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DYNAMICS OF THE RELIC FOREST LANDSCAPE IN AZERBAIJAN AND WAYS TO SOLVE ENVIRONMENTAL PROBLEMS

Abstract. For the first time in the article, emerging the historical dynamics of the relief landscape of Azerbaijan and the ecological problems from ithave been studied extensively. It has been established, plain forests completely destroyed and transposed to anthropogenic complexes; the biodiversity of existing forest ecosystems has been diminished, some species of trees and shrubs have been ruined, and the density of the forest has dropped from the ecological norm. The proposed environmental sustainability index is calculated (by the formula $\boldsymbol{\Sigma}_i = S_1/S_3$) ecological stability in the studied region. Taking into consideration the role of the Relict Forest Ecosystem in the preservation of the global gene pool, the Hirkan National Park area must be expanding to three times.

Keywords: the National park Hirkan, relic forest ecosystem, initial forest, relief, natural landscape.

1. Introduction. The study of relic elements of natural complexes studies, their role in the genesis, structure, function, dynamics and evolution of landscapes is one of the important issues in modern landscape science. In the structure of Azerbaijan landscapes, it is possible to find both natural and anthropogenic relic elements. Usually, the relic elements in landscapes complicate its structure and further enhance internal diversity.

2. Objects and methods of researches. The research area is located on the west coast of the Caspian Sea in the south of the Republic of Azerbaijan. The area is 6069.0 km^2. The relief is located in the eastern part of the plain and in the west from the Talish, Pestasar,andBurovar mountain ranges. The absolute height of the relief ranges from 27 m to 2493 m.

Method of the research. The relief elements of the landscape are divided into two places: dynamic and static. Static relief elements include relief, lithological composition of rocks, and dynamic relic elements to fauna and flora. The research area region landscapes are mostly rich in dynamic relic elements.

The relief of the Lankaran lowland and the rocks forming it are younger than the New Caspian area. But later, the Hirkan-type relic flora and fauna species in the neighboring mountainous region migrated to the lowlands and formed existing grass-forest landscapes. Thus, the relief of the Lankaran lowland's natural forest ecosystems and the geological substrate is relatively young and the formed biocenoses have older relic elements. For this reason, modern natural landscapes of the plains are relict complexes. The forest and forest-field complexes consisting of hirkan flora formed on the volcanic sedimentary rocks of the eosan-oligocene age are the typical relict landscapes of the mountainous part of the study area [1; 9; 10].

These landscapes are the largest single relief natural system in Azerbaijan, which has reached today, leaving behind the harsh climatic conditions of millions of years of geological eras and of the fourth era of glaciation. However, during the historical periods, the natural landscapes of the Lankaran region have undergone severe structural transformation through man's economic activity and have been transformed into derivative forests in some territories (table 1).

Table 1 – Structural signs of primary and derivative (secondary) forests in Lankaran geographical area

Rich variety of plants	Age of trees	Tiers	The height of the trees	Forest structure	Growth		Age of forest	Type of plant species
					height, m	volume, m^3		
Initial forest in Astara river basin								
1000 hectare 32 species of plant	Different age composition from 30 years 100 and more than	Tiers: I-IV-tree V-bush VI-grass	Middle: from 25 to 40 m	Regular	0,26 0,40	0,14 0,45	65-80 years	Sibljakand others
Secondary forest								
Monodominant	The same age as the composition 50-60 years	2-3 yaruslu I-tree II-bush III-grass	Middle: 10-15 m	Irregular	0,60 0,70	0,38 0,57	40-50 years	Thin herbs, sibljakand others

The analysis of Table 1 shows that in the natural-geographical region of Lankaran, every 1000 ha of the initial relic forest landscape were 32 types of trees and shrubs.At present, we can find relict forests, which have relatively preserved their original structure in the Hirkan National Park and the Astara river basin.

