THE IMPACT OF LOGGING WORKS ON THE MAIN COMPONENTS OF FOREST ECOSYSTEMS - SHORT REVIEW

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ABSTRACT

By their nature, logging works generate various negative effects on the forest ecosystem, through the damages brought to its components. The objective of this paper is to establish, on the basis of an extensive bibliographic study, the specific damages to the components of the forest ecosystem and to study the tolerability thresholds of the main components of the forest ecosystem, with the implementation of logging works. Thus, the main research methods used, were bibliographic research and analysis and synthesis. According to the current state of knowledge in the field, damages to forestry are represented by changes in the natural state of soil, seedlings and trees, produced through anthropogenic interventions in forest care and regeneration, that can adversely affect the further development of forest ecosystems. The paper summarizes the main national and international classifications, on the damage caused to the main components of the forest ecosystem by logging. At the same time, the main researches in the field are mentioned, identified in the specialized bibliography and presented in the paper in chronological order. All the mentioned aspects regarding the damages of the forest ecosystem components are presented for trees, seedling and soil. The conclusions bring together the most relevant aspects of research on damage caused by logging works.

INTRODUCTION

Through their nature, anthropic interventions for tending and regenerating forests generate different negative effects on the forest ecosystem as a result of the damages brought to its components (Blaga et al., 2019; Dincă et al., 2019). The damage represents a change in the natural state of soils, seedlings or trees caused by anthropic interventions in forest tending and regeneration with negative effects in the further development of forest ecosystems.

The definition above emphasizes the fact that not every action of applying silvicultural works causes damages on the forest soil, the seedling that must be promoted or the trees that remain in the forest after the works. The damages are represented by actions that exceed the tolerance degree of the forest ecosystem components and that lead to numerous damages and dysfunctionalities.

Regardless of their nature, regeneration works must be followed by economically rentable conditions fort the forest maintenance, regeneration and wood extraction. These conditions are represented by expenses accepted by society, by using equipment of increased productivity and by respecting silvicultural conditions of achieving the objectives proposed. As such, the realized works must have a damage level that does not exceed the general tolerance level of the forest ecosystem and especially of its components (Chisăliţă et al. 2011).

A long-term analysis cannot easily differentiate economic loses from the ecological ones; a certain damage can be considered an intervention result and a function that depends on a specific value system. Because of this fact, a better approach of the impact of interventions in the forest's life is represented by

identifying its sensible areas and adapting work methods to its specific restrictive conditions (Horodnic 2014).

The classification of damages takes into account the nature of the ecosystem's elements that can be prejudiced through applying silvicultural works and represent its sensible points. As such, we can differentiate between:

- Forest soil damages;
- Seedling damages;
- Standing tree damages.

The impact of logging works on the main components of forest ecosystem must also be viewed from the perspective of current climatic changes (Dincă et al., 2018; Constandache et al., 2018; Vizitiu et al., 2018; Constandache et al., 2019; Vlad et al., 2019).

The present paper intends to illustrate the main classifications of damages brought to forest ecosystems by forest exploitation works based on a large national and international bibliographic study.

MATERIAL AND METHOD

The materials used for achieving the purpose of this paper consist in magazines, brochures, books, international databases as well as specialty articles that present the results of investigations in the forest exploitation domain.

The research methods used were represented by bibliographic research and documentation as well as by analysis and synthesis. These methods are presented in more detail below.

Bibliographic research consists in consulting all the possible bibliographic sources that help in fulfilling the paper's purpose. The bibliographic sources were selected from international and national specialty literature works. As such, the bibliographic documentation was realized in order to study the specialty literature works that approach researches regarding the damages caused to forest ecosystems by wood mass exploitation works and their impact on the forest.

Analysis and synthesis were then applied to the consulted bibliography and allowed to filter the information presented in these sources. The information that corresponded to the proposed purpose was then chosen and presented. In this way, the sources that were chosen were those that approach the subject of damages caused to forest ecosystems resulting from applying wood mass exploitation works.

RESULTS AND DISCUSSIONS

In order to satisfy both interests regarding the harvesting of wood material as well as the necessary conditions for natural regeneration and the creation of healthy stands that are also economically valuable, it is necessary for work technology and methods to be synchronized with adequate treatments for the essential characteristics of stands and with the major requests of conserving the forest's protection potential. Damage threshold (limits) are necessary to be established for remaining standing trees, seedlings and soils in order to satisfy silvicultural and functional requests. These limits should be supported by the forests and should avoid the derangement of forest ecosystem production and protection functions (Dămăceanu and Gava, 1991).

