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Investigation of The Dynamics of Landscapes on The Basis of Vegetation Indication (Sample Area along Kura River)

Peyzaj Dinamiğinin Bitki Örtüsü Gösterme Esasına Göre İncelenmesi (Kura Nehri Üzerindeki Örnek Alan)

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Abstract: *The dynamics of landscapes in the Kura River, inhabited by highly populated, were studied based on the change in the nature of the surface cover, especially the NDV index. During the study, vegetation was considered as a key indicator. The NDV index was compared with Landsat 5 and 8 satellite data for different years (2002, June 14 and 2019, June 9) and anthropogenic changes were determined. Acquired materials were processed in ArcGIS version 10.3 and maps showing the NDV index for the relevant periods were made by us. In the end, these maps were compared, the areal of the territories reflecting the performance of the index were compared, and the impact of anthropogenic factors on the dynamics of landscapes were analyzed. The study area covers 1,764 km2, extending 255 km along the Kur river. The area extends from Mingachevir reservoir to Carli village of Kurdamir district. The study area is divided into 5 sectors at a distance of 50 km for a clear view of the dynamics of landscapes.*
Key words*: NDVİ, Kura river, anthropogenic effects, Landsat 5 and 8, GIS.*

Özet: *Çok kalabalık olanların yaşadığı Kur nehri'ndeki manzara dinamikleri, yüzey örtüsünün niteliğindeki, özellikle de NDV endeksindeki değişime dayanarak incelenmiştir. Çalışma sırasında, bitki örtüsü kilit bir gösterge olarak kabul edildi. NDV endeksi, farklı yıllar için (2002, 14 Haziran ve 2019, 9 Haziran) Landsat 5 ve 8 uydu verileriyle karşılaştırıldı ve antropojenik değişiklikler belirlendi. Elde edilen malzemeler ArcGIS 10.3 versiyonunda işlenmiş ve ilgili dönemlere ait NDV endeksini gösteren haritalar tarafımızca yapılmıştır. Sonunda, bu haritalar karşılaştırılmış, endeksin performansını yansıtan alanların alanlarının karşılaştırılması yapılmış ve antropojenik faktörlerin peyzaj dinamikleri üzerindeki etkisi analiz edilmiştir.*
Çalışma alanı, Kur nehri boyunca 255 km. Bölge, Mingachevir rezervuarından Kurdamir bölgesindeki Carli köyüne kadar uzanır. Çalışma alanı, peyzaj dinamiklerini net olarak görmek için 50 km mesafedeki 5 sektöre ayrılmıştır.
Anahtar sözcükler: *NDVİ, Kura nehri, antropojenik etkiler, Landsat 5 ve 8, CBS.*

1. Introduction

Investigation area covers hydromorph and semi-desert landscapes along Kura river on the intensive tectonic depression of Kura-Araz plains in Azerbaijan. It covers 2% area of the Azerbaijan Republic.

The Kura River is used both for irrigation and drinking water throughout the country. At one time, there were extensive Tugai forests along the Kura River. However, as a result of anthropogenic impact the area of these forests has sharply decreased. Structural-geomorphological studies of Shirinov N.Sh. (Shirinov, 1963) were used to make some adjustments based on landscape studies in the separation of morphostructures in the Kur-Araz lowland. Kura-Araz lowland are divided into 5 landscape-ecological morphostructures regions due to modern and new tectonic distribution regime, tectonic structure, lithological composition of the rocks, character and distribution of exogenous processes, and landscape generally. 1. Hydromorphic-acoustic complexes of accumulative alluvial-lake plains along Kura River, 2. Semi-deserts of Shirvan accumulative alluvial-proluvial palin, 3. Semi-deserts and steppes of Mughan accumulative alluvial plain, 4. Semi-deserts of hilly denudation-accumulative alluvial plains along Caspian Sea shore and 5. Semi-deserts of Salyan accumulative smooth alluvial-marine plain (Ismayilov, 2010,2011,2014). Hydromorphic-acoustic complexes of accumulative alluvial-lake plains along Kura River cover a very large landing area of the Kura-Araz lowland. At present, the process of sedimentation is in progress. This complex is different from other morphostructures of Kura-Araz plain due to landscape-ecological features. The Kura River flows through the central part of this plains, creating complex meandr curves. Standing lakes formed during the final stage of meandr curves and their development have played an important role in the landscape-ecological differentation and formation of accumulative plain along Kura River. Most of standing lakes dry up during summer months and a thick layer of salt is formed at the bottom. Most of these lakes are surrounded by dense tamarisks and sometimes with shrubs. Nutrition sources of lakes are flood waters and precipitation. 54 meandr curves from Mingachevir to the mouth of Gargar river where the first curve is creted along Kura river and 24 standing lakes on the left bank of the river are observed (Ismayilov and Amanova, 2015; Guliyeva, 2014, 2017).

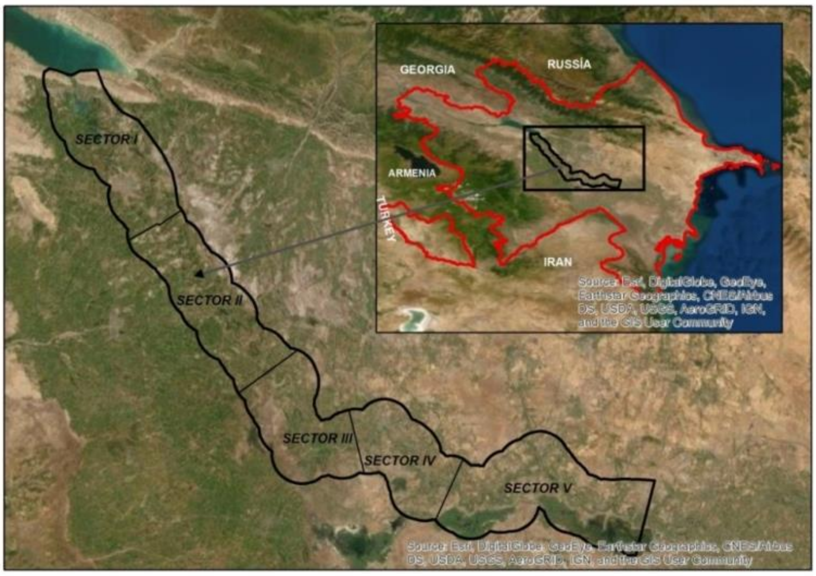

Figure 1. Location of investigation area.

