Determination of efficiency of the forest skylines in Artvin forest region of Turkey

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Abstract:
The use of mechanization techniques is very technically difficult with regards to the extraction of thin wood materials in Turkey due to about half of its forests being located in the mountainous areas. The use of mechanical tools in forestry activities is limited, because of difficult terrain conditions, forestry policy and economic constraints. Machinery used for extraction activities such as forestry tractors, cable systems and loaders were imported from abroad. The most efficient utilization of these machines is important with the implementation of forestry activities in an economic as well as environmental suitable manner. In this study the effectiveness of Urus M III (2 Units), Koller K 300 (3 Units) and Gantner (1 Unit) was examined using within the production areas of Artvin Forest Management Directorate in 2008, 2009 and 2010. Average efficiency of the machines was calculated based on monthly working hours in the year and the amount of volume produced. As a result of the research, it was found that the Urus M III was the most efficient cable yarding system on average and the Koller K 300 was one of the fastest moving.

Keywords: Wood extraction activities, Forest skylines, Mechanization, Productivity, Artvin region

1 Introduction

About half of forests in Turkey are deployed on the mountainous areas where hill slope is over 44% (SOP, 2001). Particularly, forest areas located in the East Black Sea Region are situated at great altitude on steep and mountainous terrain making extraction activities further difficult. During the extraction process, significant economic damages are inflicted on the wood material carried (Winkler, 1997; Ünver and Acar, 2009a) and on the productivity of the field; environmentally, on the residual trees and saplings (Solgi and Najafi, 2007; Ünver and Acar, 2009b), on the forest soil (Block et. al., 2002; Nugent et. al., 2003; Eroğlu et. al., 2010) and the quality of river water (Collier et. al., 2003). In addition, these activities have many risks with the difficult field conditions and the type of work being performed. Priority must be given to increasing mechanization due to increases in environmental awareness of the public, as well as improving ergonomics and ensuring that the demand for raw wood material for market is meet in both terms of quantity and type.

While the rate of mechanization used in processing raw wood materials in developed countries is around 80%, this rate is only around 13% in Turkey (Hasdemir et. al., 2007). This situation derives from the fact that mechanization techniques such as helicopter and balloon are expensive with some mechanization techniques not being suitable for mountainous conditions. 5% of mechanization techniques used in Turkey consists of forestry skylines (Erdaş and Acar, 1993). Skylines are used in and around Artvin Province, in East Black Sea Region which is dominated by mountainous terrain (Aykut et. al., 1997). Utilizing skylines systems in the most efficient way is important in terms of executing extraction activities as economically, environmentally and ergonomically.

Ledoux et. al. (2000) determined daily and annual average production of Koller K 300 mobile craned skyline at 94 m^3/day and 23 526 m^3/year respectively. Hourly production of Koller K 300 and Urus M III type skylines in East Black Sea Region was determined to be 3.31 m^3/hour and 6.73 m^3/hour respectively (Acar, 1997). Similarly, Winkler (1999) in areas where clear-cutting was used calculated the productivity

of Koller K 300 at 3.88 m^3/hour. In another study, Eker et. al. (2001) determined the productivity of Gantner type skyline to be 4.03 m^3/hour and 6.98 m^3/hour for carriage distances of 1200 m and 700 m respectively.

In this work, productivity of Koller K 300 (3 Units), Urus M III (2 Units) and Gantner (1 Unit) in Artvin locality in 2008, 2009 and 2010 were examined.

2 Material and Method

The research area is geographically located between 40° 31' 32.55" and 41° 33' 46.58" north latitudes and 41° 08' 42.10" and 42° 38' 12.01" east longitudes (Figure 1).

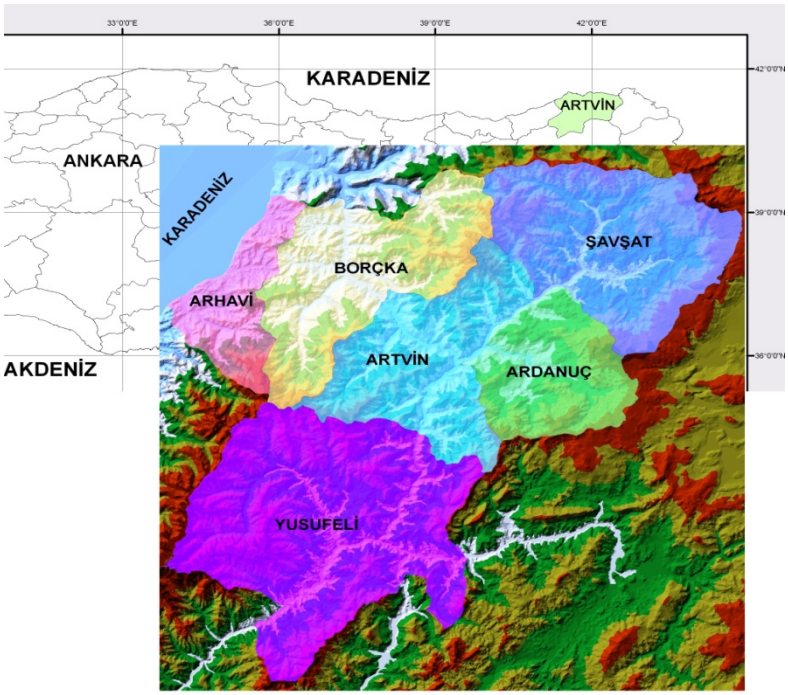

Figure 1: General appearance of research area

Average height of forests in Artvin locality is 1500m above sea level on average or higher and an average gradient of 60% or greater. Dominant tree types in the region are spruce [*Picea orientalis* L. (Link)], fir [*Abies nordmannianna* (Steven) S], Scots pine [Pinus sylvestris L.] and beech [*Fagus orientalis* Lipsky.]. There is brown forestry soil without clay in great quantities in terms of soil type. Climate of the region varies; in interior parts, continental climate dominates, whereas in coastal line, typical Black Sea climate is seen (http://artvinobm.ogm.gov.tr).

