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[1.]Elena C. MUŞAT, [2.]Arcadie CIUBOTARU,
[3.]János SZÁVA

A SHORT REVIEW REGARDING THE LOSSES RECORDED IN WINDFALL

[1,2.] Transylvania University of Brasov, Faculty of Silviculture and Forest Engineering, Department of Forest Management and Engineering, Brasov, ROMANIA
[3.] Transylvania University of Brasov, Faculty of Mechanical Engineering, Department of Mechanical Engineering, Brasov, ROMANIA

ABSTRACT: Stability of trees is a current and very important issue in the context of increased of living standards that involving a pressure increasingly higher on the forest. The aim of this paper is to highlight the devastating impact of wind on trees stability and the factors that influence the behavior of trees under the action of wind. Windfalls have both negative economical and ecological effects, the latter having a particularly strong impact in the long term. In the paper are mentioned the windfalls produced in past on European level, with accent on wooden affected volumes, but are synthesized also information regarding the dynamics of windfalls at Romanian level. The rooting depth and the slenderness ratio are indicators that influence decisively the stability of trees.
Keywords: windfalls, wind, resistance at wind

1. INTRODUCTION

During their existence, the trees are constant subjected to the actions of some factors on which depends their mechanical and biological stability [15]. Due to the ecological and structural fragility at the action of environmental factors and of their ecological and eco productive importance, the forest ecosystems, especially those with spruce, have constituted the subject of many complex and interdisciplinary studies [3-5, 15, 26, 28, 33, 35 and 37]. However, the assessing of failure risk is very difficult [20] because must to be studied aspects related to tree biomechanics (architecture, structure, damage and defects, the roots characteristics, the peculiarities of wood) and also the stationary/localized/fixed to a place/ conditions (topography, geomorphology, soils and hydrology) and weather conditions (normal and catastrophic storms, wind, snow, ice and rain).

Unlike other materials, trees, as living tissues, have the ability to increase and the consequence of this growth is exactly the changing of dimensions and mechanical proprieties [14]. The vertical growth of the trees is conditioned primarily by the bending movements resulted as response at wind and gravity actions [2].

Tare weight, air masses moving (with or without precipitations) require the trees especially at

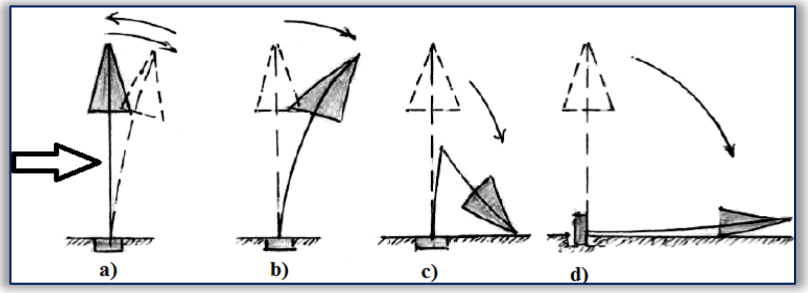

Figure 1. Forms of instability at spruce: a) bending and elastic buckling of the stem, in which case the stem will return to the original vertical position; b) bending and plastic buckling of the stem, in which case the stem remains deformed; c) breaking the stem; d) the overturning of the spruce by uprooting [15]

compression and bending [15] and the intensity of these forces, correlated with other specific factors, can affect the stability of trees (Figure 1).

Knowing the biomechanical behavior of the trees at the requests of the destabilizing factors is an essential step in understanding the stability [22] because is influenced by the characteristics and the peculiarities of each part of the tree. Since the stability of trees depends by the response at the external natural mechanical requests, the trees were considered, for the first time [14], optimal biomechanical structures.

2. THE SPECIES RESISTANCE AT THE DISTURBING ACTION OF WIND

The resistance at wind of the individual trees and stands is influenced to a large extent [37] by the characteristics of the trees (specie, height and diameter, crown and rooting peculiarities), by the densities of the stands and also by the peculiarities of soils, compared with the wind average speed, duration and the rhythmicity of gusts.