In this section, two terraces levels are clearly selected in the Kura River and Tugai forests including poplar, willow, elm, bindweed and etc. are formed over them. According to tectonic fractures, the Kura River extends in latitude from the mouth of Gargar river to the northeast to the Zardab city. At the result many standing, dry and relict river valleys stand on the left bank of river (Amanova, 2015, 2016). Alluvial-lake-chala plains along Kura river are divided into two parts like right and left banks due to morphological features. Left bank plains of Kura river cover areas to the Garasu depression in the north. Right bank plains of Kura river cover areas extending to the zero line horizontally areas on the shore of Caspian Sea (Ismayilov, Mammadbeyov, Yunusov and Amanova, 2012). According to the investigations, plains along Kura river and their hydromorph and semidesert landscapes have been formed in Khvali and Holosen. The formation of the plain and natural systems that have formed on its surface is still underway. Many positive and negative relief forms in the plains give hilly, roughly forms to them. This also strengthens the internal differentiation of the landscape and causes the formation of more complex structural landscapes (Figure 2).

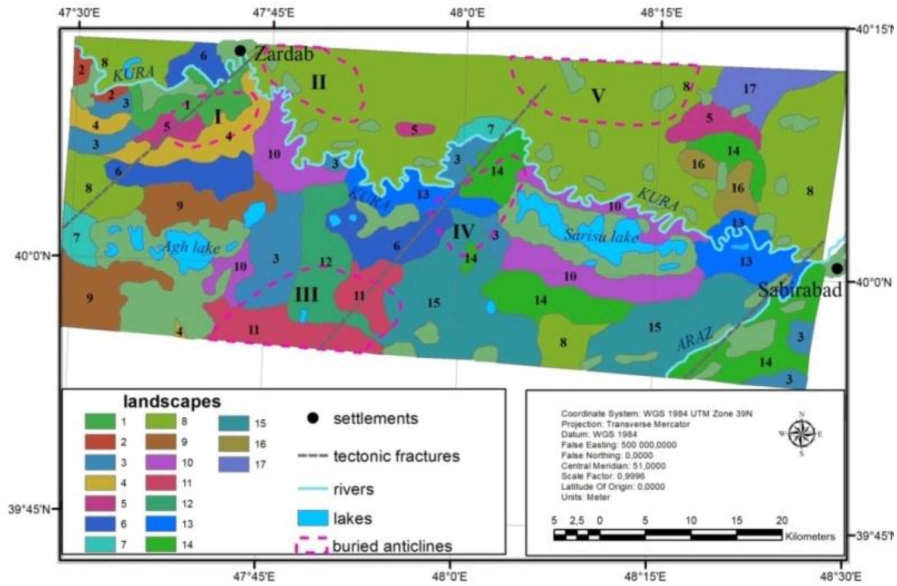

Figure 2. Effects of buried aticlines to the formation of landscape-ecological structure of accumulative alluvial-lake-chala plains along Kura river.

1. Repeated tamarisks in place of Tugai forests, 2. field complex in place of chala-saline plants, 3. field complex in place of chala-saline, artemis-saline plants, 4. Iris, grain-iris 5. Artemis semi-deserts, 6. Hole-meadow plants, 7. Salsola, 8. Semi-desert with artemis, artemisian-salsola, hole-salsola, 9. Semi-desert with artemisian-salsola, 10. Marsh-meadow, tamarisk-sedgering, 11. Semi0desert witk eolian hills, 12. Salsola, hole-meadow, cultural plants, 13. Grain, reedian-grain, 14. Artemis, 15. Cultural plants with salsola-ephemer, 16. Ephemer, poa-bulbosa, 17. Caragana

Buried anticlines: I. Sotheren Zardab, II. Northeren Zardab, III. Shirin Sand, IV. Mammadli, V. Chartaz

Extension of hills to the east along the Kura and occurrence of marine sediments in the Shirin-sand natural boundary region are connected with the buried anticline (Shirinov N.Sh., 1963). Deflation processes intensified as the result of opening the surface of the sea sands in some places and small lakes of eolian origin were formed in depressions (Ismayilov M.J. and Amanova Sh.S, 2018).

The rise of the land relative to the modern valley of Kura river contributed to the formation of the Agh, Mehman and Sarysu lakes in the middle part of the right plains along Kura river. Formation of these lakes along Kura river and apeearing meandrs are connected to the buried anticlines.

2. Material and Methodology

We have used traditional and modern methods, such as, mathematical-statistical, observation, comparison, cartographic, systematic analysis, historical-geographical, aerospace, field research.

Vegetation index can be used as an indicator to quantify the greenness of plants within remote sensing materials. There are a lot of vegetation indexes, but an important index to use is the Normalized Difference Vegetation Index (NDVI). By analyzing images recorded from visible red (RED) and near-infrared (NIR) wavelengths, we can determine the coverage of vegetation in the investigation areas. We can express NDVI as following (Rouse , Haas , Deering and Sehell, 1974):

$$NDVI = (NIR - RED) / (NIR + RED)$$

Normalized Difference Vegetation Index (NDVI) was calculated using following equation. During analyzes we use Band 4 and 5.

$$NDVI = (Band\ 5 - Band\ 4) / (Band\ 5 + Band\ 4)$$

The NDVI values range from –1 to +1. But in the investigation area these values range from -0.26 to +0.67.

