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Austria-Central Asia Centre for GIScience
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CONTENT

The functionality of applications for processing of the remote sensing data

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The GISCA'13 Program Committee accepted this paper as a reviewed full paper

Abstract

The article deals with the functionality of applications for remote sensing data processing by comparing NDVI to create maps of agricultural land.

Keywords: the remote sensing, NDVI, agriculture

Introduction

Relevance of the topic. Vast territories is agricultural land, it is difficult to control due to the lack of the accurate maps, poor network of real-time monitoring, ground stations, including the weather, the lack of aviation support because of the high cost of maintenance staff, etc. In addition, due to various natural processes, there is a constant change in the borders of areas under crops, soil properties and vegetation conditions in different fields and from section to section. All those factors which prevent the objective, timely information necessary for ascertaining the current situation, and its assessment and forecasting. It's impossible virtually to increase without it in agricultural production, optimization of land use, crop yield forecasting, reduce costs and increase profitability. Therefore, spatial data of the remote sensing in recent years have become an important part in solving the problems of creating and updating digital maps, plans and project implementation of geographic information systems (GIS) for various levels and purposes.

In this article, we discussed the possibility (in the example, Normalised Vegetation Index (NDVI)) the most common complex of ENVI 4.8 software for the remote sensing data processing. NDVI identifies problem areas depressed vegetation, giving the opportunity to the most loyal in the long-term solutions to increase productivity. Typical problems in this area are: inventory of agricultural land, crop condition monitoring, allocation of areas of erosion, paludification, salinization and desertification, the determination of the composition of soil, monitoring the quality and timeliness of various agricultural activities.

Agriculture - one of the most perspective areas for the use of the remote sensing to increase the intensification of livestock and especially plant growing production. Agricultural crops are brilliantly displayed on the satellite images, they are no hidden, single storey, well deciphered as a texture, and the spectral characteristics /1/.

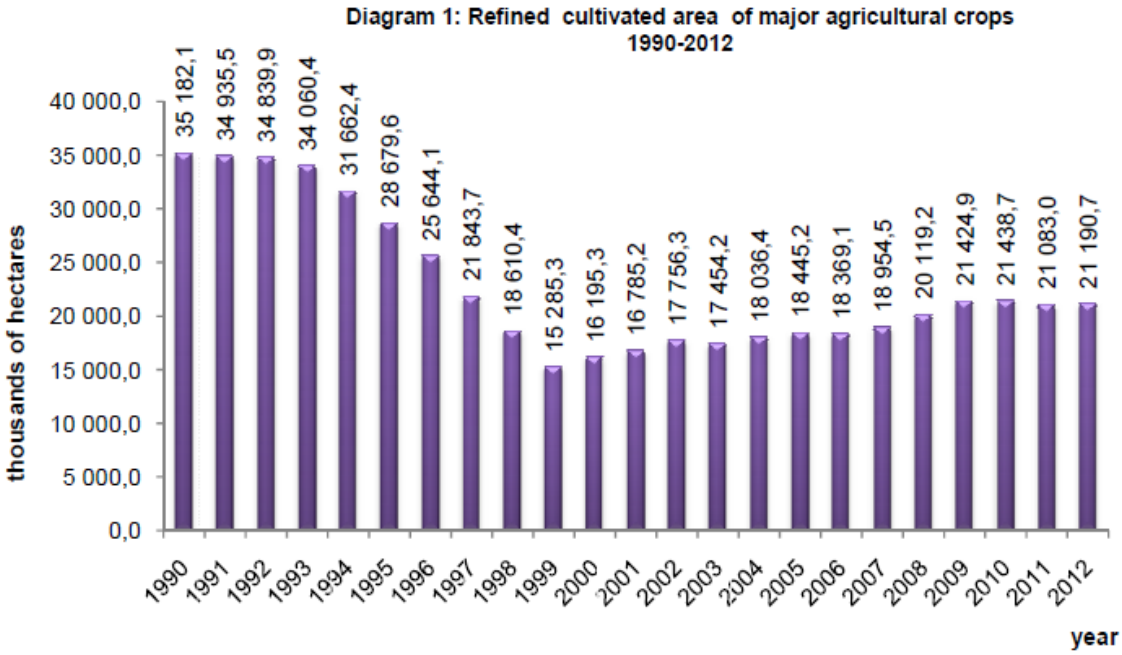
Kazakhstan has a vast territory which is more than 2.7 million square km. Nature and landscape of Kazakhstan is very diverse and represented as highlands east and low-lying plains of the West, as well as harsh climate industrial north, vast, arid steppes of the center and highly fertile land south of the country.

