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RESEARCH CONCERNING THE EVENT OF UNCONTROLLED INSTALLATION OF FOREST VEGETATION ON THE TORRENTIAL MANAGED NETWORK IN THE UPPER TĂRLUNG WATERSHED

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Abstract: *After 20-25 years from building the hydrotechnical structures for managing the hydrographic torrential network on the Tărlung Valley, the event of uncontrolled installation of forest vegetation on the central corridor of flow, upstream the structure, has developed on a surface of approximately 110 m² on average. The average blocking degree of the flow corridor was of approximately 37%. The variability of the event, from case to case, was highly salient (s% = 74...84%). By applying the χ^2 test, we demonstrated that the experimental frequency distribution meets the condition of normality, only with regard to the size of the surface on which the forest vegetation on the flow corridor has installed, and not in terms of the blocking degree of this corridor.*

Key words: *behavioural event, managed torrential hydrographic network, uncontrolled installation of forest vegetation.*

1. Introduction

It is well-known that one of the most important effects of the torrential hydrographic watershed management works consists in the stabilization and consolidation of the alluvial source terrains on the hydrographical network of torrential watersheds [2-4], [10], [11], [13], through the installation and development of forest vegetation on the shelter created by hydrotechnical structures.

Indeed, not only the direct protection of the objectives intercepted/endangered by the torrential flows, but also an important ecological effect can be ensured by retaining the brutish alluvia - directly by means of the transverse hydrotechnical structures (sills and dams) and indirectly by covering the valleys with all types of used hydrotechnical structures, as well as with the reciprocal support provided by the traverses. This effect is the result of the installation and development of forest vegetation on the alluvial source terrains within the hydrographical torrential network.

But, in natural conditions, without any human intervention, the installation process of forest vegetation proceeds in a

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chaotic way (Figure 1), meaning that, on the torrential deposits and on the formed or developing atterations, because of the high humidity of deposits and the supplementary contribution with nutritive substances, forest species like the Grey Alder, Goat Willow etc. can easily install [13], [9], [1], including on the central flow corridor. Not in few cases, the forest vegetation installs right in the execution zone of the constructions, on certain components, like: the apron in the masonry joints, the crown of the guarding walls, the crown of the canals. Likewise, forest vegetation installed on the atterations formed on the apron is frequently found, including in the space between the energy dissipation teeth [4], [6].

Fig. 1. *Examples of uncontrolled installation of forest vegetation on the managed torrential network in the Upper Tărlung Watershed. Photo: Clinciu, 2003*

The diversity of situations in which the above detailed event manifests has as a result the blocking of the corridor used for the free flow of the water, which, in normative terms, means a dysfunctionality, namely an event which negatively affects the functionality of individual structures, the interaction of the structures integrated in hydrotechnical systems, as well as the interaction between these structures and the environment. Indeed, following the installation of vegetation, the valley roughness increases, leading to a decrease of the average stream speed and, implicitly, of the capacity of draining of the discharge; because of this, there occurs the risk that during torrential flows, the spillway of sills and dams and/or the section of canals are overtaken and the overflowed waters can cause the flooding of the objectives and/or the terrains in close proximity [5], [7].

This kind of dysfunctionality can be easily identified on the hydrotechnical managed networks in Romania, but, over time, few forest districts have distinguished themselves as having systematic preoccupations regarding the monitoring and maintenance of hydrotechnical torrent control structures.

This situation is due not only to the lack of interest coming from forest companies, or to lack of financing, but also to the lack of a coherent scientific knowledge system to substantiate the above-mentioned action.

Only a well-organized scientific research, powerfully engaged into the concepts and methods of mathematical statistics, will be able to lead to the true knowledge of this event; this is the only way to give priority to the future emergency interventions and to open the way to conceptual rethinking, to improving the present technical norms [12], [8].

For this reason, by means of the case study presented in the present paper, the approached thematic is encompassed into a completely different research scope, even though this continues and develops our previous research [6]: that of discovering the statistical laws concerning the frequency and intensity of the uncontrolled installation and development of forest vegetation on the managed torrential network in a mountainous watershed of Romania; thus, on this basis, we shall resort to a systematic monitoring of the events in the future, according to the needs ensuing from the principle of interdependency of silvotechnical and hydrotechnical works, which is fundamental for the success of the torrential hydrographic watershed management.

