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ENVIRONMENTAL ISSUES OF ZAKARPATTIA

Manual

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Manual

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The manual contains scientific materials devoted to the coverage of contemporary environmental issues of Zakarpattia. Considerable attention is paid to the peculiarities of its natural conditions. Emphasis is placed on the preservation of biodiversity in the face of climate change. While devising this textbook, the authors resorted to the analysis of literary sources as well as the findings of their own research. It will benefit school teachers, students and postgraduates of higher educational institutions majoring in natural sciences, employees of the nature reserve fund, and representatives of the authorities.

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A characteristic feature of the high-mountain landscape tier of the Ukrainian Carpathians is the dominance of massive relief forms with steep slopes and deeply incised glacial cirques, corries, nival niches and other geocomplexes. The landscape structure of the high mountains acquired its modern features during the ancient Pleistocene glaciations, and the modern development of landscape complexes occurs mainly under the influence of erosion and denudation (Karabiniuk, 2020). Subalpine and alpine vegetation is most common in the high mountains. The bottoms of corries, glacial troughs and lower parts of the massive slopes are covered with crooked forests of mountain pine, green alder and Siberian juniper. In the subalpine vegetation zone, there are also admixtures of fir-mountain pine groupings, which are sporadically distributed among continuous thickets of shrubs (Baitsar, 1994; Malynovskyi, 1980, 2003). At altitudes over 1850 m above sea level alpine meadow vegetation is widespread.

In the Ukrainian Carpathians, the high-mountain landscape tier is best expressed at the highest hypsometric levels of the Chornohora, Svydovets, Marmarosh, and Borzhava mountain landscapes. The dominance of hard sandstones in the geological base and the long history of the development of the high-mountain layer under the influence of intensive mountain formation, glaciations and modern climate changes caused a high landscape diversity (The State Geological..., 2009; Karabiniuk, 2020). The convex and flat surfaces of the crests of the main ridges of the high mountain massifs preserve the features of ancient denudation, and are now covered with juncus-fescue meadows and juniper. On the steep slopes of the high-mountain landscape, avalanche and crumbling processes are quite common, avalanches and manifestations of other physical and geographical processes are recorded annually.

1.8. CONTEMPORARY LANDSCAPE STRUCTURE *(M. Karabiniuk)*

On the earth surface, under the influence of zonal and azonal factors, there were formed numerous geocomplexes of various ranks and sizes, of different genesis and complexity of internal organization, forming a clear hierarchical structure, from the smallest landscape unit of the local level (facies) to the largest natural territorial complexes of the global order (geographic shell). Landscapes occupy a special place in this hierarchical system. The landscape studies approach envisages the exploration of the object taking into account its location in this landscape system and the features of the internal structure (Melnyk, 1999).

Each landscape complex at the local level is a clearly defined element of the internal structure of the landscape. They formed historically and

separated primarily in the processes of development of the lithogenic (geological-geomorphological) base, and now are connected to one another by numerous 30 functional and energy connections (Miller, Fedirko, 1990; Miller et al., 2002). Such a system of internal organisation of the landscape, subordinated to functional quantitatively determined connections, which is represented by an aggregate of geocomplexes of lower ranks, that is, they are its morphological parts, with a peculiar character of spatial combination, shaped mainly in the process of historical development, is called a morphological structure (Melnyk, 1999; Karabiniuk, 2020). Analysing the landscape organisation of any territory, the boundaries of which do not coincide with the boundaries of landscapes as the lowest unit of physico-geographical zoning, it is appropriate to use the term «landscape structure».

According to the physico-geographical zoning of the Ukrainian Carpathians by A. Melnyk (1999), the territory of Zakarpattia Region is divided between Hirskokarpatskyi (Mountain Carpathian) and Zakarpattia physico-geographical lands (Fig. 1.8.1). The first of them occupies more than 85 % of the area of the region and is represented by 8 physico-geographical areas, which stretch mainly from the northwest to the southeast in the form of strips of various configurations and widths from 5-10 to 30-35 km, repeating the direction of the main mountain ranges of different genesis and geological structure. Each of the physico-geographical areas is characterized by unique lithological features and internal structure, which is constantly developing and transforming under conditions of climate change and a sharp increase in economic activity. The transversal division of physico-geographical areas by river valleys is due to the presence of a significant number of tectonic disturbances, which were formed during the geological development of the territory and serve as the location of the largest river valleys. Also, a number of river valleys (the Chorna Tisza river, the Teresva river, the Rika river, etc.) serve as boundaries between physico-geographical areas that were formed on lower-order morphostructures and are morphologically different from one another.

