VOLEC II – "THE FOREST ROAD NETWORK INFLUENCE ON RUNOFF FROM FORESTS IN CHANGING CLIMATIC CONDITIONS"

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Abstract
The VOLEC II project, supported by the NAZV agency of the Czech Ministry of Agriculture, is primarily focused on water management on forest roads, or rather on influencing the hydric regime of forests through the forest road network. It provides outputs that can be used not only for technical practice, but also for the practice of ecology and forest protection and their stabilization, and also for the area of the social functions of forests. In this area, it is possible to speak in particular about the specific microclimate in the vicinity of forest roads, which forest roads determine, among other things, by adjusting the visual regime in their surroundings. The purpose of the project and the submitted contribution is to propose technical measures to minimize the negative effects of forest roads on the runoff regime in forests in a technical sense, but secondarily to propose measures to improve the microclimate in the vicinity of forest roads and thus strengthen their explicit recreational function.

Key words: humidity regime of forest roads surrounding, microclimate modification, water on forest roads, fecreational role of forest roads

Introduction

In the Czech legislative environment (Decree No. 239/2017 Coll.), a forest road is a purpose-built road for making forests accessible to traffic and connecting them with roads, local or purpose-built roads, which serves for forest management, and in particular for carrying out rescue and liquidation work by components of the integrated rescue system of the Czech Republic and for recreation. The cited decree further defines other technical aspects of forest roads, including measures that address their drainage or water traffic in their surroundings in general. Technically, the forest road network is dealt with in ČSN 73 6108, and recommendations for designing a forest transport network are given in great detail in Zlatuška et al., (2020).

It is generally known that LCS significantly affects runoff processes. Older works, for example, Herynek, (1999) notes the intensification of this influence, especially in areas of spring micro-basins with increasing road network density and the number of drainage elements. The influence of LCS density on the runoff process in the basin was investigated using the DHSVM model by Dymond et al. (2014).

In our conditions, the influence of LCS on the elements of the emergence, recurrence, intensity and peaks of flow waves has been studied for a long time in the Beskydy Mountains in the Červík and Malá Ráztoka basins. However, Chlebek (1987) did not obtain a sufficient set of data for statistical calculations in his research here. Vícha et al. (2009) or Bíba et al. (2006) (in their publications they repeatedly draw attention to this issue and point out the need to pay attention to this topic. In their articles they also mention that forest roads, compared to soil in a forest environment, reduce the possibility of water infiltration and have a higher runoff coefficient. They also summarize the findings of other authors in terms of increasing the culmination of flood flows in the range of 12.5 - 90%. The same conclusions were reached by groups of authors from Oregon, USA and Queensland, Australia, e.g. Wemple et al. (2000) and Forsyth et al. (2006). Lane et al. (2006) in their research on the dispersion of concentrated runoff state that the possibility of dispersion or retention significantly reduces the increase in runoff and the culmination of flood waves from the catchment area. This topic was addressed, among others, by the NAZV project, QK22020146: Technical recommendations for water management within the forest transport network led by doc. Ing. Karel Zlatuška, CSc. solved in cooperation with ČZU in Prague and MENDELU in Brno.

Perhaps the only comprehensive overview of the topic can be provided by a review by Kastridis (2020). In his work, he discusses currently used procedures, emphasizes the importance of already acquired knowledge and suggests measures to mitigate the impact on runoff processes. Like other authors, he points out the need for further research in this area. Among the measures he suggests are, for example, minimizing the creation of incisions when building LCS and within the framework of routing, avoiding source micro-catchments. He also recommends abandoning the idea of modeling

these effects and focusing on direct field measurements, e.g. within the framework of a paired catchment model.

Material and methods

The research project QL25020051 follows on from the research project QK22020146 "Technical recommendations for water management within the forest transport network" (2022-2024) and uses the original locations and their instrumentation. At the Lesy ČZU V Kostelec nad Černými lesy enterprise, this is the JEVANY research object (49.957N, 14.807E); at the ML Křtiny School Forest Enterprise, this is the HABRŮVKA object (49.308N, 16.699E). A total of 90 TOMST point dendrometers with increment measurements in 15-minute intervals and a total of 12 sap flow sensors (EMS Brno, CR) are installed on these areas on the same trees on which dendrometric measurements are performed; with values measured in 10-minute intervals.