2. Research Location and Method

As underlined in the title, the research is located in the Upper Tărlung watershed (delineated upstream the Săcele water storage - Braşov County), where a series of management works on the hydrographical torrential network were performed starting from 1975.

Throughout the 21 valleys - for which project documentations for this area were drawn up - a number of 106 hydrotechnical structures for torrent control were constructed on the hydrographical network, out of which: 55 dams, 22 sills, 25 traverses and 4 canals.

For the analysis of the dysfunctionality triggered by the event of uncontrolled installation of forest vegetation, only the transverse works with complete atterations (40 structures) were taken into consideration, for which we used the field data collected during the research project (A type) financed by CNCSIS-UEFISCU, during 2002-2004 (director: prof. dr. eng. Ioan Clinciu). The area on which the forest vegetation has installed was determined by using expeditious topographical measurements. The effective area of the flow corridor (upstream the structure, without the structure area) was estimated for each transverse work separately, as the multiplication of the length of the inferior part of the spillway by the length of the atteration. Thus, the ratio of these two areas shows the blocking degree of the flow corridor.

In order to discover the statistical law for the occurrence and manifestation of the event, the frequency distributions were calculated using the above-mentioned data. The studied cases were grouped into classes by two criteria: the size of the surface on which the forest vegetation installed in the flow corridor zone (upstream the hydrotechnical structure) and the blocking degree of this corridor.

Further on, the main statistical indicators were calculated and interpreted in the case of the two obtained frequency distributions and, finally, the experimental frequencies were fitted by three of the most well-known theoretical distributions (normal, Charlier - A type and Beta).

3. Obtained Results. Discussions

The first aspect of the statistical analysis referred to that part of the flow corridor area (expressed in m^2) on which the forest vegetation has installed.

Following a first data analysis, as we found that the event of uncontrolled installation of vegetation occurred in areas up to 1000 m^2 in most of the cases, a second data analysis was carried out, by class intervals with the amplitude of 500 m^2. 37 cases were found within the 0…500 m^2 interval. For the same interval, the frequency distribution histogram was found (Figure 2) after regrouping the data into classes with the amplitude of 100 m^2.

Centralized in Figure 3, the data obtained from the detailed study of this distribution show that the uncontrolled installation of forest vegetation on the central flow corridor (upstream the structure) has developed on an average area of 110 m^2, but the variability of this event, from one case to another, is highly salient ($s\%$ = 84%).

From the same figure, statistically significant values draw the attention, both for the asymmetry index and for the excess

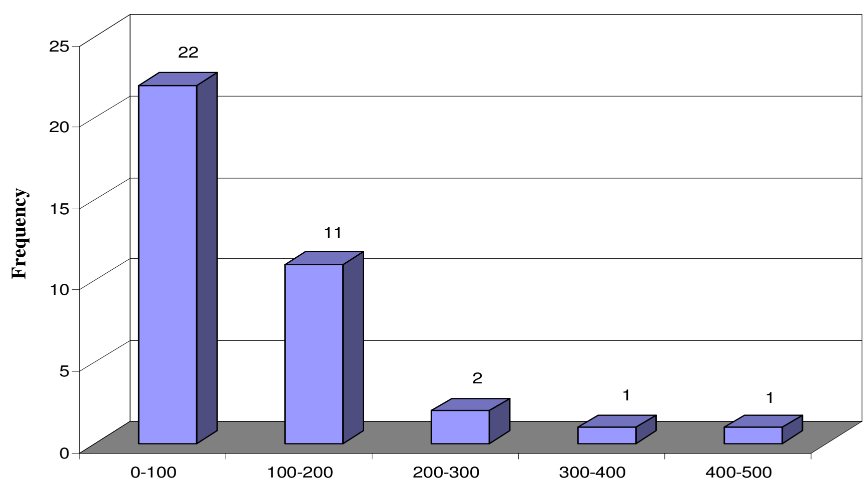


Fig. 2. *The frequency of uncontrolled installation of forest vegetation for the 0…500 m^2 interval, where most of the cases are grouped*

