Monitoring of Land and Forest Cover Change Dynamics Using Remote Sensing and GIS in Mountains and Foothill of Zaamin, Uzbekistan

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Ilhomjon Aslanov
TIIAME National Research University

Keunimjay Allanazarov
Karakalpak State University

Monitoring of Land and Forest Cover Change Dynamics Using Remote Sensing and GIS in Mountains and Foothill of Zaamin, Uzbekistan

Sokhib Islomov[1], Ilhomjon Aslanov[2,3,3](✉), Gulnaz Shamuratova[4], Azamat Jumanov[2], Keunimjay Allanazarov[5], Qazaqbay Daljanov[5], Marat Tursinov[5], and Qoylibay Karimbaev[5]

[1] Tashkent State Agrarian University, 2, University Street, Tashkent, Uzbekistan 100140
[2] Tashkent Institute of Irrigation and Agricultural Mechanization Engineers, 39, Kori Niyozi Street, Tashkent, Uzbekistan 100000
ilhomaslanov@tiiame.uz
[3] Philipps-Universität, 10, 35037 Biegenstraße, Marburg, Germany
[4] National University of Uzbekistan Named After Mirzo Ulugbek, 4, University Street, Tashkent, Uzbekistan 100174
[5] Karakalpak State University Named After Berdakh, Republic of Karakalpakstan, 1, Dosnazarova Street, Nukus, Uzbekistan 230100

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 suggest 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. Geoinformatics 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

1 Introduction

Nowadays developing remote sensing technology and Geographic Information Systems (GIS) allow us to perform analysing and monitoring landscape ecology and spatial analysis approach to address the problem of deforestation. [1–3]. Monitoring and studying

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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 activities, 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 analyse 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.

2 Study Area

This study area is located on the northern slopes of the Turkestan ridge. This area an administrative division constitutes the discitis of Zaamin and Bakhmal Jizzakh region of Uzbekistan (Fig. 1). Preparation of remote sensing images of land cover for ten years was carried out in this study (2001, 2011 and 2021). 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 39º 41’ N to 39º 38’ N latitude and 68º 51’ E to 68º 43’ 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].

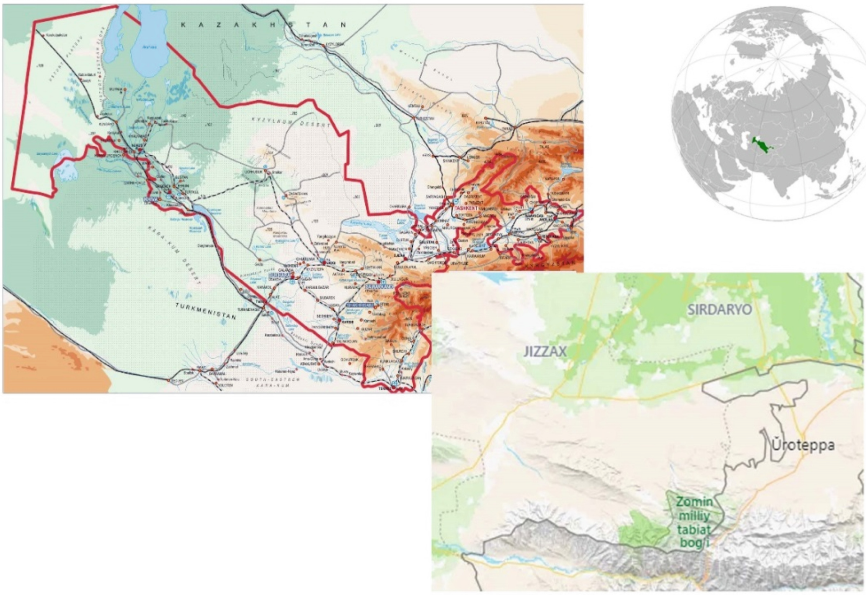

Fig. 1. Study area (*Source* GRID-Arendal and www.earthexplorer.usgs.gov).

To achieve additional increases of monitoring land cover changes, the grower deliberately 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 information 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].

3 Materials and Methods

For the current research data periods of 2001, 2011, and 2021, 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).

