

The natural factors and the risk of fire in the forests of Suceava county - short technical review

Ion Burlui

Faculty of Forestry, "Stefan cel Mare" University, Suceava, Romania.
Corresponding author: I. Burlui, ionburlui@yahoo.com

Abstract. The paper identifies the natural factors which act in the forests of Suceava county and influences upon the risk of fire. In this respect, a diagnosis of them is made in order to accurately determine the direction and the way in which the risk of fire is influenced upon the forests from Suceava. The work is based on data collected at the level of the county. Thus, after a brief overview of the natural factors with an influence upon the risk of forest fire, a separation will be done, treating them differently according to the moment of their appearance, the manifestation of the influence: continuous or variable. The risk factors are presented and analyzed according to the physical size of the state parameters registered at the level of the county, according to the consequences determined upon the risk of fire in the mountain forests. Finally, the work examines the causal link between the action of the natural factors and the risk of fire upon the forest, by two dimensions: the frequency and the intensity of fires.

Key Words: critical values, values of climatic factors, forest fire, risk,

Rezumat. Lucrarea face o identificare a factorilor naturali care acționează în pădurile județului Suceava, cu influențe asupra riscului de incendiu. În acest sens, se face o diagnosticare a acestora pentru a se putea determina cu exactitate direcția și mărimea în care se influențează riscul de incendiu asupra pădurilor sucevene. Activitatea se bazează pe date statistice culese la nivel de județ. Astfel, după o prezentare succintă a factorilor naturali cu influență asupra riscului de incendiu la păduri, se face o separare și tratare diferențiată a acestora în funcție de apariția lor în timp, de modul de manifestare a influenței: continuă sau variabilă. Factorii de risc sunt prezentați și analizați în funcție de mărimea fizică a parametrilor de stare înregistrați la nivel județean, de consecințele determinate asupra riscului de incendiu în pădurile montane. În final, lucrarea analizează raportul de cauzalitate dintre acțiunea factorilor naturali și riscul de incendiu asupra pădurii, prin două mărimi: frecvența și intensitatea incendiilor.

Cuvinte cheie: valori critice, valorile factorilor climatici, incendiu de padure, risc.

Introduction. Through its effects, the fire can be a damaging factor both for people and their activities and also for the environment. The forest fires are a special category of fires, distinguished fundamentally from other types of fires. Moreover, they are also legally differentiated. Thus, in the categorization of the risks which are taken into consideration for the classification of the territorial administrative units, the public institutions and businesses in terms of civil protection, the forest fires are part of the natural hazards, and the other fires are part of the category of technological risks. The classification of the forest fires in the category of natural hazards is sustained also by the influence of the natural factors upon their initiation and development.

The meteorological evolution from the last years, after 2004, from Romania shows a total change from the previous years. Extreme meteorological phenomena being present on larger and larger areas, with short-term manifestations. Thus there were recorded massive quantities of precipitations, wind speeds close to 100 km/h), extremely high temperatures (close to 40° C), which measured at the level of the soil are higher with up to 5-10 units, according to the radiant surface of the soil. The interdependence between the meteorological conditions and the forest is a unanimous accepted fact, therefore the two components influence each other.

The forest fond of Romania is under the influence of weather and climatic fluctuations characteristic to the continental climate of Europe. Periodically, there are recorded drought episodes or excessive drought with influences upon the vitality of the existing forests, but mainly upon the plantations and the regenerations which are to be installed. In the conditions of a prolonged drought, the risk of the forest fire is very high (Barbu & Popa 2001).

The forest fires from 2010, from Russia, Moscow's region, because of their magnitude and spread speed, put into counterbalance the idea that the major risk fire would exist only for the forests from the Mediteranean area of Europe (Grece, Spain) and they exclude the possibility of grouping them in "the reduced risk of fire" category of the forests from the cold and wet regions (as the forests from the Suceava area are sometimes characterized).

