The Risk of Forest Fire in Suceava County

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Abstract: The paper aims to identify and diagnose the risk of fire in the forests of Suceava County, approaching the activity from the point of view of the fireman acting to implement the measures of prevention and firefighting, as well as from the point of view of the one who organizes, coordinates, leads and carries out activities of limitation and extinction of the fires affecting the forest fund.

Therefore, after a brief overview of the defining elements of Suceava's forest fund, of the importance and the role of the forest in the life of the county, we will move on to the development of a risk analysis, pointing the risk factors with an active or potential presence. The presentation of a few elements of risk theory, which places landmarks in a research of this kind, creates the premises of an objective approach, concrete and with commensurable results of the fundamental elements that define the risk of fire in the forests of Suceava.

The risk factors are presented and analyzed according to their presence and influence, the dimensions of their consequences and the frequency of risk manifestation. Also, the risk factors are each analyzed, both in terms of the natural and anthropogenic contribution and the way in which they manifest their presence in the production of the risk fire: as determinants or as situational factors.

Finally, the paper briefly presents the similarities and the differences of risk fire between the mountain forests and the plain forests.

Key words: Risk, fire, forest, anthropogenic, factor

1. The Forest in Suceava County

Suceava County is located in the North–Eastern part of Romania. With an area of 8553.50 square kilometers, it is the second largest county in the country and it occupies 4% of its surface. It is a border county, in North bordering Ukraine, in East, Botosani County, in South, Iasi, Neamt, Harghita and Mures, and in West Bistrita Nasaud and Maramures. Except the Eastern and the South-Eastern borders, all the other ones are timbered.

The main landforms are arranged from east to west in parallel longitudinal sections from North to South, distinguishing itself by diversity, with heights from 225 m in the Siret riverbed to 2100 m Pietrosul Calimanilor peak. Therefore, the mountain area occupies 53% of the surface, 30 % plateau and 17 % meadow area.

The forests occupies about 51% of the county (the timbered area being of 439,862 ha), forming the most extensive and rich forest fund of our country and representing a share of over 7% of the full Romanian forest potential.

The species which the forests of the county have are mainly the following: coniferous forests – 76%, broadleaf forests – 24%.

According to the age of the forest trees, we encounter the following groups: a) 1 at 20 years: 13%, b) 21 at 41 years: 30%, c) 41 at 60 years: 18%, d) 61 at 80 years: 16%, e) 81 at 100 years: 16%, f) over 100 years: 8% [6].

2. The Risk

Each system has the protection which it can afford. Thus, the risk it assumes is inversely proportional to the level of protection achieved. At the same level of risk, different measures of protection can be adopted, depending on the stage and the system development, the importance and the interest manifested in the functioning or the disturbance of its smooth functioning or in different systems.

There is always a risk, in any natural system, economical or social. Together with the evolution of society, the real risks their members expose themselves to, diversify and develop too. Thus, in time, different categories of risk may appear or disappear, depending on the stage of development of the society. Man, through his will and action, can identify, diagnose and monitor the imminent or potential threats, he can know the causes of their production, minimize and
keep under a certain limit the probable effects of risks, aiming at protecting the people, the animals, the material goods and the environment, but he cannot eliminate them entirely. As long as there is a cause, there is also an effect.

It is widely agreed that practically, there is no natural or anthropogenic system that can function at risk “zero”.

2.1. Definitions

Currently, there are different understandings and uses of the term “risk”, but all of them have some common elements, namely:
- it refers to an imminent or potential danger;
- it can be the consequence of the evolution of some phenomena/natural or anthropogenic processes;
- through the consequences that it can cause, the risk can affect, to a certain extent, the smooth operation of the system;
- it has a certain degree of probability of occurrence/repeatability
- the minimizing of the effects of its occurrence implies the consumption of resources.

The risk can be considered as a dimension which defines the negative consequences of a phenomenon, process, event or action, according to the frequency / probability of manifestation, localized in time and space.

