

## ROAD TRANSPORTATION OF TIMBER AND FOREST ZONES POLLUTION

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**Abstract:** *Road transportation of timber presents undesired effects upon the environment, determined by pollutant factors which appear in the respective transport process: noise, vibrations, exhaust gases, dust deposits etc. In this context, in the present paper we analyzed the influence (action) of each factor on forest vegetation, the influence intensity as well as the possibilities of counteracting and limiting of the noxious effects. The antipollution functions of the forest are emphasized, functions which are to be considered in the strategy plans elaboration which follow the environment planning.*

**Key words:** *forest vegetation, vibrations, noise, exhausts gases.*

### 1. General Aspects Regarding Timber Transportation on Roads

As any transport activity, timber transport supposes, on one hand, the existence of a transportation infrastructure, and, on the other hand, the existence of transportation means. In timber transport, the base activity in forest economy, as transportation infrastructure is concerned, forest roads along with public roads, and, as transportation means, specialized vehicles, generally with increased gauge dimensions are utilized [7].

Timber movement from stump (harvesting zone) to a depot or processing center is realized in two consecutive stages: from stump to landing site [5] - small distance transportation known as timber logging, and from landing site to a timber processing center - long distance transportation.

The short distance transportation - called logging - is developed generally in forested areas, and it has the role of successive

concentration of wood to a permanent transportation construction. The timber logging operations are realized by using temporary installations [5], which, by their construction are generally cheaper and applied only for a short period. Presently, timber logging is realized in accordance with local conditions, with tractors or cableways, or with machines derived from these machines (tower-yarders, combination machines etc.).

Timber transportation from a landing site to a permanent facility or processing unit is called long-distance transport, or timber transport, and it is developed both, in forested areas as well as in forest exterior, on forest roads network which is connected to the national public network.

Due to the fact that timber logging is generally more expensive than timber transport, the trend in forest management follows the rational development, in forested areas, of the permanent transportation network, in order to gradually

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reduce the logging distances. Consequently, timber transportation network must be regarded as a unitary system, in order to avoid logging distance increment and to be uniformly distributed on the forest surface. Also, it has to comply with an adequate transportation capacity, which, first and foremost, must respond to harvestable stands utilization [1].

The vehicles used in forest transport [8] display variable characteristics (forest train-trucks vehicles, trucks, auto platforms) and they can be of Romanian manufacture (older or newer concepts), or of foreign manufacture. In Figure 1 (as a representative vehicle) the ROMAN 26.230DF vehicle, equipped with diesel engine, 230 HP, EURO2, 6x4 traction and net load of 26,000 kg is presented.



Fig. 1. *Roman 26.230 DF vehicle*

As for Romanian more recent and respectively more performing forest train-truck vehicles, we mention R.26.410DF forest vehicle (Figure 2), equipped with platform for timber transport, MAN EURO 3 Diesel engine, 410 HP, 6x4 traction and net load of 40,000 kg.



Fig. 2. *Roman 26.410 DF vehicle*

In the last period, in the Romanian forest traffic a variety of foreign manufacture vehicles, like MAN 26.460, EURO 3, and net load of 13,600 kg appeared (Figure 3).



Fig. 3. *MAN 26.460 EURO 3 vehicle*

## 2. Pollutant Effects Generated by Timber Transportation

Timber transportation on forest roads affects the environment especially by: noise, exhaust gases, dust deposits etc. Also, there can be added the vibrations provoked by engine running, which do not affect the environment but the vehicle itself, contributing to the driver discomfort as well as forest workers taken as passengers to their work site, by using the unloaded haul of the vehicle (in case of vehicles endowed with special bodies), in order to obtain a better transportation capacity; also, the negative effect of vibrations is felt by the persons who are walking on forest roads towards certain touristic objectives.

The above mentioned emissions constitute the objective of the present paper, except dust deposits which are to be treated in another paper.

### 2.1. Noise and vibrations

Noise is an assembly of disagreeable discordant sounds, produced by one or more elastic environments which act on human organism, provoking a state of psychic irritability, as well as functional

and organic modifications with a pathologic character [2].

For a certain frequency, there is an inferior sound intensity limit called lowest threshold of audibility, as well as a superior sound intensity limit called threshold of painful sensation (in the internal hear the pain sensation is felt). The amplitude between the mentioned limits (Figure 4) is represented by audibility area [9].

