DETERMINATION OF FOREST COVER CHANGE IN SHAKI-OGHUZ DISTRICTS

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Abstract: This article investigates the changing trends in the territory of Shaki and Oghuz districts of Azerbaijan, especially in the forest cover, and studies the floristic composition of the forests. The research includes the registration of the species composition of forests from various points in the regions and collection of literary information. To study the changing processes, the chlorophyll index method based on the reflection of chlorophyll in leaves (CIgreen) was applied. For this research, multispectral images from 1987 to 2022 were obtained from the Landsat satellite database of the United States. Additionally, comparing the suitability of weather conditions and the vegetation period suitable for mountainous terrain, a comparison of July months was conducted using the ArcGIS Pro platform. The results of the analysis show that the density of forests in the territory of Shaki region has decreased (Figure 1). During the desert research in the forest ecosystems of Shaki and Oghuz regions, a total of 147 species belonging to 45 families and 118 genera were identified in the area. In Shaki region, approximately 2969 ha of surface covered by water or ice (-1), 5169 ha of open land cover (0), 10437 ha of dense forests (3), and 1106 ha of high-density forests have decreased, while medium-density or sparse forests, woodlands, and shrubs have increased by 19684 ha. 11543 ha of dense forest vegetation was replaced by medium-density forest or shrubs. The density of forests in the territory of Oghuz region has also decreased (Figure 2). Approximately 2719 ha of surface covered by water or ice (-1), 22047.84 ha of dense forests (3), and 1106 ha of high-density forests have decreased, while open land cover (0) has increased by 4290 ha, and medium-density or sparse forests, shrubs, and vineyard areas have increased by 20951 ha. 22521 ha of dense forest vegetation was replaced by medium-density forest or shrubs. Approximately 1500 ha of forest area has been lost as land over the years 1987-2022.
Keywords: landsat, forest density, vegetation cover, chlorophyll reflection

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Introduction:

The Caucasus region, renowned for its rich biodiversity and unique ecosystems, harbors a diverse array of flora and fauna, making it a global biodiversity hotspot (Abiyev, 2020a). Among the countries within this region, Azerbaijan stands out with its remarkable natural landscapes, including the Oghuz-Shaki region, which is characterized by its lush forests and unique biodiversity (Mehdiyeva & Mursal, 2022).

Over the past decades, however, the Oghuz-Shaki region has experienced significant changes in its forest cover, influenced by both anthropogenic activities and natural factors. These changes have raised concerns about the preservation of biodiversity and the sustainable management of natural resources in the region (Mehdiyeva & ets, 2022).

Understanding the dynamics of forest cover change in the Oghuz-Shaki region requires an analysis of various factors, including land use,

land cover changes, and the impacts of human activities. Anthropogenic factors such as deforestation, agricultural expansion, and infrastructure development have played a significant role in altering the natural landscape of the region. Additionally, natural factors such as climate change and natural disasters have also contributed to changes in forest cover.

Studying changes in forest ecosystems using aerospace remote sensing is crucial for the sustainable management of biodiversity (Fescenko & Wohlgemuth, 2017). The analysis of plant spectra is important for evaluating plant health (Brown & ets, 2019). The process of satellite image processing relies on the differential absorption, transmission, and reflection of the electromagnetic spectrum using passive sensors, including red, blue, green, and infrared (Wu & ets, 2012). The biochemical and biophysical properties of green leaves affect their reflection spectrum (Hunt & ets, 2013). Monitoring chlorophyll content in leaves (green biomass) is not only useful for assessing plant physiology, production, and nutritional status, as well as detecting aging and stress due to drought and disease spread, but also for measuring changes in forest cover boundaries and density (Darvinzadeh & ets, 2019). Vegetation indices are now considered a simple, rapid, and cost-effective method by researchers (Le Marine & ets, 2008). The "Chlorophyll Index Green" (CIgreen) is commonly used to estimate chlorophyll content in leaves (Croft & ets, 2013). "CIgreen" is directly related to the difference between the reflectance of broad green and near-infrared wavelengths (Yin & ets, 2016).

