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GPS and Google Earth integration; one step further to operational planning

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Abstract: In order to extensively and efficiently manage the forest areas, a well thought and constructed forest road network, "secondary transportation plan", on which the timber will be hauled to log yards or processing mills must first be devised. "Primary transportation plan", which is the initial phase of timber extraction (logging) in any forest operation from stump to forest road side landing, can then be properly executed. Forest roads in Turkey serve multiple functions such as administrative (forest management, conservation, fire suppression, etc.), social and recreational, and get planned and constructed as the management strategies and foresights mandate. Logging which includes felling the timber(s) and removing them out of the stands is the combination of becoming a relatively tough profession and the major player in the environmental adversities examples of which are endless throughout the world as well as in Turkey. Logging, at the same time, is also the part in forest operations, which always surpasses initial cost estimations because Turkish logging operations are still rather rudimentary compared to those of other nations, due to lack of technological advancements. Although relatively well known and used in Turkish forestry, Global Positioning System (GPS) implementation in the profession is only limited to location confirmation by foresters because they do not want to interfere with the administrative boundaries of their fellow neighboring foresters. GPS by itself can be an effective operational planning tool if coupled with the Google Earth. This paper will show with onsite knowledge of how bad an unplanned logging operation would result in an environmentally sensitive area and explain how such mishaps might be avoided if a simple GPS to Google Earth integration can be achieved and put into practice in similar circumstances.
Keywords: Global positioning system, Google Earth, Operational planning, Skidding route planning

1. Introduction

Professional forest management and planning in Turkey started more than a hundred years ago in 1907 with the approval of first ever law dedicated to forest administration. Afterwards, the first forest management plan was put into effect in January 1918 after a group of 10 foresters, 5 Austrian, 5 Turkish, had surveyed an area, near the present day sub-province Hendek, Cam Mountain Forests, in 1917 (Panel, 2017). Modern forest management planning dating back to 1960s produced first comprehensive forest management plans in 1972. Today, Turkish forests are managed according to the principles set towards achieving ecosystem based functional planning (economic, ecologic, social aspects) (Keles et al, 2017) (Figure 1).

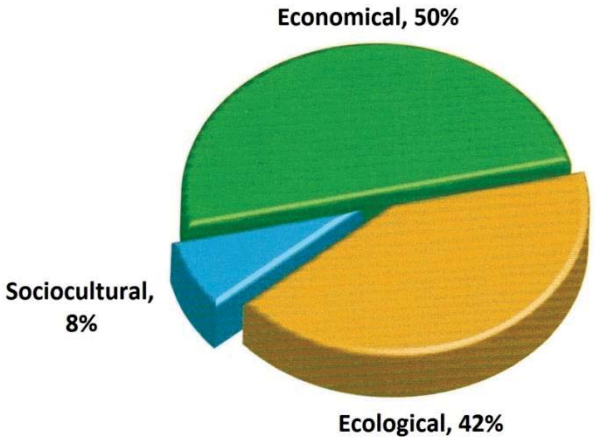

Figure 1. Ratio of main functions to Turkish national forest area, (Bülten, 2015)

Administration structuring is shaped under the governing body, Forest Service, with 28 regional forest directorates including 242 forest enterprises nationwide. Enterprises are also divided into numerous forest directorates, which house a patch of state forests in an approximate acreage of 15000 to 18000 ha. Forest management plans are made for each and every forest directorate depending on the forest stand types with different rotation ages. 10 year management plans are produced for

directorates heavily stocked with shorter rotation species of 50 to 60 years (red pine, pinus brutia) whereas a 20 year interval is used for longer rotation period of 100 to 120 years (other pine variants, coniferous and deciduous species).

Management strategies mandated in management plans of particular forest directorates are applied by state employed forest engineers, so the forests are sustainably managed, depending on the function assigned to them. The professionalism in the management state is at the highest level.

Sylvicultural principles and on-site practices starting from stand initiation via stand exclusion and reinitiation to old growth are applied in every stage of the stands' rotation cycles in accordance with the sustainability principle in utmost priority. The term sustainability, since its inception more than 20 years ago in Rio, dictates the fact that forest resources and forest land must be managed to satisfy the social, economic, ecologic, cultural and spiritual needs of today's and future generations (Cubbage et al., 2007).

