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ARCHITECTURE. LANDSCAPE ARCHITECTURE

A.Jumanov, I.Norqobilov
Monitoring the dynamics of changes in land and forest cover using remote sensing and GIS in mountainous and mountainous areas of Kashkadarya region......5

ECONOMY. ECONOMIC SCIENCE. OTHER BRANCHES OF THE ECONOMY.

S. Umarov, F. Kadirkhodjaeva
Importance and benefits of using wastewater in irrigation farming.....9

F.Ahrorov
Revitalizing agriculture through organic practices: a comprehensive analysis of the Samarkand region's transition and consumer demand dynamics.....12

Sh.Murodov
Innovation as the main factor in the development of agriculture in the region.....17

U.Alimov
Ways to improve the forms of economic management: the network of policing.....21

B.Nosirov
The quality of livestock products is a key development factor of sphere.....24

Sh.Murodov, A.Mamasodikov
Theoretical foundations for the development of the agricultural products market inUzbekistan.....29

B.Raxmonova
Results of reforms in the field of walnut in Uzbekistan.....32

U.Sangirova, Z.Pardayeva
Foreign experience in flax production and its importance in the national economy.....36

Sh.Murodov, G.Arifjanova
Assessment of use and development of the region's tourism capacity.....40

O.Sattorov
Current trends in the development of farms in intensive horticulture.....44

Sh.Murodov, Sh.Muhammadjonov
Institutional concepts and theoretical-methodological basis of agricultural cooperation related with transactional costs in agriculture.....48

D.Islamova, S.Abdusalomov
The role of potato in agriculture and food production and ways of its development.....52

I.Yunusov
Foreign experience in developing the infrastructure of the fishing industry.....55

O.Shermatov
Issues of improving the organizational and economic mechanism in fruits and vegetables production.....59

M.Qobulova
Organizational and economic principles and evaluation methods of improving personnel competence in the development of agroclusters in Uzbekistan.....63

Z.Shodmonov
The importance of implementation of Islamic finance products to commercial banks.....66

S.R. Umarov, N.J. Mamanazarova, Kh.N Mirjamilova
Efficiency of modern technologies in increasing yield and improving soil fertility.....69

M.Kholikulov
Enhancing agricultural output in Uzbekistan: a study on fruit and vegetable production dynamics.....73

Sh.Sherkabilov
Assessment of the role of potatoes in ensuring food security and the impact of seed potato imports on sector development.....76

M.Inoyatova
Economic mechanisms of land use in agriculture.....79

HIGHER EDUCATION. PEDAGOGY.

F.B. Kilicheva
Development of critical thinking in the process of teaching russian to students of technical universities.....82

MONITORING THE DYNAMICS OF CHANGES IN LAND AND FOREST COVER USING REMOTE SENSING AND GIS IN MOUNTAINOUS AND MOUNTAINOUS AREAS OF KASHKADARYA REGION

A.Jumanov, I.Norqobilov - "Tashkent Institute of Irrigation and Agricultural Mechanization Engineers" National Research University

Abstract

Remote sensing and Geographical Information System (GIS) are the most effective tools in spatial data analysis. Natural resources like land, forest, and water, these techniques have proved a valuable source of information generation as well as in the management and planning purposes. This study aims to sug- gest possible bare land/open land, agriculture land, and forest land management strategies in mountains and highlands of Zaamin based on land cover analysis and the changing pattern observed during the last twenty years. Nowadays human encroachment is taking place for more land for the misuse of pastures. The changes were well observed in the land use and land cover in the study region. A large part of fallow land and open forest were converted into bare land/open land. Geo- informatics and remote sensing techniques give an opportunity to obtain results with low costs, less time consumption, and good accuracy of land cover changing. Continuously capture the Earth's surface and decision-makers can easily apply satellite imagery to monitor dynamics of change land cover.

Keywords: *Agriculture industry Forest cover Remote sensing Mountains and foothill.*

Introduction. Nowadays developing remote sensing technology and Geographic Information Systems (GIS) allow us to perform analysing and monitoring landscape ecology and spatial anal- ysis approach to address the problem of deforestation [1–3]. Monitoring and studying of recent changes in natural resources like land, forest using remote sensing and geo- information technologies have put forward a new dimension and interactive approaches in mapping and analysis. Studying forest resources during the last twenty years, the availability of remote sensing data is Landsat 5 TM, Landsat 8 OLI [4]. Land cover changes it embraces, for example, the quantity and type of surface vegetation, water, and soil cover. Land-cover changes fall into a modification class of land-cover. The latter is a change of condition within a land-cover category, such as the thinning of a forest, bare land/open land, and agricultural area composition [5]. The purpose of the research discussed in this paper was analysing land cover changes and creating map that occurred from 2001 to 2021, using pre-existing land cover map data sets as inputs. This work aimed to assess apparent land cover changes during the observed time frame mainly with respect to forest bare land and agricultural areas. Such information was needed to augment understanding and interpretation of land cover effects on remote sensing analysis [6].

