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Monitoring the Transport on the Ciobănuș Forest Road within the Bacău Forestry Department

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Abstract
Compared to other types of transport, log transport has its own characteristics related to both the transport route and the means of transport. Because, over time, both the routes used to transport timber and the means of transport have constantly evolved, being adapted to the new requirements, specialists in the field always seek to extend the period of operation of forest roads, especially that, in the case of the present, most of them have been designed and built to withstand lower traffic in terms of intensity and frequency. Thus, in order to behave as well as possible in operation, forest roads must be made more precisely the geometric and constructive elements of forest roads and must take into account the constructive characteristics and the movement of vehicles to travel on these roads. Considering the current situation, a very important one, it was considered opportune to research a forest road from the perspective of the traffic on it, recorded for a longer period of time. Thus, the research was carried out on a valley road from the administration of the Bacău Forestry Department - the Ciobănuș forest road. Following the centralization and interpretation of the data, it resulted that the annual distribution of transported volumes is approximately equal and no significant variations were found between 2014 and 2018 and that annually, on the Ciobănuș forest road, a specific tonnage transits the main forest roads, which supports , once again, the accentuated degree of degradation and the rapidity of degradation on this road, due to an insufficiently dimensioned superstructure, which cannot support the annual volumes transited.

Keywords
forest road, traffic monitoring, forest truck, wood mass, log transport

1. Introduction

The Ciobănuș forest road is located outside the village of Asău commune, Bacău county, Romania. The objective is a valley road that runs along the Ciobănuș river valley, a right tributary of the Trotuș River (Siret river basin), being a main road, with a platform of 4.5 meters and a road of 3.5 meters. The forest road was put into operation in 1973.

The forest road under study was taken over, in 1994, by the Bacău Forestry Directorate from the I.F.E.T. Bacău, its delivery/receipt being made on the basis of a report, the delivery not being accompanied by the technical book of the objective. After 1994, only maintenance works were carried out on the Ciobănuș forest road, and no current repairs, capital repairs or rehabilitations were carried out. Also, during the last two decades, the forest road has been affected by numerous torrential floods (the most significant in 2005, when the objective was 50% disastrous, becoming impassable), which led to the current technical condition of the road.

The forest transport network is used intensively only in certain periods of the year, more precisely outside the periods of exploitation restrictions [1, 2] when, on the forest roads, the most important quantities of wood, consisting of materials, most of the times, voluminous, degradable and with relatively high weight and variable in time [3, 4], which require specialized transport vehicles.

It should also be mentioned that, although the forest transport network consists of three categories of roads, depending on their importance and functionality - main roads, main roads and secondary roads [3, 5-8], which have different technical characteristics depending on the forest area served and the

annual traffic, the maximum total mass allowed for lorries with trailers transiting on them is restricted to 38 tonnes [8, 9], as most of the current forest roads have non-rigid road structures, made of stony materials, most of the time the clothing is simple hardening of one or two layers [3, 5, 6, 8].

On the other hand, the expansion of forest car transport (over 90% of the transported volume is carried out by car – i.e., on roads [3, 10], and the gradual abandonment of other modes of transport [7, 10, 11, 12] is justified by the advantages of the forest road network, such as [3, 6, 8, 10]:

- shows a better adaptation to different terrain conditions, which offers the possibility to penetrate deeper into the forest (thus a reduction of the average collection distance);
- ensures the continuous development of the activities necessary for the sustainable management of forests;
- offers advantageous technical and economic premises for the superior and integral capitalization of wood and other forest products;
- ensures the transport of wood, as the main product of the forest, in economic conditions, even in the case of small quantities of wood.

In addition, the analysis of the state and behaviour of the forest transport network over time must take into account the means of transport transiting the roads and the volumes transported, as it is known that the degradation of forest roads may be exacerbated by different factors either by the faulty design or execution of the works, or by improper maintenance, or even by the circulation of heavy trucks [13, 14] which require the transport network.

