

УДК 911.2:502.5(477.87:332.62)

ОПТИМИЗАЦИЯ СИСТЕМЫ ЗЕМЛЕПОЛЬЗОВАНИЯ АЛЬПИЙСКО-СУБАЛЬПИЙСКОГО ВЫСОКОГОРЬЯ ЧЕРНОГОРЫ НА ОСНОВЕ ЛАНДШАФТНОГО ПОДХОДА

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Представлен опыт применения ландшафтного подхода в оптимизации системы землепользования территории альпийско-субальпийского высокогорья Черногоры в пределах Закарпатской административной области в качестве полонинского хозяйства. На основе установленных нами особенностей ландшафтной организации высокогорной территории и свойств целостных геокомплексов Черногоры на примере ключевого участка Шешул – Петрос, а также закономерностей распространения негативных природных процессов были определены главные очаги и масштабы влияния объектов полонинского хозяйства на конкретные природные территориальные комплексы уровня урочища. С учетом ландшафта условно разделены высокогорные природные комплексы и искусственно сформированные пастбищные угодья лесного среднегорного яруса. В ходе исследований определены крупнейшие полонины выгонного типа в окрестностях ключевого участка Шешул – Петрос, особенности их размещения и функционирования, а также масштабы привлечения высокогорных урочищ, которые также используются в хозяйстве как пастбищные угодья. Анализ морфологической структуры высокогорья позволил установить закономерности организации природных комплексов, выражающие свойства и экологическое состояние полонинских пастбищных угодий, и разработать рекомендации по оптимизации полонинского хозяйства как основного землепользователя высокогорья Черногоры.

Ключевые слова: ландшафтная структура; Черногора; альпийско-субальпийское высокогорье; землепользование; оптимизация; полонинское хозяйство.

OPTIMIZATION OF LAND USE OF ALPINE-SUBALPINE HIGHLANDS CHORNOHORA ON THE BASIS OF THE LANDSCAPE PRINCIPLES

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The article presents the experience of using the landscape approach in optimizing the land use system of the alpine-subalpine highlands of Chornohora in the borders of the Transcarpathian region, the quality of the pasturage. On the basis of the features of the landscape organization of the mountainous territory and the properties of the integral geo-mapplexes of Chornohora, on the example of the key-site Sheshul – Petros, as well as regularities of the distribution of

Образец цитирования:

Карабиниук НН, Пересоляк ВЮ. Оптимизация системы землепользования альпийско-субальпийского высокогорья Черногоры на основе ландшафтного подхода. *Журнал Белорусского государственного университета. География. Геология*. 2019;1:73–81 (на англ.).
<https://doi.org/10.33581/2521-6740-2019-1-73-81>

For citation:

Karabiniuk MM, Peresolyak VYu. Optimization of land use of alpine-subalpine highlands Chornohora on the basis of the landscape principles. *Journal of the Belarusian State University. Geography and Geology*. 2019;1:73–81.
<https://doi.org/10.33581/2521-6740-2019-1-73-81>

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negative natural processes, the main centers and scale of the influence of the pasturage objects on the specific natural territorial complexes of the level of the tract were determined. On the landscape basis there are conditionally distinguished highland natural complexes from artificially developed pasture lands of forest middle level tier. The largest field pasturing type in the vicinity of the key area of Sheshul – Petros, the features of their placement and functioning, as well as the extent of attracting highland tracts, which are also used in the economy as pasture land in our research. The analysis of the morphological structure of the highlands made it possible to establish regularities of the organization of natural complexes, which express the properties and ecological state of the polonina pasture lands, and to develop recommendations for optimization of the pasturage as the main land useage of the highlands of Chornohora.

Keywords: landscape structure; Chornohora; alpine-subalpine highlands; land use; optimization; pasturage.

