Eur J Forest Eng 2016, 2(1): 48-53

Helicopter Logging Method for Reduced Impact Timber Harvesting Operations*

Abdullah E. Akay, Ebru Bilici**

Bursa Technical University, Faculty of Forestry, 16330 Bursa, Turkey

Abstract

Traditional timber harvesting methods can result in serious impacts on vegetation structures, soil properties, and biodiversity in forested areas. Helicopter logging provides important advantages of implementing environmentally friendly harvesting techniques. However, the cost of helicopter logging can be much higher than that of ground-based logging due to high equipment costs, maintenance costs, the cost of flight crew, and fuel costs. Thus, the helicopter logging operation should be carefully planned to implement cost effective and environmentally friendly logging operations. In this study, the stages of helicopter logging and operational factors were first described, and then the operation cost, environmental concerns, and safety practices in helicopter logging were discussed. It can be concluded that the helicopter logging can be effectively used for extraction of timbers especially from environmentally sensitive areas where road construction and logging operations are restricted. In fact, helicopter logging may be the only option to solve timber extraction problems in difficult terrains with steep slope.

Keywords: Forest harvesting, Reduced impact logging, Helicopter logging

1. Introduction

Helicopter logging is an aerial harvesting method in which forest products are removed vertically from the stands and flown to the roadside landing areas (Chua, 2001). Helicopter logging can be considered as a common method in the Pacific Northwest of the USA and in western Canada in timber production (Akay et al., 2008). Amount of timber harvested by helicopter logging is about eight million cubic meters per year in British Columbia in Canada (Dunham, 2006). They are preferred by logging managers for harvesting timbers from difficult steep sites and sensitive forest lands, and for accessing unreachable areas due to terrain conditions or remoteness from the road network.

Helicopter logging, also called as helilogging, has been employed since early 1970's as a reduced impact logging method. Even though logging with helicopter costs more than other logging systems, the use of this alternative method continues to expand in forestry. Helicopter logging provides logging managers with important advantages.

Helicopter logging method requires less road constructions, reduces soil disturbance, and minimizes logging related sediment production as well as damages on residual stands and other forest vegetation. The helilogging operations provide access to remote and difficult terrain that cannot be reached through ground transportation. In general, helicopter logging method increases productivity by producing large amount of logs quickly. Besides, it provides better working conditions in terms of worker health and safety. Furthermore, visual impacts from harvesting operations can be minimized by implementing helicopter logging (Aust and Lea, 1992; Akay et al., 2008).

On the other hand, logging managers should consider potential downsides of helicopter logging methods. For example, the helilogging requires high investment and operating cost, needs large landing areas, and demands for trained and experienced personnel. Previous studies and past practices also indicated that helicopters cannot operate under difficult weather conditions (Bruce, 2003; Akay et al., 2008; Dunham, 2006). In order to overcome downside of helicopter logging, the logging operation should be well-planned and logging equipment should be carefully selected to minimize cost and reduce environmental impact. There are various types and sizes of helicopters which have been employed during logging operations (Figure 1). The specifications for the most common logging helicopters are indicated in Table 1.

---

*This work has been partially presented in FETEC2016 Symposium

**Corresponding author: Tel: +90 2243003426 E-mail: abdullah.akay@btu.edu.tr

Received 14 October 2016; Accepted 30 October 2016

Figure 1. Some of the helicopters used in logging operations (Akay et al., 2008; URL-1)

Table 1. Specifications for some logging helicopters (Dunham, 2006)

Make/Model	Rated payload capacity (ton)	Engine Power (kW)
Bell 204B	1.8	820
Bell 204A	2.3	1044
Bell 212	2.3	671
Bell 214B	3.6	2185
Boeing V-107 II	4.8	932
Boeing CH-234LR	12.7	3039
Sikorsky S-64E	9.1	3356
Sikorsky S-64F	11.3	3579
Eurocopter A-Star B2	1.2	732
Eurocopter SA-315B Lama	1.2	640
Kaman K-1200	2.7	1342
Kamov KA-32A	5.0	1645
Sikorsky S-58T	2.3	700
Sikorsky S-61N	3.6	1044
Sikorsky S-61N Shortski	4.1	1044

2. Helicopter Logging

Extraction of forest products by helicopter logging system starts with felling and bucking operations. Then, operation continues with yarding cycle that includes outhaul, hooking, inhaul, and unhooking stages. Helicopter logging also requires service cycle which involves flying to service area for fuel, the process of refueling and any maintenance activities at landing area. In helicopter logging, there are usually two pilots; one for flying the helicopter and controlling the lifting cable and other for the monitoring instruments of the helicopter (Chua, 2001).

