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Determination of Correction Coefficient of Skidding Distance According to Existing Road Network in Lalis Forest of Iran

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Abstract

Logging and wood transportation in forest that is the most common and with the most expensive stage of forest harvest is considered as the most important aim in forest road network planning. Therefore the study that can decrease the expenses is an important step in forest road network planning. One of the factors that have an important role in logging is the average skidding distance. As a theory, this distance is calculated on map by considering the forest roads density and areas that is covered by them. This basic digit is used in calculations related to skidding expenses. This theoretical digit is always less than a real one. Therefore, in planning and study of road variants and calculations related to logging is needed that average skidding distance be used. In this case it is necessary that in each area must be gotten. In order to reach into this coefficient, measurement forest roads length and skid trails in a surface of 372 ha in ten parcels in Lalis forest plan was done. The forest roads network density in study area was calculated and the theoretical distance of skid trails was evaluated (on the map). The ending of calculating average skidding distance in its transporting and calculating with the theoretical distance of correction coefficient skidding distance in the area of researching is defined equal to F = 2.3 .

Key Words: Skidding distance . Skid trails . Forest road . Network density

INTRODUCTION

Logging is the predominant form of human disturbance in mountainous forests [8]. Many steps are involved in the planning and execution of logging operations in mountainous forests of Iran. There are approximately 1800000 ha of broadleaved temperate forest in the North of Iran, the vast majority in Mountainous area. Of this, it has been estimated that ~34% are unharvestable because they are in streamside zones or on steep and rocky terrain, or occur in special protection zones for biodiversity protection; other areas is actually available for timber harvesting [2, 10]. Forest road construction is the most costly operation in forest management. In order to choose the optimal variant with regard to costs and performance, it is necessary to evaluate road variants before construction [11]. Wheeled skidders appeared in the early 1970's and are now the most widely used in Hyrcanian forests [2]. The major problem with wheeled skidders in selective logging methods is their requirement for a dense network of roads and skid trails [10].

Harvesting methods, different types of roads, the ratio of each road to the whole network, stand per hectare, slope, geological conditions, presence of sand mine for constructing surface of roads, capital interest rate, wood exit costs, type of skidding or yarding machinery, slope and length correction coefficient, routes, type and number of load, allowable winching distance, brush and underbrush, condition of the roots, silvicultural methods (cutting form), regional soil, regional height, direction of the slope and morphology of the forest are factors which can influence on determination of roads network density and correction coefficient of skidding distance [6]. Mean skidding distance is a main factor that should be considered when we calculate the formula of reasonable forest road network [13]. The main objective of this study was to Determination of correction coefficient of skidding distance according to existing road network in Lalis forest of Iran

MATERIAL AND METHOD

Description Of The Site

The study was conducted in Lalis forest with an area of 2140 ha. The area extends from 36°29′38″ to 36°32′45″ N in latitude and from 51°23′30″, 51°28′30″ E in longitude. The mean slope of Lalis forest is about 34%. The climate is moist and cold. Altitude ranges from 1000 m a.s.l. to 2000 m a.s.l. Structure of growing stock was 75 % of beech. The terrain consists of limestone and conglomerated stone.

Measurements And Calculations

The azimuth of skid trail direction from road and depot junction to forest interior was measured by compass on each node. Real (on slope) and horizontal distance between two stakes were taken after every 20 m by meter. Moreover, the position of skid trail junction on road and depot was recorded by GPS. These skid trails were designed on topographical map using Arc GIS software. The maximum distance of winching for skidders is 70 meter. So, for each skid trail a buffer of 140

m was considered on map based on scale. The road density (Equation 1), road spacing (Equation 2) and theoretical mean skidding distance (Equation 3) in our study area was calculated by the following formula:

$$RD = \frac{L}{S} \quad (1)$$

$$RS = \frac{10000}{RD} \quad (2)$$

$$ASD_t = \frac{2500}{RD} \quad (3)$$

Where, RD is road density (m ha^{-1}), L is total length of forest road (m), S is area of study forest (ha), RS is road spacing (m), and ASD_t is theoretical mean skidding distance (m). The real mean skidding distance in our study area was calculated by the following formula (Equation 4):

$$ASD_r = \frac{\sum_{i=1}^{n} d_i(\frac{Md_i + md_i}{2})}{\sum_{i=1}^{n} d_i} \quad (4)$$

