ANALYSIS OF THE DEGRADATION STAGE OF THE ROAD SYSTEM ON THE FOREST ROADS WITHIN P.U. I CISLA (CISLA-BORȘA COMPOUNDING OFFICE)

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Abstract

The need to analyze the state of forest roads results from the concern for their maintenance in order to ensure a transport network capable of serving all the needs of the forest sector.

In order to determine solutions for the maintenance and rational exploitation of forest roads, in this paper were studied a series of correlative links in order to identify the existence of correlations between declivity, average pit depth, road system thickness, and their total affected area.

The case study was carried out on the forest roads Arineş and Izvorul Ursului, with a length of 1800 m, located in Borşa (Maramureş), in the P.U. I Cisla, Cisla Borşa Composesorate.

In order to obtain a correlative link between all the elements determined and presented in tables 1 and 2, all types of regression equations (logarithmic, polynomial, exponential, linear and power) were tested, so that the interdependence between them can be established.

The testing of the four ranges determined for the above-mentioned elements on the two forest roads revealed the existence of distinctly significant correlations between the declivity and the total area affected.

The regression equations obtained by polynomial correlation, which are distinctly significant, show the existence of close interdependencies between the declivity of longitudinal roads, the total area affected by their operation and climatic factors, the thickness of the road system and the depth of pits formed over time.

From the interpretation of the tests performed it can be seen that in the road sectors with higher declivities the surface of the roadway, respectively the thickness of the road system are much more subject to physical degradation.

Key words: forest roads, geometric elements, exploitation, analyze, correlations;

INTRODUCTION

In forest management, taking into account the complexity of the functions performed by forest roads (Gucinski et al.,2001), the future strategy for the expansion of road networks must aim first of all at the strict observance of forest management in order to ensure a continuous assurance of forest production on the one hand and to exercise the protective role of forests along with a more efficient accessibility of the forest fund. (Ungur et al.,2003; Iovan, 2017).

In order to analyze the stage of degradation of the road system on forest roads within P.U. I Cisla, a series of correlations were sought between the declivity, the average depth of the pits, the thickness of the road system, and their total affected area.

The need to analyze the state of forest roads results from the concern for their maintenance in order to ensure a transport network capable of serving all the needs of the forestry sector in close accordance with current environmental requirements (Lugoa et al., 2000; Lazăr et al., 2008), this is due to the fact that starting the design and execution of new roads involves a difficult and obviously expensive methodology, so that the maintenance of existing ones becomes a major concern (Ungur, 2005; Nevečerel et al., 2007).

In order to determine solutions for the maintenance and rational exploitation of forest roads, in this paper were studied a series of correlative links in order to identify the existence of correlations between declivity, average pit depth, road system thickness, and their total affected area.

For this purpose, two forest roads with a length of 1800 m each were analyzed, fragmented on sections of 100 m, on which certain geometric elements, constructive characteristics and existing degradations were followed, which are presented in table no. 1 and 2.

Ways of communication (forest roads) are the physical support for the opening of forest basins (Klč P.,2005). A rational management of the forest fund must respect the technical, managerial, economic and ecological principles (Murphy, 1985; Crețu, et al.,2006).

MATERIAL AND METHOD

The case study was carried out on the forest roads Arineș and Izvorul Ursului, with a length of 1800 m, located in Borșa (Maramureș), in the P.U. I Cisla, Cisla Borșa Composesorate. The roads are located in a mountainous region, the predominant geomorphological unit being the slope, with mostly undulating terrain configuration, altitudes between 800 and 1770 m. The current accessibility of the forest fund is 77%, and the current density of forest transport facilities is 3,1 m / ha (20***). The coordinates of the perimeter that includes these two forest roads are between 47°38' 04" / 40°39' 04" N and respectively 24°50' 33" / 24°52' 01" E.

In order to determine the geometric peculiarities and the existing degradations, a visual inspection of the analyzed roads was performed.

