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INDICATOR STATE AND ANALYSIS OF DAMAGE TO FOREST FIRES ON THE TERRITORY OF THE REPUBLIC OF SERBIA FOR THE PERIOD FROM 2012-2016 YEARS

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Abstract: The paper presents the current state and analysis of the consequences of forest fires in the territory of R. Serbia in the period from 2012 to 2016, when a total of 414 fires were registered, with affected area by fire of 9.428 ha, and a damaged wood of 122.890 m³. In Serbia, forest fires are one of the more frequent natural disasters, but caused by human neglect. Therefore, in addition to the ecological problem, fires also represent the main economic problem of our forestry, destroying and devastating huge forest areas and consequently affecting the reduction of wood mass. The aim of this paper is to present and analyze the state and damage caused by forest fires in the territory of Serbia and the importance of timely education and legal protection of forests as a natural good.

Keywords: forest fires, natural disasters, affected area by fire.

Introduction

The general role of forest cover is commonly known for the functioning of the biosphere, where the influence of forest ecosystems is reflected in the diverse interconnectedness of all members of the living community and the entire planet. In addition to the production of oxygen, it is undoubtedly one of the most important functions of absorbing harmful gases from the atmosphere, primarily carbon dioxide during the photosynthesis process, where at the same time a

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large amount of oxygen returns to the atmosphere and thus ensures the survival of all living beings on Earth. This way, the effects of “greenhouse” and the warming of the planet slow down, as well as the deposition of the terrain and the formation of the desert, which examples we see in many parts of the world.

Based on data published in the *Global Forest Resources Assessment* in 2015, in the world forests occupy an area of 4 billion hectares, accounting for 30.6% of the total Earth’s surface. The forest cover in Europe occupies an area of 182 million hectares, which is 43% of its total area, making it one of the richest regions in the world. The recent growth of forest cover is the result of national laws and the implementation of measures of afforestation and natural expansion.

Serbia belongs to medium-forested countries, since 29.1% of the total land area is under the forest cover. Of this, 7.1% belongs to AP Vojvodina, and the rest of 37.6% in central Serbia. In relation to the global aspect, the forestry in Serbia is close to 30% of the world, where it is significantly lower than the European with 46% of forest cover. World examples show that, in Norway in relation to the number of inhabitants, the forest is 6.93 ha, 5.91 ha in Finland, 1.8 ha in the countries of the region - Bosnia and Herzegovina and Croatia, 0.3 ha per capita in Serbia (<http://www.srbijasume.rs/sumskifond.html>).

Data taken from the Bulletin Forestry in the Republic of Serbia (2016) shows data on the state of the forest fund by ownership for 2007 (Table 1).

Table 1. State of the forest fund according to ownership in Serbia in 2017

Ownership	Area (ha)	%	Volume (m ³)	%
State	896 400,0	39,8	175965880,5	48,5
Private	1 175 200,0	52,2	162820921,8	44,9
Other	180 800,0	8,0	23700615,3	6,5
Total	2 262 400,0	100,0	362487417,6	100,0

Source: Bulletin Forestry in the Republic of Serbia 2016.

Based on the data from Table 1, in the total area of the forest fund of 2 262 400 ha, there is a noticeable increase in the share of privately owned forests by 12.4%, compared to the state-owned land area of 39.8%. There is noticeable increase in the total area under forests in the period from 2013 to 2017, which is the result of the application of appropriate forest protection measures, among which is the most significant afforestation. However, by inadequate sanctions and omissions in the organization of state-owned enterprises, the threat to forests caused by various factors, where the human factor is crucial, creates the possibility of a fire. In addition to geophysical factors, when considering the frequency of occurrence of forest fires, anthropogenic impact should also be considered (Lukic et al., 2017). More specifically, about 5% of the fire is attributed to natu-

ral causes, the other 95% to human activity, such as negligence, pyromania or works on agricultural land (Radovanovic, Periera Gomes, 2008). In the Republic of Serbia forest fires are classified as a group of natural disasters, while in the world they are classified as a group of climatic natural disasters, where more than 50 thousand forest fires are registered annually, which on average destroy more than 40 million hectares of forest, and as a result, there is a large number of human casualties, reduction in the number of wild animals, landslides, etc. (Lukic et al., 2013). As the most extreme form of devastation and destruction of the forest fund, forest fires represent a global problem and require the engagement of all entities in preventing and extinguishing the fire. In addition to human casualties, it creates economic damage and ecological consequences, and their occurrence and spatial distribution depend on climatic conditions, humidity conditions, quantity of fuel plant material and human activity as a crucial factor (Avramovic et al., 2017). In the last decades, in addition to increasing the number of forest fires, there is a trend of increasing their destructiveness, where such events negatively affect the society as a whole, economic development and the environment (Cvetkovic, 2016). However, predicting future forest fires in practice is difficult to achieve because existing meteorological data and general fire statistics are only available for a short time (Girardin et al., 2013).