At both locations, the flow is continuously measured through pipe culverts equipped with sharp-edged Thomson overflows with US1200 ultrasonic sensors and H7-G-TA4-SZ data loggers (both devices Fiedler AMS, České Budějovice). In the infiltration pits and in the connecting transects related to the infiltration pits, pipe shafts with a perforated lower part are set up, which are equipped with submersible pressure level gauges (TSH37, Fiedler AMS, České Budějovice) continuously monitoring the height of the free water surface; there are a total of 32 measuring points at both locations. Climatic data are obtained from the network of local meteorological stations of the company Amet (Velké Bílovice). For the Kostelec SLP, data from the Tuchorazy station was used, and for the Křtiny SLP, data from the Útok 6 station were used. SMT100 pedological sensors for measuring bulk moisture and soil temperature are installed near the pipe shafts in the walls of the soil excavations (pedological probes); they are placed to a depth of 10 cm, 30 cm and 60 cm. A total of 66 soil profiles were opened and described and 198 soil sensors were installed at both locations. Continuous measurement was set to 10 min. intervals with cloud storage and data management.

Two new research objects were newly established for the research project QL25020051. At the ML Křtiny School Forest Enterprise, this is the ÚTĚCHOV object, cadastral register Bílovice nad Svitavou, South Moravian Region (49.280N, 16.646E); at the Lesy ČZU enterprise in Kostelec nad Černými lesy, this is the DÍLNA research facility, cadastral area Stříbrná Skalice, Central Bohemian Region (49.904N, 14.863E). The location of the existing and newly established research facilities is schematically shown in Figure 1.

Fig. 1: Project localities

Results

Although the project results are still only in the phase of primary collection and evaluation of the first synergies between the individual determined parameters, everything indicates that shallow subsurface runoff is currently a crucial factor in the water balance in the forest stands of the lower hills in the changing climate. At the same time, it is evident that forest drainage routes traced in contour directions interrupt its paths and thus disrupt its natural hydrological influence both in the system of the catchment-runoff process and the soil-wood system, and in its role in providing other forest functions, including the recreational function.

The following graph (Figure 2) demonstrates how significant the influence of the forest drainage road on shallow slope subsurface runoff is. This graph describes the course of the so-called rain experiment at the Habrůvka site. Using this experiment, we create precipitation of the required intensity. We carry out rain experiments because we do not normally achieve the required precipitation

naturally at the project sites. The blue columns in the graph show natural precipitation amounts, the orange column shows the total artificial experimental precipitation, the red line shows the water level in the borehole in the forest road and the gray level in the infiltration pit.