2.1. Felling and Bucking Stages

The felling operations should be well planned ahead of time, coordinated by the timber operators, and proper felling techniques should be implemented during the operation. Felling of trees is usually done couple weeks prior to scheduled arrival move in time of the helicopter because the felling by chainsaw has lower production rate comparing with capacity of logging helicopters (Stampfer et al., 2002). Due to difficult terrain conditions, average of five trees can be cut by felling crew of two people per day (Hui, 2001). There is another system, called fly-in feller-buncher, in which a custom-built feller-buncher is delivered to the woods by aerial transport in pieces and rebuilt at stump. This system is used in British Columbia for harvesting second and third growth timber (Dunham, 2006).

After felling operation, trees are generally bucked into suitable log sizes according to the payload capability of the helicopter. Besides, log lengths and grades desired by the market should be considered during bucking operation. For each cycle, designated logs should be marked to make them easily visible by the pilot (Hartsough et al., 1986). To ensure safe lifting operation, any obstacles around pre-bunched logs should be cleared (Chua, 2001).

2.2. Yarding Stage

A typical yarding cycle of the helicopter logging operation includes flying outhaul to the harvest area, hooking the logs in woods, flying inhaul loaded to the landing area, and unhooking logs at the drop zone. At the beginning of the yarding cycle, helicopter moves in to the woods where trees are fallen and drops the lifting cable which is located under the helicopter.

There are three types of rigging systems including grapple, load-hook, and standing stem (Dunham, 2006). The logs are commonly carried by a grapple or load-hook positioned at the end of a lifting cable (Akay et al., 2008). The length of lifting cables ranges from 75 m to 100 m (Hui, 2001). There are various grapple control systems such as electrical, hydraulic, or mechanical. The grapple allows the pilot to include trees unassisted. During hooking stage, a grapple or load hook should be dropped at the point where logs are located, which requires experienced and well trained pilots (Sloan et al., 1994). Generally, logs are pre-choked on the ground by choker setters. A logger, called hooker, grabs lifting cable and slides the chokers into the hook suspended below the helicopter (Figure 3). In some applications, lifting cable attached with double load-hooks that ensure optimum utilization of the helicopter reach and also allow pilots to release part of the load when it exceeds the payload capacity (Krag and Clark, 1996).

The standing stem is another rigging system that can be employed to carry high value timber from the woods or to extract mature trees from environmentally sensitive areas. In this system, full length trees are extracted from the standing position (Dunham, 2006). Trees are first delimbed, topped by chainsaw, and cut at the bottom (cut up), then carried by using a horizontally oriented grapple (Figure 2). After picking up the logs, the helicopter moves up vertically to lift the logs off of the ground and over the forest canopy (Stampfer et al., 2002). Logging crew should always stay clear when helicopter is climbing up after loading for safety purposes.

Figure 2. The hooker attaching chokers to the lifting cable attached with double load-hooks (left) and helicopter grapple (right) (URL-2)

In the inhaul stage, helicopter caries the logs from the hooking point to the landing area. For each trip, logging helicopter should carry optimum payload which is slightly less than maximum load capacity (Akay et al., 2008). Payload capacity is mainly adjusted based on temperature and altitude. Christian and Brackley (2007) reported that the optimum payload for Sikorsky 61N helicopter is about 3400 kg when flying at elevation up to about 900 meters. It is more convenient to carry heavy logs when the air temperature is the coolest and air is dense. It is also suggested that heavy logs should be extracted near the refueling cycle since total weight of the helicopter will be lower (Chua, 2001).

At the final stage of yarding cycle, the pilot flies back to landing area and gently places the logs on the ground in the drop zone (Figure 3). Then, chaser releases the chokers from the hook at the landing. For operation take place in coastal regions, logs can be also dropped water drop zones located in salt water adjacent to harvest area (Figure 4). Water drop zones should be away from the main water traffic route. Minimum water depths in drop zone and log storage are 30 m and 20 m, respectively (BCTS, 2009).

