Impact of traffic characteristics on forest roads due to forest management

Potočnik Igor, Pentek Tibor, Pičman Dragutin

Abstract

Traffic load and transported quantity due to forest management were analysed on the forest roads in the forest district Dragatuš, SE Slovenia. On the basis of timber gravitating to particular sections, the traffic load and transported quantity were calculated for each of seven forest road sections. The cumulative traffic load is the highest on the section connected to the public road and the lowest on the section situated the furthest away from the public road. The cumulative transported quantity is the highest at the connection of the forest road to the public road and the lowest on the section situated the furthest away from the public road. Considering the distance from the public road, the technical elements and the level of maintenance of such forest road could be lower but the basic maintenance should be ensured (draining). Additional non-forestry uses of forest roads could change the described situation.

Key words: *wood transport, traffic load, transported quantity, forest road, forest, Slovenia*

1. Introduction – *Uvod*

Slovenia is unique in Europe with its 53 % surface covered by forest and relatively well preserved forests. The present situation is the consequence of forest management planning, including planning of primary traffic. Forest management is oriented to production of high-quality wood along with ecological and social functions of forests. Well preserved forests also provide conditions for the development of tourism, recreation etc. so that accessibility of forests has an important role. Forest roads (excluding some exceptions) are used by non-forestry users free of charge (Forest Act 1993). Forest roads are not a natural element in the forest and therefore our aim is to incorporate them into the natural environment. This is the reason why technical elements of the forest roads are low – but at the same time forest roads should enable rational forest management considering minimal costs of wood transport and considering the use of forest roads by other non-forestry users. Taking into account the demands of traffic, forest roads should be devised with respect to technical quality, quality of building and maintenance. Only by ensuring high-quality level required for the normal forest management, rational investments into forests can be achieved. The bases for the categorisation of forest roads are different services of forest roads and intensity of the traffic load (Potočnik 1996d). Thus technical characteristics and the level of maintenance depend on the category of the forest road.

Besides its traditional productive task, the forest road should also provide several non-productive tasks, which are the consequence of the modern way of life, escape from industrialisation, noise etc. to unspoiled nature (Potočnik 1996c). These trends are shown through an increasing number of personal vehicles, as well as higher probability of traffic accidents. More intensive traffic increases the costs of forest roads maintenance and request for higher traffic safety, as well as the need for better traffic equipment. Thus additional costs arise, which would not exist or would be considerably lower if forest roads provided no non-forestry services. The existing forest roads are of low technical quality as a rule and therefore they are not suitable for the demands of increasing personal traffic. Forestry itself has no enough financial capacity needed for better maintenance due to increased non-forestry services of forest roads.

2. Object of research and working methods – *Objekat i metode istraživanja*

Changing of traffic load and transported quantity in the forest regarding the distance from the public road (case study) were analysed on the forest roads in the forest district Dragatuš (Figure 1). The aim of the research was to study the traffic raised by wood transport; it is known that the largest amount of traffic load and transported quantity is raised by harvesting (Potočnik 1996b, Žalec 1999). Non-forestry services of forest roads in the studied case are less significant due to distance of larger towns and rural character of the landscape.

