

# Social-Recreation Evaluation of Forest Roads and their Suitability for Trails: Towards a Complex Approach

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## Abstract – Nacrtak

Marked trails in forests usually make use of forest roads. Nowadays, the selection of a suitable forest road is predominantly, if not solely, based on the technical aspects of the road: the running surface and the available facilities enhancing their suitability for outdoor activities. However, the quality of the surrounding forest stands and their suitability for recreation – their social-recreation potential are not considered. We hypothesize that it is possible and desirable to evaluate forest roads using another criterion – the potential of the social-recreation function of forest roads according to the social-recreation suitability of surrounding forest stands. Degrees of the social-recreation value of a forest road were calculated as the weighted average of the degrees of values of individual surrounding forest stands and values of the significance/weight according to the length of individual forest stands along the road. The data were processed graphically using the ArcGIS geographic information system, in which it is possible to carry out the presented procedure. Forest roads with the highest degree of social-recreation potential were chosen to plan a trail and the direction of the trail was marked in the maps. The results demonstrate a new possible complex approach to trail designing; it represents an interactive way to choose suitable forest roads, with respect to both their technical quality and also the highest achievable recreational effect of the adjacent forest stands. This brings us closer to the achievement of a complex approach to trail designing: to be able to evaluate not only the technical aspects of roads but other criteria as well and use this ability to achieve the highest possible recreational effect of forest roads. If the interest of the community in the recreation in a particular forest area increases, we have provided the bases for the planning of new forest trails and roads, suitable surfaces, resting and parking places in purposeful locations.

Keywords: forest road, trail designing, recreation

## 1. Introduction – Uvod

As the society and technology are evolving, people are migrating to larger settlements and their requirements concerning the way they spend their leisure time are changing. Especially outdoor activities are gaining in popularity and these are mostly performed in forests. Forests, as the information on the status of forests in the Czech Republic tell us (MZE, 2010), represent 33.7% of its entire area and they form an opposite of urban areas. In the Czech Republic, based on the Act on Forests (1995), everybody is entitled to enter forests and move there freely, pick forest fruits and wood residuals for their own disposal. However, the citizens are not allowed to move

outside forest roads and marked tracks on bicycles, skis or sledges. Consequently, the increasing sporting population has to put up with forest roads only.

For that reason, the selection of locations suitable for these activities and the associated quality of environment, in our case forest ecosystems, remains an issue. Potočník (1996) remarked that besides its traditional productive task, forest roads should also perform several non-productive tasks, as a consequence of the modern way of life: escape from industrialisation, noise, ect. to unspoiled nature. Also Potočník et al. (2005b) mentioned that in conditions of public free and unlimited access to forests, the standard of forest road maintenance is higher. Along with this they con-

sider that unlimited access to forests means higher personal standard and higher quality of modern life, and that hence the higher cost of wood extraction is not the most important condition of multi-purpose and natural forest management.

As early as in 1994, Keller (1994) pointed out that as the interest of the public is rising, it is necessary to quantify forest functions for the purposes of Swiss forest policy. He defined other forest functions, but he referred to them as non-productive. He also presented possible geographical information systems as suitable instruments for a graphical representation of forest functions and space analysis. Authors from the Finnish Forest Research Institute (Engelmark 1998) remarked that the forest ecosystem cannot be any longer looked upon as a source of wood material only; it is vital that the approach of forestry changed to multiple-use forestry. They emphasize that this kind of research is certainly needed as the economic role of timber, pulp and paper production is currently changing, and perhaps its relative importance is decreasing in relation to other demands, such as tourism and environmental concerns. Other authors (Brändli and Ulmer 2001) discuss the opposing demands for the productive use and the recreational use of the forest ecosystem. They point out the increase in popularity of active outdoor recreation, including trekking, mountain biking, and also climbing and mountaineering. They suggest that the solution is to control and limit recreational activities to certain locations. This would reduce the risk of the recreational forest function conflicting with its other functions. Also Bell (2005) emphasizes the increasing interest in good quality natural environment. He notes that with the falling price of wood it is possible to make use of this interest in and popularity of forests and according to him the value of the recreational forest function should be expressed financially. He discerns the high efficiency of investments – with relatively low expenses for technical facilities, the value of the forest rises considerably. The Danish authors (Larsen et al. 2008) point out that the recreational value of forests does not depend on technical facilities solely but that it is also in direct relation to biodiversity.