3. Results

We have learned NDV indexes based on remote sensing materials. We have prepared NDV index maps of the investigation area, during 2002 and 2019 years (Figure 3 and 4). In the end, these maps were compared, the areal of the territories reflecting the performance of the index were compared, and the impact of anthropogenic factors on the dynamics of landscapes were analyzed (Figure 5).

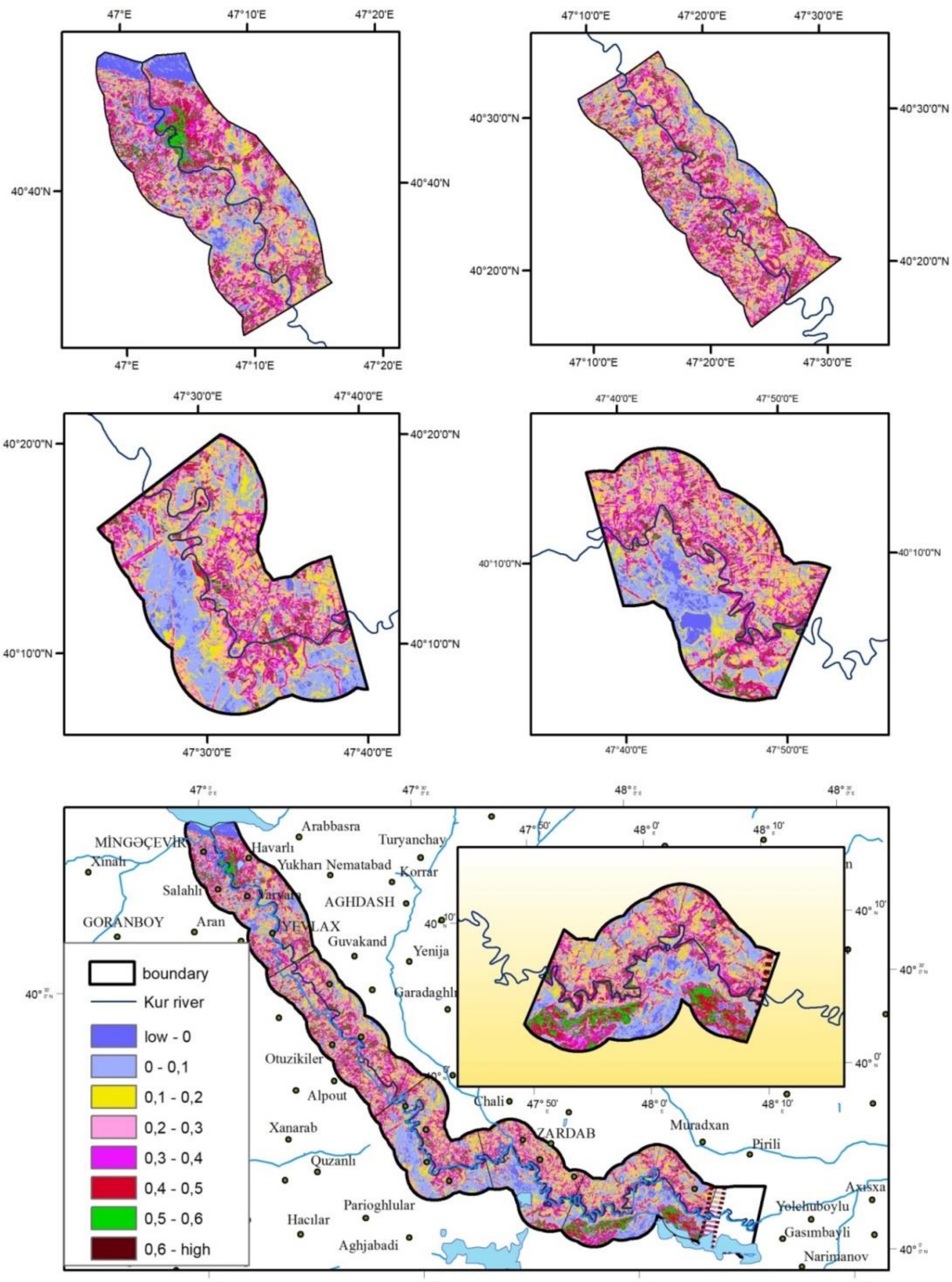

Figure 3. NDV index at a distance of 5 km from the Kurariver coast (2002, June 14).