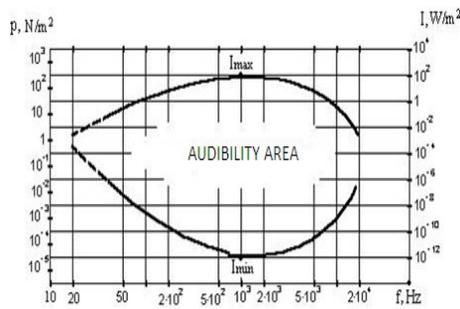


Fig. 4. Delimitation of the audibility limits according to sound frequency [9]

The level of noise produced by forest traffic varies according to the vehicle the vehicle type, traffic speed, traffic intensity, and lateral distance of the road for which determinations are made. The average values of the noise, according to the mentioned parameters are presented in Tables 1 and 2.

Forest vegetation presents an increased capacity of noise absorption. Thus, a forest strip of 25...30 m, realized from 5-6 tree rows,

Table 1  
The noise produced by road traffic

Vehicle type	Traffic speed, [Kmh <sup>-1</sup> ]	Lateral sampling distance, [m]	Acoustic level, [dB]
Auto vehicle	50	6	74...84
Bike	60	7	81...98
High tonnage camion	50	6	85...97
Tram	30	5	83...90

Table 2

Traffic noise measured at different distances from the road, according to traffic intensity

Traffic intensity [vehicles/minute]	Acoustic level at distances of ... m [dB]		
	6	30	120
100	73...77	58...63	46...51
10	63...68	49...53	38...42
1	55...59	41...46	29...33

decreases the noise intensity with approximately 1.8 dB each row; a greater reduction of sound pollution is obtained if the rows are Z-shaped [4].

The noise reduction capacity provided by forest vegetation is in relation with forest species. For example, trees with big leaves and dense crowns are likely to provide a better sound shield. The resinous species are the most recommended in antiphonic strips construction due to the fact that they maintain their leaves during the hibernal season [6].

By considering the above mentioned elements, it can be appreciated that, in the case of forest road traffic, effectuated with increased tonnage vehicles, and having a reduced and intermittent intensity, the acoustic level varies according to distance, from 86 dB at the road edge to 30 dB at distances of 120 m.

In the timber transportation activity, frequently occur such situations in which, for a superior utilization of forest transportation, on the unloaded transport direction, the forest workers are moved to the working sites. In this situation, the forest workers are affected by noise and vibrations generated by engine running, and which are transmitted to the entire vehicle and passengers through the vehicle's body.

Vibrations are high frequency and low amplitude oscillations which appear on vehicle movement due to engine running and friction forces. When they exceed a certain limit, they become harmful, causing,

in time, severe organic perturbations which are harmful to people's health.

It was concluded that trucks generate vibrations of 2...4 Hz, which can increase according to the duration and frequency of vibrations transiting the human body. According to scientific literature, neural and osseous systems disturbances appear at frequencies between 4...36 Hz, and, at frequencies between 2...250 Hz, disturbances in the circulatory system appear. In road transport of timber, vibrations are maintained generally below 15 Hz.

Both, noise and vibrations, from the point of view of their acting level, depend on vehicle characteristics, roadway nature, respectively roadway type and its uniformity.

In order to attenuate, eventually remove the noise and vibrations generated by engine running, the following measures are recommended:

- Regarding the vehicle:
  - elimination of clearances between piston and cylinder;
  - assuring a great rigidity for crankcase walls and for carburetor distribution mechanism caps;
  - utilization of some rubber dumpers in order to reduce vibration transmission from engine to vehicle's body;
  - utilization of some electric engines powered by batteries;
  - coverage of metal-sheet surfaces with antiphonic paints;
  - luting foot command openings.
- Regarding the road:
  - reducing of movement speed to at most 50 km/h in order to reduce the level of noise and vibrations generated by skid-proof tires (adopting of some neat silent tires, which generate emissions lower by 18 dB than skid-proof ones is considered non-recommended due to the fact that the forest roads roadway is wet most of the year);
  - adopting some roadways which would offer plain surfaces, providing, at the same time, a proper adherence.

## 2.2. Exhaust gases

Environment pollution through exhaust gases, caused by vehicle traffic is felt throughout the whole length of the road, affecting air quality, and through it, both, forest and non forest vegetation.