A new approach to forestry was introduced by Vyskot (Vyskot et al. 2003). He accepts the philosophy of equal importance of all forest functions for the community, not only wood production but also what he calls the social-recreation function. However, the equal importance of forest functions does not mean that the forest stands are able to fulfil them all to the same degree. The ability of forests to perform functions is highly differentiated and can be expressed by the degree of their real potentials. The

acceptance of the multifunctional nature of forests inevitably leads to the necessity of a complex approach to the evaluation of stands. The degree of the real potential of the forest social-recreation function can be used to decide upon the recreational use of a forest. So far, the decision-making process concerning the spending of leisure time has been based on the quality of services and technical recreation – related qualities. However, it is necessary to use the possibilities naturally provided by the forest ecosystem.

Therefore, the objective of this study is to evaluate forest roads according to the values of adjacent stands with regard to their social-recreation function. The hypothesis is that such evaluation is possible, plausible and will bring benefits to the field of planning of marked trails, making such planning highly interactive, flexible and purposeful.

## 2. Materials and methods – *Materijal i metode*

The basis of the study is the evaluation of forest roads with the criterion of social-recreation function of the surrounding forest stands. For the evaluation of the surrounding forest stands we used the method acknowledged by the Ministry of Environment of the Czech Republic (Vyskot et al. 2003); it defines the social-recreation function as the ability of forest ecosystems to produce effects providing human and social satisfaction of physical and psychological needs (the optimization of organism's physiological processes). The real potentials are then used to classify the scale of suitability for recreation and to quantify the effects of all systemized ecosystems in Czech forests.

The suitability of stands for recreation is evaluated by direct and indirect ecosystem criteria. The direct criteria category consists of two criteria: the real species composition expressed through a stand type, and the forest type, which is based on data on precipitation, temperature, soil type and terrain type. When the evaluation of one location is conducted, as in our case, it is the direct criteria which are of the more determining nature as the indirect criteria for individual stands within one location can be very similar (the same geographical features).

The indirect criteria are numerous and varied, and they are based on climatic, hydrological, terrestrial, geopedological, and physiological and biological data, which can be acquired from database sources. They include air temperature in the growing season (affecting the overall resulting impression of the stand); physiological climatic optimum (the interaction of air pressure, temperature, wind); the number of summer days (based on temperature); the number

**Table 1** Colour coding of individual degrees of real potentials of social-recreation forest function according to Vyskot (Vyskot et al. 2003)**Tablica 1.** Mogućnost korištenja šumskih sastojina u društveno-rekreacijske svrhe

Functional interval of the degree, 0–100% <i>Kakvoćni udio čimbenika, 0–100 %</i>	Real potential of the function <i>Prikladnost šumskih sastojina za rekreaciju</i>	Degree – <i>Razina</i>	Colour code <i>Boja prikaza</i>
<10	Unsuitable – <i>Neprikladna</i>	0	
11–30	Very low – <i>Vrlo niska</i>	1	
31–45	Low – <i>Niska</i>	2	
46–55	Average – <i>Prosječna</i>	3	
56–70	High – <i>Visoka</i>	4	
71–90	Very high – <i>Vrlo visoka</i>	5	
>91	Outstanding – <i>Izvanredna</i>	6	

of rainy days (based on precipitation); the number of snow days (based on snow cover); the duration of sunshine (number of hours of sunshine); the altitude (diversity of terrain), the terrain accessibility (slopes, surfaces, obstacles); the soil depth (as a result affecting the variability of the environment); the site bearing capacity (the capacity of a site to bear the load of recreating population); »physiological« biodiversity of trees; herb layer – species diversity; and herb layer – cover. The degrees are expressed in direct proportion with the available data, with the exception of the number of rainy days where the proportion is inverse. As a result all the criteria affect human feelings, impressions and the sense of well-being while staying in the actual stand.

In the study, the real potentials of the social-recreation function of forest stands adjacent to forest roads in the example area were evaluated and individual degrees were marked with a colour so that they could be visualised in stand maps (Table 1).

The vector layer representing the boundaries between forest stands – the stand map created during the preparations of Regional Plans for Forest Development (ÚHÚL 2001) – was used as the basis for visualising the degrees of the social-recreation forest function. The resulting map of the social-recreation function potentials was then used for the degree evaluation of the road network in the area. Subsequently, the vector layer of forest hauling roads was projected onto this map.

