



Original Contribution

ENVIRONMENTAL AND SOCIAL ECONOMIC CONSEQUENCES OF FOREST FIRES ON THE TERRITORY OF STARA ZAGORA REGION

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ABSTRACT

This article presents the dynamics of ground and canopy forest fires outbreaks on the territory of Stara Zagora region in the period of 1990-2016. We have also made a detailed analysis of the fires with the causes for their occurrence, the burnt area, damages, the number of firefighters and equipment used to extinguish fires by the Regional Directorate of Forestry – Stara Zagora in 2016. It was found that the total number of fires during the studied period was 821, as the largest number was registered in 2001 (115 fires), and the lowest – in 2014 (3 fires). There were three times more ground fires than canopy fires for the whole period of study. The total burnt area was 204 710 decares. This indicator reached its peak in 2007 (52 310 decares), and its lowest point in 2014 (7 decares). The damages inflicted by forest fires on the Regional Directorate of Forestry –Stara Zagora in 2016 amounted to 434 116 BGN. In the same year, the firefighters involved were 449 state forestry employees, 347 fire safety employees, 30 military servants and 154 volunteers. The number of equipment used was: 156 from the state forestries, 109 from the fire safety services, 6 heavy vehicles and 128 mobile devices.

In conclusion, in the past 15 years, Bulgaria, and Stara Zagora in particular, have become a high risk territory for forest fire outbreaks, which requires an entirely new level of firefighting practices.

Key words: forest fires, burnt area, low and canopy fires, environmental and social economical consequences

INTRODUCTION

The role of fire for the well-being and development of humanity is an inarguably essential. Since ancient times fire has been an inseparable part of human existence and growth. It was a chief tool for the management, spreading and cultivation of living areas. In the very beginning it was used for thermal processing of food, which facilitated people's adaptation to new lands and the impact of nature on humans. Later, metalworking and other crafts were practiced, to reach the current state characterized by highly efficient and technological industries. Parallel to that, however, forest fire disasters are a factor with serious environmental consequences. As a

result of such ecological catastrophes valuable trees and natural habitats are destroyed, the soil is deteriorated, and the air, water and earth are polluted. The destructive power of forest fires is phenomenal. The forest is an integrated ecosystem comprised of biotic factors such as animals, insects, birds, bacteria, plants and abiotic factors, such as water, rocks and climate. When a forest fire afflicts such an ecosystem, all forms of life disappear. The air and water are heavily polluted, the soils degraded, and other abiotic elements, including water collection areas are damaged (1).

The damages which can be caused by fires have immense proportions and often long-term consequences. The strong commercialization and consumer habits of contemporary society have not allowed us until recently to realize that the losses from an ecological perspective have greater and long-term effects. At the background of a fast changing environment

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and all related consequences, forest fires have tilted the scales in a negative direction (2, 3).

When studying the statistical data, it is important to state that the cause behind forest and field fires in 99% of all cases is human negligence, incompetence or arson. The inferred conclusion is that with adequate measures and intent on the part of legislative and executive authorities, the problems with forest fires can be minimized to some acceptable limits. After deforestation, forest fires are the second largest factor for the disappearance of forests areas on a national and global scale. With this, their role for shaping the environment and microclimate also decreases. The water balance, the soil quality composition, and the purifying effect on the atmosphere are disrupted, and, last but not least, their recreational property is compromised (4).

With recent advances in science and technology the models and regularities characterizing this problem have become even more specific and global. It became clear that the consequences are deeper and involve aspects which have not been considered until now. The importance of forests as a wood source, as well as a means for recreation and sports has been taken into account. There is no doubt that even commercially grown forests develop best when they function with parameters close to those of natural ecosystems.

The aim of the present work is to study the dynamics of the outbreaks of ground and canopy forest fires and the resulting ecological and social economic consequences on the territory of Stara Zagora region during 1990-2016.

MATERIALS AND METHODS

The object of the study is the forest land of Stara Zagora region, which has 1 665 026 decares of forests in total. The lands in the respective municipalities are distributed as follows (in decares): Stara Zagora - 276 378, Kazanlak 276 816, Radnevo - 22 658, Bratya Daskalovi - 162 012, Chirpan – 84 292, Pavel Banya – 293 759, Maglizh – 220 382, Galabovo – 65 013, Gurkovo – 200 558, Opan – 21 479, Nikolaevo – 41 649.

