Using remote sensing and GIS techniques for landscapes and their features mapping: a case study from Baikal region, Russia.

J. Vanteeva[1], S. Solodyankina[2], E. Istomina[3]

The V.B. Sochava Institute of Geography SB RAS, Irkutsk, Russia

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Summary

Using different scale remote sensing data (Landsat, Rapid Eye, etc.), landscape approach, mathematical modeling methods and GIS techniques the local and regional level landscape maps of key areas in Pribailakye were made. These maps were used as a database containing information of all landscape components for the landscape assessment from various points in the mode of the landscape interpretive mapping. Different territorial zoning maps were made: landscape planning, hunting and birdwatching recourses assessment, ecosystem functions and services potential, ecological monitoring etc.

KEYWORDS: Russian landscape approach, landscape functions, landscape classification, landscape-interpretative mapping

1. Introduction

Traditional landscape approach is an important part of land-cover mapping in Russia. Since different regions have different landscape's hierarchy, it is impossible to use one classification for all the regions. The hierarchical classification of landscapes may include a lot of data about the main components of landscapes and information about succession stages (Bastian et al., 2015). The intensive development of remote sensing data and processing methods of these data allows solving tasks of landscape mapping in different scales.

The aim of this research is mapping of landscapes for different study areas in Baikal region using available remote sensing data and techniques of their automatic processing. On the base of these maps there is possibility to assess different features of landscapes which can be used for landscape optimization and planning.

As an object of investigation the Baikal region was chosen because it is the one of the most mobile continental rift zones with high grade crustal movements, complex orography, land forms and hydrothermal conditions. These features determined the modification of landscape functioning, structure and development. We analyzed three study areas which are located in different parts of Baikal region (in the north-east - the piedmont of the Barguzin range; in the western – Priol'khonie plateau, and in the south – Tunkinskaya Valley). They are notable for conditions of formation such as form of relief, climate conditions, different degree of human impact, etc. They represent the diversity of surrounding Lake Baikal's landscapes from steppes to boreal taiga.

2. Data and methods

The research is based on the theory of geosystems (Sochava, 1978; Krauklis, 1979) and their self-organisation (Konovalova et al., 2013), factor-dynamical classification method, as well as up-to-date methods of mathematical and geoinformational modeling and mapping, statistical analysis, methods of complex field investigations, GIS and remote sensing methods.

For creation of the landscape maps, the complex of environmental variables from independent sources are used: data collected during field excursions, digital elevation models, remote sensing data, open source databases, published maps and other publications. Namely, we use multiband space images

[1] ula.vant@mail.ru

[2] sveta@irigs.irk.ru

[3] elenaistoma@gmail.com

Landsat (4, 5, 8), the high resolution images RapidEye (scene size 77x77 km) and QuickBird (scene size 16.5x16.5 km), as well as DEM SRTM and AsterDEM (30x30 m).
For the processing of space images modern object-based and pixel-based methods are used. We used also mathematical models of landscape complexes developed by Istomina (2009) and methods of image processing based on the autocorrelation and Jacobi determinant calculation (Istomina and Cherkashin, 2013).
The first stage includes delineation of borders of the landscape units using different spatial resolution remote sensing data. Classification of these object-units is made on the base of the next parameters: shape of the unit, brightness of certain bands of different season space images and parameters of their distribution inside the unit, DEM information (elevation, slope, aspect, curvature, convergence index, wetness index etc.), type on the existing geological and geomorphologic maps, as well as maps of soil, vegetation, land use etc. To better differentiation of deciduous and coniferous forests space images from different season are used. For the determination of the potential stages of units maps of potential vegetation and natural landscapes are taken into account.
For different landscape features quantification and localization landscape-interpretative method is used. It means that we evaluate different parameters for each type of landscape using key areas and interpolate these assessments for the all area of this landscape type.

3. Results

In result different landscape maps were compiled for Priol'khonie plateau (1:50 000) (Konovalova et al., 2005; Vanteeva et al. 2015), Tunkinskaya Valley (1:100 000) (Istomina, 2012), the north-eastern shore of Lake Baikal (1:50 000) (Vanteeva et al., 2014). Each landscape map is a database which contains information on all components. These databases can be used for estimation of different landscapes features and functions using GIS techniques and interpretative mapping. Landscape maps were used for the creation of different territorial zoning maps: landscape planning, hunting and birdwatching recourses assessment (Istomina et al., 2016), ecosystem functions and services potential, etc.
As an example, consider one of the study areas. It is Priol'khonie plateau. There are steppes and forest steppes landscapes. The steppe landscapes is mainly rocky occurring on gentle slopes with *Festuca* spp. and *Poa* spp. or with *Agropyron cristatum* L. and *Stipa* spp. on chestnut or soddy shallow soils, which in some places gradually change to forest steppe and larch forest.
The initial land-cover map for this area was prepared 10 years ago. Since then, the study area has been intensively developed (the expansion of roads and recreation facilities). For the assessment the area of changed landscapes, the satellite image (SPOT 4) processing was made using the results of fieldwork. The changes in the areas of settlements and recreation facilities were calculated by GIS tools. The transformed area has increased by 6.3% (Vanteeva et al., 2015).
The specific climate and soil conditions and human activity (especially, recreational activity) lead to erosion processes on study area. The vegetation cover and phytomass play an important proactive role on sedimentation and mitigate silt detaching by rill and inter-rill. These indicators were used for mapping. As a result the maps of phytomass stocks and landscape vulnerability to soil erosion were compiled based on landscape map.

4. Conclusion

Medium- and large-scale remote sensing data allow studying the characteristics of landscapes and classifying landscape units on the local and regional levels. Obtained landscape maps can be used for the territorial and landscape planning and the assessment from various points in the mode of the landscape interpretive mapping. Also using constantly updated satellite imagery data, we can assess changes in landscape cover and land use. These data can be used for ecological monitoring.

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Biography
M.Sc. Julia Vanteeva is Ph.D. student of The V.B. Sochava Institute of Geography of Russian Academy of Sciences (RAS). Research interests are the studying landscape structure and functions, processing of remote sensing data and mapping, landscape planning. An author of journal articles and participant of international scientific conferences.

Dr. Svetlana Solodyankina works as a senior researcher at The V.B. Sochava Institute of Geography of RAS. Research interests are in the field of physical geography and landscape ecology, functions and classification of landscapes, landscape and urban planning. Leader of research projects, an author of journal articles and monographs.

Dr. Elena Istomina works as a senior researcher at The V.B. Sochava Institute of Geography of RAS. Physical geographer specialized on geoinformatics, remote sensing, mapping and mathematical modelling of natural landscapes and their components, earth surface temperature. Leader of research projects, an author of journal articles and monographs.