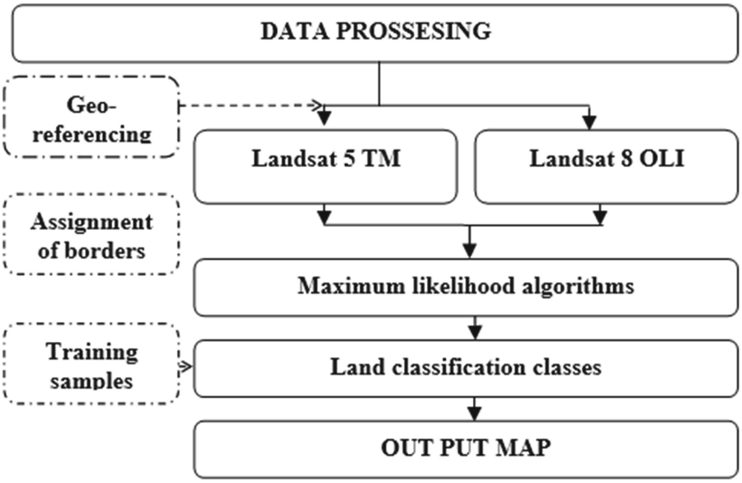

Fig. 2. Flow chart for adopted methodology.

4 Results and Discussion

Results of study land use/land cover index for transforming remote sensing data was proposed 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 classification. 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 2001–2021 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 20-year interval from 2001 to 2021, 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 20-year time frame.

The relief map of the study area is taken from the DEM file from the resource earthdata.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 2001 to 2021, forests in the study area, mainly in the area of 1000 m up to 2500 m, decreased and became open lands (Fig. 3).

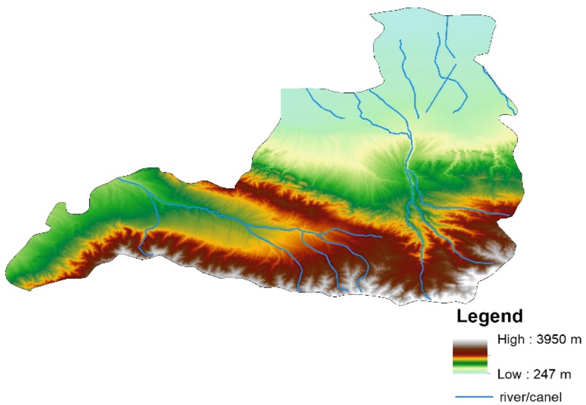

Fig. 3. Relief map research area (*Source* earthdata.nasa.gov).

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).

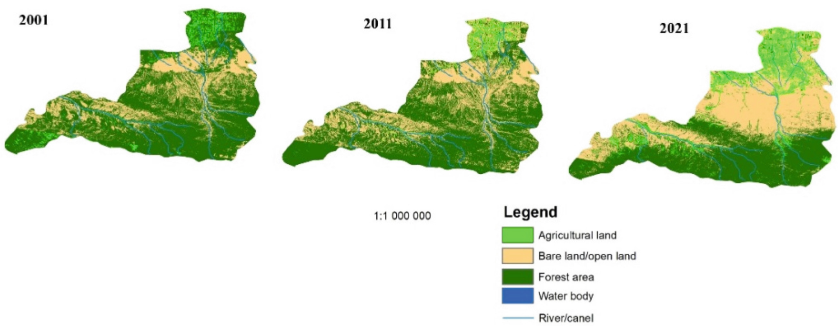

Fig. 4. Land cover changing map.

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.

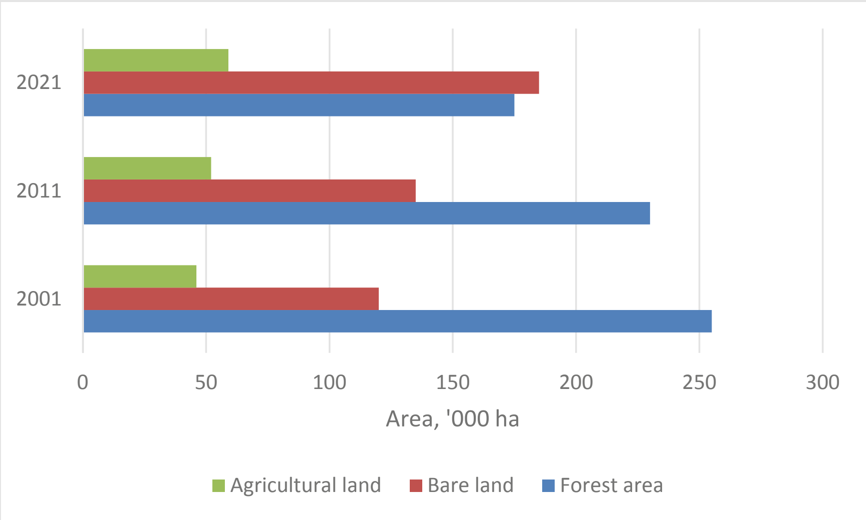

Fig. 5. Land cover changing of twenty-years data (2001–2021).