The management of the emergency situations as a result of forest fires is an activity of national interest, given the frequency of the production and the dimensions of the effects of these types of risks.

Following the outbreak of forest fires, the following socio-economic-natural components are directly or indirectly exposed to this risk factor:

- a) the population and its properties;
- b) the economical and social objectives;
- c) road and rail routes, utility networks;
- d) natural environment (forests, agricultural lands, settlements).

Material and Method. The determination of the risk of fire should start from identifying "the triangle of fire", generator of the fire: the combustible material – the air – the source of ignition, as shown in Figure 1.

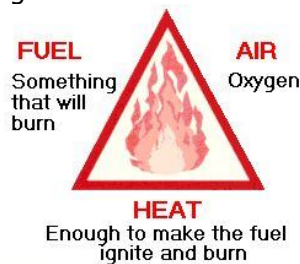


Figure 1. The triangle of fire.

In the case of the forest, the combustible material can be seen throughout the forest as a whole. The existent layers of the vegetation in the forest and which are under the risk of fire, are:

- the bedding: is the origin of a great number of beginnings of fire, because it is highly flammable, when the humidity drops below 5% (Ene 2008);
- the herb layer: highly flammable and in strong interdependence with the meteorological factors;
- the undergrowth: medium flammability, it quickly spreads the fire towards the upper layers, making the transition between the litter fires and the fires of the canopy;
- the tree, rarely at the origin of a fire (in case of lightning), it still allows its propagation when the flame reaches it, causing the fire of the canopy.
- the ruptures and the fellings: are part of a special category of combustible material generated by the forest vegetation. Thus, they arise from violent manifestation of natural phenomena (wind, snow, landslides) and which manifest mainly to a part of the forest, the one which is less protected, less healthy or not sufficiently rooted. After the ruptures and the fellings, agglomerations of wood are produced, which, through drying, increase the danger of fire, both through their own contribution and through the spread of diseases and pests in the nearby forest.

Remnants of exploitation: although it is not among the vegetation layers, they are often at the origin of fires, when the cutting area was not cleaned or the exploitation was done without respecting the norms of fire prevention. The same behaviour at fire is

presented by the wood material resulted from the execution of silvic and technical works from the forest, without taking the necessary protective measures.

Determining the risk of fire in the forests from Suceava County was based on the analysis of the evolution of forest fires during 1990 – 2009 (Inspectorate for Emergency Situations "BUCOVINA" Suceava County, Statistical data). As a result, it has not been uniform in time and space, and the physical and the geographical characteristics of the terrain, the climatic component and the anthropogenic factor have influenced and have caused a differentiation of the risk of fire for the same category of forest vegetation and the same period of year.