Introduction

The key to the stable functioning and economic development of the state is the efficient usage of all natural resources that can meet the needs of the population and can reach national goals. At the same time, the issue of preservation of the environment arises, because the environmentally safe usage of the resources contributes to the long-term development, reduction of the degree of exhaustion and the possibility of transferring it to the next generations.

A particularly valuable resource of the Transcarpathian region is the alpine-subalpine highlands, which is timed to the maximum hypsometric levels of the mountain ranges of the Ukrainian Carpathians, the highest of which is Chornohora. The territory of the highlands is the main place for conducting the pasturage for local population and recreation, as well as an integral part of the nature-protected objects of the highest level of the heritage (the Carpathian Biosphere Reserve (CBR)), which emphasizes the value and necessity of preservation. There is a tendency to reduce the number of lands of high-mountain pastures as a result of overgrown forest over the last decade, in the structure of agricultural land of the Rakhiv district of the Transcarpathian region. In this case, it is expedient to establish the territory of «just high mountain» and its conditional separation from the artificially developed pastures of the forest middle mountains tier.

Topicality of research

For a thorough study of the alpine-subalpine highlands of Chornohora, it is necessary to apply a landscape approach that will make it possible to establish the morphological structure and properties of integral geocomplexes, the patterns of the proliferation of negative natural processes, the present state and depth of anthropogenic modification, as well as the centers and scale of the impact of specific objects of polonina farms. The peaks of the mountains and the surface of the ridges are covered with grass, shrubs and moss-lichen vegetation, which are located above the upper limit of the forest and are used as pasture in the Ukrainian Carpathians are called «polonina».

Comprehensive analysis of the highlands of Chornohora on the basis of the landscape approach will allow the development of an individual set of measures to optimize the management of the pastoral economy as the main type of economic use of high mountain geocomplexes in the final stage. Similar ecological and landscape studies of the highlands have not been conducted before, therefore, the results of the analysis will be useful for optimizing the system of land usage, primarily in the form of a justification for the allocation of certain tracts of pasture land in the management and conservation of deeply modified tracts.

Analysis of recent research and publications

A detailed study of the issues of optimizing the land use system of the alpine-subalpine highlands of Chornohora landscape with the use of the landscape approach was not carried out before.

Instead, some studies related to the issues of the proper management of the pastoral economy (E. Egan [1], M. P. Tivodar [2], V. M. Klapchuk [3]), the consequences of its influence on the ecological state of geocomplexes and vegetation dynamics (K. A. Malinovskii [4; 5], M. Troll and I. Sitko [6; 7], I. B. Koinova, I. M. Rozhko [8]). Study of the structure of the land of regional physical and geographical units and separate natural territorial complexes of the Ukrainian Carpathians, including the Chornohora landscape, was conducted by A. V. Melnyk [9]. His research on land use mainly concerned the analysis of the factors of anthropogenic modification of landscape complexes and their ecological status, as a consequence of the structure of land and the nature of land use [9]. The authors of this article [10] also analyzed the current state of economic use, the problems of using high-mountainous natural territorial complexes and the structure of land in high mountains of the Chornohora landscape.

The first information about the peculiarities and genesis of natural territorial complexes of the alpine-subalpine highlands of Chornohora within the Transcarpathian region is presented in the work of G. P. Miller [11], who carried out a comprehensive landscape analysis and made the landscape map of Chornohora at the level of highlands and complex tracts. The morphological structure of the alpine-subalpine highlands of the Chornohora landscape at the level of types of terrain is presented in the work of K. I. Gerenchuk, M. M. Koynova, P. M. Tsysy [12]. Later, the features of the landscape structure on the territory of the studied key area were partly disclosed in the analysis of the landscape structure of the Ukrainian Carpathians [9; 13; 14], Transcarpathian region [15]. Particular attention deserves the work of G. P. Miller [16], in which he introduced the scheme of separating the strings, highlands and sectors in the form of a transect from the White Tysa river to the Lazeshchyna river through the central part of our key area Sheshul – Petros [16]. The structure of the land of high mountains of the Chornohora landscape was also carried out by some authors of this article [10].

