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Evaluation Of Existing Forest Road Network Based On Single Tree Selection Cutting Silvicultural Method

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Abstract: This study was conducted to evaluate the forest road network in Alandan district. In comparing the variants, it was revealed that the current road is considered as a feasible one in terms of coverage, but in some areas, some extra paths have been constructed which are not so applicable. Those paths should be back to the nature. The suggested road creates a %9.5 extra coverage using 1200 meters fewer length and 0.59 mh^{-1} fewer coverage comparing to the current road. Determining the annual traffic of the road network, it was revealed that the current traffic is less that 5 per day. Therefore, there is no need to construct he 1'st grade roads in the area and the roads should be of 2'nd and 3'rd grades. The results of the study showed that if all the required roads would be constructed for the entire silvicultural revolution, the shelterwood and selection system would not be very different in terms of road distribution. However, since the logging volume in shelter wood system is many times as more as volume in selection system, the road networks are different in terms of standards.

Key words: Evaluation; Forest Roads Network; Selection system; Alandan District.

INTRODUCTION

Forest roads are the most important foundation for sustainable forestry operations (Aruga *et al*., 2005). In the Hyrcanian Forest located in north of Iran, extraction with ground-skidding equipment is the most common system and also the one that tends to cause the greatest environmental problems (Jour Gholami and Majnounian, 2008). Three types of road are built for selective logging in these areas: (a) major access roads to be used for trucks carrying logs to sawmill; (b) temporary local roads into individual logging areas; and (c) skid trails made by bulldozers dragging logs to truck loading areas. The first two types usually have a gravel surface protection, while the latter are simply loose soil. Skid trails are defined as tertiary roads that are used by skidders that move logs from the point of felling and bucking to log landings (Demir *et al*., 2008).

The total length of Hyrcanian forest roads in Iran at the end of year 2009 was about 10000 km. Roads network planning and standard methods for their construction are performed according to principle of the bulletin No. 131 (Sarikhani and Majnonian, 1994) and 148 (Sarikhani and Majnonian, 1999), published by Plane and Budget Organization of Iran (PBOI). In Iran, to find optimal locations for the road network, many forest engineers still use traditional methods that are almost entirely manual. Rafiei *et al.* (2009) estimated the optimum road density by minimizing sum of skidding and roading costs. The results showed that the optimum road density for Timber jack 450C and HSM 904 in Dalak kheyl forest were 2-4 m ha^{-1} and 3-5 m ha^{-1}, respectively. These estimated densities were less than existing road density which was 16.1 m ha^{-1}.

Recently, shelterwood cutting have been replaced by low-impact forest management systems such as single-tree selection cutting as alternatives to logging in northern hardwood stands in Iran, because this system differs in size, intensity, frequency, and in the pattern of disturbance, local habitat structures and spatio-temporal habitat distribution in the landscape should be quite different (Frelich and Lorimer, 1991; Doyon *et al*., 2005). Selection cutting is the silvicultural practice of harvesting a proportion of the trees in a stand. Selection cutting is the practice of removing mature timber or thinning in all of the forest area to improve the timber stand (Runkle, 1990; Seymour *et al*., 2002). Because of wide distribution of harvesting area in single tree selection cutting method, the high density of road with suitable dispersal is required. After the analysis of 48 Austrian forest roads (built between 1995 and 1999), the construction of forest road networks leads to some important results: Silvicultural strategies have changed (less clear cuts) and forest regeneration is realized in 74% by natural regeneration (Steinmüller, 2003).

Determining the efficient density for forest roads is essential to decrease the costs of skidding and road constructing in forestry plans. Therefore, the objectives of this research were to evaluate existing forest road network according to single tree selection cutting silvicultural method and to propose new network to achieve maximum coverage.

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MATERIALS AND METHODS

Site Description:

This study was conducted in the Alandan Forest, south east of sari city, Mazandaran province, Iran (53°24′00″ to 53°27′26″ E, 36°10′57″ to 36°13′56″N). The elevation of the site ranges from 1000 to 1783 m and slopes are in the range of 0 to 30%. The mean annual temperature is 10.5°C, and annual precipitation is 858 mm. The total amount of annual evaporation is 760 mm and average relative humidity is 75.2%. General texture type of soil in research area is loam. The bedrock is typically marl, marl lime and limestone. Vegetation period maintains for 7 months in average (Fig. 1).