Important sector of the economy of Kazakhstan is agriculture. According to the Agency of Statistics of the Republic of Kazakhstan, the total refined cultivated area of major agricultural crops in the country amounted to 21,190,710 hectares in 2012 (Diagram 1) /2/.

In the north of the climatic conditions are favorable for the cultivation of spring wheat, oats, barley and other grains, as well as allow to develop vegetable, melon and cultivate a number of industrial crops - sunflower seeds, etc. In the south of the country in the foothill

and river valleys, where a lot of heat, with irrigation give high yields of cottonand sugar beets, rice, fruit orchards and vineyards.

It follows that the most important task which first need to be addressed through remote sensing data in the agricultural sector of the economy, an inventory of agricultural lands, and special thematic maps /1/.



The data source: The Agency of Statiistics of the Republic of Kazakhstan, www.stat.kz

Studies

Methods of the remote sensing are used widely in agriculture around the world (USA, Canada, European Union, India, Japan, etc.). In the economy of Kazakhstan introduced modern technology of the remote sensing for applications of monitoring of agricultural land, emergency, environmental and technological safety. So, for the Ministry of Agriculture determined area of crops and condition of crops, perspectives of crop on are estimated, implemented inventory and monitoring of agricultural land /3/.

The use of the remote sensing data in agriculture is a rapidly growing and promising area. An important advantage of satellite imagery is timely information use on the spatial distribution of agricultural land, as well as the objectivity and independence of information obtained /4/.

Currently, there are a number of software tools used for preliminary and thematic processing of the remote sensing data. The most common ERDAS Imagine, ER Mapper, ENVI, IDRISI, etc. The distinctive feature of ENVI is an open architecture and the availability of programming language IDL (Interactive Data Language), with help which can significantly extend the functionality of programs for specialized tasks: automate the existing algorithms as well as create their own data processing algorithms, and perform batch processing of the remote sensing data /5/.

Observations of the dynamics of agricultural crops by the remote sensing data showed that in the spectral feature space each type of culture at certain times and in certain phase of development forms a compact cluster /6/.

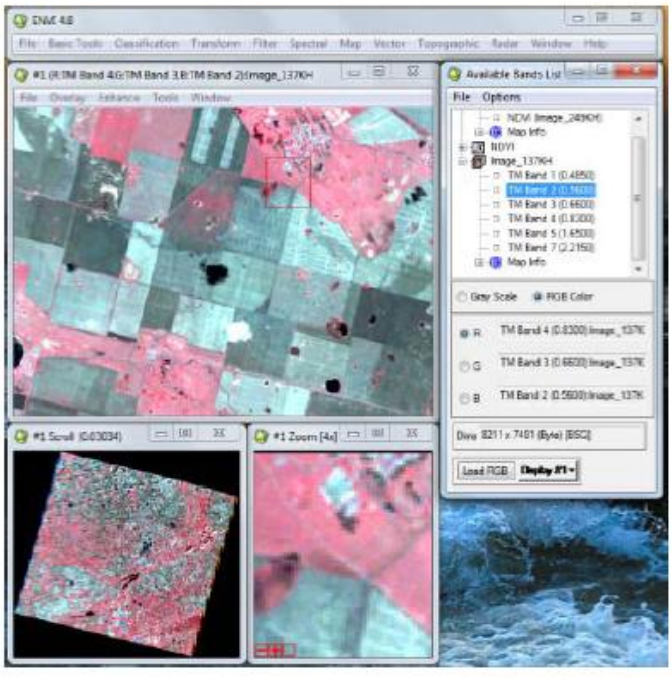
Quantitative characteristic of the crop condition is normalized vegetation index (VI) NDVI (Normalised Vegetation Index). Calculation of the most popular and commonly used the vegetation index NDVI (Normalized Difference Vegetation Index) additionally placed in a separate instrument ENVI. NDVI - normalized difference vegetation index was first described Rouse B.J. in 1973, a simple quantitative measure of the phytomass. Speaking vegetation index, often imply it instead. The index is calculated by the following formula:

NDVI = (NIR-RED) / (NIR + RED), where RED and NIR - the spectral brightness of the red and near infrared bands, respectively.

The vegetation index NDVI is positive, and the more green phytomass, so they are higher. On the value of the index is also influenced of the species composition of vegetation, its compactness, condition, exposure, and the angle of inclination of the surface, the color of the soil under the rarely vegetation. Index is moderately sensitive to changes in soil background, except when the density of vegetation cover below 30%. The index can range from -1 to 1. For the green vegetation index usually ranging from 0.2 to 0.8 /7/.

For example, of calculation of the index NDVI, clearly showing its information. The initial data was taken from the satellite image Landsat 4-5 TM (http://glovis.usgs.gov/) on a part Denisovskoye, Karabalyk, Kostanai, Taranovskiy, Fedorovsky regions of Kostanai oblast (Figure 1) for May 17, 2011. Since the degree of processing of satellite imagery 1G, its projection UTM on the ellipsoid WGS84.

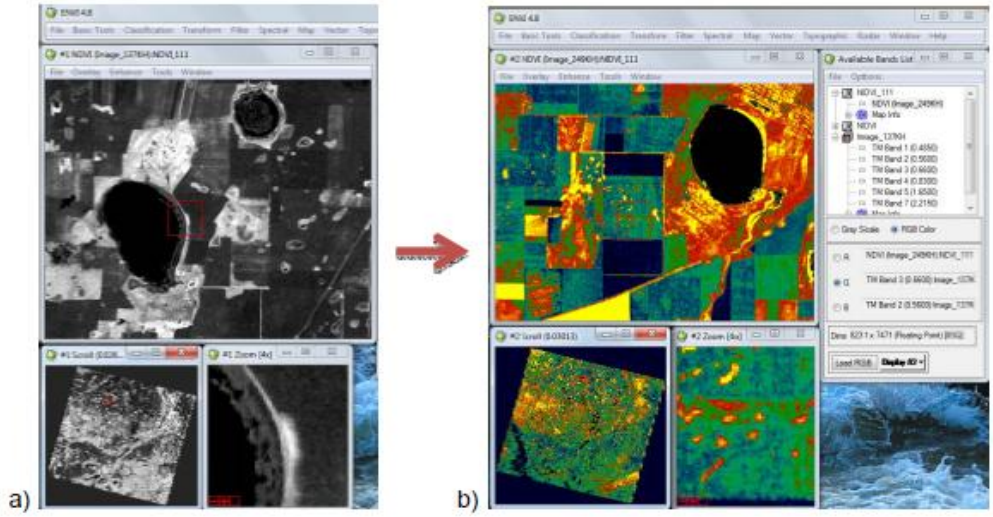
Figure 1: The original image of Landsat 4-5 TM



The next step is the calculation of vegetation index NDVI to the original image (Figure 2):

The resulting image (Figure 2a) can "colorize". There is a standardized scale of NDVI, it is used infrequently. If describe space image by value NDVI, the yellow color characteristic of rarefied vegetation, orange mainly for roads, buildings and other man-made objects, green and dark green - for open soil, black - for water, and the different shades of blue - for man-made materials. Open ground on NDVI is intermediate between vegetation / no vegetation and water. Often, areas of open soil are recognized as water or as an artificial material, have

Figure 2: The result of the calculation of the index NDVI:
a) indexed image to grayscale version; b) The index picture, painted in false color



index values near 0 or <0. In the observable image to very little vegetation and almost not at all dense vegetation, because the image was taken in mid-May. As known to all, Kostanai oblast well known outside of Kazakhstan his own kazakh agro-industrial potential. It is traditionally called the main bread granary of the country. Special climatic conditions of the region help grow wheat (spring) with characteristics unique in the world. According to that table below (table 1), in the month of May has just begun sowing wheat, so in satellite imagery of this study areas very little vegetation, and vice versa to the most common area of open soil.

