WILD LAND FIRES IN THE BLACK SEA REGION: IMPACT, MANAGEMENT AND NEEDS FOR INNOVATIVE TECHNOLOGIES

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Abstract

Due to rapid socio-political, economical changes, land use and global climate changes in countries of the Black Sea basin threat from large forest fires to the population, infrastructure and ecosystems has been constantly increasing during last decades. Fire hazard and fire management in six countries in the Black Sea Ecoregion were analyzed in order to develop a unified strategy of fire management and improve cross-boundary cooperation. The highest danger in the region poses critical fire seasons, like 2007, when annual burned area exceeded total burned area for the period 2004-2006, 2008-2009. Development of a regional early warning system, better preparedness of fire forces to extinguish large fires during critical fire seasons and implementation of decision support systems based on innovative technologies are the key steps to reduce impact of fire on the regional level.

Key words: Black Sea Ecoregion, forest fires, biodiversity, protected areas, fire management

Introduction

The Black Sea Basin is an important region in the South-Eastern Europe situated on the cross border of countries experiencing rapid and intense development, structural evolution and thus experienced serious changes on land and natural resources use (Black Sea Basin, 2007). In this context various cross-border cooperation programs aimed to support sustainable natural resource, their protection

and to address the modern challenges are of high importance. The initiative to establish a Black Sea Euroregion was launched at an International Conference on Interregional Cooperation in March 2006 in Constanţa, Romania. The objective of the Euroregion initiative is to reinforce regional cooperation in order to protect natural resources, strengthen social cohesion through joint projects and provide a platform for cultural cooperation and exchange. The Black Sea Basin region occupies a territory of 834,719 sq. km. and includes a population of 74.2 million people.

Wildland fires that often lead to large scale environmental degradation and serious social-economic impact is among the common challenges that were recognized in the last decades by the countries of the region. The factors that accelerated this processes were geopolitical and economic changes in the early 90-s. Urbanization that leads to reduce rural population and thus to decreased amounts of lands that are under proper agriculture and forest management have resulted in the increase of areas of abandoned lands. Global climate change from one side that makes climate less predictable and stable, as well as lack of efforts aimed in support of rural infrastructure create favorable conditions for large wildland fires that often have serious negative impact on local or even regional scale.

There is a great need to protect the unique environmental assets that have survived in the region, characterized by high biodiversity. Such assets are in particular the Caucasus, the Black Sea Riviera sites with direct access to the Sea, the Danube river sites. These sites are transboundary and require joint regional scale efforts to reduce negative impact of wildfires on fauna and flora. Results published by IPCC (Solomon et al. 2007) shows that the impact of wildland fires is expected to grow in the future and that better analysis and understanding of this problem is required. Global climate change is expecting to lead to substantially higher temperatures in the region especially during the summer period that significantly increase the potential of forest fires and especially large scale fires. Examples of large catastrophic fires, in areas that they do not frequent occur, are the forest fires in Russia (2010) outside of Moscow. One of the major problems was that the region was not prepared properly for such a fire. The fire hazard in the Black Sea region is much higher due to drier

climate and prevailing of conifer type ecosystems. In some countries of the region forested areas are quite limited that makes them a priority to protect them. The region has had anthropogenic activities for centuries that have heavily impacted forests and extensive fires would substantially decrease the already limited forested areas of the regions.

During the last decade after a number of critical fire years, the national level fire research was extended mostly in Greece, Turkey and Ukraine with the aim in improving early warning system, fuel models and fire management as well as raising awareness of the public authorities responsible for firefighting public and the society in general (Dimitrakopoulos, 2001; Dimitrakopoulos and Mitsopoulos, 2006; Mitsopoulos, 2009; Dimitrakopoulos et al. 2011; Xanthopoulos, 2010, 2012; Saglam et al. 2013; Zibtsev, 2000, 2010; Kuzik, 2011; Serez et al. 1997).