Figure 3. Placing logs at the landing (URL-2)

Figure 4. Water drop zones used in helicopter logging

After releasing the logs, the pilot manoeuvres the hook, clears the landing area, and returns back to the woods for the next turn. The yarding cycle usually continues for 60 to 90 minutes till refuelling of helicopter (URL-2).

3. Operational Factors

3.1. Yarding Distance

To perform productive and cost effective helicopter logging operations, logging managers should carefully determine the optimum flying (yarding) distance which is usually kept within two kilometers from the drop zone (Akay et al., 2008). Yarding distance can be defined as the flight path of the helicopter from the landing area to the harvesting unit. The main factors that affect yarding distance are elevation differences between landing and log pick up location, wind direction, and natural or manmade obstacles (i.e. hills, power lines, etc.) in the region (URL-3).

The flight distance increases as elevation between landing and log pick up point increases. Wind direction negatively affects operation, especially unhooking stage over landing area. The obstacles in the region prevents pilot to fly straight-line flight path. In order to minimize adverse effects of these factors, location of the landing area has to be properly determined prior to operation (Hui, 2001). Besides, enough space should be provided for piling logs, servicing helicopter, etc. at the landing area (Akay et al., 2008).

3.2. Weather

Helicopter logging is susceptible to poor weather conditions such as strong wind and fog. It becomes very difficult to operate logging helicopters during windy weather (more than 55 km/hr) conditions (URL-3). Foggy weathers cause serious problems when they affect visibility of pilots. Deep snow and heavy rain makes it impossible for ground team to work in woods. In order to minimize weather effects, helicopter logging operations should be carried out in late spring, summer, and fall seasons (Dunham, 2006). Besides, local weather broadcast should be regularly obtained to determine appropriate time for helicopter logging.

3.3. Crown Closure

The cycle time of helicopter logging is negatively affected by high crown closure because less wood is being removed from unit area (URL-3). In stands with high crown closure, longer chokers are used to collect logs from a greater lateral distances, which results in slower lifting operation. Pilots often spend longer time to find the hooker on the ground. Besides, pilots slow down the lifting operation to prevent residual stand damages.

3.4. Wood Availability

The helicopter logging is very productive extraction method; however, it is an expensive operation which requires proper planning, coordination, and monitoring activities (Hui, 2001). It is crucial to make optimum payload ready for each cycle to ensure high volume per turn and fast cycle times. First of all, felling crew has to select appropriate trees to be cut and buck them into log lengths considering payload capacity of helicopter. Then, choker setters pre-set chokers on available logs to be extracted. Finally, the hooker has to make sure that the helicopter is loaded by a full payload capacity for each cycle. Therefore, providing optimum payload for each cycle highly depends on wood availability in harvest area. It was reported that a wood availability of less than 80% is considered as low helicopter productivity (URL-3).

4. Production Rates and Costs

Helicopter logging provides very high daily production rate comparing with other logging methods. Wang et al. (2005) reported that the production rate of helicopter logging was 1.5 to 2.8 times more than ground-based harvesting methods. The critical parameters that affect the productivity of helicopter logging include timber volume per unit area, stem volume, and optimum payload capacity (Heinimann and Caminada, 1996). A minimum amount of timber volume required for a helicopter logging is estimated as 10000 m3, considering the cost of planning, reconnaissance, cruising and layout work (BCTS, 2009). The rated payload capacity of various helicopter types ranges from 1.2 ton (e.g. Eurocopter A-Star B2) to 12.7 ton (e.g. Boeing CH-234LR) per turn (Dunham, 2006). The actual weight of tree species should be considered since a m3 of coniferous tree weight less than that of a deciduous tree.

The production rate increases by an experienced ground crew and pilot (Hartsough et al., 1986). An experienced helicopter pilot potentially increases productivity by 63% (Stampfer et al., 2002). Besides, the productivity of the helicopter logging is affected by yarding distance which directly reflects cycle time. Average yarding distance is usually under two kilometers, but it may slightly vary based on helicopter types. For example, optimal yarding distance is 600-800 m for Skycrane helicopters while it is about 1000 m for Bell 214B helicopters (BCTS, 2009). The production of helicopter logging is also affected by rigging systems. It was reported that productivity of load-hook system is 20-30% more than a grapple system, and 5-15% less than standing stem system (Dunham, 2006).

