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Assessment of a Salvage Logging Operation after Winter Storms: A Case Study of Ihsangazi Forest Directorate, Kastamonu-Turkey*

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Abstract

Timber extraction (logging), an initial stage of forest operations, involves felling of timber and removing them off the stands. This stage of forestry, if not planned and supervised properly, is the reason for various adversities one never expects happening in forested areas, such as erosion, sedimentation, soil compaction and displacement, etc. Logging on the other hand, is a never ending process which will happen here and there as the forests continue to exist. That's why this unavoidable part of forest management demands operational planning in micro detail because especially edaphic and topographic factors differ tremendously in close distances. As previously reported in many studies, logging may cause far more serious circumstances to soil and the environment when it is not contracted and practiced professionally. Natural disasters especially winter storms potentially lead to devastating impacts on forest ecosystem and turn logging into even more complicated tasks that require well planned forest operations. In the scope of this study devised following a logging operation which occurred in Ihsangazi Forest Directorate in the spring of 2015 after an unexpected windstorm had swept a 100+ years old Scots pine forest in February, 2015, it was determined that excessive ground water further worsened the soil compaction within the first 20 cm. Results revealed that reduced impact logging principles should be implemented especially in environmentally sensitive areas, otherwise hastily executed practices may yield even worse results.

Keywords: Operational Planning, Salvage logging, Skidding operation, Soil Compaction

1. Introduction

Forest soils will be much more extensively utilized as the demand for forest product continues to increase, and the amenities (aesthetic, ecological, social, etc.) forests provide, are enjoyed by people. Forest management practices such as shortened rotation cycles, the introduction and adoption of fast growing hybrid species, mechanical and chemical site preparation techniques, abruptly executed logging operations might have dire effects on soil and water quality (Young and Giese, 1990). Site preparation generally refers soil displacement techniques formulated to disseminate or eliminate the logging residue or any other type of organic/inorganic debris, control weed or fast growing unwanted plant competition, prepare a mineral bed for seeds to take hold, reduce compaction and improve better drainage, create more preferable microhabitats for planting tree, and keep the diseases at bay.

Improper and hastily materialized road building techniques, whether haul or skid roads, have often been cited as a primary cause of sediment movement toward lower elevations where a stream drains most of the time in mountainous areas (Eroglu, 2012). Accelerated surface erosion on severely disturbed soils i.e., forest road construction or a logging site is the highest immediately after disturbance (Gorcelioglu, 2004). Logging most certainly contribute to increased accumulations of sedimentation in perennial streams, lakes and reservoirs by disturbing the forest floor, especially during timber skidding. Skidding of timber with tractors, which is the predominant method of transporting logs off the forest tracks in Turkey and any type of rubber tired vehicles causes soil erosion and sediment movement and extensive soil displacement compared to other types of logging methods in which the logs are hoisted off the ground i.e., cable cranes. Logging on wet or saturated soil creates situations that must be avoided at all cost if proper timber harvesting techniques could not be employed. Although there are simple measures like deflating some of the air from rubber tired skidding tractors or hauling trucks/trailers so the enlarged tire footprint better disperses the dragged or carried heavy load to the already weak soil or not so high quality forest road so the degree of

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deterioration can be kept to a minimum (Altunel and deHoop, 1998), there is no hauling truck or logging machinery in Turkey equipped with a system like Central Tire Inflation, which could do such changes in minutes. On the other hand, soil strength and bulk density which are the common variables when checking for soil compaction, were reported to remarkably increase on untreated skidding lanes even after a couple of trips rubber tired tractors make between the felled tree and road side landing. Especially, in the first 10 cm of the mineral soil, soil strength increase ranged from 43 to 139% depending upon the number of trips (Akay, et al., 2007). However, under extraordinary situations where an unpreventable insect infestation or an unexpected wind storm causes extensive damage, and an immediate salvage attempt needs to be performed, then some harvest planning, although not expected to address all concerns, might still ease up the ill effects of a hastily executed logging operation. The utilization of specialized logging systems or implementation of well-organized planning can result in lower costs and acceptable/quickly remedied environmental impacts when compared to one size-fits-all kind of approach (Bayoglu, 1996).

