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ESTABLISHING CRITERIA FOR CALCULATING THE TAX/ROAD TOLLING FOR VEHICLES USED FOR TIMBER TRANSPORT ON FOREST ROADS

**Rudolf A. DERCZENI[1] Emilia A. SALCĂ[2] Valentina D. CIOBANU[1]
Ioan BITIR[1,3] Elena C. MUȘAT[1] Sarantis A. LIAMPAS[4]**

Abstract: *The article presents four principles for calculating the toll for vehicles running on forest roads, whether they transport timber or other materials. Based on the discussions with the representatives of the National Forest Administration ROMSILVA RA, the ideas that formed the basis of establishing the calculation principles were outlined. Thus, the first principle involves the establishment of a charge at toll based on the volume of timber harvested and transported on the road, length of the forest roads network and investments on these roads. Taking these aspects into consideration for a period of four years, and the specific weight of the transported material, it reaches a value that will be applied to each cubic meter, under the conditions that does not exceed the maximum permissible total weight. If maximum permissible total weight exceeded, it is recommended to double the value. The second principle involves the establishment of a tool based on the method of calculating the fund for accessing the forest fund. The third principle aims presume to introduce a "Forest Vignette ", similar to the one on national roads, and imposing sanctions under the conditions of exceeding the maximum permissible total weight. Principle four involves differential application of the road tolling according to the type of vehicle, taking into account the wheel-road contact, axle number and axle load. After analyzing the four principles, it is considered that the most viable principle to be applied at national level for forest roads under administration of ROMSILVA RA is the second one.*

Key words: *forest roads, road tolling, wood transportation, vehicles for transport.*

1. Introduction

[1] Faculty of Silviculture and forest engineering, *Transilvania* University of Brasov, Șirul Beethoven no. 1, Brasov 500123, Romania;
[2] Faculty of Wood Engineering, *Transilvania* University of Brasov, Universității Street, no. 1, Brasov 500068, Romania;
[3] Forest County Administration Bacău, National Forest Administration, Bacău, Romania;
[4] Democritus University of Thrace, Department of Forestry and Environmental Management and Natural Resources, Greece;
Correspondence: Elena C. Mușat; email: elena.musat@unitbv.ro.

Investments in transport infrastructure involve a number of costs relating both to its extension and to the maintenance of the transport network under optimum operating conditions. In Norway, for example [5], revenue from tolls are directed more than 50% for investment in roads and the remaining for investment in public transport, the amounts being considered a joint contribution of users, state and local authorities, representing a consistent source of incomes for the state budget. The problem toll for transport infrastructure is approached differently, in some cases having a fairly long history [5] and can be applied both for highways [7], national roads [5, 10], bridges [8, 10], ring networks around cities [5] or private roads managed by local municipalities [5] or other owners. In case of Romania [10], a usage tariff called vignette, is applied on national roads for both Romanian and foreign users using the national transport network. It is set according to the journey and stationary time, the class of pollutant emissions (EURO), the maximum authorized mass and the number of axles.

In addition to this usage charge, the legislation in force [10] also provides tax that involves the payment of a sum of money for a vehicle crossing a road sector, a bridge, a tunnel or a mountain pass part of the national road network, electronic registration of the tariff crossing representing the toll paid before crossing.

The importance of collecting tolls for transport network lies in the impact that cars have on transport routes, which why there are many studies that highlight the effect of traffic on the structure of the road [2-3], degradations arising from traffic [2, 4], the interaction between vehicles and bridges [8] and even influence electronic automatic charges on the level of emissions in air [7].

The forest roads are designed to meet their own road transport requirements in forest activity, for the purpose of forest management and timber transport, being classified as transport roads in the group of construction for transport [1].

On the forest roads are transported both timber (round wood, split wood, shredder wood, charcoal), as well forest products (fruit, resin, shell), goods needed for supply and maintenance, workers and administrative staff, all leading to wear the forest transport infrastructure.

In order to finance the investment works in forest roads, it is intended to apply a tool tariff which will concentrate the income in a separate account which shall be used only for the maintenance and repair of forest roads [13]. Even if a tariff for use of the transport network can not lead to cost efficiency [5], it has beneficial effects on the investment fund.

Based on these considerations, the paper presents four principles that can be taken into account when calculating the tool for vehicles travelling on forestry roads, especially since the financing of the forest roads construction and maintenance is provided from three sources [11], respectively from the forest accessibility fund, from the state budget or from other sources, according to the law.

2. Principles for Establishing Road Tolling

Based on the discussions with the representatives of the pilot forest county, respectively Bacău, Piatra Neamț and Suceava and the studying of the specialized literature, there are 4 principles that were considered viable and

can be applied for a unitary collection of the toll for vehicles running on the forest roads administered by the ROMSILVA RA National Forestry Administration, whether they transport wood or other materials.

