



AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search

<http://ageconsearch.umn.edu>

aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

**Zentrum für internationale Entwicklungs- und Umweltforschung
der Justus-Liebig-Universität Gießen**

**Proceedings of the International Conference
and Young Researchers' Forum**

“Natural resource use in Central Asia:
Institutional challenges and the contribution of capacity building”

held in Giessen, 1st October 2013

MIRZA NOMMAN AHMED, IRA PAWLOWSKI (EDS.)*

No. 64

Giessen, October 2013

Keywords: natural resources, water, agriculture, climate change, Central Asia

* Dr. Mirza Nomman Ahmed and Dr. Ira Pawlowski are research assistants at the ZEU and coordinators of the postgraduate programmes “Climate Change Network for Central Asia (CINCA)” and “Land use, ecosystem services and human welfare in Central Asia (LUCA)”. This conference has been organized in the framework of both these projects. In respect thereof, particular thanks goes to the German Department of Foreign Affairs and DAAD for facilitating CINCA) and the VolkswagenStiftung for funding LUCA.

Contact: clinca.ahmed@zeu.uni-giessen.de
ira.pawlowski@zeu.uni-giessen.de

TSYCHUYEVA, NATALYA ¹; OTTE, ANNETTE ²; SPIVAK, LEV ¹:

THE ANALYSIS OF LAND COVER CHANGES IN MOUNTAIN REGION USING REMOTE SENSING DATA

¹ *Space Research Institute, Almaty (Kazakhstan), n-tsyhuyeva@yandex.ru*

² *Justus Liebig University (Germany)*

1 PROBLEM STATEMENT

Livestock is one of the priorities of agricultural production in Kazakhstan and Central Asia as a whole. Kazakhstan is the five world leaders by area of rangeland resources. Pastures occupy more than 70% of the country and are a unique potential for the development of economy and environmental sustainability. Therefore, the issue of security feeding lands and their quality is important. During the planned economy mountainous territory used as summer pastures – dzhaylyau, often these areas were overgrazed and complete degraded. A similar situation was in 1990, when the territories near the villages were completely shot down, and in other hand, distant pastures and hay fields are not used at all. Pastures degraded by unregulated grazing, loss of irrigated pasture, exemptions for industrial facilities, landfills and human settlements, lack of control over the condition and use of pastures, non-land laws and other reasons [1]. Such drastic changes in land use could affect to phytodiversity of pastures and their nutritional value.

The art production of the problem of obtaining information on the state of the land cover is solved with using remote sensing techniques to quickly get enough information about the full range of condition and productivity of pasture ecosystems. Nowadays, remote sensing, as a method of rapid and large-scale monitoring of agricultural land, not has an alternative. Therefore, the development of methods of application of space data to assess and food supply is today an urgent task.

The purpose of this study is to investigate phytodiversity of mountain pastures, as an indicator of socio-economic changes, using remote sensing data.

As the region of research was chosen the mountainous part of Karasay district of Almaty oblast. This area was used as a summer pasture for sheep and cattle, and horses grazing. The animals were driven out from the flat part of the Almaty oblast. Since 1996, part of the mountainous territory belongs to the Ile-Alatau National Park. This area became more interesting for research, cause of possibility to observe the consequences of changes in land use and track the direction and speed of natural revegetation.

2 METHODOLOGICAL APPROACH

Research is aimed to address the following questions:

What are the temporal and spatial changes in land cover of a mountainous region in Central Asia during last 30 years? How are changes in land cover connected to phytodiversity? What are the drivers of land cover and phytodiversity changes?

Methodological concept of the research project consisted of three main phases: (I) developing a landscape classification and definition of the spatial changes in land cover, (II) validation of classification and modeling changes of phytodiversity, and (III) analysis, which is the cause of such changes and interactions between ecological and social processes.

The studies will develop recommendations for the sustainable land use and the decision to use this method in other mountain regions of Central Asia.

GIS of the project was created with the involvement of all possible geographical material for the study area. For development GIS we used ArcGIS 10.0 software from ESRI Company. In the process of conducting scientific research and practical work in the project area GIS database is continuously replenished.

The geodatabase contains a variety of their characteristics and purpose data: raster, vector, grids, and statistical tables. Raster data includes cartographic material and satellite images. Thus, the database contains topographic maps of the 1980s, the scale of 1:200 000, 1:100 000 and 1: 50 000. Thematic maps of the 1970s and 1980s: a map of soils and geobotanical maps of scale 1: 100 000. As the data for digital elevation model (DEM) we used SRTM model established in 2000 according to data from the radar satellite [2]. The resolution of this model is 60 m, which corresponds to the DEM derived from maps of scale 1:100 000.