Forest fires

Forest fires can be defined as uncontrolled movement of fire by the forest surface, where its effect disappears huge areas of forest vegetation, leaving only devastated areas covered with gravel and ash. The damage of such proportions inflicts enormous material and economic losses on the company, which includes the costs of extinguishing the fire, the damage caused by the fire itself and the costs of the rehabilitation and reconstruction of the forest fund. They arise as a result of physical and chemical processes when the source of heat, fuel and air found in synergy to provide flame, "Fire triangle" (Keller, Blodgett, 2008). The consequences of ecological damage that are manifested for many years after the fire has happened: the disappearance of rare and endangered plant and animal species, changes in the chemical and physical properties of the land, changes in the landscape, climate and microclimate, landslide and increased erosion, impact on biodiversity, combustion of wood returns carbon dioxide to the atmosphere, etc. (Aleksic et al., 2009). Extreme climatic conditions, such as prolonged warm waves, droughts and strong winds, are one of the crucial factors in climate change and will more likely and more seriously affect European forest ecosystems (JRC Science for policy report, 2017). It is often that the forests can't be generated after the fires, where the entire ecosystem with the plants and ani-

mals living in it is irreversibly lost. From the point of view of the World Wildlife Fund, the effects of forest fires on diverse global species are serious: 84% of the surface of all ecoregions that are critical to preserving the diversity of the global species are threatened by the change in intensity of fire and its frequency. Also, by creating greenhouse gases, forest fires contribute to climate change. Warm waves lead to degradation and drying of trees, which increases their vulnerability. About 15% of global emissions (greenhouse gases) are attributed to forest fires - most of them are caused by the resulting conversion of land and the decomposition of fire in tropical rain forests. Forest fires cause about 32% of carbon monoxide and 10% of methane emissions, as well as over 86% of carbon dioxide emissions (Forests ablaze, 2016).

The Decree on the classification of buildings, activities and land in the categories of vulnerability to fire, and according to the area occupied by the forests, are classified into the following two categories:

Category I - High risk facilities for fire-extinguishing:

I7.7 - spaces with protected and high quality forest (national parks etc.) with an area greater than 10,000 ha

I8.10 - spaces with protected and high quality forest (national parks etc.) of 5000 to 10.000 ha

Category II - Facilities with increased risk of fire outbreaks:

II1.11 - spaces with protected and high quality forest (national parks etc.) of 800 to 5000

II2.7 - spaces with protected and high quality forest (national parks etc.) of up to 800 ha (Decree on classification of buildings, activities and lands in categories of fire threats, „Sluzbeni glasnik RS“, number 76/10).

Several types of fire are known, which depends on the place where they developed, or from the fuel which is affected by fire: underground, terrestrial (low), fire in crowns of trees (crown / high) and fire related to lonely tree (Sorak , Rvovic, 2016). The most dangerous are underground fires that are difficult to detect and extinguishing, and they pose a threat to roots of trees. These are the most “tiring” fires that can cause great damage to forest vegetation, primarily by destroying the roots of trees. In Serbia there are more frequent terrestrial fires, especially in deciduous forests, which are the most harmful in young stands, while in the older they lead to damage to the bark and trees. In the case of terrestrial fire, the fire mostly covered dry grass, dry trees and shrubs. High fires involve larger areas, the whole tree, where it is supported by the wind, expands its activity and thus destroys primarily coniferous forests (Aleksic, Jancic, 2011). Because of sensitivity to ignition and burning due to the presence of resin and essential oils, coniferous forests are most endangered by forest fires, followed

by mixed and at the end of the deciduous forest. From the species of trees, by threat, in the first place are white and black pine, marine and "Vajmutov" pine, larch, spruce and least sensitive fir three. From the deciduous trees, the most sensitive is the oak tree (Jancic, 2014). High fires are usually occurred during the summer period when drought and strong wind can completely destroy the affected trees. They are monitored by large heat allocation, where large flame and strong spinning poles are created in the tree canopy creating a fireball with plenty of sparks (Djordjevic, Djukalovic, 2016).