Organizing logging which will minimize or to some degree eliminate the ill effects of the operations can only be achieved if all conditions considered such as size of the track to be harvested, accessibility to and from the track, type of logging machinery to be used, the number of machinery to be used at one time, the volume to be harvested, tonnage of a single load to be skidded, minimum and maximum skidding distances, landing locations, slope, elevation, the length of the harvesting season, etc. are known and orchestrated through an operational planning. Thus, while the output is optimized to the highest achievable level, many environmental constraints would have been taken into account (Eker, 2004).

Natural disasters especially winter storms frequently and unexpectedly impact forests in unprecedented ways in many parts of the world. In average, four million m3 of timber are lost to heavy snows in Europe (Nykanen et al., 1997). Two separate wind storms ravaged 7 million m3 of timber in Finland in 2001. In 2010 again, four consecutive summer storms devastated a total of 8 million m^3 of timber (Gerendiain et al., 2012). In March 15th of 2013, a severe wind storm hit Kastamonu Regional Forest Directorate and caused 1.6 million m^3 of damage in six enterprises. When the nature calls, there is not much anybody can do to stop what's going to happen. However, when cleaning up the salvages, foresters and loggers should not create any additional problems that will adversely affect the environment to recuperate itself.

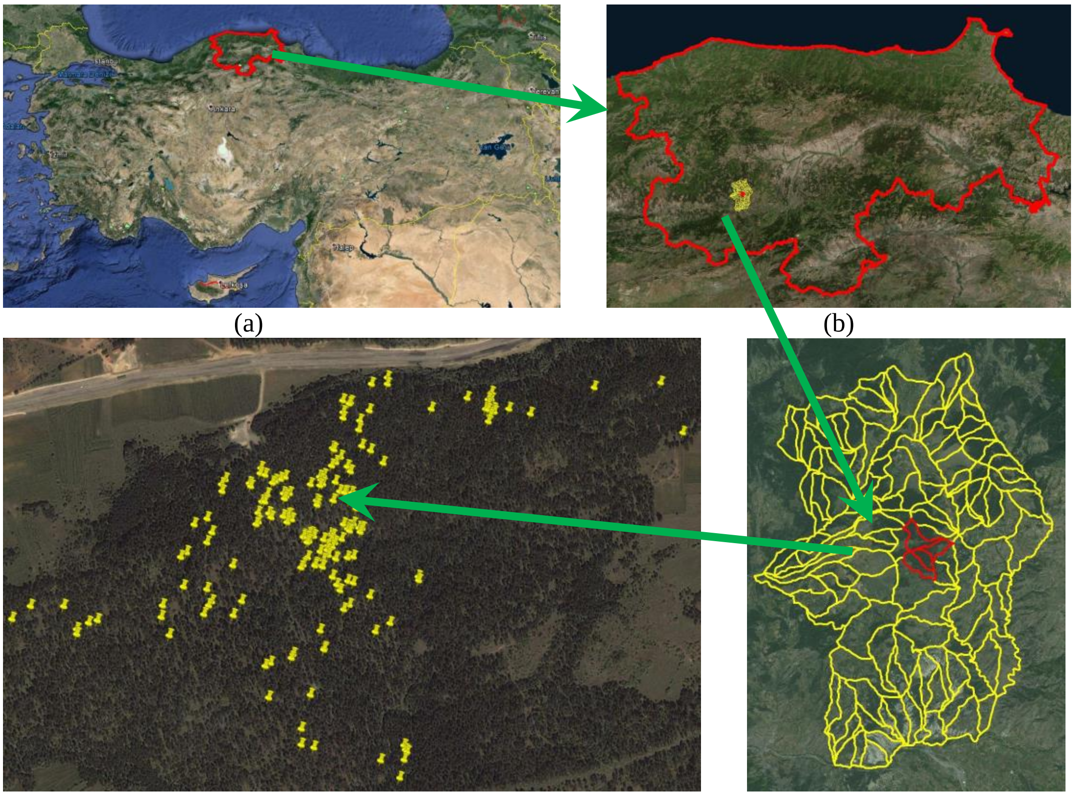
Logging is not a matter of hastily executed decisions. That's why the term Reduced Impact Logging (RIL) has come to the agenda of forest operation starting from the early 2000s. What is emphasized in the principles of "RIL" is not new, however majority of the common practices require strict planning and utmost compliance to the guidelines (Dykstra, 2002). When the concept of careful planning before any undertaking is comprehended, today there are lots of approaches that can be applied to logging. Best Management Practices, which are long been voluntarily applied and executed in the forest operations in the US are good examples. They are formulated to encourage the loggers and foresters to consider harvest planning and careful execution of forest or skid roads that strip the bare soil from any stabilizing cover above, minimizing the traffic crushing the same section over and over, safeguarding any perennial or intermittent stream/creek with protective measures, such as buffer zones, silt fences, etc., and straightening the site to its original status, following the completion of any forest operations (Aust and Blinn, 2004).