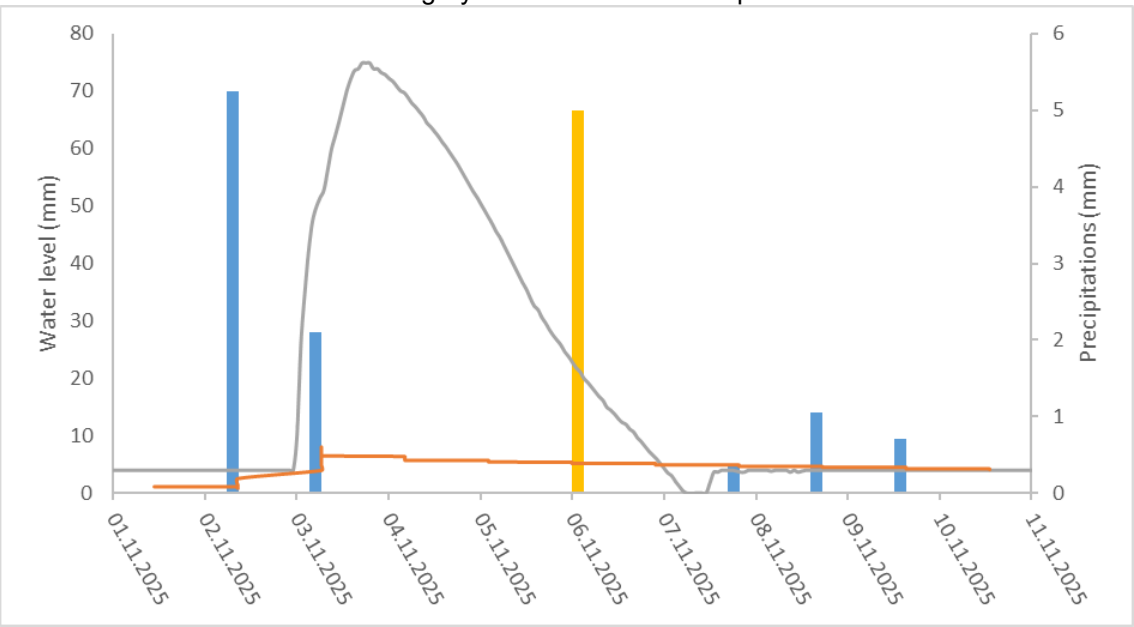

Fig. 2: Results of the rain experiment at the Habrůvka site 6.11.2025

It is clear from the graph that water, the source of which is rain, whether natural or artificial, passes under the road body by means of a pipe culvert, however, a shallow slope drain does not pass under the road.

Discussion

Although the importance of forest roads for recreation in forests is obvious and is also enshrined in some legislative regulations, in the Czech Republic, for example, Decree No. 239/2017 Coll., there are relatively few scientific works that deal with the technical aspects of the effects of forest roads as such on recreation in forests. Most published works understand forest roads more as a means of achieving recreational satisfaction through the forest or natural environment and its effect in general. There are works that address the limits for the use of forest roads for various groups of recreationists in a more technical way (e.g. Lepoglavec et all, 2023).

In this context, we expect that the results of our project will bring, in addition to improving knowledge about the influence of forest roads on shallow slope subsurface runoff, the possibility of using this knowledge not only in the practice of designing forest haul roads, but also in the practice of optimizing their multifunctional use, especially in the field of recreation in forests.

Conclusion

The article presents the VOLEC II project, supported by the NAZV agency of the Ministry of Agriculture of the Czech Republic, and its first results. The project is primarily focused on water management on forest roads, or rather on influencing the hydric regime of forests through a network of forest roads. It is intended to bring outputs that can be used not only for technical practice, but also for the practice of ecology and forest protection and their stabilization, and also for the area of social functions of forests. In this area, we can speak in particular of the specific microclimate in the vicinity of forest roads, which forest roads determine, among other things, by modifying the visual regime in their surroundings. It turns out that the knowledge of the parameters that influence the recreational understanding of forest roads other than just as a means of achieving other recreational connections is relatively low. In addition to the specific limits resulting for vacationers, e.g. from restrictions on their movement, it is clear that the character of the forest road and its technical facilities can be one of the fundamental factors of its recreational use. The project is currently in the phase of data collection and testing of the first implemented measures. Current data indicates that the project's objectives and planned results will be achieved without any problems.

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Souhrn
Projekt VOLEC II, podporovaný agenturou NAZV Ministerstva zemědělství ČR, je primárně zaměřen na hospodaření s vodou na lesních cestách, respektive na ovlivňování hydrického režimu lesů prostřednictvím sítě lesních cest. Poskytuje výstupy, které lze využít nejen pro technickou praxi, ale i pro praxi ekologie a ochrany lesů a jejich stabilizace, a také pro oblast sociálních funkcí lesů. V této oblasti lze hovořit zejména o specifickém mikroklimatu v okolí lesních cest, které lesní cesty určují mimo jiné úpravou vizuálního režimu v jejich okolí. Účelem projektu i předkládaného příspěvku je navrhnout technická opatření k minimalizaci negativních vlivů lesních cest na odtokový režim v lesích v technickém smyslu, ale sekundárně navrhnout opatření ke zlepšení mikroklimatu v okolí lesních cest a tím posílit jejich explicitní rekreační funkci. V současné době je projekt ve fázi sběru dat a testování prvních zrealizovaných opatření. Aktuální data naznačují, že cíle i plánované výsledky projektu budou bez problémů dosaženy.

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