

## FIRE PROTECTION PROBLEMS WITH LARGE FOREST FIRES IN DELIBLATSKA PEŠČARA (SERBIA)

Milan Milenković<sup>\*1</sup>, Milan Radovanović\*, Vladan Ducić\*\*, Marko Milošević\*

\* Geographical Institute “Jovan Cvijić” SASA, Belgrade, Serbia

\*\* Faculty of Geography, University of Belgrade, Serbia

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**Abstract:** *Purpose* - The aim of the paper was to investigate the major forest fires in Deliblatska peščara, as well as to analyze the efficiency of fire protection measures. *Design / methodology / approach* - The analysis included interviews with participants in extinguishing the major fires. The questions referred to the course of fires, as well as to the main fire protection disadvantages. The documentation of the “Banat” Forest Management - Pančevo (Public Enterprise “Vojvodinašume”) was also used in the paper for the period 1948-2012. *Findings* - The major forest fires in Deliblatska peščara in the studied period were recorded in 1973, 1990, 1996 and 2007. Although they account for only about 1.5 % of the total number of fires, they collectively have invaded more than half of the total burnt area and more than two-thirds of the forest area. According to the surveys, the main characteristics of these fires were: frequent appearance of new fire hot spots, strong wind variable in direction which crucially affects the spread of fire and the impossibility of direct action on fire. The main disadvantages of fire protection were: inefficiency of fire breaks, blockage of forest roads for the passage of vehicles and the lack of the modern means of fire protection equipment. *Research limitations / implications* - Given the specificities of the studied area (the absence of surface water, sandy soils, microclimate conditions and vegetation composition), the research results cannot be fully generalized for Serbia. *Practical implications* - The research results indicate the need for making changes in the fire prevention system, as well as the possibility of fire danger forecast based on the heliocentric hypothesis. *Originality / value* - What has been the importance of the paper is that it provides the basis for a new approach to the planning of fire prevention measures.

**Key words:** forest fires, Deliblatska peščara, solar activity

### Introduction

Deliblatska peščara is located in the south-eastern part of Vojvodina; it is elliptical in shape and extends NW-SE direction. The maximum length is about 35 km, and a width is 15 km. The relief is extremely dune, and the highest elevation is 192 m.

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<sup>1</sup> Correspondence to: m.milenkovic@gi.sanu.ac.rs

In 2002, Deliblatska pešćara was declared a Special Nature Reserve, and forest fires are the major problem of the protection of this area. Important factors of fire risk are the absence of surface water, sandy soil and microclimate conditions (Ducić, Milenković, & Radovanović, 2008). Fire hazard is particularly contributed by the presence of coniferous species that are at greater risk of fire than the deciduous ones. These are primarily European black pine (*Pinus nigra* Arn.) and Scots pine (*Pinus sylvestris* L.), which account for about a quarter of the forest area. The presence of extremely vulnerable juniper (*Juniperus communis* L.) is also of significance.

Data on fires in Deliblatska pešćara are related to an area covered by the Forest Management Unit “Deliblatski pesak” (28 464 ha). Although the territorial divisions of forestry organizations that managed the region during this period changed to some extent, the data were always being collected in areas under forest, shrubby and grass vegetation. Fires that occurred in the surrounding agricultural areas have been taken into account only when they expanded into the area that is managed by forestry organization.

According to records of the “Banat” Forest Management - Pančevo (Public Enterprise “Vojvodinašume”), a total of 265 forest fires were recorded (4.08 per year on average) in the studied area in the period 1948-2012. The total burnt area was 11 941.8 ha (183.72 ha per year on average). The total burnt area under forest vegetation was 6 137.23 ha (94.42 ha per year on average). Fires also raged at 5 804.57 ha without forest vegetation (89.30 ha per year on average). Number of ground fires was 236 (about 89%), while crown fires were in the remaining 29 cases (about 11%). For about 63% of fires it was established that the cause was the human factor, while in the remaining 37% of cases, the cause was not determined.