According to A. Melnyk's landscape map (1999) and own field research (Karabiniuk, 2020), the contemporary landscape structure of Zakarpattia Region is formed by 12 high-altitude areas of various origin and with significantly different properties (Fig. 1.8.2.). Hypsometrically, the highest and oldest high-altitude area is *a convex peneplenized alpine-subalpine highland* (1), which preserves relict traces of early denudation and today covers the exposed surfaces of the highest mountain massifs – Chornohora, Svydovets, etc. Strong Pleistocene glaciations in the Ukrainian Carpathians led to the formation of *the high terrain of the Paleoglacial-exaration subalpine highlands* (2), which are represented by powerful corries, cirques, through

valleys and other tracts with peculiar morphometric features. Both high-altitude areas are located at altitudes above 1,450 m above sea level. and are unique in the landscape structure of the area.

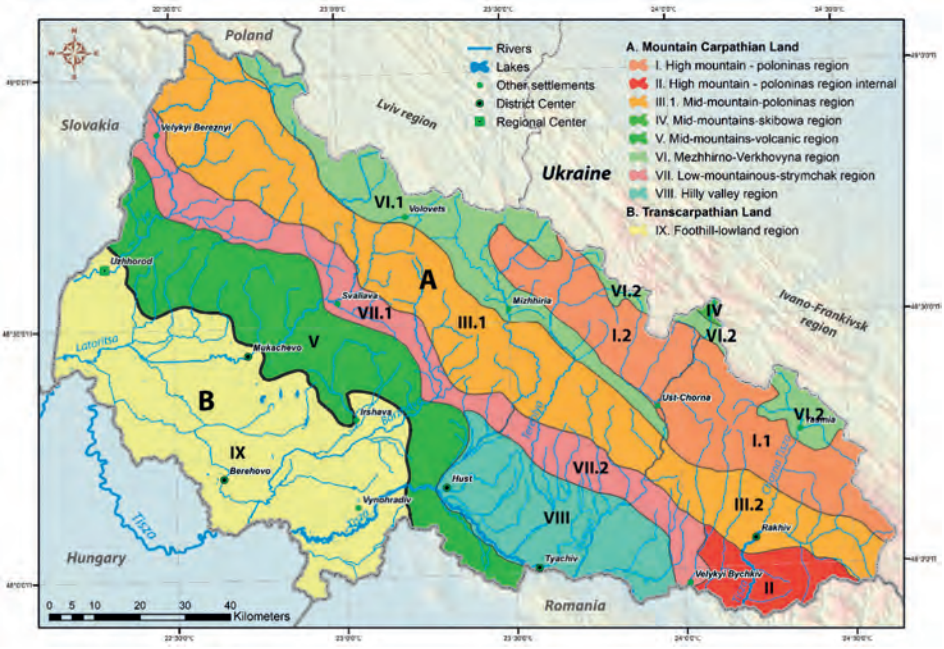

Fig. 1.8.1.Physico-geographical zoning of Zakarpattia Region (prepared according to A. Melnyk's materials, 1999)

A. Hirskokarpatskyi krai (translated as Mountain-Carpathian Land). ***I. Vysokohirno-Polonynska (Highland-Meadow) area.*** I.1. Svydovets-Chornohora district; I.2. Nehrovets-Bushtul district. ***II. Vysokohirno-polonynske yadro area (The area of High mountain-meadow core).*** Rakhiv-Chyvchyn district. ***III. Serednohirno-polonynska area (Middle mountain-meadow)***. III.1. Plonyna range district; III.2. Stih-Plai district. ***IV. Serednohirno-skybova (Middle mountain-skybova) area***. Gorgany district. ***VI. Mizhhirno-verkhovynska (Intermount-upland) area.*** VI.I. Mizhhiria district; VI.II. Mizhhirno-ulohovynny (Intermoinnt-basin) district; ***VII. Nyzkohirno-strimchakova (Low mountain-cliff) area.*** VII.1. Turia district. VII.2. Uholka district. ***VIII. Horbohirno-ulohovynna (Hump mountain-basin) area***. Solotvyno district.