Wildfire related research in the Ukraine is devoted mostly in the assessment of economic and ecological impacts of fires on forests in the South, South-Eastern (steppe zone) and Northern (forest zone – Ukrainian Polessie) parts of the country, in particularly on their productivity and biodiversity and analysis of fire management effectiveness in the country (Zibtsev, 2000; Voron, 2005; Ustsky et al. 2008; Zibtsev, 2010; Kuzik, 2011). A number of studies related to post fire regeneration of vegetation were made in critical fire regions of Southern Ukraine such as the Crimea Peninsula and Kherson oblast (Koba, 2000). These studies showed that the post-fire regeneration of the unique natural forests of Pinus nigra L. var. Pallasiana essentially depends of the fire season part and severity of fire. In a case of a large crown fire (August, 2007) in the Yalta Mountain Natural Reserve (Crimean Peninsula) 10 to 50 years are needed for regeneration of pre-fire vegetation types. Natural regeneration of pine forests failed also after large (8,000 ha) crown fire in Kherson oblast due to dryness of climate, insects and lack of seed source. Much more successful Scotch pine regeneration were described in Northern part of Ukraine after large crown fires in Polesskiy Natural Reserve (2009) and Volyn oblast (2007) (Kuzik, 2012). One of the most critical fire issues in Ukraine is the assessment of wildland fire risks and their consequences in forests and grasslands contaminated by radionuclides after the

disaster of Chernobyl Nuclear Power Plant in 1986 (Ohkubo and Zibtsev, 2012; Hohl et al. 2012). At the same time, the lack of regional studies of the fire situation in the region does not allow elaborating in common for all abovementioned countries approaches for prevention and reducing the risk of catastrophic wildland fires.

Materials and Methods

The project "Utilizing stream waters in the suppression of forest fires with the help of new technologies (Streams-2-Suppress-Fires) as a part of Black Sea Basin action in the abovementioned context the EU international was launched in 2013 in six countries of the region: Armenia, Greece, Moldova, Romania, Turkey and Ukraine (http://suppressfires.eu) (Fig. 1).

The aim of the project is to develop of number of computer tools, maps and data sets helping to alert authority and society about future fire risks. This will enhance the prevention and preparedness for fighting forest fires in territories with a high protection status and were the use of fire aviation is limited. The official statistical data on areas and number of fires, time they occurred for the period 2004-2009 years in the countries of the region, national fire management systems capacity, climate and forest resources data, protected areas description and their status were used to provide a regional assessment of the impact and respond.

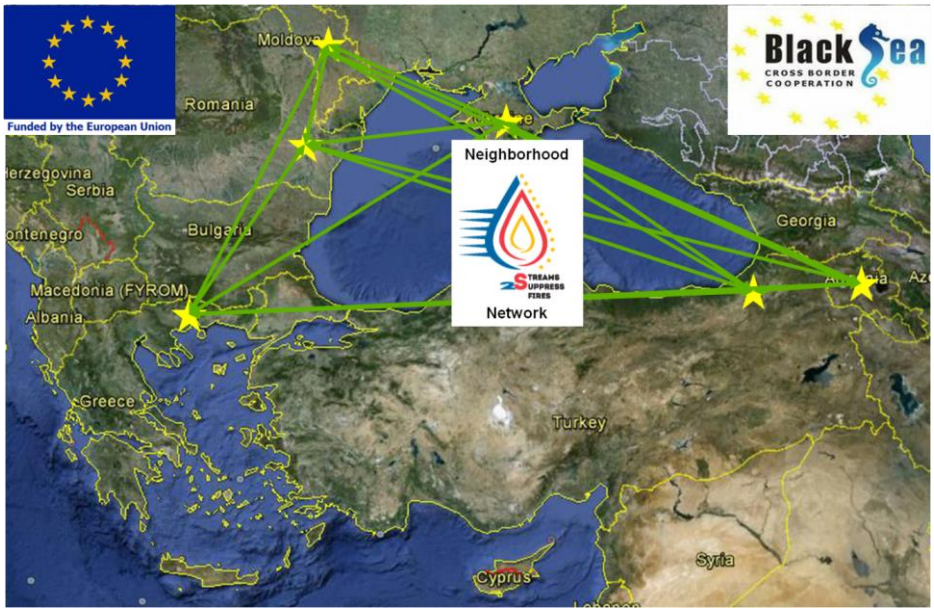

Figure 1. Countries of the Black Sea Basin region that participated in the "Streams-2-Suppress-Fires" project and selected pilot areas of the project

Results

In total, selected countries of the region manage 32.16 million ha of forest lands, most parts covered by forests (Table 1) (GFRA, 2010).