2.2. General elements on risk theory

The acceptance of risk and the establishment of a tolerable risk level to the individual and society differs from one community to another, from one stage to another, it has a strong psychological and emotional character and it is influenced by a number of economic, behavioral, socio-demographic, psychological, being significant: the accumulated experience, the trust taken in the decision and the action factors, the economic potential of the society/of the individual, as well as the level of education.

Accepting a risk does not necessarily mean seeing it as being negligible or as a fact which can be ignored, but as something that has to be known, taken into consideration and diagnosed, monitored and controlled to an acceptable level. Therefore, accepting a risk is diametrically opposed to irresponsibility or ignorance of its consequences and the inaction of the individual or of the society towards the implementation of some compensatory measures is not done due to the acceptance of some possible consequences, but to the ignorance of the consequences and the lack of realization of the compensatory measures of protection [2].

Summarizing, when analyzing the risk, the following structural relations have to be taken into consideration:
- the type and the dimension of the consequences / losses that are likely to occur;
- the probability / the frequency of production;
- the entity (persons, goods, environment) at risk;
- the value of the losses expected to occur, estimated according to the worst scenario;
- the value of the compensatory measures to be taken in order to minimize the risk.

2.3. The risk of fire

The fire, one of the essential elements of life, the true driving force of the development of the human civilization, can be, when out of control, its fearsome enemy. When it was not known and controlled, together with the earthquakes, floods, droughts and other disasters, the fire has caused major and painful damages to humanity, material and environmental. The risk of fire, particularly the forest risk fire has always existed and will always exist, independently from the human will and action. If the risk of fire is categorized as belonging to the technological risk category, according to the present legislation on emergency situations, the risk of forest fire belongs to the category of natural hazards. Thus, after a forest fire, the evaluation of the damages is done taking into consideration both the damages caused by the burning of timber, but also the collateral effects produced upon the biocenosis of the forest.

When analyzing the risk of fire, an essential element is the risk of fire which, as defined by the legislation on emergency situation, represents a phenomenon, a process or a complex of congruent circumstances, matching the same time and space, which may determine or favor the production of some types of risks. Thus, it is well known the fact that for a fire to start, three elements have to be simultaneously met, in the same area: the carburant – the combustible material which has the property of burning, the carburant – the gas which favors and maintains the combustion and the source of ignition – which has to provide the temperature necessary to the ignition of the carburant, depending on the time in which it is in contact [1].
As shown, when assessing only the risks with a financial impact, then the results can easily be made, and the decision to establish the threshold of acceptability is taken by analyzing the value which can be confused with the threshold of cost effectiveness. In the case of the risks with an impact on more levels, as the fire risk, when deciding the threshold of acceptability each type of consequence has to be analyzed separately. Consequently, the following consequences of the forest fire will be taken into consideration upon:
- the timber destroyed or damaged;
- the fauna;
- the forest vegetation;
- further protection against soil erosion
- the protection of water courses;
- the protection against wind;
- the air regeneration;
- the landscape effect;
- the social protection of the staff in terms of employment.

3. The Risk Factors of the Forest Fires in Suceava County

The forests from Suceava County, due to some situational disadvantaging parameters, from this point of view, are exposed to releasing risk factors of the fires, with an upwards evolution in time. Thus, the situation during the last years shows an increase in the number of fires in the forest area, an extent of the affected localities as well as the diversification of the fire causes and of the favoring situational factors which contribute to the initiation, the maintenance and the development over time and space.

The history of the emergency situations produced because of the risk of fire in forests, in the area of expertise – Analyzed period January 1990 – September 2009 shows that during this time at the level of the Forest Directorate Suceava were 132 forest fires [7]. The presentation is done without considering the indicator “damage value” or “consequences of fire” because it could include too much subjectivity.

Graphically represented, the distribution of fire on years, does not allow seeing their downward trend, but a situational evolution, with peaks between 19 and 25 fires per year, which represents two fires per month.

Fig. 1. The analysis of forest fires during 1990 – 2009.