The next step of our research was to determine the basic habitat types, based on the physical location data: the elevation, angle and slopes exposition. Background information was obtained on the basis of the SRTM digital elevation model. Using the extension module Spatial Analyst in the ArcGIS 10.0 software we calculated the basic parameters of the ground to the center point of each pixel (60m * 60m), as well as additional parameters, such as eastness and northness, showing the relative location of the slope of the northern and eastern direction. All data were recorded after the calculation in a single table using an Extract Multi Values Tool. Data from landcover maps has also been entered in each point. The whole process of calculation was built in Model Builder module and represents the following sequence. These calculations allowed us to create a single database with information on the physical parameters of the terrain and land surface at each pixel.

The use of cluster analysis in software Statistica 10.0 it possible to identify the 7 most significant clusters, taking into account all the possible combinations of different angles, heights and slope exposure, and then based on them to create a map of unique spatial sites. The resulting spatial sites represent the most important differences in the topography of the area.

The purposes of our study include the establishment of a unified methodology to use satellite imagery and digital elevation model data for the period of 30-40 years. In this regard, we tried to find the same characteristics of satellite imagery and make them a similar transformation. In our opinion Landsat satellite imagery best suited for this task, the data also are in a free catalog on the official website of the NASA [3]. The basic principles that we follow - is to use public and, if possible free data, which is important for research in the Central Asian region.

In vegetation seasons of 1970-80 years on the territory of Trans-Ili Alatau mountain we have selected space image with a lack of cloud cover and the good quality of the scene. The image LM21610301975190AAA05 date 09/07/1975 was taken from Landsat Multispectral Scanner (MSS) with 60 meters spatial resolution and consist of four spectral bands. A similar scene was taken in 2011 from Landsat Thematic Mapper (TM) camera that stays in satellite Lansat-5. Scene

number is LT51490302011197IKR01 date 16/07/2011. This image consists of seven spectral bands with a spatial resolution of 30 meters. The images have different number of channels, but they have 4 same bands, and each band is useful for capturing different land cover aspects.

Processed images were subjected to multiple stages of classification. Thus, the method of expert decoding allowed allocating urbanized areas and gardens. Then use the method of supervised classification allocated classes of glaciers, water bodies, forests and shrubs. Calculating of vegetation index NDVI (Normalized Difference Vegetation Index) allowed dividing remaining area into classes with different projective cover and the amount of green biomass, like: bare soils, pastures with low, medium and high volume of green biomass. Thus, remote sensing data allowed creating "Maps of Land Cover in 1975 and 2011" with a total amount of classes 12. Thus the following classes of the underlying surface were obtained to landcover map:

«Water bodies» – this class includes moraine lakes, reservoirs and lakes; "Ice" - a class includes the glaciers and snowfields; "Rocks" - a class includes open rocks deposits, picks and cliffs; "Open soil" – plots free of vegetation, sometimes with erosion, on the slopes of low mountains and hills, also broad areas for parking at the roads; "Grasslands with low green biomass" - areas with natural herbaceous vegetation cover used for grazing and hay with a projected cover (20-50%); "Grasslands with high green biomass" areas with natural herbaceous vegetation cover used for grazing and hay with a projected cover (50-100%); "Solid bushes" - class includes continuous shrubs of wild rose and spirea in the middle mountain, junipirus cover shrubs in alpine areas; "Forest" - includes a pine forest on the slopes of middle mountains and deciduous forest along the river floodplains; "Arable land" - cultivated fields; "Settlements" - settlements, cottages and individual buildings; "Cloud cover and shadows".

The result is shown in Figure 1.