The products and services supplied by forests are timber, water, food, fodder, shelter, employment, recreation, natural bio-reserves, landscape variations, carbon storage/pools and other produces. To continue, benefitting from the multi-dimensional advantages of forests, they must be closely guarded against any kind of threat, such as pollution, fires, insects, diseases and so on (Gunn, 1998).

Practices followed in Turkish forestry are rather tender in the early years of stands' establishment. An irregular grid of maintenance tracks, depending upon the slope and tree species is laid out within compartments (Figure 2).

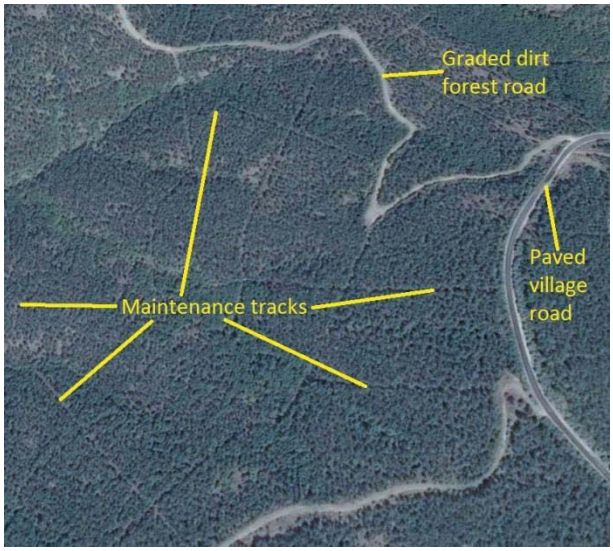

Figure 2. Layout of maintenance tracks in conjunction with other access roads (Daday forest enterprise)

Regenerating stands (predominantly naturally) in the early stages of stands' initiation are furnished with such maintenance tracks to facilitate easy access to any type of tending operations (Figure 3). They provide;

- Convenience during sylvicultural practices
- Extensive stand/compartment tending/maintenance
- Easy access during fire suppression or insect fight
- As skidding roads for longer rotation species

However, this good intension slowly fades away as the stands grow and spacing among individual trees enlarges; as the stands get older, tree trunks start thickening. Competition to reach the upper most canopy is immense in the early ages; this is when the foresters intervene and make thinning according to management plans. Common application to categorize the even aged stands to development classes in Turkish forestry is done in four categories: if 0<stand median diameter (smd) at dbh ≥7.9 cm, then the stand is classified as development class "a", if 8 cm < "smd" ≥ 19.9 cm, "b"; if 20 cm < "smd" ≥ 35.9 cm, "c" and if "smd" ≥ 36 cm, "d". If the stand is composed of uneven aged trees these designations can be paired like "ab", "bc", etc. Crown closure is also attached to the signage as "1" if crown closure is between 11-40%, "2" between 41-70% and "3" >70%. Maintenance tracks laid out and used up until the stands reach development class "c", is no longer needed because the spacing among individual trees are wide enough for skidding machinery to wander in any direction freely. All the good intentions and professional manners brought up in the early stages of stands' development are somewhat undermined when the stands reach maturity for timber harvesting. This is when the pristine forest floor starts getting trampled by heavy machinery while skidding or carrying the harvested timber in every allowable cut period.

Figure 3. Maintenance tracks (courtesy of Bolu Regional Forest Directorate)

In order to efficiently and sustainably benefit from forests, first a planned and constructed forest road network (secondary transport planning) interlinked with village, municipal and intercity roads, must be put to use to provide access to the tracks to be harvested and to enable any type of management activity to be applied inside the forests . Then, a subordinate transport scheme (primary transport planning) must be devised, implementing skidding tracks and roads and yarding possibilities, to move the felled tree(s) from their stump(s) to road side or designated landing.