Setting objectives

Natural territorial complexes of the alpine-subalpine highlands of Chornohora are characterized by considerable diversity and a peculiar combination of the expressed morphological structure. Much of the highlands are widely used in the economy, which is often accompanied by the destruction of soil and vegetation cover, the development of negative physical and geographical processes, which makes worse the quality and ecological stability of high mountain geocomplexes. Significant use of tracts of highlands as natural pasture lands requires monitoring of their ecological status, degree of modification and opportunities for further use. Therefore, the main task of our study is to optimize the land use system of the alpine-subalpine highlands of Chornohora as a management of the pastoral economy based on regularities of the landscape organization of the territory.

Materials and methods

Application of the landscape approach in optimizing the land use system of the highland area implies the establishment of interconnections and the functioning of individual structural units. On the basis of spatial relationships between natural territorial units, five main types of landscape-territorial structures are identified, which together define the main features of the landscape territorial organization as a whole and the possibility of solving the overwhelming majority of practical problems of rational land use. These relationships and their corresponding types of landscape-territorial structures (LTS) are positional-dynamic, paragenetic, basin, bio-centric-network and genetic-morphological [17]. The strongest interrelationships, and therefore, the highest stability, are characteristics of genetically related geocomplexes, which are characterized by a certain process of formation and development, an integral combination between components and the same ability to counter anthropogenic load. This is especially important in the study of high mountain natural complexes. Therefore, in our opinion, the identification and study of high mountain natural complexes is a priority from the point of view of their genetic affiliation for the purposes of land management. Based on these positions, we consider it expedient to use the genetic-morphological LTS as our one, which is best suited for studying the landscape structure of the alpine-subalpine highlands.

According to A. G. Isachenko scheme of the hierarchy of natural territorial complexes of the local level is as follows: facies → under tract → tracts → terrain [18]. The landscape structure is added to the structure of the mountain landscape, such as range, altitude (analogue of the terrain, expressing altitude landscape tiers) and sector [19].

In our opinion, for the practical tasks of land management, the greatest interest in the geosystem of the local level is lower tracts and tracts, because the basis of their isolation lie purely internal landscape and environmental factors, and the size of economic lands, their zones of influence are compatible with the geosystems of this level. Therefore, their analysis is most needed for solving practical tasks of land management [17].

Emphasizing the peculiarity and complexity of the morphological structure of the highlands as the object of our research, as well as the complex of applied aspects and tasks set for optimization of the land use system, the theoretical and methodological basis of our research served the position and methods of field landscape mapping of mountain landscape studies developed by G. P. Miller in 1974 [16; 20].

The study of the landscape structure of the alpine-subalpine highlands of Chornohora within the Transcarpathian region was carried out at the key site Sheshul – Petros. They took place in three stages: preparatory (pre-field), field and chamber. At the preparatory stage, a map-hypothesis was created on a key site, the initial data for which the existing maps and diagrams [9; 11; 13; 16] were used, and the branch maps (geological, geomorphological, maps of the quaternary deposits) were used for making the conclusion [21; 22], and soil survey materials [23], Google Earth cosmic photos (2015), etc. were used. For the complete analysis of the key area relief, the vectorized topographic scale of scale 1 : 25 000 was vectorized and a digital model of relief was created, which formed the basis for constructing thematic maps: steepness and slope exposures. When deve-

loping the map of the earth's steepness, the degree of G. P. Miller [16; 20] was used, namely: less than 3° – very slope; 3–6° – slope; 6–9° – slowfalling down; 9–12° – falling down; 12–15° – strong-burning; 15–30° – steep; 30–45° – very steep; more than 45° – precipice.