The equipment used was:

► telemetry (for determining distances, surfaces and depths)
► clinometer (for determining the slope in longitudinal profile)

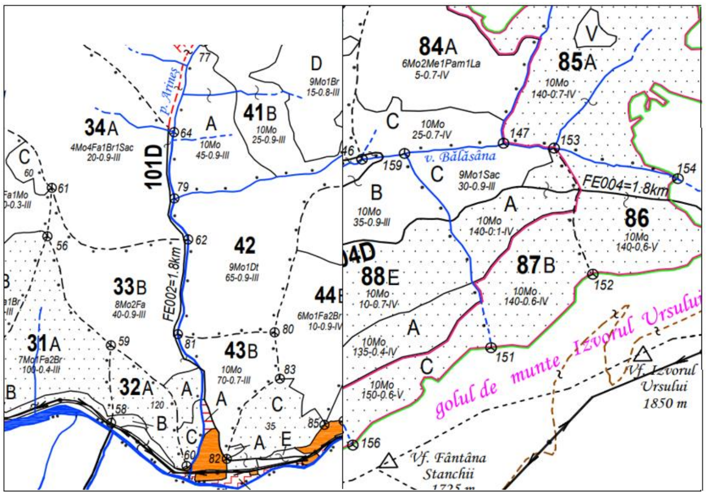

Fig. 1. Case study localization – Cisla P.U. I, Borșa Composesorate (Maramureș) (20***)

Declivity (%) shows the degree of inclination of the road in longitudinal profile (Olteanu N.,1996) and was determined with the help of the clinometer, the depth of the pits (cm) was determined with the help of the rangefinder by measuring from the upper level of the roadway, the thickness of the road system (cm) starting from the maximum value (initial 30 cm) and the total area affected was determined in percentages.

All these geometric elements and the degradations formed at the level of the roadway, respectively of the drainage ditches present the current stage of the forest road platform (A.C.F., 2006) analyzed.

Table 1

The value of geometric elements and degradations, on the Arineș forest road

Section	Interval [m]	Declivity %	Average pit depth [cm]	Road system thickness [cm]	Total area affected [%]
1	0-100	9,0	10	13,0	55,0
2	100-200	10,5	5,0	20,0	48,0
3	200-300	10,0	6,0	21,0	50,0
4	300-400	11,0	9,0	16,0	44,0
5	400-500	11,0	5,0	19,0	43,0
6	500-600	10,0	6,0	19,0	48,0
7	600-700	9,5	6,0	20,0	39,0
8	700-800	8,0	5,5	22,0	49,0
9	800-900	9,0	8,0	16,0	48,0
10	900-1000	9,5	8,5	16,0	47,0
11	1000-1100	11,0	6,0	19,0	40,0
12	1100-1200	10,0	5,5	19,0	42,0
13	1200-1300	9,5	8,0	15,0	50,0
14	1300-1400	10,0	8,0	18,0	44,0
15	1400-1500	8,0	10,0	14,0	35,0
16	1500-1600	10,5	6,0	20,0	43,0
17	1600-1700	11,0	5,0	20,0	40,0
18	1700-1800	10,5	6,5	20,0	46,0

Table 2
The value of geometric elements and degradations, on the Izvorul Ursului forest road

Section	**Interval [m]**	**Declivity %**	**Average pit depth [cm]**	**Road system thickness [cm]**	**Total area affected [%]**
1	0-100	8,5	9,0	15,0	53,0
2	100-200	9,0	10,0	13,0	54,0
3	200-300	11,0	12,0	13,0	40,0
4	300-400	10,5	6,5	21,0	38,0
5	400-500	11,0	6,5	21,0	41,0
6	500-600	12,0	12,5	15,0	35,0
7	600-700	12,0	13,0	15,0	36,0
8	700-800	10,0	12,0	14,0	41,0
9	800-900	10,0	12,5	12,0	40,0
10	900-1000	9,0	13,0	14,0	38,0
11	1000-1100	10,5	11,0	14,0	41,0
12	1100-1200	10,5	10,0	16,0	37,0
13	1200-1300	11,0	8,0	18,0	39,0
14	1300-1400	12,0	6,0	24,0	38,0
15	1400-1500	11,0	5,0	24,0	40,0
16	1500-1600	10,0	5,0	23,0	39,0
17	1600-1700	9,0	14,0	12,0	46,0
18	1700-1800	9,5	14,5	14,0	45,0

In order to obtain a correlative link between all the elements determined and presented in tables 1 and 2, all types of regression equations (logarithmic, polynomial, exponential, linear and to power) were tested, so that the interdependence between them can be established (Horvat, D. 1994).