Material and methods

The Statistical Office of the Republic of Serbia within the framework of the publication Forestry in the Republic of Serbia for the period from 2007 to 2016 presents data that have been analyzed and presented for the purposes of this paper. The state-owned enterprises "Srbijasume" and "Vojvodinasume", as well as public enterprises of national parks and agricultural cooperatives dealing with forestry activities, submit a report on the damage caused to the forests in the RS. Data on forest damage to the Republic Statistical Office are submitted by the Ministry of Internal Affairs - Emergency Management Directorate and the Forest Administration. In addition to state forests, damages caused by fires are also shown for privately owned forests. According to the criteria ICP Forests, DG Environment, UNECE / FAO, the methodology for collecting and calculating data is defined every two years as forest fire statistics. The International Cooperative Program for Assessing and Monitoring the Effects of Air Pollution in Forests (ICP Forests) was established in 1985 with the aim of collecting, compiling and evaluating data on the state of forest ecosystems throughout the UNECE region (UN Economic Commission for Europe). ICP Forests monitor the state of forests at of monitoring intensity: Level monitoring based on around 5600 observation plate on a systematic transnational grid (16x16 km) across Europe in order to gain insight into the current state of geographical and temporal variation of forest ecosystems. The second level includes the monitoring of selected forest ecosystems in order to explain the cause-effect relationship between environmental drivers and responses to forest ecosystems among the 42 participating countries. In order to ensure a regular review of the activities of the program, the Program Coordinating Center of ICP Forests, annually publishes technical report with summarized research, which gives an opportunity to all participating countries to report about their national activities (Technical report of ICP Forests, 2017). Data on forest damage are collected by causes of their origin, and by type of forest, and are expressed in m³ for the average wood mass and to ha for the surface area (Avramovic et al., 2017). Under the area

affected by fire, the total surface area is considered to be the area under forest land and the forest affected by the fire. The paper presents data on the volume of damaged wood mass and the burnt surface from terrestrial and high fires, as well as data on the wood volume that had to be cut due to the damage. In the region of R. Serbia, and on the basis of the national report as a member of the ICP Forests, the first level control (16x16 km) is based on the 101 plot for sampling and additional (4x4 km), 29 new parcels, the total number of 130 parcels. The data collected refer to: the total number of conifers and deciduous forests and percentage of the degree of defoliation (depletion of leaves) caused by the effects of negative agents (Technical Report of ICP Forests, 2017). For the collection of data, it is necessary to define the required data such as: date and time of the fire, place of occurrence, size of the fire and the affected area by fire. Data is collected in several ways: through a completed form - reports of forest fires and cartographic data collected through GPS. The main topics for analyzing the data are: the state of forests, the effects on forest ecosystems of acidity, nitrogen and ozone, as well as the contribution in the field of climate change and biodiversity. Simple data processing shown in the form of a table comprise general statistics (number of fires during the year and fired area), monthly distribution per day, distribution by surface classes, causes of fire and by geographical units, according to administrative or forest units. The minimum necessary information that each member must provide, as an official report, has information on the date and time of the first warning, the date and time of the first intervention, the date and hour of extinguishing, the speed of fire spread, the location of the fire (state, area, province, community), total burnt surface, fire reason and localization of the burnt surface. Integration of all data can be achieved according to the availability of data in the time and space. Forest condition in terms of growth, tree condition, variety of plants and soil conditions can be affected by biotic (pests and diseases) and abiotic factors (climate and air pollution). Before published relevant data, the update must be approved by the ICP Forests Working Group, where data revision are made every 5 years (ICP Forests, 2017).

Results and discussion

The data and indicators of the condition of forest fires on the territory of the Republic of Serbia in the period 2012-2016 were analyzed in the framework of the paper. The total number of forest fires based on the place of origin (terrestrial, high), number of fires by regions, total fired area (ha), total damaged volume of wood mass (m³), damage in the state forests of Serbia, by type of forest, is shown.

Since the beginning of the recording in Serbia, the longest warm waves and the worst drought have been registered during the summer of 2012. Warm waves registered on the territory of the Balkan Peninsula, including R. Serbia, were responsible for the largest number of forest fires (Unkasevic, Totic, 2014). Table 2. shows the total number of forest fires and damages they produced in the observed period from 2012-2016, based on the data of the Republic Statistical Office. The largest number of fires was registered in 2012 with an affected area by fire of 7,460 ha. For the observed period (2012-2016), a total of 414 fires with affected area by fire of 9.428 ha and damaged wood mass of 122.890 m³ were recorded.