Observations made in the area near Haftoni and TazaAlvadivillageswere shown the secondary forest ecosystems are more monodominant and the species of trees and bushes are 5-6 times smaller than earlier. There are no significant differences in the age of trees in such forests, just its structure is 2-3 tires. The height of trees and the increase in wood is 1.5-2 times more than the initial forests.

Anthropogenic dynamics of forest ecosystems. As a result of man's economic activity, the area of the forest has declined, the composition has changed, the density decreases, and the natural regeneration has weakened. Currently, the relict ecosystem forest of Talish has remained in episodic form, only in the plains of the region. In the biogeographic surveysthere are 1167 species of plants in the Hirkan (369 km^2) forest ecosystems[6]. According to this indication, Hirkan forest ecosystems occupy the first place among 18 Caucasian states of the florist. Even in the low-density subtropical Kolxida region of Georgia, the number of plant species in 1,000 hectares is three times less than the Hirkan forests.

According to [3; 11] there are 150 trees and shrubs in the dendroflora of Talish, 36 of them are endemic. Iran's Caspian region is the center ofHirkan forest ecosystems with the relic elements. The area of these forests has been more than 35,000 km^2.

3. Results. The major violations of the forest ecosystem with anthropogenic impacts are more common in the plain. Each landscape must fulfill a certain function in accordance with the socio-economic requirements of the existing society. The analysis shows that socio-economic functions of the forest ecosystems of Lankaran have also changed in the historical periods change, and natural complexes have been reconstructed accordingly (table 2).

Table 2 – Trends in the economic functioning of forest landscapes in Lankaranand the surrounding lowlands

Years	Area, hectares	Forest ecosystem, %	Anthropogenic landscapes, %	Trends in the economic functioning of forest landscapes
1890-1898	135 890	49 037/36	86 853/64	Rice paddy, cattle breeding, hunting
1914-1930	138 494	28 038/20	110 456/80	Rice paddy, cattle breeding, tobacco-cultivation
1930-1950	138 010	21 100/15	116 910/85	Tea-growing, rice paddy, citrus fruits growing, vegetable growing, cattle breeding
1980-2017	250 974	2618/1	248 356/99	Tea-growing, vegetable growing, cattle breeding, tourism

By the end of the 19th century, the forests were broken down for the use of rice paddy, expansion of habitat and the use of fuel. Until that time, 36% of the plain was covered with forests [2; 5]. The massive destruction of the forests was observed in the first half of the 20th century. During this period, to develop intensive tea-growing and citrus fruits, 27 937 ha of valuable relict species were destroyed by extinction. At present, up to one percent of the plains can be found with anthropogenic degradation in the forests (figure 1).

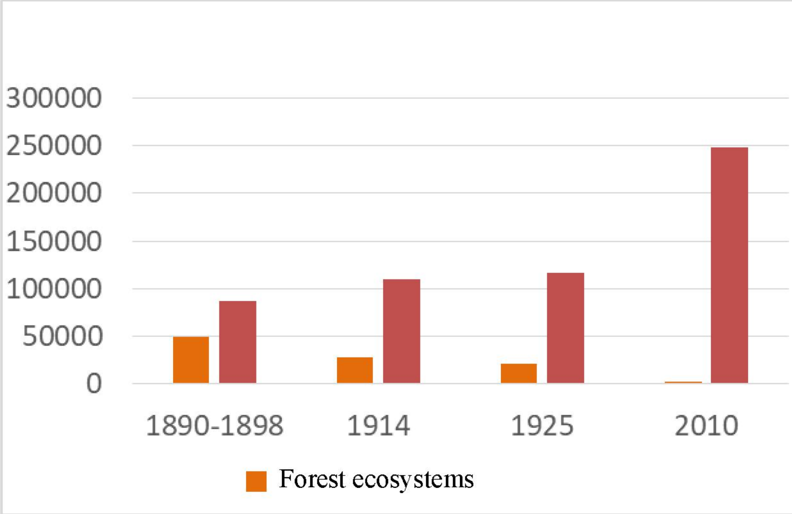

Figure 1 – Dynamics of the ratio of agro-ecosystems to ecosystems over the past 120 years in the Lankaran and surrounding lowland