The majority of fires occurred in late winter and early spring (to the beginning of the growing season), so in the period March-April there were 105 fires recorded (about 47% of the total). In the period June-September there were 73 fires (about 27.5%).

The aim of this paper was to investigate the major forest fires in Deliblatska pešćara, especially to determine their characteristics and analyse the efficiency of fire protection measures on the basis of the experiences of the participants in the actions of extinguishing. The results should be used to make decisions that would promote measures of prevention against forest fires.

## Materials and Methods

Data on forest fires are taken from the documentation of the “Banat” Forest Management - Pančevo (Public Enterprise “Vojvodinašume”). Also, the reports on forest fires were used from the same source.

Interviews were conducted with 19 employees of this company who took part in extinguishing the fires in 1990, 1996 and 2007. Three participants who took part in extinguishing the fires in 1973 were also interviewed. The questions referred to the course of fire and the fire protection deficiencies that disabled the localization of the fire.

## Results and Discussion

In Serbia, there are occasional catastrophic forest fires with affected area of over 1000 ha, and examples are Deliblatska peščara in 1996 – 3 815.4 ha and the Stara planina Mt. in 2007 – 1 389.85 ha (Aleksić, Krstić, & Jančić, 2009). However, in the literature Serbia lacks fire classification according to the size of the affected area.

In the area of Deliblatska peščara four fires have been recorded so far, representing environmental disasters according to burnt area and damages they caused.

Table: The major wildfires in Deliblatska peščara in the period 1948-2012

Forest fire	Burnt area		
	total (ha)	under forest (ha)	under conifers (ha)
27-29. 03. 1973.	1006.69	748.38	478.05
30. 08. – 5. 09. 1990.	881.60	705.16	636.11
10-16. 08. 1996.	3815.40	2235.01	1557.63
24-31. 07. 2007.	546.79	414.58	333.50
total (ha)	6250.48	4103.13	3005.29

Source: Documentation of the “Banat” Forest Management - Pančevo, Public Enterprise “Vojvodinašume”)

These four fires account for about 1.5% of the total number, but they collectively include 52.3 % of the total burnt area. If only burnt forest area is observed, these four fires make 66.9%.

Similarly, fires over 200 ha in Canada in the period 1959 - 1997 accounted for about 3.1% of the total number, while at the same time they participated with about 97% in the total burnt area (Stocks, 1993). An interesting example is the Mesa Verde National Park (Colorado, USA), where in the second half of the 20th century there were four large forest fires recorded, while in the first half of

the 20th century fire occurrence was less frequent. In this area also there are pines and *Juniperus* species (Floyd, Romme, & Hanna, 2000).

Based on interviews with participants in fire extinguishing in 1973, 1990, 1996 and 2007, the following common characteristics of fire were determined:

**a) The frequent occurrence of new fire hot spots**

All interviewed participants agreed with the fact that these fires had a number of hot spots. Therefore, it was difficult to determine the main front, and difficulties were encountered during the deployment of personnel. In many cases it was necessary to move firemen quickly from one place to another. It also happened that the fire persisted in places where previously was extinguished. Most respondents also spoke about simultaneous outbreak of a number of fires in different locations.

**b) A strong wind variable in direction which crucially affects the spread of fire**

Survey participants mentioned the strong and variable wind direction as a crucial factor in the spread of fire. Due to sudden changes in wind direction, it was not possible to predict the most suitable sites for men to be disposed. All that resulted in the impossibility of putting the fire under control.

**c) Impossibility of direct effect on fire**

It was generally agreed that the four major fires in Deliblatska peščara represented the events that significantly differed from all others in the same period, so that the applied measures of fire extinguishing could not be the same. Namely, in many cases they could not be extinguished by direct measures, and it was resorted to cutting the fire way by making breaks, and backfires were also used. In such cases, the only effective way of direct extinguishing was to act out of the air using planes and helicopters. However, participants agreed that extinguishing from the air was overdue in all cases.