As unexpected disasters have kept unfolding, professionals have started developing customized solutions; however one common approach to every dilemma is planning and becoming ready for whatever nature throws at us. This will provide a rather quicker response time in better handling the problem, organization of the work force and available equipment, selection of the suitable techniques to approach the problem(s), arranging the logistical capabilities accordingly and satisfying the financial necessities (STODAFOR, 2004). This study outlined the aftereffects of a logging operation practiced, following a winter storm in a critical location. Besides, some suggestions are provided on how to practice reduced impact forest operations during salvage logging activities.

2. Material and Methods

2.1. Study Area

The study was conducted within the administrative boundary of the Ihsangazi Forest Directorate, which is a part of the Ihsangazi Forest Enterprise within Kastamonu Regional Forest Directorate, 41°17'43" N, 33°31'38" E. An unexpected wind storm with gusts reaching up to 50-55 km/h on the evening of February the 8th, 2015 swept through in and around central Kastamonu township. Consequently, the same storm affected and did moderate level damage on the forests of Ihsangazi Forest Directorate. The data were collected from a picnic site situated along Kastamonu-Karabuk provincial highway housing an old, 90-112 years, Scots Pine stand. Soil type was Brown Forest Soil heavily laden with clay minerals (Atalay, 2006). The geographical location of the directorate and the locations of the fallen trees through which this study was conducted are given in Figure 1.



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

Figure 1. Kastamonu Regional Directorate (a), Ihsangazi Forest Directorate compartments (b), Damaged trees (c) in the red outlined compartments (d)

2.2. Field Measurements

Occasional wind and snow damage, degree of which varies depending on the time of a year, cause losses on the forests of Kastamonu Regional Forest Directorate. In 2013, a serious late winter storm caused extensive damage, ravaging 1.6 million m3 of timber in six forest enterprises of the directorate. The damage caused by the localized storm of February the 8th, 2015 affected predominantly the compartments of Ihsangazi Forest Directorate within Ihsangazi Forest Enterprise. When the news reached our faculty, a team of scholars mobilized and visited the compartments the next day. It was seen that the damage got concentrated along highways and forest roads where road orientation related to wind direction is known to exacerbate the effects of wind speed, turbulence formation, relative humidity and soil drying tendencies (Forman et. al., 2003).

When the compartments along Kastamonu-Karabuk provincial highway checked, it became obvious that the fallen trees were in close proximity to one another and the ground was waterlogged. When the waterlogged area was traced, using a Global Positioning System (GPS), it was noticed there an excessive amount of ground water surfacing within the area (Figure 2).

The data pertaining to the fallen trees such as dbh, length of tree, green stem height, fall direction, crown dimensions, etc. were recorded in order to establish a significance between the stand dynamics and the silvicultural treatments being applied in the area. Also, a GPS coordinate from each root hole and stem butt in order to establish the distribution pattern of the fallen trees was taken and a point cloud was generated. When the point cloud was intersected with the waterlogged area, it was seen that >80% of the fallen trees were inside this area.

Figure 2. Waterlogged ground and fallen trees

When collecting the data (Figure 3), it was hypothesized that the authorities would have difficulty because the forest soil was beyond any acceptable condition to perform any ground based logging. After checking with the responsible engineer we learned the fact that no cable crane was available anywhere in Kastamonu Regional Forest Directorate, nor was there any in the neighboring directories. We thought it would be a real test for foresters to salvage the wood because the common application in Turkey if some unexpected natural or unnatural situation causes damage to forests, it would be best for the sake of the timber to be salvaged or the residual stands, to do the wood extraction in the earliest possible time available to prevent an insect outbreak (Ozcan, 2009).

