Assessment of pastures degradation and it’s dynamics in the Central part desert Kyzylkum with use of methods the remote sensing and GIS-technologies

Ibragimov I.A. #1, Sichugova L.V. #2 and Toderich K.N. #3
#1#2 The Astronomical Institute, Uzbekistan Academy of Science
#3 ICARDA Project in Uzbekistan
Email: sloka988@gmail.com

Abstract- The Karakata saline on Central Kyzylkum desert has been chosen as a model site of biomonitoring to reveal the spatial and temporal changes of vegetation cover and declining of soil fertility related to climatic variables. Vegetation cover of sandy desert rangelands has a complicated spatial structure is determined mostly by impact of heterogeneity of desert environment. Drought and salinity in desert regions of Uzbekistan can have a far greater effect on food security than in other areas. The use of RS and GIS technologies for evaluation of current trend of land degradation and changes of cover vegetation that is related to aridity of climate and soil salinity impact on small scale level (the Karakata Saline as case study) is described in the article.

Keywords- The Karakata Saline, Kyzylkum desert, Uzbekistan, vegetation, salinization, satellite images, remote sensing.

I. INTRODUCTION
Republic Uzbekistan - the country is far from the sea and located in the central part of the Eurasian continent. The climate is arid so agriculture substantially depends on irrigation. Irrigated farming and processing of agricultural products are the major source of employment and of incomes of population in rural areas. The most part of the used land is heavily salted as a result of intensive irrigation. The high dependence on irrigation together with the natural predisposition to desertification and salinization of soil endanger to the degradation of land used.

II. DEGRADATION OF THE LAND AND THE SPREAD OF DESERTS IN UZBEKISTAN
Degradation and arid soil - is a varied complex of processes that decreases moisture in the extensive territories and decreases the biological productivity of ecological systems. Manifestations of aridity from private drought to full desertification cause profound changes in ecosystems over extensive areas of the country and increasing problems in food and water. The natural factors of degradation of the land are followings: climate variables (low rainfall, high temperature, winds and droughts), mudflows, landslides, the slope areas, the sources of natural deposits of salt, water erosion, forest and steppe fires and others. In the last years frequent recurrence of drought increasing salt and aerosols from drained bottom of the Aral Sea is rising annually by winds up to 150 million tons of salt [1].

Human activities bring a greatest contribution to the degradation of the land. Physical aging of irrigation and drainage systems, poor irrigation technique, wasteful water use, and exhausting structure crop leads to a worsening of reclaimed land. Salinization of the soil is increasing continuously and the storages of nutrients are reducing critically. Pollution of water by industrial waste and heavy use of fertilizers and pesticides are additional reasons for the increase of salinity and pollution of soil. Besides that, degradation is a result of overgrazing, of unreasonable felling of woods, of uprooting shrubs, influences of transport. These processes lead to an annual loss of thousands of hectares of agricultural land. The sharpest example is changes of the Southern Aral Sea ecosystem, where the vegetation has decreased from 1 million hectares (1961) to 56 thousand hectares (2009).
Degradation of the land is a common problem for the whole country, but the most affected areas are concentrated in the basin of Amu Darya River (Bukhara, Navoi, Kashkadarya), in the its delta (Khorezm and Karakalpakstan, the Aral Sea), and in the Basin of Syr Darya River (Syrdarya, Tashkent and Fergana valley). Besides, there is enhanced degradation of extensive pastures located on the deserts of Uzbekistan, mostly in the Kyzyl Kum desert which is the main resource of livestock.

III. KYZYLKUM

Kyzylkum - is sandy desert between the rivers Amu Darya and Syr Darya in Uzbekistan, Kazakhstan and partially Turkmenistan [3]. It is limited in northwest Aral Sea, in northeast by Syr Darya River, in the east by Tien Shan and Pamir-Alay ridges, in southwest by Amu Darya River. The Kyzylkum area is about 300 thousand km$^2$. The desert represents plain with the general bias on northwest. It has a number of the closed saline and isolated strongly dismembered mountains. The most part of desert is sandy areas and sorts generated semi fixed by sand. The farm holders of the region are the animal industries, basically, fine-wool and karakul sheep breeding. There are the marble, graphite, turquoise are developed in the mountains area of the desert. In the center of desert there are deposits of uranium, gold, phosphorites. The one of the largest gas deposits is exploited in the Kyzyl Kum desert which is the main resource of processing industry.