Today, as the technological improvements and mechanization possibilities are diversified, planning the timber harvesting (logging) has become extremely important in practice. Such plans should be drafted and put into practice by taking all the restricting criteria into consideration as each and every harvesting scenario differ from one another in terms of topographical and ecological sensitivities. Thus, there is no one fits all type of approach in logging.

Logging can be formulated, benefiting from various planning approaches. "*Strategic planning*" is devised in rather large areas, spread over more than one compartment or track. They require topographical map drafting and field survey cross-check on critical issues to be addressed. A hardcopy logging plan is designed, pointing landing locations, haul road and skid road locations, appropriate logging system and yarding patterns. This hardcopy plan is later cross-checked in the field to accordingly address and adjust questionable points such as access locations and major road ways. In this approach, different timber harvesting techniques can be considered for their likely environmental impacts and cost. Following strategic logging plans representing the timber and the terrain that harvesting will take place, patterns, specialized approaches and habits start to develop and lead the way to logging system equipment selection. Another approach "*Tactical planning*" involves unique track(s) with pre-determined logging systems. They are field checked to an extent verifying the fact that the devised plan can be realized as envisioned with minimal environmental impacts, and well within the cost adjusted for the track(s). This is such a plan that specialized logging crew can take to forest with their specific equipment. They build the roads on sides as shown and then, do the harvesting as specified at the cost that has been planned. Knowing what and how to do enables the harvesting crew to program the work efficiently and guard themselves against any unexpected mishaps. As logging system specialization occurs, the track(s) will be further subdivided for other more specialized crews and systems to better fit the timber's and the terrain's needs. By tactically naming logging systems locations, and targeting the specialized system to the forest and the topography, a control in both the logging cost and the possible environmental impacts can be accomplished (Virginia's Forestry BMPs, 2002). The concept of timber production on the other hand is the subject of "*Operational planning*". They can be annually, seasonably, monthly and weekly drafted. For example, an annual operational planning for timber production includes how much allowable cut will be extracted from what compartment(s), using human, animal or machinery at what cost; where and how timber will be transported to what landing/depot, considering topographic, technical, environmental, ergonomical and socio-economical criteria. Planning is the process of decision making, thus the periodical selection of the compartments to be harvested, the preferred logging method or the selection the timber harvesting equipment and their performances, the determination of the compositions to be hauled to log depots, the loading means, the routes over which entire operation will proceed and the selection of the transportation means are the subjects of the operational planning (Eker et al., 2006).

Although expected to be entirely covered with forest vegetation, forest management blocks or planning units can include range and agricultural lands. Such planning units are generally encircled with natural and man-made restrictive phenomenon such as ridges, fissures and waterways, and local roads and links; these can be envisioned as a block including several compartments. The aim of distinguishing and dividing a forest management planning unit into logging planning units is to enable and define sections each of which will be harvested with a different method (Figure 4). Such separation is generally accomplished through available forest roads which are already considered as a transportation boundary, and naturally restrictive barriers.

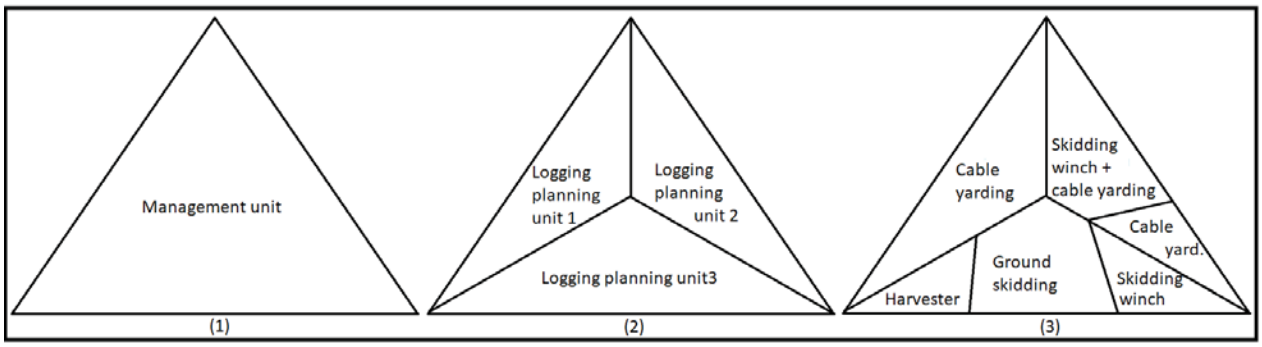

Figure 4. "1" Management block, "2" Logging blocks, "3" Logging methods per condition (Bayoglu, 1996)