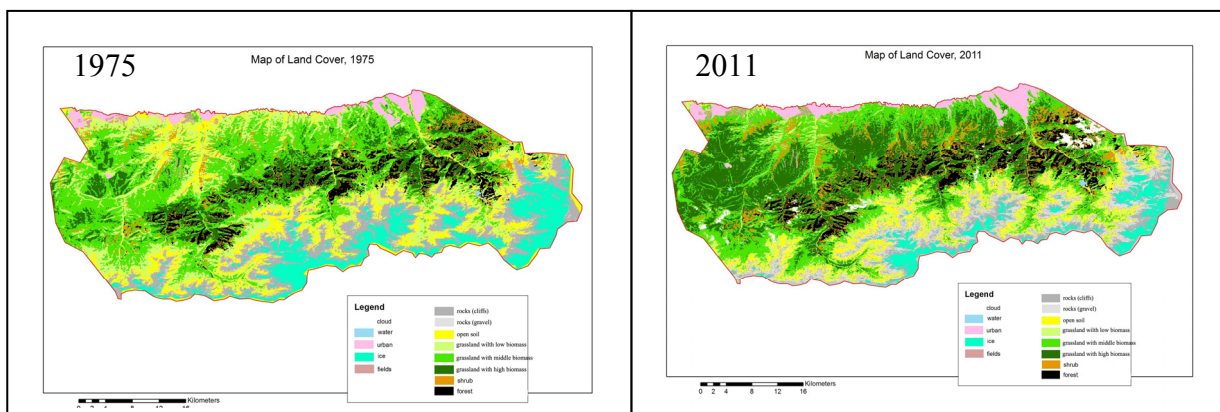


Figure 1 - Maps of Land Cover in 1975 and 2011 based on remote sensing data

Verification carried out by the classification of satellite imagery in 2011 by ground-based data from field work, as well as by high-resolution satellite image GeoEye. The area covered by satellite imagery includes the most of classes of landcover map. Boundaries of classes from Landsat images are aligned with the boundaries of classes dedicated by expert detected method. Checking the interpretive features of different classes based on thematic processing of remote sensing data has

confirmed the basic criteria for recognition of these territories. According to the materials of field work in July 2011 (50 points) the following conformance was taken. Accuracy assessment of the following classes: 100% - forest, 81% - class of shrubs, 95% - accuracy of the rocks. Total accuracy is more than 92%.

Maps of Land Cover of 1975 and 2011 were compared and as a result showing the changes of classes for the last 35 years. For this purpose, the method of Change Detection in software ENVI 4.7 used. According to the results of the calculations obtained table of changes in each class of units of area and percentage of the area of all classes. This information makes possible to determine the nature of changes in each of the classes, as well as create a map of class changes. Thus, half of the area of glaciers class went to a class of rocks. This confirms the fact of glaciers degradation. Territory with open soils in 1975 now covered with grasses with low biomass in 47% of the class area.

Next step, we combined the data of calculations with information about relief and got the values in which topographical clusters the landcover changes are most pronounced. In other words, in the territory with some slopes, altitude and exposure the melting glaciers is most prominent, and where it did not happen. So, this analysis forecast the territories with which topographical features land cover changes will occur in the future.

The next step was to determine the changes occurring in phytodiversity of pastures. For this we digitized geobotanical map 1985 scale 1:100 000 [4], contains the full list of dominant plants. All information has been entered into the geodatabase. The field works in the summers 2010-2011, during which were described in detail 50 points of observation. Information on the species composition at these points let us to compare with the species composition in 1985.

The studies identified the following specific changes: grain types (eg, *Helictotrichon pubescen*) at some points no longer dominate, and became species forming herbs, on the one hand, increases the amount of green biomass, but at the same time affects the food potential of pastures. At many sites, recorded improvement in the vegetation, which is likely due to the lower pressure of grazing, as the increased role of grain grasses, special attention should be paid to *Helictotrichon pubescen* and fewer *Ligularia macrophylla*. At the same time, there are areas where there is still an intensive grazing. In such territory is marked disturbance average cover (*Ligularia macrophylla* and *Aconitum*). Also, there is a restoration of bushes. Previously, they were burned to make way for pasture grass vegetation.

3 DISCUSSION OF RESULTS

The reasons for such changes could serve a number of factors. One of the most significant in this region: changes in pressure on pastures and land use change, and climate change (taken into account components, such as precipitation and temperature).

As already mentioned the study area since 1996 belongs to the National Park, and therefore intensive agricultural activities are prohibited. However, there are some areas which are in private ownership, which still is an intensive grazing. It is in these small areas, revealed changes associated with overgrazing. On the contrary, the area affected by overgrazing in the past, now restored, has a

high green biomass and could be used in the power saving mode for haying, which would increase the share of cereals in the grass and forage quality improved pastures.

Climate changes have occurred in the area in the direction of a small increase in rainfall, as recorded at the meteorological stations, and has influenced the increase of green biomass. As a whole, any changes in land use must be justified and beneficial both economically and environmentally, to maintain the stability of the area.

REFERENCES

Torehanov A.A., Alimayev I.I. Natural and sown pastures in Kazakhstan .- Almaty, 2006.- 416p

<http://srtm.usgs.gov/>

<http://landsat.gsfc.nasa.gov>

Map of grassland Kaskelen District. -M 1:100000. – 1985.