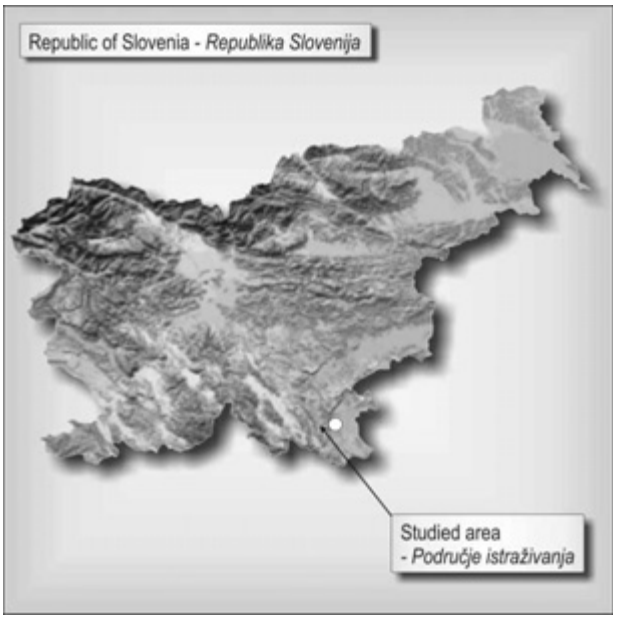

Figure 1 Map of Slovenia and studied area

Slika 1. *Zemljovid Slovenije s područjem istraživanja*

2.1. Research object – *Objekt istraživanja*

The field object was set in co-operation with the district forester – the studied area was a area gravitating to the forest road Tančegorski ovinek – Razvaje, forest district Dragatuš, Management Unit Stari trg, SE of Slovenia. The forest gravitating to the forest road covers an area of 440 ha divided in 18 forest divisions. The forests are mainly in private hands (88 %), forest property is small-scaled. An average property usually covers an area of less than 4 ha of forest and an average forest parcel is less than 0.50 ha. The forest is made of 91 % broadleaves and 9 % conifers. The share of beach accounts for 37 %, oak for 22 %, maple for 5 % and chestnut for 3 %. There is also 6 % of spruce and fir. The growing stock amounts to 145 m^3/ha on an average, which is lower than the Slovenian average (220 m^3/ha). Natural conditions only allowed the development of poor forests, which were also littered in the past. Generally speaking forests are less productive, the main assortments are less valuable round wood of broadleaves and fire wood. This was also the main role of the forest in the past, when agriculture and later industry were considered more important than forestry. Some forestry facts about the analysed area are shown in Table 1.

Table 1 Surface, growing stock and 10-year harvesting volume in the studied object

Tablica 1. *Površina, drvna zaliha i desetgodišnji etat objekta istraživanja*

Surface, ha *Površina, ha*	440
Growing stock, m^3 *Drvna zaliha, m^3*	63910
10-year harvesting volume, m^3 *10 – godišnji etat, m^3*	11774

2.2. Working methods – *Metode rada*

The map of the studied area and the existing skidding roads connected to the forest road were used as a basis. The first step was to calculate the forest surface and the volume of a 10-year cut gravitating to it. Also the ratio of wood transported by trucks and tractors with semitrailers was estimated (85 % by trucks and 15 % by tractors with semitrailors). The second step involved the calculation of traffic load and transported quantity taking into account the data obtained by the first step. The distance among the possible turning points, to which a particular skidding road gravitates, was used as a section of the forest road. In further steps comparison was made between absolute values and cumulative traffic load and transported quantity. Figure 2 shows the layout of the studied area with skidding roads, sections of the forest road and particular gravitating areas.

3. Results of the research – *Rezultati istraživanja*

The study of the traffic load was based on the results of the absolute traffic load on a particular section of the forest road. In doing the calculation, the amount of wood transported from a particular sec-