B. Zakarpattia Land. *IX. Peredhirno-nyzovynna (Foothill-lowland) area.* Prytysianska Lowland district.

The territory of Zakarpattia Region is also home to *a high-altitude terrain of gently sloping ancient-glacial-accumulative forested midland*

(mid-mountains) (3), the limited development of which is determined by the movement of ancient mountain glaciers during glaciation periods (Melnyk, 1999; Melnyk, Karabiniuk, 2018). It is represented by a system of loamy-boulder moraine ridges, dissected by a dense network of mountain streams and covered with fir-spruce forests. The largest glaciers in the Pleistocene period and the best-expressed paleo-glacial-accumulative landscape complexes are on the northern and northeastern macroslopes of Svydovets, Chornohora, and Maramures massifs. In the landscape structure of the oblast, the high-altitude terrains of glacial origin are unique and occupy the smallest areas (Table 1.8.1).

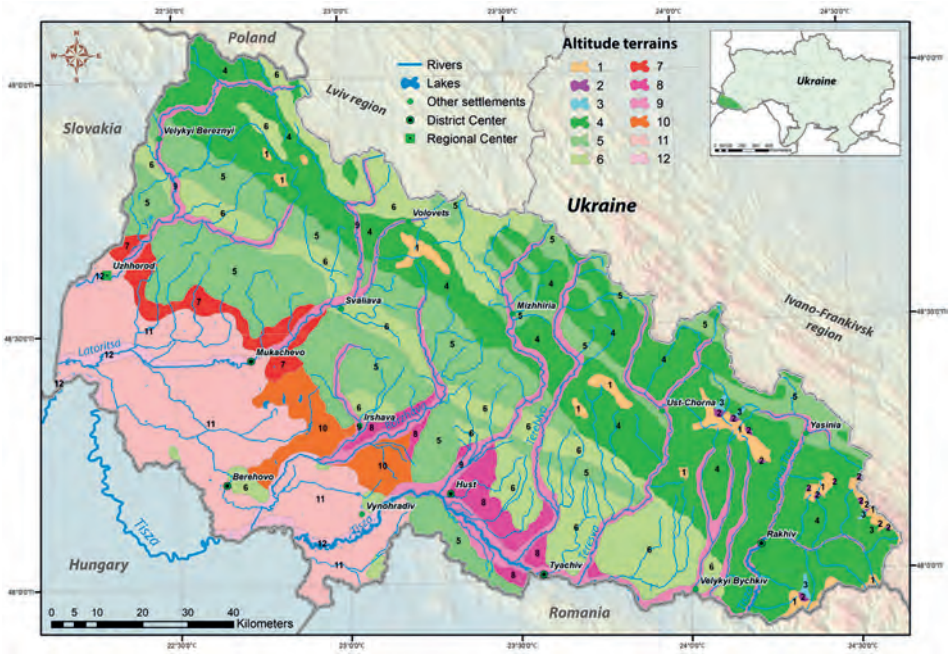

Fig. 1.8.2. Landscape map of Zakarpattia Region on the level of high-altitude terrains (based on the materials of A. Melnyk (1999) and M. Karabiniuk (2020)). Names of high-altitude terrains according to A. Melnyk (1999)

The high-altitude area of the steep sloping erosion-denudation forested middle mountains (4), the area of which is 3302.5 km^2 and covers the main part of the mid-mountain landscape layer of the Ukrainian Carpathians is the most representative in the landscape structure of Zakarpattia Region. It is characterised by a steep erosion relief, formed on massive sandstones and sandstone flysch, and the dominance of beech-fir-spruce and beech forests on low-strength brown soils (Miller et al., 1997; Melnyk, 1999; Melnyk et al., 2018).

Table 1.8.1.

Areas of High-altitude Terrains of Zakarpattia Region (calculated by the author)

Index of high-altitude terrain	Area, km²	%	Index of high-altitude terrain	Area, km²	%
1	244,6	1,9	7	275,7	2,16
2	17,8	0,14	**8**	291,2	2,28
3	19,2	0,15	**9**	1207,4	9,48
4	3302,5	25,9	**10**	353,6	2,77
5	2817,6	22,09	**11**	1917,3	15,03
6	2019,7	15,84	**12**	287,1	2,25

The basis of the low-mountain landscape tier is formed by high-altitude terrains of steep sloping erosion-denudation forested and secondary grass lowlands (5) and gently sloping erosion-denudation forested and secondary grass lowlands (6), which territorially border each other and are formed by basins and depressions of the terrain in places where argillite flysch occurs (The State Geological..., 2009; Melnyk, 1999). As a result of long-term economic development activities, a large part of the natural beech-fir-spruce and beech forests within the terrains was destroyed, and secondary grasslands were formed in their place, which are actively used as pastures and hayfields in agriculture.