As a general line, the vegetation is polluted, mainly, by the following factors: sulfur and its compounds, fluorine combinations, arsenic, nitrogen compounds, carbon dioxide and lead deposits.

It was found that in the 20<sup>th</sup> Century Romania, approximately 15,000 ha from the total forest fund were affected by pollution. The pollution level produced by forest transport increases in the same time with the vehicle's tonnage increment; the first one is in direct correlation with fuel consumption. In this context, timber transport becomes one of the principal atmospheric pollution sources, being 30...40 times greater than that determined at the beginnings of forest industry.

In 1984, at the Munich Conference, under the aegis of the UN, causes and prevention measures of forest vegetation damages provoked by atmospheric pollution were analyzed, and the recommendations for a non degraded life environment were the use of gasoline lead-free fuel as well as the reduction of sulfur, nitrogen oxides emanations by at least 30%.

Research regarding these aspects was oriented in three directions as following: the effect of exhaust gases on the forest vegetation, forest tree species resistance to certain pollutants and synergies between forest and pollution counteracting.

It was found that the photosynthesis process, necessary to the growth and development of forest species is determined by the sulfur dioxide which together with sulfur, nitrogen and fluorine products, determine severe damages to forests through acid rains.

Regarding the sulfur interception by

forest vegetation, several mechanisms as the following are known:

- leaves and small branches retain a part of the sulfur dioxide and they modify their color;

- forest vegetation is capable of retaining 150 t/ha which is very few in comparison with the total emitted sulfur dioxide;

- trees' capacity to eliminate the absorbed sulfur, such as hydrogen sulfide, decreases pollution intensity.

In the areas polluted with sulfur, species which are resistant to pollution like cypress, thuja, red oak, beech, sycamore, manna ash etc. are recommended [6].

Lead from exhaust gases has negative repercussions on the forest vegetation through its deposits in the leaves, even when they are located at 100 m from the pollution source. These deposits can gain over 100 p.p.m. lead in dried vegetal substance, provoking the contamination of both, special cultures for game food as well as of agricultural products for general alimentation.

Usually, vegetation contamination with lead is reduced by the washing away of the deposits generated by periodical rains. Also, for this purpose, along the road, at a 10 meters distance, a strip of shrubs having a width of 6 meters, which assures a permanent reduction of lead deposits by 10% can be planted. The most resistant forest species on lead action are: Scots pine and tuja [6].

Important damaging effects for humans are carbon monoxide and nitrogen oxides, which result from engine emanations as well as fossil fuel combustion.

Nitrogen oxides enter leaves through stomata, without causing any closing effects, negatively acting upon the entire forest ecosystem, by soils and waters acidification as well as by forest vegetation sensitizing to action of some environment factors as drought, freeze and biotic factors: fungi, insects. In dense forests, the

presence of nitrogen oxides facilitates tree growth which could have negative repercussions: wind falling and breaking.

The distortion of some vegetation's vital physiological processes, like photosynthesis is determined also by ozone, due to its high oxidation capacities, by the modification of the structure and permeability of cellular membranes. Leaves are losing their turgescence, stomata are closing and the overall effect is represented by transpiration and carbon dioxide reduction in assimilation.

The reduction of nitrogen oxides pollution is possible by means of the following strategies [3]:

- utilization of fuels of non sulfur Diesel type;

- promoting alternative energies (electricity - which is emanates only water vapors, oil gas - GPL and natural gas - GNV - 90% methane);

- limitation of increased tonnage vehicles which emit increased nitrogen oxide quantities;

- movement speed reduction, in order to reduce fuel consumption and noxious nitrogen emissions.

### 3. Conclusions

Timber transportation, despite the fact that it assures the utilization of the main forest product, determines by its own way of development, some ecosystem disturbances due to the generated emissions. Their intensity limitation represents an actual problem and imposes measures regarding both transportation structures and transportation means, including the way in which traffic is realized.

It can be mentioned that the emissions caused by timber transport can affect both the forests and its proximities. The forest, by being the bearer of negative impact, represents an important factor in pollution limitation and counteracting. It reduces the velocity of air currents, acts as a shield

against noise and pollutant substances, retains dust and toxic gases (by transpiration and absorption), and assures the freshness of the internal air. As a consequence, the society's development programs must grant an important role to the forest ecosystem by emphasizing the value of forest anti pollutant properties.

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