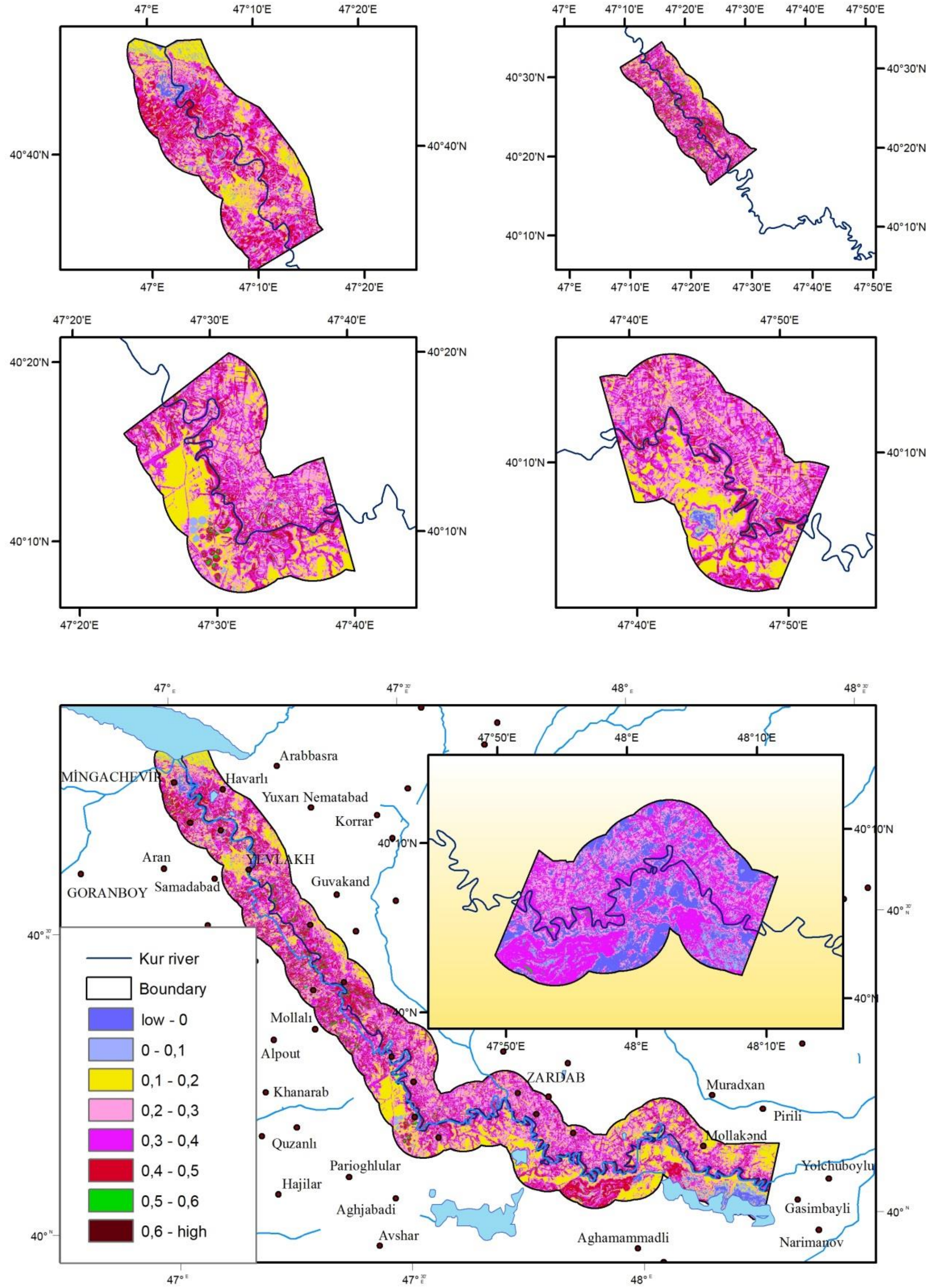

Figure 4. NDV index at a distance of 5 km from the Kurariver coast (2019, June 9).

