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Full Length Research Paper

Constitution of the forest road evaluation form for Turkish forestry

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It is highly important to describe the capabilities of existing forest roads in terms of all the functions assigned to them in line with forestry objectives and to define their conditions of utilization in the future. This study aimed at determining and grading the factors that are required to make an evaluation concerning the forest roads and preparing an evaluation form for them. Twenty-three evaluation factors and indicators that subgroup these factors were defined to evaluate forest roads. The method of Analytical Hierarchy Process (AHP) was used to define the significance rates at the step of factor evaluation. Survey method was applied for expert group evaluation. Significance rates of the factors were found through an evaluation of the data obtained. After the significance rates of the factors that were regarded at the outset as significant factors for evaluation of roads were defined, factors having a significance rate of lower than 2% were extracted and calculation was repeated accordingly. After four iterations, the forest road evaluation form was prepared with 13 factors. Factors in the form and their respective significance rates were defined as vertical slope value, 12.73%; condition of superstructure, 6.89%; condition of art structure and its compliance with the draining system, 5.71%; availability of continuous access, 5.17%; transportation costs, 3.94%; availability of fire protection 12.37%; proneness to develop erosion and any water quality problem 11.45%; the risk of land-slide due to high hillside slope 12.55%; proneness to make pressure on water courses 5.97%; risk to damage or annihilate the wild habitats 5.63%; eligibility for forestry works 2.64% and eligibility for utilization for security 6.45%. The evaluation form was prepared as practical and handy to use.

Key words: Forest roads, road evaluation, road classification, road evaluation form, AHP.

INTRODUCTION

Forest roads are the most important infrastructural facilities to exploit forests that are renewable natural resources. A road network that leads us to our goals needs to be established in order to plan forestry activities sustainably. In addition to forestry services, forest roads provide economic benefit for rural population by enabling them to market their products and help them meet their health-care, education and other social needs. Forest roads interact with many technical, economic, environmental and social factors to render these services.

Although roads are the first step to start exploitation of forestry resources, they are also infamous for paving the way for erosion and sedimentation and for their adverse impact on wild life and water resources, which make forest unavailable for production and other significant forestry activities. Therefore, an environment-friendly and economically and technically sufficient road plan should be implemented. In many countries, forest road networks are realized as a part of the land planning. When a forest road system is planned, condition of the forest, structure of the land, climate data, environmental factors, infrastructure, non-wood forest products and services, user groups of the road, value of access to the forest and national policies are often taken into account (Potocnik, 1996; Bjorklund, 2006).

For long years, economical feasibility of forestry production works has served as the main goal in establishment and maintenance of forest road networks. However, recently, utilization of new techniques resulted in or paved the way for evaluation of different factors, too. These studies look into fallowing considerations transportation cost, distance, maintenance cost, vehicle types and road categories, friction distances and costs, road surfaces, road space and density values (Paterson et al.,

Table 1. Geometrical standards of these roads.

Road features	Unit	Main forest roads	Secondary forest roads				Tractor roads
			A - Type	B – Type			
				HBT	NBT	EBT	
Platform width	m	7	6	5	4	3	3.5
Number of road line	Number	2	1	1	1	1	1
Roadway width	m	3	3	3	3	3	3
Maximum longitudinal slope	%	8	10	9	12	12	20
Minimum vertical curve diameter	m	50	35	20	12	8	8
Shoulder width	m	0.50	0.50	0.50	0.50	0.50	
Ditch width	m	1.00	1.00	1.00	1.00	0.50	
Superstructure width	m	6	5	4	3	3	
Bridge width	m	7+(2 x 0.6)	6+(2 x 0.6)	5+(2 x 0.6)		4+(2 x 0.6)	

HBT: High standard B type forest road: NBT: Normal B type forest road: EBT: Extreme B type forest road

1975; Wolf, 1996; Greulich, 2002; Huang et al., 2006; Weston et al., 2004; Palmgren et al., 2004; Martin et al., 2001; Saari et al., 2007; Pentek et al., 2007; Demir, 2007; Acar and Unver, 2007; Gumus et al., 2008).

Parallel to the increased competition under globalization, there is also an increase in measuring and comparing the administrative efficiency. Various parametrical and non-parametrical techniques are used both in public and private sector to measure and increase efficiency and productivity (Sowlati, 2005; Fouracre et al., 2006).