2.1. First Principle

For establishing the first principle, the data provided by Forest County Suceava were taken into account.

The calculation method mainly refers to report of the cost corresponding to the current maintenance and repairs, and possibly also the capital repairs, where applicable, for the last 4 years, to the volumes transported on forest roads. Thus, in addition to the volume of the transported mass and the maintenance and repair costs, the length of the entire transport network, the number of roads and the specific weight of the transported material are taken into consideration, finally resulting a tariff expressed in lei/tons*km.

It is worth mentioning that this tariff it is applies if the transported mass does not exceed the total admissible maximum value of 38 tons mentioned in the Normative Document for Design the Forest roads [12], for trucks with trailers. The quantity transported above the maximum total allowable weight shall be taxed by double the tax determined by the previous calculation, applied for each cubic meter of timber transported over the accepted limit. The toll for overtaking the allowable tonnage can also be applied to economic agents transporting wood from the state forest fund or any other material.

2.2. Second Principle

The second principle has the main argument Law no. 56/2010 regarding the accessibility of the national forestry fund, which follow a sustainable management of this, carried out both by road construction works and through interventions on the existing roads in order to maintain the integrity and functionality of them.

Thus, it is proposed that the calculation of the rate of toll on using forest roads to be like the calculation of forest fund accessibility, respectivelly 10% of one cubic meter of standing timber [11], approved by the central public authority responsible for forestry, and the National Forestry Administration which will establish annually the value of the percentage of application.

If the wood mass of a harvested stand crosses forestry roads belonging to several owners, the tariff of toll due to the use of the transport network will be paid to them in proportion to the length of the throughput.

The payment of this charge will be made prior to the issue of the harvesting authorization, by transferring by the forest district that made the stand registration into SUMAL of an amount owed to the Forest County or to the Territorial Administrative Unit that manages the forest road.

The fund will be set up for the entire amount of wood that is harvested, regardless of the nature of the product or the owner.

The same amount (calculated in lei/ tonne) will also be due for the economic operators carrying out works to extract mineral aggregates, for the volume

authorized by the National Authority for Mineral Resources.

2.3. Third Principle (Forest Vignette)

This principle is based on the toll tariff use for national roads, with a new form of tolling called " Forest vignette ", which can be purchased for a day, 7 days, 30 days and 12 months.

Although these time intervals are similar to those vignette applied for national roads [10], there some differences that take into account that take into account the specifics of the forest roads, where traffic on the intermittent.

Establishing a toll must take into account the average travel speed (15 km / h), the average length of the country's forestry roads (considered twice for full drive and empty drive, approximately 7 km), the time of the wood loading operation in the loading area (1,5 hours) and the time of the unloading operation. Including the driver's rest times, according to the tachograph diagram finally results 4 hours for each transport. Thus, the type of "Forest Vignette" is proposed with the following alternatives (Table 1): daily, weekly (4.5 actual days), monthly (18 effective days) or yearly (216 real working days).

Table 1

Parameters took into account for establishing the Forest Vignette

Type of “Forest Vignette”	Average mass for one drive [t]	Tonaj maxim admis [t]	Maximum allowable tonnage [m^3]	Number of drive per day	Number of drive days
Daily	18	38	20	2	1
Weekly					4,5
Mothly					18
Yearly					216

It is worth mentioning that the one-day toll corresponds to the value determined by one of the above principles but is multiplied with the average transport distance, and the value is finally expressed in Euro. For the other types of Forest Vignette, the daily toll is multiplied by the real number of transport days.

In addition, it points out that the Forest Vignette calculated in this variant, it could be applied to all vehicles complying with the maximum allowed tonnage [12].

For over tonnage, the legislative framework specific to national roads [9], referring to the maximum masses and dimensions admitted in Romania (Table 2) is applied, compensations taking into account the additional volume transported and the average distance for transport.

2.4. Fourth Principle

Fourth principle is more laborious, but more accurate and leads to differentiated application of the toll based on the characteristics of the vehicle used to transport, taking into account the wheel-road (p * D) characteristic, but also the number of axles and the load on each axis, elements closely related to the magnitude of recorded degradations [2-4, 8].

At the basis of this principle is the very large variety of vehicles traveling on forest roads (truck, semi-trailer tractor, trailer truck) in which the number of axles and maximum permissible load on each axle are different.