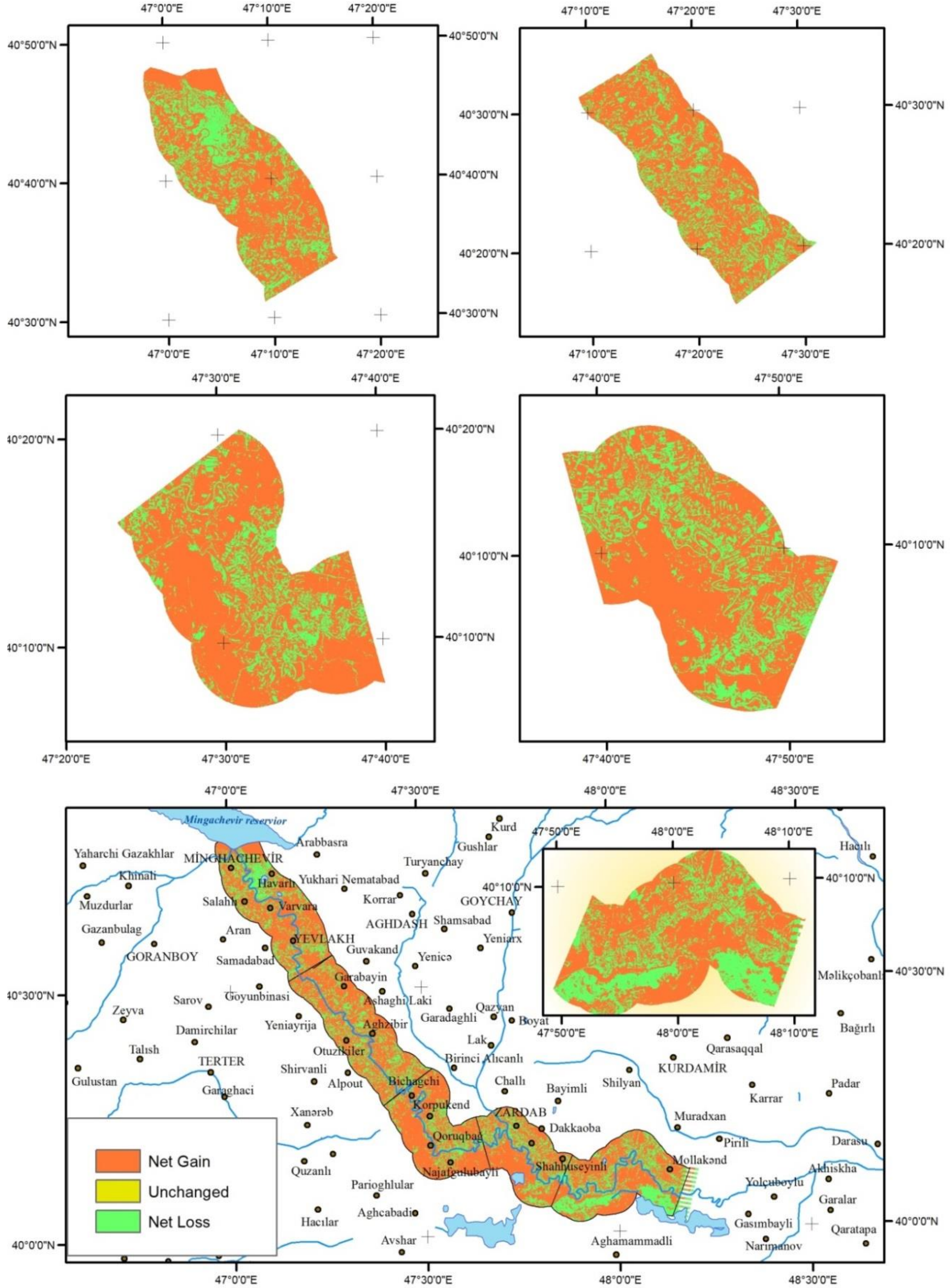

Figure 5.Dynamics of NDV indices at a distance of 5km from the Kurariver coast (Comparison of 2002 and 2019).

To analyze anthropogenic effects in investigation area we have learned land use and directions. We analyzed settlement areas, growing zones, pastures, forests, swamp and etc. To determine anthropogenic effect we analyzed settlement area dynamic during 2002 and 2019 years, and we determined that area of them has decreased (Table 1).

Table 1.Statsitical inicates of land use.

sectors	Area		settlements					growing zones		pastures		forests		swamps
	km^2	%	2002		2019		dynamics	(km^2)	%	(km^2)	%	(km^2)	%	(km^2)
			km^2	%	km^2	%								
I	387	22	34,9	10	64,5	17	54	70,6	18	120,7	31	2	1	-
II	390	22	13,95	4	28,3	7	49	156,3	40	87,5	22	37,8	10	-
III	320	18	8,3	3	24,7	8	34	139,9	44	131,4	41	12,4	4	-
IV	272	15	12,5	5	34,1	13	37	91,1	33	146,6	54	4	1	-
V	395	23	21	5	41,9	11	50	123,2	31	240,2	61	3	1	64
total	1764	100	90,65	5	193,5	11	47	581,1	33	726,4	41	59,2	3	64

For comprehensive survey anthropogenic modifications have researched, NDV indexes have analyzed, and communication between them has appeared. The first 50 km territory continues from the Mingachevir reservoir to the settlements of Eymur and Arabshaki villages of Aghdash district covering 387 km^2. It covers 22% of investigation area.

Table 2.Statistical indicators of NDV index in the sector I.

NDV index	year 2002		year 2019		dynamics	
	km^2	%	km^2	%	km^2	%
Low-0	48	12,4	15	3,9	-33	-68,8
0-0,1	68	17,6	16	4,1	-52	-76,5
0,1-0,2	71	18,3	78	20,2	7	9,9
0,2-0,3	68	17,6	100	25,8	32	47,1
0,3-0,4	62	16,1	104	26,9	42	67,7
0,4-0,5	47	12,1	65	16,8	18	38,3
0,5-0,6	21	5,4	8	2,1	-13	-61,9
0,6 -high	2	0,5	0	0	-2	-100

In 2002, areas that NDV indexes were below 0 covered 12,4% (48 km^2) of sector I. But it has fallen 3,9% (15 km^2) in 2019. Areas where the NDV index is 0-0,1 cover 4,1% (decrease by 76.5%), 0,1-0,2 cover 20,2% (increase by 9,9%), 0,2-0,3 cover 25,8% (increase by 47,1%), 0,3-0,4 cover 26,9% (increase by 67,7%), 0,4-0,5 cover 16,8% (increase by 38,3%), 0,5-0,6 cover 2,1% (increase by 61,9%) of sector I. Areas where the NDV index is higher than 0.6 have disappeared completely (Table 2). Areas where NDV index is higher than 0,5 correspond to the boundaries of forest areas, their destruction indicates the strong economic activity of the population in sector I. The area with the NDV index of 0.3-0.5 corresponds to the cultivation area, which indicates an increase in cultivation in the area. Pastures correspond to the area where NDV index is 0.1-0.3. As is known, expansion is also observed in these areas (Figure 6).

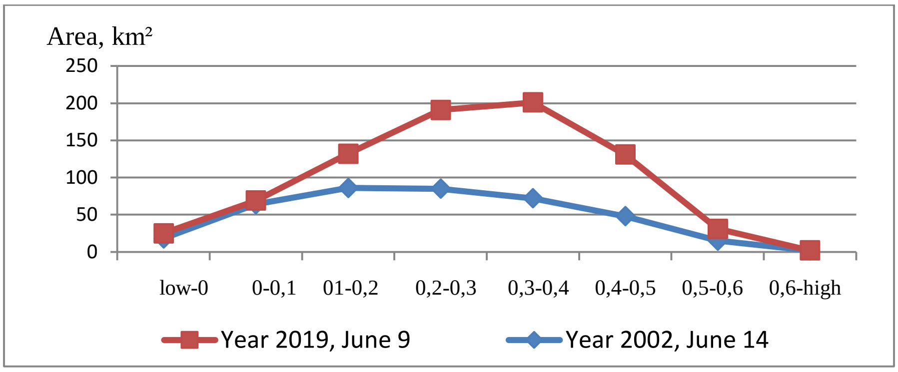

Figure 6. Dynamics of NDV indexes in the sector I.

In 2002, settlements covered 10% (34,9 km^2) of sector I, but in 2019 it rises to 17% (64.5 km^2). Growing zones cover 18% (70,6 km^2), pastures cover 31% (120,7 km^2), forests cover 1% (2 km^2) of sector I (Table 1).