Six forest farms and the Regional Directorate of Forestry are responsible for Stara Zagora region. Approximately 350 people in total work for the preservation and management of

forest land, 320 of whom are armed guards, and 30 – forest rangers. The monitored territory is over 170 000 hectares.

The most widely spread forest species include the sessile oak, beech, pine trees, conifers, Italian oak, Turkey oak, white oak, Oriental hornbeam, manna ash, silver linden, and Tatar maple. The trees at present have predominantly epicormics shoots (due to the short-stem tree farming in the past), and are of pure and mixed composition. The plant formations include *Paliurus*, hazel, blackthorn, hawthorn, rosehip, dogwood and other shrubs.

We used materials and literature from the Ministry of the Environment and Waters, the National Service for Fire Safety (NS “FS”), the Regional Directorate “Fire Safety and Protection of the Public” (RD “FSPP”) and the Regional Directorate of Forestry (RDF) – Stara Zagora, as well as information from the official websites of international forestry organizations such as Forest Stewardship Council (FSC) and PRO SILVA (5-7). The data were studied in dynamics.

An analysis was performed based on collected information for the impact of forest fires on the ecosystems, as well as the environmental and social economic consequences.

The forest fires were also analyzed in terms of the causes, the burnt area, the inflicted damage and the number of the people and machines involved in the extinguishing of fires provided by the Regional Directorate of Forestry – Stara Zagora in 2016.

RESULTS AND DISCUSSION

The dynamic balance in the environment and forests in particular is due to the cumulative effect of all ecological factors. The mechanism for maintaining homeostasis in an ecosystem is the result of millions of years of evolution and building of relationships both between living and non-living nature, as well as among inhabiting organisms. The balance between biotic, abiotic and anthropogenic ecological factors over a long period of time has been almost constant, which allowed a normal development of the organisms and the environment. Unfortunately, during the years after the so called “technical revolution” and the technological progress, the influence of anthropogenic factors has increased continuously, which has led to their limiting effect on the sustainable existence of natural ecosystems. As such a factor, forest fires have

become a powerful moderator of the environment, sadly, in a negative way. The consequences after such a total forest fire could be detrimental for one, several, or all components of the environment (8-10).

Table 1 shows the results of the outbreaks of ground and canopy forest fires in Stara Zagora region for the period of 1900-2016. It is evident that the largest number of forest fires was registered in 2000 (115 fires in total). The following numbers are arranged in descending

order as total values: in 1994 (89 fires in total), 1993 (75 fires in total), 1998 (63 fires in total), 2001 (62 fires in total), and 1992 (59 fires in total). The remaining years have witnessed between 3 in 2014 and 45 in 2007 fires annually. The lowest values were noted in 2014 (3 fires), 2004 (5 fires) and in 1995, 2003, 2005 and 2010 (7 fires each). The total number of fire outbreaks for the studied period is 821.

Table 1. Dynamics of ground and canopy forest fire outbreaks on the territory of Stara Zagora region for the period of 1990-2016

Year	Total		Including:					
			Ground fire			Canopy fire		
	Number of fires	Burnt area in decares	Number	Area, decares	Average area per fire	Number	Area, decares	Average area per fire
1990	18	882	17	842	50	1	40	40
1991	13	1641	9	153	17	4	1488	372
1992	59	4013	45	538	12	14	3475	248
1993	75	5981	50	3630	73	25	2351	94
1994	89	32665	55	6237	113	34	26428	777
1995	7	403	6	293	49	1	110	110
1996	24	1187	16	452	28	8	735	92
1997	21	136	19	131	7	2	5	2
1998	63	5800	47	4517	96	16	1283	80
1999	39	17383	29	7698	265	10	9685	968
2000	115	49783	91	32233	354	24	17550	731
2001	62	13387	45	8088	180	17	5299	312
2002	16	1011	12	648	54	4	363	91
2003	7	360	5	337	67	2	23	12
2004	5	33	5	33	7	0	0	0
2005	7	173	5	45	9	2	128	64
2006	9	406	4	188	47	5	218	44
2007	45	52310	27	31748	1176	18	20562	1142
2008	12	580	10	549	55	2	31	16
2009	8	82	7	64	9	1	18	18
2010	7	208	7	208	30	0	0	0
2011	18	675	15	613	41	3	62	21
2012	34	3374	28	2876	103	6	498	83
2013	18	5138	16	4118	257	2	1020	510
2014	3	7	3	7	2			
2015	15	139	13	131	10	2	8	4
2016	32	6953	25	5757	230	7	1196	171
Total	821	204 710	611	112 134	184	201	91 372	455

