

Risks Factors Associated with Post-Fire Salvage Logging Operations

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Abstract

Logging operations are generally listed in the most dangerous work groups since they require very heavy and difficult tasks. Besides, they are performed in varying, unpredictable, and uncontrolled work environment. In Turkey, traditional logging operations with limited usage of mechanized harvesting systems potentially increase occupational health and work safety problems. On the other hand, the logging operations can become even more dangerous during timber salvage activities after fire because regular work conditions dramatically change and work environment may carry different risks in fire-damaged stands. In this study, it was aimed to evaluate risk factors associated with post-fire salvage logging operations considering occupational health and safety problems. By synthesizing previously conducted studies and works, potential risk factors in regular logging operations were presented and then additional risk factors related with salvage logging operations were discussed. Finally, some suggestions were provided to reduce risks associated with post-fire salvage logging operations.

Keywords: Post-fire salvage logging, Loggers, Occupational risks, Health and safety problems, Forest fires

1. Introduction

In recent decades, forest fires tend to increase in many regions of the world especially in Mediterranean countries (i.e. France, Greece, Italy, Portugal, Spain, and Turkey) due to their climate conditions (Demir et al., 2009). Forest fires result in serious biological and ecological impacts on forest ecosystems, as well as economic value loss of forest products (Bilici, 2009; Sivrikaya et al., 2014). Thus, pre-fire precautionary measures, fire fighting systems, and post-fire regeneration activities should be well planned and implemented in order to ensure sustainable management of forest resources (Vieira and Marinho-Filho, 1998; Pausas et al., 2004; Akay et al., 2012). Besides, post-fire salvage logging operations can be useful in recovering some economic value of timber and reducing heavy fuels before regeneration (Akay et al., 2006; Coban and Eker, 2010; Ozturk et al., 2011).

The logging operations are still considered as one of the most hazardous occupations in many parts of the world since they are scattered over wide areas with varying and uncontrolled work environment (Akay and Yenilmez, 2008). In Turkey, the logging operations are mostly performed by traditional methods (i.e. mainly relying on human and animal power), which dramatically increases the occupational risks because

the forests in Turkey are mostly located in mountainous regions with rough terrain and difficult working conditions (Bayoglu, 1996; Acar and Senturk, 1999). Moreover, extraction of timber from a fire-damaged stands involves very heavy tasks and even more dangerous working environment comparing with regular logging operations. Especially handling, felling, moving, sliding, and skidding the fire-damaged logs in recently burned stands with difficult terrain conditions may result in a significant risk to the loggers (Akay and Yenilmez, 2007). Forest managers usually aim to extract fire-damaged timber from the stand in the shortest amount of time possible in order to initiate post-fire regeneration activities and to prevent deterioration of timber caused by fungus and insects. However, the forest fires are categorized as one of the main sources of air pollution due to excessive amount of dust and ashes, smoke, and fire related fine particles in the air (Karanasiou et al., 2012; Akyurek et al., 2013). Thus, the loggers who enter the stands just after the fire incidence can experience additional occupational health problems (Hänninen et al., 2009).

There are many studies on occupational risks related with regular logging operations, however, there are very limited number of risk studies involving post-fire salvage logging operations. To ensure safe and effective

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post-fire salvage logging operations, work environment of the forestry workers should be evaluated and occupational health and safety problems in logging activities should be defined. In this study, it was aimed to evaluate risk factors associated with post-fire salvage logging operations considering occupational health and safety problems. Firstly, risk factors in regular logging operations were indicated and then additional risks that have to be taken by logger during post-fire salvage logging operations were discussed. Besides, some suggestions were provided to reduce occupational risks during post-fire salvage logging operations.

2. Risk Factors in Logging Operations

There are number of risk factors that cause work related accidents and health problems in forestry works (Figure 1). In logging operations such factors include physical, chemical, biological, and psychosocial factors (Poschen, 1998).