The development and accumulative capacity of the river network of the Tisza River basin during the entire orogenic stage of forming the Ukrainian Carpathians and Zakarpattia, in particular, led to the formation of the system of high altitude terrains of gently sloping surfaces of high and medium terraces (7, 8), terraced bottoms of river valleys (9), etc., on different sections of lower hypsometric levels of the foothills and lowlands (Fig. 1.8.3.). On the flat territory of Zakarpattia lowland, *the high terrains of gently undulating surfaces of high terraces (10) and flat, wide, sometimes swampy surfaces of low terraces, floodplains of rivers and riverbeds (11)*, composed of pebbles and loamy alluvium, are actively developing.

Fig. 1.8.3. Riverbed and floodplain landscape complexes in the middle part of the Borzhava river basin (photo by Yana Karabiniuk)

The most complex landscape structure is typical of the mountain landscapes of Zakarpattia Region, which are characterised by a complex geological structure, a well-defined vertical differentiation of natural components and landscape complexes of various origins, sizes and possibilities of use. Therefore, the detailed exploration of the contemporary structure of mountain landscapes of Zakarpattia Region with regard to landscape

studies was conducted on the example of the key area of the upper basin of the Chorna Tisza river. It is representative from the point of view of landscape tiering and placement of the main high altitude terrains of the mountainous part of the region. For a comprehensive analysis of the regularities of the spatial landscape organisation of the upper basin of the Chorna Tisza river, we developed a landscape map in scale of 1:25 000 at the level of high altitude areas and analysed the regularities of the morphological structure of the territory (Fig. 1.8.4.). The designed landscape map represents the detailed location of the high altitude terrains and was created on the basis of the analysis of numerous landscape, geological, topographic, industry maps and the author's own field research. The landscape surveying of the territory in the expeditionary manner became the primary purpose of modelling the landscape map and the comprehensive study of the natural territorial complex of the river basin. The software ArcGIS 10.4.1. became the environment for creating and modeling the natural territorial complex of the upper basin of the Chorna Tisza.

References:

1. Herenchuk K. I. Landshafty. Pryroda Ukrainskykh Karpat / za red. Herenchuka K. I. [Landscapes. The Nature of the Ukrainian Carpathians / ed. by K. I. Herenchuk]. Lviv: Vyd-vo Lviv. un-tu, 1968. S. 208–23. [in Ukrainian]
2. Hrodzynskyi M. D. Piznannia landshaftu: mistse i prostir: monohrafia u 2-kh tomakh [The Recognition of the Landscape: Place and Space: Monograph in 2 volumes]. K.: Vydavnycho-polihrafichnyi tsentr «Kyivskyi universytet», 2005. T. 1. 431 s. [in Ukrainian]
3. Karabiniuk M. M. Pryrodni terytorialni kompleksy subalpiiskoho i alpiiskoho vysokohiria Chornohirskoho masyvu Ukrainskykh Karpat [Natural Territorial Complexes of Subalpine and Alpine Highlands of Chornohora Massif of the Ukrainian Carpathians]: avtoref. dys. na zdobuttia nauk. stupenia kand. heohr. nauk: 11.00.01. Kyiv, 2020. 21 s. [in Ukrainian]
4. Karabiniuk M. M., Kalynych I. V., Peresoliak V. Yu. Morfometrychni osoblyvosti reliefu landshaftiv Chornohora i Svydovets v mezhakh Zakarpatskoi oblasti [Morphometric Features of the Relief of Chornohora and Svydovets Landscapes within Zakarpattia Oblast]. *Naukovi zapysky Ternopilskoho natsionalnoho pedahohichnoho universytetu imeni Volodymyra Hnatiuka. Ser. Heohrafia*. 2017. Vyp. 43 (2). S. 10–19. [in Ukrainian]
5. Karabiniuk M. M., Markanych Ya. V. Dynamichnist klimatychnykh umov ta suchasni tendentsii yikhnikh zmin u pivnichno-skhidnomu sektori landshaftu Chornohora (Ukrainski Karpaty) [Dynamics of Climatic Conditions and Contemporary Trends of Their Changes in the Northeastern Sector of Chornohora Landscape (The Ukrainian Carpathians)]. *Pryroda Karpat: naukovyi shchorichnyk Karpatskoho biosfernoho zapovidnyka ta Instytutu ekolohii Karpat NAN Ukrainy*. 2020. Vyp. №1(5) S. 58–70. [in Ukrainian]