In Central Asia, the work related to land cover change dynamics seen in the works of various researchers. Most researchers work on the land in a micro watershed in the mid-elevation zone of mountain and highland areas. The vegetation cover was altered drastically with inefficient land-use pressure (both human and animal), human activ- ities, and inefficient use of pastures. Geo-informatics and remote sensing analysis of give opportunity to increase machine learning capacity and obtain efficient monitoring land use and land cover changing [7]. Important in any studying any changes of land use creating map also key important of managing to complete mapping capacity may prevent completion of a lands create ecological penalties [8]. Remote sensing data anal- yse loggers can easily generate and store time and position information of monitoring large areas [9]. Remote sensing data analysis and algorithms can provide managers with essential information for analysing machine learning [10]. Information about land use and monitoring of land resources is essential for correct management planning and management the use land area of such resources.

Study Area. Kashkadarya region is a region of Uzbekistan with plains, mountains and mountain slopes, unique natural and climatic conditions. The total length of its borders is 795 kilometers, so 400 kilometers pass through mountain ranges. Its total area is 28.4 thousand km 2, which is 6.3% of the republic's land area. Its area is equal to the area of Albania, Netherlands, Belgium and Armenia. The territory of the region mainly includes the Kashkadarya basin; It is surrounded by Zarafshan and Hisar mountain ranges in the northeast and southeast. Hills occupy the gap between mountains and plains. A large part of the plain consists of the Karshi desert, bordering Sandiqli and Kyzylkum deserts in the west. The current relief forms of the Earth's surface were formed as a result of the interaction of internal (endemic) and external (exogenous) forces of the Earth over a long period of time, and the surface was not uniform. formed under the influence of internal forces in a long "geological process". On the other hand, small landforms are river valleys, ravines, hills, rocks, etc. - created under the influence of external (exogenous) forces of the earth. The main landforms of the terrestrial part of the Earth's surface are plains and mountains, 60% of the land area is occupied by plains and 40% by mountains. On the contrary, the plains occupy 43% of the territory of Asia. The places where the absolute height of the land surface is more than 500 m are called mountains. The area of mountains is 67.0 million km 2, which is 13.2% of the entire globe.

This study area is located on the northern slopes of the Turkestan ridge. This area an administrative division constitutes the discitis of Dehkanabad and Hussar, Kashkadarya region of Uzbekistan (Fig. 1). Preparation of remote sensing images of land cover for ten years was carried out in this study (2010, 2016 and 2020). Suggesting some possible measures for the improvement of the area based on the results obtained for land cover changes is the prime aim of this study. The region currently extends between 37° 58' N to 39° 32' N latitude and 64° 23' E to 67° 42' E longitude. The territory of the reserve is a mountain range with a well-expressed zonation: low land, middle and high mountains, located at an altitude of 250–4000 m above sea level. The southern part of the reserve occupies the steep slopes of the Turkestan ridge, cut by deep gorges; the northern part has a smoother relief with terraces covered with a thick

layer of marls and loess-like loams. On the territory of the reserve, three types of juniper grow together: Zerafshan, hemispherical and Turkestan. Juniper hemispherical forms mixed plantations in the upper part of the slopes with the Turkestan juniper, and in the lower part with the Zerafshan juniper.

The undergrowth layer is represented by shrubs: Turkestan hawthorn, Fedchenko's rose hip, Korolkov's honeysuckle, oblong barberry, multiflower cotoneaster, occasionally Tien Shan mountain ash is found among the rocks. In the reserve, at present, more than 700 species of higher vascular plants from 70 families, 280 genera have been identified, of which 13 species are included in the Red Book of the Republic of Uzbekistan, 48 species are endemics of the western part of the Turkestan ridge. The growth of 216 species of cap fungi – macromycetes –has been noted and studied. More than 20 species of medicinal plants grow here: aconite, colchicum, immortelle and valerian, ziziphora, snakehead, etc.; more than 15 decorative species: veronica, carnation, primrose, tulips, eremurus, crocuses, iris, delphinium, etc. [11–13].