Only plains of forests have been found in the territory of the Hirkan National Park. In the mountainous part of the area, there is an ancient history of deforestation [3; 6]. According to our research, the ecological potential for the initial settlement in Azerbaijan was the arid forests and forests of low mountainous and foothill, which are more accessible for human activity. These landscapes are widely spread in the middle mountainous area of Talish. The arid forests, including half-humid and humid mountain forests, have been transformedto the present-day mountain xerophyte stony and forest bushes with anthropogenic impact (figures 2, 3). Due to the destruction of forests, some species of animal perished or sharply reduced. From the analysis of historical sources has been discovered in the beginning of the XVIII century the lion (Potheraleo), the wild bull (B.mstana-Zadei) (beginning of the XIX century), Leopard (Panthera pardus Y) until the end of the XIX century, 1912 the white deer (Carvuselapus Y.), and until 1890-1932, the tiger (Pantheratigir Y.) was widely spread in the natural geographical region of Lankaran (table 3).

Table 3 – Dynamics of biodiversity in natural-geographical region Lankaran (M.Ismayilov, 1990)

The name of the species	Perished period, century/year
1. The tiger (Panthera tigirs Y)	Beginning of the XVIII century
2. The wild bull (B.mstana-Zadei)	Beginning of the XIX century
3. The white deer (Carvuselapus Y.)	1912
4. The lion (Pontheraleo)	1890-1932
5. The leopard (Panthera pardus Y)	1950

Table 4 – Distribution of available natural landscapes in Lankaran physical-geographical region

The number in map	The landscape name	Area, km^2
1	The xerophytic bush in the middle hill	938,7527
2	The forests of the low and middle mountain	1442,071724
3	Dry xerophyte steppe low mountain landscapes	491,915377
4	The meadow grass bush after the forest	712,070904
5	The low mountain steps	176,307631
6	The xerophytic steppe meadow landscapes	310,521866
7	Dry steppe meadow landscapes	305,880385
8	The hydromorphic landscapes	477,642945
9	The semi-desert of the lowland	353,127003
10	The coastal sand dune semi-desert	23,236721