The desert territories of the republic are of little use for intensive agriculture because of dryness of climate. So the territorial organization of industrial production and extensive animal husbandry has localized character that influences on the general moving of the population. The cities and settlements in the deserts of Uzbekistan have the dispersed form of placement developing in essence without the suitable agricultural zone. Absence of reliable water resources limits formation of group system of moving. City agglomerations and other types of territorial systems of moving are forming only in small oases of intensive agriculture and in the regions having processing industry.

Information about natural potential of this region is very important for maintenance of its landscape ecological equilibrium. It is possible to develop uniform system of environmental measures if we know landscape structure. It will allow keeping separate model areas and defining natural resource potential for maintenance and improvement of ecosystems on the big areas. The remote sensing technologies have the important role in physiographic researches and studying of a soil-vegetable cover of the Kyzylkum Desert for an assessment and forecasting of possible dangerous changes.

IV. THE USING OF REMOTE SENSING METHODS FOR MONITORING THE DESERTIFICATION

The assessment and analysis of processes the desertification and degradation of lands requires continuous monitoring both by ground (land) methods (field researches), as well as by remote sensing techniques. Important advantages of satellite images are efficiency, objectivity and independence of received information. Typical issues of such monitoring are control of a condition of a vegetative cover, allocation of erosion areas, bogging, salinity and desertification, definition of structure of soils, inventory of agricultural grounds. Satellite data for the different periods of time facilitate use of remote sensing for monitoring of change in a vegetative cover and land use. The automated technologies of processing and the analysis of satellite data are an important step in creation of monitoring system the farmlands in Uzbekistan. One of the problems of this system is improvement of a technique of an interpretation of space images for identification and the analysis of target objects of monitoring.

Interpretation of images is a method of research of territories (убрали лишнее) on aerial and space images which is the most important part of technological process by making thematic maps. Result of an interpretation is object identification, definition of their qualitative and quantitative characteristics, extraction information on the basis of the dependences existing between properties of objects and their display in images. The most common application problems solved on the basis of remote sensing (RS) from space, are investigating the characteristics and condition of the soil, vegetation and water bodies.

According to interpretive features we can identify certain properties of the soil: its texture, salinity, moisture regime, etc. The most clearly distinguished from the extreme properties of the soil: a very light texture, very strong saline, very strong waterlogged. The temperature of the surface layer of soil depends on the humidity [3], so it is possible to determine the moisture content of the soil in their temperature detected when at surveying in the infrared.

The shrubby and wood-shrubby vegetation in deserts is dated (belongs to) for river valleys, deltas [2]. The characteristic feature of vegetation for landscapes of semi-deserts and deserts is its mosaic structure and complexity. Semi-bushes, bushes, herbs, mosses, lichens differ in the small sizes. They have no specific image and do not create the drawing. So the image gives the integrated drawing. Its interpretation should perform on a complex of sign. It is necessary to have the knowledge of plants development and geography their placement for the interpretation a vegetation cover.
One of the main directions of using the multispectral images is creation - generation of color images for a visual interpretation. It is necessary to choose several colors and combine them to receive that synthesis image. The combination of colors in different ratios gives all variety of tints in the synthesized image.

Firstly, we need to select the types of classes of objects to do the classification. There is need to choose the reference sites for each class in the source images. After these preparations in the corresponding software environment (ArcGIS and ERDAS) we perform automatic classification: the program compares the spectral sign of each pixel with standard spectral signs and assigns it to one of the specified classes. The result is a new digital image; each pixel with a certain degree of probability corresponds to a particular class of objects.

The tone of fields in the image can be judged about their agro technical condition with using interpretation information on change of spectral brightness of vegetation during the vegetative period and an index of NDVI (Normalized Difference Vegetation Index) [5].

NDVI is also characterized by the density of vegetation. It allows plant growers to evaluate germination and plant growth, productivity land. Index is calculated as the difference between the values of reflection in the near infrared and red ranges of the spectrum divided by their sum. As a result the NDVI values change in a range from –1 to 1. The reflection in red area always is less than in the near infra-red for green vegetation. It occurs at the expense of light absorption by a chlorophyll and consequently NDVI values for vegetation cannot be a less than 0.