During the field stage, we conducted field landscape mapping of natural complexes according to the method of G. P. Miller [16; 20], objects of which were geocomplexes of all levels of the morphological structure: range, highlands, sectors, and especially tracts. At the departmental stage of the study, the results of their field landscape mapping were processed, and the materials obtained in the course of complex landscaping studies of facies, the laying of a landscape map on a key plot at the scale of 1 : 25 000 and a legend to it were carried out.

Results and discussion

The landscape of Chornogora is integral, clearly expressed in the relief and the highest mountain range of the Ukrainian Carpathians. It extends from the Black Tisza river to the southeast to the Black Cheremosh river. On the main ridge of Chornohora there is a watershed between the basins of the Prut and Black Cheremosh rivers on the one hand and the Black Tisza and White Tisza on the other. At the same time, the boundary between the Ivano-Frankivsk and Transcarpathian administrative regions passes along the watershed. Within the Transcarpathian region, Chornogora is located in the outskirts of the Rakhiv administrative-territorial area, the area of which is 1892 km², and occupies about 344.5 km² (18.2 % of the district's area). The landscape of Chornohora from ancient times was at the heart of the spiritual and economic life of the hutsul region.

According to the physico-geographical zoning of A. V. Melnyk, the Chornohora landscapes are the part of the Svydovets-Chornohora district of Vysokogorno-Polonin region [9]. The highest gipsometric level in the morphological structure of the Chornogora landscape is occupied by high-mountain geocomplexes, which are confined to massive ridges and their spurs, composed predominantly of solid sandstones. In the course of landscape studies, it has been established that the high mountains of Chornogora are represented by two fragmented fragments that extend from the northwest to the southeast. Most of the high mountains of Chornogora are confined to the main ridge, which stretches 25–30 km in the southeastern direction from Goverla to the city of Pip-Ivan Chornohirsky. The second fragment is located in the area of Petros and occupies an area of 14.9 km². This site is a model in our research, since most of it is part of the CBR and retains traces of significant anthropogenic load of ancient economic use and modern recreation.

The territory of the key site Sheshul – Petros is located in the northwestern part of the alpine-subalpine highlands of the Chornohora landscape within the Transcarpathian region. It is a continuation of the Main range Chornohora, which turns from the top of Hoverla (2060.8 m) to the west to the peak of Petros (2020.2 m), from which the spine branching in two directions: a small part – in the northwest, and most of it – in the southwest. At the same time, the orographic axis of this territory has a southwestern orientation in the direction Petros – Sheshul (1727.8 m) – Menchul Kvasivsky (1305.2 m). In this direction there is a decrease in the maximum heights from 2000 to 1600, the average height is 1750–1800 m above sea level (a. s. l.) (fig. 1).

Complex combination of forms of relief of the key plot and associated with these forms of morphologic units of the alpine-subalpine highlands is the result of petrographic and lithologic features of geological breeds formed as a result of peculiar development of the geological foundation of the territory as a leading factor in the formation of the landscape structure.

Characteristics of the natural territorial complexes of the alpine-subalpine highlands of Chornohora are difficult accessibility, significant temperature variations, and the dismemberment of the relief. Therefore, historically, the following types of economic activity are made: high-mountainous natural pastures for livestock farming (pasturage economy) and recreation, which together with environmental protection activities are decisive in the structure of functional use of the territory [10].

The most negative anthropogenic impact on the highlands of Chornohora is the exploitation of geocomplexes in the pastures of pasturage farm. Polonina is characterized by a cold and humid climate, a short and rainy vegetation period, a long and snowy winter. The total area of the valleys in the eastern part of the Carpathians is about 50 thousand hectares, including in Chornohora (including areas of the Chornogora estuary within the Ivano-Frankivsk region) – 16 thousand hectares [5].

