A Skyline Yarder Model Design Approach for Turkish Forestry

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Abstract:
Timber harvesting is a difficult, dangerous and expensive operation. A suitable machine power should be used for economic and safety work. In past decades, few number of skyline yarders have been bought from abroad companies and used. But, approximately all of them have been completed their economical life and out of order. Today, there is not any skyline yarder for primer wood transportation in Turkey.
These machines can be manufactured by local companies in Turkey. However technical qualification of the skyline yarder such as effective working distance, hauling capacity power and cost ext. must be determined. This study was prepared for determining the technical qualification of the model skyline yarder which is useful for Eastern Blacksea region in Turkey.
Forest sites topographical features, forest road network layout, forest stand types, average skidding distance, average weight of harvested logs, average log volumes and numbers of per collecting points will be investigated for model skyline yarder. The skyline yarder features can be configured according to investigation results.
There is an important market potential in Turkish forestry. If an appropriate skyline yarder can be manufactured lower cost, foresters produce lower cost logs.

Keywords: Wood transportation, Skyline, Yarder models, Yarder design, Manufacture

1 Introduction

One of the branches of science with technological developments is forestry. Forestry must always change in itself. 2000 years ago, "the observations of the hill" was being made for determining of iron mines. At the same times, natural wood raw material needs of persons were being supplied for housing, at a later date, the increase of positive changes in the needs of human beings cause. In addition, the use of developing technology in forestry, was not limited only this. Forestry should be treated as the most important task to see the reestablishment. This shows us both structure of forestry and structure of humanity as the basic of science. So Forestry mechanization maintained a permanent way with the principle that is EES. These principles, "Ergonomics, Economics, Safety".

Forest areas transforms to steep terrain and mountainous day by day because many mistakes was made and people have used limited resources as unlimited. This situation also affects the environmental factors. A live system to ensure continuity in the ecosystem, forestry, science and techniques appropriate to the applied methods, it has become necessary to use a natural structure as a model of analogy. In this case, harvesting has become an important factor to supply the needs of forestry.

As the needs of society increase about forest products, to respond to these needs and to deliver higher quality product to the buyer as soon as possible, transportation has become more important than before. Shortage in the wood raw material in our country, growing rapidly every year. As this shortage increase, forests in our country is decreasing. Although forest products are value today, transport studies must be done regularly to keep quality and quantity losses in minimum level (Aykut and Ozturk 1999).

Since 1967, the ergonomic design of large forestry machines has been the subject of continuous study. Ergonomic guidelines have been developed and successfully introduced to the manufacturers of

themachines and to the forest industries. Manufacturers have implemented comprehensive ergonomic improvements. Operator workspace, visibility, lighting, operator's seats, mounting and alighting, cab climate, and service of machines have been improved. Noise and vibration levels have been reduced. The risk of accidents is slight. In many respects, the ergonomic standard is now good (Hansson, 1990). A Health Risk Program for forest work has been developed in order to improve health risk identification by systematic evaluation of the relationships between work and health complaints, and to create a base for decisions on different actions to reduce the health risk (Axelsson and Ponten, 1990). Some of skyline harvesting problems identify several studies (Lysons and Twito, 1973; Cummins, 1977).

This paper was prepared to define a methodology for model skyline yarder features for Eastern Black Sea region of Turkey.

1.1 Wood transportation

Transport is a must for the transport of forestry products. The continuity and sustainability of the forest continue with transport operations, at the same time these operations are important for the necessity of silvicultural interventions. Transport processes is divided in itself into two part as primary transport and secondary transport. Primary transport is seen as the extraction process from forest zone. In the place where trees are cutted namely it is process that logs are taken from the place and are transported to the nearest forest road or main warehouses. Secondary transport; wood raw material on the roadside or temporary collective areas, is to be transported to the temporary and main warehouses.

Forest skylines, the primary factor of production, are the subject of the primary transport. “the process of extraction from zone is just an election” is wrong as an idea because it is not a choice, it is result of application duration that is decided the most effectively. The most influential factors in this duration are transport distance and terrain slope. In addition, other factors are log size, productivity, production costs, silvicultural intervention or the severity of cutting applications, the distribution of product to be transported in the forest, topographic limitations, existing roads and forest distribution. When the slope of terrain is a general problem, mechanization is used.