All of the above mentioned planning schemes and approaches makes sense as long as the equipment and the people using them are up to date and functions flawlessly. However, mechanization and expertise levels in logging operations in Turkey are rather low (Demir, 2010). Logging is done by the members of forest cooperatives which are formed by the villagers who happened to dwell in or adjacent to state forests. The level of expertise is limited to being reared by the elder generations; no formal training concerning logging and its challenges is available. They are employed by the forest service with a mandatory constitutional decree that "job opportunities must be created for this people by the forest service", so logging has become their main occupation to make a living. Since logging is not providing a steady source of income year round, they also occupy themselves with husbandry, raising livestock and other forest service offered jobs such as sylvicultural tending, nursery and afforestation practices, free range none wood forest products picking, etc.

Forest Service has always procured the service of these cooperatives in timber production, however due to the fact that the rather low level of mechanization these cooperatives can provide (conventional 2x4 or occasional 4x4 farming tractors and attached skidding winches) and the lack of professionalism such "would be" loggers can manifest, there are considerable losses in timber quality and quantity (Yilmaz et al, 2008). Despite all the drawbacks and mishaps, technology is still giving an applicable edge to foresters as long as forest service would opt to implement simple but effective planning tools: Global Positioning System (GPS) and Google Earth geo-portal.

2. Methodology

2.1. Study area

Study was conducted in the "compartment #111" of Aksudere forest directorate in Samatlar Forest Enterprise within Kastamonu regional forest directorate. The standing stock was composed of pure "Corsican Pine_development class-"c"_crown closure 70%". The compartment was due for allowable cut dictated in the management plan. Directorate forester was measuring and marking the individual trees to be selectively harvested, timber cruising. A Garmin Montana 650 hand held GPS devise was used to get a position coordinate from marked trees' stumps, a point cloud including "724" tree positions was generated (Figure 5).

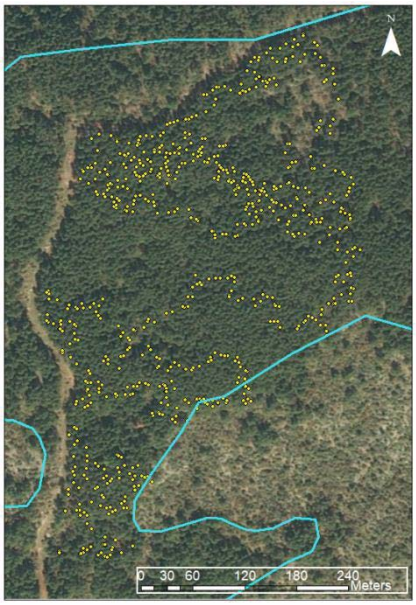

Figure 5. Positions of the marked trees within the compartment

2.2 Data handling

The distribution of the marked tree locations did not seem to deviate from the actual tree locations in the field. To make sure the point cloud was accurate for the task, three Garmin brand hand held GPSs', Montana 650, Etrex 20 and 60csx, generated point locations were compared to that of a Real Time Kinematic (RTK)/ Continuously Operating Reference System (CORS) suitable GPS receiver generated point. Out of 12 comparison points, positions generated by held hand GPSs were well within the manufacturer's assurance of "3 m", even within "1 m" in "x" and "y" directions (Figure 6).