The impact of exploitation works on the forest ecosystem's main components was studied in the specialty literature, namely in works that have approached this thematic or a collateral one over time. The results of the present paper consist in succinctly comprising and comparing the investigations from the forest exploitation domain from the perspective of damages caused to the forest ecosystem's main components.

In our country, the first normative acts that have indicated the admissible limits for damages caused to seedlings when cutting forests with restrictions were represented by MEFMC nr. 380/1969. For regulating other aspects, these were followed by the Ordonnance of the

Ministry Council number 920/23.VII.1973, the State Council Decree nr. 248 and Law nr. 59/1979 regarding the evaluation of soils removed from the economic circuit.

In regard with investigations regarding the damages caused to the forest ecosystem by anthropic interventions for forest maintenance and regeneration, Petrescu (1980) has determined the damages brought to trees in relation with the collection technologies and methods. In addition, he also established criteria for situating trees in damage classes. Călugărescu et al. (1980) have approximately established limits for the frequency damages caused to soils as well as admissible limits for damages caused to standing trees. In 1980, Giurgiu proposed that future technical norms for choosing and applying treatments and establishing work technologies should also include silvicultural restrictions on treatments. Four years later, in1984, Rotaru has shown which are the bearable effects for stands in regard with soil damages. Dămăceanu and Gava (1991), have realized, within ICAS experimental basis, researches for establishing the minimum damage thresholds for trees, seedlings and soils, by applying silvicultural works, In 2009 Spârchez et al. has shown that measurements along tractor roads and harness tracks up to 5 m from the ax of these collection ways are necessary for studying soil damages.

More recent works were published by Boghean and Dragnea (2001, 2003), namely on new work techniques and procedures that minimally satisfy forest protection exigencies. Ciubotaru and Nicolescu (2011) focused on soil damages caused by wood mass harvesting and collection. Carpea Laura Ionela et al. (2009) realizes investigations regarding standing tree damages caused by anthropic interventions for forest maintenance and regeneration, while in 2011 Ciubotaru and Nicolescu have published researches concerning soil damages caused by the same activity. Chisaliţă (2015) focused on researches regarding the elaboration of technical norms in forest exploitation and approaches the problem of damages caused to forest ecosystems.

In Balkan countries, researches realized by Cudzik et al. (2017) indicate the fact that the extension of damages caused by tractors depend on the exploitation method and the number of car circulations. A largest diversity of ditch depth appears during the “trunk and mast” exploitation method than during the “definitive stub assortment” method. A higher percentage of damaged trees was found during the “trunk and mast” exploitation method. The highest percentage of damages was observed at primary tractor terraces. For both exploitation methods, mechanical damages of residual trees are numerous in the case of trees located on the margin of collecting roads. These injuries are situated especially on root insertion and on the trunk’s inferior part (Kachova et al., 2015; Cudzik et al. 2017; Hinkov et al., 2019).

Investigations realized in the same European region show that forest exploitation is an example of the strongest human influence on the forest environment because it causes damages to both forest soil and residual trees. Damages that appear during exploitation are more frequent in the gathering process compared with the harvesting one. Knežević et al. (2018) have researched the impact of forest exploitations with harnesses in a fir and Norway spruce mixture forest. According to them, it can be assumed that harness exploitation causes insignificant damages to residual trees. The most frequent damage type was tree barking (61,54%), followed by grazing (23,08%) and splintering (15,38%). Damage length varies between 60 and 570 cm^2, with an average damage length of 222,54 cm^2 (Knežević et al. 2018).

In other European countries, as shown by Dămăceanu (1991), the problem of forest ecosystem damages was approached from 1937 (Rohmeder).

However, investigations became more intensive after 1940, coinciding with the introduction of mechanization (Doble, 1962; Zicha şi Kato, 1967; Steiner, 1968; Reeder, 1972) (Dămăceanu și Gava, 1991).

Horodnic (2014), quoting Furuberg Gjedtjernet (1995), has shown that the interest for reducing prejudices from forest interventions decreases with the increase of the mechanization's degree.

Current preoccupations regarding damages brought to forest ecosystem components belong to researchers from München's technical university which have created a system for classifying the damage degree of roots under the action of the certain machineries.

