



## Fire History in Mountain Forests of the Crimean Peninsula of Ukraine

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### Abstract:

The Crimea peninsula is one of critical region in Ukraine from point of view of wildfire risks. Forests of Crimean Mountains play an essential role in regulating the water resources in the regions and protecting biodiversity as well important social and recreational roles creating unique Semi Mediterranean climate. More than 5 millions of tourists visit Crimea every year. Conifers which grow mostly in Mountains conditions cover 18 % of forest land of the peninsula are most fire prone type of vegetation. Numerous ignition sources originated mostly from peoples together with drought conditions resulted in regular fire events all over the peninsula. During the period 1991-2012 2826 wildfires occur and burnt totally 3928.8 ha, including 630.8 ha of crown fires. Annually 0.46 wildfires per 1000 ha of forest fund occur and burnt area is 0.6 ha per 1000 ha of forest fund including 0.1 ha of crown fires. Within the Crimean Peninsula 30.4% of total number of wildfires and 71% of crown fires occur in Yalta Mountain-Forest Nature Reserve (Yalta MFNR). Most often (84%) wildfires damaged *Pinus nigra* var. *pallasiana* Lamb. and *Pinus sylvestris* L. stands, which occupy 50% of Yalta MFNR forests. Suppression of forest fires in Yalta MFNR is extremely difficult and costly because of absence of regular forest management due to reserved regime of the territory, intensive accumulation of fuel, lack of forest roads in steep terrains and lack of fire pounds that make delivery of water to fire very complicated and slow. For improving forest protection from wildfire the European Union project of the Joint Operational Programme "Black Sea Basin 2007-2013" with title "Utilizing Stream Waters in the Suppression of Forest Fires with the Help of New Technologies" program has started in 2013. Fuel sampling, fuel models and integrated fire system for mountain forests will be developed in frame of the project.

*Key Terms:* Wildfire, Crimean Peninsula, Ukraine, fire management, burnt area, fuel

### Introduction:

Wildfire is a second major disturbance in forests of Ukraine (Zibtsev 2004, Zibtsev 2000). In average up to 3581 ha of forest land and 11833 ha of grass lands burned annually during the period 2000-2012. Impacts of fires affecting forests and other vegetation in Ukraine have resulted in severe environmental damages and high economic losses. Wildfire in the Crimean mountain forests is the most dangerous disturbance which leads to biggest fire losses at the Mountains of Southern coast of the peninsula (Koba 2000, Voron et al. 2005)

At the end of XX century due to global climate change, increasing of human impacts, growing of number of wildfires and the area burned needs of improvement of fire management has increased all over the country. Under the threat of wildfires are 812 thousand hectares of Crimea Peninsula, or 29.6% of its total area. Special attention need to be paid to mountain forests of Crimean Peninsula, which occupy up to 11% of all forests. Fires in mountain forests in

addition to economic losses can cause significant environmental damage and therefore it is important to prevent them (Ustsky et al. 2008). Forests of Crimean Mountains are critically important in regulating the water resources in the regions, in particularly Bigger Yalta area as well as playing important social and recreational role not only for Ukraine but for whole Eastern Europe region. More than 5 million tourists visited Crimea every year. An important step for improving fire protection is development of integrated fire system for mountain forests of Crimean Peninsula.

### Materials and Methods:

Forests of the Yalta Mountain-Forest Nature Reserve of the Republican Committee of Forestry and Game Management of Autonomous Republic Crimea were selected as a study area.

Fire history analysis in the region were based on fire statistics of fire cases and their occurrence time, burned area, information of fire detection

and fire causes of Public forestry enterprises and Yalta Mountain Forest Natural Reserve of the Republican Committee of Forestry and Game management of the Autonomous Republic Crimea. The data were analyzed for the period 1991–2012. More detail analysis of fire history was performed for Yalta MFNR for the period from 2006 to 2012.

**Results and Discussion:**

Crimea is one of the sunniest regions in the Eastern Europe. The annual duration of sunshine here varies from 2180-2470 hours. The mean annual temperature in the region ranges between 5°C and 8°C. The mean temperature in July varies between 15.6°C and 25°C. Period with temperatures above 20°C varies from 70-80 days to 88-103 days on the Crimean South Coast. Because of the complexity of terrain rainfall is very unevenly distributed in the peninsula and ranged from 250 mm per year in the steppe to more than 1000 mm in the mountains (Plugatar 2008).

Up to 92% of forests of the Study area are located in the Crimean Mountains. Deciduous forests are dominated, in particularly *Quercus*

*pubescens Willd.* and *Quercus petraea (Matt.) Liebl.* – 57.1%, *Fagus orientalis Lipsky* – 12.8%. *Pinus nigra var pallasiana Lamb.*, *Pinus sylvestris L.* and *Pinus stankeviczii (Sukacz.) Fomin* occupy 19.8% of forests (Poliakov and Plugatar 2009; Plugatar 2008).