The analyzed risk factors influence, under one form or another, the burning rate, which is a main characteristic of combustible substances and materials and it depends, in the case of forest fires, on: the temperature at which the first oxidation reaction takes place; - the chemical composition, - the humidity of the substance or of the combustible material; - the air currents; - the atmospheric pressure; - the ratio between the free surface and the volume of the combustible material. For solid materials, as timber, in the analyzed case, two terms of burning rate are used: the actual speed of burning, reported to the total surface unity. The statistical analysis takes into account the overall speed, reported to the burned area, in the case of the laboratory tests, the real speed is taken into account, reported to the surface of the burning material. The burning speed increases with the raising of the temperature and it depends on the amount of oxygen involved in combustion. In the case of the decreasing of the quantity of oxygen, the burning speed is reduced. For the burning of the combustible material which exists in the forest fund, the oxygen is taken from the air. If the atmosphere contains less than 14 – 15% oxygen, the combustible substances and materials cease burning, meaning that the burning rate becomes zero, which, practically, seems impossible in a forest environment. On the other hand, the temperature influences the burning rate in two ways:
- on the one hand, the temperature of the environment where the oxidation reaction takes place influences the quantity of heat necessary to initiate combustion, in an inverted ratio – the higher the temperature of the environment is, the lower the quantity of heat necessary for the initiation of the burning.
- On the other hand, the higher the temperature of the environment is, for the same amount of heat destined to the initiation of the burning, the time of initiation will be smaller. The identification of the risk factors of fire for the forests of Suceava, has to be done separately, dealing with the two major influences – nature and man, in this way:

**a) natural factors**
The natural risk factors of the forest fires, predominantly in Suceava County, are:
- the forest fund
- the climate, the atmospheric pressure and the air currents;
- the landforms;
- the hydrographic network;

The forest fund is the main combustible material from the forests. The forests from Suceava County are rich and diverse in species, mainly predominant are the coniferous forests – 76%, among which the spruce contributes with 64% to the forest fund and 84% to the coniferous forests. As a reaction to fire, the spruce meets all requirements to be considered as being the tree with the most qualities favoring the initiation and the development of the fire. Thus, because of the chemical composition of wood (cellulose, resins, essential oils, gums) and of leaves, with a favorable ratio between the surface and the volume due to the arrangement of leaves, the spruce has the highest burning rate – 80.1 g/min, the second calorific power after pine – 15.596 MJ/kg, with a combustibility index 6, it is the second after the pine [1]. Also, the structure and the composition of timber directly influence the process of initiation of fire. The higher the density of the wood is, the higher the temperature needed for the initiation of fire, or a longer contact with the surrounding heat. Under identical conditions of humidity and time, the density of the wood material determines the ignition temperature. The low density species start burning first (the coniferous forests).

According to the composition of the forest from the mountains where the 132 fires took place in the analyzed period, it appears that the highest number was from the spruce forests – 33,33%, followed by the mixed coniferous forests – 25,76%, (resinous composition is 59,09% pure), coniferous – hardwood / hardwood – coniferous – 16,67, summing the pure composition and mixed with the coniferous represents 75,25%, broadleaf – 12,88%, and the fires in the forest fund in the buildings and facilities – 11,36%. It is significant and to be noted that the fires are mostly in the coniferous forests. This is not only due to the extent of the coniferous forests, but mostly due to the different ways in which the species of softwood and hardwood react to fire, according to the following indicators:
1. The burning rate, measured in grams per minute burnt wood;
2. The caloric value developed through the burning of the wood, measured in MJ/kg;
3. The combustibility indexes.

The rapport between the free surface of the combustible material and its volume, especially for the solids, has a great influence upon the ignition and the combustion process. The higher this rapport is, the faster the ignition takes place, and the fire occurs more quickly. This is evidenced in the large area of forest material reported to its volume, where it also includes a large quantity of air that favors the maintenance of fire.

As it is known, the greatest fire danger is represented by the combustible substances, in which there are basic elements like carbon and
hydrogen. These elements, combined, in the case of the coniferous forests, with a constitution of a low density wood where, besides carbon and hydrogen, which can be found in any wooden material in the form of cellulose (C6 H10 O5), resins and natural oils can be found, which can increase the risk of fire, compared to the deciduous stand.