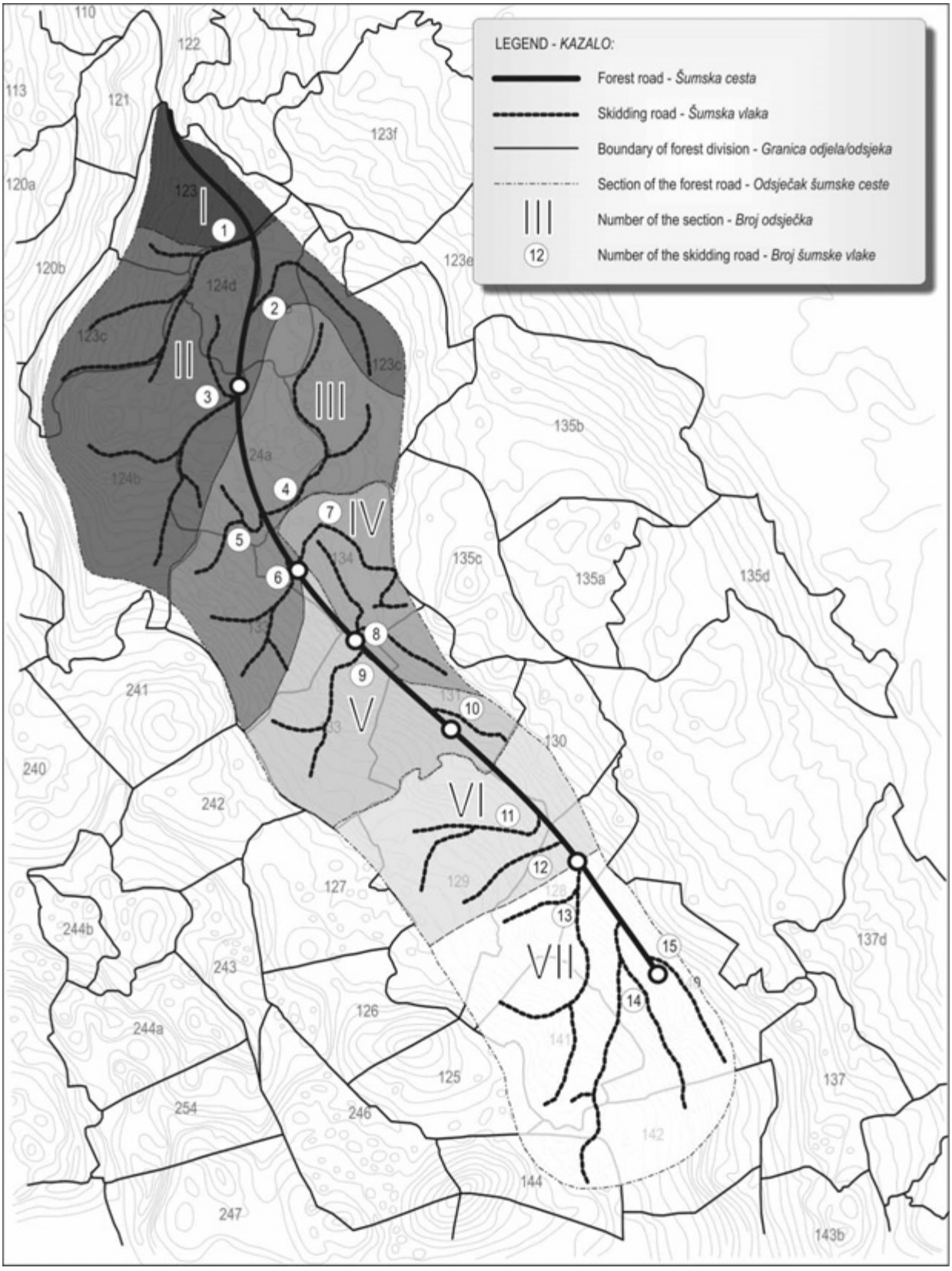

Figure 2 Layout of seven gravitation areas on the studied forest road

Slika 2. *Prikaz sedam gravitacijskih područja na istraživanoj šumskoj cesti*

tion of the forest road was taken into account (Table 2). Using ranks which represent the total amount of wood transported from one section of the forest road, we determined its absolute traffic load. We found out that the highest absolute traffic load was calculated on the last section of the forest road – counting from the connection to the public road – (section VII, rank 7) which was also the furthest away from the public road. The least traffic load was found out on the section I where 387 m^3 of wood was transported.

Table 2 Amount of wood transported by the forest road sections

Tablica 2. *Količine prevezin drvnih sortimenata po dionicama šumske ceste*

Forest road sections *Dionica šumske ceste*	Amount of transported wood m^3 *Količina prevezenih drvnih sortimenata, m^3*	Rank Poredak
I	387	1
II	2159	6
III	1956	5
IV	1740	4
V	1049	2
VI	1358	3
VII	3125	7
Total *Ukupno*	11774	/

From the traffic point of view the most similar results were obtained for the sections of the forest road in the middle where the absolute traffic load has changed the least. Consequently, it can be concluded that the pattern of skidding roads and turning points were carefully planned.

