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Evaluation of Logging Operations in terms of Sustainable Forest Management*

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Abstract

Today, the importance given to the sustainability of the existence of forests and to usage of forest products has increased. This brings to the forefront that forestry activities should be carried out in accordance with sustainable forest management (SFM) criteria. Sustainable forest management criteria and indicators determined in Near East and Helsinki processes have been assessed by the General Directorate of Forestry (GDF) and 6 criteria and 28 indicators have been put forward for Turkey. The forest ecosystem is influenced by every factors originating from nature or human. Forestry activity which has the largest share in terms of production of goods in forests is the logging activity that requires periodical intervention to forests in every year. The logging activities have important economic functions in terms of meeting the wood needs of the country, ecological functions in terms of some of the services offered, and social functions in terms of being realized by forest villagers who live in villages located within or near forests. SFM has briefly been defined that the environmentally appropriate, socially beneficial, and economically viable management of forests for present and future generations. This study includes assessment of wood logging activities according to sustainable forest management criteria and indicators.

Keywords: Sustainable Forest Management, Harvesting Activities, Logging

1. Introduction

The forest operations are to produce goods and services from the forests continuously in order to meet the needs of the people. Today, both sustainability of the existence of forests and the production of wood or non-wood forest products and services (such as recreation, oxygen, soil and water conservation) have gained great importance with increased awareness of the community. In Turkey, forests are spread in mountainous areas because of incorrect land use, unconscious urbanization and overuse.

The main revenue source of forest managements is the timber production activities in the production function. The General Directorate of Forestry (GDF) has approximately 2 billion 883 million TL/year of revolving capital income which is close to the sale of wood materials. The amount of industrial woods and firewood produced annually are 16.6 million m^3 and 3.5-4 million m^3, respectively. The annual industrial wood production of the private sector is around 3-3.5 million m^3/year. Annual consumption of wood raw materials is 29-30 million m^3/year, and the amount of wood imported from foreign countries is 1.5-1.7 m^3/year (GDF, 2016). In addition, the costs of producing wood raw materials cover more than 30% of the GDF budget.

While wood production has been made only for economic gain in the past, nowadays it has started to be done taking into account the economic and social functions as well as the economics (Unver, 2008). Logging is the first step of the wood production. It has different characteristics such as the nature of the work, the heavy work material, the working environment and the status of the workers compared to other works. These differences indicate that the logging has various social, economic, and environmental functions.

Logging activities have a social function due to realization by forest villagers who live in villages located within or near forests. Such that 16% of Turkey's population provides its subsistence from the forests, and on average 300,000 villagers are being employed in the

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wood production activities (GDF, 2014). Logging activities which is essentially performed to meet the wood needs of the society has an economic function due to the high cost and the quantity and quality losses on the wood during extraction activities. Improperly planned logging activities may cause various ecological damages to trees and seedlings (Solgi and Najafi, 2007; Unver and Acar, 2009b; Badraghi, N., 2013). These damages can cause both decrease in the quantity and the quality of the wood material to be supplied from the forests in the future (Spinelli, 1999; Pape, 1999) and increase the risk of fungi and insects damages on the trees. In addition, forest soil (Block et al., 2002; Nugent et al., 2003) and river waters (Collier and Bowman, 2003) can suffer significant damage during logging activities. It is emphasized in various studies that these effects of the harvesting activity have a negative impact on the sustainability of the forest (Kluender et al., 1998; Stevens et al., 2000).

2. Sustainable Forest Management (SFM)

In recent years, ensuring and measuring of sustainability of forest ecosystems and other natural resources has gained great importance (Durusoy, 2012). Although the sustainability concept is quite new for many sectors, the main components of sustainability in forest management have long been applied. The concept of continuity in forestry was first used in 1940s as a response to the inadequacy of wood supply chain. It was used as field continuity, tree fortune continuity, revenue continuity and income continuity (Turker, 2000). With the concept of "permanent crop" brought to the agenda by the German Georg Hartig in 1975, the amount of harvested crops should not exceed growing so that the supply of wood can be sustained for generations (URL-1, 2015).