Accordingly to the official statistics of Republican Committee of Forestry and Game Management of the Autonomous Republic Crimea during 1991-2012 years in Crimea a total number of 2826 forest fires registered that burned 3928.8 ha of forests, including 630. ha by crown fires. In Yalta Mountain Forest Natural Reserve number of fires reach for the same period 899 (31.8%) with total area burned 2461.2 ha, including 447.9 ha of crown fires. Average annual number of fires for period 1991 - 2012 is 128 for Crimean forests and 41 fires for Yalta MFNR with average annual burnt area - 168 ha and 112 ha respectively. General data of areas burned and number of fires in Crimea and Yalta MFNR for the years 1991-2012 shown in Table 1. Annually occur 0.46 wildfires per 1000 ha of forest fund; burnt area is 0.6 ha per 1000 ha of forest fund including 0.1 ha of crown fires in Crimea.

**Table 1.** Fire occurrence and affected surfaces in Public forestry enterprises of Crimea and Yalta MFNR (1991–2012).

Year	Public forestry enterprises of Crimea			Yalta MFNR		
	number of fires	burned area, ha	crown fires	number of fires	burned area, ha	crown fires
1991	41	12.1		10	1.0	
1992	73	29.5		27	7.9	
1993	218	626.6	50.7	47	498.6	44.8
1994	257	406.8	93.4	33	49.4	
1995	58	25.1		16	7.2	
1996	145	177.3	37.9	29	91.5	24.6
1997	18	3.4		9	2,8	
1998	264	438.4	37.2	123	347.5	33.5
1999	147	60.9	5.6	39	18.6	
2000	237	117.4	7.6	51	13.7	
2001	225	85.0	8.0	52	10.6	
2002	88	57.7	1.0	35	28.7	
2003	97	24.8		37	4.8	
2004	40	44.4	1.8	20	27.9	1.8
2005	210	70.8	8.8	70	5.4	
2006	112	90.0	6.4	69	48.7	3.2
2007	179	1408.9	352.1	61	1227.9	336.3
2008	152	161.6	14.8	51	39.8	2.3
2009	136	46.2	4.0	52	4.1	
2010	69	11.5		38	2.3	
2011	6	1.8		5	0.9	
2012	54	28.5	1.5	25	21.9	1.5
Total	2826	3928.8	630.8	899	2461.2	447.9

Amount of fires in Crimean forests are slightly decreasing from 1998 but there is no such trend in burned area. Period between large fires or large number of small fires is around 5-10 years. Due to large fires there was biggest average fire size in 1993 and 2007 (Fig. 1). Average fire size

for period 1991-2012 is 1.1 ha for Crimea and 2.1 ha for Yalta MFNR. The reason of that fire size is large fires in some years, that's why average fire size is lower than average for period for most of years.