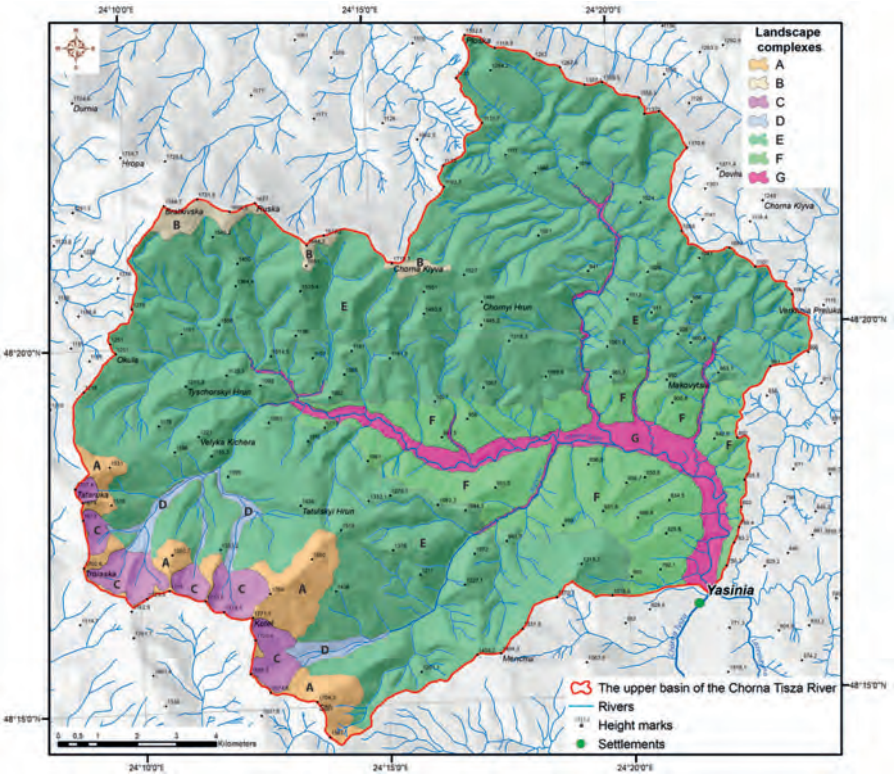

Fig. 1.8.4. Landscape map of the upper basin of the Chorna Tisza river in Rakhiv district of Zakarpattia Region (designed on the basis of A. Melnyk's (1999) and M. Karabiniuk's (2020) cartographic materials and the findings of the author's own field studies)

Map legend (Fig. 1.8.4.)

High-altitude terrains: **A** – The peneplenized very cold and very humid alpine-subalpine highlands are composed of conglomerates, massive sandstones and thick rhythmic flysch with alpine grasslands, wastelands, mountain-pine and green alder crooked forests on mountain-grassland- and mountain-peat-brown soils; **B** – Sharply concave paleoglacial-exarational very cold and very humid subalpine highlands composed of conglomerates and massive sandstones with mountain-pine and green alder crooked forests, secondary grasslands and wastelands on mountain-peat- and mountain-grassland-brown soils; **C** – Soft convex denudational cold and humid forested midlands composed of conglomerates and massive sandstones with the dominance of forests and secondary grasslands on brownsoils and sod-brown soils; **D** – Gently sloping old glacial-accumulative moderately cold and humid forested middle mountains composed of loamy-bouldery moraine with fir-spruce forests on brown soils; **E** – Steep sloping erosion-denudation moderately cold and humid forested midlands composed of sandstone flysch with spruce and beech-fir-spruce forests on low-strength soils; **F** – Steep sloping erosion-denudation moderately and humid forested and secondary grassland lowlands composed of sandstone flysch, argillites and aleurolites with interlayers of sandstones with spruce-fir and beech-spruce-fir forests on medium-strength brown soils; **G** – Terraced bottoms of the river valleys with a cool and humid climate composed of loam sandy and sandy pebbly alluvium with spruce and grey alder formations and secondary grasslands on на sod-brown soils and brown soils.