Today, the concept of sustainability is defined as the balanced use and conservation of all functions of the forest and multi-use of forest (Colak, 2000). Similarly, GDF (2009a) defines sustainability as a sustainable management of forest resources and forest areas to meet the social, economic, ecological, cultural and spiritual needs of present and future generations.

Sustainable forest management (SFM) is defined as "the stewardship and use of forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national and global levels, and that does not cause damage to other ecosystems" at Pan-European level, the Ministerial Conference on the Protection of Forests in Europe (MCPFE) in 1993 (Yıldırım and Velioglu, 2006). The concept of SFM has been developed in the light of decisions taken at meetings such as United Nations Conference on Environment and Development in Rio de Janeiro-Brazil in 1992, the Intergovernmental Panel on Forests (1995-1997), the Intergovernmental Forum on Forests (1997-2000) and the United Nations Forum on Forests in 2001 (Wang, 2004). Many SFM criteria and indicators presented in various international processes such as Montreal Process, Tarapoto Proposal, Pan-Europan Forest Process (Helsinki Process), African Timber Organization, Dry-Zone Africa, International Tropical Timber Organization (ITTO) initiative on criteria and indicators, Lapaterique process of Central America, Near East Process (FAO-UNEP) and Dry Forests in Asia are available (Castaneda, 2000; Wang, 2001). There have been intense interest in these initiatives to address sustainable forest management criteria and indicators, and 149 countries have participated in the process worldwide (FAO, 2001).

Numerous countries have regulated their national SFM criteria and indicators using these international process criteria (Rametsiteiner and Simula, 2003). It has been used that Helsinki criteria and indicators in European countries, Montreal process in Outside Europe Other Temperal-Boreal, Tarapoto process criteria in Countries of the Amazon Cooperation Agreement, FAO-CCAD Lapaterique process in Central America (Dolarslan, 2003), Near Eastern process criteria in nearly 30 eastern countries (Afghanistan, Bahrain, Algeria, Morocco, Iran, Iraq, Syria, Tunisia, Turkey, Egypt, Turkmenistan etc.) (Cavdar, 2012), ITTO criteria for natural tropical forests, and Dry-Zone Africa criteria in African countries (Akyol, 2004).

Turkey is geographically located between Europe and the Asian continents. Thus, it is affected by the Pan-European Helsinki process having 7 criterias-63 indicators and FAO-UNEP Near East process having 6 criterias-36 indicators when determining the national SFM criteria and indicators (Ozcan, 2008). The national SFM set of Turkey has been created by selecting the indicators that fall within among the scope of the GDF's mandate and authority from the criteria and indicators determined in these two processes (Ok, 2008; Sener et al., 2011). The national sustainable forest management set in Turkey consists of 6 criteria and 28 indicators (GDF, 2007) (Figure 1).

3. Logging Operations and SFM Relations

When the national SFM criteria and indicators of Turkey are examined, 3 criteria under 2 indicator titles are directly related logging activities. The "wood product" indicator under the heading "Production Capacity and Functions" and the "forest product value" and "created employment" indicators under the heading "Socioeconomic Functions" are relevant to the wood logging activity at first grade.