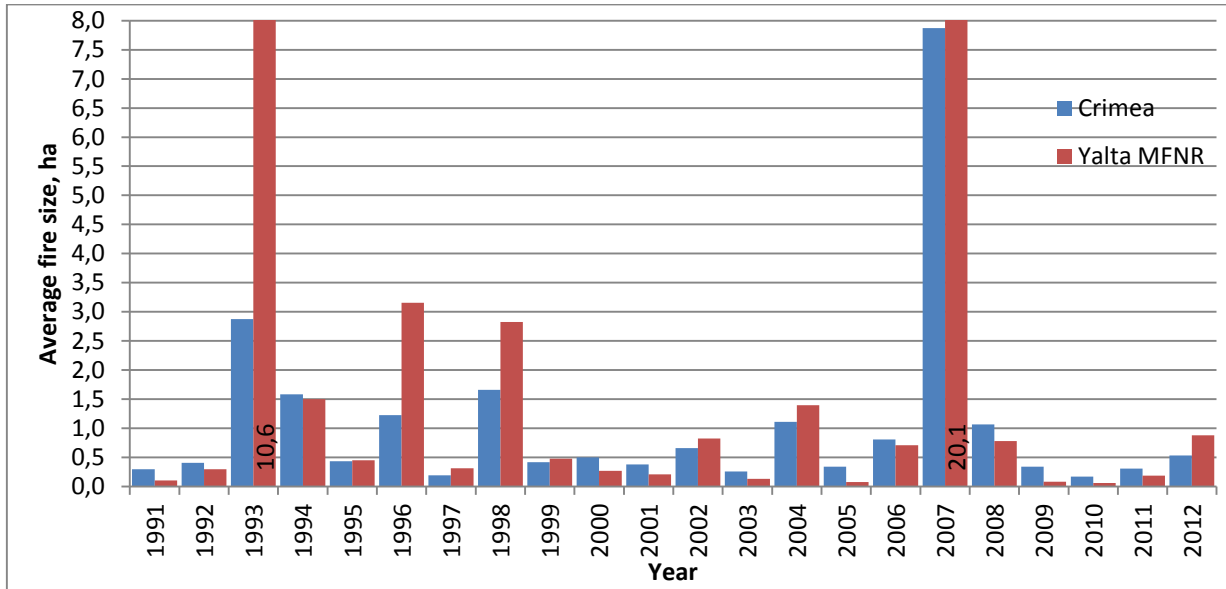


Figure 1. Average fire size in Crimea and Yalta MFNR (1991–2012).

According to Yalta MFNR forest fire statistic total number of fires for period 2006-2012 reached 301. Majority of fires (Fig. 2) occurred in August (22.3%) followed by July (16.6%). Seasonal dynamic of fires determines by weather index means and ignition sources e.g.

part of touristic season. Burnt area reaches highest level in August and July similar to fire numbers. These two months have largest average air temperature during year and highest number of visitors in forests.

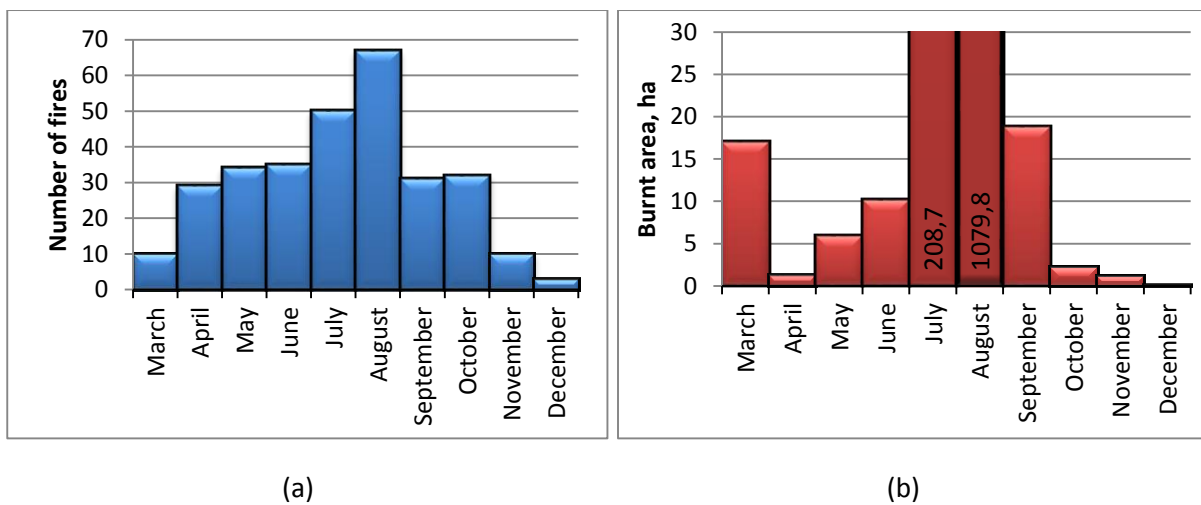
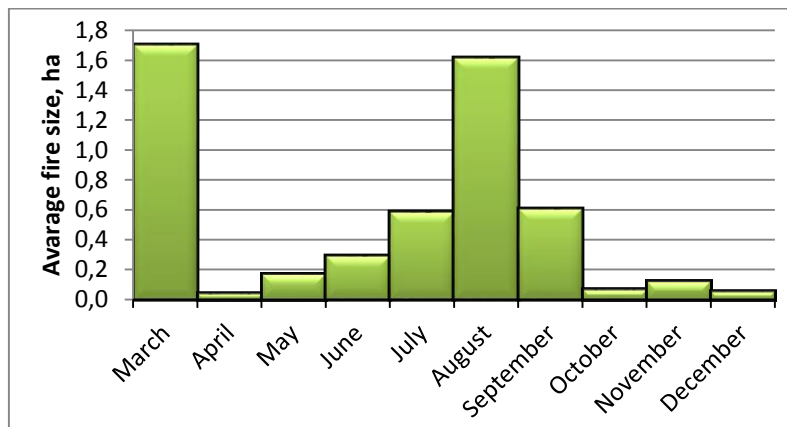


Figure 2. Fire occurrence and affected surfaces distribution by months: number of forest fires (a) and burnt areas (b) in Yalta MFNR from 2006 to 2012.