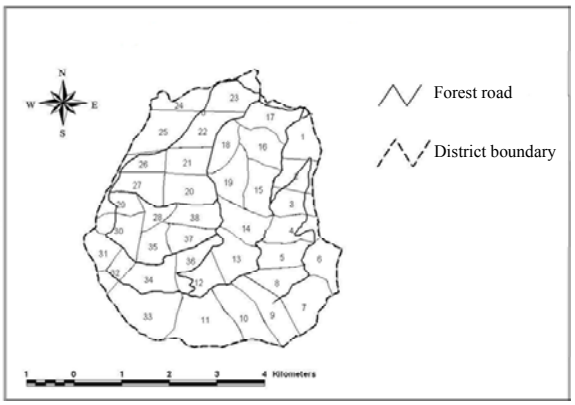

Fig. 1: The map of the study area.

Data Collection:

In this research, first the district's map was matched to the natural field after visiting the study site. Then, the current road was drawn on the map and the relevant factors were measured. The current road's length is 32400 meters, the linear road density is 15.81 mh^{-1}, and the road's coverage is %72. In the next phase in field observations, the quality of the road was evaluated and the defects were determined. Then, two different road variants were planned and drawn regarding to the effective factors on forest road planning procedure. The variants were compared together and the following variant was selected as the best choice. The road's length in the suggested road is 31200 meters, the density is planned to be 15.22 mh^{-1}, and the road coverage is %81.41.

RESULTS AND DISCUSSION

In comparing the variants, it was revealed that the current road is considered as a feasible one in terms of coverage, but in some areas, some extra paths have been constructed which are not so applicable. Those paths should be back to the nature (Fig. 2). Forest management requires a dense forest road system which combines truck roads and skidding tracks. However, harvesting machines cause damage to forest stands and soils (Ebrecht and Schmidt, 2003). An erosion and sediment pollution control plan is required for each timber harvesting operation and must be available at the site during the entire period of harvesting operations.

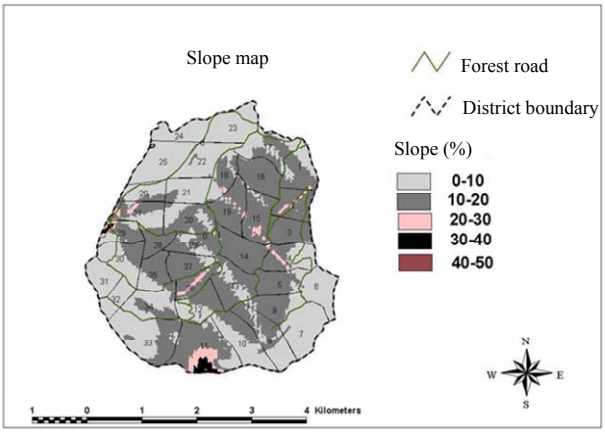

Fig. 2: Slope classes in Alandan forest.

The suggested road creates a %9.5 extra coverage using 1200 meters fewer length and 0.59 mh^{-1} fewer coverage comparing to the current road (Fig. 3). According to Figure 4 the skidding costs of Timberjack 450c and HSM reduced by increasing forest road density. Lotfalian *et al*. (2008) assumed that the effective factors in costs can be determined by using the mathematical model, as well as by the help of graphical model, less costs of skidding and road construction can be obtained; therefore, optimal road density can be evaluated. The new proposed forest roads have been shown in Figure 5.

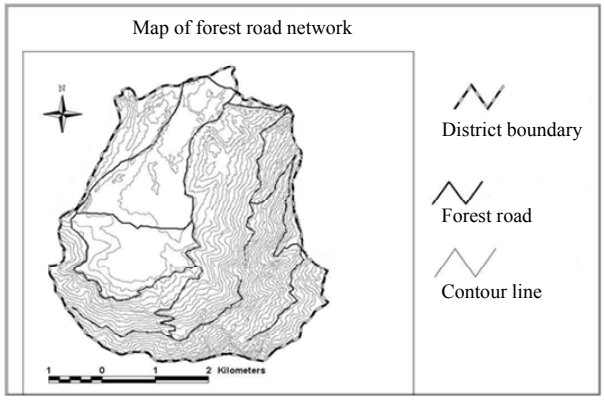

Fig. 3: Forest road network in Alandan forest.