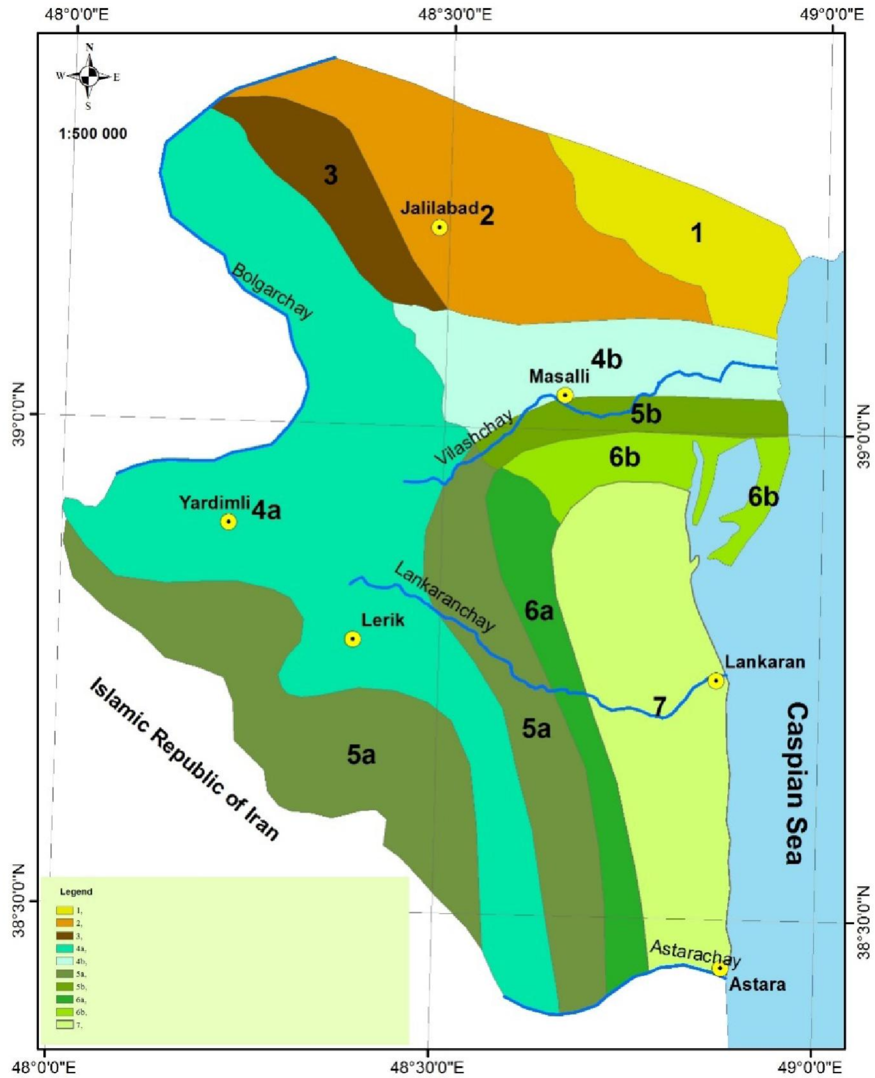

Figure 2 – Natural landscapes that can be formed

The climate is one of the later changing components of the landscape from anthropogenic impacts, that is why the initial landscape map (figure 4) is based on the heat and humidity quantities (figure 4).

By the formula of Shashko (1961):

$$\mathrm{Md} = \frac{P}{\sum(E-e)}, \tag{1}$$

P – quantities ratio of atmospheric precipitation; $\boldsymbol{\Sigma}$ (E-e) – saturation deficit; Md – moisture supply of plants.

The advantage of this formula is expressed as the quantities ratio of atmospheric precipitation to the moisture deficiency, which is the main factor in evaporation.The obtained quantities are closely linked to the composition and productivity of plants. This index is a more reliable tool for studying humidification in complex relief areas [1; 4; 7].

The results obtained from the comparison of the above-mentioned landscape maps are shown in table 5. As is evident, the areaof the Suppose forest landscapes is 4427.8 km^2. During the past decades, forests have been demolished and transformed into different landscapes. As a result, arid mountain forests (0.2), arid (0.0), half-humid (0.0), moisture (0.0) and Moisture-rich (0.01) forest landscapes. Accordingly, xerophyte landscapes were largely transformed into dry steppe and grassy landscapes.