There is also a difference in traffic load transported by tractors and trucks. As mentioned before, because of specific management features, private property, low dependence of owners on income from the forest, only 15 % of wood was transported by tractors with semitrailers mainly for domestic needs. The rest of wood was transported by trucks to be sold on the market.

Figure 4 shows the results of the study of the cumulative traffic load. The real traffic load is shown on a particular section of the forest road – including wood transport from a particular section of the forest road and transportation of wood from sections further away from the forest. Therefore, within a particular section of the forest road »productive« transport and »connecting« transport can be found. Both together represent the real picture of the real

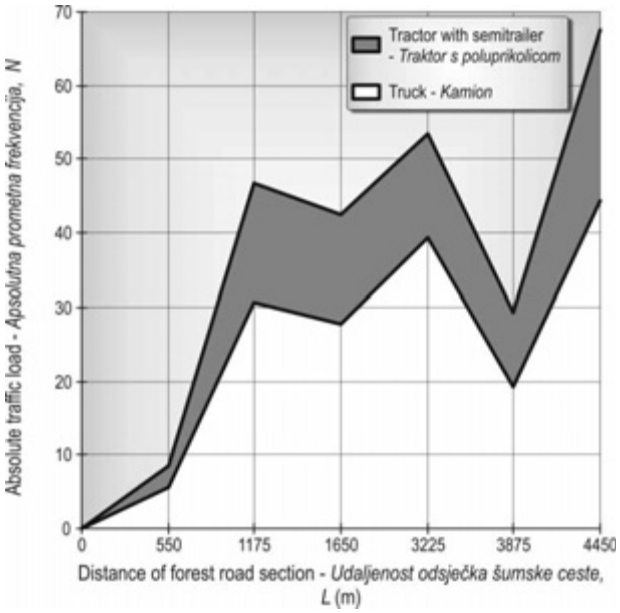

Figure 3 Absolute traffic load by the forest road sections and type of vehicle

Slika 3. *Apsolutna prometna frekvencija prema dionici šumske ceste i tipu vozila*

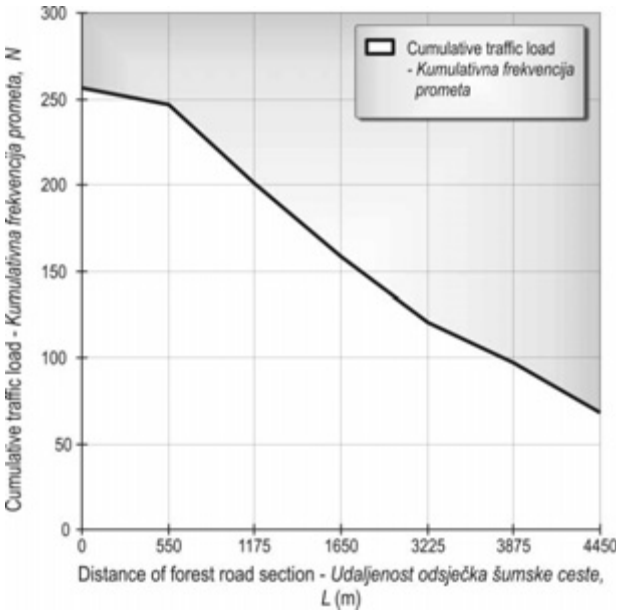

Figure 4 Cumulative traffic load on the forest road

Slika 4. *Kumulativna frekvencija prometa na šumskoj cesti*

traffic load of the particular section of the forest road.