In Finland [37], the most affected by wind are the stands with spruce and pine, and the damages caused by the snow are more evident in stands with pine and birch, after performing of too intense thinning, executed too early or too late for those stands. The occurrence of those damages is associated also with the high values of slenderness ratio [37].

Figure 2. Windfalls produced in pure spruce stands during 2008 – 2012 [39]

Using the slenderness ratio, [5] analyzed the resistance at wind of the forest species from Romania and arrived at the following hierarchy in terms of relative wind resistance: common larch (Larix decidua Mill.), oak (Quercus petraea L.), black pine (Pinus nigra J.F. Arnold), fir (Abies alba Mill.), scots pine (Pinus sylvestris L.), hornbeam (Carpinus betulus L.), beech (Fagus sylvatica L.) and spruce (Picea abies L.).

In Romania [33], the largest share of the affected areas of windfalls is located in pure spruce stands, statement confirmed also by [35], but there were situations [21] that were affected stands with conifers species (80%) and deciduous species (20%). In this regard, [13] mentions that the deciduous stands (Figure 2) or conifers with deciduous stands have a greater resistance to destabilizing action of the wind compared to pure conifers stands, especially during winter storms because of its reduced surface of interception due to the loss of foliage. In literature [13] is mentioned that the stands with irregular structure, specific to the uneven-aged stands, in general shows a better stability to the destabilizing factors compared to the even-aged stands that are uniforms.

3. LOSSES RECORDED IN WINDFALLS

Global climatic changes, through the modification of meteorological elements, lead to changes in terms of stability of trees at wind action [25].

Among the environmental factors that influence the stability of trees, the wind and the snow play an important role, statement sustained by the numerous studies conducted over the years [1, 6-14, 17-19, 21, 23-24, 30, 32, 34, 36 and 37]. However [16] have mentioned that windfalls are

produced on a smaller scale every year, but there are situations when these phenomena are manifested on large surfaces with devastating effects on the forests.
The author of the reference [28] established that the structure and functioning of mountain forest ecosystems are strongly affected by the disruptive action of the wind. According with [27], the windfalls are the main stress of the mountain forest ecosystems, with major implication both economically [7, 11 and 37] and environmentally.
The economical impact is significant in the forest management [37] because reduce the yield of processing of logs and increase the costs of unscheduled harvesting occasioned by these damages. On the other hand [31 and 37] increase the danger of attacks by insects on the trees left in the forest.

3.1. Losses recorded at European level

According to data from the literature [28], at European level there is an increase in the frequency and the amplitude of windfalls, especially during 1965 – 1990 when the volume affected by the wind was two times higher than that recorded in the XIX century.
Another source [13] mentioned that during 1950 – 2000 at European level, the annual medium volume resulted from the actions of biotic and a-biotic factors were 35 million m³ (i.e. 8% from the volume that was planned to be harvested), of which the wind it was responsible for 53% of damage. The literature [12] states that, in the mentioned period of time, in the European forests were produced over 130 storms, which is equivalent, in mean, with two phenomena per year. The author of the reference [25] says, that at European level, only in 1990 were affected, in a single night, over 110 million m³.
In 1950 – 1980 in Finland [24] were lost almost 20 million m³ of wooden material due to the windfalls. According to [37], in Finland, in the autumn of 2001 were damaged 7 million m³ of wood during the two storms Pyry and Janike, in 2010 four summer storms led to prejudicing of 8 million m³ and in December 2010 were damaged other 3.5 million m³.
In the last twenty years at European level they have strayed three catastrophic storms. The Vivian storm (1990, January 25 – March 1) is considered to be the storm of the century in Switzerland [13], because it determined the breaking and uprooting of 120 – 130 million m³ of wood [12] on the territory of 14 countries, the damage being amounting to about 13 billion Euros [12].