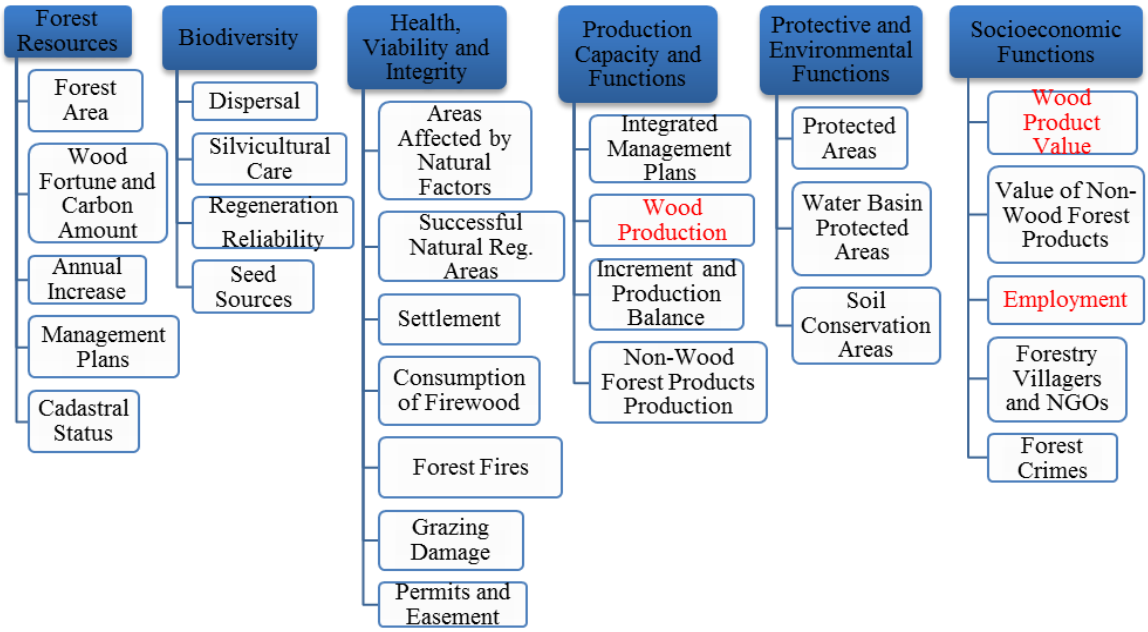


Figure 1. National Sustainable Forestry Management Criteria and Indicators in Turkey

3.1. Logging

This indicator is proposed for timely monitoring of changes in supply and demand to wood products in the market (Akyol and Tolunay, 2014). In Turkey, wood production in different types such as logs, poles, fiber chips or firewood has varied from year to year. The most widely used production technique in our country is timber production both because of meeting timber needs in the country and because of expensive. Reductions in annual timber production may occur from being imported at a price much cheaper than other countries.

The increase in the production of thin woods can be occurred by the using of every dimension wood as a result of the developments in industry in recent years or the standing tree sales method. The decline in the production of firewood may come down to a large decrease in the population of the villagers and the widespread using of alternative heating systems such as coal, natural gas or electricity instead of wood.

Ground-based skidding extraction technique is largely used in Turkey. In this method, human, animal or tractor power is generally used as power source. While the most used source of power in the 90's was the manpower, 4W agricultural or forest tractors (skidders) have been increasingly used with the development of mechanization nowadays. Especially, ground-based skidding by tractor in the forest has become quite widespread in small and medium sloping areas. In Turkey, there is only cable yarding systems from the aerial transportation systems which transports to the logs without touching on the ground. First, about 50 cable yarding systems were purchased in the 1980s, but today only three of them which generally used in Artvin and Antalya regions are left (Gumus and Hatay, 2017). The chute system is used to extraction of thin woods downhill skidding (Acar et al., 2003; Acar and Unver, 2005). In addition, the using of portable hand winch is carried out in maintenance areas for the transportation of medium-sized woods (Akay et al., 2014; Sert, 2014; Acar et al., 2015) (Figure 2). Similar studies have been carried out and assessed for scientific purposes with using portable winch integrated chute system in timber production (Acar and Unver, 2012; Gulci et al., 2016).