Similar picture was achieved when the cumulative transported quantity was studied (Figure 5). The transported quantity is the largest at the connec-

tion to the public road, although the »contribution« of the section I was the least because of the smallest amount of the cut wood gravitated to the section I. Thus 1 m^3 of wood transported from the section situated the furthest away (turning point) has to be transported across the whole length of the forest road. Larger amounts of wood on sections situated further away, means larger cumulative traffic load and transported quantity on the whole length of the forest road.

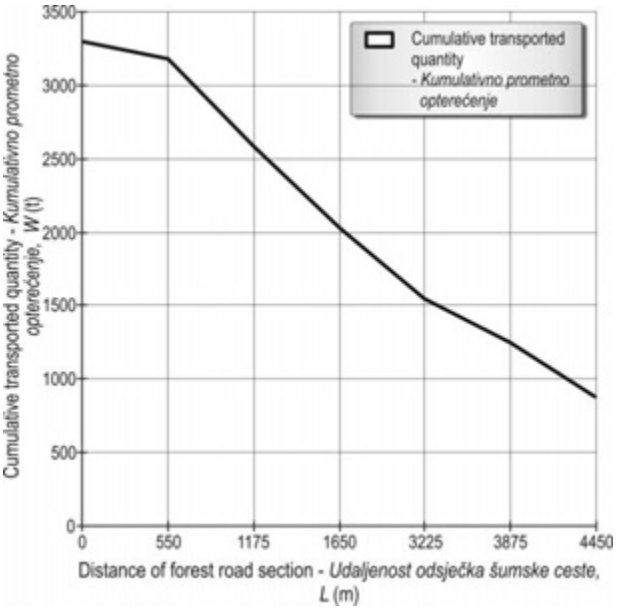

Figure 5 Cumulative transported quantity (t)

Slika 5 *Prikaz kumulativnog prometnog opterećenja (t)*

4. Discussion – *Rasprava*

Distribution of wood mass gravitating to the forest road, positions of turning points and pattern of skidding roads have impact on total (cumulative) traffic load and transported quantity on the forest road, depending on the length of the forest road. Sections of the forest road with the highest traffic load (closer to the public road) should be better adapted (in terms of technical elements and maintenance quality) to higher traffic loads and with the carriageway suitable to high transported quantities. In the case we studied (440 ha of forest gravitating to the forest road with 12000 m^3 of 10-year harvesting volume) the transported quantity reached 3500 t/year and traffic load 350 vehicles/year at the connection to the public road. Results are only relatively high. If these values are divided by days suitable for forest work (180 days/year) we get only 19 t/day or less than 1 vehicle/day.

Naturally such results do not support the idea of better forest roads. But we should be aware of the technical minimum that can ensure normal transportability with the least possible disadvantages of the forest road in terms of environmental impacts. Another important problem is maintenance of forest roads. Maintenance of the draining system should be ensured across the whole length of the forest road – efficient draining system is crucial for the normal service of the forest road (Potočnik 1993, Potočnik 1998). Higher traffic load indicates traffic as a more significant factor of destruction. The level of forest roads maintenance should reflect this fact. Beside maintenance of the draining system, reconstruction of the upper road layer, traffic signs etc. should also be ensured on the sections of forest roads closer to the public road. Periodical inspections and maintenance of the draining system are normally enough on the sections of the forest road with lower traffic load – depending on general maintenance plan and plan of forest operations.

Changing (decreasing) of technical elements of forest road and decreasing of the maintenance quality is useful if forestry service of the forest road is solely or at least the most important on a particular forest road. In the case where one of non-forestry services of the forest road is significantly important on the section situated the furthest away (opening of the farms, tourism etc.) the character of the forest road changes. Due to permanent traffic such forest road transforms its forestry character to the public one. The consequence is that the whole length of the forest road must be of the same quality in several terms. At this point the problem is met of over-standard maintenance of forest roads. The level of over-standard means the level which is higher than minimum requirements for normal forestry service of the forest road. Support should be provided from the state, local communities and social groups interested in a particular forest road. Forestry itself could not support higher standards without extra financial support.