Table 1

VEGETATIONAL CYCLE OF WHEAT

Sowing Plantling	Tillering	Heading	Flowering Swelling	Ripening

MAY	JUNE	JULY	AUGUST

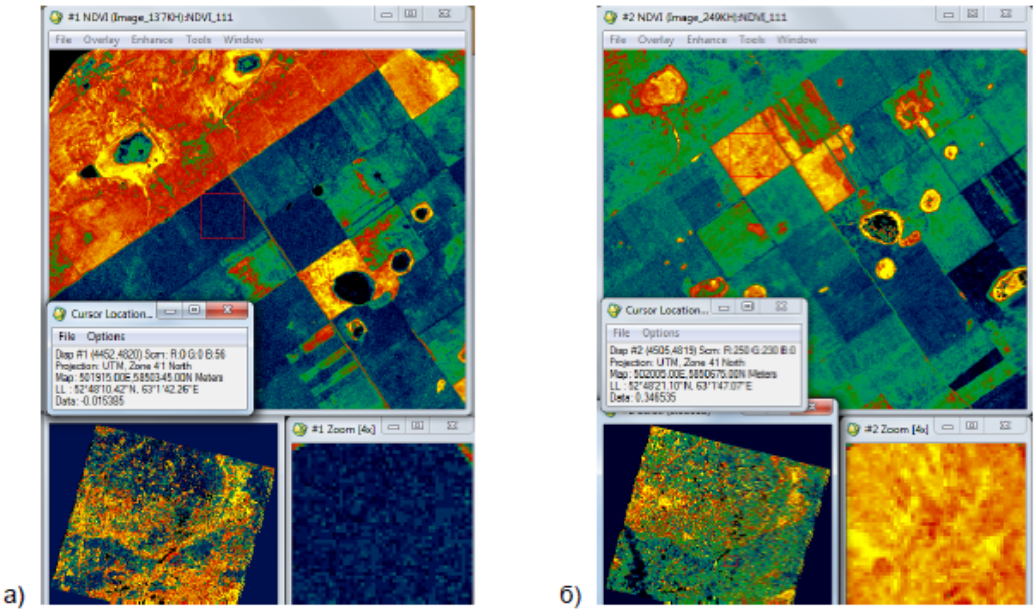
The data source: Institute of space research, RK

If we compare the calculated NDVI for the months of May and September, seen a huge difference. If, for example, in May, where the value of NDVI was equal - 0,01-0,025, in September, they are already equal 0.34-0.38 (Figure 3).

Conclusion

The main advantage of vegetation indexes is the ease for their preparation and a wide range of solved problems with them. Thus, NDVI is often used as a tool during the more complex types of analysis, which may be the maps of forest productivity and agricultural land, maps of landscapes and natural areas, soils, arid, phyto hydrological, phenological and other environmental and climatic maps. Also based on it is possible to obtain quantitative

Figure 3: The result of the calculation of the index NDVI:
a) indexed image for 17/05/2011g.; b) indexed image for 06/09/2011g.



а) б)

data for use in calculations assessing and predicting the yield and productivity, biodiversity, the degree of disturbance and damage of natural disasters, industrial accidents, etc. /7/.

In conclusion, it should be noted that any vegetation indexes do not provide absolute quantitative study the properties and their values depend on the characteristics of the sensor (the width of the spectral bands, resolution), shooting conditions, lighting, atmospheric conditions. They give only a relative assessment of the properties of vegetation, which can be interpreted with the assistance of field data converted to absolute. And it should be noted that using the software can be solved issues in the field of agriculture. Further studies are needed to compare other features ENVI in different branches of science.

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