Table 1. Main indicators of forest lands of selected countries of the Black Sea Region

Countries	Forested Land area		Other wooded lands, 1000 ha	Naturally regenerated forest, %	Growing stock	
	1 000 ha	% of total land area			Coniferous (million m3)	Broad-leaved (million m3)
Armenia	333	9	107	92	-	-
Greece	3903	30	2636	96	79	106
Moldova	386	12	70	99	1	47
Romania	6573	29	160	78	417	973
Turkey	11334	15	10368	70	1001	524
Ukraine	9705	17	41	50	1122	997

The countries in the region dramatically differ by the amount and percentage of forests lands. The largest area of forest lands is in Turkey - 21.7 million ha and Ukraine – 9.7 million ha. Among them from 50% to 99% originated naturally that demonstrates their high environmental values and could serve as an additional argument of their needs for protection. From the point of view of fire management, first of all conifer forests require the most attention from the forest fire services. Conifers are widely distributed in all countries except Moldova, where fires often occur in broadleaves. Regardless of the total areas of forests it should be underlined that in all countries of the region maintaining the environmental services of forests is among national priorities of forest policies. In addition, every country has its own specifics in fire management related with the historical peculiarities that need to be taken into account.

Climate, vegetation types and topography often determine the severity of fires, fire behavior and the amount of resources needed for fire suppression. The Most difficulties for fire services are created by coniferous forests or wooded lands in mountains especially on steep terrain. From this point of view Armenia, Greece,

Turkey and Ukraine should be mentioned because the pilot areas included difficult to access coniferous mountainous forests. For example in the Armenian pilot area the forests are distributed at altitudes of 500-2500 m a.s.l.. More specifically, 19.4% is located at an altitude of 1200 m, while 46.3% is located between 1200-1800 m and 34.3% is located at an altitude of 1800 m and higher. In regards to slopes, 0.2% of the forests are located on 10° slopes, 10.6% on 20º slopes, 44.8% between 21-30º, while 44.4% of forests are located on slopes greater than 3°. In Ukrainian pilot area, the Yalta Mountain Natural Reserve, forests grows on altitude ranging from 150 to 1200 m a.s.l. with slopes that vary between 20° and 40°. In this type of forests the use of aviation has a lot of restrictions such as operating only during the daytime; mountains conditions often do not allow for fire aircrafts maintaining low effective altitude for the initial attack, while the use of helicopters is also limited due to unstable air flows around large fires. This obstacle requires more attention for the better organization of ground suppression, in particularly harmonization of the fire detection, proper water distribution and supply within the areas with a road network and with technical capacities of fire forces.

Global climate changes is also among recent challenges in fire management and science that need to be taken into account, first of all, in dry arid zones and mountains terrains - most sensitive to climate change areas in the region. For example, Armenia has been identified as one of the most sensitive countries in Europe and Central Asia in regards to climate change. Compared to the 1961-1990 mean, the average annual temperature has increased by 0.85ºC and annual precipitation has decreased by 6% in the past 80 years. In Ukraine climate changes also were identified with changes in the average annual precipitation and air temperature in the Eastern and South parts of the country (Shvidenko, 2009).

Vegetation on pilot areas of the countries – of the participants of the project represented by fire prone forests types vary from semi-desert types represented by oak, juniper, hornbeam, pine in the vicinity of Meghri, Agarak and Nrnadzor rivers (Armenia), Mediterranean and Sub-Mediterranean vegetation types as maquis, low-elevation conifer forests, oaks (mainly Quercus pubescens, Quercus frainetto,

Quercus petrea), high-elevation conifers and beech (Greece), red and black pine, various oak species (Turkey), Pinus nigra var pallasiana and Pinus sylvestris, Quercus pubescens, Juniperus excels, Pistacia mutica, Carpinus orientalis, Paliurus spina-christi, Quercus petraea, Carpinus betulus, Fraxinus excelsior forests in Crimean Peninsula (Ukraine) to temperate types of vegetation represented by ash, linden, maple, hornbeam, apple and pear tree, strainer, beech, poplar and mesophilic meadows with coppice willow in the floodplains (Moldova, Romania).