Regarding the composition of the traffic, it is mentioned that a wide range of means of transport circulates on the forest roads, some destined for the transport of workers and forestry personnel, others destined for forest accessory products and various goods necessary for a good management (seedlings, pheromone races, etc.) and, most of them, intended for the transport of wood, in various forms (round wood, split wood, wood chips, manganese [3]. On the other hand, there are also automobile vehicles, with animal traction, that run on forest roads, but this transport is low and is not important for establishing the geometric elements of forest roads, the demands produced by these transports being insignificant.

Basically, they can drive on forest roads [3, 6, 10]:

- animal-drawn vehicles;
- ordinary motor vehicles (lorries, with or without trailer, and vans), with load capacities of 8 to 18 tonnes. They are used for the general transport of goods, but also for transporting split wood, wood chips, manganese or ancillary products and even workers;
- forestry road trains (ATF), means of transport specialized in the transport of round wood. They consist of a tractor unit and a single-axle or semi-trailer (ATF 25-30 t). The length of the semi-trailer can be changed (by moving the axle of the semi-trailer in relation to its longitudinal axis) depending on the length of the wood assortments to be transported. In practice there are many situations in which the length of the semi-trailer is not adjusted correctly, which makes the load distribution on the two axles (tractor and semi-trailer) not uniform;
- forestry platforms (APT), in general, used to transport both round and felled timber. In addition, it has a very important advantage, namely that the loads are much better distributed on the axles, which makes the car platform fit more easily in curves;
- dump trucks (with load capacities of 6.5; 8; 10.5 or 16 tons), used for the transport of quarry and ballast products, necessary for the maintenance of existing forest roads or the construction of new roads.

Compared to the mentioned vehicles, on the forest roads there are also a series of service or personal vehicles of those involved in forest management (forestry personnel, control bodies) or of various economic agents that either pre-set services for the forest administrator or the adjudicator exploitation parquets in the area.

For the above reasons, it was considered appropriate to study the traffic on the Ciobănuș forest road, through monitoring of wood transports, which is the real objective of the paper. This has as final goal, the knowledge of the deterioration of the road taken in work, in order to manage the remediation and restoration operations.

2. Location and Research Methodology

There are several aspects to be mentioned regarding the technical condition of the Ciobănuș forest road, namely:

- as a result of the torrential floods that affected the body of the road, in the areas near the minor bed of the Ciobănuș river, the width of the platform no longer presents the dimensions related to a main road;
- the geometric elements of the road no longer ensure the development of a safe traffic;
- the location of the primary platforms in the immediate vicinity of the road or even on its platform generates a consistent supply of non-compliant material (earth, mud, debris, etc.) that contaminates the superstructure of the forest road, with direct consequences affecting its load-bearing capacity.

In order to highlight the traffic structure, on the Ciobănus forest road, a daily traffic monitoring was performed, for a long period of time, more precisely for five and a half years (from 2014 to the first semester of 2019). The daily data collected consisted in mentioning, for each timber transport carried out, the following information (table 1): date, registration number of the platform / trailer, number of the consignment note (s) accompanying the wood, consignee of the consignment, assortment transported, the transported volume broken down by species (resinous and / or deciduous), the information being centralized in an Excel database. The calculation of the transported tonnage was performed with the following values for the specific weights: 0.87 tons/m^3 for softwoods, 1 ton/m^3 for hardwoods and 1.7 tons/m^3 for ballast.

3. Results and Discussion

As a result of special technical development, the means of transport have undergone a rapid modernization, which has led to an increase in the maximum authorized payload from 2.5 tons in 1962 to over 46.5 tons in 2018 (equivalent to 60 tons mass total). Although the payload of forestry platforms has increased exponentially (figure 1), the technical parameters of forest roads have not changed significantly, the entire forest road network being designed for a maximum total allowable load of 24 tons (38 tons for roads built after 2015).