The analysis of the number of forest fires during 1990 - 2009

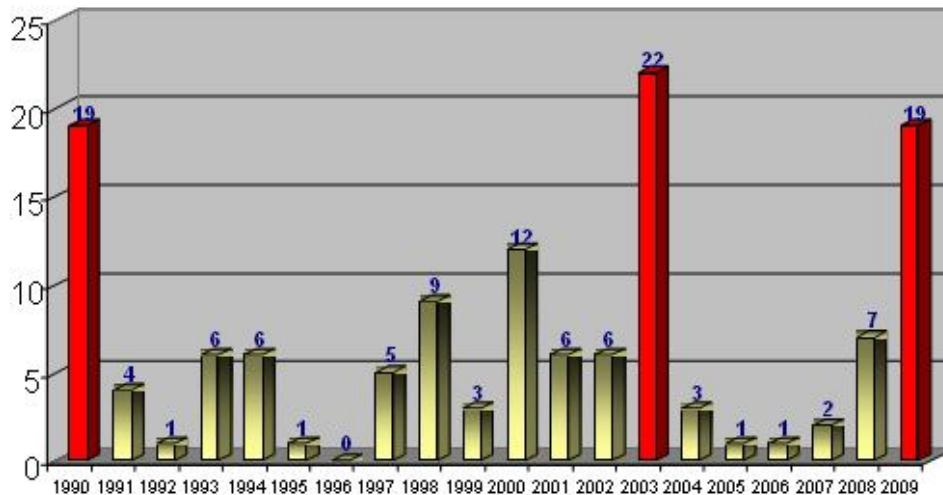


Figure 2. The analysis of the number of forest fires during 1990 - 2009

On forest ranges, for the same period of time, the situation is very varied, with maximum ranges of 9 to 15 fires / forest district (Marginea, Patrauți, Vama and Pojorata) and minimum ranges of 0 to 1 fires / forest district (Brodina, Malini, Dolhasca).

As seen from the Figure 2, the degree of risk in the forests of Suceava, has an oscillating evolution in time and space. Mathematically, the risk of fire can be calculated from the formula:

The risk of fire = the losses generated by the fire * the probability of occurrence

Identification of the factors favouring the production of forest fires is the first point in determining the likelihood of forest fires. Among these, the natural and the anthropogenic factors can be distinguished.

The natural factors make their influence felt through climate, terrain and the characteristics of vegetation.

- **The climatic conditions:**

The high temperatures, the drought periods and the strong wind are favourable to fire outbreak and development. Wind forces the elimination of water from the soil and vegetation and increases the speed of propagation of the fire through an ample supply of oxygen, sending the burning suspensions of the material away. Heat dries the vegetation by excessively evaporating the water and causes during hot periods, liberation of volatile essences, found at the origin of fire initiation. Humidity favours or not in an inverse proportional report with its size, the initiation and the development of fires, through the concentration of water found in the atmospheric air.

- **The orographic conditions:**

In a plane area of terrain, the fire suffers a directly proportional increase with the intensity of the wind, in the conditions of the existence of the combustible material. In an area with uneven terrain, the spread of the fire is influenced by its configuration, so the

acceleration of its speed is done towards the upper part of the steep, and the decrease towards the lower part of the steep.

- **The characteristics of the vegetation:**

The propensity of the vegetation for ignition and burning is mainly linked to its chemical composition, which determines the combustibility indexes (the existence of volatile chemicals and resins), texture (wood density) and the water content, which is determined by weather conditions. The phyto-sanitary status of the forest vegetation can determine its consistency and the content of water, having also an important role in the ignition and the spread of forest fires. The content of water of the vegetation is directly proportional with the quantity of precipitation from the soil and the humidity from the air. When the content is low, then the ignition of the vegetation can burst at relatively low temperatures. Thus, the inflammation temperature of the forest vegetation can vary between 260° C and 450° C (Ciobanu & Ioraş 2007). This temperature is sustained by diverse sources of heat, but in the presence of the temperature of the environment, the contribution of the initiation source can be considerably modified, in the conditions of the same type of forest vegetation.

The chemical composition of the forest also influences its behaviour in case of fire. Thus, from this point of view, the essences of the trees differ as being:

- pirofile essences (with sympathy towards an easy initiation of fire – the pine and the resinous in general), whose characteristics (the resin, the essences) favour the initiation and the spread of fires;
- piroresistent essences (with antipathy towards an easy initiation of fire – the oak, the chestnut tree), whose characteristics (the lack of resin, the density, the thick bark), favours their resistance to fires.

From the evidences of the Forestry Administration of Suceava county (2009) , the pirofile essences represent 76% from the total forest vegetation at the level of the county, fact which contributes also to increasing the risk of forest fire.