The resulting degrees of the social-recreation potentials of the forest stands were then used for the degree evaluation of the road network in the area. The forest roads were evaluated in sections between crossings with other roads; thanks to this, the direction of the designed trail can be changed on demand.

Degrees of the social-recreation value of a forest road were calculated as the weighted average of the

degrees of the values of individual surrounding forest stands and the values of the significance/weight according to the length of individual forest stands along the road, according to the following formula:

$$x = \frac{\sum_{i=1}^n w_i \times x_i}{\sum_{i=1}^n w_i} \quad (1)$$

Where:

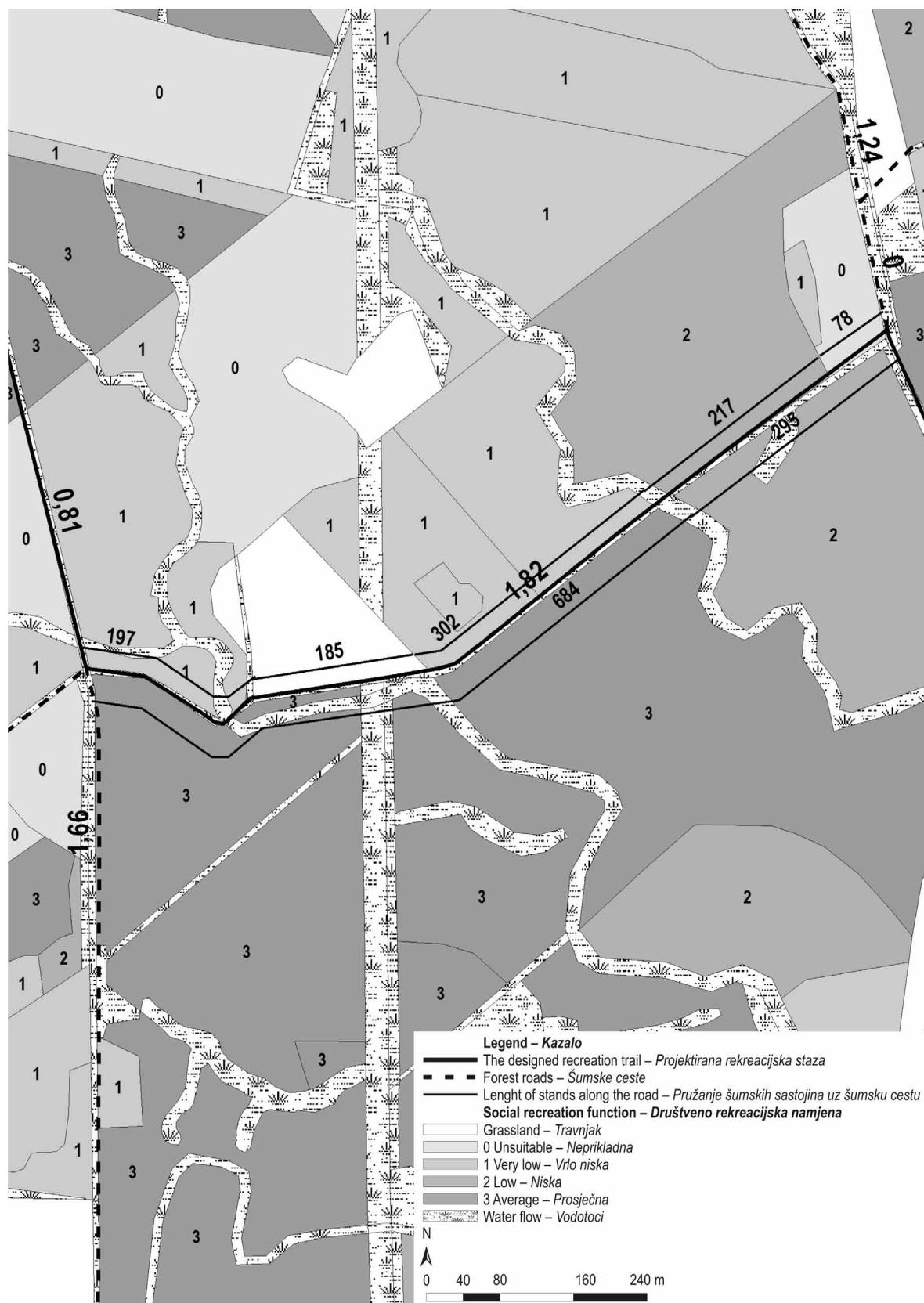
$w_i$  are the values of degrees of individual surrounding forest stands

$x_i$  are the values of significance/weight, which means the length of individual forest stands along the road.

