ACTA TECHNICA CORVINIENSIS
– Bulletin of Engineering
Tome IX [2016] , Fascicule 1 [January – March]
ISSN: 2067 – 3809

[1.] Adrian Laurențiu POPOVICI

ESTABLISHING A RECURRECNY PERIOD AND IDENTIFIYNG THE MAIN FOREST SPECIES WITHIN THE AVALANCHE PATHS IN LALA VALLEY, NATIONAL PARK OF RODNEI MOUNTAINS

[1.] "Ștefan cel Mare" University, Silviculture Department, Suceava, ROMANIA

Abstract: The purpose of the present paper focuses upon the importance of the establishment a recurrence period for avalanches and the identification of the main forestry species, due to the juvenile vegetation found in the avalanches paths. During measurements, there were registered a series of characteristics which proved the existence of a major event (scars, changings in wood reactions, deviated tree-rings etc.). Based on the results reported through the presence of the events on dead wood but also on the present vegetation in the area, we shall realize a relative chronology of high-magnitude avalanches in the studied area, for every avalanche path considered. As our research advanced, we noticed that beyond the enhancements brought in the specialty field, the establishment of a recurrence period for avalanches may have a scientific impact, from the perspective of understanding which pioneer species are going to install in the juvenile forestry vegetation, localized in the avalanches paths. All data (dendro-chronological and susceptibility analysis) indicate that in 2006 occurred a high-magnitude avalanche, destroying trees from slopes but also a cottage. The cottage was nearly built and was localized in path I.
Keywords: avalanches, chronology, avalanche patch, susceptibility, pioneer species, progression dynamics

INTRODUCTION

The silviculture has a colossal importance at a global scale. With a history evolving from the role of raw material easy to procure in the ancient times, until the role of endangered resource, the forests had and will have a major impact upon all important domains: industry, economy, health or tourism etc.

In Romania, the avalanche entered into the attention of the scientists much more lately than in the rest of the Europe. The firsts observing and making researches on avalanches were researchers of the sylvan domain. (Gaspar, Munteanu, 1968; Bădescu, 1972; Alexa, 2005).

The avalanches' action generate a fragmentation and the partial destruction of the vegetation in the area. The poor frequency of avalanches allows a partial reconstruction of the path in the period between two events. However, each event implies an important force of movement, fact proved by the trees which lose their peaks or high diameter trees tilted. The colonization in these extreme conditions is characterized by a slow growth of species and by the presence of periods of species domination. In addition to this, it increase the vegetal propagation mainly in the distal area of the accumulation.

The identification of data obtained from more than one dendro-ecologic indicator is essential for the calculation of avalanches frequency. Three of the most useful indicators in dating avalanches are: abrasion scars, reaction wood and the traumatic resin ducts. The first two indicators are recognized as the best in calculating the snow avalanches. (Potter, 1969; Smith, 1973; Burrows & Burrows, 1976; Shroder, 1980). The largest annual rings supplied complementary information. With respect to tight rings, their dating did not allowed the utilization of the data obtained, because of other indicators, their sensibility being too high in front of many other risk environment factors.

On the other hand, prudency is required in the general utilization of abrasion scars in the areas affected by avalanches, because there are other factors generating scars, for instance the fire, the detritus or animal behavior. (Carrara, 1979; Johnson, 1987).

According to Marion et al. (1995), traumatic resin ducts constitute the best indicators, as they correspond to the years of scars formation and are visible on the larger longitudinal side of the trunk. Yet, those anomalies may appear as response to other stressful conditions, especially in case of insect pestilences. Moreover, during an avalanche, the trees basis is often protected by snow, a fact which explains the absence of scars and damages on trunks basis. However, in 1985 Ward reported a concentration of basal scars in some avalanche paths. According to the same author, these scars underestimate the intensity of an avalanche, which makes that the scars height being a factor difficult to utilize as an intensity indicator.

RESEARCHES LOCALISATION

Rodnei Mountains present the highest altitudes in the Oriental Carpathian Mountains, dominating the landscape, and the biggest level differences are recorded reported to Maramureș depression, situated at north. The National Park of Rodnei Mountains is situated in the central area of Rodnei Mountains, on the area of Maramureș and Bistrița Năsăud counties. Internationally, it is designed as Reservation of the Biosphere by UNESCO Committee "the human and the biosphere" based on Ministry Order no. 7 of 1990 issued by the Ministry of Waters, Forests and Environment protection and confirmed by Law 5 of 2000. From a geographic perspective, it extends between 47º25'54" and 47º37'28" northern latitude and 24º31'30" - 25º01'30" eastern latitude, having a total surface of 46,399 ha. (Anonymous, 2010)

Three avalanche paths were considered, situated in Rodnei Mountains, more precisely in the subcompartment 18B, on the Northern versant of Gajei peak, closely to Ineu peak.