Table 2. Damages from forest fires in the forests of Serbia for the period from 2012-2016.

Year	2012.	2013.	2014.	2015.	2016.	Total
Affected area by fire (ha) (state and private forests)	7.460	561	284	827	296	9.428
Damaged wood mass (m³)	63.118	7.343	10.256	5.059	37.114	122.890
Number of fires	282	43	12	47	30	414

Source: <http://publikacije.stat.gov.rs/G2018/Pdf/G20181133.pdf>

Data on forest damage are collected on the basis of the type of forest and the causes of the damage, and they are expressed in ha for affected area by fire and in m³ for the average damaged wood mass. Based on the given table, we can see that the number of forest fires ranged from 12 in 2014 to 282 in 2012, with a number of oscillations in the years to the last recorded 30 in 2016. The affected area by fire in 2013, 2014 and 2016 did not exceed 600 hectares, in 827 ha in 2015, while in 2012 it was marked with the largest number of affected area by fire of total 7.460 ha - most for the five-year period (Damage in the forests, 2016).

Table 3 shows data on the total number of fires in the regions for the five-year period from 2012-2016. in the state forests of Serbia. Of the total number of (282) in 2012, most of the fire occurred in the region of Sumadija and Western Serbia (96) and South and East Serbia (95), Vojvodina (71), and in the territory of the Belgrade region 20. Then follows the period of decline in events during 2013, 2014 and 2015 to the last recorded 30 fires in 2016. In the region of South and East Serbia, 16 fires were registered that year, three more than in the region of Sumadija and Western Serbia, where 13 accidental fires were detected. In the region of Vojvodina in 2016 only one fire was recorded, and in the Belgrade region there was no recorded case.

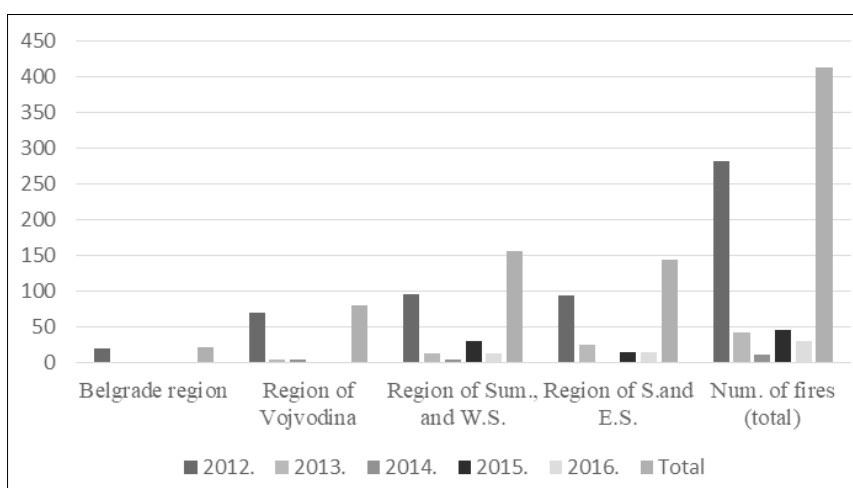
Table 3. Number of fires by regions for the period 2012-2016, in the state forests of Serbia

Year	2012.	2013.	2014.	2015.	2016.	Total
Belgrade region	20	-	2	-	-	22
Region of Vojvodina	71	4	4	-	1	80
Region of Sumadija and Western Serbia	96	13	4	31	13	157
Region of South and East Serbia	95	26	2	16	16	145
Number of fires (total)	282	43	12	47	30	414
Affected area by fire (total ha)	5108	326	52	688	261	6435

Source: Done on the basis of the data of the Republic Statistical Office

During the five-year period observed, the smallest number of occurred cases, it happened in the Belgrade region, where in 2012 there were 20 fires, and during 2013, 2015 and 2016 there were no phenomena. In relation to other regions of Serbia, the region of Sumadija and Western Serbia had the most recorded fires, in the total amount of 157 occurrences. In 2012, 96 fires were recorded, one more than in the region of South and East Serbia, when 95 cases were recorded. In all regions, the smallest number of fires occurred in 2014 in a total number of 12 fires. According to the frequency of the fire, after the region of Sumadija and Western Serbia, followed by region of South and East Serbia, then the region of Vojvodina and the last place Belgrade region.