As we analyzed the results for the burnt area, we established that the largest burnt forest land was 52 310 decares in 2007, despite the fact that there were only 45 fire outbreaks in the same year. The year 2000 follows lead with 49 783 decares which were burnt by the highest number of fires - 115. Considerable burnt area was noted in 1994 (32 665 decares), 1999 (17 383 decares), 2001 (13 387 decares) and in 2016 (6 953 decares). The total burnt area for the studied period was 204 710 decares.

The highest values of burnt land by ground fires were noted in 2000 (32 233 decares), 2007 (31 748 decares), 2001 (8 088 decares), 1999 (7 698 decares), 1994 (6 237 decares), and 2016 (5 757 decares). The total area of ground fires for the period of 1990-2016 was 112 134 decares, while the canopy fires reached 91 372 decares.

Viewed chronologically, the number of ground fires during the studied period was three times higher than the canopy fires (respectively 611 vs 201). The highest number of ground fire outbreaks was noted in 2000 (91 in total). Next in line were 1994 (55 in total), 1993 (50 in total), 1992 and 2000 (45 each), and 2012 (28 in total).

The number of canopy fires for individual years is as follows: in 1994 (34 fires), 1993 (25 fires), 2000 (24 fires), 2007 (18 fires), 2001 (17 fires), 1998 (16 fires). We need to

emphasize that in 2004, 2010 and 2014 no canopy fires occurred, while for all the other years both ground, and canopy fires were observed. The burnt area of canopy fires had its peak in 1994 (26 428 decares), 2007 (20 562 decares), 2000 (17 550 decares), 1999 (9 685 decares) and 2001 (5 299 decares).

The average area of a ground fire was highest in 2007 (1 176 decares), and lowest in 2014 (2 decares). The respective values for canopy fires were 1142 decares in 2007 and 2 decares in 1997.

The total number of fire outbreaks for the RDF – Stara Zagora in 2016 was 32 (Table 2). For this period the highest number of forest fires occurred in State Forestry Farm (SFF) – Stara Zagora (14 fires in total). In SFF – Kazanlak this indicator equaled 7 fires, and in SFF – Chirpan 5 such fires were registered. There were no registered forest fires in SFF – Galabovo and SFF – Pavel Banya. The total burnt area was 6 953, as this indicator was highest in SFF – Stara Zagora and equaled 5 660 decares. Regardless of the fact that the number of forest fires in SFF – Kazanlak was high, the burnt area was just 139 decares, while in SFF – Chirpan it was 1 104 decares. The following decares of burnt area were owned by: the state – 5 961, municipalities – 453, private owners – 469 and legal entities – 70.

Table 2. Forest fire outbreaks in RDF – Stara Zagora in 2016

№	SFF	Number	Burnt area (decares)
1	SFF Gurkovo	3	12
2	SFF Kazanlak	7	139
3	SFF Maglizh	2	33
4	SFF Pavel Banya	0	0
5	SFF Stara Zagora	14	5660
6	SFF Chirpan	5	1104
7	SFF Mazalat	1	5
8	Galabovo Municipality	0	0
	Total	32	6953

The burnt vegetation consisted of: 892 decares of conifers, 4 742 decares deciduous trees, 614 mixed and 705 decares of grass, barren land and dead forest ground. The inflicted damage by forest fires amounted to 434 166. The highest values are of other costs equaling 332 921 BGN. The damages on standing trees of 8 022 m³ timber volume cost 71 168 BGN. The total number of young trees was 120 750 BGN, and the costs – 24 150 BGN. The expenses for staff were 473 BGN, and for transport – 5 424 BGN.

The causes for all 32 fire outbreaks were negligence, including burning cigarette ends – 3, landfills – 2, burning grazing land – 4, arson – 1, and other unknown causes – 17.

In 2016 the firefighters who participated in extinguishing the forest fires on the territory of RDF Stara Zagora were: 449 employees of RDF, 347 fire safety employees, 30 military servants, and 154 volunteers. Furthermore, 156 cars from RDF, 109 cars from Fire Safety Department, 6 heavy vehicles, and 128 mobile devices were used for firefighting purposes.