Table 2

Establishment the forest tax / road tolling for forest roads in accordance with national road legislation [9]

Application interval	Computing Unit	The compensation fee applied per m^3 of additional transport, with VAT (Euro)
40,01 – 45,00	Tax/road tolling x average transport distance	0,56
45,01 – 50,00		0,62
50,01 – 55,00		1,37
55,01 – 60,00		1,49
60,01 – 65,00		1,62
65,01 – 70,00		1,74
70,01 – 75,00		1,86
75,01 – 80,00		1,99
80,01 – 85,00		2,11
85,01 – 90,00		2,24
90,01 – 95,00		2,36
95,01 – 100,00		2,48

The analysis of the influence of the wheel-road contact characteristic is particularly important when assessing the impact of traffic on the roadside, and has been studied in numerous papers [3-4, 6, 8]. The wheel-road characteristic, hereafter denoted as p * D, is influenced by the load applied to the tire and its size, since the dimensions determine both the pressure to be inflated and the pressure on the ground.

Analyzing the most used vehicles forest transport, it has been found that they have a maximum authorized mass on the rear axle of 21 tones, and the traction type is 6x4. For these types of vehicles, a value of p * D (loaded) of about 190 results (double deck whit twin wheels).

Thus, there is obtained a ratio between the ordinate values corresponding to the values of the abscissa 170 and 190, between 1.05 and 1.2, depending on the type of road structure.

These ratios increase for p * D = 210 with about 0.1 (the increase is linear). In conclusion, the approximate increase, which could be adopted for any of the types of road structure, is 10% for 20 units of the p * D characteristic, as in the example in Table 3.

Table 3

Increasing the ratio E_{nec}/E_{ech}, according to p * D (170 beeing the reference value)

type/p*D	170	190	210	230
1.5	1.00	1.11	1.21	1.32
1.6	1.00	1.12	1.22	1.32

It is important to note that these values are for a deck of the forest truck.In determining the degree of damage to the

road structure by a truck or trailer (and hence the toll) must take into account the total number of loaded decks.

Thus, it can be considered as a reference a vehicle for which all axles have the characteristic p * D = 170, with a number of two decks (front simple axle andrear axle twin-wheeled). This means that all vehicles used will relate to the reference vehicle as the number of axles and value p * D for each axle.

For each axle a weighting factor (cp) is applied and for the whole vehicle the effects of all decks will be added:

$$C_p = 1+0.1*(p_iD_i-170)/20 \quad (1)$$

For example, when considering a Mercedes ACTROS 2646 truck (Figure 1) with 6x4 traction, unloaded at full capacity, then each deck falls to the standard deck (p * D = 170).

Adding the effects of all decks, a multiplication factor is obtained for the entire truck (Table 4):

Fig. 1. Mercedes ACTROS 2646 [14]

Table 4

Example of decks loading for 6x4 trucks

	Mass [kg]	Number of axle	Load on deck [kN]	Pressure [kPa]	Equivalent diametre [mm]	p*D	c_p
Rear deck	2x 8500	2	85	900	173	156	0.93
Front deck	6000	1	60	750	226	170	1.00

Adding effects to all decks provide a multiplier for the entire truck:

$$c_v = 2*0.93 + 1.00 = 2.86 \quad (2)$$

For wood transport often is used trucks with trailers. An example is the one in Figure 2, a 6x4 truck with a 2-axle trailer.

In the study it was considerate that this type of vehicle is loaded at maximum capacity, that means almost 16 tonnes on the truck and 16 tonnes on trailer. The truck has a proper load of approximate 15 tones, and the trailer almost 4 tones. Taking into account all this information, it resulting the data from Table 5, respectively the load on the axles and the multiplication coefficients.

Gathering the effects of all the axles, it can be obtained a multiplication coefficient for the entire vehicle:

$$c_v = 2*1.10 + 1*1.00 + 2*1.35 = 5.90 \quad (3)$$

Fig. 2. Truck with trailer for logs transport [14]

Table 5

Example of decks loading for a truck with trailer

	Mass [kg]	Number of axle	Load on deck [kN]	Pressure [kPa]	Equivalent diametre [mm]	p*D	c_p
Rear axle truck	2x 12500	2	125	900	210	189	1.10
Front axle truck	6000	1	60	900	226	170	1.00
Trailer axle	2x 10000	2	100	750	266	239	1.35

For different types of trucks / trailer, with loads between 0 and 70 t, the diagram from Figure 3 was determined. For each of the vehicle types from the chart, a typical mass (for example about 15 tons for a semi-trailer truck, 4-5 tons for a trailer) was considered, and the charge was added gradually by 5 tonnes to

5 tonnes, distributed on decks proportional to the load capacity of each axle. The horizontal axis of the chart represents the payload, in tones. This means that the total weight for curves 1 and 2 exceeds 80 tones.