MATERIAL AND METHOD

Upon taking off the drill cores, a series of characteristics was noted, like: current number, basal diameter, broken limbs, damages, broken peaks, presence of wounds.

For dating extreme events (herein, avalanches) wood discs were taken off from final areas of the avalanches and drill cores of the trees situated in the proximity of the avalanche paths.

The counting of annual rings was realized with the LINTAB 6 system, having a precision of 1/1000 mm. Drill cores and discs were counted from bark to medulla. Discs were taken off from dead trees situated in the storage area of the avalanche paths, and based on the information offered by the National Park of Rodnei Mountains we find that in 2006, in the area was a high magnitude avalanche, bearing down those trees. During the measurements, the characteristics relieving the existence of a major event were highlighted (clogged bark, changing the appearance place for reaction wood, deviated annual rings etc.).

After noting these characteristics, an identification of forest species localized in the vegetation permanently juvenile, was developed.

RESULTS

In order to determine the versants susceptibility on Lala Valley upon the production of extreme snow events (avalanches) the following parameters were considered: exposition, slope, vegetation coverage, lithology and soil conditions.

Concerning the susceptibility degree on producing avalanches, we identified that the production of avalanches is increased by the northern exposition (shaded), which helps the snow to persist a longer time. The slopes of 31-53° generate the extension of avalanche intensity. The presence of subalpine grazing vegetation (juniper trees) even in the detachment area of the avalanches, leads to the production of extreme events, even if there is a coniferous forest in the paths basis. The soil conditions influence the production of avalanches even if in a small measure, the soil being composed of micaschist and paragnaise.

These mentioned parameters are essential, according to the specialty literature, bringing forward the production of avalanches.

In order to elucidate the hypothesis issued on the dynamics of radial growth, a close analysis of drill cores and was performed, with the precise purpose to register all traces left by disrupting factors (scars, clogged bark, annual rings deviations etc.). This analysis was performed on each avalanche path, both based on biotic trees, dead wood and on a global analysis.

To obtain an overview of the snow events in the studied area, a common graphic was performed, which integrates the events both from drill cores and from discs.

Based on the results from above, we will realize a statistics of avalanche production in the studied area, considering the results procured from biotic trees.

In the path I snow events (with reaction upon more than five trees) were registered in the years: 1923, 1936, 1947, 1950, 1957, 1962, 1987, 2006 and 2009. It is interesting that in 2006 there are no data recorded by dead wood, because it was borne down by the avalanche of that year. The eliminated trees have no longer recorded the avalanche of 2006, because they were in vegetative dismissal in the moment of its production. (Figure 1)

In the path II, we found out that in the years: 1924, 1928, 1930, 1931, 1934, 1935, 1937, 1946, 1947, 1950, 1952, 1953, 1594, 1957, 1959, 1963, 1965, 1970, 1987, 2006, 2007, 2009 extreme snow events were registered by a large number of trees (more than five trees). We also noticed that in the years

2006, 2007 and 2009 there are no data recorded by dead trees, because they were borne down by the avalanche of April 2006.

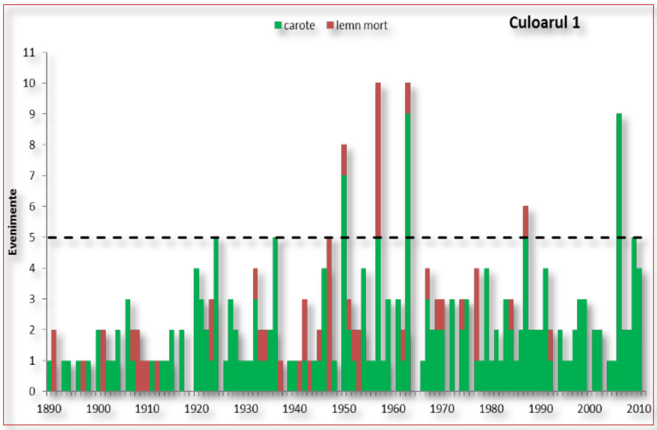

Figure 1. The number of events per year (in the path I)

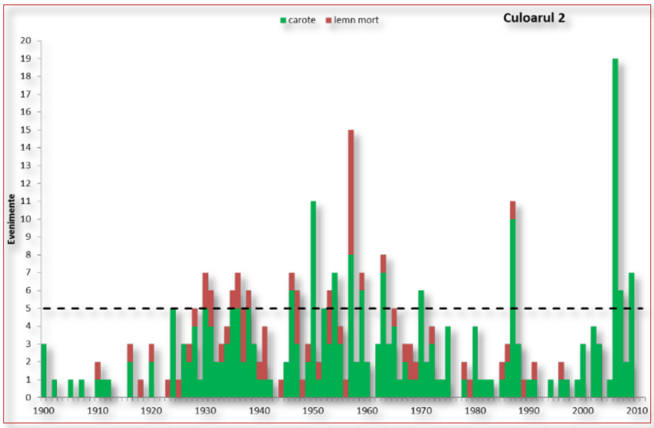

Figure 2. The number of events per years (in the path II)

In path III, over five events were registered in the years 1947 and 1950, with traces mainly on the dead trees.