2.1. Physical Risk Factors

Climate, noise, vibration, dust, and heavy loads are considered as common physical risk factors in working environment (Ponten, 1998). Logging tasks conducted in outdoors can be subject to extreme climatic conditions such as very hot or cold temperature, moist or dry weather, snow, rain, and high wind. Besides, the loggers often work on rough terrain conditions and slippery grounds on steep mountainous areas (Acar and Senturk, 1999). These unfavorable conditions increase the risk of accidents, injuries, and various health problems such as hypertension, high body temperature, the loss of fluids, bronchitis, and colds (Akay and Yenilmez, 2008).

The forestry workers operating mechanized logging equipment and machinery for a long time are vulnerable to vibration and noise related health problems such as white finger disease, weakness on arms, loss of muscle strength, and deafness (Neitzel and Yost, 2001; Akay

and Yenilmez, 2008). The loggers operating chainsaws for a long time usually experience white finger disease due to hand-induced vibration. The operators of heavy logging machinery (i.e. skidder, forwarder, etc.) are exposed whole-body vibration which also causes serious health problems such as repetitive strain injuries to the neck, shoulder, arm, and hand (Ponten, 1998).

Depending on the level and duration of noise effect on the workers, the high level noise caused by logging equipment may also result in physiologic health problems such as hearing impairment, high blood pressure, heart diseases, and breathing difficulties (Piccolo et al., 2005; Serin and Akay, 2008). Many chainsaw operators, who are usually exposed to very high noise levels (i.e. over 100dBA) in regular forestry works, suffer hearing impairment (Ponten, 1998).

The logging operations adversely affect air quality in the harvesting units due to dust generated by logging equipment. The amount of dust exceeded the normal quantity and density level result in important health problem for the loggers (Akyurek et al., 2013). Dust is usually more effective during logging operation in semi-arid regions with hot and dry climates (Mundial, 1991). The source of air pollution during logging operation also includes soil, tire wear, brake wear, non-exhaust emissions, and coarse particles (Stafoggia et al., 2013).

The loggers potentially suffer from heavy load related health problems during logging operations which require intensive use of muscle power. These health problems may include muscle injuries, backache, neck and shoulder sickness, and arm and leg pains (Akay and Yenilmez, 2008). The traditional logging methods relaying mainly on man power requires very heavy workloads (Ponten, 1998). Table 1 indicates energy expenditure required by various logging activities (Durnin and Passmore, 1967). Working in inappropriate working posture also cause serious strain injuries and increase the risk of accidents (Enez, 2008).



Figure 1. Main risk factors in logging operations

Table 1. Energy expenditure in various logging activities

Felling, trimming, etc. with hand tools	Kj/min (for a 65 kg worker)	Mean
Felling	28.5-53.2	36.0
Carrying logs	41.4-60.3	50.7
Dragging logs	34.7-66.6	50.7
Horizontal-sawing by chainsaw	15.1-26.8	22.6
Operating harvester/forwarder	12.0-20.0	16.0

2.2. Chemical Risk Factors

The main sources of chemical risks are forestry machines (i.e. fuel, oil) and chemicals used in forestry (i.e. pesticides, herbicides, etc.) (Kangas, 1998). The fuel contains aromatic (toluene and benzene) and aliphatic (straight-chained) hydrocarbons and some additives which may cause detrimental effects on loggers. Toluene and benzene result in serious problems on central nervous system, immune system, kidney, and liver while additives can cause degeneration of motor nerve cells (Mergler and Valciukas, 1998; Syed, 2010). Portable forestry machines such as chainsaw consume mixture of fuel and lubricating oil which leads to irritation and skin problems (Kangas, 1998). Besides, fuel and oil are recognized as powerful explosive materials with very high fire risks.

Chemicals are usually defined as pesticides, insecticides, herbicides, fungicides, and fertilizers (Page, 1998). Pesticides and insecticides are used to control and kill insects in forests, while herbicides are used to control hardwood brush, weeds and grass in young coniferous stands (Kangas, 1998). Fungi cause diseases in living plants and also damage non-living materials such as woods (Kaloyanova-Simeonova, 1998). Fungicides are used to prevent diseases and damages on plants and woods caused by fungi. Fertilizers are used to enhance the growth of the plants and usually they are in the form of ammonia, ammonium nitrate, urea, ammonium sulphate and ammonium phosphate (Page, 1998).