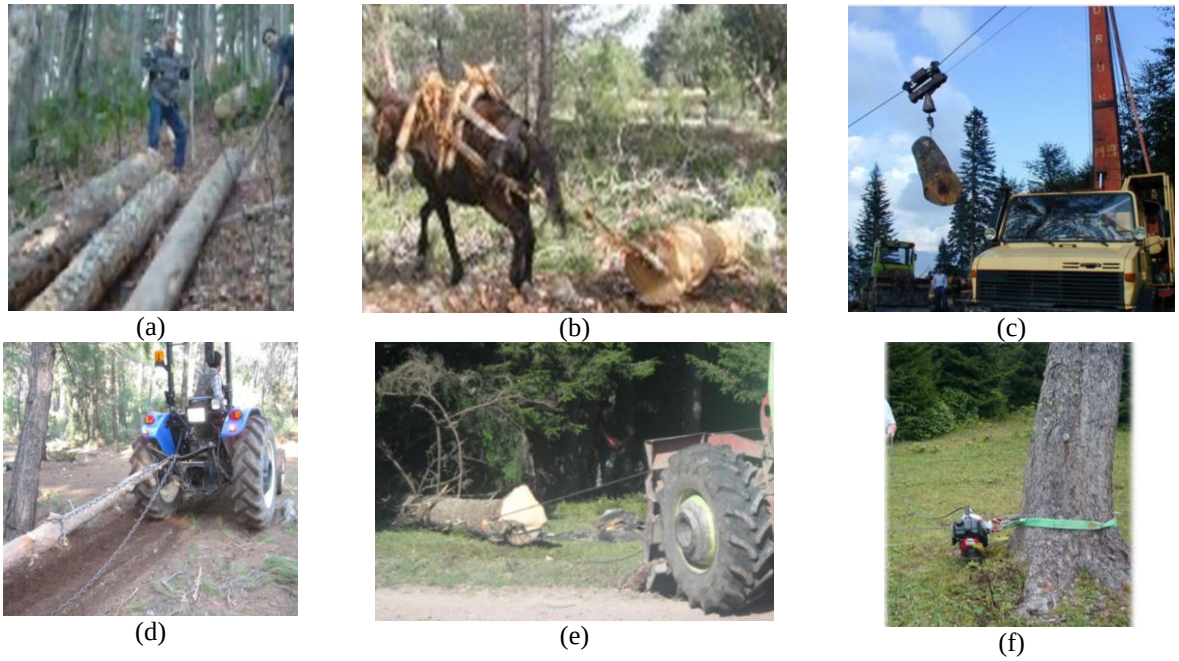
In many studies, it was found that significant quantities and quality losses had occurred on logs during ground-based skidding and depending on them the logs suffer losses of value. (Gurtan, 1975; Winkler, 1997; Unver and Acar, 2009a). Some of these damages occurred on wood are fracture, cracking, fringing or injury because of bumping into trees and frictions of rocks with the ground (Figure 3).

3.2. Wood Value

The main objective in this criterion is to determine the economic value provided by each type of wood product produced. Wood value (P) is calculated by multiplying the quantity (M) (m^3) of each type of forest products and the unit price (t) (TL or $) of each of them (Equation 1).

$$P = M \times t \quad (1)$$

The decreases in the sizes of the woods and the losses on log cause a significant decrease in unit prices. While 5%, 10% and 85% of the wood in the forests of Turkey are determined as in first, second and third quality classes respectively, the proportion of the produced wood material in quality classes is only 0.5%, 3.5% and 96%, respectively (GDF, 2013). These big differences between quality classes can be caused by incorrect / inadequate evaluation of trees or damages on logs occurred during extraction activities. The decline in quality classes also leads to a significant decline in the price of wood.



(a) (b) (c) (d) (e) (f)

Figure 2. Extraction techniques used in Turkey

(a) (b) (c) (d)

Figure 3. Damages caused by skidding (Unver, 2008).

3.3. Employment

It is aimed to determine the employment created by the forest villagers and the private sector depending on the time in forestry activities and the changes in the amount of support provided to the forest villagers at the level of national and forest management unit. Approximately 99% of the forests in Turkey are owned by the state and operated by GDF. In GDF, employees are officers, permanent workers, and temporary workers, but these workers do not work in logging activities. Apart from these, the work force is provided by forest villagers and the private sector directly and indirectly related to forestry (GDF, 2009b).

Logging activities are generally required to be completed within a period of 5-6 months between May and October. These activities are carried out by forest villagers or development co-operatives with the unit price method or with standing timber sales method. Despite the fact that it is provided the direct jobs to the villagers in the unit price method, the demand for logging works has decreased due to not having any insurance related to logging work, job difficulties, and increase in average age of forest villagers. Also, there is a steadily standing timber sales method to reduce the workload of forestry enterprises. In this method, contractor usually carries out all stages of harvesting activities by using own workers and resources.

4. Evaluation of the Logging Techniques in terms of SFM Criteria

In terms of social, economic, environmental aspects, comparisons of logging techniques used in Turkey are given in Table 1. As seen in this table, although the ground-based skidding by human power provides more employment, it economically causes significant losses in the wood value and environmental damages on the residual stands. In addition, work efficiency is also low due to the length of completion time of the work. Wood extraction by animal power is carried out as skidding by animals or loading on animals in low slope areas. But this method is not used much today due to the decrease in animal farming activities in Turkey. While damages to the residual stands and logs are less than that of the skidding by human power method in this method, the purchase, maintenance and feeding costs of the animal are economically also added.