Analytic Hierarchy Process (AHP) was first introduced in 1968 by Myers and Alpert and was developed as a model by Saaty in 1977 and made available to use in resolution of decision-making problems. AHP is a mathematical method that takes into consideration the priorities of an individual or a group and evaluates collectively both qualitative and quantitative variables in decision making (Yaralioglu, 2001). There are many AHP applications on different problems (Liberatore and Nydick, 1997; Forman and Gass, 2001; Qureshi and Harrison, 2003; Randall et al., 2004; Dikmen and Birgonul, 2006; Liu et al., 2008; Wong and Li, 2008).

Forest road planning is conducted in accordance with the Communiqué no. 292 by Directorate General of Forests in Turkey. Place, route, slope, width, curves and lases are examined for evaluation of roads already built in the forest. It has been provided that roads that currently meet the forest road standards are included in the new plan while those that are not possible to re-build even through extensive repair are left out of the road plan (GDF, 2008).

This directive covers only technical specifications for evaluation. Nonetheless, economic, environmental and social factors should also be considered as well as technical specifications. There is not any evaluation form developed and approved for an evaluation study in Turkey. It is highly important for a standard practice all around the country to define the factors to be taken into consideration for evaluation and criteria (indicators) that define these factors.

This study aims at describing the capabilities of existing forest roads in terms of all the functions assigned to them in line with forestry objectives and defining their conditions of utilization in the future. Therefore, this study also targets to define and to classify the factors that need to be used for evaluation of roads and indicators describing these factors and to develop an evaluation form for forest roads.

MATERIALS AND METHODS

Forest roads are divided into three main groups with respect to the amount of the load to be transported over them, the objective of construction, traffic density and tonnages in Turkey: Primary forest roads, Secondary forest roads (Type A and Type B secondary forest roads) and Tractor roads. Geometrical standards of these roads are shown in Table 1 (GDF, 2008).

A survey form was used to determine the order of significance of the significant factors in evaluation of forest roads. For the survey, stakeholder groups included the academic staff of Division of Forest Transport in Forest Engineering Departments of Faculties of Forestry, academic staff of other divisions of Forest Engineering Departments, technical staff of Department of Machinery Supply in provincial directorates of General Directorate of Forestry and Chief Offices for Forestry Administrations.

For evaluation of forest roads, technical, economic, environmental and social groups were defined as generally-approved factors for forest road plans and projects through a consensus. Twenty-three sub-evaluation factors and indicators describing the factors were defined under the four main headlines through an examination of the previous studies on the subject in consensus.

AHP method was applied for evaluation. In AHP method, the order of significance of the factors to be used in evaluation was determined first. For this purpose, opinion of an expert group of 33 people from our stakeholders was obtained through the survey. In so doing, factors to be used in evaluation of a forest road and order of significance of these factors were determined. The evaluation form was given the shape by the total point obtained through multiplying the significance rate of each factor and the grade of the road according to the indicators.

Table 2. Distribution of significance of factors in the evaluation.

Evaluation factors	Significance rates (%)
Technical features	30.07
Longitudinal slope (Transportation quality and safety)	10.05
Superstructure	6.75
Necessity of drainage structures	6.62
Continuous access	7.27
Temporary access	2.91
Skidding distance	3.47
Economical features	7.77
Transportation expenditures	3.91
Maintenance expenditures	3.86
Environmental features	37.29
Fire protection (possibilities of accessing and linking)	7.62
Partition or destruction of valuable forest lands	5.68
Soil erosion and water quality problems	6.75
Risk of landslides by high hillside slopes	7.04
Pressure on water courses	5.26
Partition or destruction of wildlife habitats	4.94
Social features (User groups)	17.87
Suitability for forestry activities (opening-up rate %)	3.33
Suitability for villagers	2.32
Suitability for agricultural activities	1.95
Suitability for transit pass	1.67
Suitability for security aimed usage (army and police)	2.89
Possibility of hunting aimed usage	1.26
Potential usage for truism and recreation	1.57
Suitability for sportive usage	1.12
Suitability for scientific research usage	1.76
Total	100

RESULTS AND DISCUSSION

The distributions of significance rates of factors in the evaluation were obtained through the calculation using AHP method. Individual analysis of calculation results reveals that vertical slopes, superstructure, necessity of drainage structures, continuous access, fire protection, protection of valuable forest areas, high slope of hillsides and pressure on water courses over 5% significance rates were defined as the most significant factors. Factors such as agricultural use, availability for transit pass, hunting, tourism and recreation and suitability for sports and scientific research that have a significance rate lower than 2% were defined as the less significant factors (Table 2).