Figure 3. Windfalls produced between 1960 - 1963 in Forest District Dorna Candreni, Suceava County [38]

According to the literature [13], in December 1999 there have been produced three storms with a particularly strong impact (Anatol, Lothar and Martin) which have affected 15 countries and a total volume of wood of over 240 million m³.
In the Central Europe due to the Lothar storm, who struck with a magnitude of 45 m/s (160 km/h – [29]), there were lost almost 185 million m³ in the northern of France (26 to 28 December, 1999 – [13]), in south-eastern of Germany and northern of Switzerland. The maximum speed of wind (241 km/h) has been registered in Zürich (Uetliberg Hill at 900 m altitude) and had led to windfalls on large surfaces, which affected 3% from forests [29], causing breakings and uprooting. As mentioned by [17] the damages were estimated at more than 10 trillion of US dollars.
In 8 to 9 January 2005 [13], it was another storm which has affected about 87 million m³, the most of damages being registered in Sweden (70 – 75 million m³).

3.2. Losses recorded at Romanian level

In Romania, the effects of wind upon the forest have always existed. The first notes regarding these phenomena appeared in 1844 [28], when was described a windfall produced at Sinaia in1838. After that, Fischer quote by [28] had described another windfall produced in 1943 in Bucovina.

In the literature of Romania [30] are mentioned also the windfalls from 1947, that were occurred in Bucovina. The same source [30] states the windfalls produced in the autumn of 1964 in Bucovina, when were registered wind speeds between 140 and 150 km/h, that led to prejudicing of 5279 thousand m^3, from which 2038 thousand m^3 distributed on a surface of 1605 ha. [13], mentions that, at Romanian level, in September and November 1964 were affected by windfalls about 7 – 8 million m^3.

Analyzing the temporal dynamic of cumulated wood volume affected by the windfalls produced in Romania, [28] draws the attention on the exponential tendency of increasing of damaged volume, thus delimiting the period up to 1947 – 1948, characterized by a frequency and intensity relatively small of the phenomena, by the periods 1947 – 1948 and 1974 – 1975 when were recorded the strongest windfalls (Figure 3), with an affected volume of 30 million m^3 only in the last quarter century. In the literature [13] are reported other windfalls that hit Romania, of which, the most important, are those from July and September 1969 (10 million m^3), November 1971 (1.4 million m^3) and November 1973 (3.1 million m^3). Significant are the windfalls from November 1995 [25] when were affected 141657 ha, with a damaged volume of 7.3 million m^3. According to official data presented by National Forest Administration – Romsilva, the a-biotic factors continued to affect the stability of trees, so that in the period 2008 – 2012, it was affected a volume of 2902.07 thousand m^3 (Figure 4), which corresponds to an annual average of 580.4 m^3. Also in 2013 were registered weather phenomena with peculiar character, which produced windfalls both in stands of conifers and in the mix of beech with conifers from the mountain areas, but the magnitude of them was at a much lower level comparing with 2012 [39].

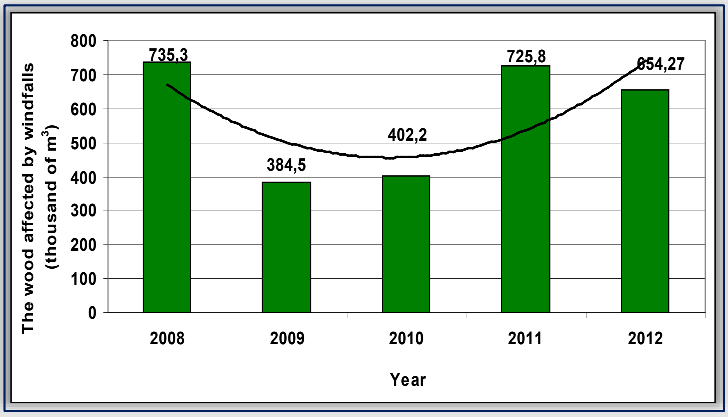

Figure 4. The volume affected by windfalls, at nationally level, during 2008 – 2012 [39]

4. CONCLUSION

The information from the literature draw attention on the increased frequency of the windfall at European level, leading to the idea that should be designed special measures for the management of stands, in order to increase their resistance to the perturbing action of wind.

The effects of those disasters are not felt only at economically level, but also at ecologically level, because the affected wood volumes must to be removed in the shortest time, to avoid the infestation of the wood and of other standing trees with biotic pests and emergence, in this way, of outbreaks that can attack the neighboring stands, which were not affected by wind.

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