This means that the degrees of potentials were related to the length of the boundary between a forest stand and the forest road. The weighted average was calculated for both sides as forest roads often form boundaries between stands.



**Fig. 1** Area of study  
**Slika 1.** Područje istraživanja



**Fig. 2** Graphical visualisation of forest road evaluation  
**Slika 2.** Razredba terena prema kakvoći šumskih cesta za rasonodu ljudi

Then, the sections of forest roads with the highest degree of the social-recreation potential were chosen to plan the trail.

The data were processed graphically using the ArcGIS geographic information system, in which it is possible to carry out the presented procedure.

### 3. Area of study – *Područje istraživanja*

The area used for the proposal for interactive planning of trails is the floodplain forest of the Židlochovice Forest Enterprise of the Forests of the Czech Republic, state enterprise (Fig. 1).

The Židlochovice Forest Enterprise is located in the southern part of the South Moravian region and its floodplains have been preserved in the southern part of the Thaya-Svratka Dell (Dyjsko-svratecký úval), which stretches along the Morava and the Thaya Rivers. Long, quite straight, broad, and shallow valleys are typical for the area. The current level of the area accessibility is very good due to the flatland terrain, with the average density of forest hauling roads being 16 m/ha, their surface using mostly bituminous binder (ÚHÚL 2001). The forest road network in the area in question was built gradually throughout the history and it has been updated when needed. It means that besides historic roads, forest roads built in the second half of the last century are used. They are mostly classified as the highest class of forest roads. A part of the area is located in the Lednice-Valtice Cultural Landscape, which has been an UNESCO site since 1996. All in all, this environment is suitable for recreation and free-time activities of the South Moravian region inhabitants.

### 4. Results – *Rezultati*

The hypothesis that it is possible to evaluate forest roads from other perspectives than technical has been confirmed. The degrees of the social-recreation forest roads evaluation were calculated. The graphical visualisation of the evaluation is presented in the geographic information system ArcGIS in Fig. 2.

The evaluation of forest road sections was carried out for forest hauling roads, as these are most often used as trails for hiking, cycling or cross country skiing. The degrees of forest road sections were added to the database of forest hauling roads as an independent field and visualised graphically. For the actual design of the trail, forest roads with the highest degree of the recreational function were chosen and the direction of the trail was marked in the maps (Fig. 3).

The presented solution allows for a qualified interactive designing of trails, making use of the forest