Table 1. Logging techniques and impacts on forests and management tools

Technique	Environmental	Social	Economic
Human Power	High damage to residual stand	High employment (3-5 forest workers in a production unit)	High damage to wood, Long time
Animal Power	High damage to residual stand	Little use because there is no farmer	High damage to wood, Cost of animal, Long time
Tractor	Light damage to residual stand	1 operator, 1-2 forest workers	Light damage to wood, Expensive tractor, Operator sales, Short time
Cable Crane	No damage to residual stand	1 operator, 1 operator assistance and 2 forest workers	No damage to wood, High expensive, High operator sales, Very short time

Skidding or cable towing with tractor is carried out on the tracks or the skidding routes which are cleaned from the dead vegetation cover and the stones. This situation provides less damage to the wood and less loss of wood value resulting from collisions with obstacles. In addition, controlled skidding on maintained skidding roads having a certain width contributes to the reduction of damage to residual stand, which will result in of the logs hit by trees and seedlings. From an economic point of view, additional costs such as trained operator fee, purchasing, fuel/oil and maintenance costs may arise.

In the cable yarding method, the damage to the logs is minimized because the logs are moved without touching the ground. While this method is economically very expensive and requires high operator fee and long installation and dismantling time, it has high productivity rate. During the installation of the cable yarding system, the damage to residual stand can be minimized if it is not necessary to cut to open the route.

5. Conclusion

When the timber harvesting operations are evaluated in terms of social, economic, and environmental aspects, it can be concluded that the most effective stage is logging activities. However, during unplanned timber extraction activities, there can be significant damages to the logs, residual trees, seedlings and forest soil. On the social side, these activities provide the forest villagers with employment and income source.

According to SFM requirements, logging plans should be made considering parameters such as land characteristics (slope, stiffness, ground roughness), diameter of the product to be transported (large, medium, and small), harvesting method (cut-to-length, tree-length, whole tree), and extraction conditions (skidding distance and direction). According to these logging plans, the most suitable extraction method is selected considering not only the economic factors but also environmental constraints.

As an alternative methods, aerial extraction methods (skyline yarders, balloons etc.) and chute system that cut the product's contact with the ground and provide controlled transportation on the fixed route should be preferred in order to reduce the damage to the logs and the environment. The skidding by tractor in the forest should be used up to 120 m skidding distance in low or medium sloping areas where the using of aerial systems is technically or economically unsuitable. The use of the portable winch system is suitable for thinning or maintenance areas where the transport distance is longer than 120 m. The pulling of logs by motor power on an artificial chute system will be beneficial both economically and environmentally when the ground is especially too stony or rough. The polyethylene chute system can be effectively used to transport thin woods downhill in steep slope areas.

The skidding cones must be installed at the front-end of the logs in order to prevent damage on the log heads and to reduce the residual stand damage during ground-based skidding operations. Thus, skidding cones can maintain the economic value of logs and protect the residual trees. Besides, fully or semi-mechanized systems should be developed considering self-depreciation in a short-term, simple usage techniques, environmentally friendly operation, and suitability with land and economic conditions of Turkey.

Harvesting workers are in the status of temporary workers and most of them do not have detailed training on harvesting activities. This causes significant damage to the logs and residual stand during logging. Therefore, it must be obliged to give wood harvesting supports to those who have been trained and certified. In this case, certified loggers will be permanently employed in the timber production period of about 5-6 months.

In the methods outlined above for logging operations, it is extremely important that SFM can be implemented using appropriate planning and project techniques. It is not possible to obtain SFM according to the relevant criteria if regulations are not implemented.

References

Abdi, Acar, H.H., Eroglu, H., Ozkaya, M.S., 2003. A study on the possibilities of extraction of the thin woods by the log-line system in mountainous forests. FM Project 2003A/050090, Trabzon-Turkey.

Acar, H.H., Unver, S., 2005. Work production of extracting of small size woods by polyethylene chute system: its application in the Giresun region. *Gazi University Journal of Forestry Faculty,* 5(2): 154-163.