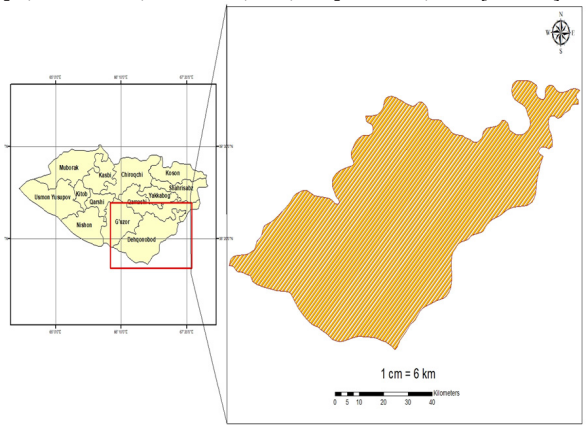

Figure 1. Study area Dekhanbad districts, Qashqadaryo region (Source: www.diva-gis.org/data adapted by ArcGIS).

To achieve additional increases of monitoring land cover changes, the grower deliber- ately applies approximately of the substance in certain areas of the area to test the correct application of remote sensing [12]. This technology became possible to the development of Geo-informatics, data progress in the land cover of automation of machinery learning, the development of remote sensing data and measuring complexes for collecting infor- mation in the land use land cover changes [10], understanding how land use land cover changing analysis [6] and assessing the effects of future land use change and monitoring [9].

Materials and Methods. For the current research data periods of 2010, 2016, and 2020, Landsat 5 TM and Landsat 8 OLI images provided by the USGS (United States Geological Survey) were downloaded from Earth Explorer database system. The spatial resolution of Landsat imageries is the equals 30 m. To analysing of the study area is mountainous and ground data reference for visual interpretation the classification of images used Google Earth Pro. Processing classification steps were completed using the software packages and tools ArcGIS 10.6. The data reprocessing steps included the assignment of the borders, coordinate system, and sub-setting the images based on the polygon of the research area. For Land classification were used supervised classification methods and maximum likelihood algorithm of ArcGIS. Figure 3. Maximum likelihood algorithms are most used and well-known in assessing Landsat satellite imageries [13]. Land classification classes were identified in the study area: bare land cover, forest, waterbodies, agriculture area and built-up areas. For obtaining more accurate land cover classification maps, for every land classes 20 training samples were selected from study area (Fig. 2).

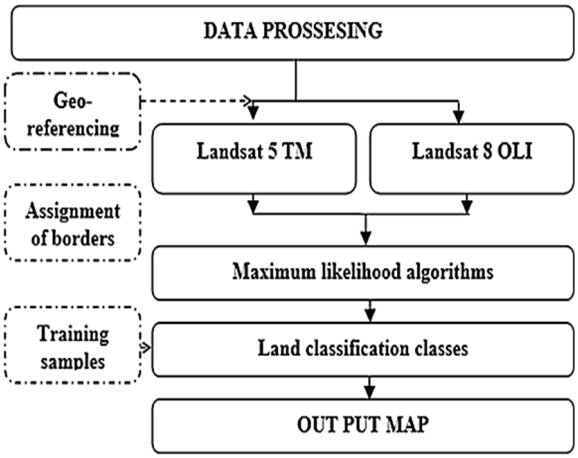

Figure 2. Flow chart for adopted methodology.

Results and Discussion. Results of study land use/ land cover index for transforming remote sensing data was pro- posed and evaluated for mapping forest area and bare land/open areas. The index was able to study of changing forest and bare land/open areas with a Maximum likelihood classi- fication. The classification indices could perfectly differentiate between forest and bare land/open land because both of these land types show significantly spectral responses in all Landsat 5 TM + bands, Landsat8 OLI. The 2010–2020 land cover change map indicates a mix of forest and bare land/ open land change classes. Although some of the study area has undergone noteworthy land cove change over the 10-year interval from 2010 to 2020, extensive areas of forest and bare lands were not converted to some other land use. Some of the apparent land cover change during the observation period appeared to be of an agricultural area. Figure 4. In addition, the land cover change map included areas with deforestation, which help to illustrate the dynamic anthropogenic factors of land cover changes in the region during the observed 10-year time frame.

The relief map of the study area is taken from the DEM file from the resource ear thdata.nasa.gov. The relief map of the studied area identifies the elevation zones of that area, and in the surface classification it is possible to determine at what altitudes the classification has changed. The results of the analysis show that between 2010 to 2020, forests in the study area, mainly in the area of 1000 m up to 2500 m, decreased and became open lands (Fig. 3).