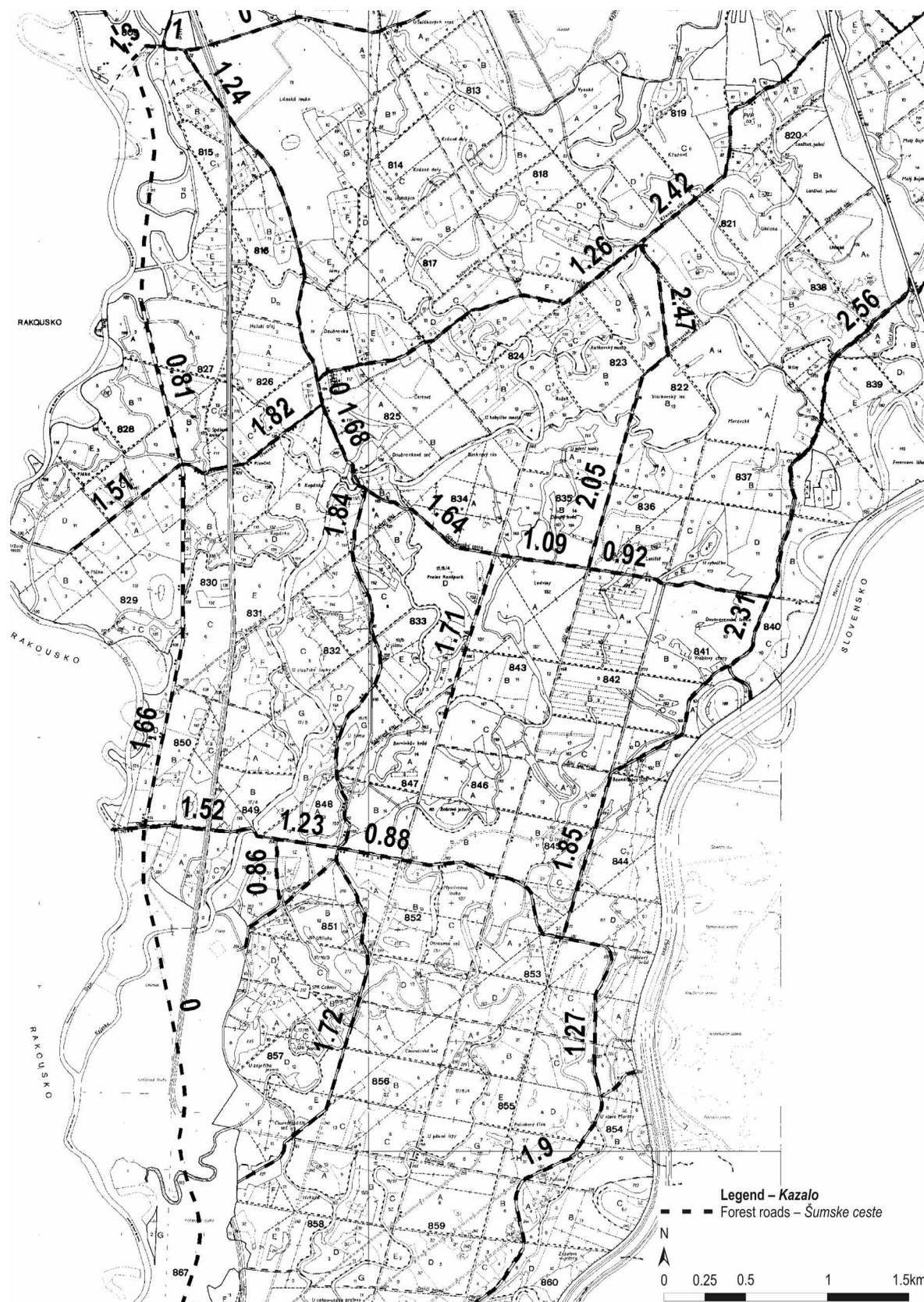
roads, which are most suitable and of the highest quality for recreation; moreover, it makes the planning of accompanying recreational facilities possible and purposeful.

The forest trail was designed so as to lead through the section of forest roads with the highest social-recreation degree (Fig. 4).