Study forms are preferred to be as lean and practical as possible. Therefore, factors with significance rates lower than 2% were taken out and calculation was repeated accordingly. The evaluation of the remaining 17 factors also showed that temporary access and access of rural population stayed below 2% of significance rate. Transport distance remained below 2% significance rate in the next trial while the maintenance cost could not achieve the 2% rate in the third trial.

As there was no factor under 2% significance rate in the 4th iteration, the remaining 13 factors were selected for the evaluation form. The study form, or the check table, that was finalized for forest road evaluation is included in Table 3. It was therefore observed that the due care should be paid to the environmental issues on forest roads that have adverse impact on the forest ecosystem that has a specific balance.

Conclusion

Technical factors represent 30.5% in evaluation of a road while economic factors and environmental factors and social factors represent 3.94, 56.46 and 9.09% repectively.

The evaluation form developed through this study should be used in renewing the forest road networks and roads to be included into the new plan should be determined according to this evaluation form.

Table 3. The forest road evaluation form.

Forest Range Headquarters		Forest enterprises	
Local forest office		Serial	
Road code		Name	
Length		Longitudinal slope	
Construction year		Average side slopes	
Other features:			

Evaluation factors	Indicator	Indicator points	Road points	Significance rate (%)	Road value (point x rate)
Longitudinal slope (Transportation quality and safety) (%)	0 - 1.9	50		12.73	
	2 - 8.9	100			
	9-12	90			
	12.01-20	30			
	% 20.01 < ..	0			
	Adverse slope	0			
Superstructure	Asphalt	100		6.89	
	Concrete	100			
	Stabilize	90			
	Soil	50			
	Damaged	20			
Necessity of drainage structures	Adequate	100		5.71	
	Cross concrete	90			
	Concrete pipe	70			
	Culvert	50			
	Bridge	30			
	Walls	20			
Continuous access	10- 12 month	100		5.17	
	8- 10 month	70			
	6- 8 month	50			
	less than 6 month	0			
Transportation expenditures (TRY/m^3)	1 - 10	100		3.94	
	11 – 20	80			
	21 – 30	50			
	Over 30	20			
Fire protection (possibilities of accessing and linking)	Wide range forest and rural settlement areas	100		12.37	
	Only forest areas	80			
	Only rural settlement and agricultural areas	70			
	Blind roads	0			
Partition or destruction of importance forest lands	No affect	100		8.49	
	Relatively negative effect on stand type	20 - 80			
Soil erosion and water quality problems	No effect	100		11.45	
	Effective	50			
Risk of landslides by high side slopes	Flat and low side slope terrain (% 0 – 33)	100		12.55	
	Sloping and upright terrain (34-65%)	50			
	Steep terrain (Upper than 66 %)	0			

Table 3. contd.

Affect to stream bodies	No negative effect	60 - 100		5.97	
	Effect to profile narrowing	0 - 59			
Partition or destruction of wildlife habitats	No effect	60 - 100		5.63	
	Effective	0 - 59			
Suitability for forestry activities (opening-up rate %)	81 – 100	100		2.64	
	61 – 80	70			
	0 – 60	50			
Suitability for security aimed usage (army and police)	Suitable	100		6.45	
	Unsuitable	0			
Road value points					
Quality class					

AHP was found to be an effective method in evaluation of forest roads. It will be helpful to use it in similar studies. The data obtained in this study will be stored in digital databases and serve as an infrastructure for future studies all around the country.

About 430 125 000 TRY has been provided for forest roads under the forestry investment activities section of the 9th Development Plan, which covers the years from 2006 to 2013, in Turkey. This amount will be able to be used more efficiently if the results of this study are taken into due consideration by the practitioner the field of forestry.

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