Nevertheless, in recent decades the capacity of the pasturage farm has significantly decreased as a result of a significant reduction in the livestock population of the local population. Analyzing the composition of agricultural lands in Rakhiv district for 2011–2016 (table 1), it was revealed that quantitative indices of pasture are characterized by considerable dynamics (although data are not isolated separately for Chornohora, but they express a general tendency). Of all pastures, the status of mountainous have pastures of more than 71 %. According to table 1, the lands of mountain pastures decrease in their areas. If from 2011 to 2012 their area decreased by 0.77 hectares, then from 2012 to 2013 this figure already became 2.99 hectares. Such indicators may show a reduction in the capacity of the polonina farm and the development of the process of restoring natural landscapes in the forest belt [10].

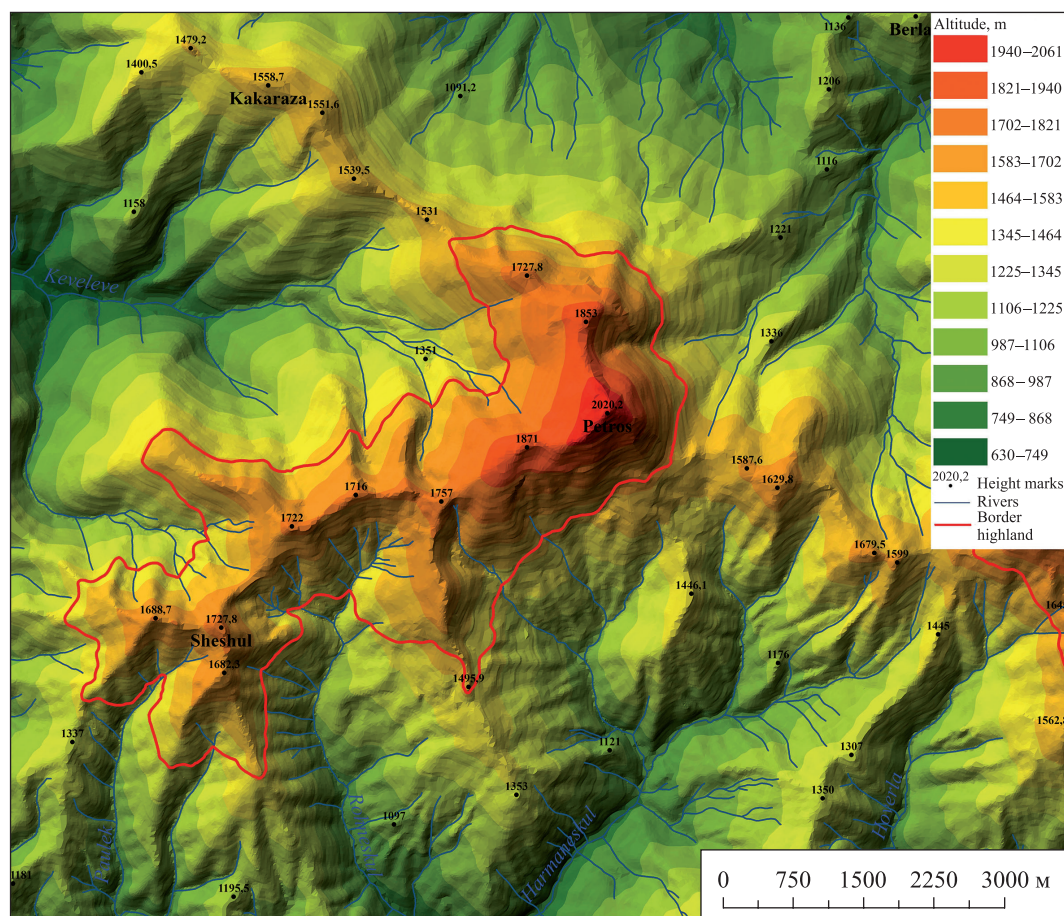


Fig. 1. Hypsometric map of key area Sheshul – Petros

Table 1

Composition of farming land of Rakhiv district

Farming land		Area of agricultural land, ha					
		2011	2012	2013	2014	2015	2016
Tillage		1990.431 2	1990.531 2	1990.531 2	1989.867 3	1872.651 0	1872.651 0
Gardens		190.379 6	190.379 6	190.379 6	190.379 6	216.080 1	216.080 1
Hayfields		19 199.471 6	19 199.089 9	19 199.089 9	19 198.339 9	19 167.796 9	19 166.167
Pastures	Total	14 281.309 2	14 280.474 3	14 277.486 4	14 277.486 4	14 242.111 2	14 242.111 2
	Including mountain	10 268.353 9	10 267.604 0	10 264.616 1	10 264.616 1	10 264.616 1	10 264.616 1
Under the farmstead buildings yards		96.852 2	97.092 7	97.031 0	96.669 5	93.045 6	93.328 6
Under the farmstead roads and stringer		478.955 3	478.955 3	478.867 1	478.867 1	426.786 2	426.721 6
Others		1.220 0	1.220 0	1.220 0	1.220 0	2.348 7	2.348 7
Total		36 238.619 1	36 237.743 0	36 234.605 2	36 232.829 8	36 020.819 7	36 019.408 2

Source: [10].

As a confirmation of the reduction of the Chornohora pastures, the results of the study of the state of the pasturage economy in the western part of the highlands of the Chornohora landscape in the spatial-temporal aspect, its impact on the ecological state of the geocomplexes and the dynamics of the upper boundary of the forest conducted by the Polish scientists M. Troll and I. Sitko [6; 7]. These studies also prove that the polonina farm is closely related to the high altitude of the steep-sloping erosion-denudation forest middle mountains, which is hypsometrically lower.