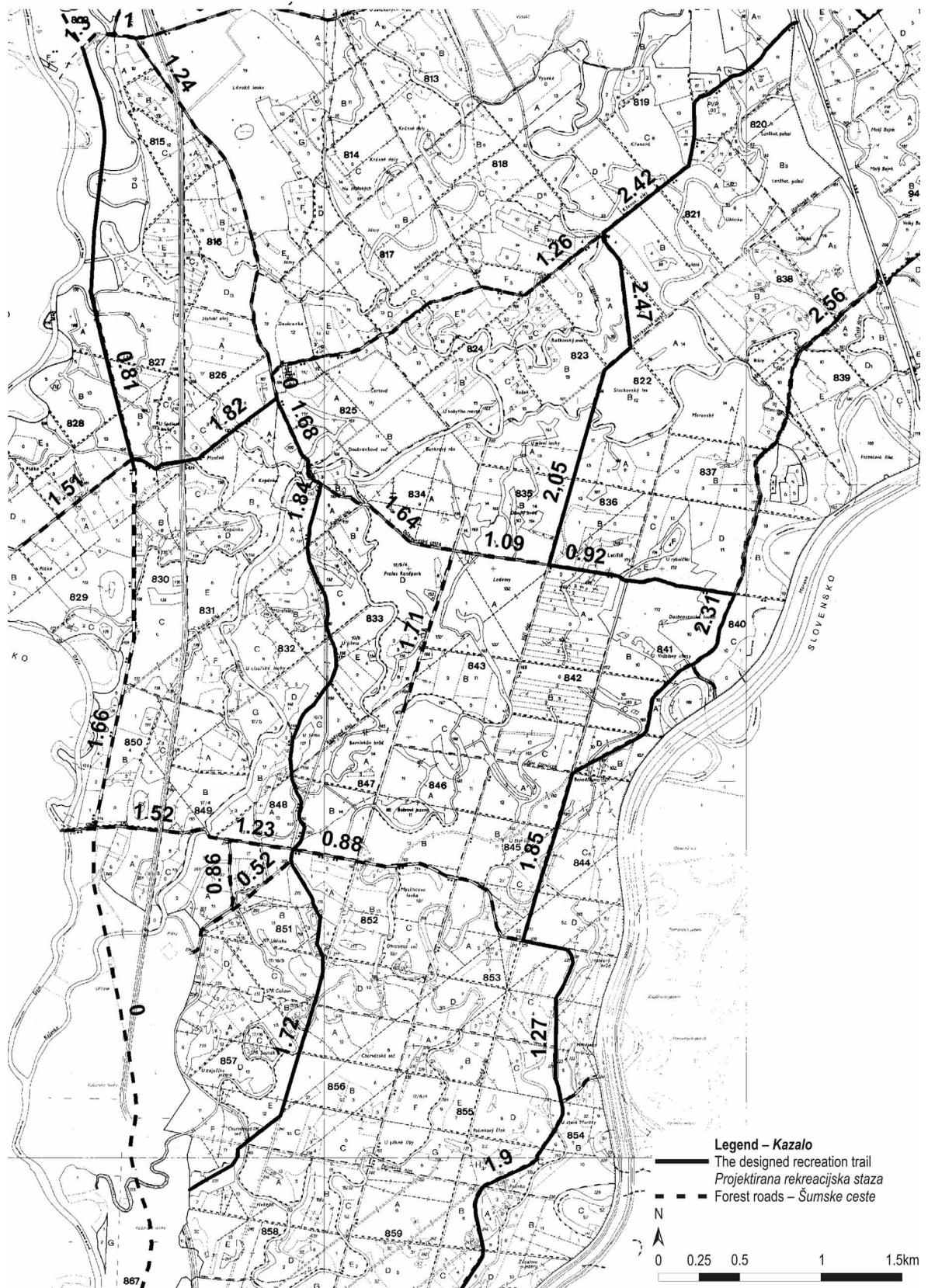
The results demonstrate a possible complex approach to trail designing; it represents an interactive way to choose suitable forest roads, with respect to both their technical quality and also the highest achievable recreational effect of the adjacent forest stands. We have provided the foundations for planning new forest hauling roads, suitable surfaces, and resting and parking places in purposeful locations, which can be easily applied, if the interest of the community in the recreation in this particular forest area increases. This is the practical implication and the main benefit of the forest road evaluation from the social-recreation function perspective.

### 5. Discussion – *Rasprava*

The development of outdoor activities is becoming a priority for some areas, and planning and building of facilities for hikers, bikers and others has to be based on a concept. Gül et al. (2006) point out that it is necessary to create a recreation management plan for these areas. The authors also mention the need to control the movement of tourists (hikers, bikers, etc.) and to build some facilities for them in designated places (including picnicking, sports facilities and playgrounds, camping sites, walking paths, food and local outlets). However, this requires a qualified selection of trails and locations where the facilities should be built. In his paper Potočník (2006) deals with the management strategy in a preserved forest area. The strategy proposed the regulation of parking lots and introduction of alternative public transport, fees, providing wide tourist plateau and providing visitors with information about the natural environment, protected natural and forest areas, the national park itself, code of behaviour in the natural environment. The methodology presented is a useful tool for the above mentioned selection of new facilities. It allows maximum utilization of the social-recreation function of forest stands and efficient investments in the promotion of recreation in the particular area. In this way, it is possible to mark the trails so that the hikers (or bikers, etc.) use the forest roads with the highest degree of the social-recreation function and also make sure that the trails have the necessary facilities. This does not only mean minor recreational constructions, such as resting places, but also an overall technical design of a forest road. The design of the surface



**Fig. 3** Degree evaluation of individual forest road sections  
**Slika 3.** Stupanj vrijednosti pojedinih dijelova šumskih cesta



**Fig. 4** The designed recreation trail  
**Slika 4.** Projektirana rekreacijska staza

cross-section affects the road appearance and its aesthetics. This concerns mainly the length of fill and cut slopes and the type of surface (Akay et al. 2007). Other authors (Lugo and Gucinski 2000), who study relations between forest roads and forest ecosystems, confirm their close relationships; they use the terms road ecology and technoecosystem. A suitable technical design of roads on selected trails enhances the attractiveness for recreation provided that the recreation carrying capacity of the forest ecosystem is not exceeded. Daniels and Marion (2006) state that the management of backcountry recreation areas involves a balance of actions taken to meet environmental and social objectives. In their study, a group of European scientists (Bartczak et al. 2008) prove that e.g. the willingness of people to pay for a stay in the forest is continuously increasing. Authors Potočník et al. (2005a) present the level of over-standard, which means the level which is higher than the minimum requirements for normal forestry service of a 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.