The ecological and social economic consequences of forest fires are direct and indirect. Forest fires are an extremely important environmental factor related mostly to human activity. Until recently, they have been regarded justly as a natural ecological factor with important implications for humanity. However, the development of the civilization proved that prevention and fighting human-started fires is of utmost importance (11, 12).

Fires have influenced directly all vegetation even before the appearance of human settlements. For the existence of fires in ancient times we can judge from plant evolution. In high-risk areas where fires are common, many trees have adapted to the effects of wildfire and have managed to survive.

Burning vegetation and soil organic substances has had a continuous effect on forest development. Most affected are the young conifers in low-level vegetation, whose natural restoration is hindered. Conifers contain many resin substances which facilitate their rapid burning and lead to larger fire damage. Tree species such as the beech, fir, spruce, Balkan pine, birch, aspen, etc. have thin bark which burns easily and can be damaged quickly by fire. In contrast, the oak, black pine and larch

have thick bark, which helps them resist ground fires (13, 14).

An important feature for tree resistance to fire is the presence of dormant buds, especially when they are found on the root system. After fires, the roots remain alive and from them, through root or stem shoots, vegetation can restore itself. The ability to produce many root shoots is typical for the aspen, hornbeam, beech, linden, etc.

Forest fires have an indirect impact as they destroy the vegetation, animals, and microorganisms necessary for the normal natural cycle of living nature. The soil humus is also destroyed, which damages the homeostasis, i.e. the sustainability of ecosystems. Burning the vegetation cover changes almost all environmental conditions. Many fungal diseases are likely to penetrate and grow on the remaining living trees (15).

The quantity of sunlight which the soil receives increases after a fire. That is why the first species which settle on the burnt areas are photophilic trees. Fires lead to a loss of organic substance and destruction of soil surface and structure after fire, new grass species appear that attract livestock and widens their grazing area. Thus, the risk for enforcing soil degradation processes is increased (16).

The lack of vegetation cover allows bigger and more direct penetration of precipitation in soils. Transpiration expenditure decreases. Water balance is disrupted. The soil moisture increases excessively which leads to erosion processes.

Forest fires affect mostly sprouts and low-level vegetation, and destroy seed reserves. Fire can burn the forest floor which leads to the destruction of many micro and macro-organisms inhabiting the soil surface.

Forest fires can cause long-term disruption of ecological balance of affected areas whose restoration can take decades. One of the consequences of global warming is shifting the boundaries of the fire risk season which can complicate the problem even further. Early spring warming and especially late autumn cold are another factor for forest fire outbreaks. This problem has a social economic aspect as well. Very often forests are burnt for economic gain, which affects people of all social strata (17).

The prevention and timely extinguishing of forest fires is an extremely responsible activity which requires high organization and a state of constant alert by the specialized firefighting groups.

On the basis of our studies, we can state that the consequences of forest fires in Stara Zagora region can be grouped into the following main areas:

- 1) Ecological consequences
 - a. Deforestation and soil erosion
 - b. Change of water drainage
 - c. Disruption of the thermal and water balance of ecosystems
 - d. Destruction of rare, protected species and limiting biodiversity
 - e. Worsening of the sanitary state of forests
- 2) Economic consequences
 - a. Loss of wood
 - b. Additional investment for curbing harmful consequences
 - c. Reduction of land productivity and deterioration of growing conditions
 - d. Considerable decrease of financial income
- 3) Social consequences
 - a. Negative impact on the micro-climate and economic conditions
 - b. Decrease in tourist business
 - c. Limiting work opportunities and impoverishment of people
 - d. Migration of people from the burnt regions

CONCLUSIONS

The examples for the destructive action of forest fires in Stara Zagora region are numerous. The tendencies for the upcoming years are not optimistic and this should be a main benchmark for building a national strategy for tackling this problem. The consequences of forest fires in the region and in Bulgaria as a whole implicate huge burnt territories over a short period of time. Over 1.9 million m³ of wood have been lost, and the consequences are varied. These risks require firm control over the management of forest land, and strong collaboration between institutions and population as a whole.

In conclusion, we can note that in the last decade Bulgaria has changed from a country where wildfires do not pose a considerable threat to forests, to a country which is facing a serious problem. This requires forest firefighting to be led at an entirely new level. What is more, Bulgaria needs to commensurate

its firefighting policy with the practices of the most vulnerable to wildfire countries which dictate the European and world standards of firefighting.

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