RESULTS AND DISCUSSION

The testing of the four ranges of values determined for the above-mentioned elements on the two forest roads resulted in the existence of distinctly significant correlations between the slope and the total affected area, partially presented in figures 2 and 3.

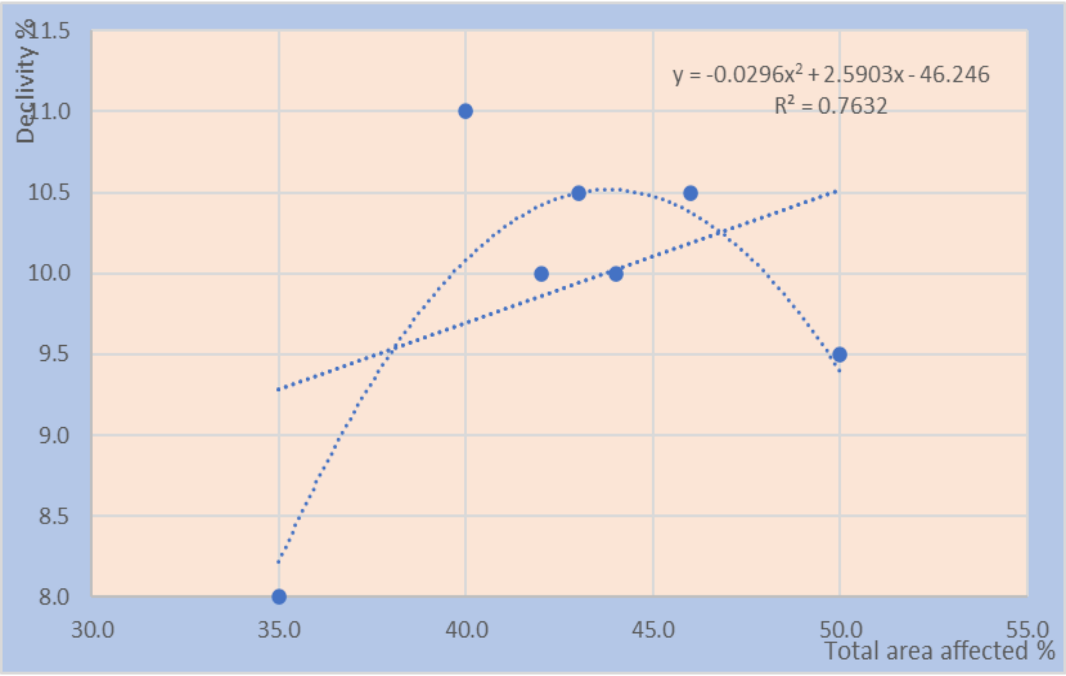

Fig.2. Graphical representation of the polynomial correlation between the declivity and the total affected area resulting on the Arineș forest road

Table 3

The value of the correlation relations obtained between the elements studied on the two forest roads

Forest road / Determined elements	Declivity / Total area affected	Average pit depth / The thickness of the road system
Arineș	R^2=0,7632 R=0,8736	R^2=0,8341 R=0,9132
Izvorul Ursului	R^2=0,6043 R=0,7805	R^2=0,9185 R=0,9583

