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GEOECOLOGICAL ANALYSIS OF LANDSCAPE ZONES OF TAVUSH REGION

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The article analyzes the geoecological condition of the landscape zones of Tavush Region. Anthropogenic load on natural landscapes expresses the degree of intensity of anthropogenic negative impacts in a given landscape zone. And anthropogenic impact on landscapes is expressed by the nature of land use structure.

According to the concept of B. Kochurov, ecological and economic balance of the area 1–6 points of expert assessment are used to determine the degree of anthropogenic load on the area. Areas depending on the type of land use receive a corresponding score and are grouped into appropriate groups. Using B. Kochurov's methodology and applying the cartographic tools of the ArcGis, we obtained the map of the anthropogenic load of the landscape zones and calculated the surfaces of the areas with the corresponding level of load in each zone expressed as percentages. Then we carried out a spatial quantitative assessment of the anthropogenic load of the landscape zones with the absolute and relative coefficients of the selected concept and the tools of the ArcGis. As a result of the research, the forest-steppe zone was considered an area of critical tension based on ecological and economic indicators, the forest and meadow landscape zones were considered tense and conflicting, and the sub-alpine and alpine landscape zones were conditionally favorable.

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***Keywords*:** landscape zone, natural use, anthropogenic load, land use.

Introduction. The complex mountain relief and climate play an important role in the formation and development of the landscapes of Tavush Region. Landscapes in mountainous countries have an unique pattern of distribution, exhibiting upward zonation. Climatic conditions closely related to topography produce an unique ratio of heat and humidity. As a result of the diversity of the above-mentioned factors, clearly defined landscape zones have been formed in the territory of the region, each of which is distinguished by the monotony of hydrothermal conditions, soils, vegetation cover and fauna.

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The following landscape zones are distinguished in the territory of Tavush Region:

1) low mountain, forest-steppe landscapes (375–1000 *m*, 25.5% of the territory of the region);
2) low mountain and medium mountain wet forest landscapes (1000–2300 *m*, 62% of the territory of the region);
3) high mountain, humid meadow-steppe landscapes (2200–2600 *m*, 12% of the territory of the region);
4) high mountain cold, humid sub-alpine and alpine landscapes (2400–2993 *m*, 0.5% of the territory of the region) [1].

Materials and Methods. For the analysis of the geoecological state of the region's landscapes and the assessment of the anthropogenic burden, we adopted the concept of ecological-economic balance of the territory as a methodological basis. According to which, the anthropogenic impact on the natural environment is expressed by the nature of the land use structure and the quantitative and qualitative measure of anthropogenic impact, which is considered as the anthropogenic load. It includes the amount of emissions per unit of an area, the area of disturbed land, the amount of fertilizers and pesticides per unit of area of cultivated land, the proportion of eroded land, etc. Quantitative indicators of anthropogenic burden are derived in relation to the unit area.

To determine the degree of anthropogenic load (AL) on the territory, the point system of expert assessment (1–6 points) is used. Depending on the type of land use, the areas receive an appropriate score and are grouped into homogeneous groups [2–6]. It was localized by us based on the climatic conditions of Tavush Region and the vulnerability of natural landscapes (Tab. 1).

Table 1

Classification of land use forms of Tavush Region according to the degree of AL [2]

<table>
<tr><th colspan="3">Land classification
according to AL</th><th colspan="3">Adaptation of the AL factor
to RA conditions</th></tr>
<tr><th>Degree
of AL</th><th>points</th><th>categories of land
use by AL</th><th>degree
of AL</th><th>points</th><th>categories of land use in
Tavush Region by AL</th></tr>
<tr><td>Upper</td><td>6</td><td>land for industry,
transport, settlements
and infrastructure</td><td>very high</td><td>6</td><td>land for industry,
transport,
settlements and
infrastructure</td></tr>
<tr><td>Very high</td><td>5</td><td>irrigated and
drained soils</td><td rowspan="2">high</td><td rowspan="2">4–5</td><td rowspan="2">arable land,
perennial plantings</td></tr>
<tr><td>High</td><td>4</td><td>arable land,
intensive logging,
inefficiently used
pastures and meadows</td></tr>
<tr><td>Average</td><td>3</td><td>perennial plantings,
land for recreation</td><td>average</td><td>3</td><td>water, meadows,
pastures</td></tr>
<tr><td>Low</td><td>2</td><td>limited use of
meadows, forests</td><td rowspan="2">low</td><td rowspan="2">1–2</td><td rowspan="2">forests, protected and
special purpose lands,
specially protected
natural areas</td></tr>
<tr><td>Very low</td><td>1</td><td>ecological zones
and unused lands</td></tr>
</table>

Tab. 2 shows the vulnerability of the natural landscapes of the region according to various authors [3, 4].