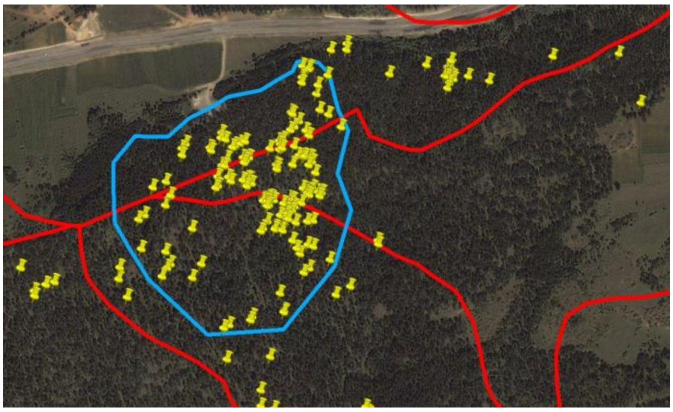


Figure 3. The concentration of the fallen trees in waterlogged area (in blue)

When the timber extraction and the salvage operation were over two months later, the site was revisited and yielded the fact that the logging operation created an environmental disaster because the impossibilities forced the responsible engineer to go with the ground operation, which devastated the forest floor beyond recognition (Figure 4). After seeing the aftermath of one of the worst logging jobs, the skidding routes that were used during the extraction operation were traced, using a GPS and were superimposed over Google Earth to calculate the length of the disturbed forest soil (Figure 5).

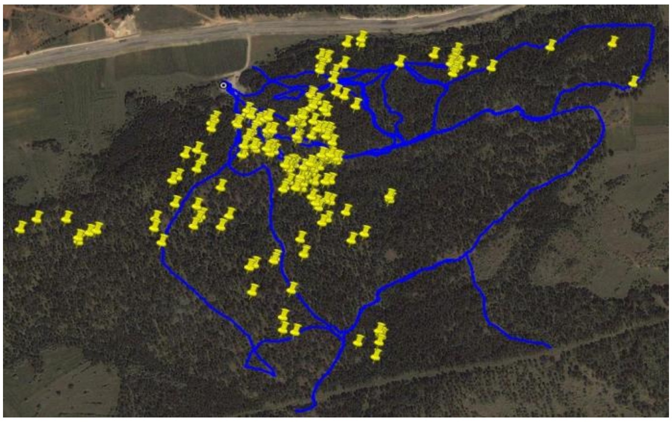


Figure 5. The extend of skidding roads used during timber extraction

The skidding tracks were sampled in linear fashion with a meter stick along the ruts with 20 cm intervals; however, since there were two adjacent rut lines as a result of tractors pulling the logs to the landing, we sampled every other line in each sequential sampling. Whereas, the undisturbed sites were sampled along 3x10 m buffers placed on either side of the skidding tracks in a square fashion with 4 corners and 1 center measurements to cover more ground. Both sampling schemes were averaged in their respected segment to assign a compaction value to the location. A 30^0 cone penetrometer with 2.54 cm^2 basal area and 5 cm height was used to collect the data.

3. Results and Discussion

GPS tracking showed that there was heavy soil damage along 7.3 km of skid trails which were recklessly laid out within the study area during logging operations. Conventional farm tractors with a +/- 3 m tire width created ruts as deep as 40 cm (Figure 6) and caused an amazing amount of soil displacement especially where the majority of the damaged trees were. The salvage operation took place in a 50 ha study area. A simple calculation confirmed the fact that heavy soil damage occurred on more than 2% of the entire study area when excluding the little to moderate damage from the analysis.


Figure 4. Heavy soil damage after ground skidding on wet soil


Figure 6. Deep cuts on forest floor

The alternative skid trail that could be devised through the Google Earth showed that no more than 3 km would have been needed to keep the degree of inevitable soil damage at bay (Figure 7). The situation also created heavy soil displacement and compaction problems inside the stand. Compaction is known to create problems ranging from insufficient aeration of the roots to bad drainage that result in inadequate transmission of the air, water and nutrients to the plant itself is hindered, and plant development in the long run (Savaci and Sariyildiz, 2015).

Figure 7. Google Earth devised skidding roads

To assess the degree of the compaction, a soil sampling scheme is the preferred method of collecting soil related data, because studies have shown that bulk density and soil strength remarkably increased as the skidding road got run over numerous times by skidders pulling the felled timber (Akay et al., 2007). However, these increases varied from little to none as per different soil types (i.e, sandy, clayey, etc.) (Ampoorter et al., 2012). Although the soil damage is a known fact as a result of the logging operations, knowing how and where the samples would be collected is another matter. A 20x20 m north oriented grid was superimposed over the study area (Gorman et al., 2001). This was intersected with the laid out skid trails (Figure 8), and the simple penetrometer measurements were performed from the first 20 cm of the mineral soil with 5 cm intervals. To increase the amount of sampling, the grid cells diagonally intersected with the skid trails were sampled, along with the random undisturbed soil samples for control purposes throughout the area.