In the boundaries of the forest zone, buildings (blocks, stools, fences) of the pasturage economy are located as a result of the need for access to wood for the construction and logging of wood, as well as better protection against adverse weather events. On the ground, deforestation, increasing the secondary (after-forest) meadows, is mainly used for harvesting hay and grazing livestock. According to E. Egan, «the Carpathian hills were once virgin olive trees. Those [hutsuls], which eradicated the forest and created a land here»¹ [1, p. 39], it can be argued that artificial expansion of areas for grazing took place already in the 18th century. Only a small part of the pasture is located in the vegetation zone of natural alpine meadows; instead, most were created by purifying subalpine shrubs and forests [6]. That is, the alpine-subalpine highlands of Chornohora are used in the pasturage economy mainly as pasture, and then fragmentary. Therefore, the main task of optimizing the land use system of the alpine-subalpine highlands of Chornohora is to establish the main cells and specific geocomplexes, which undergo periodic loading and determine their current state.

The mountains and vegetation belts of the mountain range are divided into two types: the first type of valleys is located only in the sub-alpine zone, the second – in the sub-alpine and alpine zones [5]. According to this classification the mountains of the Chornohora massifs belong to the second type, the peaks of which exceed 1800 m a. s. l., on which the alpine belt of vegetation has been formed.

The grazing of livestock directly on the alpine-subalpine meadows of Chornohora is accompanied by a decrease in biomass through eating and dredging, a change in the species composition of vegetation, the destruction of turf, the creation of micropores and potholes, consolidation of soil, increased erosion processes, etc. In intensive grazing of cattle from ecosystems regularly withdraw an essential part of primary production. As a result, not only the composition of the biota changes, but also the amount of dying phytomass, which enters the biological cycle, changes the structure of the soil, decreases the flow of nutrients into the soil. The effects of such influence sometimes do not appear immediately, but the effect is superimposed and leads to significant degradation processes, mainly in the case of intensive grazing [8].

The grazing is carried out along the Chornohora main dividing range, in the pasturage around Petros, such as Menchul, Konets, Sheshul, Garmenskaya, Govcheskaya, Stupi, Shumensk and others. The grazing takes place mainly in the buffer zone of the CBR, but is often observed in the reserve area on the slopes of the city of Turku, Gutin-Tomnatka and in the brown lake Brebenscule. This is a consequence of the imperfect zoning of the CBR territory and a significant disagreement with the functioning of local areas.