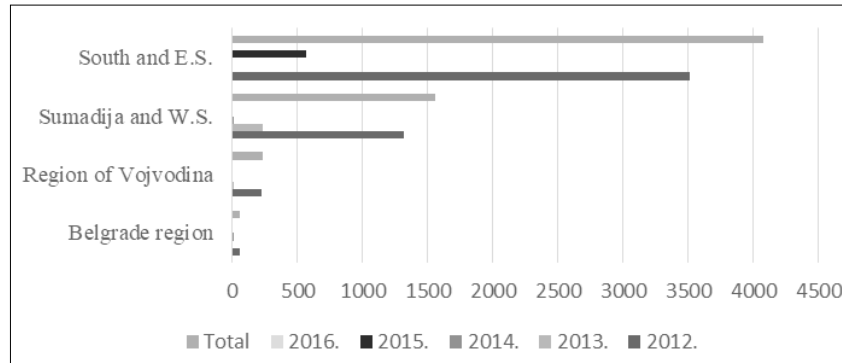
Graph 1. Frequency of fire in state forests of Serbia by region for the observed five-year period (2012-2016)



Source: Done on the basis of the data of the Republic Statistical Office

In relation to the observed five-year period, the region of South and East Serbia had the greatest amount of damage from fire, especially in 2012 when the affected area by fire in the state forests of Serbia was 3510 ha, then in 2015, 569 ha. Forest fires in Sumadija and Western Serbia affected the largest area in 2012, 1316 ha, then in 2013, the surface area of 232 ha, and the least in 2014, with affected area by fire of 13 ha. In 2012, for the observed period in the region of Vojvodina, the largest area affected by fire of 227 ha was recorded, and the smallest in 2013 with 3 hectares affected area by fire. Unlike other regions of Serbia, the Belgrade region is the least affected region in terms of fire in the observed period from 2012-2016. years. Only in 2012, the area of 55 ha in the Belgrade region was affected and in 2014, 1 ha. During 2013, 2015 and 2016, there are no recorded areas affected by fire in the Belgrade region.

Graph 2. Area affected by fires by regions for the period 2012-2016. in the state forests of Serbia



Source: Done on the basis of the data of the Republic Statistical Office

The total number of forest fires according to the place of origin in the state forests of Serbia for the observed five-year period (2012-2016) is shown in Table 4.

Table 4. The total number of forest fires according to the place of origin in the state forests of Serbia in the period from 2012 to 2016

Year	Place of origin		Total	Index	
	Terrestrial	High		Base	Chain
2012.	211	71	282	85.98	433.85
2013.	37	6	43	13.11	15.25
2014.	9	3	12	3.66	27.91
2015.	38	9	47	14.33	391.67
2016.	29	1	30	9.15	63.83
Total	324	90	414		
Annual average	65	18	83		
%	78.31	21.69	100.00		

Source: Done on the basis of the data of the Republic Statistical Office

Based on the data presented, it can be concluded that during the five-year period, a total of 414 fires occurred, which is an average of 83 cases per year, and on average 6.9 on a monthly basis. Of the total number of fires, the terrestrial fire participates in a percentage of 78.3%, while high fires account for 21.7%. At an annual average, 65 terrestrial fires and 18 high fires occur on average. Most of the cases occurred in 2012 in the total amount of 282 fires, and given the place of origin, terrestrial 211 and high 71. The least cases occurred in 2014 in the total amount of 12 fires, of which the terrestrial fires participated with 9, and high in 3 cases, where the terrestrial ones represent the smallest number of fires in the observed five-year period. In the total amount of 90 high fires in the period from 2012-2016. the smallest number of them occurred in 2016 when only one was recorded, as opposed to 2012 when a total of 71 high fires were recorded.

Analysis of the data about affected area by fire in state and private forests in Table 5. show that in the observed period from the total area during 2012, 2013, 2015 and 2016. state forests were more vulnerable than private ones. In 2014 there is a turning point where private forests dominated in relation to the state, forasmuch as that area affected by fire in private forests amounted 232 ha, compared to 52 hectares of state-owned land. The largest difference in the affected area occurred in 2012 when the area covered by fire in state forests amounted 5.108 ha (3,510 ha of the South and East Serbia region) and 2352 ha in private. In the five-year period (2012-2016), the biggest damage to private forest ownership was in 2012, compared to state forests in 2014. The least affected area of firefighting privately owned forests was gain during 2016 when the affected area by fire amounted to 35 ha .

