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упорядочены следующим образом: начиная со значения «4» vs. «согласен» и далее по убыванию «3», «2» и «1», без учета пропущенных ответов, т.е. значения «0». Таким образом, показатели среднего значения относятся только к выборке – т.е. к формулировкам вопросов, на которые фактически были даны ответы. В каждом вопросе справа от текста расположены две графы: в первой находятся данные других партнеров, вторая графа содержит собственные результаты. Показатели остальных партнерских учреждений представлены с поправкой на собственные, т.е. чем меньше часть собственного образца в целом, тем ниже отклонения от противопоставленных результатов. Рядом в таблице приведены значения средней величины, в первой графе со значениями - результаты всех опрошенных, далее показатели разделены по целевым группам: доценты/преподаватели, студенты – будущие специалисты в сферах, не связанных с образованием, и студенты педагогических специальностей.

УДК 378:502/504

## TO THE QUESTION OF THE ENVIRONMENTAL EDUCATION: HOW LANDSAT TM, ETM+ AND MSS IMAGES CAN BE PROCESSED BY GIS-TECHNIQUES FOR GEOSPATIAL RESEARCH

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*Цель данного исследования заключается в демонстрации применения спутниковых снимков Landsat, а также ГИС в качестве основного ресурса для студенческих научно-исследовательских и образовательных работ по экологии. Ландсат являются эффективным и рекомендуемым средством информации для наук о Земле, особенно для студентов, т.к. они представляют собой космоснимки с 30-метровым разрешением, распространяемыми в свободном (т.е. бесплатном) доступе по интернет. Снимки регулярно обновляются и покрывают любую территорию планеты. Данная работа представляет пошаговое детальное объяснение конкретного применения снимков для картографирования экосистем.*

*The emphasis of this research is to demonstrate application of Landsat satellite imagery as a major resource for student and educational research. Landsat images are highly useful and strongly recommended for educational purposes as they are provided free of charge and timely regular geospatial data with 30-m resolution covering any places of the Earth. The case study describes mapping land cover types in ecosystems. It details how exactly satellite images can be used for geospatial research step by step.*

The Landsat is a series of imagery received from the Earth-observing satellites jointly managed by NASA and the U.S. Geological Survey with capacity to assess vegetation patterns and land cover types by various sensors [3]. The overall resolution of the Landsat scenes is rather coarse comparing to such sensors as Quickbird, SPOT or ASTER. However, the scale coverage by the Landsat TM and ETM+ imagery is evaluated as «visible with effort» for medium scale images and “moderately visible” for the large-scale scenes, which is suitable and acceptable for the scope of our research. In the current research I used orthorectified Landsat Thematic Mapper (TM), MSS and Enhanced Thematic Mapper (ETM+) data in Geographic Tagged Image-File Format (GeoTIFF) acquired over the area of Bovanenkovo region, Yamal. The images cover study area for different time periods, with a total time span of 12 years: 1999, 2001, 2007, 2009 and 2011. Additionally, SPOT and ASTER images for year 2001 and a mosaic of several images have been used.

The choice of Landsat data application for land cover mapping is explained by its 30-m high spatial resolution, well-known advantages of application of the Landsat scenes in research and cartography, almost 40 year old history of the image record, successful distribution and open availability [1]. The research data included in total a subsequent mosaic of neighboring Landsat scenes, which shows area of Yamal composed from different images, and nine separate scenes, all of which are taken in growing season, i.e. from spring to early autumn. The mosaicking of the area has advantages of ‘chain’ classification of larger extends comparing to a single image, which has been tested previously [2]. After review of the available resources, Landsat scenes were selected for the pair analysis: Landsat TM scenes for 1988-08-07 and 2011-07-14 and Landsat ETM+, 2001. The choice is made due to their spatial and temporal suitability for analysis of change detection. Thus, they cover the same area and their time span is reasonably broad for the change detection: 23-years in total and 10-13 years between each image, so that we can analysis gradual and progressive trends in land cover changes. These images are taken in growing season, i.e. in August and July, respectively. Therefore, the vegetation coverage can be detected and well distinguished.

Table 1 – Inventory of the research data covering Yamal Peninsula, Bovanenkovo region

Imagery type	ASTER	TM	ETM+	ETM+	MSS	TM	TM	Mosaic	SPOT
Acquisition date	2001	2009-07-31	1999-08-08	2001	1985-07-28	1988-08-07	2011-07-14	n/a	1993-07-29

Data pre-processing. The research methodology is based spatial analysis tools of the open source GIS software: Quantum GIS and ILWIS GIS. The pre-processing of the imagery included data import and settings of colors and contrast. The contrast of the Landsat TM imagery has been enhanced using «Stretch To MinMax» function in QGIS viewer. The series of Landsat TM images, which cover Bovanenkovo region in Yamal peninsula with 30-m resolution, were initially stored as raster file in Erdas Imagine (.img) format. Therefore, the initial working step consisted of data import. The images were imported to ILWIS from .img into ILWIS .mpr raster map format (ASCII) using GDAL (Geospatial Data Abstraction Library) in main ILWIS

menu. After converting, each image contained collection of 7 Landsat raster bands, as well as their metadata stored in Map List (.mpl) file, information about georeference (.grf) and coordinate system in .csy file. The new created imagery were automatically associated with Domain Type «Image» in ILWIS, usually used for raster images and adjusted for file types containing pixel values between 0 and 255 for each band. Thus, the images are stored in the ILWIS GIS system using their pixel values, or the digital numbers (DNs), represented from black (0 values) to absolute white (255 value) colors in the system representation “Gray” [4]. The pyramid layers were created for image each data set, in order to accelerate the display of large raster images.