The second 50 km area covers 390 km2 up to the Bichagchi settlement of the Zardab district.

In 2002, areas that NDV indexes were below 0 covered 4,6% (18 km^2) of sector II. But it has fallen 1,8%-ə (7 km^2) in 2019. Areas where the NDV index is 0-0,1 cover 1,3% (decrease by 92.2%), 0,1-0,2 cover 11.8% (decrease by 46.5%), 0,2-0,3 cover 27.2% (increase by 24.7%), 0,3-0,4 cover 31.1% (increase by 79.2%), 0,4-0,5 cover 21.3% (increase by 72.9%), 0,5-0,6 cover 4.1% (increase by 6.7%) of sector II. Areas where the NDV index is higher than 0.6 have disappeared completely (Table 3). In 2002, settlements covered 4% (13.9 km^2) of sector II, but in 2019 it rises to 7% (28.3 km^2). Growing zones cover 40% (156.3 km^2), pastures cover 33% (87.5 km^2), forests cover 10% (37.8 km^2) of sector II.

Table 3.Statistical indicators of NDV index in the sector II.

NDV index	year 2002		year 2019		dynamics	
	km^2	%	km^2	%	km^2	%
Low-0	18	4,6	7	1,8	-11	-61,1
0-0,1	64	16,4	5	1,3	-59	-92,2
0,1-0,2	86	22,1	46	11,8	-40	-46,5
0,2-0,3	85	21,8	106	27,2	21	24,7
0,3-0,4	72	18,5	129	33,1	57	79,2
0,4-,5	48	12,3	83	21,3	35	72,9
0,5-0,6	15	3,9	16	4,1	1	6,7
0,6 -high	2	0,5	0	0	-2	-100

As can be seen from Figure 7, the area where the index is 0.2-0.5 increased.

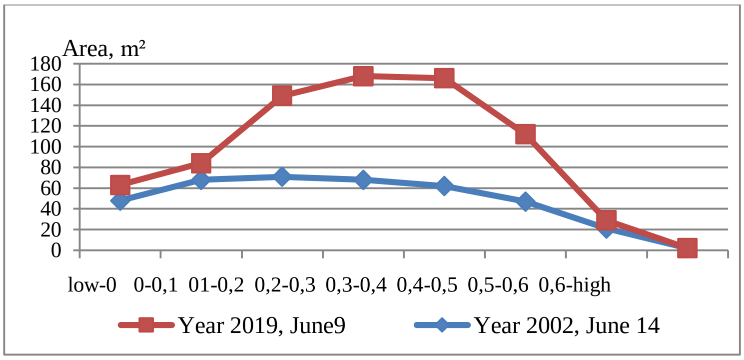

Figure 7. Dynamics of NDV index in the sector II.

The third 50 km territory continues to the village of Allahkulubagi, covering 320 km^2.

In 2002, areas that NDV indexes were below 0 covered 6% (19 km^2) of sector II. But it has fallen 1,9%-ə (6 km^2) in 2019. Areas where the NDV index is 0-0,1 cover 1,9% (decrease by 94.1%), 0,1-0,2 cover 22.8% (increase by 4.3%), 0,2-0,3 cover 31.3% (increase by 78.6%), 0,3-0,4 cover 28.8% (increase by 114%), 0,4-0,5 cover 12.5% (increase by 60%), 0,5-0,6 cover 1.3% (increase by 33.3%) of sector III. Areas where the NDV index is higher than 0.6 have disappeared completely (Table 4).

Table 4.Statistical indicators of NDV index in the sector III.

NDV index	year 2002		year 2019		dynamics	
	km^2	%	km^2	%	km^2	%
Low-0	19	6	6	1,9	-13	-68,4
0-0,1	101	31,6	6	1,9	-95	-94,1
0,1-0,2	70	21,9	73	22,8	3	4,3
0,2-0,3	56	17,5	100	31,3	44	78,6
0,3-0,4	43	13,4	92	28,8	49	114
0,4-0,5	25	7,8	40	12,5	15	60
0,5-0,6	6	1,9	4	1,3	-2	-33,3
0,6 - high	1	0,3	0	0	-1	-100

As can be seen from Figure 8, the area where the index is 0.1-0.5 increased.

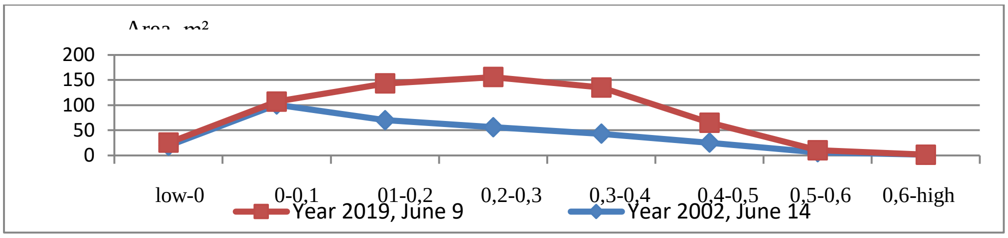

Figure 8. Dynamics of NDV index in the sector III.

In 2002, settlements covered 3% (8.3 km^2) of sector III, but in 2019 it rises to 8% (24.7 km^2). Growing zones cover 44% (139.9 km^2), pastures cover 41% (131.4km^2), forests cover 4% (12.4 km^2) of sector III.

Next 50 km distance continues to Seyidlar village covering 272 km^2.In 2002, areas that NDV indexes were below 0 covered 7% (19 km^2) of sector IV. But it has fallen 2.2%-ə (6 km^2) in 2019. Areas where the NDV index is 0-0,1 cover 1.5% (decrease by 93.8%), 0,1-0,2 cover 18.1% (decrease by 15.5%), 0,2-0,3 cover 35.7% (increase by 83.1%), 0,3-0,4 cover 31.3% (increase by 93.2%), 0,4-0,5 cover 11.1% (increase by 15.4%), 0,5-0,6 cover 0.7% (decrease by 71.4%) of sector IV. Areas where the NDV index is higher than 0.6 have disappeared completely (Table 5).