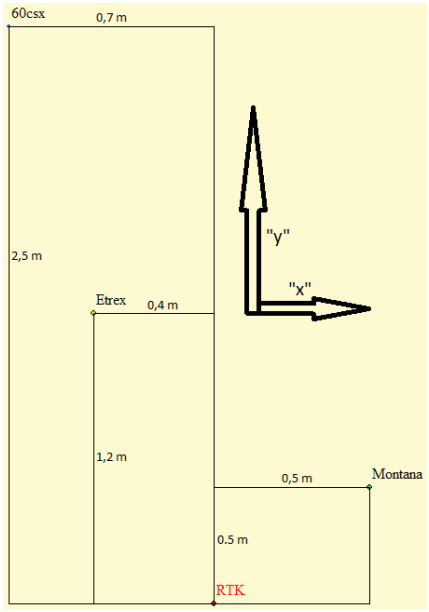

Figure 6. "x" and "y" deviations of different hand held GPS devices from that of RTK

RTK comparison showed that the point cloud was good enough to properly locate the marked tree distribution. Knowing how logging planning was done on topographical maps, knowing only the drafted compartment borders, GPS approach and visualizing it on almost real time imagery can be considered quite an achievement to speed up the process. To designate the skidding trails suitable for timber extraction from the compartment, the GPS generated point cloud was placed on Google Earth geo-portal. It was determined that a total length of 1621 m skidding trails would be needed to extract the timber to be harvested from this 262 m East facing slope (Figure 7).

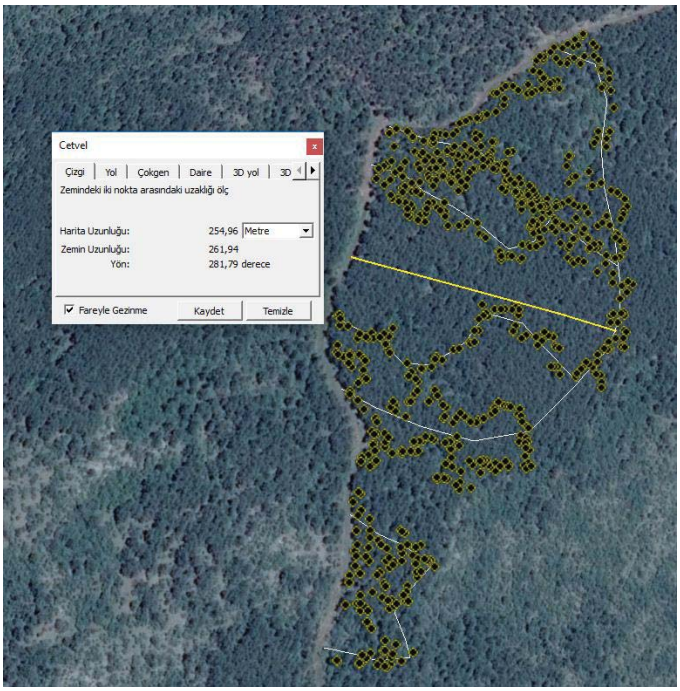

Figure 7. Farthest marked trees from the surrounding forest road

It is possible to evaluate slope on Google Earth, so this particular "logging planning unit" can be related to the specific logging method. 0% gradient as shown on "Figure 8" guarantees the fact that near level forest floor will be suitable for ground skidding with farm tractors on this occasion (Bayoglu, 1996). Slope evaluation is made possible in Google Earth because it shelters Shuttle Radar Topography Mission "SRTM"s global digital elevation model "DEM" underneath the images. This is how three dimensional viewing is achieved in the geo portal (Kennedy, 2010).