Table 5. Affected areas by fire of state and private forests in Serbia during the five-year period (2012-2016)

Year	2012.	2013.	2014.	2015.	2016.
Affected areas by fire in state forests (ha)	5108	326	52	688	261
Affected areas by fire in private forests (ha)	2352	235	232	139	35

Source: Done on the basis of the data of the Republic Statistical Office

The economic consequences of forest fires primarily depend on the flammable surface area, i.e. of the total area of forest land affected by the fireworks, as well as from the damaged volume of wood mass. Table 6. shows and analyzes data related to the total volume of damaged wood mass as well as the volume by one forest fire in the state forests of Serbia in the period 2012-2016.

Table 6. The total and damaged wood mass by fire in the state forests of Serbia for the period from 2012. to 2016

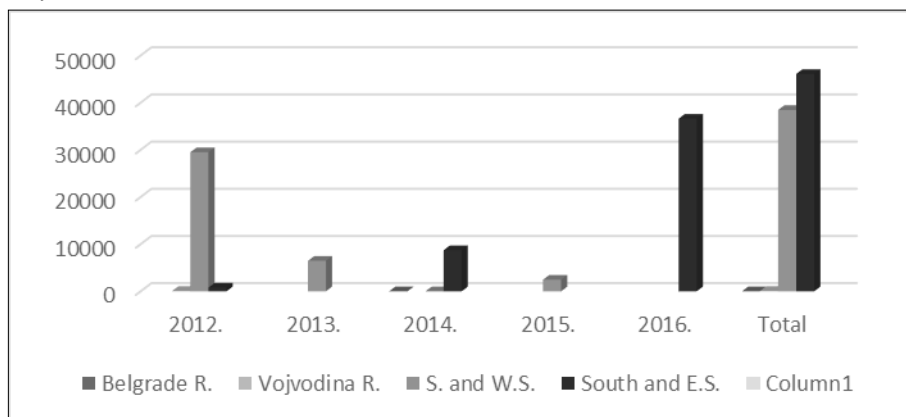
Year	Number of fires	Damaged wood mass (m ³)	Damaged wood mass by one fire (m ³)
2012.	282	30 377	107.72
2013.	43	7 178	166.93
2014.	12	9 606	800.50
2015.	47	2 479	52.74
2016.	30	36 600	1 220.00
Total	414	86 240	2 347.89
Annual average	83	17 248	469.578

Source: Done on the basis of the data of the Republic Statistical Office

In the observed period from 2012 to 2016, the total damaged volume of wood mass in the state forests of Serbia amounted to 86 240 m³, with an annual average of 17 248 m³. The smallest damaged wood mass was recorded in 2015 with 2 479 m³, and the largest last year of the five-year period, in 2016, when the damaged wood mass amounted to 36 600 m³. Taking into account the data on damaged wood mass by one fire, we can conclude that the total damaged volume in the period from 2012-2016. amounted to 2 347 m³, with an annual average of 469 m³ of damaged wood mass per fire. The least damage was recorded in 2015 when damage to the volume of wood mass by one fire was 52 m³ and the highest in 2016 with 1 220 m³ of wood mass.

According to the regions in the observed five-year period, the largest damage to the wood mass in the total amount in the state forests of Serbia has the region of South and East Serbia with a total damaged wood mass of 46 790 m³. Then follows the region of Sumadija and Western Serbia (39 309 m³), the region of Vojvodina with 127 m³ and the Belgrade region with only 14 m³ for the period 2012-2016. Analyzing the data by years, it can be concluded that in 2012, the year of the largest number of fires occurred, the region of Sumadija and Western Serbia predominated from the region of South and East Serbia by damaging the wood mass in relation to 29 497 m³ according to 785 m³. Significant damage in this region was recorded in the next 2013. During 2014, the forests in the region of South and East Serbia (8705 m³) were most affected, as well as in 2016 with the only and the largest damaged wood mass of 36 600 m³. The Belgrade region recorded the largest damage in 2014 with 14 m³ of wood mass, and the region of Vojvodina in 2012 with 95 m³.