Under the structure of Artvin Forestry Regional Directorate, 120 000 m^3/year raw industrial wood is harvested on average annually. Average length of this industrial wood is 4m with an average diameter of 40 cm. Koller K 300 short distanced, Urus M III middle distanced and Gantner long distanced skylines are used in extracting woody material with thick diameters in the working area (Figure 2).

Figure 2: Koller K 300 type forestry skyline

Log extraction was either partially or completely suspended according to gradient status of the bearing field. Technical specifications of forest skylines researched in this study are provided in Table 1.

Table 1: Some technical specifications of forest skylines

Specifications	Koller K 300	Urus M III	Gantner
Carriage distance (m)	300	600	1400
Mast height (m)	4	6	-
Carriage capacity (kg)	1000-1500	1000-2500	2000
Diameter of rope (mm)	16	22-24	22-24
Length of rope (m)	350	700	1400
Diameter of pulling rope (mm)	9-14	9-14	9-14
Length of pulling rope (m)	300	600	1400
Diameter of back-movement rope (mm)	-	9-14	-
Length of back-movement rope (m)	-	1200	-
Number of safety rope (piece)	3	4	2
Diameter of safety rope (mm)	14-20	14-20	14-20
Length of safety rope (m)	20-40	40-60	-
Number of drum (piece)	2	8	1
Maximum side pulling distance (m)	50	50	50
Truck model	-	Mercedes Benz Unimog U1500	Fiat 1180 Tractor

Usage rate of each model according to usage of total skylines within the year was calculated with equality [1]. Monthly working areas and the product amounts carried by the skylines in 2008, 2009 and 2010 were obtained from transportation receipts. By utilizing such data, average production of mechanization vehicles was calculated in m^3/hour and m^3/day.

$$KO = \frac{d_x}{D} \times 100 \qquad [1]$$

Where; KO, usage rate of vehicle within year (%); d_x, is the number of the working days for each model skyline within one year (day) and D is total number of working days that all the skylines worked within one year.

3 Results and Discussion

Working days and hours, the amount of logs carried, daily and hourly average production and usage rates per year of Koller K 300, Uus M III and Gantner skylines used in Artvin Region in 2008, 2009 and 2009 are provided in Table 2.

Table 2: Average productivity of examined skylines in 2008, 2009 and 2010

Year		Koller K300	Urus M III	Gantner	Total
2008	Number of days worked	142	188	71	401
	Number of hours worked	759	1440	295	2494
	Carried wood (m^3)	2460	4255	1011	8026
	Hourly production (m^3/h)	3.24	3.16	3.43	-
	Daily production (m^3/day)	17.32	24.23	14.24	-
	Usage rate (%)	35.41	46.88	17.71	-
2009	Number of days worked	208	140	63	411
	Number of hours worked	1332	1133	237	2702
	Carried wood (m^3)	3080	2687	1121	6888
	Hourly production (m^3/h)	2.31	2.37	4.73	-
	Daily production (m^3/day)	14.81	19.19	17.79	-
	Usage rate (%)	50.61	34.06	15.33	-
2010	Number of days worked	298	154	105	557
	Number of hours worked	1144	1285	422	2851
	Carried wood (m^3)	2762	4015	1779	8556
	Hourly production (m^3/h)	2.41	3.12	4.22	-
	Daily production (m^3/day)	9.27	26.07	16.94	-
	Usage rate (%)	53.50	27.65	18.85	-

Results obtained from the study were found to be similar to the work done by Acar (1998) and it is determined that Urus M III has the highest daily production for three years. While Urus M III model skyline was used the most in 2008, Koller K 300 was the most used in the other two years. While the use of Koller K 300 increased according to years, there was decrease in the usage rates in the other skylines. Skyline with the highest hourly production for three years was Gantner, whereas the skyline with the highest daily production was Urus M III model.

The season when skylines were most used over the three years was between June and November. The highest volume in 2009 was hauled with Koller K 300, whereas the highest volume in the other two years was hauled by Urus M III model skylines.

4 Conclusions and Recommendations

In the study, it was determined that efficiency of forest skylines used in Artvin region varied. This situation arose out of the fact that some mechanization vehicles were not being utilized as they had broken down. For this reason, mechanization vehicles to be used for the wood extraction seasons should be subject to a general maintenance standard in order to reduce work downtime.

It is necessary to control each part of forest skyline systems which take time to be ‘landed’ on the ground and which are adversely influenced by open air conditions before they ‘hooked up’ with wood. In addition, in order to prevent productivity losses by keeping the skyline carriage waiting, chokers should be pre set on the ground after the volume of wood reaches to an optimum volume.

It would be best to use the Koller K 300 for carrying lighter loads and the Urus M II for carrying heavier loads. Efficient use of mechanization vehicles are in direct correlation with the information, skills and professionalism of operators. For this reason, operators should be kept subject to good training and enabled to have certificates.

Before skylines are established in the field, a good field study should be done and the shortest and the most suitable route through which the product can be transported close to the road should be determined and skylines should be located accordingly. In addition, good working rates and productivity should be reached by considering working conditions such as type of skyline used, field conditions and number of workers in order to have efficient and productive work.

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