As the main fire prevention deficiencies, the interview participants mentioned the following:

**a) The inefficiency of fire breaks in the prevention of the spread of fire**

At large fires, the existing width of breaks did not prove to be enough to stop, and in many cases even to slow the spread of fire.

### **b) Unreachable forest roads for the passage of vehicles for fire fighting**

In a significant number of cases, the fire trucks jammed on forest roads, primarily due to inadequate width and poor maintenance.

### **c) Lack of the modern means of fire prevention equipment**

Due to the adverse financial situation, during the past decades there have not been significant acquisitions of fire protection equipment, while investments in the existing infrastructure were minimal.

The network of the fire breaks in Deliblatska peščara has existed for more than 100 years, which means that it is one of the earliest applied fire prevention measures. In this way the whole area is divided into sections of a rectangular shape with dimensions 948×607 m (57.54 ha), and this division is ongoing today.

Fire breaks in Deliblatska peščara are divided into the transverse (major) and vertical (side). Transverse ones stretch southwest-northeast direction and are marked with numbers 1-34. They are designed to hinder the fire coming from the southeast. According to the current standards, the width of these breaks is 23 m (the belt without vegetation 3 m wide is in the middle, and 10 m with no trees and shrubs on both sides). The vertical breaks stretch southeast-northwest direction and are marked with the letters A-S. Their width is 10 m (the belt without vegetation 3 m wide, and the belt of 3.5 m on both sides with no trees and shrubs).

The breaks wider than the existing ones would lead to a further reduction of the forest area, and the risk of wind erosion would be increased due to sandy soil. Total length of the network of fire breaks (transverse and vertical) in Deliblatska peščara is 652 km. In places where the terrain allows it, the breaks represent the forest roads at the same time. The total length of the soft (sandy) roads in Deliblatska peščara is 420 km (including roads at breaks). These routes are internal and are built for forestry organizations. A sandy surface makes them unfavourable for the passage of larger vehicles, so it has occurred that they often jammed. A particular problem is the expansion of the surrounding woody vegetation. Asphalt roads intersect Deliblatska peščara at two points (central and south-eastern part) and they are only at a few locations around the margin of Peščara.

Fire breaks 3-5 m wide are built around conifers in Deliblatska peščara and they are maintained by land cultivation. The fire breaks are also set around the entire area in order to prevent the spread of fire from the surrounding area.

Although they did not produce satisfactory results in preventing the spread of wildfires, the fire breaks are suitable for the deployment of people and the formation of line of defence. It is important to point out that the fire breaks can be effectively used only if they are properly maintained. Unfortunately, in Deliblatska peščara they are more or less covered with vegetation at many places, so their main function is endangered.

Afforestation of deciduous tree species was carried out at certain points in Deliblatska peščara, which was aimed at chopping the areas under endangered conifer species. Afforestation was primarily carried out in the form of belts, which have been known as biological fire prevention belts. They were usually built along both sides of the breaks, but it was also afforested without the interruption of plant communities. The belts of deciduous tree species were built around the endangered coniferous cultures both during the afforestation and subsequently around the existing cultures.

In addition to the fire breaks and other barriers for the spread of fire, the removal of combustible materials, promotional measures and fire detection by video surveillance system were also applied in Deliblatska peščara, while the forecast of fire risk was carried out primarily on the basis of experience. Measures that have also been applied do not fall directly into fire protection, but help to reduce the risk of fire, simplify extinguishing and reduce possible damage to a minimum. Thus, measures to protect conifer plantations from diseases and pests contribute to improving their health, making them more resilient even in relation to forest fires. In addition, the aim is to increase the share of deciduous tree species which helps to reduce fire danger.