This article aims to provide a comprehensive analysis of the dynamics of forest cover change in the Oghuz-Shaki region, focusing on the interactions between anthropogenic and natural impacts. By examining historical trends and current patterns of forest cover change, this study seeks to identify the key drivers of change and their implications for biodiversity conservation and sustainable land use practices.

Material and Methods:

Research was conducted in the territories of Shaki and Oghuz regions of Azerbaijan (Figure 1). The structure of these forests is similar to each other, mainly represented by 27 species that mainly constitute the forest community. *Quercus petraea* subsp. *polycarpa* (Schur) Soó, *Carpinus betulus* L., *Fagus orientalis* L., *Alnus incana* (L.) Moench, and *Carpinus orientalis* L. are the dominant species in the forests. Additionally, *Crataegus monogyna* Jacq., *Crataegus pentagyna* Waldst. & Kit. ex Willd., *Cotinus coggygria* Scop., *Mespilus germanica* L., *Populus alba* L., and *Fraxinus excelsior* L. are the main components of the forests.

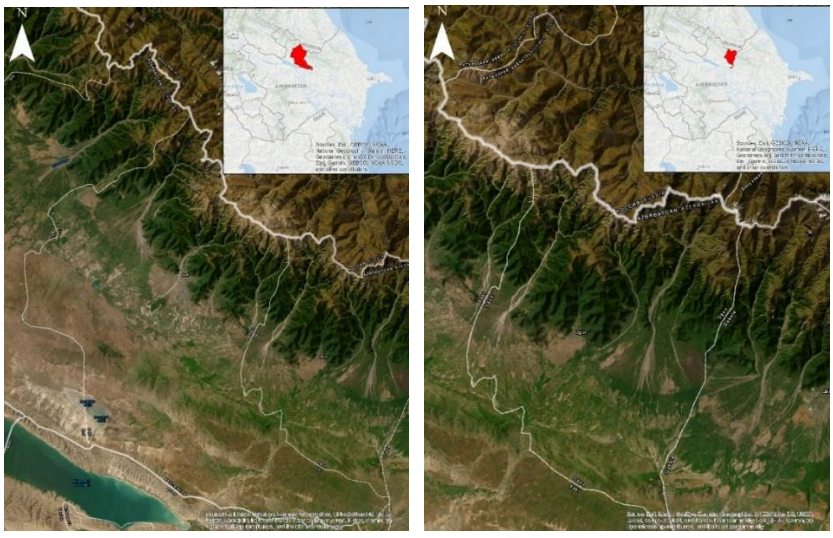

Figure 1. Study area.

This research utilized multispectral images obtained from the Landsat satellite database between 1987 and 2022. Additionally, a comparison of June and July was conducted based

on the suitability of weather conditions and vegetation periods for mountainous terrain. The research was carried out using the ArcGIS 10.8 platform. Infrared (Landsat 5 - Band 4; Landsat 8 - Band 5) and green (Landsat 5 - Band 2; Landsat 8 - Band 3) bands in the images taken with the Landsat sensor are standard bands applied in chlorophyll indexing. Calculations are based on the ratios of values owned by each pixel in the images (Gitelson et al., 2003).

$$CIgreen = (NIR/GREEN) - 1$$

"CIgreen" - chlorophyll index green, NIR - near-infrared wave, GREEN - green wave.

The values of the chlorophyll index increase from -1. The spatial expression of the values obtained in our results is as follows: -1 - water, ice, stone, etc., 0 - non-vegetated, dead vegetated (e.g., harvested crop area) soil areas, steppe and semi-desert zones, 1 - normal density forests, forest-shrub vegetation, sparse floodplain forests, etc., 2 - dense forest cover, healthy or in the best condition of vegetation period, 3 - very dense forest or vegetation.