The helicopter logging is generally more expensive than ground-based harvesting systems due to high ownership cost, operating costs, and higher labor costs of felling crew (Akay et al., 2008). The ownership and operation costs of logging helicopter comprise half of the total harvesting cost (Dunham, 2006). Hui (2001) reported that helicopter logging cost is twice the tractor harvesting cost under similar difficult terrain conditions. The cost of helicopter logging is mostly affected by the loading operation, flying distance, and pilot experiences (Sloan et al., 1994). In another study, Sloan and Sherar (1997) reported that the main factor affecting the operation cost was estimation of suitable payload sizes. To overcome the high costs, the amount of material removed per turn should be maximized and the time per turn has to be minimized (URL-3).

5. Environmental Concerns and Work Safety Issues

Helicopter logging provides logging managers with advantages of environmentally friendly harvesting practices and safer work conditions for the loggers. Besides, it enables access to unreachable areas due to extreme terrain conditions or remoteness from the road network (Bruce, 2003). Helicopter logging can be only option to extract mature trees in environmentally sensitive areas where road construction and logging operations are restricted (Akay et al., 2016).

Table 2 indicates comparison of some harvesting methods with respect to environmental concerns and work safety issues. Using helicopter logging reduces soil disturbance, minimizes sediment yield to streams, and protects water resources by reducing forest road, skid trails, and cable corridors (URL-3). Compared with ground-based harvesting methods, helicopter logging increases the woody biomass regrowth and minimizes undergrowth damages (Aust and Lea, 1992). Besides, it reduces damage to residual trees and forest vegetation, especially during selection cutting systems. Thus, helicopter logging can be implemented as reduced impact logging system especially in environmentally sensitive areas such as high-use recreational areas, special wildlife areas, archeological sites, and sensitive landscapes.

In terms of work safety and occupational health issues, helicopter logging cause potential noise effects on loggers. Logging crew should be provided with necessary ear protection equipment during operations. The ground team always needs to stay clear of flight paths. The landing areas are the most risky area during helicopter logging; thus, it should be properly organized and should have enough space to ensure an efficient and safe logging operation (Akay et al., 2008). According to OSHA requirements, drop zones should be at least twice the length of logs and located at least 40 meters from the loading and decking area. Besides, number of loggers on the landing area should be kept to a minimum during dropping logs (Hui, 2001).

If there is powerlines around harvesting unit, landing areas and log pick-up points should be at least 60 meters away from the power lines (URL-3). Poor weather conditions increase the risk of accidents due to mechanical failure or inexperienced pilots (Figure 5). The helicopter should be regularly maintained to prevent mechanical failures during flights.

Table 2. Comparisons of various harvesting systems (adapted from Akay et al., 2016)

	Helicopter Mi-8 MTV	Skidding CAT TT-4	Cable system ML-43	TJ Harvester1270 TJ Forwarder 1110
Forest roads, check	-	√	√	√
Undergrowth damage, %	0	80	75	60
Soil deterioration, %	0	100	80	100
Noise affect, %	100	100	50	100
Safety of work, %	0	50	80	50

Figure 5. A logging helicopter crashed in Oregon at a logging site (URL-5)

6. Conclusion

Helicopter logging provides important advantages over ground-based harvesting methods regarding with reduced impact logging procedures. The total forested area affected during logging operations is reduced by helicopter logging. Helicopter logging results in minimal damages on residual stand and other forest vegetation. Helicopter logging requires less road constructions which reduce damages on forest soil and minimize sediment yield to water bodies. Besides, visual impacts from harvesting operations can be minimized by helicopter logging.

Implementing helicopter logging, it is possible to extract longer and larger logs with high quality and sale price, while it is not possible to extract those logs using ground-based harvesting methods or to transport them through low-standard forest roads in Turkey. Forested areas located in remote and difficult terrain cannot be reached through ground transportation while these areas can be accessed by helicopter logging. Also, helicopter logging operations provide better working conditions and ensure worker health and safety.

The disadvantages of helicopter logging include lack of well-trained and skilled loggers in forest industry in Turkey and potentially high initial purchase price and operation costs of helicopters. Although there are several helicopter companies that produce special helicopters for logging operations there is still need for alternative types of helicopters to improve productivity and reduce total cost of helicopter logging operations.