The Forestry Development Center from Tapio (Finland) defines root damage as the one manifested around the trunk's ax (the effects are considered economically insignificant if they exceed 1 m). Furthermore, injuries lower than 20 cm are not considered root damages (Horodnic 2014 quoting Owende et al. 2002). The same Owende et al. (2002) affirms that the formation of gullies can be considered soil damage if the trace's depth is larger than 100 m for more than 10% of the track's length.

At a global level, investigations that approach the problem of damages brought to forest ecosystems by exploitation works were initiated on the majority of continents.

In Africa, investigations realized in tropical forests have shown that selective exploitation has some important negative effects on the forest's structure, dynamic and biodiversity, as well as on its ecosystem services. These effects can truly be evaluated only on long-term, by analyzing the dynamic evolution of repeated exploitation and not the average value of structure indexes, which are connected to the stand's density (Cazzola et al. 2015).

The impact of wood mass selective exploitation was analyzed in Gabon in 2011 by Medjibe et al. (Medjibe et al. 2011)

In the Middle East, the evaluation of damages on trees remaining after selective exploitation in a broad-leaved forest are initiated in countries such as Iran by Nikooy, M. (2010). Studying cutting phases, the formation of tasks and collecting wood mass during the technological harvesting processes (with electric saw) and collecting processes (with skidder tractor) offer the possibility of analyzing not only the damages caused to residual trees but also the classification of damages on technological processes, tree species, location, length and types of damage. The effect of these factors on trunk damages should be well understood in order to adequately plan a wood mass exploitation with minimum damages (Nikooy 2010).

In South America, researches realized in Amazon basin on soil compaction after forest exploitation have shown that forest managers must take into account the potential impact caused on regeneration by soil perturbation on tractor roads. This is essential as numerous management systems depend on natural regeneration. In addition, if the surface of a tractor road takes over 30 years to recuperate its compactness induced by cars, the surface covered by tractor roads should be considered as unproductive terrain for forest regeneration as long as soil treating works are not realized (DeArmond et al. 2019).

In Asia, investigations realized 19 years after harvesting wood mass in exploitation parcels from Mongolia tackle the quantification of the impact of selective forest exploitation on soil properties and regeneration methods with linear mixt models (LMM). These researches have shown that organic matter, total nitrogen, potassium and pH are especially affected by forest exploitation. Their analysis has shown that values for all these variables indicate a linear decrease once the selective forest exploitation intensity increases. Another important observation of this

study is that selective forest exploitation with reduced and medium intensities can promote a natural regeneration for Silvester pine with higher values than the ones from other reference surfaces. However, intensive wood mass exploitation and razing cuttings limit the regeneration of Silvester pine, reduces the total number of plants and creates conditions that are adequate only for the regeneration of broad-leaved species (Sukhbaatar et al. 2019).

In Indonesia, Bertault and Sist (1998), have realized experiments for reducing the impact of different works on stands, while in 2005 Putz et al. have studied the decrease of the impact of interventions in tropical forests by focusing on challenges and opportunities.

By taking into account all the information presented above, it is important to specify that not all injuries can be considered as damages. This notion should be applied only for the ones that exceed the tolerance threshold of each component and of each forest ecosystem. In order to investigate and evaluate the damages from wood mass exploitation and to differentiate them based on the tolerance thresholds, it is necessary to include an initial inventory and analysis of all damages. These should then be observed in time, namely to differentiate the ones that become permanent (unmaking wood, making the soil unproductive or seedlings unusable) from the ones that can be cured over a certain time period.

CONCLUSIONS

As it can be seen, the present paper has realized an ample analysis on the topic of damages caused by forest exploitation, both nationally and internationally, by approaching the main researches realized in this field and the main international research directions.

In our country, the first normative acts that have indicated the admissible limits for damages caused on seedlings date back to 1969 (MEFMC nr. 380/1969), and were followed by decrees and orders in 1973 and 1979. Investigations have begun in 1980 and continue to this date.

In other European countries, the problem of damages brought to forest ecosystems was approached earlier, starting with 1937, but have amplified after 1949, once mechanization was introduced.

Recent investigations from Balkan countries, European ones or from other continents, approach the damages brought to all forest ecosystem components, including soil, trees and seedlings.

Future investigations, adapted to new technological systems used in this activity and their analysis in the context of current damages, can help in scientifically establishing the tolerance thresholds of the main forest ecosystem components.

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