Results and Discussion. Analysing the annual numbers of fires, from Suceava county, related to the periods 1990 – 2009, it can be observed the fact that the climatic factor (high temperatures and drought) significantly influenced the number of fires, this being higher in the years with drought and higher temperatures than the normal thermic for the same period (Figure 2). The excessive humidity reduces the speed of burning, while the high drouisness substantially increases it. The currents of air, the wind, has a greater influence upon the burning speed of the combustible material. At the mountain, the main place of the forests fires from Suceava county, the currents of air are present with a permanent character, and on a strong wind the burning is intensely fed with oxygen, thus the speed of burning is also accelerated. Therefore, the statistical data of Regional Meteorological Center "Moldova" Iasi, (2009) measurements of the weather station "Călimani Retitis", are presented as follows:

March 1990

- Maximum temperature = 19 °C
- Minimum humidity % = 17 units
- The maximum speed of wind = 40 m/s
- The directin of the dominant wind = N-W

March 2003

- Maximum temperature = 27 °C
- Minimum humidity % = 17 units
- The maximum speed of wind = 25 m/s
- The directin of the dominant wind = N

The years 1990, 2003 și 2009 were years which were characterized through a lower rainfall regime from the normal of the analysed period, which together with high temperatures followed by strong winds had as a consequence an increase in the number of forest fires.

The assessment of the meteorological danger is done on a scale that includes 6 levels of fire hazard (represented in Table 1). The table below defines for each level of

meteorological danger the sensibility of the fire area, in particular the severity of the danger and the speed of fire propagation.

Table 1

The level of meteorological danger (Ene 2008)

Level	Definition and recommendations
LOW	Definition: The area is little sensible to fire. The meteorological danger of fire production is very weak. The production of a fire is improbable. Recommendation: any activity is authorized on the condition of obeying the legislation.
LIGHT	Definition: The zone is a little bit sensible to fire. In case of a fire, this will spread with a relatively easy speed. Recommendation: any activity is authorized on the condition of obeying the legislation.
MODERATE	Definition: The sensibility of the area to fire is moderate. In case of fire, this will spread with a moderate speed. Recommendation: any activity is authorized on the condition of obeying the legislation.
SEVERE	Definition: The area is sensible to fire. Two main cases: - the production of the fire is little probable. Anyway, in case of production of a fire, this could spread with a high speed. This case is encountered when the humidity of the air is high and the wind is strong. - the meteorological danger of a fire production is high. In the presence of a cause of fire, the production of a fire is probable. The speed of the fire could be rather high. This case is encountered in the situation in which the humidity of the air is low. Recommendation: The access in the forest is not recommended.
VERY SEVERE	Definition: The area is very sensible to fire. The meteorological danger of emerging fire is high. Any flame or source of heat risks the production of a fire with a high speed of spread. Recommendation: the access in the forest is forbidden
EXCEPTIONAL	Definition: The area is extremely sensible to fire. The level of drought is extreme. The danger of the production of a fire is very high. Any cause of fire risks a fire of a great intensity, with an extremely high speed. Recommendation: the access in the forest is forbidden.

The influence of the natural factors mentioned above, upon the risk of fire, it is argued through their way of manifestation during the production of fires in the first forest ranges, as a number of produced fires, in the period 1990 – 2009.

Conclusions. Comparatively analyzing the data from Table 3, columns 2 and 3 – value/day/fire with columns 6 and 7 – critical values of fire, it can be observed that the values of the three indicators (maximum and minimum limits) – temperature, humidity, wind – recorded during the days with forest fires, with the exception of the minimum limit of temperature, fits in the critical intervals favourable to the initiation of forest fires.

The influence of these factors upon the fire is done in its three phases: **the evaporation of the water** from the combustible material, **the emission of inflammable gases** through pyrolysis and **the ignition followed by the burning itself**. The level of the exterior input of the energy produced by the source of ignition for the initiation of fire will be inversely proportional with the level of the input brought by the climatic factors – temperature and currents of air. Thus, an exterior high temperature together with strong currents of air favour an accentuated evaporation of the water from the combustible material and the increase of its temperature so that the emission of

inflammable gases to be done after a minimum input of heat. Also, at a low humidity of air, the evaporation of the water from the combustible material is done more easily, because of the fact that the environment is not saturated of water vapours.