Based on our studies of the landscape structure of the northwestern part of the alpine-subalpine highlands of Chornohora, on the example of the key site Sheshul – Petros, the landscape confinement of the pasturage to the geocomplexes from the highest morphological units (sectors and localities) to the lowest (simple tracts and ridges) is established.

As a result of the orographic impact on the redistribution of heat and moisture within the highlands, the landscape sector can be traced. The consequence is the domination of meadow vegetation in the tracts of the sector of the southwestern macro-slope and the predominance of the juniper-green-eyed curvature in the tracts of the sector of the northeast macroslope. Such a distribution of plant cover is enhanced by anthropogenic activity. The slopes of the southwestern sector, which receive more solar heat and precipitation for growing vegetation, which also contributes to the regeneration of arid vegetation, as the main feedland of the valleys, are widely used as pasture land in the pasturage farm. This contributed to a significant degradation of the vegetation and significant destruction of the subalpine curvature. Instead, tracts of the northeastern sector are found mainly in the beds of the heads and are characterized by greater steepness and domination of the shrubs, which makes it difficult and sometimes impossible to use them as pastures.

It was established that the largest mountain valleys in the outskirts of the key area of Sheshul – Petros, which use the breeding type of cattle, are Menchul, Konets, Sheshul, Garmenskaya, Govcheskaya, Stupi, Shumensk. Under the influence of the Menchul valley there are tracts: weak and hilly (6–12°) weakly convex surface of the spurs, steep (15–30°) convex spur vertices, steep (15–30°) slopes of western and northwest exposures, declining and strongly-dead (9–12°) step slopes of the southwest exposition, steep (15–30°) slopes of southwest expositions, and others.

As the pastures of the valleys, the end uses tracts: the steep slopes of the west and northwest exposures, steep and very steep (15–45°) slopes of the drainage basins of the southern and southwestern expositions, steep and very steep (15–45°) slopes of southern and southeast exposition, steep and very steep (15–45°) slopes of drainage basins of southeastern and eastern expositions with processes of linear erosion, etc.

One of the largest mountain polonina, which is located in the middle of Chornohora, but used as pasture tract highlands is Rogneska. Geocomplexes are used as pasture lands: steep (15–30°) slopes of southwest expositions, steep (15–30°) slopes of western and northwest exposures, steep (15–30°) wavy slopes of drainage reservoirs of western exposition on shoulders geological layers, loose and weakly flaccid (3–9°) surfaces of the moraine-feathered bottom of the carcasses, as well as weak-fall and drops (6–12°) of weakly convex surfaces of the spurs and weakly convex ridges of the jagged surfaces.

¹ Hereinafter translated by M. K.

One of the largest mountain polonina in the vicinity of Petros is the Garmanets polonina, which is located on genetically distinct tracts, than the rest of the mountain valleys of the key plot. The main part of polonin's buildings (the local name «the stilo») is located in the tract of loose and weak-fall ($3-9^\circ$) surfaces of the moraine-feather-bed bottoms of the waves of wavy surfaces of loam-boulder furrow moraines. As a consequence of the management of the tract of the moraine-clinging bottoms of this strata is characterized by significant anthropogenic modification, the destruction of mountain-pine curvature and the spread of secondary meadow whitewashed wilderness and horse radish. As a result of the annual livestock grazing, permanent paths of wood are formed, along which partially (in places completely) the turf is destroyed, numerous micro beds and potholes are formed, which intensify erosion processes. As grazing lands of the valleys, besides the neighboring tracts of steep ($15-30^\circ$) dismembered slopes of the moraine-bearing bays, the tracts are used: steep and very steep ($15-30^\circ$) slopes of southern and southeastern expositions, steep ($15-30^\circ$) convex spurs of vertices, as well as tracts of middle-highland belt.