To better illustrate seasonal dynamic of average fire size for the period 2006–2012 from data on Fig. 4 fires with size of more than 100 ha were excluded. There were two such fires: one - in the end of July 2007 with burned area 180 ha and another one - in the end of August with a size of 973 ha. So except abovementioned cases, largest fires by area occur in March and August. The large fire size in March related with lower

preparedness of fire brigades as officially fire season in Ukraine started on 1-st of April. The reason of large average fire size in August is a weather conditions (Ustsky 2008). Average fire size distribution by months was changing from year to year and a trend which is visible on Fig. 3 may depend from weather condition during a year (Voron et al. 2005). Largest average fire sizes each year vary between summer months.



**Figure 3.** Distribution of average fire size in Yalta MFNR during fire season (2006–2012), (fires larger than 100 ha excluded).

Pure stands composed from *Pinus nigra* var *pallasiana* and *Pinus silvestris* most affected by fires (84% of fires). Other 16% of fires occur in *Quercus pubescens* forest. Among main reasons of this accumulation of forest fuel in pine stands and their location on a height 400-900 meters above sea level should be mentioned. Tourists may reach pine stands much easier than most of broadleaves forest that grows on higher altitudes. This may also be confirmed by fact

that most of fires caused by human activities (Table 2). Amount of fires in different years presumably determines by weather conditions and by amount of tourist that visit forests. For 61 % of fires (2006–2012) causes were not determined, followed by 36% of human caused fires and 2% - natural factors caused. Major of human caused fires (33%) were occurred due to negligence (careless smoking and leaving camp fire).

**Table 2.** Causes of wildfires in Yalta MFNR according to official statistics data (2006–2012)

Year	Number of fires	Causes		
		human activities	natural	unknown
2006	69	23	1	45
2007	61	18	1	42
2008	51	21	1	29
2009	52	16		36
2010	38	24	1	13
2011	5	1		4
2012	25	7	2	16
Total	301	110	6	185

Fast and effective fire detection during fire season considered by local forester as a major step to reduce average fire size. Up to 52.2% of fires detected by staff foresters of Yalta MFNR

that related with location of most part of forests in mountains, complicated topography, low visibility and large number of wildfires. Other fires occurred was reported to local emergency

dispatch centers by civilians (26.2%) and ground patrols of the State emergency service (21.6%). This may be changed with development fire detection system based on automatic video surveillance cameras distributed on territory in the way that allow detection of any fire from two towers. GIS based information system for fire detection is developing now for Yalta MFNR in a framework of SUPPRESS-Fires 2 project.

Suppression of forest fires in Crimean mountains is extremely difficult and costly because of heavy accumulation of fuel in forests, lack of forest roads in steep terrains and lack of fire pond that makes delivery of water to fire very complicated and slow. At the moment for the area 14523 ha of Yalta MFNR there are only three fire ponds established: on the Ai-Petri Plato (30 cub m), upper station of the cable system (85) and near cable station Mishor – Ai-Petri (150). But because of well-prepared fire teams in forest enterprises most of fires were suppressed until their rich 1 ha size. Wildfires distribution by size is shown in Table 2.

**Table 2.** Wildfire distribution by size in Yalta MFNR for period 2006 -2012

Months	Number of fires by size of burnt area (ha)			Total
	< 1	1-50	>100	
March	9	1		10
April	29			29
May	32	2		34
June	34	1		35
July	43	6	1	50
August	60	6	1	67
September	29	2		31
October	32			32
November	10			10
December	3			3
Total	281	18	2	301
%	93	6	1	100

For improving fire protection development of integrated fire system for mountain forests of Crimean Peninsula is needed. Such system will be developed through realization of the European Union project of the Joint Operational Programme “Black Sea Basin 2007-2013” with title “Utilizing Stream Waters in the Suppression of Forest Fires with the Help of New Technologies” program. This program will allow: identifying the areas with greatest fire

risk, optimize utilization of stream water to suppress fires and water delivering by land vehicles, develop software for the optimal location of the water reservoirs and mobilization of fire vehicles.

### Conclusions:

A large number of fires cases indicate high fire risks of Crimean forests. The greatest fire risk exists in coniferous forests. Due to climate changes which lead to an increase in temperature, especially in summer, needs to improve preparedness forest enterprises to fight wildfires and improve the system detection and development of forecasting fire risk and behavior of forest fires is increasing.

Accumulation of fuel in forests, lack of forest roads in steep terrains and lack of fire pond makes fire suppression complicated and slow. Therefore, improving the road network and a network of fire pond will lead to more effective wildfires suppression. All these tasks will be resolved during implementation of the project of the Joint Operational Programme “Black Sea Basin 2007-2013” with title “Utilizing Stream Waters in the Suppression of Forest Fires with the Help of New Technologies”. Development of integrated fire system is one of tasks of a project. The greatest attention during project implementation should be focused on coniferous forests.

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