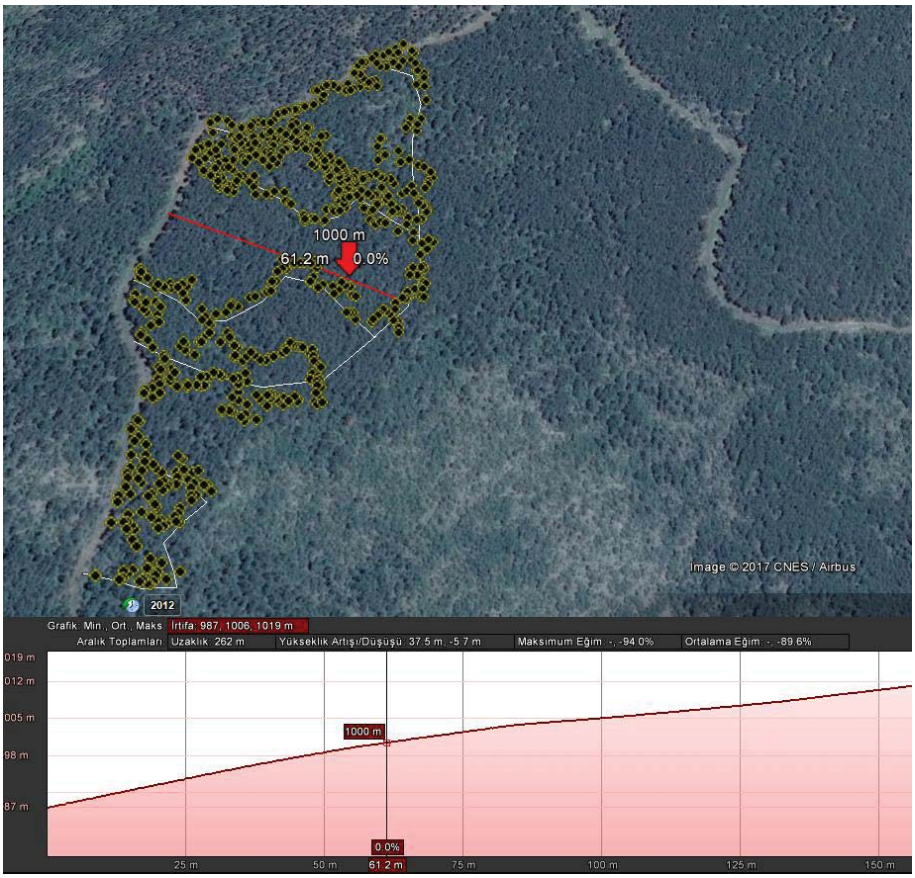

Figure 8. Slope evaluation of possible skid trails

3. Conclusion

Logging is a rather broad, but an unavoidable part of forest management. It deserves meticulous planning, otherwise all those long years of patience and good intentions are jeopardized. Logging planning in operational level involves dealing with many uncertainties many of which can be considered as a subject in itself. Location determination of the cruised timber can be accomplished with a hand held GPS which is widely available in any forest directory in Turkish forestry. GPS enabled hand held terminals will also ease up the clerical work done by a ranger during cruising (Garnett et al., 2014). Skid track designation can be accomplished, using "Google Earth", pending further field verification in the field. Designation of skid trails was proven to lessen the environmental and product damage (Wang et al., 2004). Nearly 40 % of the forest floor might be covered with skidding tracks, impending the taking root of the next generation of trees during a one-time harvesting attempt if no prior work is carried out to plan and place the proposed skid trails on site (Garland, 1997). When felling the trees are still achieved with chain-saws and manual labor, the expertise of the loggers to drop the trees toward the skid trails or cable corridors would considerably increase the production level, even offsetting the cost of expensive yarding operations (Olsen et al., 1984). It is also possible to keep the undesired soil impacts at bay when the initial phase of logging is directed through preplanned skid trails (McNeel, 1997). Two proven and accepted common knowledge can make a difference in logging when they are sincerely embraced and put into practice.

4. Discussion

Planning is the utmost priority in forest management. If it is only limited to the management phase, then harvesting becomes anyone's game. When performed haphazardly, timber harvesting not only decreases the quality of timber, but also leaves deep scars which themselves might need fixing at unnecessary expanses. Timber harvesting requires intricate planning, whereas the situation in Turkish forestry is very far from it. After the strands are timber-cruised by the foresters, forest cooperatives, loggers, come to do the logging. Their only agenda is to extract the timber as in a good enough form as possible, but there is still considerable difference between the standing volume and the extracted volume. Since the priority is on

timber, they do not care much about the remaining stand and the environment. Timber cruising can very well benefit from a GPS. This will enable forest engineer to see if he/she marked his/her stand(s) harmoniously or not. Once the distribution pattern of the cruised timber is visualized on Google Earth, it is then possible to evaluate the situation to further degree. Forest engineer can easily plan, verify, field check and finally peg the skidding trails in his/her stands. This way the most damaging part of logging can be restrictively executed.