Table 5.Statistical indicators of NDV index in the sector IV.

NDV index	year 2002		year 2019		dynamics	
	km^2	%	km^2	%	km^2	%
Low-0	19	7	6	2,2	-13	-68,4
0-0,1	65	23,9	4	1,5	-61	-93,8
0,1-0,2	58	21,3	49	18,1	-9	-15,5
0,2-0,3	53	19,5	97	35,7	44	83,1
0,3-0,4	44	16,2	85	31,3	41	93,2
0,4-,5	26	9,6	30	11,1	4	15,4
0,5-0,6	7	2,6	2	0,7	-5	-71,4
0,6 -high	1	0,4	0	0	-1	-100

As can be seen from Figure 9, the area where the index is 0.2-0.5 increased.

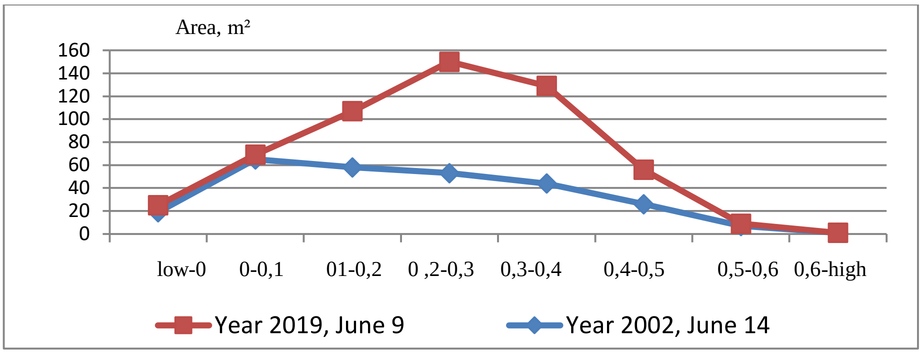

Figure 9. Dynamics of NDV index in the sector IV.

In 2002, settlements covered 5% (12.5 km^2) of sector IV, but in 2019 it rises to 13% (34.1 km^2). Growing zones cover 33% (91.1 km^2), pastures cover 54% (146.6 km^2), forests cover 1% (4 km^2) of sector IV.

Last 50 km distance covers 395km^2. As can be seen from the table, areas with an index of 0.2-0.5 during the comparable period have increased twice. According to the form, these areas correspond to the cultivated lands and show that anthropogenic load has increased in the landscape over the past 17 years.

In 2002, areas that NDV indexes were below 0 covered 5.6% (22 km^2) of sector V. But it has fallen 1.8%-ə (7 km^2) in 2019. Areas where the NDV index is 0-0,1 cover 1.8% (decrease by 68.2%), 0,1-0,2 cover 25.6% (increase by 40.3%), 0,2-0,3 cover 28.1% (increase by 91.4%), 0,3-0,4 cover 25.1% (increase by 70.7%), 0,4-0,5 cover 16.7% (increase by 11.9%), 0,5-0,6 cover 0.8% (decrease by 90.6%) of sector V. Areas where the NDV index is higher than 0.6 have disappeared completely (Table 6).

Table 6.Statistical indicators of NDV index in the sector V.

NDV index	year 2002		year 2019		dynamics	
	km^2	%	km^2	%	km^2	%
Low-0	22	5,6	7	1,8	-15	-68,2
0-0,1	94	23,8	12	3,1	-82	-87,2
0,1-0,2	72	18,2	101	25,6	29	40,3
0,2-0,3	58	14,7	111	28,1	53	91,4
0,3-0,4	58	14,7	99	25,1	41	70,7
0,4-,5	59	14,9	66	16,7	7	11,9
0,5-0,6	32	8,1	3	0,8	-29	-90,6
0,6 -high	4	1,1	0	0	-4	-100

As can be seen from Figure 10, the area where the index is 0.2-0.5 increased.

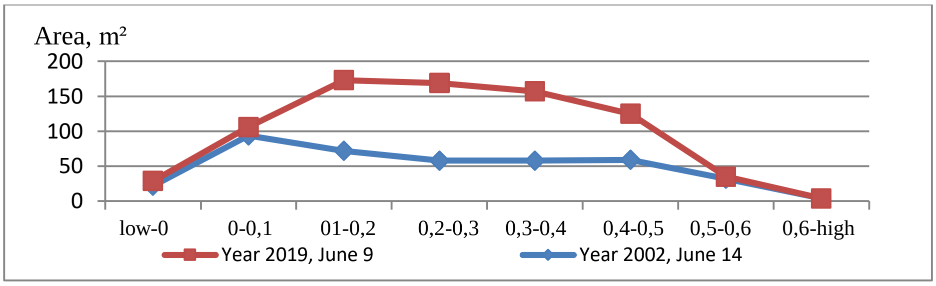

Figure 10. Dynamics of NDV index in the sector V.

In 2002, settlements covered 5% (21 km^2) of sector V, but in 2019 it rises to 11% (41.9km^2). Growing zones cover 31% (123.2 km^2), pastures cover 61% (240 km^2), forests cover 1% (3 km^2) of sector V. In sector V, 64 km^2 area is covered by swamps.