Table 2

Vulnerability of natural landscape zones according to various sources and studies that we have conducted

Natural landscape zones of Tavush Region and their vulnerability according to the National Atlas of the RA [3]			Natural landscape zones of Tavush Region and their vulnerability according to [4]		
Landscape zone	altitude zone, *M*	vulnerability of the landscape	landscape zone	altitude zone, *M*	vulnerability of the landscape
Forest-steppe, low mountain	400–1000	0.8–1.0	forest-steppe low mountain, hot semi-arid steppe	375–1000	0.8–1.0 (very strong)
Forestry, low and mid-mountain	800–2300	0.3–0.5 0.5–0.8 0.8–1.0	low mountain and mid-mountain humid forest	1000–2300	0.3–1.0 (mid and strong)
Steppe, mid-mountain	1400–2300	0.8–1.0			
Meadow steppe, mid-mountain	2200–2600	0.2-0.3 0.3–0.5	high mountain, humid meadow-steppe	2200–2600	0.2–0.5 (low and mid strong)
Subalpine high mountain	2400–2800	0.1–0.3 0.2–0.3	high mountain cold, humid subalpine and alpine	2400–2993	0.1–0.3 (low strong)
Snowy high mountain	2800–3400	0.1–0.3			

Each type of use of the territory corresponds to a certain degree of anthropogenic impact on the territory. Depending on the intensity of the degree of anthropogenic load on the territory, the following types of their use are distinguished:

1) territories that are not used or mostly used in a natural way (specially protected natural areas, recreation areas, forests);

2) slightly modified areas of the natural environment (meadows, pastures);

3) relatively highly modified areas of the natural environment (arable land, perennial plantations);

4) territories with fundamentally changed natural environment (residential, industrial, transport, hydraulic structures).

Grouping of land plots according to the degree of anthropogenic load allows using cartographic tools of geoinformation systems to express the anthropogenic variability of the landscape zones of the region in absolute and relative coefficients of ecological and economic tension of the territory:

$$C_{ab}=AL_{vh}/AL_{l},$$

where C_{ab} is the absolute ecological and economic tension; AL_{vh} is the surface of areas with a very high degree of AL; AL_{l} is the surface of areas with a low degree of AL. C_{ab} shows how favorable the ecological condition of the landscape is, on the basis of which, in order to balance the anthropogenic influence, the area of specially

protected areas of nature can be expanded. The larger the area they occupy, the lower the C_{ab} values are, and the ecological state of the landscape zone is considered favorable. Unlike C_{ab}, C_r covers the entire area of the studied landscape zone:

$$C_r = (AL_{vh}+AL_h) / (AL_m+AL_l),$$

where C_r is the relative ecological and economic tension; AL_{vh} is the surface of areas with a very high degree of AL; AL_h is the surface of areas with a high degree of AL; AL_m is the surface of areas with a medium degree of AL; Al_l is the surface of areas with a low degree of AL. If C_r is close to or equal to 1, then the ecological and economic tension of the landscape zone is considered balanced [2].

Results and Discusion. Guided the concept of ecological-economic balance of the territory by B. Kochurov and using data on the distribution of the land fund of the region (for its intended purpose) and using cartographic tools of geoinformation systems, we obtained a map of the AL on the landscape zones of the Tavush Region (Fig. 1) [5].

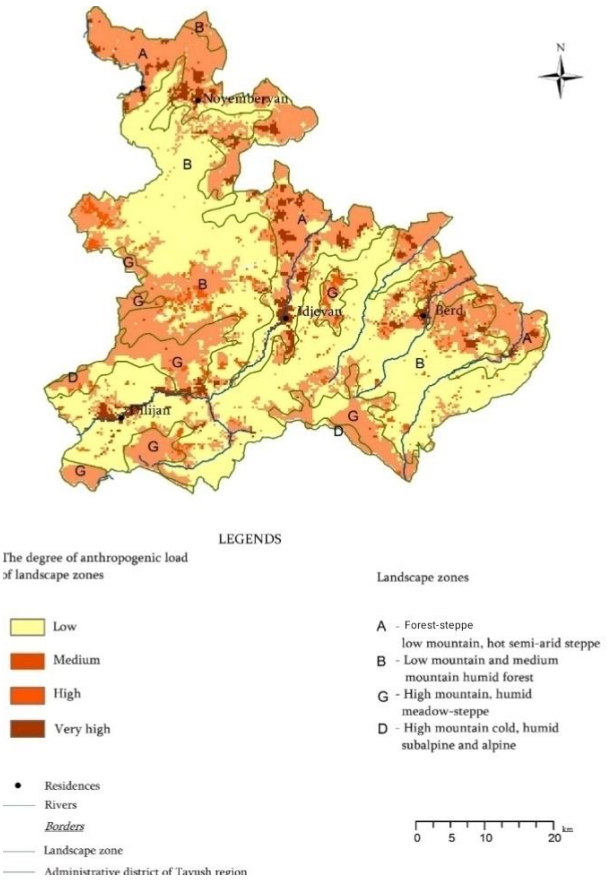

Fig. 1. Anthropogenic load of landscape zones of Tavush Region.

