

GeoTerrace-2023-006**The use of GIS for mapping and analysis of changes in the vegetation cover of Chornohora (Ukrainian Carpathians) under the influence of the pasture farming**

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SUMMARY

On the basis of the landscape approach, the location of the boundary of the highlands landscape tier within the Chornohora landscape of the Ukrainian Carpathians was identified. An analysis of the features of the placement and load of pasture farming on mountain geocomplexes was carried out, taking into account the area and specialization of polonynas, the number of livestock, etc. The impact of pasture farming on the structure and features of the vegetation cover of the high and mid-mountain landscape tiers of Chornohora, where the largest polonynas of the massif are concentrated, is characterized. The main result of the research is a compiled map of the current vegetation cover on the example of the section of “Sheshul-Petros”, which also reflects the location of the forest on the territory of the forest and the height position of the timberline. As a result of the research, more than 10 km² of meadows and shrubs of secondary origin were identified and mapped, which in modern conditions of climate warming and reduction in the number of livestock are overgrown with shrubs and tree species.

Keywords: pasture farming, polonyna, pasture, geocomplex, degradation, vegetation zone, Chornohora

Introduction

In modern conditions of increasing anthropogenic load and increasing environmental threats in Ukraine, it is important to study the geoecological situation and changes in the natural environment of various regions, including mountainous areas. Valuable and unique mountain landscapes of the Ukrainian Carpathians deserve special attention, among which the Chornohora mountain massif with well-defined subalpine and alpine highlands (Karabiniuk et al., 2022). A feature of the high-altitude landscape layer is a high landscape diversity, the preservation of relict glacial and nival-erosion geocomplexes in the landscape structure, the predominance of a cold and wet climate, which contribute to living in the vegetation cover of alpine meadows and shrubs of the subalpine zone. Such conditions significantly limit the possibilities of economic use of the territory, with the exception of recreational activities and pasture farming. As a result, Chornohora became a powerful center of traditional pasture (pastoral) farming in the form of nomadic animal husbandry (Gudovski et al., 2010; Lavruk, 2011; Karabiniuk et al., 2022).

Intensive management of pasture farming in the highlands of Chornohora and adjacent territories can contribute to the aggravation of a number of geological threats – from the development of short-term erosion processes to long-term changes in the structure of the vegetation cover (Warchalska-Troll & Troll, 2014; Sitko & Troll, 2008). It is the degradation and changes in the vegetation cover that is one of the main negative consequences of long-term pasture farming in Chornohora, which in the past was accompanied by intensive cutting of subalpine shrubs and forests at the highest hypsometric levels in order to increase the area of pastures (Baitsar, 1994; Lavruk, 2011; Sitko & Troll, 2008). The significant decline of the pasture farming now and modern global climate changes contribute to the intensive restoration of natural vegetation and the restoration of the upper limit of the forest. Therefore, today it is necessary to study changes in the structure of the vegetation cover of the highlands of Chornohora, as well as the identification and mapping of secondary meadows within the natural forest mid-mountain landscape layer with the help of modern geoinformation systems, which without appropriate human care can be lost as pastures.

Theory and Method

The study of changes in the vegetation cover of the highlands of Chornohora and adjacent territories under the influence of the pasture farming was carried out on the basis of a landscape approach with extensive use of specialized ArcGIS software. In order to determine the natural limit of the high mountain landscape tier in Chornohora and the levels of potential elevation of the upper limit of the forest in modern conditions, we implemented a long-term detailed landscape survey of the territory on the theoretical and methodological basis of mountain landscape science with a combination of field survey methods and geoinformation analysis. Taking into account the altitudinal differentiation of factors of landscape formation, the experience of landscape mapping of highlands natural territorial complexes in the Ukrainian Carpathians of Chornohora, we singled out and applied the main criteria for the selection of the highlands landscape tier:

- hypsometric position – heights above 1 450–1 600 m a.s.l.;
- the commonality of the geological construction area – the dominance of coarse-grained and massive sandstones;
- the genesis of the relief – the presence of a denudation surface and alpine relief;
- steepness of slopes – mostly 15–30° or more;
- change in the properties of the lithogenic territory – contacts of the geological structure and tectonic disturbances;
- the nature of exogenous dismemberment, the presence of traces of nival processing of the relief, the presence of alpine forms (corries, cirques, nival niches), etc.;
- nature of the vegetation cover – location, usually above the natural upper limit of the forest (projective cover does not exceed 0,2), dominance of native subalpine and alpine vegetation;