4. Discussion

Before us investigation area has researched by Shirinov N.Sh., Suleymanov M.A and others (Suleymanov, 1965,2005; Shirinov N.Sh. and Suleymanov M.A., 1964). They have learned by traditional methods such as analysis of topographic maps of different periods, paleo-geographical, paleo-geomorphological, survey of population, geobotanical, etc. This work took a long time, the results obtained were subjective.Unlike them, we have learned with modern methods as Filiz Bektas Balcik and Baturalp Arısoy, Afirah Taufik, Rouse, Venkata Ravibabu Mandla, Tucker C. And others (Afirah, Sharifah and Asmala, 2016; Vani Vand Venkata, 2017; Balcik and Arısoy, 2018; Rouse, Haas, Deering and Sehell, 1974; Tucker, 1979).

5. Conclusions

For the last 40 years, Tugai forests along the Kura river , which have played an important role in climate mitigation for the dominant semi-desert landscape with rich biodiversity, have been eliminated in the study area. Only 5% of the study area contained rebuilt Tugai forests. Forests are transformed to anthropogenic landscapes such as growing zones, settlements, pastures, roads and etc.

Vegetation is a component of the landscape more responsive to anthropogenic effects, that is why we learn dynamics of land use based on NDV indexes. Comparative analysis of the available spatial data shows that the increase in the area of seliteb landscapes (settlements) by the research sectors varied between 34-54%. The highest increase in Seliteb landscapes (54%) was in the sector I, where cities are more prevalent. In sector V, the highest dynamic indicator of these landscapes (50%) is related to recent refugee camps. The majority of seliteb landscapes have increased due to growing zones and forest areas.

We have conclused our NDV indexes results as following table 7. Areas where NDV indexes below 0,2 point have decreased, it means that areas covered by soil have decreased, it has been covered by vegetation or settlements, roads and etc. Areas where NDV indexes over 0,5 point have also decreased, it means that forest areas have decreased, it has been covered by pastures and growing zones.

Table 7.Statistical indicators of NDV index in the investigation area.

NDV index	year 2002		year 2019		dynamics	
	km^2	%	km^2	%	km^2	%
Low-0	126	7,142857	41	2,324263	-85	-67,5
0-0,1	392	22,22222	43	2,437642	-349	-89,1
0,1-0,2	357	20,2381	347	19,6712	-10	-2,8
0,2-0,3	320	18,14059	514	29,13832	194	60,6
0,3-0,4	279	15,81633	509	28,85488	230	82,4
0,4-,5	205	11,62132	284	16,09977	79	38,5
0,5-0,6	81	4,591837	33	1,870748	-48	-59,3
0,6 -high	10	0,566893	0	0	-10	-100

References

Afirah T., Sharifah S.S.A. and Asmala A., 2016. Classification of Landsat 8 Satellite Data Using NDVI Thresholds. *Journal of Telecommunication, Electronic and Computer Engineering*, 8 (4): 37-40

Amanova Sh.S., 2016. Anthropogenic dynamics of the forest landscape of plains and their optimization. *Geography and Natural Resources*, 1: 29-32

Amanova Sh.S., 2015. Optimization of ecological landscapes of Ajinohur low land and surrounding areas. *Works of young scientists*,11:140-144

Balcik F.B. and Arısoy B., 2018. Analysing the impact of vegetated areas on land surface temperature using remotely sensed data. *Eurasian GIS Congress*, 206-210

Guliyeva I.F., 2014. Concerning the antropogenic transformation of Talyshs mountain forest landscapes. *Baku World Forum of Young Scientist,* 49-54

Guliyeva I.F., 2017. Effects of anthropogenic factors to the vegetation covers of Talish mountain. *Materials of Conference I of Young Scientestists,* 228-230

Ismayilov M.J., 2011. Identification of the structural and functional features of modern landscapes of contact zones for the purpose of spatial planning. *Actual problems of landscape planning*. 138-142

Ismayilov M.J., 2010. Formation of geophysical features of landscapes of the Eastern Caucasus. *Transaction of the Azerbaijan Geographical Society,* XIX: 74-80

Ismayilov M.J. and Amanova Sh.S., 2015. Influence of land use to anthropogenic transformasion of landscapes in Ajinohur low mountainous and surrounding areas. News of Baku University, Series of natural sciences 4, p.158-175

Ismayilov M.J. and Ismayilova L., 2014. Scientific-methodological approaches of revelation of landscape-recreation potential of mountain geosystems (an example of southern slopes of the greater Caucasus). *ANAS, News, Earth sciences,* 3-4; 86-92

Ismayilov M.J., Mammadbeyov E.Sh., Yunusov M.I. and Amanova Sh.S, 2012. Landscape-ecological variety of Ajinohur foothills and their protection. *Globalization and geography*, 289-295

Ismayilov M.J. and Amanova Sh.S., 2018. Investigation of the influence of climate changes to the formation of surface structure of landscapes based on GIS (Ajinohur low mountain and surrounding areas). *Eurasian GIS Congress*. 34-40

Rouse J.W., Haas R.H., Schell J.A., Deering D.W. and Harlan J.C., (1974) Monitoring the vernal advancement and retrogradation of natural vegetation. *NASA/GSFC, Type III, Final report, Greenbelt* MD: 1-371

Suleymanov M. A., 2005. *Geographical rules of natural and anthropogenic landscapes of the Azerbaijan Republic*, Elm: 248, Baku

Suleymanov M. A., 1965. *Natural landscapes of Jeyranchol-Ajinohur lowland*. Elm: 258, Baku.

Shirinov N.Sh. and Suleymanov M.A., 1964. Anomalies in the landscape of the southern foothills of the Greater Caucasus. *Heralds of Azerbaijan University,* 2: 195-2005

Tucker C., 1979. Red and photographic infrared linear combination for monitoring vegetation. *Remote sensing of Environment,* 2: 127- 150

Vani V. and Venkata R.M., 2017. Comparative study of NDVI and SAVI vegetation indices in Anantapur district semi-arid areas. *International Journal of Civil Engineering and Technology (IJCIET),* 8(4):559–566