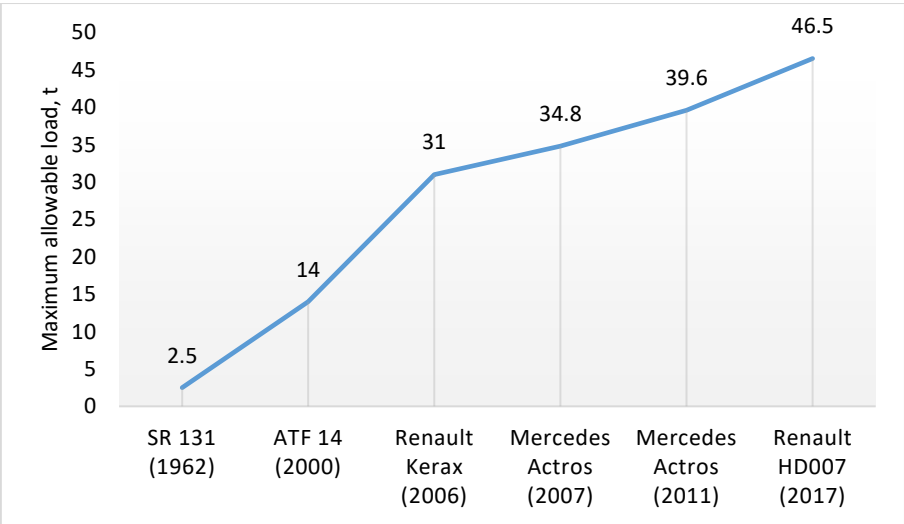

Fig. 1. In-time evolution of tonnage for forest trucks (1962 - 2017)

Following the centralization of the collected data, it resulted that, for the period 2014-2018, on the forest road under study, a volume of 171,691 m^3 was transported with a tonnage of 153,246 m^3, equivalent to an average annual volume of 34,338 m^3, with a mass of 30,650 tons. The total mass of the "vehicle-volume of transported wood" was 235,093 tons, the average annual equivalent of 47,018 tons. As can be seen from the data presented in table 1, the annual distribution of the transported volumes is approximately equal and no significant variations were found.

Table 1. Synthesis of data regarding the volume and tonnage transported in the period 2014-2018 on the Ciobănuș forest road

Year	Volume [m³]	Tonnage transport [tons]	Tonnage transited [tons]
2018	35297	30717	45428
2017	30827	28851	43383
2016	35192	32065	49373
2015	34607	29871	46579
2014	35767	31742	50329
TOTAL	171691	153246	235093

As it results from the diagrams shown in figures 2 – 6, the monthly distribution of the transported volumes is similar in the five years, respectively a higher volume is registered in January-March, followed by a decrease in April-September and a return in the middle of the fourth trimester. This distribution is caused by three exploitation restrictions for certain types of products and species.