Taking into account the above-mentioned criteria, clear boundaries of the natural highlands and its total area of 80,5 km² were determined within the landscape of Chornohora. A large-scale landscape survey was carried out on the entire territory of the highlands landscape tier of the massif, and a geo-informational analysis of the properties and features of the functioning of highlands geocomplexes was carried out (Karabiniuk et al., 2020, 2022). On the basis of geospatial and statistical data of the department of agro-industrial development of the Rakhiv District State Administration (Results of livestock..., 2023), the Main Department of the State Geocadaastre in Transcarpathian region (Accounting of agricultural..., 2023) and the Carpathian Biosphere Reserve (Journal of accounting..., 2023) the number of livestock and spatial differentiation of the farming load on the geocomplexes of Chornohora was analyzed.

A detailed geo-informational analysis and mapping of changes in the vegetation cover of Chornohora under the influence of the pasture farming was carried out in the ArcGIS 10.4.1 software environment on the example of the key site “Sheshul-Petros” with a total area of more than 84 km² (Fig. 1). In the process of mapping, we identified natural grass (meadows) and shrub vegetation in the highlands landscape tier, and forests, as well as meadows and shrubs of secondary origin, in the med-mountain tier. Among them, the secondary meadows deserve the most attention, which today are a valuable resource for pasture farming and are at the greatest risk of being overgrown with shrub and tree vegetation. At the same time, we took into account our own experience of mapping and geo-informational analysis of physical-geographical processes in mountain landscapes (Karabiniuk et al., 2020, 2022; Buriannyk et al., 2021). In the process of research, we also processed published literary and cartographic materials related to the research area (Sitko & Troll, 2008; Troll & Sitko, 2006; Gudovski et al., 2010; Lavruk, 2011; Warchalska-Troll & Trol, 2014; Karabiniuk et al., 2022).

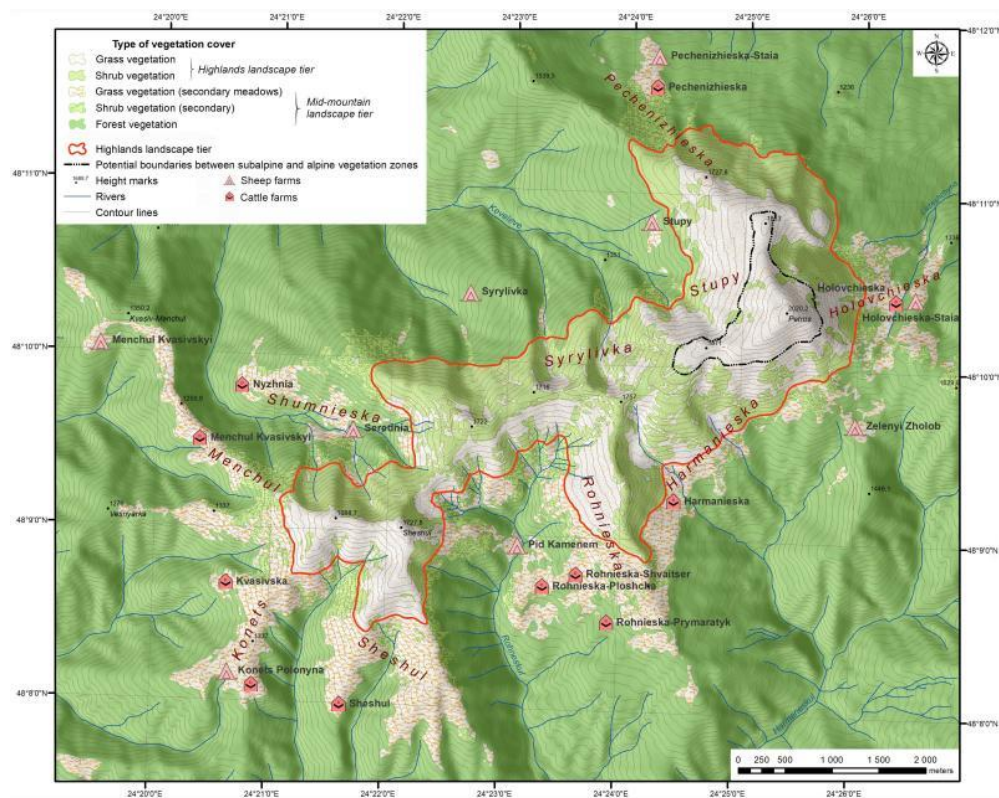


Figure 1 The actual vegetation cover on the territory of the key section of “Sheshul-Petros” (Chornohora, Ukrainian Carpathian) in the conditions of pasture farming