Graph 3. Damaged wood mass by region in the total amount of state forests in Serbia for the period from 2012 to 2016



Source: Done on the basis of the data of the Republic Statistical Office

Depending on the type of trees, forests have a different degree of fire risk. Due to the sensitivity to ignition and burning because of the presence of resin and essential oils, coniferous forests are most endangered by forest fires, followed by mixed, and at the end by deciduous forests. Based on the analyzed five-year period in Table 7, data on damages in state forests of Serbia according to types of forests caused by fires (terrestrial and high) are presented. It can be noted that terrestrial fires in the five-year observed period caused damages in the forests in total amount (deciduous and coniferous) 2135 ha. Thereof, 1624 ha were damages in deciduous forests, 325 ha per year on average, and 511 ha in conifers, 102 ha per year. If we look at the share in percentage, it is 27.3% for the deciduous, and for coniferous forests it is 8.6%. As they capture larger areas, whole trees, high fires supported by the wind widen their effects and thus destroy primarily coniferous forests. For the period from 2012 to 2016, high fires affected coniferous forests in the total amount of 3385 ha, unlike deciduous forests with 428 ha of total area. The presence of high fires in a percentage of 11.38% belongs to coniferous forests, while damages in the deciduous forests belong 7.2% of the total amount. The largest number of fires occurred in 2012 when terrestrial and high fires damaged a total of 4387 hectares of coniferous and deciduous forests. Another significant year in terms of forest damage was in 2013 with a total of 787 ha damaged forest fund in fires, and the smallest damage is in 2014 with 15 ha damaged deciduous and coniferous forests according to the cause of the damage.

Table 7. Damage in the state forests of Serbia, by types of forests for the period from 2012 to 2016

Year	Terrestrial		High		Total
	Deciduous forests	Coniferous forests	Deciduous forests	Coniferous forests	
2012.	683	107	411	3186	4387
2013.	447	167	10	163	787
2014.	1	13	-	1	15
2015.	257	210	7	26	500
2016.	236	14	-	9	259
Total	1624	511	428	3385	5948
Annual average	324.8	102.2	85.6	677	1189.6
%	27.3	8.59	7.19	11.38	100.00

Source: Done on the basis of the data of the Republic Statistical Office

Conclusion

Uncontrolled spread of fire in 95% of cases was caused by human factor. Forest fires supported by the wind undoubtedly capture large areas and on that occasion represent the most extreme form of complete destruction of forests or devastation. Due to its catastrophic consequences, the problem of the appearance of forest fires has been on the rise in recent years. We are witnesses of change in climatic conditions (increasing air temperature, decreasing precipitation and increasing air flow rates) that increase the risk of fire and spread. Based on the facts about the state of forest fires in the state forests of Serbia for the period from 2012 to 2016, we can conclude the following:

- In the observed five-year period, 414 fires with affected area by fire of 9,428 ha and damaged wood mass of 122,890 m³ occurred, where the number of forest fires ranged from 12 in 2014 to 282 recorded in 2012, with numerous oscillations in the next years until the last recorded 30 in 2016.
- The region of South and East Serbia had the largest area of fire damaged during 2012, when the affected area by fire in the state forests of Serbia amounted 3510 ha, 1316 ha in Sumadija and Western Serbia, and the largest affected area by fire of 227 ha was recorded in Vojvodina region.
- At an annual average, 65 terrestrial fires and 18 high fires occur on average. Most cases occurred in 2012 in the total amount of 282 fires, where,

according to the place of origin, terrestrial fires participated with 211, and high fires with 71.

- In the period from 2012 to 2016, the total damaged volume of wood mass in the state forests of Serbia amounted to 86 240 m³, with an annual average of 17 248 m³. According to the regions in the observed five-year period, the largest damage to the wood mass in the total amount in the state forests of Serbia has the region of South and East Serbia with a total damaged wood mass of 46 790 m³. Then follows the region of Sumadija and Western Serbia with 39 309 m³, the region of Vojvodina 127 m³ and the Belgrade region with only 14 m³.
- Terrestrial fires in the five-year observed period caused damages in forests in the total amount (deciduous and conifers) of 2135 ha, and high fires 3813 ha.

Increasingly frequent occurrences of forest fires, which beside the forest destroy agricultural crops, threaten populated areas and human lives, requires organized and planned monitoring of those elements that influence the occurrence of fire and the taking of appropriate preventive measures of protection. It is certain that various types of education, especially younger populations, can help to spread awareness of the importance of forests and the effects of forest fires, as well as the definition of stricter legal regulations for timely response in the event of a widespread fire.