1.2 Skyline yarders

Skylines are motor-assisted mixed systems equipped with steel cables, they deliver forest products on air (with hanger) in limited distances. The most important phase of extracting from area is harvesting of area. Skylines may harvest larger areas in the Eastern Black Sea region because of the slope. Provides many pluses in terms of silvicultural and ecological balance. Not be used anywhere at any time, such as skyline, use cases should be avoided. Eastern Black Sea region, if necessary, provide information about the situations in which the necessity of the use of skylines:

⇒ Given the multiplicity of ways in Eastern Black Sea region, the skyline should be used from slope roads where underway of roads. Skylines are not to bring the forest service but they are intended to take more time.
⇒ Regions have more the cost of road construction is not economical in region. Because Eastern Black Sea region, In this regions, we should be preferred skylines instead of road construction.
⇒ Should be used Skylines in Eastern Black Sea region where road density is not sufficient, in places.
⇒ Skylines is benefit from a shield is required for lighting cutting and unloading cutting parts of operating area. Thus, when the stand are the least harm, would not intervene. This is also provides every kind of biological life for entering a new field rejuvenation
⇒ Where the workforce is not enough, skylines should be established for the opening of the forest operation.
⇒ Erosion hazard is skid forest products reason that created dangers by the Eastern Black Sea Region of the slope. Air lines should be established to eliminate this situation.

Depending on this information in the Eastern Black Sea Region, Slope steepness and condition of forest roads is not sufficient. It is the main reason for the establish of skylines and topographic factors can affect the skyline facilities.

2 Material and methods

2.1 The structure of general forest and land in eastern black sea region

Eastern Black Sea Region, located north-east of Turkey and covers reputation of 4.3% for the general area of the country. Trabzon, Rize and Giresun provinces in Eastern Black Sea coastline. Gümüşhane, Bayburt and Artvin provinces remain further inland in this region (Turker and Toksoy 1989; Anonymous 1997).

On the other hand the average land slope is above 65% of the Eastern Black Sea region, the dominant vegetation is the forest. As the climate and tree species, forest structure is suited to be the richest regions of Turkey. (Acar and Senturk 1999).

Table 1: Earstern Black Sea region forest types and areas distribution according to province*

Province	Normal (Fertile)			Damaged (Infertile)			Total Forest [m^3]
	Coniferous [m^3]	Leafy [m^3]	Total [m^3]	Coniferous [m^3]	Leafy [m^3]	Total [m^3]	
Trabzon	56795.9	94753.9	151549.8	16110.4	29274.2	45384.6	196934.4
Giresun	57984.0	59859.5	117843.5	50060.0	72440.5	122500.5	240344.0
Rize	27011.6	38827.0	65839.5	32501.0	61665.2	94166.2	160005.7
Artvin	199979.5	2644.0	202623.5	129722.2	66925.5	196647.7	399271.0
Gümüşhane	53625.9	9154.8	62780.7	71915.1	47610.5	119525.6	182306.3
Bayburt	1521.8	2334.8	3856.6	5674.2	4633.7	10 307.9	14164.5
						Total	1 193 025.2

* This table has been arranged by databases of Easter Black Sea Region Development Project (DOKAP).

Looking at the condition of forests in the eastern Black Sea, Trabzon, Artvin and Giresun provinces are important places for forest trees. Provinces of Gümüşhane Bayburt and Rize are no more subject for production forests. In this case, the production work of the Eastern Black Sea region, sufficient to demonstrate that most provinces in which a data source.

Eastern Black Sea Region is composed of forests, coniferous and broadleaved species. Province of Trabzon and Rize have mixed-leaf and coniferous forests. But Coniferous trees are prodominant in Gümüşhane. In Easters Black See Region have trees thats are picea, pinus, abies, alnus, casteanea, carpinus, quercus, fagus and this trees consists of the main tree species (DOKAP 2012).