Twenty-year data (2001–2021) have been taken into account to analyse the pattern of land cover changes (Fig. 5). For the year 2001, Forest area covered nearly 61% of the total area of study area. Bare land and open land constituted nearly 28%, agricultural land covered nearly 12% of the area. Year 2011, displayed nearly 32% share area under the total Bare land and open land an increase in nearly 7% during the 2001–2011. Dense forest covered 55% of enhancement of the total area, as it was nearly 7% increasing in the year 2001–2011. From 2011 to 2021 changes are significantly bare land and open land an increase up to 45% of total area. And forest has decreased from 61% (2001) to 42% in the year 2021. This shows a decrease of forest are 19% during the last 20th years. Fallow land shows the highest change in the pattern.

5 Conclusions

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 20 years the land cover changes of the mountains and highlands of Zaamin significantly. As a result of 20 years of inefficient use of pastures in the mountainous and foothill areas of Zaamin, 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.

References

1. Kulmatov, R., Khasanov, S., Odilov, S., Li, F.: Assessment of the space-time dynamics of soil salinity in irrigated areas under climate change: a case study in Sirdarya province, Uzbekistan. Water Air Soil Pollut. **232**(5), 216 (2021)
2. Lehoczky, M., Abdurakhmonov, Z.: Present software of photogrammetric processing of digital images. E3S Web Conf. **227**, 04001 (2021)
3. Oymatov, R., Safayev, S.: Creation of a complex electronic map of agriculture and agro-geo databases using GIS techniques. E3S Web Conf. **258**, 03020 (2021)
4. Oymatov, R.K., Mamatkulov, Z.J., Reimov, M.P., Makhsudov, R.I., Jaksibaev, R.N.: Methodology development for creating agricultural interactive maps. IOP Conf. Series: Earth Environ. Sci. **8680**, 12074 (2021)
5. Makhmudova, U., Djuraev, A., Khushvaktov, T.: Environmental flows in integrated sustainable water resource management in Tuyamuyin water reservoir, Uzbekistan. IOP Conf. Series: Earth Environ. Sci. **937**, 032024 (2021)
6. Kulmatov, R., Mirzaev, J., Taylakov, A., Abuduwaili, J., Karimov, B.: Quantitative and qualitative assessment of collector-drainage waters in Aral Sea Basin: trends in Jizzakh region Republic of Uzbekistan. Environ. Earth Sci. **80**(3), 122 (2021)
7. Liu, Y., et al.: Sustainable use of groundwater resources in the transboundary aquifers of the five Central Asian countries: challenges and perspectives. Water **12**(8), 2101 (2020)
8. Matyakubov, B., Goziev, G., Makhmudova, U.: State of the inter-farm irrigation canal: in the case of Khorezm province. Uzbekistan. E3S Web Conf. **258**, 03022 (2021)
9. Khasanov, S., et al.: Landslides in Central Asia: a review of papers published in 2000–2020 with a particular focus on the importance of GIS and remote sensing techniques. GeoScape **15**(2), 134–144 (2021)
10. Gerts, J., Juliev, M., Pulatov, A.: Multi-temporal monitoring of cotton growth through the vegetation profile classification for Tashkent province Uzbekistan. GeoScape **14**(1), 62–69 (2020)
11. Aslanov, I., Kholdorov, S., Ochilov, S., Jumanov, A., Jabbarov, Z., Jumaniyazov, I., Namozov, N.: Evaluation of soil salinity level through using Landsat-8 OLI in Central Fergana valley Uzbekistan. E3S Web Conf. **258**, 03012 (2021)
12. Khasanov, S., et al.: Evaluation of the perennial spatio-temporal changes in the groundwater level and mineralization, and soil salinity in irrigated lands of arid zone: as an example of Syrdarya Province Uzbekistan. Agricult. Water Manage. **263**, 107444 (2022)
13. Inamov, A., Avilova, N., Norbaeva, D., Mukhammadayubova, S., Idirova, M., Vakhobov, J.: Application of GIS technologies in quality management of land accounting in Uzbekistan. E3S Web Conf. **258**, 03014 (2021)