A similar influence of pastures from the valleys of Stupa and Serilivka is experienced by the tracts of the bottoms and walls of the carcasses, and especially the tracts of the precipitated surfaces of the besieging walls of the right-handed beats on the shoulders of the strata. Specialization of these valleys is oriented on sheep breeding, but the approach to organizing grazing is significantly different from the previous ones. It consists in the alternate use of mountain polonina, depending on the condition of the forage base and weather conditions. That is, the valleys of Stupi, Serilivka and several smaller ones do not function simultaneously and are used in fact by one economy. The nature of the economy is reflected in the local name of the polonina of this type – «staya», that is, the place of parking. This type of organization of the pasturage contributes to reducing the concentration of loading on the geocomplex, the best restoration of biomass, reducing the depth of modification of the complex, etc.

Most of the territory of the highlands of the Sheshul – Petros site uses region of Shumensk for grazing. In the past it was formed of Lower, Medium and Upper parts of the stila. Polonina specializes in cattle grazing. Although the whole polonina is located in the middle mountains, where a large part of the pasture land is also found, but annually uses high-altitude natural complexes as a raw material base for biomass: steep ($15-30^\circ$) slopes of the Southwest exposure and steep ($15-30^\circ$) slopes of the drainage basins of the northwest and southwestern expositions. As a result of the pasturage economy in the tracts involved, the belt of subalpine crookedness has been significantly destroyed and the development of erosion processes has taken place.

Recommendations

The cessation of the destruction of the structure of the alpine-subalpine phytocoenoses of the high-mountainous georgetal complexes of Chornohora can be achieved due to the strict separation of forests from pastures and the observance of special rules of management in them. Until recently, the main reason for such rules was the introduction of graft forage system as the basis of rational pastures in the mountain polonina, but due to the decrease in livestock and the general decline of the pasturage farms, the need for it has lost its relevance. Optimization of the land use system is reduced to the dispersion of the load of the pasturage economy on the geocomplex. This can be achieved by dividing the capacity of individual mountain valleys in pasture lands and infrastructure (sheds, residential buildings) of non-functioning mountain valleys, thus achieving the optimal number of livestock.

The restoration of the forest cover in the middle of the mountains in the vicinity of abandoned valleys should be accompanied by cleansing from the young, because from an economic point of view, due to the considerable distance of these lands, it is not economically advantageous to transport wood, but these pasture lands are an important part of the feed base and a prerequisite for the development of the economy in the province. Now there is a danger of losing pastures located in the middle reaches, which are in contact with tracts of the alpine-subalpine highlands and are an important raw material resource and feed base.

To maximize the effect of the concentration of polonina farms, it is advisable to conduct a study of the present state and anthropogenic modification of natural highland complexes. After all, in view of the nature-conservation purpose of most of the highlands, it is not appropriate to involve valuable geocopies or territories with primary vegetation in operation. In addition, for harmonious development and ecologization of the traditional pastoral economy, it is appropriate to combine it with recreational activities, limiting livestock, but attracting tourists to visit the pasturage farms.

Conclusions

The main economic component of the land use system of the alpine-subalpine highlands of Chornohora within the Transcarpathian region is the polonina farms, which uses high-altitude geocomplexes mainly as pasture lands. Optimization of the pasturage economy is based on the genetic-morphological landscape structure

with the application of the landscape approach. The analysis of the morphological structure of the highlands made it possible to establish the regularities of the organization of natural complexes, which express the properties and ecological state of the polonina pasture lands.

In the course of our researches it was established that the largest polonina in the outskirts of the key area of Petros, which uses the curried type of grazing of cattle, are Menchul, Konets, Sheshul, Garmenskaya, Govchetskaya, Stupi, and Shumenskaya. The greatest influence of the pasturage is experienced by natural territorial complexes, which are located within a radius of 1–2 km to the valleys, the placement of which tends to the upper limit of the forest, with a slightly lesser impact of the economy, geocomplexes that are located at distances of more than 2 km and tourist routes.

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