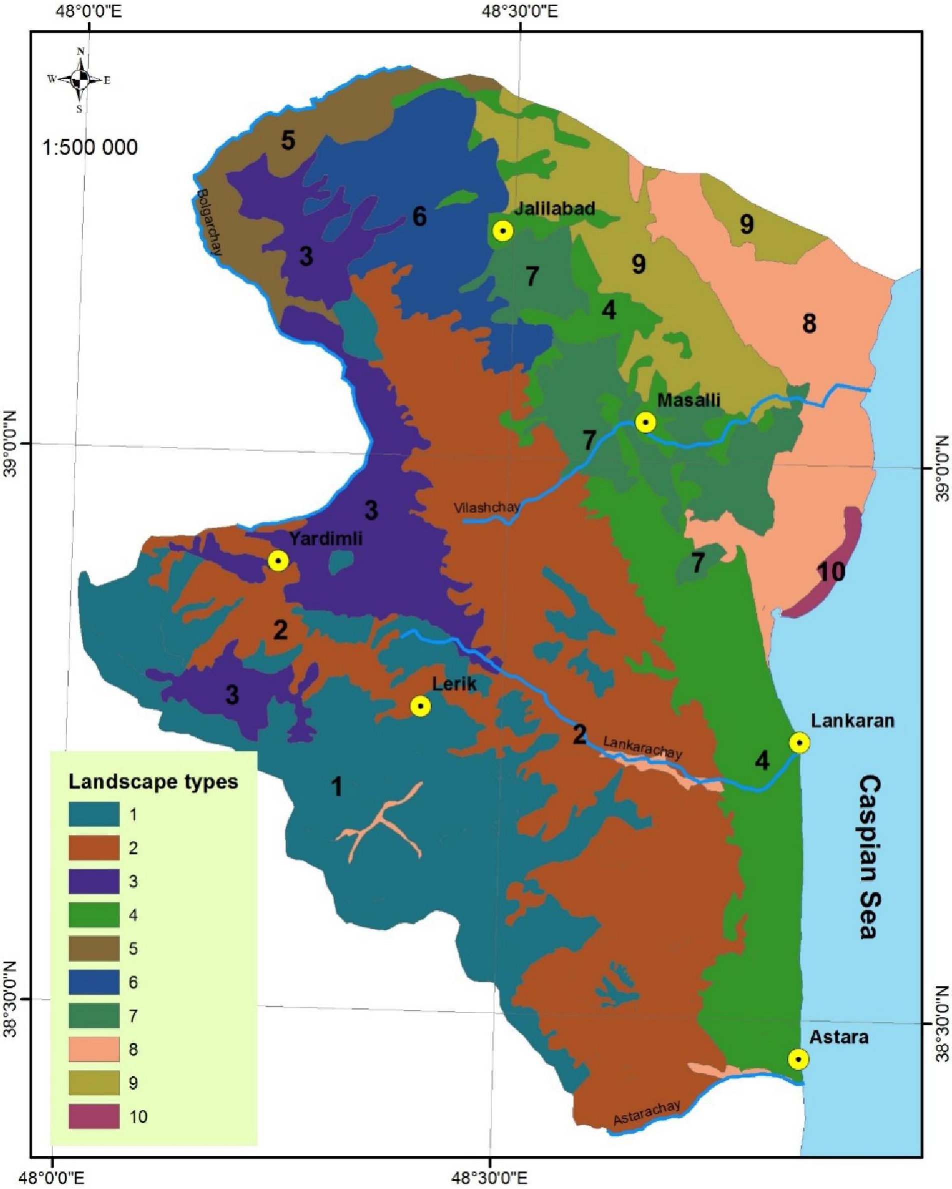

Figure 3 – Natural landscapes available at present

Role of forest ecosystems in the protection of ecological stability. For the sustainable development of the region is important to explore the environmental sustainability and the ways to optimize.

For this purpose, the role of forest ecosystems has been assessed in environmental sustainability. Currently, the total area of forests is 1472.3 km^2 in the Lankaran natural-geographical area, which makes up of the total area 24.3%. At present, the ecological situation of the region is closely linked to the structural and functional characteristics of forest ecosystems. We have identified forest covering and environmental sustainability indexes in the study area.

The forest cover index is calculated by the following formula[1; 7; 12]:

$$Mi = S_1/S_2,$$

Mi – forest coverage index; S_1 – forest covered area; S_2 – a general comparison area.

The environmental sustainability index was calculated by the ratio of forest covered area to the total area of agro-ecosystems:

$$\Sigma i = S_1/S_3,$$

here Σi – the index of ecological stability; S_3 – total area of comparable agroecosystems.

Table 5 – Comparative analysis of suppose landscapes and existing natural landscape in natural humidification conditions