Refereneces

Bayoğlu, S., 1996, Orman Nakliyatını Planlanması, İ. Ü. Yayın # 3941, İ. Ü. Fen Bilimleri Enstitüsü Yayın # 8, ISBN 975-404-438-4, p. 169.

Bülten, 2015, Türkiye Orman Varlığı 2015, T.C. Orman ve Su İşleri Bakanlığı, Orman Genel Müdürlüğü, http://www.ogm.gov.tr/ekutuphane/Yayinlar/Türkiye Orman Varlığı-2015.pdf, accessed on 07.06.2016.

Cubbage, F., Harou, P., Sills, E., 2007, Policy Instruments to Enhance Multi _Functional Forest Management, Forest Policy and Economics, 9 (2007) pp. 833-851.

Demir, M., 2010, Investigation of Timber Harvesting Mechanization Progress in Turkey, African Journal of Biotechnology, Vol. 9(11), ISSN 1684-5315, pp. 1628-1634.

Eker, M., Acar, H., 2006, Odun Hammaddesi Üretiminde Operasyonel Planlama Yönetimi, Süleyman Demirel Üniversitesi, Orman Fakültesi Dergisi, Seri: A, #2, ISSN 1302-7085, pp. 128-140.

Garland, J. J. 1997, Designated Skid Trails Minimize Soil Compaction, The Woodland Workbook, Oregon State University Extension Service, EC 1110 p. 6.

Garnett, R., Steward, R., 2004, Comparison of GPS units and mobile Apple GPS cababilities in an Urban Landscape, Cartography and Geographic Information Science, 42:1, DOI: 10.1080/15230406.2014.974074, pp. 1-8.

Gunn, A. S., 1998, Environmental Philosophy and Ethics in Budism, Macmillan Press LTD, ISBN 978-1-349-26772-9 (eBook), DOI 10.1007/978-1-349-26772-9, p. 194.

Keles, S., Durusoy, I., Cakir, G., 2017, Analysis of the changes in forest ecosystem functions, structure and composition in the Black Sea region of Turkey, Journal of Forest Research, DOI 10.1007/s11676-016-0322-2, 28(2): pp. 329–342.

Kennedy, H., 2010, Introduction to 3D Data: Modelling with ArcGIS 3D Analyst and Google Earth, John Wiley and Sons, ISBN 1118059867, 9781118059869, p. 360.

McNeel, J. F., Dodd, K. K., 1997, Improving Cable Thinning System Productivity by Modifying Felling Phase Operation, Journal of Forest Engineering, 8:2, ISNN: 0843-5243, pp. 47-56.

Olsen, E. D., Seifert, J. C. W., 1984, Machine Performance and Site Disturbance in Skidding on Designated Trails, Journal of Forestry, Volume 82, #6, pp. 366-369(4).

Panel, 2017, Türkiye Orman Kaynakları Planlamasının (1917-2017) Yüzyılı ve Hedefler, Sonuç Bildirisi, TMMOB Orman Mühendisleri Odası, 06 Mayıs 2017, Ankara, http://ormuh.org.tr/arsiv/files/09052017_EK1.pdf, accessed on 27.07.2017.

Virginia's Forestry Best Management Practices for Water Quality, 2002, Virginia Department of Forestry Publication, Fourth Edition, p.216.

Wang, J., LeDoux, C. B., Edwards, P., 2003, Changes in Soil Bulk Density Resulting from Construction and Conventional Cable Skidding Using Preplanned Skid Trails, Northern Journal of Applied Forestry, Volume 24, #1, pp. 5-8(4).

Yilmaz, M., Abdullah E. A., 2008, Stand Damage of a Selection Cutting System in an Uneven Aged Mixed Forest of Cimendagi in Kahramanmaras-Turkey, International Journal of Natural and Engineering Sciences 2 (1), ISSN: 1307-1149, pp. 77-82.