The wealth is wood forests of Eastern Black Sea Region, as the average of 99.8 m3 per hectare, while the average amount of 45.9 m3 at the beginning of our country. According to these values, we planted trees per unit area the forests of the region's wealth, more than double the national average. in parallel standing tree with wealth, the amount of the annual growth of forests in the region is over the country (Turker 1996).

Table 2: Forest products distribution into wood types according to forest headquarters*

Type	Coniferous [m^3]			Leafy [m^3]			Total
	Artvin	Giresun	Trabzon	Artvin	Giresun	Trabzon	
Log	120000	95600	40000	60000	56400	10000	382000
Wire Pole	0	1500	500	0	0	0	2000
Mine Pole	2000	5500	6200	2000	1000	300	17000
Timber	3000	2000	4200	7000	8200	1300	25700
Other Inds. Wood	226200	288400	122100	89800	291600	30900	1049000
Firewood	110000	48000	17100	90000	47000	22900	335000
Total	461200	441000	190100	248800	404200	65400	1810700

*From databases of General Directorate of Forestry of Turkish Republic (GDF)

In Studies of production in the Eastern Black Sea Region, the data are also given to up for 2012.

2.2 Forest road network

Forest lands of forest roads that are required to take advantage of the most appropriate way. Planning, implementation and maintenance of forest roads is costly, the optimal way for Turkey is 500 m in range. The road network system established and developed a method of transport with evaluation of these data.

2.3 Existing skyline models

Generally, skylines used at the Black Sea Region that have very high slope in our country. Mechanization is an important tool for skylines for continue its activities to the science of forestry transport inaccessible slopes of the eastern Black Sea and western Black Sea. There are several skyline models in Turkey. But all of them are out of their economical life. There is not new machine.

Koller K300 for use in the Eastern Black Sea region, there are air lines URUS MIII and Gantner. The air lines URUS MIII, as mounted on Unimog Mercedes truck 1500 T and transportation can be a distance 600 m. These distances can be done from the bottom up and top-down transport. Gantner Skyline, is used throughout the region. It has a slide-out class as not other air lines mobile. Transport distance of 800 meters up the mountain for the station and includes appropriate.

Due to the lack of structure is more suitable for mobile and mountain stations, due the transportation of timber types, effective use is not provided. K300 sky lines, short-range forest air lines. It transporting maximum is 300 meters distance. In terms of transport distance, it unable to meet the needs of the region (Aykut 1986).

Hinteregger URUS MIII in terms of cost ($ 24.66 / h) according to Koller 300 N (9.17 $ / hour) is shown in more expensive in terms of higher yield (3,795 m3). So when URUS skyline is attention with strong, new and costly, Koller had an effect on the yield with taking a series of air-line (Acar 1996).

URUS M III is used not working state in 1904 hours (238 days) in the region, K 300 has been exposed in this state 1311 hours (164 days). The machine can not operate all year because of weather conditions URUS M III effective of not working day 79.7%, other hand the rate of 90.4% for Koller K 300. Both air line have Inability to work. while there is technical structure in operator the ability to be in need of repair, a factor in the forefront of being in need of repair rate of 5% URUS M III, other hand, Koller K 300 was effective in 10.4% (Acar 1996).

According to this, URUS M III which is mounted T mercedes on a Unimog truck 1500 influenced by weather conditions in the field have worked for less time, especially it need to repair less Koller K 300, caused that technical superiority of the new model and Koller K 300 (Acar 1996).

Tower cranes are available in a wide variety of types, sizes and capacities. As in any other type of crane, lifting capacity is one of the more important considerations. However, length of reach (radius), maximum hook height above ground and the crane's positioning also factor into the selection (Proctor, 1995).

2.4 Method

All of the work machines must have principles ergonomics, economics and safety as well as productive. Stirler have been identify cable equipment factors as physical considerations that are terrain factor such as slope, profile and extraction location, stand data, economic, environmental considerations, management implications and safety (Stirler, 1980).

To define model skyline yarder elements some of data should be used. In this study, forest sites topographical features, forest road network layout, forest stand types, average skidding distance, average weight of harvested logs, average log volumes and numbers of per collecting points was determined as should be investigated data for model skyline yarder.