In total, 90 sampling points from the skidding tracks and 90 random points from the undisturbed forest floor were taken. The skidding trails were all found under 70 to 80% canopy cover, so there were no significant effect of the sun requiring us to sample open areas and under canopy, independently soil compaction was negligible between the disturbed and undisturbed sites for the first 5 cm on the skidding roads; there was 17% increase within the waterlogged/disturbed area vs 11% increase within the remaining area. There were no noticeable differences in the results from the undisturbed samples on each buffer, however samples taken within the waterlogged area yielded a slight increase, averaging to 1.03 kg/cm^2 vs 0.96 kg/cm^2 of the remaining sample averages (outside the waterlogged area) for 10 cm. On the contrary, results from the disturbed samples produced a different scenario. As expected, no difference was discernible between either rut lines, but soil compaction significantly increased to an average of 1.78 kg/cm^2 within the waterlogged area vs 1.56 kg/cm^2 of the remaining sample averages (outside the waterlogged area).

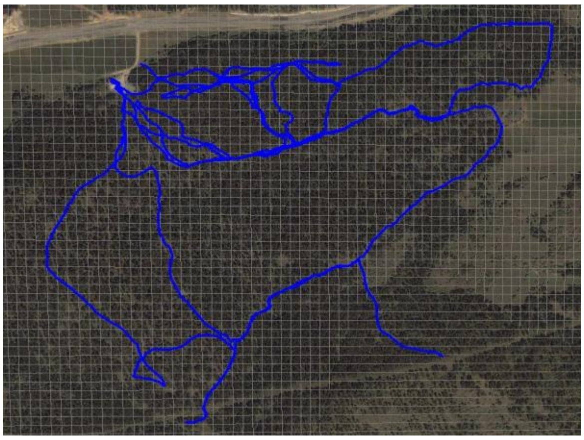


Figure 8. The grids intersected with skidding roads used during logging

The results further worsened to 91% increase for the waterlogged area vs 78% within the remaining areas for 20 cm. Pressure, vibration and shearing stress resulting from logging cause soil compaction (Eroglu et al., 2010). Studies showed that such operations adversely affected the total porosity percentage of sampled soils up to 60% (Herbauts et al., 1996), thus soil bulk density increased in the amount of 22% (Ablan et al., 1994).

This study showed that water presence exacerbated the soil compaction following tractor logging upwards of almost 90% of the control results, while it still worsened the compaction to almost 80% within the remaining areas for the first 20 cm. When routine timber cruising or the ones performed after such unexpected situations is done, the responsible forest engineer announces the operation. The interested parties (i.e., forest cooperatives, villagers etc.) accept the invitation, and the job is scheduled. Whenever the job begins, the track to be harvested and the operation to be carried out are handed over to the loggers who are supervised by the forester working in conjunction with the loggers. Turkish forests are administered, regarding the principles of ecosystem based forest management, and so multiple-use objectives are intended. Besides production, ecological and socio-cultural functions of forests which guarantee the wellbeing of all living creatures are also strictly defined (Notification 299, 2014). However, the practices on the field are overwhelmingly timber production oriented, which knowingly or unknowingly undermines any other function. In such cases, easily avoidable problems become major issues that require whole new approaches to be remedied. The invaluable building blocks of the entire Turkish Forest Service, the forest engineers, need to be as sharp and aware as possible while performing their duties because timber production is not and should not be the only agenda on their mind.

4. Conclusions

Generally, the concept of planning in any endeavor defines the purpose of the task to be carried out as well as the required tools and critical precautions while performing the task. Each harvest plan dictates the foresters to devise a new approach for the case because the parameters will always be different. That's why there is no one-fits-all kind of understanding in forest operations. However, today the practice on the field in Turkish forestry is completely different from what needs to be done. Very good intended and practiced silvicultural applications are set aside when it comes to timber harvesting, and the tracks to be harvested are handed over to forest cooperatives, composed of unprofessional forest villagers, loggers. Since the main agenda of on their mind is to finish the job in the earliest possible time, what happens to forest soil, remaining stand and adjacent creek is not among main issues to consider. Today, possibilities and opportunities are available and easy to reach. Thus, foresters and forest engineers should make wise decisions when it comes to timber harvesting. This is one of the crucial contributions to improve the environment we live in.

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