Geographic referencing (UTM). Vitaly important step in the data pre-processing includes setting of the coordinate system and geographic projection. The coordinate systems of the Landsat imagery is based on the WGS 1984 datum, and ellipsoid WGS84, however the raw data initially have undefined projection. To set up the projection we chose the Coordinate System Projection menu in ILWIS. The exact location was defined using information about location of research area of Yamal Peninsula: eastern Zone 42 and northern Zone W [5]. Therefore, I selected UTM (Universal Transverse Mercator) projection, zone 42. The last step includes geo-referencing corners in two diagonal corners of the map, where the extreme coordinates for the selected image are given in degrees. The georeferencing was performed using Georeference Corner Editor in ILWIS. After imagery was projected, the Graticule option enabled to add longitude and latitude lines on the image map. Finally, the resulting images contained true information about their geographic location.

Image enhancement. To improve the quality of image and visibility of coastal lines, the image enhancement of the Landsat bands was performed using Edge Enhancement linear filter from the Image Processing menu. Stretching filter was applied to the bands, in order to improve color contrast: since not all pixel values have been used in the image, the actual diapason range was stretched linearly to 0-255 values. As a result, colors contrast has been sharpened. Using selected MapList in catalog enabled to batch filter operation for all dependent objects, i.e. for all bands together. The radiometric correction was not applied for these data, as among optical disturbance factors, I only scanned for clouds, excluding haze, fog and other possible optical effects.

Color composition. To visualize spectral information from the Landsat image, a color composite map has been created using combination of three raster images of the individual bands. Various band compositions in ILWIS were tried, in order to find out best visualization of landscapes. Three image composite types were tested: false color composite, pseudo natural and true colors composite. As false color composite (4R-3G-2B) includes infrared band, the shallow water boundaries are shown clear and gradually, though vegetation is in red shades. True color composite image consists of bands 3, 2, 1 for RGB, but the contrast of this image is not suitable for vegetation analysis. The SWIR colors (Short-Wavelength Infrared) better highlights vegetation coverage with the 7th band displayed in shades of red, the 4th - in shades of green and the 2nd band shown by blue. Finally, pseudo-natural color composite, which shows vegetation in hell green contrast shadows, the linear stretching was applied for the following bands combination: 7 for Red Band, 4 for Green Band and 2 for Blue Band, respectively. The first band was not used, as scattering at the short wavelength blue light is maximal, comparing to other ones. It is more suitable for aquatic research and water observation.

Supervised classification of the raster imagery includes image analysis aimed at recognizing class membership for each pixel. The «a priori» knowledge of the location and identity of various landscape features and land cover types are indispensable for correct classification, but in the areas with uncertainty in recognizing land cover type, unsupervised classification may be applied. The next step was clipping the area of interest on the images. Some parts of the Landsat scenes were covered by ocean, which was necessary to study, as well as clouded areas in the upper-right corner. Both areas of water and clouds were excluded from research. Besides, I needed more detailed and large-scale area to improve results accuracy. Therefore, the images have been masked. Using polygon tools I selected representative area in the center of the image, mostly occupied by willows and shrubs and avoided coastal areas. In further steps I worked only with this area of interest. Shadows of green colors represent grass, shrub vegetation coverage and forest canopy, and belong to different classes. The respective pixels are selected in Sample Set Editor, ILWIS GIS.

The main research method used in current research is supervised classification, which enabled to assign land cover classes by adjusting classification parameters and thresholds in DN values of spectral signature of pixels. The principle of Minimum Distance method, used for pixels classification is based on the calculating of 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 connected with modeling approach and technical details of image recognition, i.e. errors in pixels classification. Thus, 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. The researched described successful application of Landsat remote sensing data and GIS for environmental studies.

#### Literature

[1] Cohen, W. B., & Goward, S. N. (2004). Landsat's role in ecological applications of remote sensing. *Bioscience*, 54, 535–545

[2] Knorn, J., Rabe, A., Radeloff, V.C., Kuemmerle, T., Kozak, J. & Hostert, P. (2009) Land cover mapping of large areas using chain classification of neighboring Landsat satellite images. *Remote Sensing of Environment*, 113, 957–964

[3] Kumpula, T., Forbes, B.C., and Stammler F., 2010, Remote Sensing and Local Knowledge of Hydrocarbon Exploitation: The Case of Bovanenkovo, Yamal Peninsula, West Siberia, Russia. *Arctic*, 63 (2), 165-178.

[4] Lemmens, R., Schouwenburg, M., Wang, L. (2011) ILWIS Open GIS 3.7. Tutorial Help

[5] Morton, A. (2011) UTM Grid Zones of the World. <http://www.dmap.co.uk/utmworld.htm>