#	Moisture supply of plants, $Md = \frac{P}{\Sigma(E-e)}$	Moisture	Suppose landscapes	Area, km²/% (S_1)	Existing natural landscape	Area of the suppose landscapes, km²/% (S_2)	The trans-formation indexes of landscapes $T_i = S_2/S_1$
1	<0,10	Arid	Semi-desert	288,4 / 5,1	Hydromorphic	277,3	0,3
					Semi-desert	74,1	
2	0,10-0,15	Semi-arid	Dry plain	670,7 / 12,1	Semi-desert	279,0	0,4
					Dry steppe	291,7	
3	0,15-0,25	Arid	Dry xerophyte steppe low mountain	219,5 / 3,9	Dry steppe	183,4	0,5
					Xerophyte steppe	108,4	
4	0,25-0,35	Semi-arid	a. Arid forests in low and middle mountains	159,3 / 28,5	Xerophyte bush	938,8	0,2
					Dry steppe	347,2	
					Arid forest	312,3	
			4 b. Arid forests landscapes of plains	387,6 / 6,9	Dry steppe	239,9	0,0
					Hydromorphic	147,7	
5	0,35-0,45	Semi-humid	5a. Semi-humid mountain forests landscapes	109,7 / 19,6	Dry xerophyte steppe	498,6	0,5
					Mountain-forest	600,1	
			5b. Semi-humid forest landscapes of plains	152,4 / 2,7	Meadow-bush	152,4	0,0
6	0,45-0,60	Humid	6a. Humid forests in low mountain	264,5 / 2,6	Mountain-forest	264,5	1,0
			6b. Humid forests landscapes of plains	185,6 / 3,3	Semi-desert	23,2	0,0
					Dry bush	162,4	
7	>0,60	Moisture-rich	Moisture-rich forests of plains and mountains	740,7 / 13,2	Meadow-bush	732,9	0,01
					Moisture-rich forests	7,8	

4. Conclusion.

1. The horizontal and vertical structure of the Talish forest ecosystems has been seriously violated in the past 100-150 years. The forests have been almost destroyed and transformed into anthropogenic complexes. The existing mountain forest ecosystems have diminished biodiversity, some species of trees have been severely damaged, and the density of the forest has dropped from the ecological norm.

2. For the first time, the environmental sustainability index was calculated by the formula $\Sigma i = S_1/S_3$, and it was determined that the environmental sustainability index for the region was above the average country level and equaled to 0.5 in the study area.

3. Taking into account the role of the region in the preservation of the unique genetic background of the unique relict forest landscape, the Hirkan National Park is to be expanded three times, creating relatively small areas of special protection requiring flexible management.

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ӘЗІРБАЙЖАННЫҢ ҚАЛДЫҚ ОРМАН ЛАНДШАФТЫНЫҢ ДИНАМИКАСЫ ЖӘНЕ ОРМАНДАРДЫҢ ЭКОЛОГИЯЛЫҚ МӘСЕЛЕЛЕРІН ШЕШУ ЖОЛДАРЫ

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ДИНАМИКА РЕЛИКТОГО ЛЕСНОГО ЛАНДШАФТА АЗЕРБАЙДЖАНА И ПУТИ РЕШЕНИЯ ЭКОЛОГИЧЕСКИХ ПРОБЛЕМ ЛЕСОВ

Аннотация. Впервые в статье была изучена историческая динамика реликтово ландшафта Азербайджана. Реликтовые ландшафты – сохранившиеся до настоящего времени черты различных компонентов древних ландшафтов, которые вырабатывались при иных физико-геогр. условиях и представляют собой наследие былых природных условий. Б. Б. Полынов (1925) отметил, что в каждом ландшафте и почве наряду с консервативными (современными) и реликтовыми элементами следует различать и прогрессивные элементы, характеризующие тренд дальнейшего развития. При изучении реликтовых ландшафтов необходимо учитывать реликтовый характер всех компонентов, слагающих реликтовый ландшафтный комплекс и отдельные его компоненты. В первом случае набор реликтовых ландшафтов достаточно узок, а во втором -необычайно широк.

В статье было установлено, что нами изученные равнинные леса (Лянкяраньская равнина) полностью разрушены и трансформированы в антропогенные комплексы, биоразнообразие существующих лесных экосистем уменьшено, некоторые виды деревьев и кустарников разрушены, а плотность леса снизилась с экологической нормы. В первые нами предложенной формулой $\boldsymbol{\Sigma}_i = S_1/S_3$ проведен расчет индекса экологической устойчивости ландшафтов в регионе.

Ключевые слова: реликтовые ландшафты, трансформация, фактор, экологический индекс.

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