Where, ASD_r is real mean skidding distance (m), Md_i is farthest distance of skidding to depot (m), md_i is nearest distance of skidding to depot (m), L_i is mean skidding distance in each depot (m) and D_i total length of skid trails diverged from each depot (m). The correction factor of mean skidding distance (μ) was calculated from division of real mean skidding distance to theoretical mean skidding distance (Equation 5):

$$F = \frac{ASD_r}{ASD_t} \quad (5)$$

The real mean skidding distance in our study area was compared to values obtained from different coefficients of a in Segebaden equation (Equation 6).

$$S = \frac{a}{RD} \quad (6)$$

RESULTS AND DISCUSSION

One major decision in road network planning in this area is to determine under what terrain conditions ground based extraction systems should be applied. Slope and topography which affect the forest road network were considered as correction factors (terrain factor) by Segebaden [12]. Results indicated that the road density and road spacing in our study area were 15 mha^{-1} and 666.66 m, respectively (Table 1). The value of road density and road spacing was obtained as below

$$RD = \frac{L}{S} = \frac{5591}{372} = 15 \quad \text{m ha}^{-1}$$

$$RS = \frac{10000}{RD} = \frac{10000}{15} = 666.6 \ m$$

Table 1. Mean skidding distance in depots

Depot number	Total length of skid trail in meter (D_i)	Real mean skidding distance in meter (L_i)	Depot number	Total length of skid trail in meter (D_i)	Real mean skidding distance in meter (L_i)
1	218	109	13	354	148
2	158	79	14	179	89.5
3	2967	680	15	580	217
4	160	80	16	257	128.5
5	318	159	17	202	101
6	526	263	18	1569	453
7	252	126	19	740	370
8	928	350	20	1101	442
9	210	105	21	205	102.5
10	685	342.5	22	387	131
11	216	108	23	1204	444
12	789	299			

Kanzaki et al. [5] described a high-density path network in a steep mountain area which supports intensive, high quality forest in Osaka, Japan. In this network, the road density was 222.94 m ha^{-1}, correction factor of real skidding distance was 1.215 and the development percentage was 77.9%. Data showed that the correction factors approach 1.0 as the road density is increased. Heinimann [4] reported that road spacing on slopes depends on the underlying off-road transportation technology. In this study the theoretical mean skidding distance and real mean skidding distance were 166.66 m and 382 m, respectively.

$$ASD_r = \frac{\sum_{i=1}^{n} d_i(\frac{Md_i + md_i}{2})}{\sum_{i=1}^{n} d_i} = \frac{5421073.5}{14205} = 382m$$

$$F = \frac{ASD_r}{ASD_t} = \frac{382}{166.6} = 2.3$$

In this research the real mean skidding distance and theoretical mean skidding distance was measured to calculate correction factor of skidding distance. According to results of study, this factor for Lalis forest in Hyrcanian zone was 2.3 (Table 2).

$$ASD_t = \frac{2500}{RD} = \frac{2500}{15} = 166.6 \ m$$

In mountainous forests of Guilan province in Iran, the correction factor of skidding distance for the mean slope of 50% has been determined 2.72 (Mohammadalizadeh 2001). Lotfalian [7] used the coefficient of 3.1 to correct the theoretical skidding distance in Sangdeh forest of Iran. Segebaden [12] in Sweden proposed the correction factor of 2.5 for the low lying

Table 2. Correction factors for different road densities

Density (m ha^{-1})	Theoretical mean skidding distance (m)	Real mean skidding distance (m)	Correction factor
15	166.66	400	2.3152
20	125	300	2.2868
25	100	240	2.2585
30	83.33	200	2.2302

area till 4.5 for the mountainous area. According to Abegg [1] in Switzerland the correction factor of skidding distance for the flat area, hilly area and mountainous area is suggested to be 2, 2.5 and 3.5, respectively, and according to FAO [3] the correction factor was defined in the range from 1.6-2 for the flat area till more than 3.6 for the steep slopes.

CONCLUSIONS

Average skidding distance for forest stands is an important parameter for the determination of the optimum road density and spacing. Overall, the road spacing of 666.66 m in Lalis forest resulted in a theoretical mean skidding distance of 166.66 m. For a real mean skidding distance of 382 m and for the mean slope of 34% in our study area, the correction factor was estimated to be 2.3.

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