The areas covered by pixel values were calculated by multiplying the number of pixels by the area of each pixel:

$$Area = cell\ count \times cell\ area$$

"Cell count" - number of pixels on the value

The change was calculated according to the following rule (Badamasi & Yelwa, 2010):

$$Change\ rate = D_{last} - D_{first}$$

"D_{first}" and "D_{last}" respectively represent the beginning (1992) and end (2017) of the research year.

The pixel dimensions in Landsat images are 30 m.

Cell area = 30 m × 30 m = 900 m^2 = 0.09 ha

"Cell area" - area covered by one pixel.

Results and discussion:

During desert studies conducted in the forest ecosystems of Shaki and Oghuz regions, a total of 147 species belonging to 118 genus and 45 families were identified. Among the families, the most represented in terms of genera and species are *Poaceae* Barnhart (9 genera, 11 species), *Boraginaceae* G. Don. (7 genera, 8 species), *Rosaceae* Juss. (15 genera, 18 species), and *Asteraceae* Bercht. & J.Presl (5 genera, 6 species). Other families are represented by fewer genera and species. Based on life forms, out of the 147 species, 27 are trees, 16 are shrubs, 1 is a shrub-liana, 12 are herbaceous monocots, and 91 are herbaceous dicots. Of these, 11 are Caucasus endemics, and 11 are rare species included in the 3rd edition of the Red Book of the Republic of Azerbaijan.

Currently, approximately 19.7% of the district's territory is covered by forests. The analysis results show that the density of dispersed forests in Shaki district has decreased (Figure 1). In July, the area covered by water or glaciers (-1) decreased by approximately 2969 ha, open soil cover (0) by 5169 ha, dense forests (3) by 10437 ha, and high-density forests by 1106 ha, while medium-density or sparse forests, shrub vegetation, and intensive vineyards increased by 19684 ha. 11543 ha of dense forest vegetation has been replaced by medium-density forest or shrub vegetation (Table 1). The decreases mainly cover the high mountainous zone. Between 1987 and 2022, approximately 8000 ha of tree-based greenery has increased in the area, the majority of which consists of dense groves of apple, almond, hazelnut, and other trees in the northwest direction of the district. Overall, 68000 ha of forests, shrubbery, and vineyards are recorded in the district, of which 48000 hectares are forested areas, 28000 hectares are riverbanks and other shrubberies, fragmented small groves, and tree-based intensive vineyards.

Table 1. Comparison of Shaki region for July of 1987-2022.

Index	Pixel count (July 1987)	Area (ha)	Pixel count (July 2023)	Area (ha)	Change (ha)
-1	36670	3300.3	3682	331.38	-2968.92
0	1976297	177866.73	1918860	172697.4	-5169.33
1	453898	40850.82	672606	60534.54	+19683.72
2	204626	18416.34	88655	7978.86	-10437.48
3	12287	1106.91	0	0	-1105.83