We also calculated the areas of the entire territory of the region and the surfaces of the sites with the corresponding degree of anthropogenic load in each landscape zone of the region according to percentages (Tab. 3, Fig. 2).

Table 3

The distribution of AL in the territory of Tavush Region

The degree of AL	Area	
	ha	%
Very high	11644.5	4.48
High	27479.6	10.58
Medium	73624.7	28.36
Low	146844.6	56.58

The analysis of Tab. 3 shows that the areas with a low load level are the most extensive in the region – 146844.6 *ha* or 56.58%, what are forests, reserve and special purpose lands and specially protected areas of nature. Areas of very high anthropogenic load – settlements, industrial, subsoil use and other production facilities, energy, transport, communication, communal subordination facilities – cover 11644.5 *ha*, or 4.48% of the territory of the region.

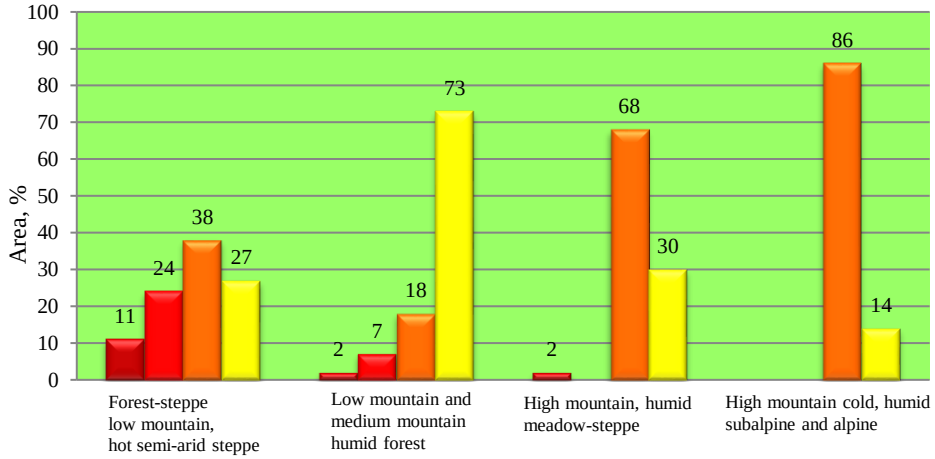

Fig. 2. The degree of anthropogenic burden of the territory of Tavush Region according to landscape zones: very high; high; medium; low.

The coefficients of ecological and economic tension of the landscape zones of the region are presented in Tab. 4.

Table 4

AL of landscape zones of Tavush Region by coefficients of ecological and economic tension

Landscape zone	C_{ab}	C_r
Post-forestry low mountain, hot semi-arid steppe	0.41	0.51
Low mountain and mid-mountain humid forest	0.031	0.09
High mountain, humid meadow-steppe	0.055	0.01
High mountain cold, humid subalpine and alpine	0.0017	0.0001

The results obtained reflect a comparative picture of the AL on the landscape zones of the region. According to the values of the coefficients, the landscape zones of the region received the following qualitative assessments of ecological and economic tension: conditionally favorable favorable (C_{ab} < 0.0002, C_r < 0.001); conflict (C_{ab} = 0.002–0.004, C_r = 0.001–0.05); tense (C_{ab} = 0.004–0.006, C_r=0.05–0.1); critical (C_{ab} > 0.006, C_r > 0.1) [2].

The forest-steppe low mountain, hot semi-arid steppe landscape zone of the region with an absolute ecological and economic coefficient of 0.41 and a relative coefficient of 0.51 is considered a zone of critical tension. Here, areas with a low AL account for 27%, areas with a medium AL – 38%. In the territory of the region, sites with a degree of high and very high AL occupy the largest area in this zone 24% and 11%, respectively.

The low mountain and mid-mountain humid forest landscape zone is considered a tense area with an absolute ecological-economic coefficient of 0.031, and a conflict area with a relative coefficient of 0.09. 73% of the zone has a low AL. In the zone, 18% are in areas with medium load, 7% in areas with high AL and 2% in areas with very high AL.

The absolute coefficient of ecological and economic tension of the high mountain, humid meadow-steppe landscape zone has a tense, and the relative coefficient has a conflict degree. Areas of medium anthropogenic load occupy a large space in the zone – 68%, 30% are areas of low and 2% – areas of high AL.

The high mountain cold, humid subalpine and alpine landscape zone are considered conditionally favorable areas with coefficients of ecological and economic tension, a significant part of which (about 86%) has an medium and 14% low AL.