3 Results and discussion

Turkey forestry required for use of skylines for both forest products, and infrastructure capabilities as terrain conditions. The problem here is to be imported machinery costs. Forest workers are limited possibilities of expensive machinery. For this reason, should be performed with use of domestic production and encouraged to use skylines.

Primarily this is required that produced modeling of the skyline and determined the technical characteristics. Within production facilities, the subject of skyline should be this focus:

⇒ The optimum transport distance of the Eastern Black Sea's forest, the optimum slope, optimum cut volume will be identified. After that analysis with statistical this and the maximum and minimum levels of transport distance should be determined.
⇒ Due to problems created by the Eastern Black Sea region of topographic structure, determination of machine power should be determined with experiment and measurement and different timber types.
⇒ Skylines should be determined in accordance with effective operating range in Turkey (500 m). Thus, every unit in the production areas, harvesting can be done. Transport distance should be set in a good way. Depending on the power cable and density of the engine, It is produce that must be provided according to the density of forest roads.
⇒ The direction of transport is an important feature in skyline. Skyline must be designed to move in either direction.
⇒ Further development of technology, it should be added new innovations such as automatic braking system and remote control in the management console. Thus, the machines make it possible to become more ergonomic.

4 Conclusions

After all features determined the prototype skyline model should be designed and manufacture in Turkey. It must be submitted as soon as possible the use of forest workers by performing a local forest.

5 References

Acar, H.H., 1996: Giresun orman bölge müdürlüğü üretim araçlarının teknik ve ekonomik açıdan incelenmesi (Investigation of production machines according to technical and economical aspect on Giresun Forest Headquarters, Tr. J. of Agriculture and Forestry 22, p. 143-149.

Acar, H.H., Şenturk, N., 1999: Dağlık ormanlık alanlardaki üretim çalışmalarında mekanizasyon (Mechanization on production studies on mountainous forest lands), Journal of Faculty of Forestry of Istanbul University 46, (1) p. 76-94.

Anonymous, 1997: Doğu karadeniz bölgesi'nde orman köylerinin sorunları ve çözüm önerileri) Forest village problems and solution proposals on Eastern Black Sea Region (Panel), Trabzon, Turkey.

Aykut, T., Ozturk, T., 1999: Vinçli hava hatlarında yapılan zaman etüdleri ve sonuçları (Time investigation on cable yarding and the resuts obtained), Journal of Faculty of forestry of Istanbul University 49 (2), p. 61-73.

Aykut, T., 1986: Orman ürünlerinin taşınmasında kullanılan kablo hatlar (Cable lines used transportation of forest products), Journal of Faculty of Forestry of Istanbul University 36, (1), p.78-84.

Axelsson, S., Ponten, B., 1990: New ergonomic problems in mechanized logging operations, International Journal of Industrial Ergonomics 5, (3), p. 267–273.

Cummins, Leo K., 1977: Landing geometry and spar lift capability, Journal of Forestry 75,(12), p. 770-773.

DOKAP, 2012: Databases of Easter Black Sea Region Development Project.

Hansson, J. E., 1990: Ergonomic design of large forestry machines, International Journal of Industrial Ergonomics 5, (3), p. 255–266.

GDF, 2012: Report of forest products sales amounts.

Lysons, H.H., Twito, R. H., 1973: Advanced logging system-III: Skyline logging: An economical means of reducing environmental impact of logging, Journal of Forestry, 71, (9), p. 580-583.

Proctor, J.R., 1995: Selecting tower cranes, Civil Engineering 65, (2), p. 52-56.

Stirler, D.J., 1980: Amethod of selection of cable harvesting machines for Vermont, Master thesis, Oregon State University.

Turker, M.F., Toksoy, D., 1989: Doğu Karadeniz ormancılığında halkla ilişkiler (Public relations at Eastern Black Sea Region forestry), Turkish Journal of Forest Engineering 11, p. 37-40.

Turker, M. F., 1996: Açık arttırmalı orman ürünleri (tomruk) satışlarında fiyat oluşumunun araştırılması (Doğu Karadeniz örneği) (Investigation of price formations at auction selling of forest products (log), Karadeniz Technical University, Research Found Project Report, 106 p., Trabzon