Hereinafter we will present the recurrence period for the avalanches produced in the study area, considering the material available for the dead and biotic wood (calculated according to each path). Therefore, for the path I the recurrence period is of 5.5 years, for path II it is of 5 years and for path II it was of 55.5 years. The probability to produce an avalanche in a year on path I is of 18.2 %, on path II is of 19.8 % and on path III is of only 1.8 %.

Table 1. Recurrence period and the probability of avalanches production in one year in Ineu Peak

	No. of years	No. of avalanches	Recurrence period (years)	Production probability (%)
Path I	121	22	5.5	18.2
Path II	111	22	5	19.8
Path III	111	2	55.5	1.8

The path III is on a reduced altitude, in the detachment area being installed a compact forest of *Picea Abies* and *Pinus Cembra*.

These statistic data present an especial practice importance, offering essential information for the studies in the field of avalanches production. The low recurrence period of an avalanche indicates a high susceptibility of versants of the right technique side of Lala Valley. The importance of knowing this parameter may be utilized within reforesting planning and prevention of these events.

Concerning the reforestation planning, the focus must be on quickly growing species, with high elasticity coefficients and with taproots.

Pinus Cembra is an example of a specie very well adapted to the conditions imposed by avalanches. Using this specie, a stabilization of the versant face to avalanches production may be obtained. However, these solutions cannot be applied in our study area, because of the high degree of protection, but it might be utilized for similar areas situated outside of protected areas.

The constitution of compact forests composed of *Pinus Cembra*, especially in the detachment area, will have a beneficial effect, by retaining the snow and avoiding the deposal of a consistent blanket of snow.

Table 2. Forest species identified in the study area

no.	Family	Specie
1	Caryophyllaceae	Arenaria procera L
2	Caryophyllaceae	Arenaria montania
3	Caryophyllaceae	Dianthus carthusianorum L.
4	Campunulaceae	Campanula abietina L.
5	Ranunculaceae	Caltha palustris L.
6	Brassicaceae	Cardamine pratensis L.
7	Cyperaceae	Carex ovalis
8	Poaceae	Deschampsia caespitosa L.
9	Poaceae	Phleum alpinum L.
10	Poaceae	Trisetum flavescens L.
11	Dryopteridaceae	Dryopteris austriaca
12	Dryopteridaceae	Dryopteris carthusiana (Vill.)
13	Onagraceae	Epilobium angustifolium L.
14	Rosaceae	Geum montanum L.
15	Rosaceae	Rubus idaeus L.
16	Cistaceae	Helianthemum nummularium
17	Hypericaceae	Hypericum maculatum Crantz
18	Hypericaceae	Hypericum perforatum L.
19	Cupressaceae	Juniperus communis L. Subsp. communis
20	Asteraceae	Leucantemum waldsteini
21	Juncaceae	Luzula albida
22	Juncaceae	Luzula luzuloides
23	Juncaceae	Luzula sylvatica L.
24	Pinaceae	Picea abies (L.) Karst.
25	Pinaceae	Pinus cembra L.
26	Polytrichaceae	Polytrichum commune L.
27	Polygonaceae	Rumex alpinus L.
28	Salicaceae	Salix caprea L.
29	Saxifragaceae	Saxifraga stellaris L.
30	Fabaceae	Trifolium repens L.
31	Ericaceae	Vaccinium myrtillus L.
32	Violaceae	Viola biflora L.

The avalanches patches generate a rich floristic diversity being appreciated by the fauna of the forest. The previous biocenosis was mainly formed by *Picea Abies*, which after an avalanche is replaced by a richer biocenosis. At a first ascertainment, the last one is composed of 22 families, with 32 species which enrich the forest vegetation (table 2). At this point, we may make reference to the succession dynamics, by which we understand the replacement of some biocenosis with others. When some species are replaced, modifications are produced in the biocenosis too. The secondary succession in our country occupies a top place compared to the primary succession, because a new biocenosis is installed in the same place where a different one which has been destroyed by natural or artificial causes.