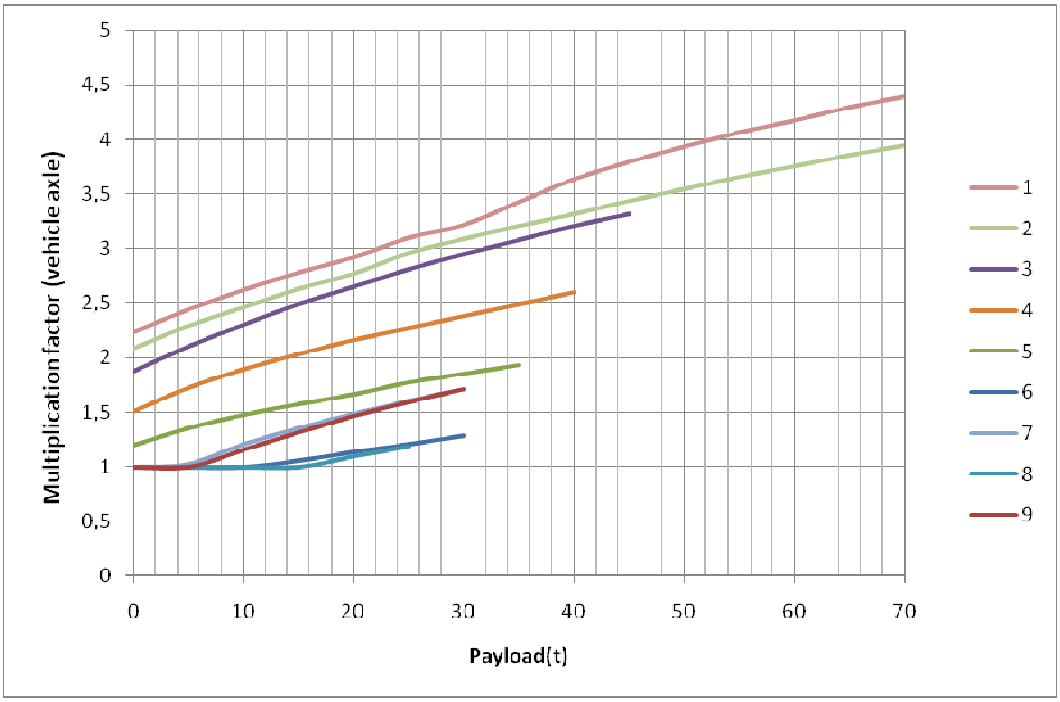

Fig. 3. Nomogram for determining the coefficient c_v for different types of vehicles used for timber transport: 1 - 6x4 truck + 2 axle trailer, single wheels;2 - 6x4 truck + 2 axle trailer, twin wheels;3 - semi-trailer truck; 4 - 4-axle truck (for example 8x4);5 - three-axle truck (6x4);6 - 2-axle truck (4x2); 7 - 3-axle trailer;8 - trailer with 2 axles, twin wheels; 9 - 2-axle trailer, single wheels

In the case of a trailer consisting from a truck and trailer, for variants not included in the diagram, the coefficients determined in the diagram for the two vehicles, depending on the load, can be summed up.

The coefficients determined in the diagram are relative multiplication coefficients to the vehicle equipped with two standard decks (for which the value of the multiplier is 1).

The coefficients are determined from the chart multipliers relative to the vehicle equipped with two standard decks (for which the multiplier value is 1). The subunit values resulting from the calculation were replaced by the value 1 (the lower limit of the multiplier).

For a certain useful mass, the distribution of the deck may vary from case to case. Also, the unloaded mass of the vehicle can be distributed differently on decks.

3. Conclusions

The first principle, although simple to apply and which respects both the values

invested in forest roads (maintenance works, current and capital repairs) and the transported volumes, refers to each Forest District in part, which will make a difference between the amounts received. But, it can also be applied at national level, at a unitary value set by the ROMSILVA National Forest Administration.

The principle two can be applied to the whole country, but the amounts collected must be transferred to each road owner, directly proportional to the length of throughput, which can lead to additional calculations and possible misunderstandings between administrators of forest roads.It is the only principle that leads to a full collection of the toll before the start of transport, which is why it is recommended.

The third principle, although referring to some compensation paid by the forest administrator in accordance with the tonnage transported, it must be based on a different way of determining the tax unit of transport, valid for vehicles which fall in tonnage limitand thus a calculation of compensation by identifying the type of vehicle used for transport.

The fourth principle, although very laborious, involves the application of the toll in concrete conditions, depending on the type of vehicle used for transport, and takes into account about the degradations resulting from the exceeding of the maximum allowable tonnage. As in the cases of the first and third principles, determination of the value will be done in the field or in the office after the transport.

Considering the above mentioned, only principle two can be applied uniformly, as the toll is collected in anticipation from all operators (transporters) and provides a separate source of funding for the maintenance and execution of current repairs to forest roads.

Given the fact that the application of principle two is not possible for various reasons (normative acts, modification of the SUMAL application), principle three (Forest vignette) can be applied.

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