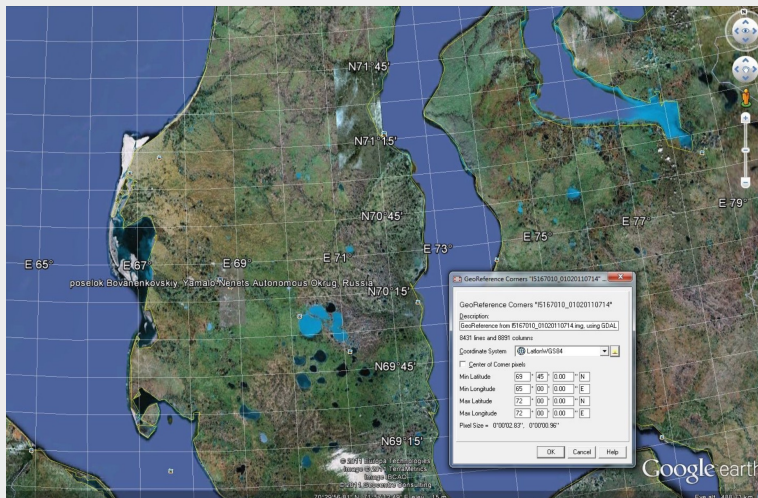
Data Import and Conversion

- 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.

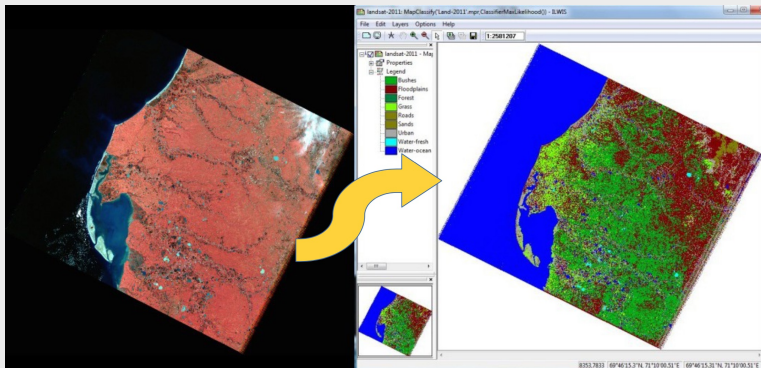


Initial remote sensing data, left to right: Landsat TM 1988, bands 7-3-1; Landsat TM 2001, pseudo natural colors composite; Landsat ETM+ 2011, bands 6-3-1.

Georeferencing: Google Earth



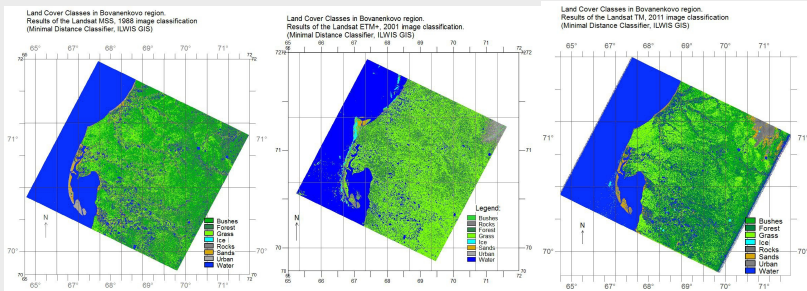
Supervised Classification of the Landsat TM Image



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 |

Land Cover Classes



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).

Comments

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).

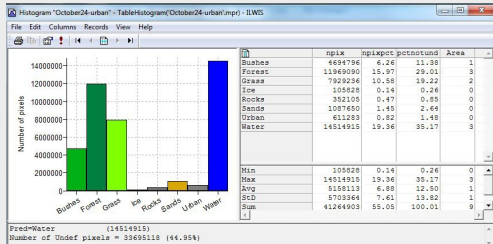
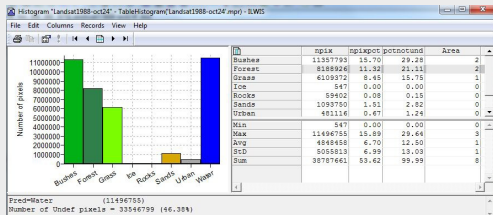
2011

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%

Statistical Histograms: 1988 and 2011



Discussion

- 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.

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.

Thanks

Thank you for attention !

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