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Erosion processes of mountain tourist trails in the Chornohora massif (Ukrainian Carpathians)

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SUMMARY

The tourist trails of the Chornohora massif of Ukrainian Carpathians are analyzed as well as different stages and degrees of trails digression are revealed. Erosion processes evolve on the V stage of recreational digression. It is established that tourist routes differ in the general condition and degrees of recreational digression and the length of the sections with the manifestation of erosion processes. Erosion processes are the most appreciable on the tourist trail “to Hoverla mountain” due to excessive recreational load. Finally, the authors propose organizational, managerial, and engineering activities for improving the condition of the trail.

Keywords: tourist trails, recreational digression, erosion processes, Chornohora massif
Introduction

Nowadays the Chornohora massif is extremely popular for hiking as the highest mountain ridge of the Ukrainian Carpathians. The Chornohora massif includes Carpathian Biosphere Reserve and Carpathian National Nature Park (NNP), which are marked by a dense network of tourist routes (Ziuzin & Rozhko, 2019). These protected areas are characterized by the most unique biogeocenosis and geological outcrops, which could be the reason for the accordance of geopark status (Bogucki et al., 2012). Erosion processes occur on the tourist routes due to excessive recreational load on natural complexes and cause the formation of erosive forms of microrelief. This fact finally significantly reduces the recreational attractiveness of nature reserves (Fidelus-Orzechowska et al., 2017).

Methods and Theory

The analysis of methods for studying the recreational load impact on natural complexes shows that the main indicator of the recreational load is the soil and vegetation cover (Brusak & Lenevich, 2020). Its condition and reaction to external influences serve as diagnostic tools of stages of recreational digression. In general, the following time series of changes of components of natural complexes is distinguished: vegetation (for meadows) or forest litter (for forests) → soils → relief → geological substrate. There are five stages of recreational digression. Normally researchers (Gensiruk et al., 1987; Prędki, 1999) suggest using the following indicators for the stages:

- quantitative and qualitative changes in vegetation in meadows or presence/absence of forest litter in forest complexes;
- soil compaction;
- the width of the trail and the presence of additional/parallel ones;
- the growth of erosion processes and the microrelief of the trail.

For IV and V stages of recreational digression, it is proposed (Brusak, 2018) to use the special indicator “degree of recreational digression” to reflect the manifestation of erosion and qualitative changes in the state of the microrelief of trails. The proposed indicators are the width of the trail, the depth of the erosion groove, the volume of the transfer of loose material in general, and with 1 m² of the trail. The last indicator is the most important, and the others are auxiliary.

The following levels of recreational digression of microrelief are known: «episodic digression» (corresponds to the fourth stage of recreational digression), «not strong digression», «temperate digression» «average degree of digression» «strong degree of digression» «catastrophic degree of digression». Erosion forms are formed and denudation processes are present in the last stages of recreational digression. Table 1 shows the degree of recreational digression of microrelief due to erosion processes on tourist routes in Carpathian NNP.

Table 1 Degree of recreational digression of microrelief due to erosion processes on tourist routes in Carpathian NNP

<table>
<thead>
<tr>
<th>The stage of recreational digression of the nature complex</th>
<th>The degree of recreational digression of microrelief</th>
<th>The volume of transfer material, m³/m²</th>
<th>The width of trail’s canvas, m</th>
<th>The groove depth of trail’s canvas, cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV</td>
<td>Episodic digression</td>
<td>0.01 – 0.025</td>
<td>to 1.5</td>
<td>to 5</td>
</tr>
<tr>
<td>V</td>
<td>Not strong digression</td>
<td>0.025 – 0.05</td>
<td>1.5–1.6</td>
<td>5–10</td>
</tr>
<tr>
<td>V</td>
<td>Temperate digression</td>
<td>0.05 – 0.075</td>
<td>1.6–1.75</td>
<td>10–20</td>
</tr>
<tr>
<td>V</td>
<td>Average degree of digression</td>
<td>0.075 – 0.1</td>
<td>1.75–2.25</td>
<td>20–30</td>
</tr>
<tr>
<td>V</td>
<td>Strong degree of digression</td>
<td>0.1 – 0.25</td>
<td>2.25–2.75</td>
<td>30–50</td>
</tr>
<tr>
<td>V</td>
<td>Catastrophic degree of digression</td>
<td>0.25 – 0.5 and more</td>
<td>&gt; 2.75–3.0</td>
<td>&gt; 50</td>
</tr>
</tbody>
</table>
Results

On the territory of the Carpathian NNP within the Chornohora mountain range tourist routes “to Hoverla mountain”, “to lake Nesamovite”, “Prut valley – Marishevska mountain – Shpitz mountain” are studied in detail. The research includes establishing stages of recreational digression of natural complexes by a complex of features as well as measuring the width of the trail and the depth of the erosion groove. After that, we form of tabular database and build the cross-section of trails at measurement points. At the last step, the calculation of the volume of the transfer loose material on separate segments of the trail (length from 8 to 20 m) and with 1 m$^2$ of the trail is established.