χ^2 test

Theoretical distribution	Experimental value	Theoretical value
Normal	7.9	9.48
Charlier - type A	1.3	9.48
Beta	2.1	7.81
Conclusion: Experimental distribution can be fitted with all three distributions		

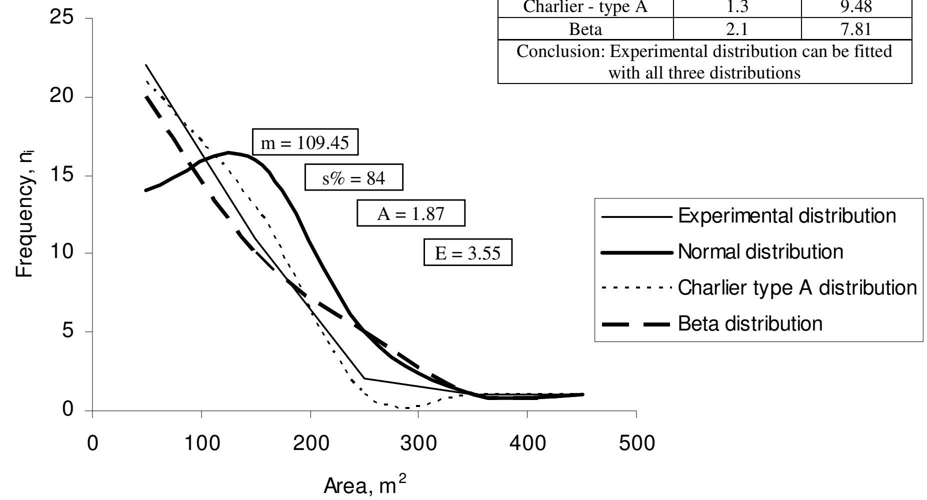


Fig. 3. *The experimental frequency polygon, the theoretical frequency curves, the values of the main statistical indicator and the χ^2 test values for the frequency distribution of the uncontrolled installation of forest vegetation (0…500 m^2 interval). Legend: m - the arithmetic mean; s% - the standard deviation; A - the asymmetry index; E - the excess index*

index. The leptokurtic curve is the experimental frequency polygon and it presents left asymmetry.

The results obtained by applying the χ^2 test prove that this curve can be fitted by all three theoretical distributions used in the present analysis. The best quality of fitting is given by Charlier - A type distribution, followed by Beta distribution. In this ranking, although the normal distribution holds only the third position, it is nevertheless important to know that the experimental distribution of the event meets the normality condition.

The frequency distribution of the blocking degree of the flow corridor underlies the second part of the research. The blocking degree has resulted by dividing the area on which the forest vegetation installed (upstream the structure) by the total area of the central flow corridor. Thus, the distribution presented in Figure 4 was found, which shows the following positioning of the studied cases, by percentage steps of the blocking degree:

- under 25% ....20 cases;
- between 25% and 50% ....8 cases;
- between 50% and 75% ....5 cases;
- between 75% and 100% ....7 cases.

Using a detailed statistical analysis of this distribution (Figure 5), we found that the blocking degree of the central flow corridor is, on average, of approximately 37%, the distribution of this characteristic being highly inhomogeneous (*s*% = 77%), with a statistically significant (positive) left asymmetry and with a statistically insignificant negative excess.

By applying the χ^2 test, it resulted that only the Beta theoretical distribution is suited for the fitting of the experimental frequency polygon. To a certain extent, the theoretical Charlier - A type distribution is