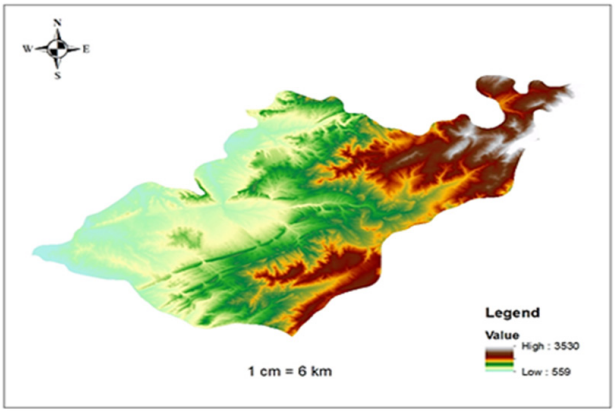

Figure 3. Relief map research area (Source earthdata.nasa.gov).

The Land cover changes index is rather a hint at what is currently happening on the land. Maximum likelihood algorithms usage for land analysis: at the beginning, in the middle, and at end of the growing season (summer). Growing of the season, the Maximum likelihood algorithms index helps to understand how the plant and trees has changes over the time (Fig. 4).

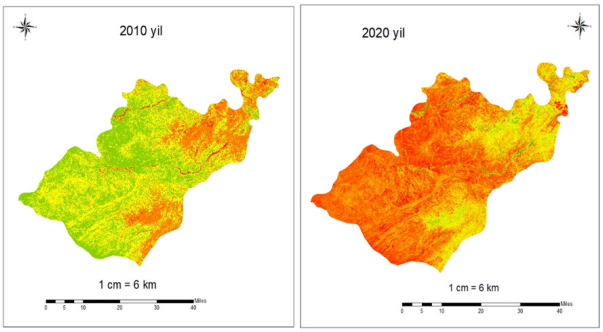

Figure 4. Land cover changing map.

Nevertheless, it should be kept in mind that high Maximum likelihood algorithms identification land cover classes needed to check using google earth pro this area. Land cover categories confirmed variation in the univariate statistical values of radiation heat flux parameters (Fig. 3). Spatial parameters characterized by gradational change in the values of each parameter. Figure 2 shows the range of each parameter under study with their average and standard deviation values gave the best results in terms of land cover classification accuracy. Figure 4 shows the comparison of classes and accuracy for every land cover classes for classifications. Land cover highlighted relative increase in accuracies for all the land cover categories forest and bare land which show increase and decrease in the classification accuracy.

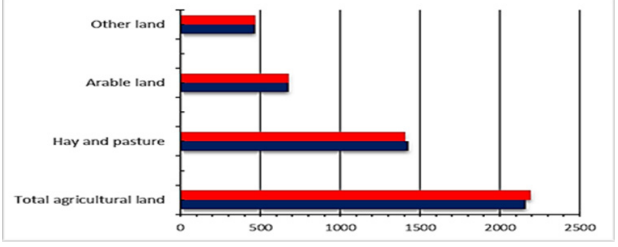

Figure 5. Land cover changing of twenty-years data (2010–2020).

A ten-year period from 2010 to 2020 was considered to analyse the land cover change pattern. In 2010, Hay and pasture covered approximately 56% of the total study area while bare land and open land constituted nearly 31%, and agricultural land covered approximately 10% of the area. Between 2010 and 2020, there was a significant increase in bare land and open land, which accounted for up to 46% of the total area. In contrast, forest cover decreased from 61% in 2010 to 41% in 2020, indicating a decline of 18% in the last 10 years.

Fallow land showed the highest change in the pattern. It is worth noting that during the initial year, i.e., 2010, nearly 32% of the total area was covered by bare land and open land, which increased by approximately 6% during the 10-year period. These changes in land cover were substantial, highlighting the need to monitor and manage land use effectively to maintain ecological balance and sustain natural resources.

Conclusion. Remote sensing methods with accurate Landsat data and monitoring results can support assessing the further behaviour of land cover monitoring. The achieved results show that within 10 years the land cover changes of the mountains and highlands of Kashkadarya significantly. As a result of 10 years of inefficient use of pastures in the mountainous and foothill areas of Kashkadarya, these areas have become open lands. The study area exhibits different land cover changes and that land changes can causes soil erosion, floods, and landslides in future – all of which can turn into hazards once elements are at risk. The land cover changing maps resulting from this study will be further used for landslide susceptibility mapping of study area, which will support the governmental authorities and stakeholders to establish land-use planning for the local government in order to prevent natural hazard losses.

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