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Sažetak

Utjecaj prometnoga opterećenja na tehničke značajke šumskih cesta

Šume i šumsko zemljište zapremaju oko 53 % kopnene površine Slovenije. Šume su kao rezultat uspješnoga planiranja i gospodarenja u vrlo dobrom stanju. Značajna sastavnica planiranja u šumarstvu jest i planiranje mreže primarnih šumskih prometnica – šumskih cesta. Šumske su ceste nezaobilazan čimbenik pri današnjem intenzivnom, multidisciplinarnom i racionalnom gospodarenju šumom, gdje se uz proizvodnju što kvalitetnijega drva kao primarnoga šumskoga proizvoda sve veća pažnja usmjerava ka sekundarnim šumskim proizvodima i općekorisnim funkcijama šume. Iako su šumske ceste, nesumnjivo, »strano« tijelo u šumi, koristi su koje dobivamo uspostavom najbolje moguće (i prema kriteriju kvalitete i kvantitete) mreže primarnih šumskih prometnica višestruko veće od šteta koje šumska cesta može imati za šumski ekosustav.

Zadatak je šumarskih stručnjaka da uklope šumsku ceste u svoje okruženje na način da se postigne neraskidiva cjelina šuma – šumska cesta – čovjek uz usuglašavnje ekonomskoga, tehničko-tehnološkoga, okolišno-ekološkoga i sociološko-estetskoga kriterija prosudbe optimalnosti odabrane inačice otvaranja šuma. Izradom se dobrih studija primarnoga otvaranja šuma mogu značajno racionalizirati i kontrolirati troškovi izgradnje i održavanja primarne šumske prometne infrastrukture. Jedna je od važnih sastavnica studije otvaranja raščlamba prometnoga opterećenja i frekvencije prometa kako postojeće tako i planirane (buduće) mreže šumskih cesta te s tim u vezi kategorizacija šumskih cesta i propisane tehničke značajke.

Iako u današnje vrijeme korisnici izvan šumarstva sve više uporabljuju šumske ceste (poglavito u šumama koje se nalaze blizu većih gradova i turističkih središta te koje samim tim imaju i naglašene općekorisne funkcije), ovo je istraživanje provedeno u šumskom predjelu Dragatuš, GJ Stari trg, gdje je čestota prometa povezana s korisnicima izvan šumarstva vrlo niska i zanemariva. Predmet je istraživanja isključivo prometno opterećenje šumskih cesta zbog daljinskoga transporta drva. Objekt je istraživanja gravitacijsko područje šumske ceste Tančegorski ovinek – Razvaje koje ima ukupnu površinu 440 ha podijeljenu u 18 odsjeka. Radi se većinom o malim parcelama privatnih šumovlasnika (88 % ukupne površine). Drvna zaliha iznosi 145 m^3/ha, od čega je 91 % listača i 9 % četinjača. Prirodne su značajke, uz gospodarenje u prošlosti, utjecale na značajno manju drvnu zalihu od slovenskoga prosjeka (220 m^3/ha) uz lošu strukturu etata u kojem prevladava manje vrijedni pilanski trupci listača i ogrjevno drvo.

Primarne su i sekundarne šumske prometnice snimljene GPS uređajem i ucrtane u šumskogospodarske zemljovide. Istraživana je šumska cesta razdijeljena u sedam odsječaka obrojčanih od I do VII s pripadajućim gravitacijskim područjima (počevši od spoja šumske i javne ceste pa do kraja šumske ceste – okretišta). Granice su pojedinih odsječaka predstavljale okretišta na šumskoj cesti koja su služila i kao pomoćna stovarišta. Izračunata je površina svakoga gravitacijskoga područja te je sukladno njegovu udjelu u ukupnoj površini gravitacijskoga područja čitave šumske ceste razdijeljen desetogodišnji etat. Utvrđen je udio prijevoza izrađenoga drva kamionima u iznosu od 85 % (za daljnju prodaju), a traktorima s poluprikolicom u iznosu od 15 % (za vlastite potrebe šumovlasnika). Temeljem navedenoga izračunato je prometno opterećenje i frekvencija po odsječcima istraživane šumske ceste za tzv. »proizvodno« opterećenje (opterećenje pojedinoga odsječka šumske ceste nastalo zbog transporta drva privučenoga upravo na taj odsječak) i za tzv. »neproizvodno« opterećenje (opterećenje pojedinoga odsječka šumske ceste nastalo zbog transporta drva privučena na neki od daljnjih odsječaka, a zbog nužnosti izlaska na javnu cestu). Prometna je frekvencija određena temeljem propisa o maksimalnom osovinskom pritisku vozila za transport drva.