Acar, H.H., Unver, S., 2012. Working efficiency during the controlled sliding of logs in the polyethylene chute by tractor power. *SDU Faculty of Forestry Journal*, 13: 97-102.

Acar, H.H., Unver-Okan, S., Ucuncu, K., 2015. Assessment on uphill yarding with the combination of log chute and portable winch. *European Journal of Forest Engineering*, 1: 34-40.

Akay, A.E., Sert, M., Gulci, N., 2014. Evaluating productivity of mobile winch system used in logging operation on gentle ground slope. *II. National Mediterranean Forest and Environmental Symposium*. 22-24 October, Isparta-Turkey, pp. 281-290.

Akyol, A., 2004. Sustainable Forest Resources Management Policies, Indicators and Applications in Turkey. Master Thesis, SDU Institute of Science and Technology, 130p., Isparta-Turkey.

Akyol, A., Tolunay, A., 2014. Modelling of sustainable forest management criteria and indicators for Turkey. *SDU Faculty of Forestry Journal*, 15: 21-32.

Badraghi, N., 2013. Productivity, cost and environmental damage of four logging methods in forestry of northern Iran. Doctorate Thesis, Dresden University Faculty of Environmental Sciences, 77p., Iran.

Block, R., Van Rees, K.C.J., Pennock, D.J., 2002. Quantifying harvesting impacts using soil compaction and disturbance regimes at a landscape Scale. *Soil Sci. Soc. Am. Journal*, 66: 1669-1676.

Castaneda, F., 2000. Criteria and indicators for sustainable forest management: international processes, current status and the way ahead. FAO, Rome. Unasylva No. 203.

Cavdar, B., 2012. The evaluation of Artvin forestry enterprise in certification process. Master Thesis, ACU Institute of Science and Technology, 99p., Artvin-Turkey.

Colak, A.H., 2000. Head and crown principles in forestry: continuity principle. *Technical Bulletin*, 1(2):1-7, Ankara-Turkey.

Collier, K.J., Bowman, E.J., 2003. Role of wood in pumice-bed streams I: impacts of post-harvest management on water quality, habitat and benthic invertebrates. *Forest Ecology and Management* 177: 243-259.

Dolarslan, E.S., 2003. Forestry strategy implemented in European Union and suggestions for Turkey. Master Thesis, Ankara University Graduate School of Natural and Applied Sciences, 100p., Ankara-Turkey.

Durusoy, I., 2012. Defining sustainable forest management criteria for Turkish forestry. *Duzce University Journal of Forestry*, 8(1): 41-49.

FAO, 2001. Key issues in the forest sector today. State of The World's Forest, Part 1, Rome, Italy.

GDF, 2007. General Directorate of Forestry, Sustainable forest management criteria and indicators 2006 annual report. http://www.ogm.gov.tr/guncel.htm (Accessed: 03.09.2017).

GDF, 2009a. General Directorate of Forestry, Sustainable Forest management criteria and indicators 2008 annual report. T.C. Ministry of Environment and Forestry, General Directorate of Forestry, Ankara-Turkey.

GDF, 2009b. General Directorate of Forestry, Strategic Plan 2010-2014. Directorate of Strategy Development Department, Ankara-Turkey.

GDF, 2013. General Directorate of Forestry, Production marketing activities in forest management. Department of Management and Marketing. 83p., Ankara-Turkey.

GDF, 2014. General Directorate of Forestry, Annual activity report in 2013. Directorate of Strategy Development. 71p. Ankara-Turkey.

GDF, 2016. General Directorate of Forestry, Production and marketing activities of wood based forest products. Department of Management and Marketing. 80p. Ankara-Turkey.

Gulci, N., Akay, A.E., Erdas, O., Acar, H.H., Wing, M.G., 2016. Controlled sliding of logs downhill by chute system integrated with portable winch and synthetic rope. *Journal of the Faculty of Forestry Istanbul University*, 66(1): 256-263.

Gumus S., Hatay T.Y., 2017. A cost-effectiveness approach for configuration of feasible skyline yarder for specific forest regions. *Fresenius Environmental Bulletin*, 26: 4656-4662.

Gurtan, H., 1975. A Research on the determination of loses during harvesting and extracting activities on the steep forests and rationalization of these activities. TUBITAK Publication TOVAG Sery No 38, 250p. Ankara-Turkey.