An important common feature of the selected countries is the extremely high biodiversity values of the pilot areas that are included in different international lists of protected areas of regional or global importance. In particularly, Caucasus-Anatolian-Hyrcanian Temperate Forests Ecoregion (Armenia) is listed by WWF as a Global 200 Ecoregion and by the Conservation International as a biodiversity hotspot. The pilot area the Menoikio Mountain in Greece have designated as Birds Directive Site (SPA) (GR 1260009) and as a Habitat Directive Site (SCI) (GR 12600004) in the Natura 2000 Network. In the "Codrii" Reserve of the Republic of Moldova almost 1000 species of plants are protected, that is half of the flora specific to Moldova, including 67 species of lichen, 334 species of fungus, and 69 species of mosses. The Natural Park Small Wetland of Braila (Romania) has a triple protection status – national park, EU Natura 2000 site and international RAMSAR site. The protected flora of the Yalta Mountain Nature Reserve (Ukraine) includes 1364 species of vascular plants belonging to 509 genera and 100 families and is included by WWF as one of the most important among other eight regions selected in Europe.

The results of the analysis of data related with forest fire statistics illustrate the magnitude of wildland fire problems in the region (Fig. 2). For the period 2004-2009 years a total of 356,460 ha of forest lands were burned in 43,209 fires cases or 7,200 fires damaged 59,400 ha annually for the region. The number of fire occurring every year in the region is approximately the same, while the burned areas in most years, except extreme year of 2007, vary from 10,800 - 50,000 ha. Low areas of fires during years with regular climatic conditions indicate high effectiveness of response of fire services in the countries outside of years with extreme fire weather patterns.

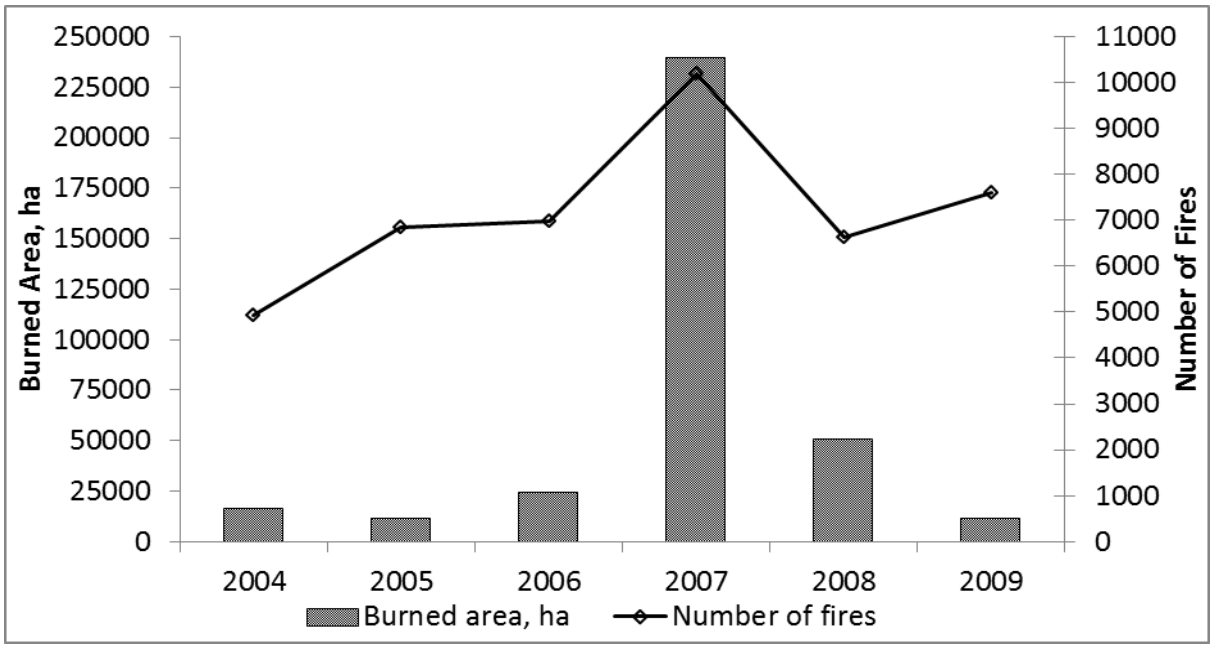

Figure 2. Number of forest fires and area burned in Black Sea Region during the period 2004-2009