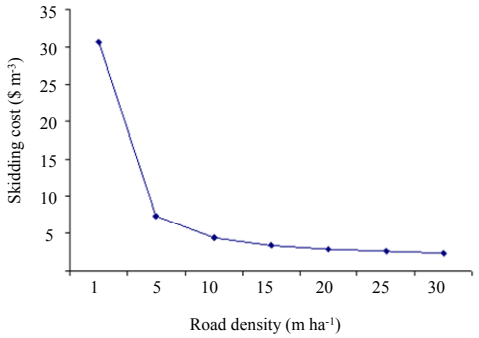

Fig. 4: Skidding cost in different densities of road network for Timberjack 450C.

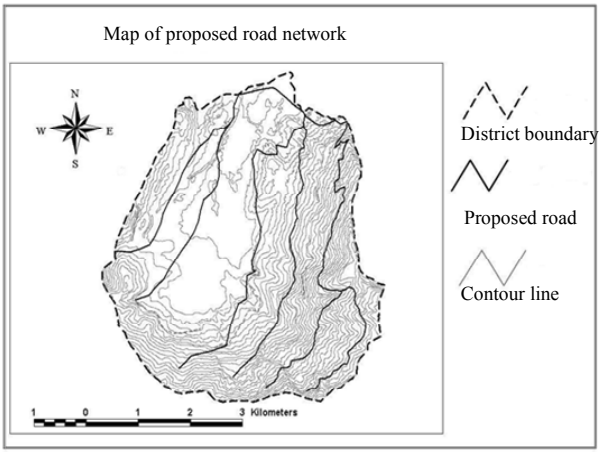

Fig. 5: Proposed road network in Alandan forest.

It was proved that the length of skid trail and consequently skidding cost of Timberjack 450c reduced by increasing road density (Table 1). This was in agreement with Rafiei *et al*. (2009) findings. He reported that the optimum road density for Timber jack 450C and HSM 904 in Dalak kheyl forest were 2-4 m ha^{-1} and 3-5 m ha^{-1}, respectively. These estimated densities were less than existing road density which was 16.1 m ha^{-1}. According to

Table 2, the network coverage less than 65% was not acceptable, while the coverage between 75% and 85% was excellent. Determining the annual traffic of the road network, it was revealed that the current traffic is less that 5 per day. Therefore, there is no need to construct he 1'st grade roads in the area and the roads should be of 2'nd and 3'rd grades (Table 3).

Table 1: Skidding cost in relation to the forest road density and timber volume for wheeled Timberjack 450C.

Density (m ha^{-1})	Length of skid trail (m)	Skidding time (Second)	Skidding cost ($)	Skidding cost ($ m^{-3})
1	6000	8041	55	30
5	1200	1897	13	7.2
10	600	1129	7	4.3
15	400	873	6	3.3
20	300	745	5	2.8
25	240	669	4	2.5
30	200	617	4	2.3

Table 2: Road classification based on network coverage (%)

Road network percentage	Description
Less than 65 %	Unacceptable
65%-75%	Suitable
75%-85%	Excellent
More than 85%	Unacceptable

Table 3: Annual traffic in Alandan forest roads.

Year	Products (Truck)			
	Log	Patches	Fuel wood	Total
2000-2001	89	78	82	249
2001-2002	14	41	19	74
2002-2003	281	311	137	729
2003-2004	22	123	27	172
2004-2005	277	282	122	681
2005-2006	119	147	89	355

Conclusion:

In summary it was concluded that if all the required roads would be constructed for the entire silvicultural revolution, the shelterwood and selection system would not be very different in terms of road distribution. However, since the logging volume in shelter wood system is many times as more as volume in selection system, the road networks are different in terms of standards.

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