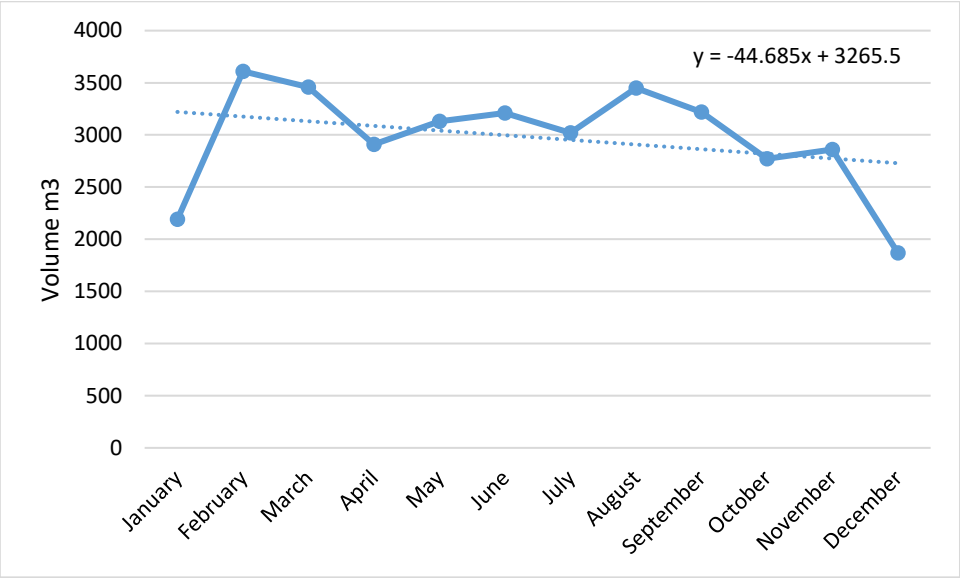

Fig. 2. Monthly distribution of volumes transported in 2014

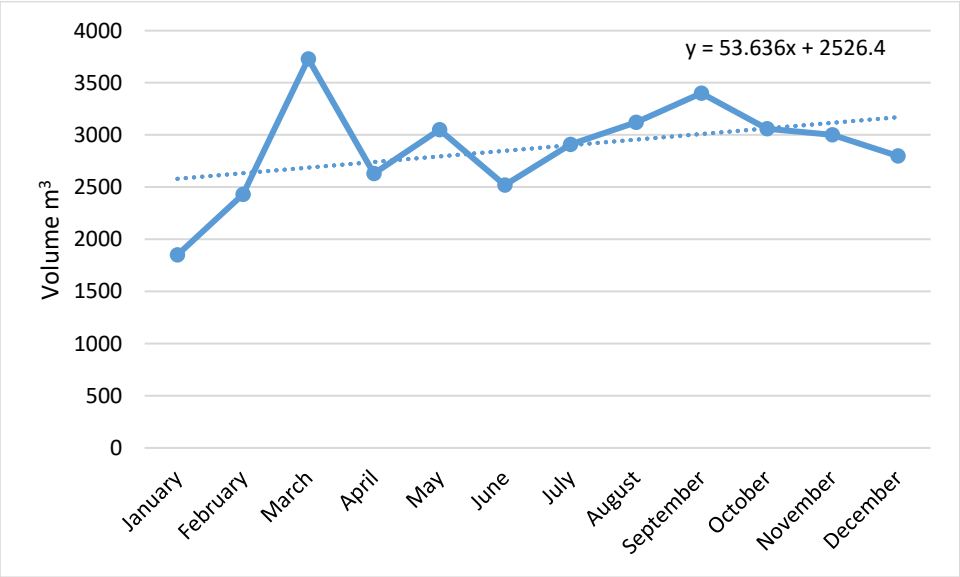

Fig. 3. Monthly distribution of volumes transported in 2015

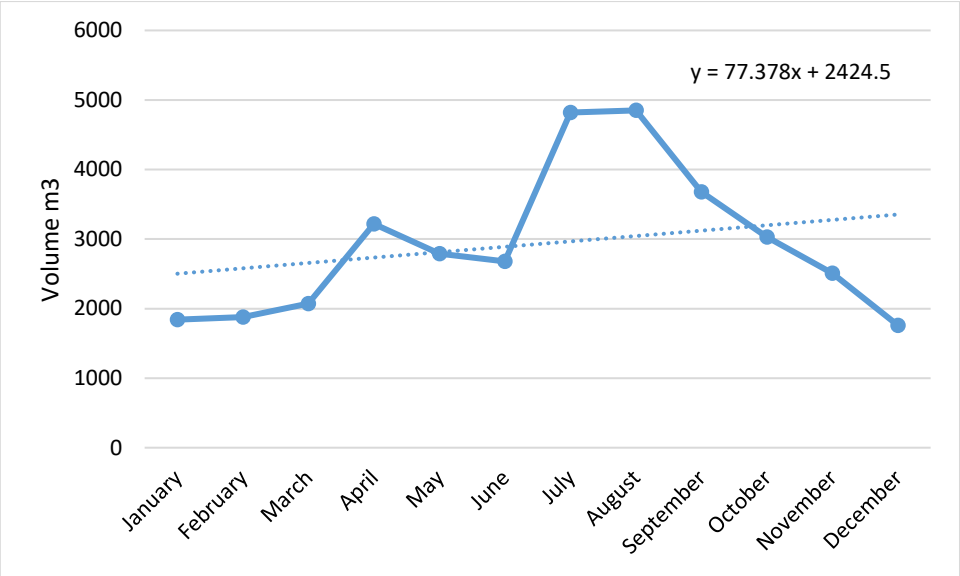

Fig. 4. Monthly distribution of volumes transported in 2016

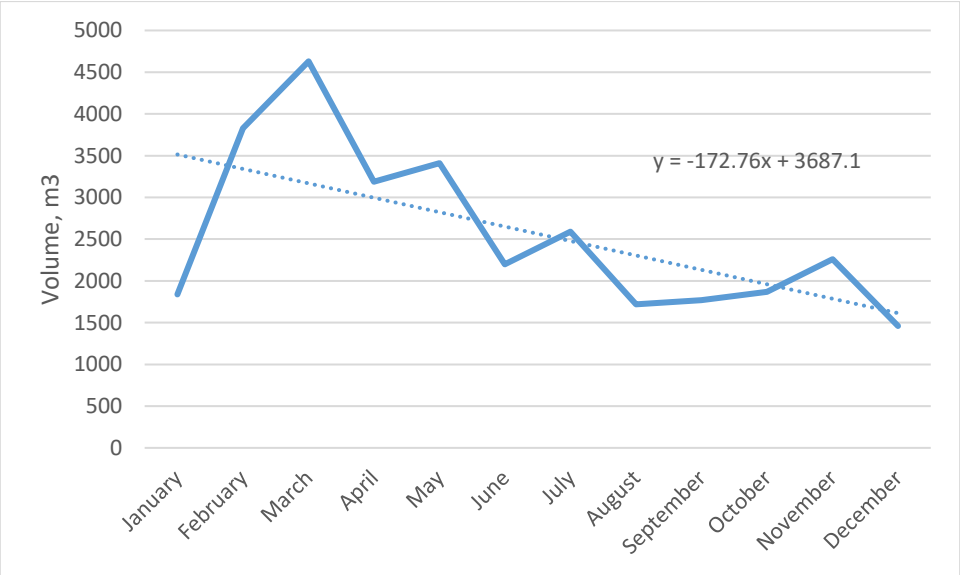

Fig. 5. Monthly distribution of volumes transported in 2017

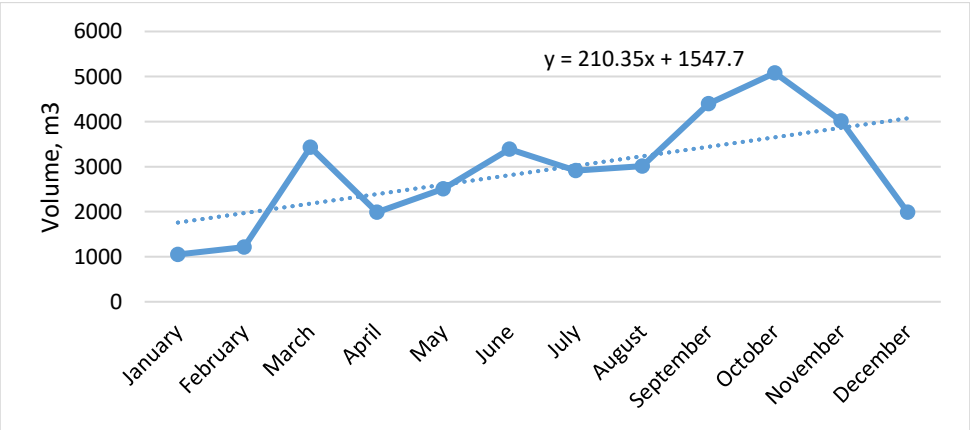

Fig. 6. Monthly distribution of volumes transported in 2018

In the period 2014-2018 (table 2), there is a significant increase in the transport of timber with means of transport with a total mass below 5 tons. Although, in the share of total transport, the use of these types of vehicles is insignificant [16], representing only 2%, however, they are generally used by individuals for the purchase of firewood (90% of the volume transported with these means of transport corresponds to firewood - table 3). The significant increase in the transport of firewood in the period 2014-2018 was determined by the increase in the price of firewood, but also by the decrease in the quantities of wood of illegal origin.

Table 2. Analysis of the transport performed in the period 2014 - 2019 from the perspective of the truck of transport used

Year	Truck tonnage range [tons]				
	0 ... 5	5 ... 12	12 ... 24	24 ... 38	Over 38
2014	367	1044	892	9740	23724
2015	526	859	621	7628	24973
2016	581	736	431	6170	27275
2017	947	428	216	5415	23821
2018	1341	91	344	4586	28935