Helicopter logging operations are highly susceptible to windy and rainy weather conditions. Besides, helicopter logging requires relatively large landing areas that should include well-organized drop zone, enough storage area for piling logs. Thus, helicopter logging demands for very strong and professional operation coordination in order to implement cost effective and environmentally friendly logging operations.

References

Akay, A.E., Acar, H.H., Sessions, J. 2008. An Analysis of Utilizing Helicopter Logging in Turkish Forestry. *Journal of Applied Sciences*. 8(21): 3910-3916.

Aust, M.W. and A. Lea, 1992. Comparative effects of aerial and ground logging on soil properties in a tupelo-cypress wetland. *For. Ecol. Mgt*.50:57-73.

BCTS, 2009. Operating Guidelines. Guidelines for Helicopter Logging in Northwest British Columbia. 10 p.

Bruce B., 2003. Helicopter Logging’s Bumpy Ride. Using helicopters to thin forests instead of fighting fires. Journal of Logging & Sawmills. Timber West. July-August 2003.

Chua D., 2001. Helicopter harvesting in the hill mixed dipterocarp forests of Sarawak. Applying Reduced Impact Logging to Advance Sustainable Forest Management. International Conference Proceedings, 26 February-1 March 2001, Kuching, Malaysia.

Dunham, M. 2006. An Overview of Helicopter Logging in British Columbia. 2006. Council on Forest Engineering (COFE) Conference Proceedings: “Working Globally – Sharing Forest Engineering Challenges and Technologies Around the World” July 22-Aug 2, Coeur d’Alene, Idaho, USA.

Hartsough, B.R., M.B. Lambert, and J.A. Miles, 1986. Simulating changes to helicopter logging operations. *Transactions of the ASAE*. 29(5):1228-1231.

Heinimann, H.R. and L. Caminada, 1996. Helicopter logging in Switzerland, analysis of selective logging operations. In: I.B. Hedin. [Ed.] Proc. of a Joint Symp. of IUFRO 3.06 Forest Operations Under Mountainous Conditions and the 9th Pacific Northwest Skyline Symposium: Addressing Today´s Social and Environmental Issues. May 13-16, 1996, Campbell River, British Columbia. For. Eng. Res. Inst. Can. Spec. Rep. SR-116: pp 45-50.

Hui, K. 2001. Helicopter harvesting in the hill mixed dipterocarp forests of Sarawak. Applying Reduced Impact Logging to Advance Sustainable Forest Management. International Conference Proceedings, 26 February-1 March, Kuching, Malaysia.

Krag, R.K. and M. Clark, 1996. Helicopter logging in clearcut, patch-cut, and single-tree selection harvests: Queens Charlotte Islands, British Columbia. In: J. Sessions [Ed.]. Proc. IUFRO XX World Congress, Subject Group S3.06 "Forest Operations Under Mountainous Conditions". Dept. For. Eng., Oregon State University, Corvallis: pp. 54-72.

Sloan, H. and J. Sherar, 1997. Hurricane fran helicopter salvage case study. Proceeding of the 20th Annual Meeting of Council on Forest Engineering, July 28-31, Rapid City, SD., pp: 107-113.

Sloan, H., J. Tollenaere, and Ch. Croff, 1994. Technology advances in helilogging: A case study of the K-MAX in Appalachian Hardwoods. In: J. Sessions and L. Kellogg [Eds.] Proc. of the meeting on "Advanced technology in forest operations: applied ecology in action". Dept. of For. Eng., Oregon State University, Corvallis: pp. 237-246.

Stampfer, K., H. Gridling, R. Visser, 2002. Analyses of Parameters Affecting Helicopter Timber Extraction. *IJFE*, 13(2): 61-68.

URL-1. Logging Machines. http://www.oregonloggers.org/Forest_Logging_Machines.aspx (Last visited on 29-10-2016).

URL-2. Heli-logging: timber harvesting by helicopter. http://www.waldwissen.net/technik/holzernte/arbeit/wsl_helilogging/index_DE (Last visited on 29-10-2016).

URL-3. Forest Operations Equipment Catalog: Helicopter extraction. https://www.forestsandrangelands.gov/catalog/equipment/helicopter.shtml (Last visited on 30-05-2016).

URL-4. Heli Logging. http://eastwesthelicopters.com/helilogging.html (Last visited on 29-10-2016).

URL-5. Helicopter Crash. http://www.northcoastoregon.com/2013/09/19/4998/ (Last visited on 30-05-2016).