For the development of effective measures to increase firefighting capacity and to reduce the burned areas, special attention should be paid to the fire conditions during seasons when an extreme fire weather condition occurs. An example is 2007, when the total burned area of that year, exceeded the total area for periods 2004-2006 and 2008-2009. Extremely hot and dry weather conditions in Greece, Turkey and Ukraine combined with strong wind led to a disastrous upsurge of forest fires; 213,000 ha were burned only in Greece. During the same year in Ukraine 5,000 forest fires occurred which is a double the amount of fires compared to the average form the period 2004-2009. The average burned areas of wildfires for the Black Sea region for the 2004-2009 period is 8.2 ha that varies with the lowest in Ukraine (1.3 ha) and largest in Greece (31.2 ha) which is determined by highest absolute number of fires in the region in case of Ukraine (21,552 fires on 9.7 million ha of forests) and largest burned area in case of Greece (260,000 ha).

Seasonal dynamics of the number of fires all over region shows that period June – September had the most, with the maximum number of fires in August indicating this month as the most critical from a fire danger perspective (Fig. 3).

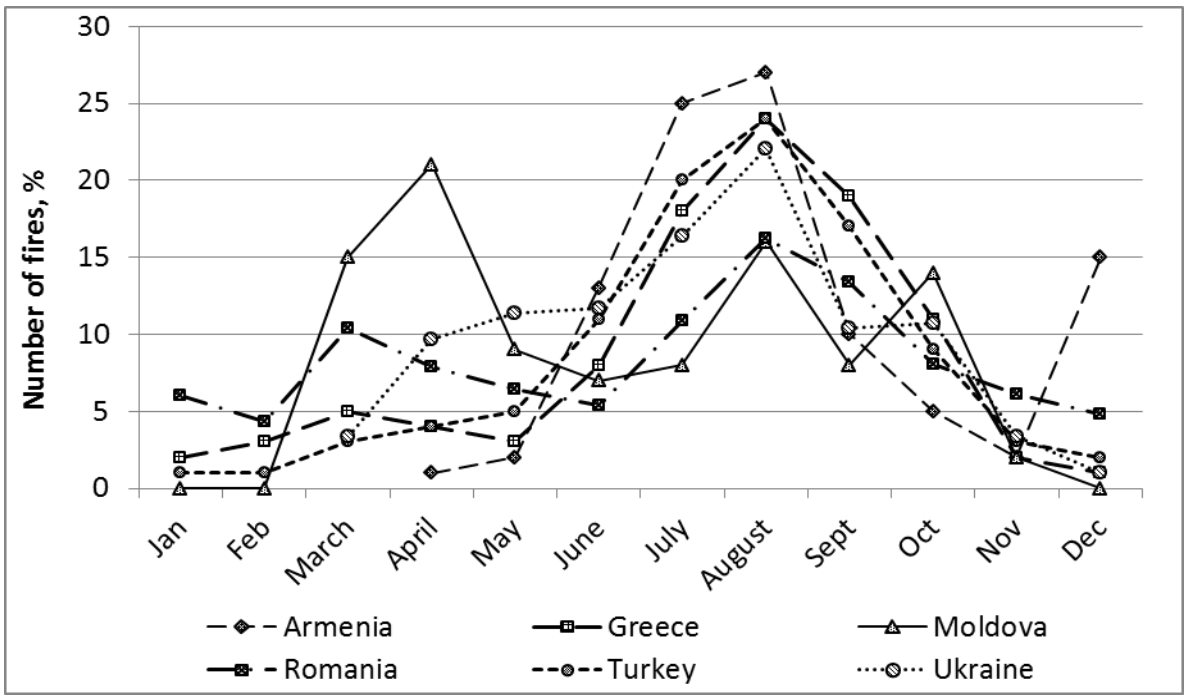

Figure 3. Forest fires distribution by month in countries of the Black Sea Region

During this period the effectiveness of trans-border co-operation in fire management in terms of obtaining assistance from other countries of the region is quite limited as all countries need to mobilize their own resources for fire prevention for their own country. This should be taken into account during preparation of documents of the joint UNECE/FAO Teams of Specialists on Forest Fire, the UNECE/FAO and the Global Fire Monitoring Center (GFMC), Germany initiative on Cross-boundary Fire Management and during the preparation of White Paper on Vegetation Fires and Global Change (Goldammer, 2013).