6. Karabiniuk M. M., Shuber P. M. Zminy klimatychnykh umov u lisystomu serednohiri pivnichno-skhidnoho sektoru landshaftu Chornohora. *Dovhoterminovi sposterezhennia dovkillia: dosvid, problemy, perspektyvy*: materialy Mizhnarodnoho naukovoho seminaru, prysviachenoho 75-richchiu z dnia narodzhennia B. P. Mukhy i 50-richchiu roboty Roztotskoho landshaftno-heofizychnoho statsionaru Lvivskoho natsionalnoho universytetu imeni Ivana Franka [Changes in Climatic Conditions in the Forested Middle Mountains of the Northeastern Sector of Chornohora Landscape. Long-term Monitoring of the Environment: Experience, Problems, Perspectives: Materials of the International Scientific Seminar Dedicated to the 75th Anniversary of B. P. Mukha's Birth and the 50th Anniversary of the Functioning of the Roztok Landscape-Geophysical Station of Ivan Franko National University of Lviv] (Lviv-Briukhovychi, 10–12 travnia 2019 r.). Lviv: LNU imeni Ivana Franka, 2019. S. 88–93. [in Ukrainian]
7. Kravchuk Ya. S. Alpiiskyi relief Ukrainskykh Karpat. *Problemy heomorfolohii i paleoheohrafii Ukrainskykh Karpat i prylehlykh terytoriy*: Zbirnyk naukovykh prats [Alpine Relief of the Ukrainian Carpathians. Problems of Geomorphology and Paleogeography of the Ukrainian Carpathians and Adjacent Territories: A Collection of Scientific Works], 2006. S. 3–18. [in Ukrainian]
8. Kravchuk Ya. S. Heomorfolohiia Polonynsko-Chornohirskykh Karpat: monohrafiia [Geomorphology of the Polonyna-Chornohora Carpathians: Monograph.]. Lviv: Vydav. tsentr LNU imeni Ivana Franka, 2008. 188 s. [in Ukrainian]
9. Melnyk A. V. Ukrainski Karpaty: ekoloho-landshaftoznavche doslidzhennia: monohrafiia [The Ukrainian Carpathians: Ecological and Landscape Research: Monograph]. Lviv, 1999. 286 s. [in Ukrainian]
10. Melnyk A. V., Karabiniuk M. M. Chynnyky formuvannia ta kryterii vydilennia vysokohirnoho landshaftnoho yarusu v Chornohori (Ukrainski Karpaty). *Problemy heomorfolohii i paleoheohrafii Ukrainskykh Karpat i prylehlykh terytorii* : zbirnyk naukovykh prats [Formation Factors and Criteria for Selection of High Mountains Landscape Layer in Chornohora (The Ukrainian Carpathians). Problems of Geomorphology and Paleogeography of the Ukrainian Carpathians and Adjacent Territories: A Collection of Scientific Works], 2018. Vyp. 8. S. 24–41. DOI: http://dx.doi.org/10.30970/gpc.2018.08.2012 [in Ukrainian]
11. Melnyk A. V., Karabiniuk M. M., Kostiv L. Ya., Senychak D. V., Yaskiv B. V. Pryrodni terytorialni kompleksy verkhivia baseinu richky Lazeshchyna v mezhakh Chornohory. *Fizychna heohrafiia ta heomorfolohiia* [Natural Territorial Complexes of the Upper Basin of the Lazeshchyna River within Chornohora. Physical Geography and Geomorphology], 2018. Vyp. 90 (2). S. 5–24. DOI: https://doi.org/10.17721/phgg.2018.2.01 [in Ukrainian]
12. Miller H. P., Petlin V. M., Melnyk A. V. Landshaftoznavstvo: Teoriia i praktyka : navch. Posibnyk [Landscape Studies: Theory and Practice: Handbook]. Lviv: Vydav. tsentr LNU im. Ivana Franka, 2002. 172 s. [in Ukrainian]

13. Miller H. P., Fedirko O. M. Karpaty Ukrainski. Heohrafichna entsyklopediia Ukrainy. Kyiv : Holovna red. URE im. P. M. Bazhana [The Ukrainian Carpathians. Geographical Encyclopedia of Ukraine. Kyiv: Edit. Board of the Ukrainian Soviet Encyclopedia named after P. M. Bazhan], 1990. T.2. S. l13–114.[in Ukrainian]
14. Pryroda Zakarpatskoi oblasti / za red. K. I. Herenchuka [Tha Nature of Zakarpattia Oblast / ed. by K. I. Herenchuk]. Lviv: Vydvo Lviv. un-tu imeni Ivana Franka, 1981. 156 s. [in Ukrainian]
15. Pryroda Ukrainskykh Karpat / za red. K. I. Herenchuka [The Nature of the Ukrainian Carpathians]. Lviv: Vyd-vo Lviv. un-tu imeni Ivana Franka, 1968. 266 s. [in Ukrainian]

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Manual

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