Examples

The pasture farming in Chornohora is currently represented by about 20 functioning polonynas, the most powerful of which are located in the western part of the mountain landscape in the “Sheshul-

Petros” section that we are investigating. Their areas here vary from 55 to almost 480 hectares (Accounting of agricultural..., 2023). The largest among them are the Shumnieska and Harmanieska fields, the area of which reaches 478,7 and 451,3 hectares, respectively (Accounting of agricultural..., 2023). More than 4 000 sheep, 800 cattle and about 40 horses are grazed annually on the ten meadows of the researched area (Results of livestock..., 2023; (Journal of accounting..., 2023). As a result, most polonynas are combined, specializing in grazing sheep in combination with cattle. They are focused on the contact of natural highlands and mid-mountains, and therefore are characterized by a significant impact on the vegetation cover of both landscape tiers.

Modern pasture farming in Chornohora is characterized by the use of highlands areas exclusively for livestock grazing, but secondary meadows in the mid-mountain forest tier, which are most often used as pastures, experience the greatest economic load. For example, today the greatest load of livestock on pastures is inherent in the pastures of Menchul, Konets, Rohnieska, etc., which reaches more than 7 heads of livestock per 1 hectare of land. Intensive livestock grazing is directly accompanied by a decrease in biomass due to eating and trampling, a change in the species composition of vegetation, the destruction of turf, the creation of micro-steps and potholes, soil compaction, increased erosion processes, etc. With intensive livestock grazing, a significant share of primary biological products is regularly removed from geocomplexes. As a result, not only the composition of the biota changes, but also the amount of dying phytomass entering the biological cycle, the structure of the soil changes, and the supply of nutrients to the soil decreases (Karabiniuk et al., 2022).

As a result of the study of changes in the structure of the vegetation cover under the influence of pasture farming in the “Sheshul-Petros” section 7,1 km² of meadows and 3,0 km² of shrubs of secondary origin were identified and mapped using GIS, which are the result of cutting down natural forests in the past for the purpose of expansion pasture. The largest areas of cut forests were recorded in the vicinity of the Szeshul, Konets, Rognieska and Šumnieska meadows, where the upper limit of the forest as a result of pasture activity has been lowered by more than 300–350 m. In the cleared areas, low-yielding meadows with *Calamagrostis epigejos* (L.).

Field research and geoinformation analysis of changes in the vegetation cover of the high-altitude landscape tier of Chornohora using the example of the “Sheshul-Petros” section also indicate the destruction of a significant part of the natural subalpine shrubs. They are almost completely absent on ridge slopes and catchment troughs of southern and south-western exposures near the polonynas of Rognieska, Seshul, Konets Polonyna, etc. This also determines the intensification of linear erosion and scree here, and also contributes to the destabilization of mudslides and floods in the midlands of the pot basins Paulek, Rogneskul, Garmaneskul, etc. Also, in the structure of meadow vegetation in the highlands, under the influence of pasture management, low-productivity meadows of arable origin have spread significantly. This also determines the intensification of linear erosion and scree here, as well as contributes to the destabilization of mudslides and floods in the mid-mountain basins of the Paulek, Rogneskul, Harmanieskul, etc. streams. In the structure of meadow vegetation in the highlands, under the influence of pasture management, low-productivity meadows of secondary origin have spread significantly.

Conclusions

As a result of the study of changes in the structure of the vegetation cover in Chornohora under the negative influence of the pasture farming, more than 10 km² of meadows and shrubs of secondary origin were identified using the methods of geo-informational analysis and field research. The lower limit of highlands landscape tier at altitudes of 1 450–1 600 m a.s.l. was determined.

The once powerful pasture farming is currently declining, and the area of the largest functioning polonynas does not exceed 500 he. Reducing the economic burden on the forests of Chornohora due to the reduction in the number of livestock contributes to the intensive restoration of natural vegetation in the territories that were previously actively used as pastures. Today, active restoration of *Pinus mugo* Turra and *Alnus viridis* (Chaix) DC. and raising of the upper forest through overgrowth of

secondary meadows are observed. Within the boundaries of the “Sheshul-Petros” area, these processes are most actively taking place in the vicinity of the Shumnieska Polonyna and are associated with a significant decrease in the number of livestock here.

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