We received and processed images from Landsat-5 data base for parts of the territory of Uzbekistan including the Karakata Saline Depression (Central Kyzylkum) in Navoi region for 1998 and 2010. The synthesized image created by combination of original images of this territory, received in three spectral classes 1, 4 and 7 is shown on fig. 1. The visual analysis allows clearly seeing the vegetation, the salted sites and water objects with gradation on depth in the combined image. We have made the preliminary maps and calculate the area of sand, saline, water and vegetation on this site with use of the program ERDAS tools. Further detailed interpretation and definition of characteristics of the soil, vegetation and water was carried out on the basis of interpretation standards. The most obvious standards (water, sand, salt) are set by the operator-analyst. For more exact interpretation it is necessary to have the land data on studied characteristics (types and vegetation density, soil structure, water quality, salinity degree etc.). Some part of such data on the Karakata Saline Depression is already received by experts (soil scientists, hydrologists and botanists) in the field works and is in a processing stage. These ground-based data on the most representative sites, called thematic polygons, after binding to the space images are the standards of interpretation (references).

The Karakata Saline Depression belongs to the extremely arid and strongly arid territories with factor of aridity 0, 11-0, 30. The soil cover of a semidesertic and desert zone is presented by the zone brown semidesertic soils lying in a complex with solonetz and saline soils. Gray-brown sandy saline soils are dated for the foothill inclined plain combined by powerful of gravel and pebble deposits with sandy and easy loamy filler. According to the maintenance of the dry rest they can be characterized, as average and strong saline sulfate-chloride type with prevalence of anions of sulfate on anion and sodium-calcium salts on cationic structure. The soil of this saline zone is characterized by very big maintenance of $SO_4^{2-}$ (9463, 48 mg/kg) and the maximum concentration of Na about a maximum in the top layer (0-25 cm).
We can observe the distinct differentiation in the contents and distribution of microcells in the soil cover of the studied territory. Concentration of the majority of microcells in the same soils varies in big limits depending on their humus, the size pH, capacity of absorption, granulometric structure and a carbonate. It was revealed that as a result of soil-forming process there is a redistribution of elements on a profile. According to the chemical analysis of the soil are defined the anion and cationic structure (concentration $Ca^{2+}$, $Mg^{2+}$, $Na^+$, $K^+$, $HCO_3^-$, $Cl^-$, $SO_4^{2-}$), the maintenance of a humus and nutritious elements ($NO_3$, $P_2O_5$, $K_2O$) that allowed to define the main tendencies of a salinization conducting to degradation of pastures. It is established that prevailing type of a salinization of this territory is sodium- calcium-sulfate-chloride. A major factor of a salinization of soils in this region is existence of the numerous artesian wells which mineralization of waters varies from 2.9 to 9.1 g/l; value of electro conductivity of water strongly varies depending on a distance from a pollution source.

Modern technologies of farming require continuous monitoring of soil cover conditions and operative tracking of occurring changes on a wide range of parameters. Collecting and the analysis of detailed information on a condition of soils in different areas are not possible without use of information technologies. Thanks to this technology the process of creation of the detailed and informative maps with availability of its editing is possible, and also to create statistics on rural objects for the detailed analysis and use planning.
V. CONCLUSION

Remote Sensing methods are most effective at the solution of problems desertification since it is very difficult to solve this problem by land tools on the big areas. Repeated space imaging allows studying and defining seasonal rhythmic of landscapes of the desert: vegetation, adjournment of salts, desertification, erosion etc. In aggregate with data of the field observations, the latest computer programs allow to create huge volume of information in survey and mesoscale maps. Use of the automated interpretation of digital multichannel space images for the last years occurring at different times in comparison with a visual interpretation of a little summer prescription with data of the comparative analysis of earlier made maps allows defining dynamics of development of the main problems with high degree of reliability. On this basis the informative maps of bulge forming of the map of desertification can be made. As a whole with use GIS-technologies and the created database it is possible to develop a method of allocation and mapping of modern types of landscapes of the Kyzylkum Desert.

REFERENCES