UTILIZATION OF GOOD PRACTICE OF TORRENT CONTROL IN RECREATIONAL EDUCATION IN THE VEĽKÁ FATRA NATIONAL PARK

Mariana Jakubisová[1], Matúš Jakubis[2]
[1]Borova hora Arboretum, Technical University in Zvolen, Slovak Republic
[2] Department of Forest Harvesting, Logistics and Amelioration, Faculty of Forestry, Technical University in Zvolen, Slovak Republic

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Abstract
In the article we present the possibility of using an example of good practice of torrent control in recreational and leisure education of the public and university students. For this purpose, we chose the torrent control Jelenec in the Hornojelenecká valley in the Veľká Fatra National Park. Hornojelenecká valley is one of the most beautiful and most visited recreational locations in the Veľká Fatra National Park. This valley forms a natural watershed of the Jelenec torrent with a historical torrent control, which was established in 1926-27 and has reliably fulfilled its function for 95 years. Based on field measurements, we analyzed the runoff characteristics of the watershed and the discharge characteristics of the torrent in an effort to present the results of research in recreational tourism and university education. The main goal is to raise awareness among the general public about the importance of integrated forestry measures to protect the landscape from flash floods and erosion in recreational education. We evaluated the capacities of flow profiles in relation to T-year discharges and the functionality of various types of transverse objects. On the information boards, we explained the implemented solutions from a technical, ecological and environmental point of view.

Key words: touristic activities, leisure education, landscape protection

Introduction

The modern education of the society has undergone great changes in recent years. Commonly accessible information technologies consistently bring wide possibilities of obtaining professional and scientific information from domestic and foreign sources. This fact can be considered a great advantage, but on the other hand, it is necessary to disseminate relevant knowledge and bring concrete solutions not only to university students and professional sphere but also to the general public, e.g. through popular activities such as tourism and non-formal recreational education. Vocational training on recreational and educational trails, focusing on the management of flood risks, erosion and their adverse consequences, is an important opportunity to involve the general public in solving these tasks. Negative human activities and climate change, which together affect the deterioration of runoff in the country, contribute to increasing the likelihood of floods and their adverse effects. Integrated forest ameliorations, including torrent control, provides positive examples of successful solutions to these important societal challenges. An important European document on flood risk assessment and management is Directive 2007/60/EC of the European Parliament and Council from 23 October 2007 (https://eur-lex.europa.eu/legal-content/SK/ALL/?uri=CELEX:32007L0060). We consider it right to leave the upper sections of the torrents in the protected areas untouched from the point of view of nature and landscape protection. On the other hand, the protection of piedmont villages and towns from flash floods and erosion requires the implementation of the necessary forestry-technical amelioration measures. In the article we present an example of good practice in solving the floods and erosion control on the example of the Jelenec torrent in the Veľká Fatra National Park which was built in 1926/27. Torrent control Jelenec performed its function well for over 95 years (JAKUBIS, JAKUBISOVÁ 2017, 2020).

Materials and methods

As an example of the possibility of informal recreational education, we chose the torrent control Jelenec in the Hornojelenecká valley in the Veľká Fatra National Park (Fig. 1). The first systematic motorrent control of a mountain torrent in Slovakia was built in this valley in 1926-1927. The impetus was a great flood on May 30th, 1925, which destroyed the entire valley. During torential rain fell in 3 hours 75 mm of precipitation (SKATULA 1973). The Hornojelenecká valley with the Jelenec torrent stretches on the south-eastern slopes of the Krížna massif (1,574.3 m a.s.l.). The mouth of the valley and the closing profile of the watershed is located below the settlement of Horný Jelenec by the state road I/59 in the direction of Banská Bystrica-Donovaly. The characteristics of the Jelenec watershed and torrent are given in Tab. 1 and Tab. 2.

Fig. 1: Hornojelenecká valley in Veľká Fatra National Park

Tab. 1: The characteristics of the torrent basin Jelenec (part 1)

A_w (km^2)	H_{minw} (m a.s.l.)	H_{maxw} (m a.s.l.)	ΔH_w (m)	$H_{øw}$ (m a.s.l.)	L_{tr} (km)	L (km)	L_t (km)	L_{th} (km)
9.58	582	1,532	950	931	21.08	5.51	26.59	5.84

Explanatory notes to Tab. 1: Aw – watershed area; H_{minw} - minimal altitude of the watershed; H_{maxw} – maximal altitude of the watershed; ΔH_w – absolute height difference of the watershed; $H_{øw}$ – mean altitude of the watershed; L_{tr} – total length of tributaries; L – length of main stream; L_t – total length of watercourses in the watershed; L_{th} – length of thalweg.