Analyzing the annual number of fires, 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 dry years and higher than normal temperatures for that period. (fig. 1). This value is directly related to the atmospheric pressure, which is higher on a sunny weather, than on a changing weather. The lowering of the atmospheric pressure reduces the burning rate, while its increase accelerates it. The excessive humidity reduces the burning rate, while the high drought, increases it substantially. The air currents – the wind – have a greater influence upon the burning rate of the combustible materials [5]. At the mountains, where the forests prevail in Suceava County, the air currents are always present, and on strong wind, the burning is intensely fueled with oxygen, hence the burning rate is also accelerated. Also, due to the wind, annually, in the Suceava forests, about 60.000 cubic meters of timber are being cut. This timber, from the Suceava forests, about 60.000 cubic meters, is being cut. This timber, from the Suceava forests, about 60.000 cubic meters, is being cut.

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The topography influences the risk of fire through the implications that it has on the currents of air and through the positioning of the stand in slope, it leads to a rapid spread of fire on height. The Suceava forests are located mostly in mountain areas, with over 2000 m height, hardly accessible, crossed by the breaking of the torrents. The steep slopes lead to a reduced accessibility for people and equipment of the fire intervention, leading to a difficult intervention with consequences upon their length, with extension in losses. The initiation of a fire on a slope, not through direct contact, but due to air currents and the positioning of the terrain facilitate the transport of solid spark combustible at quite large distances. This should be treated with utmost care by the forces of intervention, both for controlling the spread of fire and especially for preventing the surprising. Also, the mountain soil is loose, consisting layers of litter, which allows and promotes the accumulation of oxygen, with direct consequences for the development of forest fires in the underground.

In the case of the mountainous terrain, the risk of forest fire determined by the electrical discharges from the atmosphere has to be treated separately. It is known the fact that the mountain is prone to this phenomenon due to several factors, including:

- the increased rainfall regime;
- the height of the landforms;
- the location on top of the mountains of various metallic constructions: relays, antennas and others;
- the geological constitution of the mountain rocks – having lightning attraction primarily the volcanic rocks.

As a natural risk factor, but which indirectly influences the ignition and the spreading of the fire, the hydrographic network contributes more to the influence of the time necessary for the intervention operations, so through its presence and volume, it can decide the extent of the spreading of the forest fire. In the case of the forests from Suceava county, with a hydrographic network of 1370 km, of which 395 km of rivers, 975 km of streams and 0,31 km of lakes and ponds, compared to an area of 439.862 ha, it results a density of water courses of 0,003 km/ha of forest fund. This low density of water courses combined with the lack of facilities and hydro reservoirs, which should provide a certain and stable water reserve, with a reduced availability of the means of intervention – a total number of 48 alimentation ramps for the intervention machines, as well as an uneven distribution in the territory, lead to a negative influence in the rising risk of fire in the forests of Suceava county.

b) the anthropogenic factors

The anthropogenic factors of risk concerning the forest fire, predominantly in Suceava County are:

- the form and the type of ownership/management/exploitation of forest.
- the human activity in the forest area in the form of:
  - The roads
  - The railway network
  - The power lines of medium or high voltage
  - The forest exploitation activity
  - The tourism activity
  - The existence of drilling and operating wells for natural gas deposits
  - The hydro technical facilities
  - The constructions of worship
  - The psychosocial profile of the population and its economic status.
1. **The form and type of ownership/management/exploitation** of forests is a key factor in the determination of the anthropogenic risks. Thus, a legislated activity, organized at all levels, continuously and responsibly held, can minimize the anthropogenic risks to those technologically accepted, and the natural risks can be identified, diagnosed, monitored and kept to an acceptable level. The regime change has led, since 1990, to changes as far as the properties are concerned. If, in the case of factories, buildings and agricultural lands, the new owners have maintained, willingly or legally forced, the initial exploitation regime, in the case of the forest fund, once with the change of ownership, it has gone to massive “cuts”, as a “shaver” system, of the forests by the new owners or by other persons. This entailed to complaints, which lead to the increased number of forest fires, having as a cause “the intentional action”. Also, the administration of the forest, in the regulated system allows the organization of prevention and extinguishing of the fires according to some well established rules, making investments in this sector, which in particular is not possible. A centralized implementation of these measures to protect forest resources is required because more than in any other field, the localization and the liquidation of a fire cannot be strictly done at the limit of ownership.