Mostly forestry workers who are mixing and applying these chemicals may suffer from health problems (e.g. headache, dizziness, nausea, high temperature, low blood pressure, heart and liver injury) since they expose to the concentrate at first hand (Kaloyanova-Simeonova, 1998). The risk of exposure to these chemicals is typically low during logging operations. However, if they work close to application area, loggers can be also affected by the chemicals, especially female loggers who have smaller lung volume.

2.3. Biological Risk Factors

The loggers who are active in the field are exposed to biological risks such as plants and woods, draft animals, infections and diseases transmitted by animals, and poisonous creatures (Augusta, 1998). They may suffer from allergic reactions to plants and woods, and pollens. The draft animals used in logging operations (i.e. horses, oxens, etc.) may cause injuries as a result of unexpected movements.

The infections and diseases transmitted by animals are considered as the most significant biological hazards. Some of these hazards are dengue fever, malaria, rabies, tetanus, and tuberculosis (Augusta, 1998). One of the most dangerous and life-threatening risk for the loggers out in the field is bitten by a poisonous creatures such as snakes, spiders, bees, wasps, and scorpions. This biological hazard requires immediate care and professional treatment.

2.4. Psychosocial Risk Factors

Psychological and social risk factors in forestry operations may include the mental workload, stress and stress related problems, occupational risk-taking, work pressure, low profile work status, social isolation, and separation from families. Besides, working overtime, fatigue, difficult environmental conditions, insufficient work organization and teamwork requirements are considered as other psychosocial risk factors (Poschen and Juntunen, 1998). When these psychosocial factors interact with the wide range of risk factors described in previous sections, a circle of occupational problems can be encountered (Figure 2).

Among the work types in logging operations, harvester operator can be considered as a work type that exposes the highest psychosocial risk factors since operation requires large number of fast decision in a short work cycle and operators have to perform various tasks that closely affect profit (Poschen and Juntunen, 1998). Assuming that operator had proper training, mental workload capacity and stress tolerance of an operator are the main limiting factors for operational productivity (Gellerstedt, 1993).

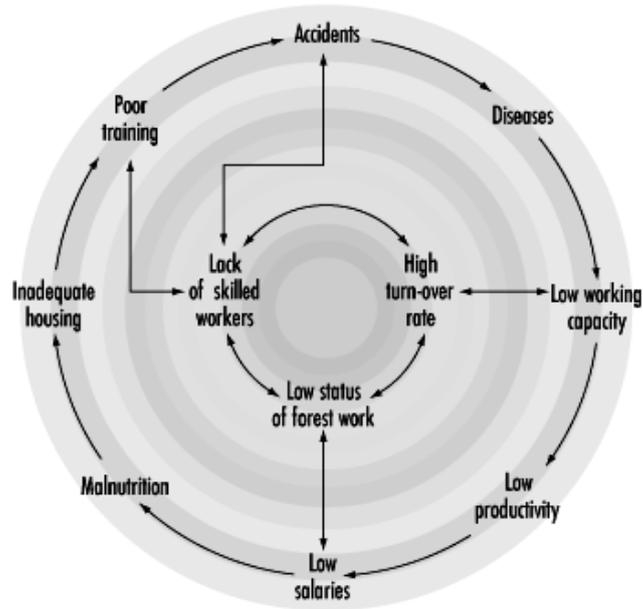


Figure 2. The circle of occupational problems encountered in forestry works (adapted from Poschen and Juntunen, 1998)

3. Post-fire Salvage Logging

The logging operations during timber salvage activities after fire involve similar risk factors associated with regular logging operations. Moreover, salvage logging operations can be even more dangerous because regular work environment dramatically alters in fire-damaged stands and that leads to different risk factors (Figure 3). Timber extraction activities are usually performed soon after the fire incidence to recover most of the economic value of fire-damaged timber with minimum deterioration. Besides, in most cases burned stands are to be made ready for post-fire regeneration activities in a short period of time; therefore, the loggers working on timber salvage activities often encounter additional risk factors when working in freshly burned forested areas. In this section, these additional risk factors are discussed and suggestions are provided to reduce risks associated with post-fire salvage logging operations.