Tab. 2: The characteristics of the torrent basin Jelenec (part 2)

H_{mint} (m a.s.l.)	H_{maxt} (m a.s.l.)	ΔH_t (m)	A_f (km^2)	$f_{\%}$ (%)	L_d (km)	$S_{øt}$ (%)	$S_{øw}$ (%)	B_w (km)	w_w/ℓ_w (-)
582	1,400	818	7.47	77.97	14.80	14.84	37.23	1.64	1:3.56

Explanatory notes to Tab. 2: H_{mint} – minimal altitude of the torrent; H_{maxt} – maximal altitude of the torrent – source; ΔH_t – absolute torrent height difference; A_f – forested watershed area; $f_{\%}$ – forested watershed in %; L_d – legth of the divide; $S_{øt}$ – mean gradient of the torrent; $S_{øw}$ – mean slopes gradient of the watershed; B_w – mean width; w_w/ℓ_w – width/lenght ratio of the watershed.

The causes of disasters in this locality can be traced to massive deforestation as early as the 13th and 14th centuries. Deforestation reached a catastrophic extent in the second half of the 15th and especially in the first half of the 16th century. In addition, the damage to the local naturally occurring young forest stands was caused by avalanches. Damage to forests was also caused by cattle herds kept by the locals for their livelihood. Cattle mainly destroyed the natural regeneration of the forest, but the damage was also caused by local settlers, who founded the wooden fences used for wintering cattle. Thus began the degradation of the soil surface, the loss of its infiltration capacity, the acceleration of surface runoff, surface and groove erosion, etc. The valley has been affected by several disasters in the past. The largest was the avalanche that fell on the settlement of Rybô on February 6, 1924 and killed 18 people (JAKUBIS, JAKUBISOVÁ 2021).
We performed measurements of geometric and hydraulic characteristics on 18 experimental flow profiles (sections) (Tab. 3). Cross sections were drawn and parameters for sizing flow profiles were calculated. The results served as a basis for educational goals on nature trails in the recreational activities of visitors to this often visited area. We have proposed explanations from a technical, ecological and environmental point of view on the educational boards.

Fig. 2: Weir and sills in Jelenec torrent in the immediate vicinity of the hiking trail

Fig. 3: Reinforced bed of Jelenec torrent in the immediate vicinity of recreational path

Results

Basic characteristics, bankfull discharges Q_{bf} and T-year discharges Q_T of the Jelenec torrent flow profiloes are given in Tab. 3

Tab. 3: Basic characteristic, bankfull discharges Q_{bf} and T- year discharges Q_T of the Jelenec torrent flow profiles

FP No.	Section (km)	A_{fp} (m^2)	v ($m.s^{-1}$)	Q_{bf}	Q_1	Q_2	Q_5	Q_{10}	Q_{20}	Q_{50}	Q_{100}
				($m^3. s^{-1}$)							
1	0.000 – 0.035	3.20	2.09	6.67	2.87	4.41	**6.47**	8.16	10.00	12.58	14.71
2	0.035 – 0.575	5.95	3.58	21.30	2.97	4.46	6.53	8.24	10.10	12.70	**14.85**
3	0.575 – 0.725	5.25	4.37	22.94	2.94	4.41	6.47	8.24	10.00	12.65	**14.71**
4	0.725 – 0.775	7.00	3.48	24.34	2.91	4.37	6.40	8.15	9.90	12.52	**14.55**
5	0.775 – 0.925	5.60	2.58	14.46	2.89	4.34	6.36	8.09	9.83	12.43	**14.45**
6	0.925 – 0.945	4.80	3.68	17.69	2.90	4.35	6.38	8.12	9.86	12.48	**14.51**
7	0.945 – 1.060	4.80	4.56	21.88	2.87	4.31	6.32	8.04	9.76	12.35	**14.36**
8	1.060 – 1.100	4.80	3.55	17.03	2.87	4.30	6.30	8.02	9.43	12.32	**14.33**
9	1.100 – 1.300	3.12	2.34	7.31	2.84	4.26	**6.25**	7.95	9.65	12.21	14.19
10	1.300 – 1.850	3.58	4.26	15.25	2.43	3.64	5.34	6.80	8.25	10.44	**12.14**
11	1.850 – 2.050	3.58	3.33	11.93	2.38	3.57	5.24	6.66	8.09	10.23	**11.90**
12	2.050 – 2.200	3.32	4.22	14.01	2.31	3.46	5.08	6.46	7.85	9.93	**11.54**
13	2.200 – 2.230	3.08	4.32	13.29	2.30	3.45	5.06	6.44	7.81	9.88	**11.49**
14	2.230 – 2.275	2.80	3.70	10.36	2.29	3.44	5.04	6.42	7.79	**9.86**	11.46
15	2.275 – 2.600	3.30	7.20	23.77	2.19	3.29	4.82	6.13	7.45	9.42	**10.95**
16	2.600 – 2.810	2.20	3.71	8.16	2.17	3.25	4.77	6.07	**7.37**	9.32	10.83
17	2.810 – 2.825	2.65	4.36	11.15	2.15	3.24	4.75	6.05	7.34	9.28	**10.80**
18	2.825 – 3.325	2.08	3.89	8.10	1.87	2.80	4.11	5.23	6.35	**8.03**	9.34