Table 2

The presence of climatic factors/ day of fire/ forest ranges
(Regional Meteorological Center "Moldova" Iasi, Statistical data, 2009)

Nr. crt.	The date of the fire production	Climatic factors			
		Max. temp. [°C.]	Min. Humidity [%]	Max. wind speed [m/sec]	Rainfall med. day [l/m ²]
I Forest Range Pojorâta					
1.	16.03.1990	14.4	19	14	1
2.	01.09.1990	22	29	12	1.5
3.	26.04.1994	13.5	42	16	1.2
4.	11.08.1994	24	48	20	1.6
5.	16.08.1998	24.7	42	12	1.7
6.	13.03.2001	6.4	31	24	1.5
7.	15.07.2002	23.5	38	18	5.1
8.	27.05.2003	20.8	14	22	1
9.	20.07.2003	21.5	50	28	5.8
10.	29.03.2008	5.2	39	34	3.7
II Forest Range Vama					
11.	16.03.1990	14.4	19	14	1
12.	17.03.1990	14.4	19	14	1
13.	02.08.1998	24.7	42	12	1.7
14.	16.11.2000	12.8	30	10	0,2
15.	03.05.2003	20.8	14	22	1
16.	20.03.2007	12	24	34	2.4
17.	28.03.2008	5.2	39	34	3.7
III Forest Range Pătrăuți					
18.	26.02.1998	19	31	14	0.1
19.	25.05.1998	26.2	36	9	4.2
20.	03.10.1999	28.4	37	14	1.9
21.	10.04.2003	26.5	22	14	0.6
22.	15.05.2003	31.2	25	12	0.5
23.	03.04.2004	21.8	32	9	0.6
24.	02.04.2006	18.6	30	12	2.4
25.	29.03.2008	20.6	20	12	0.5
IV Forest Range Marginea					
26.	25.03.1990	24.5	16	14	0.4
27.	03.11.1993	16.8	51	9	2.2
28.	07.04.1998	27	30	9	1.7
29.	26.03.2000	16.3	48	9	1.1
30.	20.06.2000	32.2	47	18	1.3
31.	08.03.2001	20.4	24	9	1
32.	02.02.2002	18.1	24	8	0.4
33.	11.04.2005	21.9	16	10	4.1

Note: In bolded figures are written the values of the climatic parameters with favourable values to the production and the spread of fires, above the normal limits of the same periods of a year. Among these values, the minimum and the maximum values, related to the annual medium values, are presented in the Table 3.

Table 3

The values of the climatic factors related to the annual medium values and the critical values of fire

Indicator	Value / day / fire		Annual medium value		Critical values of fire	
	min	max	min	max	min	max
Temperature [°C]	5.2	32.2	5.8	13.8	17	33
Humidity [%]	14	51	17	83	0	60
Windspeed [m/s; km/h]	9 / 32.4	34 / 122.4	8.5 / 30.6	1.1 / 4	10.2/37	

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References

- Barbu I., Popa I., 2001 [Monitoring the risk of drought in the forests of Romania]. Bucovina Forest, **IX**. [In Romanian]
- Ciobanu V., Ioraș F., 2007 [Forest fires]. Editura Universității Transylvania, Brasov. [In Romanian]
- Ene C., 2008 [Fire prevention and forest fire]. M.I.R.A., Bulletin no. **17**(1). [In Romanian]
- Forestry Administration of Suceava county, 2009 Statistical data. [In Romanian]
- Inspectorate for Emergency Situations "BUCOVINA" Suceava County, 2009 Statistical data. [In Romanian]
- Regional Meteorological Center "Moldova" Iași, 2009 Statistical data. [In Romanian]

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Authors:

Ion Burlui, "Stefan cel Mare" University, Faculty of Forestry, No. 13 University Street, 720229, Suceava, Romania, e-mail: ionburlui@yahoo.com

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