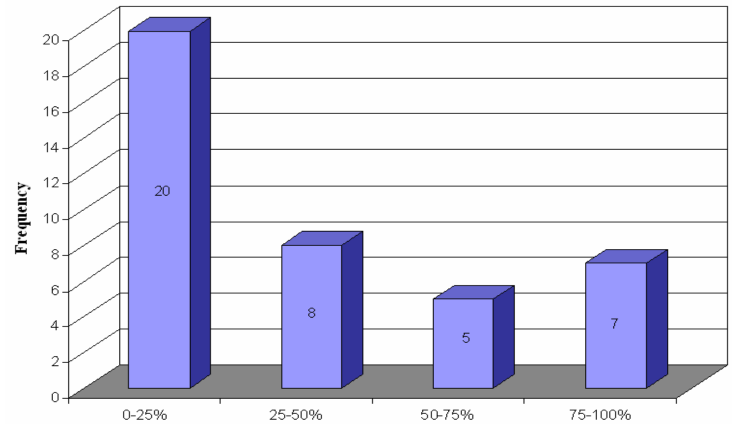
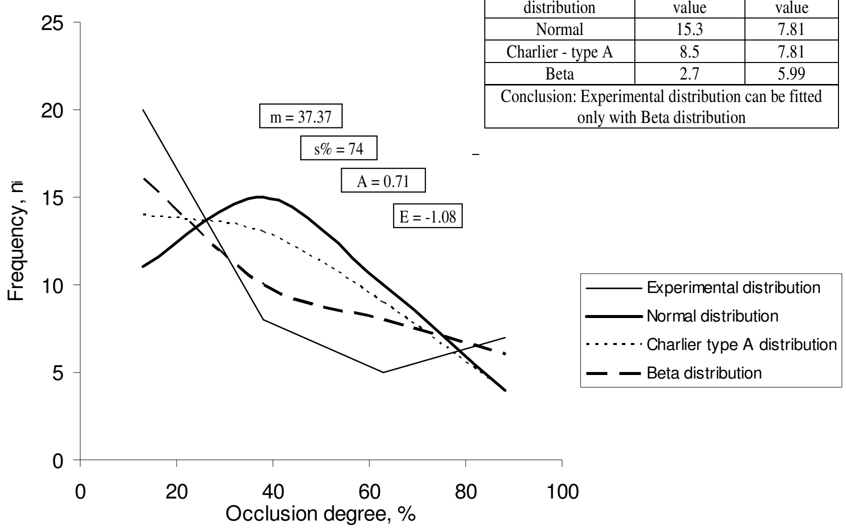


Fig. 4. *The frequency of the studied cases, by the occlusion degree of the central flow corridor, caused by the uncontrolled installation of forest vegetation*



χ^2 test

Theoretical distribution	Experimental value	Theoretical value
Normal	15.3	7.81
Charlier - type A	8.5	7.81
Beta	2.7	5.99
Conclusion: Experimental distribution can be fitted only with Beta distribution		

Fig. 5. *The experimental frequency polygon, the theoretical frequency curves, the values of the main statistical indicator and the χ^2 test values for the frequency distribution of the blocking degree of the central flow corridor, caused by the uncontrolled installation of forest vegetation (0…500 m^2 interval). Legend: m - the arithmetic mean; s% - the standard deviation; A - the asymmetry index; E - the excess index*

also close to meeting this requirement, but without complying with it rigorously.

In exchange, the experimental distribution regarding the blocking degree of the flow corridor is far from meeting the normality condition.

4. Conclusions

In natural conditions of installation, without any human interventions, the forest vegetation develops chaotically on the managed torrential network, blocking the central corridor used for the free flow of the water and leading to a dysfunctionality during the torrential flows, especially if the forest vegetation has installed also in the structure execution zone itself, on certain components, including the clogged space between the energy dissipation teeth.

A statistical approach of the event is justified both for the fact that its occurrence is at random and the fact that this kind of approach opens the way to a systematic monitoring of the hydrotechnical structures on the hydrographical torrential network, according to the needs ensuing from the principle of interdependency of silvotechnical and hydrotechnical works.

The statistical analysis of the event was performed by taking into consideration two characteristics that can render its variability:

- that part of the area of the flow corridor, covered with forest vegetation (expressed in m^2);
- the blocking degree of the flow corridor, in percent.

The first aspect of the analysis showed that the event of uncontrolled installation of forest vegetation developed, on average (per structure), on a surface of approximately 110 m^2 on the managed torrential valleys in the Upper Tărlung watershed. The event variability, from one case to another, was highly emphasized. The distribution of experimental frequencies meets the normality condition.

Following the research concerning the second characteristic, it resulted that the blocking degree of the central flow corridor was, on average (per structure), of approximately 37%, the frequency distribution of this characteristic being highly inhomogeneous, with a statistically significant left asymmetry.

In the present case, the frequency distribution is far from normality. Only the Beta theoretical distribution is suited for fitting the experimental frequency polygon. To a certain extent, the theoretical distribution Charlier - A type is close to meeting this requirement, but without complying with it rigorously.

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