Analyzing the causes which led to the ignition of the forest fires during 1990 – 2009, the top is the intentional action 35% and the fire outside the forest 34%. This can be attributed to several causes, including:
- The process of change of ownership of forest fund (re-ownership)
- Conditions resulting from some conflicting grievances caused by some legal judgments concerning the allocation of property rights;
- The coverage of forest damage;
- The economic and financial status of the population;
- The education and the criminal behaviour of those who come in contact with the forest;
- The negligence and the irresponsibility of the residents who clean the pastures and mow the hay through fire;
- Small measures of guarding the forest fire, depending on the circumstances.

2. **The human activity in the area of the forest** is present in various forms, such as:
   - **The road network** influences directly and indirectly the risks of forest fires. The forest fund of the Suceava County is lined by 56 km of national roads, 380 km of county roads, 540 km of village roads and 2435 km of forest roads. The crossing of the forests by the communication paths involves, firstly, taking the same risks in terms of fire as well as the existence of economical activity, in addition to this, the presence of the man factor has to be taken into account, the man who exploits the space, where, in the case of organized economic activities is about a stability of the staff coming into contact with the forest, while in the case of communication paths, for people transiting the forest, the variety of means of transport is given from the aim of the communication itself. Thus, besides the accepted technological risk, by their functioning, contributes to the increasing of the fire risk and the cargo content of the means of transport. Moreover, the existence of insufficient access roads to the forest fund make the monitoring poorly, the noticing and the announcement of the fires late and the intervention operations difficult to conduct without the possibility of a perimetral attack, with limited access to intervention technique up to a certain level, thus including conditional use of water to extinguish fires. This requires a high time for pedestrian movement intervention force, finally with direct consequences on the time of intervention and the dimensions of the damage.
   - In other European countries, the average density of forest roads is 0.045 km / ha [3], while Suceava’s density of forest roads is only of 0,005 km / ha, which cannot be compared to other European countries (Switzerland, Austria, Germany), but even below the national average – 0,0062 km / ha. The optimum density of the forest roads compared to Suceava’s forests’ needs is of 0,014 – 0,018 km /ha [4]. These figures lead the Forest Fund of Suceava, in terms of forest roads, to 27 – 35% from the optimal Romanian network and to 11% from the average of the forest roads from other European countries [6]. It also appears as faulty the border forest road network, where there were interventions for fires started either in Romania or in Ukraine, where the spreading of the fire across the border can have diplomatic consequences, but the Romanian intervention can only be pedestrian, with hand tools, without the benefit of the technique of intervention.
   - **The railway network** which crosses the forest fund totals 120 km. There are both electrified railways and railways for steam or diesel locomotives. The risk of fire in the case of railways is similar to the one determined by the road means of communication, except that in the case of the railways the closing of the forest fund is more than in the case of roads, and the access of intervention special cars of firefighters...
is more difficult. And in the case given, the risk of fire is given both by the technological aspect of the means of transport and by the various load from the wagons and not frequently by the inadequate behavior of the passengers.

- **The power lines of medium and high voltage** which cross the forest fund from Suceava sum up 7968 km, of which: 2640 km of high voltage lines and 5328 km of medium voltage lines [7]. The low voltage power lines can meet perimeter forest resources.

The risk of fire, in the case of electrical overhead lines that are positioned through the forests, is determined by:
- the lightning occurring between wires during wind and storm;
- the electrical discharges occurring between the broken wires and the earth;
- the atmosphere electrical discharges in medium and high voltage poles;
- the breaking of the poles due to landslides and forest cuts;
- the breaking of the trees and the touching or the breaking of the electrical wires.