The species composing the new biocenosis are mainly semi-shaded species, due to the 4 main parameters (exposition, slope, vegetation coverage, lithology), factors generating avalanches. (table 3)

Table 3. The classification of forest species depending on their different requirement of light

	heliofile	helio-sciofile	sciofile
Species	6	24	2

The vegetation inside the avalanches paths represent a rich source of food for wild animals, but unfortunately it is a source of food for domestic animals too, and they represent for human valuable product accessories. For example, *Vaccinium myrtillus L.*, is highly appreciated by *Ursus Arctos.*

CONCLUSIONS

We considered an avalanche when the presence of some traces was identified upon a number of minimum five trees. For the dead wood in the path I, scars were identified in years 1947 and 1957, in path II these are observed in year 1957 and in path III the majority of events were registered in 1947, with four events.

Based on the results signaled by the presence of events in dead and biotic wood, we will realize a statistics of avalanches production in our study area, per avalanches paths. Over five snow events were registered in path I in years 1923, 1936, 1947, 1950, 1957, 1962, 1987, 2006 and 2009, in path II snow events were recorded in years 1924, 1928, 1930, 1931, 1934, 1935, 1937, 1946, 1947, 1950, 1952, 1953, 1594, 1957, 1959, 1963, 1965, 1970, 1987, 2006, 2007, 2009, and for path II, the years 1947 and 1950 are probative.

The recurrence period for avalanches produced in the study area for dead and biotic wood for path I is of 5.5 years, for path II it is of 5 years and for path II it was of 55.5 years. Thus, the probability of producing an avalanche in a year on path I is of 18.2 %, on path II is of 19.8 % and on path III is of only 1.8 %.

In a first analysis, 32 species were identified as part of the juvenile vegetation inside the avalanches paths.

Acknowledgement

This article benefited from financial support from the project "European Quality PHD EURODOC", Contract no. POSDRU/187/1.5/S/155450, project co-financed by the European Social Fund through the Human Resources Development Operational Programme 2007-2013.

References

[1.] A. Munteanu, Al. Nedelea, L.Comănescu and C. Gheorghe, 2011, The dynamics of slopes affected by avalanches in Piatra Craiului Massif – Southern Carpathians, Bucharest, Faculty of Geography, University of Bucharest, Bucharest, Romania
[2.] B. Alexa, 2005, Monitorizarea avalanşelor produse în cuprinsul fondului forestier, Revista Pădurilor, 1, p. 35-38
[3.] C.J. Burrows, 1976, Procedures for the study of snow avalanche chronology using growth layers of woody plants
[4.] Daniel J. Smith, Daniel P. McCarthy, Brian H. Luckman, 1994, Snow-Avalanche Impact Pools in the Canadian Rocky Mountains, Arctic and Alpine Research, Vol. 26, No. 2, 1994, pp. 116-127
[5.] Daniel J. Smith, Daniel P. McCarthy, Brian H. Luckman, 1994, Snow-Avalanche Impact Pools in the Canadian Rocky Mountains, Arctic and Alpine Research, Vol. 26, No. 2, 1994, pp. 116-127
[6.] E.A. Johnson, 1987, The Relative Importance of Snow Avalanche Disturbance and Thinning on Canopy Plant Populations, Ecology, Vol. 68, No. 1 (Feb., 1987), pp. 43-53
[7.] Gh. Bădescu, 1972, Ameliorarea terenurilor erodate, corectarea torenţilor, combaterea avalanşelor, Ed. CERES, Bucureşti, 442 p.
[8.] Gaspar, R., Munteanu, S.A., Traci, C., Avram, C., Alexa, B., Teju, D., 1968, Studii privind avalanşele de zăpadă şi indicarea măsurilor de prevenire şi combatere
[9.] JF Shroder, 1980, Dendrogeomorphology review and new techniques of tree-ring dating, Progress in Physical Geography June 19804: 161-188
[10.] Joëlle Marion, Louise Filion, Bernard Hétu The Holocene development of a debris slope in subarctic Québec, Canada, The Holocene December 1995 5: 409-419
[11.] Noel Potter Jr., 1969, Tree-Ring Dating of Snow Avalanche Tracks and the Geomorphic Activity of Avalanches, Northern Absaroka Mountains, Wyoming, Geological Society of America Special Papers, 1969, 123, p. 141-166
[12.] Paul E. Carrara, 1979, The determination of snow avalanche frequency through tree-ring analysis and historical records at Ophir, Colorado, Geological Society of America Bulletin, August, 1979, v. 90, no. 8, p. 773-780
[13.] Rodney G. W. Ward, 1985, Geomorphological Evidence of Avalanche Activity in Scotland, Geografiska Annaler. Series A, Physical Geography Vol. 67, No. 3/4 (1985), pp. 247-256