References

- Avramovic, D., Mihajlovic, E., Petkovic-Ilic, A., & Milosevic, L. (2017). Indicators of the state of forest fires in the state forests of Serbia in the period from 2007 to 2016. *Safety at work – the path of successful of business* *Заступта на раду – нум успешног пословања, Divcibare, Republic of Serbia.*
- Aleksic, P., Krstic, M., & Jancic, G. (2009). Forest fires – ecological and economic problem in Serbia. *Botanica Serbica*, 33 (2), pp. 169-176.
- Aleksic, P., & Jancic, G. (2011). Protection of forest fires in the public company *Заштита „Srbijasume”*. *Forestry*, number 1-2, pp. 95-110.
- Cvetkovic, V., Jakovljevic, V., & Gacic, J. (2016). Geospatial and time distribution of forest fires as natural disasters. *Military work*, number 68, pp. 108-127.
- Decree on classification of buildings, activities and lands in categories of fire threat, *„Sluzbeni glasnik RS”, number 76/10.*
- Djordjevic, G., & Djukalovic, V. (2016). Defining the degree of forest vulnerability with the proposal of the forest fire protection system in the territory of Serbia. *Ministry of Agriculture and Environmental Protection of the Republic of Serbia - Forest administration, High Technical school of professional studies, Pozarevac.*

- Forests ablaze, Causes and effects of global forest fires.* (2016). WWF, Germany.
- Girardin, M. P., Ali, A. A., Carcaillet, C., Gauthier, S., Hely, C., Le Goff, H., Terrier, A., & Bergeron, Y. (2013). *Fire in management forests of eastern Canada: risk and options. Forest ecology and management* 294, pp. 238-249., DOI: <http://dx.doi.org/10.1016/j.foreco.2012.07.005>
- International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests) (2017). *Manual on methods and criteria for harmonized sampling, assessment, monitoring and analysis of the effects of air pollution on forest.* Thunen Institute of Forests Ecosystems, Germany.
- Jancic, G., (2014.). Protection of forest fires in JP „Srbijasume“. *Forests, number 123, pp. 20-22.*
- JRC Science for policy report. (2017). *Forest fires in Europe, Middle East and North Africa 2016. Office of the European Union, Luxembourg.*
- Keller, E.A., Blodgett, R. (2008). Natural hazards. *Pearson Education, New Jersey.*
- Lukic, T., Gavrilov, B. M., Markovic, B. S., Komac, B., Zorn, M., Mladjan, D., Djordjevic, J., Milanovic, M., Vasiljevic, A. Đ., Vujicic, D. M., Kuzmanovic, B., & Prentovic, R. (2013). Classification of natural disasters between the legislation and application: experience of the Republic of Serbia. *Acta geographica Slovenica, 53-1, pp. 149-164.*
- Lukic, T., Maric, P., Hrnjak, I., Gavrilov M., Mladjan, D., Zorn, M., Komac, B., Milosevic, Z., Markovic, S., Sakulski, D., Jordaan, A., Djordjević, J., Pavic, D., & Stojsavljevic, R. (2017). *Forest fire analysis and classification based on a Serbian case study. Acta geographica Slovenica, 57-1, pp. 51-63.*
- Radovanovic, M., & Pereira Gomes, J.F., (2008). Solar activity and forest fires.. *Geographical Institute „Jovan Cvijic“ SANU, book 71, Belgrade.*
- Republic Statistical Office. (2016). *Newsletter Forestry in the Republic of Serbia.. Belgrade.*
- Sorak, R., & Rvovic, I. (2016). Analysis of damage caused of forest fires in the Republic of Serbia for the period 2010-2014. *Proceedings of the Department of Geography, Tourism and Hotel Management, number 45-1, pp. 1-10.*
- Unkasevic, M, & Tomic, I. (2014). Seasonal analysis of cold and heat waves in Serbia during the period 1949-2012. *Theoretical and Applied Climatology, 120 (1-2), pp. 29-40.*
- Republic Statistical Office (2018). Damage in forests, 2017. Retrieved from <http://publikacije.stat.gov.rs/G2018/Pdf/G20181133.pdf>.
- Republic Statistical Office (2018). Forestry in Republic of Serbia, 2017. Retrieved from <http://www.stat.gov.rs/publikacije/>
- Srbijasume. Forest fund of the Republic of Serbia and JP „Srbijasume“. Retrieved from <http://www.srbijasume.rs/sumskifond.html>.