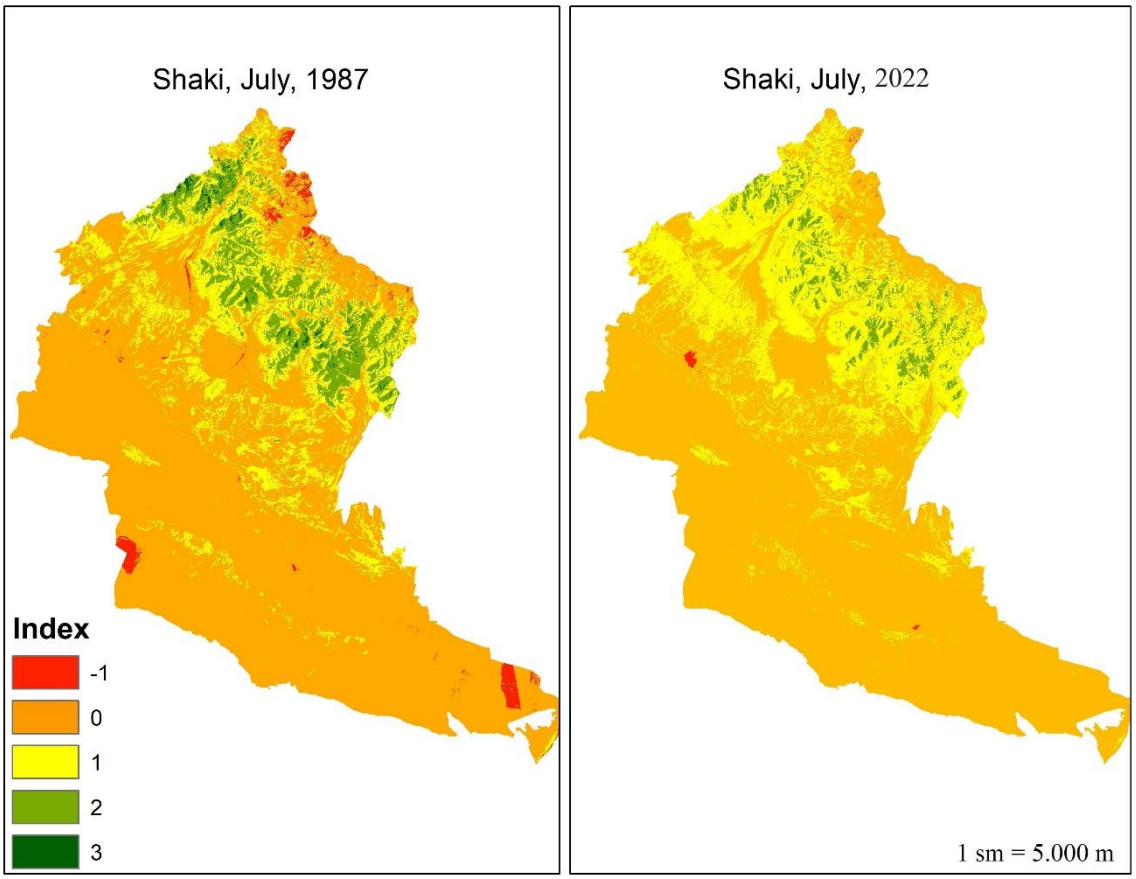

Figure 2. Surface and vegetation changes in Shaki district between 1987 and 2022.

Currently, approximately 26.9% of the region is covered with forest. The results of the analyzes show that the density of the forests spread in the territory of Oghuz region has decreased (Figure 2). As of July, the approximate surface covered by water or glaciers decreased by (-1) 2,719 ha, dense forests (3) by 22,047.84 ha, and high-density forests by 1,106 ha, dense forests (3) by 10,437 ha, and high-density forests by 473.4 ha has decreased, on the contrary, open land cover (0) has increased by 4290 ha, medium density or sparse forest, shrub vegetation and garden areas have increased by 20951 ha. 22,521 ha of dense forest vegetation was replaced by medium-density forest or shrub vegetation (Table 2). Between 1987 and 2022,

approximately 1500 ha of forest area was destroyed. In total, approximately 55,000 ha of forest, fragmented groves, shrub vegetation, and tree-based gardens were registered in the region. 29,000 ha of these green areas are covered by primary forest.

Table 2. Comparison of Oghuz district in July of 1992-2017.