2019	374	181	254	1673	13581
TOTAL [tons]	4136	3339	2758	35212	142309

Table 3. Transport of wood with truck with a total mass of less than 5 tons

Year	Tonnage truck range of 0 ... 5 tons		Fire wood [%]
	Volume total [m^3]	From which fire wood [m^3]	
2014	367	292	80
2015	526	455	87
2016	581	499	86
2017	947	864	91
2018	1341	1230	92

It should be noted that the Forest Road Design Regulation [9] legislates a maximum total permissible load for trucks with trailers, of maximum 38 tons. Reported to this mention in the regulations, it is reported that most of the timber transport is done with vehicles with a trailer with a maximum total mass exceeding 38 tons, which explains somewhat the degradations recorded on the Ciobănuș forest road

If we take into account the design regulations prior to 2015 [9, 14, 16], based on which, in fact, the design of the Ciobănuș forest road was carried out, and taking as a benchmark a maximum tonnage allowed for 25 tonnes (road-train assembly, trailer and timber transported), the situation is as follows:

- the volume transported by road trains with a mass over 25 tons: 29,062 m^3 (94% of the total);
- volume transported by road mass under 25 tons: 1,764 m^3 (6%).

Over time, the maximum permissible payload and, implicitly, the maximum total weight of trucks, has increased significantly in a very short time, most of the timber transport being carried out with means of transport where the total mass exceeds the expected value through the Forest Road Design Norm [9,17,18].

4. Conclusions

The annual distribution of transported volumes is approximately equal and no significant variations were found between 2014 and 2018.

The number of races that transited the Ciobănuș forest road experienced a slow but continuous decrease, but the decrease of the transported volume was much smaller.

Although the volume of timber transported did not change significantly, the significant decrease in the number of journeys led, in fact, to an increase in the average volume transported per journey and,

consequently, in the average tonnage.

Corroborating the monthly distribution of timber transport on the Ciobănuş forest road, in 2017, with the data of the main climatic elements registered during the same year, it can be stated that the transport with the highest intensity takes place between October and March, characterized from a climatic point of view, of low temperatures, relatively high humidity, days with high cloudiness, high wind speeds. Also, towards the end of this interval, the forest road is affected by the freeze-thaw phenomenon.

Annually, on the Ciobănuş forest road, a tonnage specific to the main forest roads transits, which supports, once again, the accentuated degree of degradation and the rapidity of degradation on this road, due to an insufficiently dimensioned superstructure, which cannot sustain transited annual volumes.

Road traffic on forest roads is the main cause of their technical wear and tear.

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