Although the protection zone around the medium and high voltage line is regulated to 2 X 1,5 h max, in reality, the width of the protection zone varies mostly between 6 to 10 m, where 2 = two halves of protection zone; \( h \text{ max} = \) the height of the tallest trees bordering the area protection. Also, usually, the access in the bordering area of the medium and high voltage lines is difficult, with no access roads for the fire equipment intervention.

- **The forest exploitation activity**

The existence of economic activities in the forest – forestry, berry gathering – is driven by economic reasons. Any type of economical activity presupposes human around, the existence of different types of machinery and equipment, the use of fire in different forms. Accepting the existence of economic activities in the forest area involves also accepting risks undertaken to these activities, risks whose factors may escape, in certain circumstances, from control, resulting in fire. The presence of the economic activities in the forest area is confirmed by the existence of over 125,210 civil and industrial buildings, at distances less than 200m from the forest perimeter. The activity of exploitation of the wooden material from the forests of the county was constant during 1990 – 2000, following a sharp increase during 2000 – 2005 due to the cutting of thee trees that took place during that period. Thus, the annual medium of wood exploitation within the Forest Directorate Suceava is 1,200,000 cubic meters on foot and 60.000 cubic meters resulting from cutting [6]. Also, the techno-silvic works should be taken into consideration and the treatments that are executed at the forest fund, all these activities determining:
- the presence of the human factor, with its errors and omissions;
- the presence of tools and machinery, which, technologically present a risk of fire production because of:
  - the internal combustion engines which equips them;
  - the electrical equipment which they serve and which, by operation, can produce electrical sparks;
  - the gears in motion which, by friction, can produce mechanical sparks;
  - the buffer reserve of fuel in the forests, needed to run the machineries.
  - the result of the above action is the mass of wood which, from the point of view of the fire risk, it is more dangerous on ground than on foot.

In this respect, a large number of exploitation and primary wood processing units appeared in contrast with the forest regeneration.

In addition to the activity of the exploitation of the timber, in the forest activity the berry pickers, the hunters, the fishermen also make their presence felt through a negligent behavior towards the protection against fire, which can increase the risk of forest fire.

It is not irrelevant to deal with this opportunity also the activity from the vicinity of forests, especially farming. It is a practice lately that the cleaning activity of the mountain pastures and the hay from the previous year to be done "through fire" in early spring. The risk of fire consists in the fact that it is caused without taking into consideration:
- the distance from the forest;
- the prevailing wind direction;
- the too small number of people to control and direct the fire;
- the initial lack of means of fighting with fire;
- the lack of statutory approvals from the local authorities;
- the late announcement of the fire or even the leaving from the fire scene.

- **Suceava County**, through the picturesque landscape, traditions and historical vestiges has developed a rich **tourist activity**. In this action, the forest cannot be omitted because the forest flora and fauna that it has, settled on a different terrain and lined with waters, it attracts like a magnet the tourists who are eager for beauty and rest. But all these bring an increase upon the risk of forest fire. In addition to the areas
which are heavily frequented by tourists and which are presented in the attached chart, the whole forest is considered prone to tourist activity, even if with a lower frequency. The confirmation of the above fact is given also by the existence of the 488 cottages and hunting houses, with 1922 half seats, camping and designed with smoking facilities in the forest. The tourism activity presents a risk only because of the negligence of the tourists, who do not meet a minimum set of preventive rules, which also appear on advertising and warning boards installed for this purpose. In this respect, in the forest fund from Suceava there are installed 840 panels with this destination [7].

- The drilling wells and the exploitation of the natural gas deposits made their presence felt on Suceava county territory too. Of the total 35 wells at the county level, 25 wells are in the forest. The risk of fire caused by the presence of drilling wells and gas exploitation is given by the following:
  - the vehicles and the equipment involved in the drilling and the exploitation activity;
  - the existing wiring inside the probe;
  - the methane gas which is exploited.

The risk of fire is even greater since an incident at a gas well can lead to the escape from control of the natural gas in the atmosphere, forming pockets that can instantly light at different distances from the probe, at the first contact with an ignition source [7].