Kluender, R., Lortz, D., McCoy, W., Stokes, B., Klepac, J., 1998. Removal intensity and tree size effects on harvesting costs and profitability. *Forest Product Journal*, 48: 54-59.

Nugent, C., Kanali, C., Owende, P.M.O., Nieuwenhuis, M., Ward, S., 2003. Characteristic site disturbance due to harvesting and extraction machinery traffic on sensitive forest sites with peat soils. *Forest Ecology Management*, 180: 85-98.

Ok, K., 2008. Sectoral policy integration of sustainable development: forestry. http://web.ogm.gov.tr/diger/mena/Dokumanlar/RAPOR/Ormanc%C4%B1l%C4%B1k%20Sektorel%20Politikalar%20ve%20surekli lik%20nihai%20raporu%201-118.pdf. (Accessed: 22.11.2017)

Ozcan, M., 2008. Forestry policies of European Union and compliance of Turkey's forestry to these policies. Master Thesis, SDU Institute of Science and Technology, 99p. Isparta-Turkey.

Pape, R., 1999. Effects of thinning regime on the wood properties and stem quality of *Picea abies*. *Scandinavian Journal of Forest Research*, 14: 38-50.

Rametsteiner, E., Simula, M., 2003. Forest certification-an instrument to promote sustainable forest management? *Journal of Environmental Management*, 67: 87-98.

Sert, M., 2014. Productivity and Ecological evaluation of mobile winch system used in logging operations in mountainous regions. Master Thesis, Kahramanmaraş Sutcu Imam University Faculty of Forestry, 82 p. Kahramanmaraş-Turkey.

Solgi, A., Najafi, A., 2007. Investigating of residual tree damage during ground-based skidding. *Pakistan Journal of Biology Science*, 10: 1755-1758.

Spinelli, R., 1999. The environmental impact of thinning: more good than bad? IUFRO 3.09.00 Harvesting *and Economic of Thinning*, 4-7 May, Ennis-Ireland, pp. 136-143.

Stevens, J.A., Barbour, R.J., 2000. Managing the stands of the future based on lessons from the past: estimating western timber species product recovery by using historical data. *USDA Forest Service*, 528: 1-9.

Sener, F.N., Tolunay, A., Gorucu, O., 2011. Certification and accreditation of sustainable forestry management applications: case studies for Andırın and Goksun State Forestry Enterprises. *SDU Faculty of Forestry Journal*, 12: 115-125.

Turker, M.F., 2000. Sustainable development and forestry interaction in Turkey in the light of international developments, KTU Faculty of Forestry, Trabzon-Turkey.

Unver, S., 2008. Determining environmental and quantitative effects of ground based skidding by human power and the damage prediction model. Doctorate Thesis, Karadeniz Technical University Institute of Science and Technology, 123 p. Trabzon-Turkey.

Unver, S., Acar, H.H., 2009a. A damage prediction model for quantity loss on skidded spruce logs during ground base skidding in north eastern Turkey. *Croatian Journal of Forest Engineering*, 30(1): 59-65.

Unver, S., Acar, H.H., 2009b. Evaluation of residual tree damage in sloping areas due to harvesting operations by manually. *Austrian Journal of Forest Science*, 126 (3): 119-132.

URL-1, 2015. Forest and Forest Products, http://ekerestecom.blogspot.com.tr/2015/05/orman-isletmeciligi-nedir.html. (Accessed: 01/10/2017).

Wang, S., 2001. Towards an international convention on forests: building blocks vs. stumbling blocks. *International Forestry Review*, 3:251–264.

Wang, S., 2004. One hundred faces of sustainable forest management. *Forest Policy and Economics*, 6(1):205–213.

Winkler, N., 1997. Environmentally sound forest harvesting, testing the applicability of the FAO model code in the Amazon in Brazil. Forest Harvesting Case-Study 8, Food and Agriculture Organization of the United Nations, 84p., Rome.

Yıldırım, H.T., Velioglu, N., 2006. Assessment of criteria and indicators in sustainable forest management. *I.U. Faculty of Forestry Journal Series B*, 56 (1):129-140, ISSN 0535-8418.