The results of the analysis of AL are of great importance for the effective organization of land use and territorial planning of the given area. Landscape planning is an effective tool for the implementation of these works [7–10].

Conclusion. Modern land use and nature use in Tavush Region are not intensive, but there are serious environmental problems here.

The distribution of AL has the following picture: Areas with a low load level make up 56.58% of the region's territory (forests, reserve and special purpose lands, specially protected areas of nature), medium – 28.36% (water bodies, grasslands, pastures) and high – 10.58% (arable land and perennial plantations).

Spatial quantitative assessment of anthropogenic load can be done with Kochurov's concept of ecological and economic balance of the area and with the tools of geoinformation systems.

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ՏԱՎՈՒՇԻ ՄԱՐԶԻ ԼԱՆԴՇԱՖՏԱՅԻՆ ԳՈՏԻՆԵՐԻ ԳԵՈԷԿՈԼՈԳԻԱԿԱՆ ՎԵՐԼՈՒԾՈՒԹՅՈՒՆԸ

Ամփոփում

Հոդվածում վերլուծվում է Տավուշի մարզի լանդշաֆտային գոտիների գեոէկոլոգիական վիճակը: Բնական լանդշաֆտների վրա անթրոպոգեն ծանրաբեռնվածությունն արտահայտում է մարդածին բացասական ազդեցությունների ինտենսիվության աստիճանը տվյալ լանդշաֆտային գոտում: Իսկ լանդշաֆտների վրա անթրոպոգեն ներգործությունն արտահայտվում է հողօգտագործման կառուցվածքի բնույթով: Բ. Կոչուրովի հայեցակարգի համաձայն՝ տարածքի վրա մարդածին ծանրաբեռնվածության աստիճանը որոշելու համար օգտագործվում են փորձագիտական գնահատման միավորներ 1-ից 6-ը: Հողօգտագործման տեսակից կախված՝ տարածքները ստանում են համապատասխան բալ և միավորվում համասեռ խմբերում: Առաջնորդվելով Բ. Կոչուրովի մեթոդաբանությամբ և կիրառելով ԱՏՀ քարտեզաչափական գործիքները՝ ստացել ենք լանդշաֆտային գոտիների անթրոպոգեն ծանրաբեռնվածության քարտեզը և հաշվարկել յուրաքանչյուր գոտում առկա ծանրաբեռնվածության համապատասխան աստիճան ունեցող տարածքների մակերեսներն արտահայտված տոկոսներով: Այնուհետև իրականացրել ենք լանդշաֆտային գոտիների անթրոպոգեն ծանրաբեռնվածության տարածական քանակական գնահատում ընտրված հայեցակարգի բացարձակ և հարաբերական գործակիցներով ու ԱՏՀ գործիքակազմով: Հետազոտության արդյունքում հետանտառային տափաստանային գոտին բնապահպանական և

տնտեսական ցուցանիշներով համարվել է կրիտիկական լարվածության տարածք, անտառային և մարգագետնատափաստանային լանդշաֆտային գոտիները՝ լարված և կոնֆլիկտային, իսկ մերձալպյան և ալպյան լանդշաֆտային գոտիները՝ պայմանական բարենպաստ:

О. Я. САЯДЯН, А. Т. ГРИГОРЯН, Е. А. ВАРДАНЯН

ГЕОЭКОЛОГИЧЕСКИЙ АНАЛИЗ ЛАНДШАФТНЫХ ЗОН ТАВУШСКОЙ ОБЛАСТИ

Р е з ю м е

В статье анализируется геоэкологическое состояние ландшафтных зон Тавушской области. Антропогенная нагрузка на природные ландшафты отражает степень интенсивности антропогенных негативных воздействий в данной ландшафтной зоне. Антропогенное воздействие на ландшафты проявляется в структуре землепользования. Согласно концепции Б. Кочурова, для определения степени антропогенной нагрузки на территорию применяются баллы экспертной оценки от 1 до 6. В зависимости от типа землепользования территории получают соответствующую оценку и объединяются в соответствующие группы. Руководствуясь методикой Б. Кочурова и применяя картографический инструментарий ГИС, мы получили карту антропогенной нагрузки ландшафтных зон и рассчитали поверхности площадей с соответствующим уровнем нагрузки в каждой зоне, выраженной в процентах. Затем была проведена пространственная количественная оценка антропогенной нагрузки ландшафтных зон с использованием абсолютных и относительных коэффициентов выбранной концепции и инструментария ГИС. В результате исследований лесостепная зона по эколого-экономическим показателям была признана зоной критического напряжения, лесная и луговая ландшафтные зоны признаны напряженными и конфликтными, а субальпийская и альпийская ландшафтные зоны – условно благоприятными.