- The hydro technical facilities contribute to the increasing of the fire risk by their absence. Thus, given the low density of the water courses and their uneven distribution in the forest, the existence of the hydro technical facilities which provide a stable and safe water volume, would allow better organization and conduct of the intervention provided to fire operations. In this context, it has to be reminded the fact that the 48 ramps for the access and the equipment involved in the forest fund from Suceava there are installed 840 panels with this destination [7].

The determining risk factors in the onset of forest fires are the human causes of fire, caused intentionally or negligently prevail in the fire statistics in the period 1990 to 2009. Of the 558 places of worship in Suceava county, currently about 30% are located in or adjacent the forest fund. Of these, about 4% are considered isolated buildings, their access only being allowed pedestrian. The risk of fire for these buildings is not given by the internal activity, which otherwise is also a user and a generator of fire, but rather that the isolation in which they are built does not allow an immediate announcement of a fire and an appropriate action of the forces of intervention. It should also be noted that most of the monasteries which were built in isolation, the dominant building material is the wood and in addition to their own monastic buildings, there are also made, of the same material, buildings to accommodate the pilgrims. All this leads to an increased likelihood of the spread of any fire inside the forest fund [7].

### The psychosocial profile of the population and its economic status

In the analyzed period, the evaluation of the fire for each month of the year highlights the fact that the risk of fire in the forests from Suceava is higher in spring (March, April, May). This is largely due to the practice of cleaning the pastures and the uncut hay from the previous year, through fire, of course combined with the weather conditions during spring. When the winter “falls over spring” and there is a lot of humidity in the soil and in air, the uncut pastures/hay ignite harder, the spreading of the fire is more difficult, so it’s spread to the forest is limited. Also, the dry herbaceous vegetation comes more easily, under these conditions, in the decomposition process, allowing the new sprouting of the vegetation. But, under dry conditions, the old vegetation dehydrates more, decomposes harder and in contact with the primary source of fire ignition, it is triggered very easily. This is shown in fig. 3, regarding the distribution of fires on months.

![Fig. 3.](image)

**Fig. 3.** The analysis of the forest / statistics on months – the period 1990 – 2009.

In analyzing the risk of forest fire in Suceava, it should also be taken into consideration the psychosocial profile of the population and its economic status as the human causes of fire, caused intentionally or negligently prevail in the fire statistics in the period 1990 to 2009.

### c) Determining factors

The determining risk factors in the onset of fires, by their presence, act directly upon three elements take make possible the outbreak of a
fire: the combustible material or the carburant, the gas which maintains the burning of the carburant and the source of ignition.

In the forest fund of Suceava, act as determining fire risk factors, the following:
- the composition and the structure of the forest
  - the landforms
  - the human activity in the forest area
  - the psychosocial profile of the population and its economic status.

The composition of the forest can determine the extent and the type of fire in the forest, leading directly to the speed of ignition and fire spread, both horizontally and vertically. The composition influences directly the first element that determines fire: the combustible material or the combustible material. Thus, depending on the type of combustible material, on its composition and form, it is necessary a greater or a smaller amount of energy to initiate ignition, the burning can maintain itself, becoming fire. In the case of the forest fund of Suceava, where the coniferous forests prevail, these, through the calorific value that they develop, through the density of the wooden material and follicular envelope, determine directly the risk of the production and the development of fires, in all their types [1].

In the case of the fires analyzed for the period 1990 – 2009, we can say that 74,25% of all fires that took place were litter fires, the opposite being the underground fires 0,76% [17]. This may have several causes, including:
- the grass blanket ignites easily;
- the spread of the fires outside the forest covers firstly the grass blanket;
- the litter is a segment with a lower humidity and where the humidity varies rapidly directly proportional to the weather condition;
- the human activity, no matter where it is performed, enters compulsory in contact with the grass blanket;
- the effective intervention of the special forces made the fire spread to be limited to the level of the trees.