Also for this reason, it is recommendable to approach the social-recreation function of forest roads competently and to harmonize it with the economic needs of wood production. The methodology presented provides a solution for outdoor recreation in the forest environment with the highest degree of suitability for recreation.

## 6. Conclusions – *Zaključci*

The evaluation of forest roads according to the functional criteria of the social-recreation function of forest stands for trail designing in the forest environment brings qualitative changes to the issue of multifunctional use of forest roads.

The functional criteria enable us to harmonize the recreational and technical aspects of forest roads used for trails and to achieve the highest social-recreation effect. The harmonization of various aspects found in forest evaluation is the complex approach we are aiming at. The technical-economic approach changes into the technical-economic-environmental approach, which contributes to the improvement of the quality of leisure time spent in forests.

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## Sažetak

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### Određivanje društveno-rekreativne kakvoće šumskih prometnica

Danas se odgovarajuća šumska cesta ili put za rekreaciju ili boravak u prirodi pretežno, ako ne i isključivo odabire na osnovi tehničkih svojstava same ceste, odnosno njezine širine (površina za slobodno kretanje stanovništva) te na osnovi dodatnih objekata koji su na raspolaganju u šumi. Međutim, kakvoća okolnih šumskih sastojina i njihova prikladnost za razonodu, tj. njihov društveno-rekreativni potencijal, ne uzimaju se u obzir. Stoga je svrha ovoga rada bila da se ocijene šumske ceste na temelju vrijednosti okolnih sastojina s obzirom na njihove društveno-rekreativne mogućnosti. Hipoteza je da će takva procjena na uvjerljiv način pridonijeti poboljšanju planiranja budućih planinarskih staza i rekreacijskih putova.

Za ocjenu okolnih šumskih sastojina primijenjena je metoda koju priznaje Ministarstvo zaštite okoliša Republike Češke (Vyskot i dr. 2003). Ona određuje društveno-rekreativne funkcije šume kao sposobnost šumskih ekosustava za stvaranje pozitivnih društvenih učinaka koji kod ljudi ispunjavaju određene fiziološke i psihološke potrebe. Izrađena je podjela šumskih ekosustava na temelju njihove pogodnosti za rekreaciju stanovništva te je potom analizirana mreža šumskih cesta po pojedinim područjima. Šumske su ceste ocjenjivane na temelju količine međusobnoga križanja, što stanovništvu omogućuje promjenu smjera kretanja po šumi. Podaci su obrađeni pomoću računalnoga programa ArcGIS. Područja s najvišom ocjenom izabrana su za planiranje rekreacijskih putova i staza čiji je smjer označen na karti. Predstavljeno je rješenje interaktivnoga projektiranja rekreacijskih staza (ali i mogućih pratećih turističkih objekata) korištenjem postojeće mreže šumskih cesta koje su unaprijed određene najprikladnijama za razonodu ljudi. Hipoteza da je moguće procijeniti šumske prometnice iz drugih, netehničkih gledišta potvrđena je. Rezultati pokazuju moguć nov pristup pri projektiranju planinarskih staza odabirom prikladnih šumskih cesta s obzirom na njihova tehnička svojstva i šumske sastojine koje one otvaraju. Osigurali smo temelje za planiranje novih rekreacijskih staza uzimajući u obzir postojeću mrežu šumskih prometnica, površinu prikladnu za odmor te parkirna mjesta na svrhovitim položajima unutar šume. Ako se interes zajednice poveća, lako se može ostvariti. Vrednovanje šumskih cesta prema društveno-rekreativnoj djelatnosti donosi pokazatelj višekriterijskoga korištenja šumskih cesta koje je odavno poznato, ali tek treba biti priznato u praksi.

Ključne riječi: šumska cesta, projektiranje rekreacijskih staza, rekreacija stanovništva u šumi

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