Index	Pixel count (July 1987)	Area (ha)	Pixel count (July 2013)	Area (ha)	Change (ha)
-1	32985	2968.65	2770	249.3	-2719.35
0	500316	45028.44	547979	49318.11	+4289.67
1	351167	31605.03	583956	52556.04	+20951.01
2	278119	25030.71	33143	2982.87	-22047.84
3	5260	473.4	0	0	-473.4

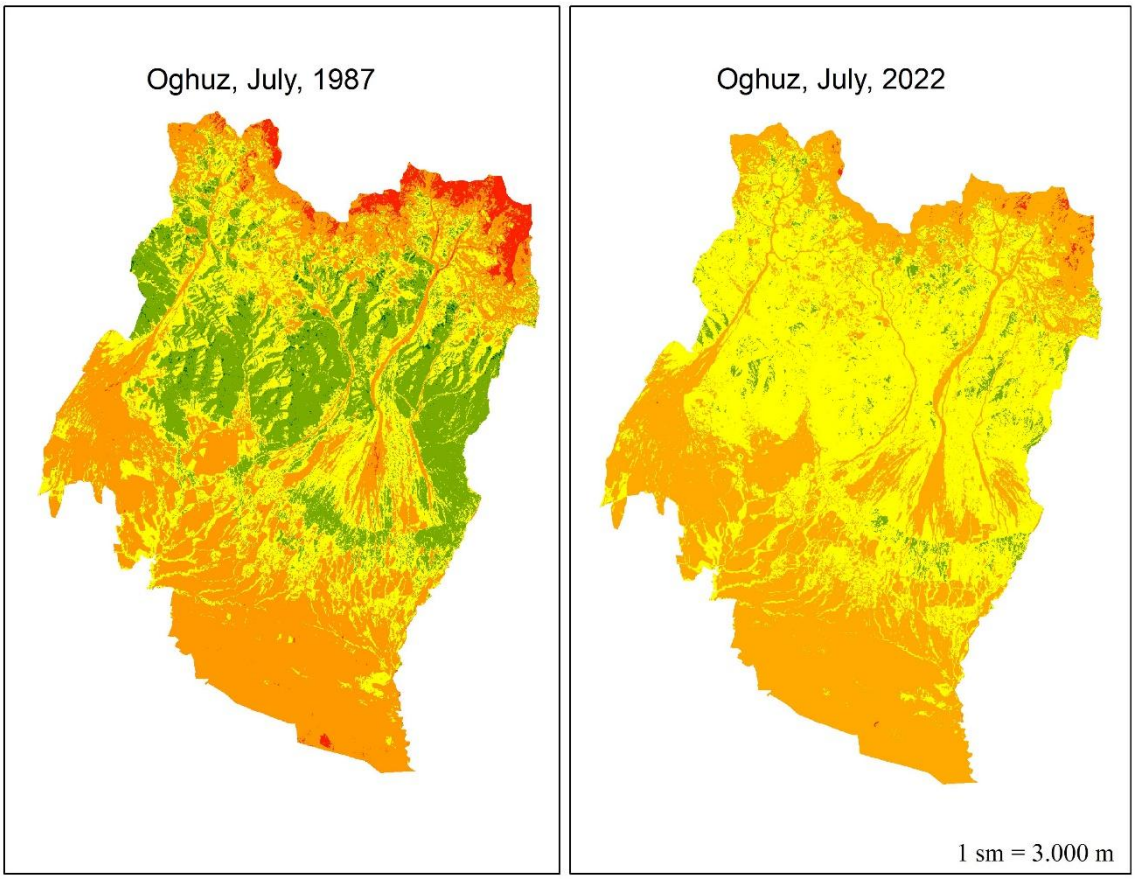

Figure 3. Surface and vegetation changes in Oghuz region between 1987 and 2022.

Conclusion:

Research conducted in the Samur-Yalama National Park in Khachmaz has shown a similar decrease of 12% in density. However, unlike in Sheki and Oguz regions, borders have remained stable (Abiyev & ets, 2020b). Research in Zangilan has shown a decreasing trend in density, but an increase in patches of natural vegetation has been observed due to the area being unused as a result of occupation (Abiyev, 2021).

Illegal logging and forest fires in the past in Oguz and Sheki regions have contributed to the decrease in forest cover. Furthermore, the development of intensive horticulture in Sheki, especially the expansion of vineyards, has had a positive impact on increasing tree cover.

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