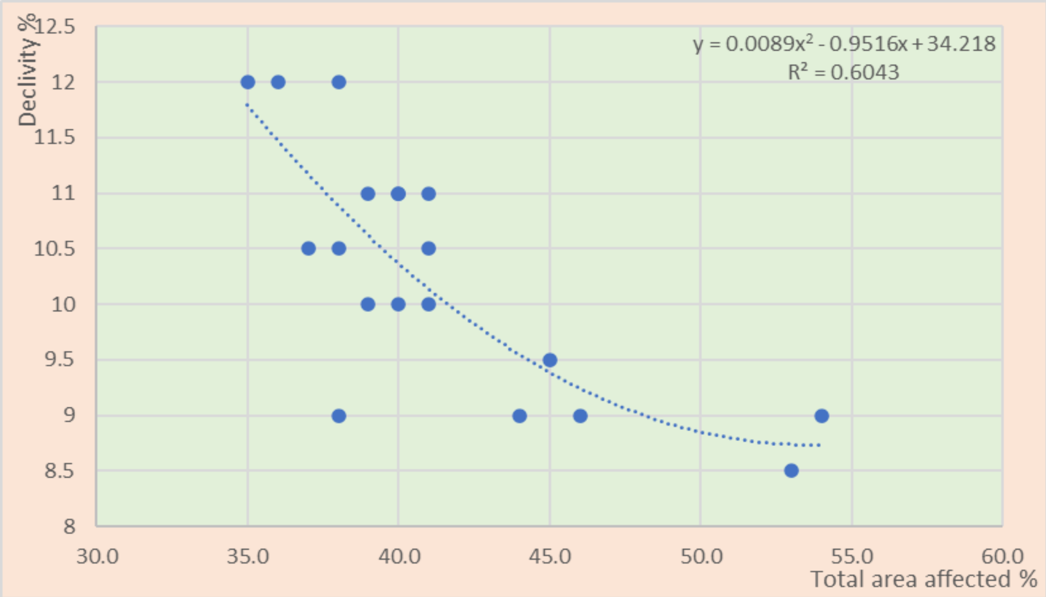

Fig.3. Graphical representation of the polynomial correlation between the slope and the total affected area resulting on the Izvorul Ursului forest road

The values of the correlation ratios obtained for the value ranges presented in tables 2 and 3, show the existence of a polynomial correlation, with a correlation ratio R^2=0,7632 (Figure2), respectively R^2=0,6043 (Figure3) therefore distinctly significant (Giurgiu V., 1972) from a statistical point of view, in terms of the interdependence between the slope and the total area affected on the Arineș and Izvorul Ursului forest roads.

At the same time, there were distinctly significant correlations between the average depth of the pits and the thickness of the road system, with R^2=0,8341 for the Arineș forest road, respectively R^2=0,9185 for the Izvorul Ursului forest road.

These polynomial correlations show that there is a very direct link between the declivity and the total area affected, respectively the average depth of the pits and the thickness of the road system of the analyzed forest roads.

CONCLUSIONS

In order to increase efficiency by ensuring optimal conditions for the practice of sustainable forestry, a pragmatic approach to the design and maintenance of forest roads is needed. In this sense, it is necessary to periodically monitor the evolution of the technical condition of the existing forest roads.

From the results obtained in this study it can be proposed that in the future to use GIS technology, in order to increase the accuracy and quality of forest road design (Crainic G.C.,2017) and subsequently the implementation of practical and efficient decisions regarding the maintenance of these roads (Martínez-Zavala L. et al.,2008; Tamaş Ş. et al., 2006).

The regression equations obtained by polynomial correlation, which are distinctly significant, show the existence of close interdependencies between the declivity of longitudinal roads, the total area affected by their operation and climatic factors, the thickness of the road system and the depth of pits formed over time.

From the interpretation of the tests performed it can be seen that in the road sectors with higher slopes the surface of the roadway, respectively the thickness of the road system are much more subject to physical degradation. These findings can be explained by the fact that in these sectors of forest roads the traction force and the adhesion force of motor vehicles act with an increased intensity on the road system, compared to the sectors with lower declivities.

Another explanation for the degradation of the road system and the road part consists in the different action of climatic factors (precipitation, temperatures) as well as the exposure of the roads. Also a decisive factor in this direction is represented by the hydrological and hydrographic peculiarities of the forest basins in which the forest roads are located. Thus, where there are small permanent watercourses, they take over and ensure a controlled drainage of water, while where temporary or torrential water formations are formed, the water causes a physical aggression on the technical quality of the roads.

By establishing a distinctly significant correlation between the analyzed geometric elements, it can be said that they directly influence the quality of the infrastructure and superstructure of forest roads (Coulter E.D. et al.,2006).

Carrying out repeated and sustained studies over time could significantly contribute to obtaining the most efficient methods for the long-term exploitation and maintenance of forest roads (Zarojanu D. et al., 2006), in line with current and perspective of sustainable forestry.

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