Explanatory notes to Tab. 3: FP – flow profile; A_{fp} – flow profile area; v – mean flow velocity; Q_{bf} – bankfull discharge (total capacity of flow profile); Q_1 - Q_{100} – annual discharges. Comment: Bold marked data means T-annual discharges, which safely flows through the flow profile (section).

We analyzed the runoff characteristics of the watershed and the discharge characteristics of the bed of Jelenec torrent. We evaluated the capacity of the adjustment flow profiles (bankfull discharge) in relation to T-year discharges. We have proved that the discharge capacity of the flow profiles at the

vast majority of the length of the Jelenec torrent control (3.33 km) is sufficient for a discharge of Q_{100}. Roughly marked data in Tab. 3 means T-year discharges, which safely flows through the flow profile (section). In some sections, the capacity of the flow profiles ranges from Q_5 to Q_{50}. In these sections, on the information boards we propose to increase the capacity of the flow profile through longitudinal reinforcement of the bed with a lower roughness (smooth wood, stone), possibly we suggest increasing the total flow profile area through natural stone wall. At the same time, we designed information boards for transverse objects along the torrent control Jelenec (belts, sills, weirs, dams) with an explanation of their construction elements and meaning.

Discussion

In both professional and lay discussions, we often encounter negative views on the use of technical elements in flood protection of the landscape. However, such discussions must always be accompanied by an important issue, which concerns taking responsibility for the loss of life and the great economic damage that can cause flash floods and erosion. As part of tourist and recreational activities, the general public, on the example of the Jelenec torrent, can understand the need for such measures to protect settlements in the foothills and in some parts of large protected areas.

Conclusion

Society-wide important issues of flood and erosion control should be part of the education not only among professionals but also in the general public. One of the possibilities for disseminating professional knowledge on this issue is recreational education. On the tourist trails, through educational boards, experts are able to explain in an appropriate form the issue of optimal management of integrated and systemic flood and erosion control of the landscape. All users of individual parts of the watersheds must strive to ensure safe drainage of flood discharges through the foothills , also by means of technical modifications of the flow profiles of the torren ted using nature-friendly measures. The main reasons for the popularization of recreational and educational education in the field of torrent control in the foothills using sensitive proposals are:

- dense settlement of the foothill areas of Slovakia and thus the threat of foothill villages and towns by flash floods and erosion;
- protection of lives and health of people, dwellings, infrastructure, civil engineering, industrial facilities, etc .;
- leaving the upper parts of the river basin free from human intervention in accordance with nature and landscape protection requirements.

Management of torrent Jelenec provide a good example of a sensitive approach in flood and erosion control in protected areas.

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Souhrn

Odborné vzdělávání na rekreačních a naučných chodnících se zaměřením na management povodňových rizik, jakož i snižování rizika bystřinné eroze a jejích nepříznivých důsledků je reálným a žádoucím úkolem zapájení společnost do systémové ochrany krajiny před povodněmi. V příspěvku uvádíme možnost využití příkladu dobré praxe hrazení bystřin v rekreačním a volnočasovém

vzdělávání široké veřejnosti. Za tímto účelem jsme zvolili hrazení bystřiny Jelenec v Hornojelenecké dolině v Národním parku Velká Fatra. Tato dolina je na Slovensku jednou z nejkrásnějších a nejnavštěvovanějších rekreačních lokalit s bohatou historií. Hrazení bystřiny Jelenec bylo realizováno v letech 1926-27 a svou funkci spolehlivě plní již 95 let. Na základě terénních měření jsme analyzovali odtokové charakteristiky povodí a průtokové charakteristiky bystřiny ve snaze prezentovat výsledky výzkumu v rámci rekreačního vzdělávání široké veřejnosti. Hlavním cílem je zvýšit povědomí veřejnosti o významu integrovaných lesnických opatření na ochranu krajiny před přívalovými povodněmi a erozí v rámci volnočasového vzdělávání. Hodnotili jsme kapacity průtokových profilů ve vztahu k N-letým průtokům a funkčnost různých typů příčných objektů. Na informačních tabulích jsme vysvětlili realizovaná řešení z technického, ekologického a environmentálního hlediska.

Contact
Ing. Mariana Jakubisová, PhD.
E-mail: jakubisova@tuzvo.sk