3.1. Physical Risk Factors in Post-fire Salvage Logging

The loggers who are performing timber salvage activities usually work in hot and dry weather condition which increases the risks of various health problems such as tiredness, exhaustion, allergy, blood pressure, and influenza (Figure 4) (Akay and Yenilmez, 2007). Adequately light clothing, as well as sufficient washing and drying facilities should be provided to the workers. Besides, the loggers should drink sufficient amount of water to keep the body fluid in balance.

Due to intensive logging activities in the field, they suffer from vibration and noise related physical hazards. The severity of these hazards highly depends on the duration of exposure (Ponten, 1998).



Figure 3. Hazardous working conditions during felling of fire-damaged trees (Photo: E. Bilici)

In order to minimize the risks of chain-saw related vibration, modern chain-saws, equipped with anti-vibration dampers, should be used in the field. The loggers should also use noise protectors. Whole-body vibration effect on operators in forestry machines can be reduced by using vibration-damping seats.

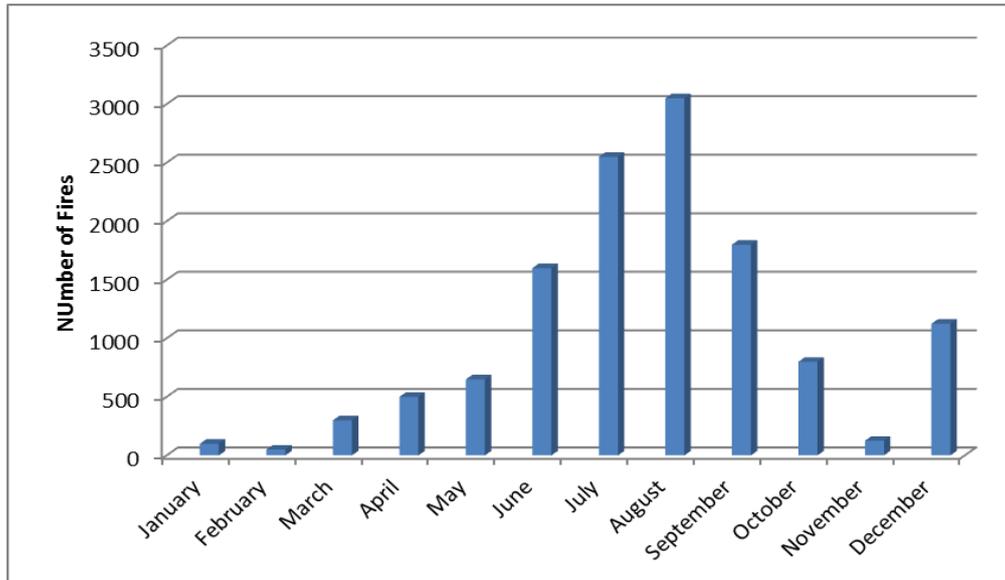


Figure 4. Number of forest fires per month in Turkey (2005-2010) (adapted from GDF, 2011)

The loggers who start timber extraction just after the forest fires often face air quality related health problems due to excessive amount of dust, ashes, smoke, and fire related fine particles in the air (Hänninen et al., 2009). These problems include shortness of breath, respiration and lung sickness, and redness and itchiness in eyes (Figure 5). In order to minimize these health problems such as dust, ashes, smoke etc., the loggers should be warned and encouraged to use personal protective gears (i.e. gas masks, glasses, etc.). The cabin of the forestry machines should be well insulated against air pollution sources.

The heavy load related health problems increase during salvage logging operations, especially when applying manual methods on difficult terrain and ground conditions. The backache, arm and leg pains, and neck and shoulder sickness are the most common heavy load related problems. The heavy load related risks can be reduced by taking frequent rests during work and implementing rotations among various jobs.