The most popular tourist route of the Carpathian NNP is from Zavoelia village to Hoverla mountain (10.5 km). In general, the route includes three segments such as “Zavoelia – Prypir” and two trails “Prypir – Zaroslyak” and “to Hoverla mountain”. The last two segments are under analysis in this research.

On the trail “Prypir – Zaroslyak” (2.1 km) mainly moderate (34.6%) and weak (26.3%) degrees of recreational digression with shallow erosive grooves (Brusak & Malets, 2018) are observed. This is the consequence of the active recreational use of the trail in the 20th century. In the last decades, there is an alternative way throw paved road for cars to go this segment of the route from Prypir to Zaroslyak. Thus, the trail is not fully used by recreants, the current state of the trail indicates a gradual transition of separate sections from V to IV and even to III stages of recreational digression. This trail is capable of self-regulation when there is the complete or gradual reduction of recreational load.

The trail “to Hoverla mountain” (4.1 km) is dominated by strong (66.6%) and catastrophic (27.7%) degrees of V stage of recreational digressions that account for more than 90% of the trail’s length (Fig. 1). On the left part of the trail “to Hoverla mountain” (blue marking) marked areas with a depth of erosion from 1 m. A ravine is formed in a sloping (10-15°) part of the trail between the Mala Hoverla and the upper forest border, which is composed of clay flysch deposits. Our monitoring during 2015–2017 and multiple measurements show that the ravine is growing rapidly. In the summer of 2015, the largest depth of the ravine was 2.1 m and the width was 1.3 m. In the summer of 2017, the depth of the ravine increased to 2.6 m, width to 3.5 m. During two years the total length of the ravine has increased by 2 times (up to 22 m).

Figure 1  Trails of the tourist path "to Hoverla mountain" (red color shows deep erosion grooves)
Figure 2 shows trails “Prut valley – Maryshevska mountain – Shpitz mountain” and “to lake Nesamovyte”. It is mostly strong (51%) and average (21%) degrees of recreational digression with erosive grooves to 20-30 cm on the trail “to lake Nesamovyte” (4.6 km). The tourist trail “Prut valley – Maryshevska mountain – Shpitz mountain” (6.3 km) is in significantly better condition. The weak degree of V stage of recreational digression prevails on that trail. A moderate degree of digressions on the trail is observed sporadically on the steep slopes of the Marishevska and Shpits ridges.

Different tourist routes differ in the general state of recreational digression and the length of segments with the manifestation of erosion processes. The greatest degradation of natural complexes is typical for two trails – “to Hoverla mountain” and “to lake Nesamovyte”.

Table 2 shows the distribution of degrees of recreational digression on tourist routes “Prypir – Zarosliak”, “to Hoverla mountain”, and “to lake Nesamovyte”.

Table 2 The Distribution of degrees of recreational digression on tourist routes in Chornohora

<table>
<thead>
<tr>
<th>The stage of recreational digression of the nature complex</th>
<th>The degree of recreational digression of microrelief</th>
<th>Recreational digression on the path, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV Episodic digression</td>
<td>“Prypir – Zarosliak” 0 0 5.0</td>
<td></td>
</tr>
<tr>
<td>V Not strong digression</td>
<td>“To Hoverla mountain” 26.3 1.77 2.0</td>
<td></td>
</tr>
<tr>
<td>V Temperate digression</td>
<td>“To lake Nesamovyte” 34.64 0 14.0</td>
<td></td>
</tr>
<tr>
<td>V Average digression</td>
<td></td>
<td>19.65 3.97 21.0</td>
</tr>
<tr>
<td>V Strong digression</td>
<td></td>
<td>18.63 66.6 51.0</td>
</tr>
<tr>
<td>V Catastrophic digression</td>
<td></td>
<td>0.67 27.66 7.0</td>
</tr>
</tbody>
</table>

Conclusions

The tourist trails of the Chornohora massif are analyzed and different stages and degrees of digression are revealed. The nature of a recreational digression, the development of erosion processes as well as the dynamics of recreational digression of the trail “to Hoverla mountain” indicates that it is not possible to improve the condition of the trail in a natural way. Therefore, some organizational, managerial, and engineering activities, which will allow leading the trail to proper operational conditions, are proposed.
Organizational and managerial activities could include:
• to restore the practice of annual trails duty. This will allow partially recovering in a natural way;
• to forbid climbing of large groups of people to Hoverla in May, when the soil on the slopes are saturated with melt-water and have the least resistance to recreational load;
• to increase the entrance fee to the Carpathian NNP, which may partially reduce the flow of tourists.

There is a couple of necessary engineering activities:
• to improve the trail in the vicinity of the Zarosliak sports base (to cover the trail with natural stones, line the canvas path with gravel).
• to limit a system of handrails within the forest belt and to pave steps which are of natural stone on the canvas path on slopes with a steepness to 20°
• to pave a system of steps stone of natural stone and limit the route of the path with handrails on the steep (25-35°) near slopes of Mala Hoverla.
• to track zigzag lines along the trail from Mala Hoverla to the top of Hoverla.

Reference