Rezultati istraživanja dani u tablici 2 prikazuju ukupnu količinu drvnih sortimenata koja je posječena, izrađena, utovarena i odvezena s pojedinoga odsječka šumske ceste (»proizvodno« prometno opterećenje) uz prikaz re-

dosljeda količine sortimenata (najmanja količina – 1, najveća količina – 7). Na slici 3 je prikazana »proizvodna« frekvencija prometa po pojedinom odsječku šumske ceste za transport kamionom i traktorom s poluprikolicom. »Proizvodna« i »neproizvodna« frekvencija prometa i prometno opterećenje prikazuju kumulativnu frekvenciju prometa i prometno opterećenje na pojedinom odsječku šumske ceste, što je uistinu realan prikaz situacije. Rezultati su kumulativne frekvencije prometa i prometnoga opterećenja dani na slikama 4 i 5.

Najveći utjecaj na kumulativno prometno opterećenje i frekvenciju prometa, uz pretpostavku stalnosti stanišnih prilika, ima položaj i udaljenost pojedinoga odsječka šumske ceste od javne ceste, mreža sekundarnih šumskih prometnica te položaj okretišta na šumskoj cesti. Što su odsječci šumske ceste bliže spoju šumske i javne prometne infrastrukture, to trebaju biti izvedeni s višim standardom gradnje te održavani kvalitetnije i u kraćim razdobljima. Iz navedenih je razloga opravdana razredba ne samo šumskih cesta već i odsječaka pojedine šumske ceste, poglavito ako se radi u duljim cestama. U konkretnom slučaju desetogodišnji etat je 12 000 m^3, što iznosi 3500 t/god., 350 vozila/godišnje, odnosno 19 t/dan (ako se kao broj dana pogodnih za rad u šumi uzme 180 dana/god.) ili manje od 1 vozila/dan. Razredba šumske ceste Tančegorski ovinek – Razvaje u odsječke zbog različitoga standarda gradnje (možebitne potrebe za podizanjem propisanih tehničkih značajki na višu razinu) i održavanja nije logična zbog maloga etata.

U slučajevima kada je u ukupnom prometnom opterećenju i frekvenciji prometa značajan ili prevladavajući udio nešumskoga prometa, tada povećanje standarda šumske ceste (rekonstrukcijom i održavanjem) nadilazi potrebe i mogućnosti šumarstva te se financijska pomoć treba zatražiti od države, lokalne uprave i samouprave ili interesnih grupa koje rabe šumsku cestu.

Ključne riječi: *transport drva, prometno opterećenje, frekvencija prometa, šumska cesta, Slovenija*

Authors address – Adresa autora:

Igor Potočnik, Ph.D.[1]
e-mail: igor.potocnik@Uni-Lj.si

Tibor Pentek, Ph.D.[2]
e-mail: pentek@hrast.sumfak.hr

Dragutin Pičman, Ph.D.[2]
e-mail: picman@hrast.sumfak.hr

[1] Department of Forestry and Renewable Forest Resources
University of Ljubljana, Biotechnical Faculty
Večna pot 83, 1000 Ljubljana, SLOVENIA

[2] Department of Forest Harvesting
Forestry Faculty of Zagreb University
Svetošimunska 25, 10000 Zagreb, CROATIA

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