The structure of the forest (of the combustible material), on age classes can also influence the speed of the initiation and spread of fire, being prone to the burning of the young trees and also the elder and withered trees. According to the age of the forests where fires took place, we can observe the fact that the highest percentage of fires – 57,58% occurred in the young forests (0 – 25 years), where the grass blanket and sub-trees make their presence felt more, 24,24% in old forests (around the age of 100 years), where there are many sick or dead trees and where the exploitation is more intense, and 18,18% in the full forests which are in full vegetative power, where the forestry work is executed on time [7].

The landform can be considered a risk factor for fire because it acts permanently upon all the other factors, determining or influencing them all. It also determines the composition and the type of tree, the hydrographic and the network road, the weather conditions and not least, the anthropogenic activity. In this way, it determines and influences the second element that contributes to ignition – the air composition. It also makes the distinction between the manifestation of fire in Suceava’s forests and the forests from the lowland area.

The human activity in the forest area, summed with the psychosocial profile of the population and its economic status determines directly the causes of human nature, whether it concerns intention or negligence in starting fires. As presented in the paragraphs above, the causes of fire of human nature, which was determined by negligence or intention, represent between 86,67 and 100% for the first 4 forest ranges as a number of fires and 95% per total number of fires in the period 1990 to 2009. The sources of ignition exclusively determined by the natural element are reduced only to the electrical discharges from the atmosphere, which in the analyzed period were “zero”[7].

d) The favorising factors

Such factors may favor the onset and the spread of a fire through the influence that it can have on the elements that determine the initiation of a fire – carburant, carburant, ignition source – and therefore on the speed of initiation and of burning of the combustible materials. They only act in specific periods of time and only in certain situations and therefore they can suffer changes in the increase/decrease as type and diversity or as a share of influence.

Among the situational factors (favoring) to the outbreak of the forest fires in Suceava are:
- the climatic factors
- the ownership / administration of the forest fund.

The climatic factors can influence, through the temperature regime, humidity or air currents, the initiation and the spread of forest fires. This fact is confirmed by the frequency of forest fires in certain periods of time of the year or in certain years, but does not determine them directly. Thus, forest fires have existed both in drought years and in the rich years, in terms of rainfall, and in all months of the year or day periods. Reading the fig. 1 and 5, it can be concluded the way in which the number of fires in the forests
from Suceava has been influenced in the drought years was influenced, in the period from 1990 – 2009, or in certain period of time of the year.

The form of ownership / administration of the forest is related to a situational moment, which could suffer changes, the reality proving that. But what it is even more important is that the owner / manager to realize the true value and importance of the forest, not just for himself or for the present, but for the whole system of values and for the risk of fire which reigns in forests, getting involved through direct and real investments in identifying, controlling and reducing the risk factors.

i. Similarities and differences between the risk factors in the mountain forests and the lowland forests

At a first glance, the forest fires are the same, regardless the place where they occur. But each fire, even if it is produced in the same location but in different moments, it may show substantial differences of manifestation. Therefore, it is necessary to present briefly some elements of resemblance and others that differentiate the risk of forest fire from the mountain area from the ones from the lowland area, as follows:

Similarities:
- in both situations the main combustible material is composed of wood and the grass blanket;
- usually, in the forest area, the air is more oxygenated than in other areas, so the initiation of the oxidation reaction and the spreading of the fire is easily done
- the human activity is present, whether it is organized or individually.

Differences:
- the forest composition is completely different: in the mountain area are present mainly the coniferous forests, with a higher combustibility and a lower density compared to the broadleaf forests from the lowland area.
- the topography of the mountains is more rugged and therefore the access is more difficult, with direct consequences upon the intervention actions;
- the arrangement of the forests in the mountain area is higher than in the lowland area, where they are more isolated, which influences the spread of the fire;
- the degree of humidity is higher in the mountain areas than in the lowland areas;
- the tourist frequency is higher in the mountain area throughout the year than in the lowland areas;
- the water courses have a higher density in the mountain area, but have a lower discharge, and some exist only as torrents;
- the risk of electric discharges from the atmosphere is higher in the mountain area than in the lowland area.

References


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