3.2. Chemical and Biological Risk Factors in Post-fire Salvage Logging

Fuels, lubricants, and other substances used by forestry machines are the major source of chemical risks factors during salvage logging operations. The chain-saw operators are the most exposed loggers who suffer from serious health problems due to these chemical hazards (Kangas, 1998). To avoid exposure to these chemical hazards, the loggers should use personal protective equipment such as masks, gloves, etc.

In timber salvage activities, the loggers often work on difficult terrain and slippery surface which increases risk of unforeseen accidents especially using draft animals for logging. Draft animals used during logging operations should be trained to safely drive or pull various equipment on difficult terrain. Other biological hazards may include danger of poisonous creatures that stayed alive after low-intensity fire and hiding under debris. Therefore, the logger should be extra careful when removing debris during salvage logging activities.



Figure 5. Salvage logging operations on dusty ground in burned Brutian pine stand of Bursa, Turkey (Photo: E. Bilici)

3.3. Psychosocial Risk Factors in Post-fire Salvage Logging

In most countries, logging contractors aim to extract fire-damaged timber from the stand in a specified time periods, otherwise they have to pay high penalty costs for every single day beyond the given due date. This critical time limitation often causes a chaotic situation and increases the pressure on the loggers which can lead to stress related psychosocial problems. Thus, it is very important for logging managers to develop and implement after-fire action plans for safe and effective salvage logging operations (Bilici, 2014).

The logging managers offer lower wages for the loggers in order to reduce total cost of logging operation, since economic value of fire-damage timber is lower than that of regular timber. For salvage logging operations, the managers sometimes hire seasonal forestry workers with low wages. In these cases, the loggers tend to quit their jobs due to inadequate working environment and low wages. On the other hand, when the loggers are paid based on unit price system, some loggers may work even harder by pushing their limits to increase productivity and their income. However, physically heavy working for long shifts results in excessive tiredness, exhaustion, and sleeplessness which then increase the risk of accidents and health hazards (Menemencioglu, 2012). Therefore, the logging managers should improve the wages, work environment, and living conditions of the loggers in order to ensure safe and effective salvage logging operations (Apud, 1998).

3.4. Training for Post-fire Salvage Logging Operations

Effective training programs today not only include productivity, product quality, and environmental protection issues but also occupational health and safety problems (Garland, 2013). In fact, the training of the loggers working in post-fire salvage logging operations is crucial to minimize occupational health and work safety problems. Therefore, appropriate training should cover topics such as proper work techniques, work organization, precautionary measures, hazard recognition and risk avoidance, prevention or minimization of injuries during logging activities (Poschen, 1998).

On-the-job training method has been implemented in forestry activities; however, this inefficient method mainly depends on trial and error concept, which increases the risks of accidents and health problems (Gumus and Turk, 2012). Technological advances and the complexity of logging machines require well trained loggers with high skills. Training programs should start with high level technical training and followed by onsite training of the loggers (Enez, 2008).

Onsite training is very effective method since loggers face actual working conditions and experience safety issues and production concerns. Worker training

programs play important role in reducing number of fatal logging accidents (Melemez, 2015).

After forest fires that destroyed very large areas, temporary loggers from other regions are hired to finish timber salvage operations in short amount of time. Those temporary loggers who are not familiar with post-fire salvage logging operations are subject to high risk of accidents and health problems. Thus, special training sessions should be provided for temporary loggers to prevent potential occupational problems.

4. Conclusion

The risk factors associated with post-fire salvage logging operations should be carefully evaluated in order to reduce occupational health and safety problems. If these risk factors and their main sources are identified, necessary precautionary measures can be taken to minimize the risks of accidents and other health hazards. In this study, occupational risk factors related with post-fire salvage logging operations were discussed considering physical, chemical, biological, and psychosocial factors. Then, some suggestions were provided to reduce these risks during timber salvage operations. The necessity of training was emphasized and some of the key points for effective training programs were highlighted. It can be concluded that fully elimination of every occupational hazards related with salvage logging is not possible; however, if the risk analysis is performed by estimating the possibilities of these hazards and their potential magnitudes, effective prevention techniques can be provided to minimize these hazards. Thus, the follow up study might involve complete risk analysis of salvage logging activities based on data from a sample logging operation in the field.

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