The answers obtained from the interviews suggest that it is not possible to explain phenomena such as the appearance of a large number of fire hot spots and frequent changes in wind direction by generally accepted views. Also, it is particularly evident fact that the application of current knowledge does not initiate the possibility of adequate notice, i.e. forecast: when and where to expect the fire in order to act preventively. On the other hand, these characteristics are consistent with the heliocentric hypothesis of the solar wind as the cause of the fire, according to which after the opening of the current field it comes to the release of charged particles, and their arrival in certain circumstances, i.e. to the biomass burning. Thus, in a number of locations there is a simultaneous ignition

of combustible plant material, which is an explanation for the ineffectiveness of fire breaks. The emergence of winds variable in direction is also associated with the penetration of the charged particles (protons and electrons). According to this hypothesis, the duration of the fire depends on the flow of the solar wind energy. The results reached by Pereira Gomes and Radovanović (2008), Radovanović and Pereira Gomes (2009), Pereira Gomes, Radovanovic, Ducic, Milenkovic and Stevancevic (2009) and Radovanović (2010) suggest the possibility that the solar wind causes forest fires not only in Serbia but also in Europe. Significant contribution to the confirmation of the heliocentric hypothesis was given by Radovanović et al. (2013) who found a statistically significant relationship between the solar wind parameters and forest fires in the USA in the period 2004-2007.

Milenković, Radovanović, and Ducić (2011) consider that the solar wind charged particles are a possible cause of the major fires in Deliblatska peščara. For the fire in 1973, there are not enough available data for the matter to be discussed. However, the fire in 1990 occurred in a period of intense solar activity, and the average value of the solar flux at 2.8 GHz during August of that year was 222.6 sfu. In case of fire in 1996, there is a temporal analogy with the flow of the solar wind energy from the energy region 7981. A possible energy source for the fire in 2007 was the CH279 coronal hole; the speed of protons was 550 km/s, the density of particles was around  $90 \text{ p/cm}^3$ , and the impact of the solar wind particles caused the geomagnetic disturbance. During the last decade of July of that year, a large number of fires were recorded in the Mediterranean.



Figure 1. Fires in the Balkan Peninsula (July 25<sup>th</sup> 2007)

[http://eoimages.gsfc.nasa.gov/images/imagerecords/18000/18768/Greece\\_AMO\\_2007206\\_lrg.jpg](http://eoimages.gsfc.nasa.gov/images/imagerecords/18000/18768/Greece_AMO_2007206_lrg.jpg)  
(Accessed on September 13<sup>th</sup> 2013)

The presented results indicate the necessity of establishing a system of fire danger forecast on the basis of the new methodology. The research of the relationship between climate indices and forest fires are necessary for the long-term assessment of fire danger. The existence of this relationship has been confirmed in the case of North America for the ENSO (El Nino Southern Oscillation) (Swetnam & Batancourt, 1993; Harrison & Meindl, 2001; Harrison, 2004; Vaillant & Stephens, 2009) and the PDO (Pacific Decadal Oscillation)

(Duffy, Walsh, Graham, Mann, & Rupp., 2005; Taylor & Beaty, 2005; Morgan, Heyerdahl, & Gibson, 2008).

### **Conclusion**

In Deliblatska peščara in the period 1948-2012 there were 265 forest fires recorded with a total burnt area of 11 941.8 ha (6 137.23 ha of forests). The major forest fires were recorded in 1973, 1990, 1996 and 2007. These four fires account for about 1.5% of the total number, but they collectively include 52.3 % of the total burnt area. If only burnt forest area is observed, these four fires make 66.9%.

Based on interviews with participants in extinguishing major fires, the following common characteristics are determined: frequent appearance of new fire hot spots, strong wind variable in direction which crucially affects the spread of fire and the impossibility of direct action on fire. As the main disadvantages of fire protection, the interviewed participants mentioned the following: inefficiency of fire breaks, blockage of forest roads for the passage of vehicles for fire fighting and the lack of the modern means of fire protection equipment.

The described characteristics are consistent with the heliocentric hypothesis of the solar wind as the cause of fire. Better knowledge of the cause and manner of fire spread should enable better planning of fire prevention measures in the future, i.e. more efficient notice of potential risk.

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