The importance of wildland fires as a problem at the national levels as well as preparedness of fire services could be reflected by the analysis of size/frequency of fires (Table 2). According to the national statistics in Armenia, Greece, Turkey and Ukraine, small forest fires dominate with the burned area less than 1 ha (40-93% of all fires), while in Moldova and Romania large fires dominate with sizes of 1-10 ha and 10-100 ha accordingly. This is related with different risk of development of large fires in first and second groups of countries.

Table 2. Number of fires distributed by size in the Black Sea Region, (%)

Fire size	Armenia	Greece	Moldova	Romania	Turkey	Ukraine
<1 ha	81.6	40.2	0	0	79.2	93.3
1-10 ha	18.4	32.6	93.7	14.1	19.2	4.0
10-100 ha	0	21.3	6.3	60.0	1.4	2.0
100-1000 ha	0	5.3	0	25.9	0.2	0.7
>1000 ha	0	0.6	0	0	0	0

In terms of burned areas, the forests of Greece, Turkey and Ukraine are most affected by fires in the region (Table 3).

Table 3. Number of forest fires, area burned per 1000 ha of forest land and causes of fires in the Black Sea region

Country	Number of fires per 1000 ha of forest lands	Burned area (ha) per 1000 ha of forest lands	Fire causes (Number of fires, %)		
			Human activities	Natural	Unknown
Armenia	0.11	0.81	90	0	10
Greece	2.10	66.88	56	3	41
Moldova	0.47	2.38	100	0	0
Romania	0.15	0.78	40	54	6
Turkey	1.08	5.43	62	13	26
Ukraine	2.22	2.83	98	1	1

In average, 1.34 fires with 11.02 ha of burned area occurred per 1000 ha of forest land in the region. The fire frequency was less in Armenia and Romania related with lower level of fire dangerous and fire hazard of forests. Human activities are the major reason of fires in the region, except Romania where the natural causes of forest fires are prevalent. In Greece and Turkey, the cause of a large percentage of fires is not known.

Impact of fires on ecosystems, except vegetation types, climate and ignition sources largely are determined by the effectiveness of the national fire management system. Legislation, institutional structure, informational systems, technical and human capacity level of fire forces are usually considered as major parts of it. In most

Black Sea Region countries fire management systems are arranged in line with the level of threats that fires potentially can pose to population, ecosystems and infrastructure to meet the required by national policy security level. In Greece, the Fire Department is responsible for fire suppression since 1998, while in Turkey these responsibilities are carried out by state forest enterprises functioning under regional directorates. In Ukraine the responsibility is divided between forestry enterprises (initial attack, prevention) and State Emergencies Service (fire suppression). Greece, Turkey and Ukraine allocate the largest budget in the region fire management and have the greatest technical and human capacity.

Over 85% of the total annual budget allocated by the State to forestry operations in Greece is spent for forest fire suppression. Presently, Greece has the largest in the Black Sea region fleet of firefighting aircrafts (15 CL-215, 9 CL-415, 18 PEZETEL, 6 GRUMMAN, 14 Helicopters), which is extensively used. Ground forces are fortified during the summer by hiring seasonal firefighters. Most large fires are controlled by combined ground and aerial attack. The average initial attack time in Greece is 33 minutes, while only ¼ of total fires are attacked in less than 15 minutes since its announcement (Dimitrakopoulos, 2001).

Fire management in Turkey relies on early detection, fast initial attack and powerful suppression. Nationwide for firefighting are available 135 fire trucks, 12 helicopters, 11 airplane, 882 fire look-out towers, 650 initial attack crews (of 12-15 men), and 120 standby forces (of 40-50 men). These forces are located in each district based on fire danger levels and area. Proper institutional arrangement of the response on fire as well as organized interagency communication during the operations are important parts of the efforts for increasing the effectiveness of fire management and reducing costs and losses due to fires. For example the Fire Command Center (FCC) established in 1997 in Turkey under the General Directorate of Forestry (GDF) aiming to administrate all fire management issues, ranging from prevention activities to fire suppression. Important/large fire situations requiring inter-regional cooperation are handled with the help of FCC. All inter-agency or international agreements/procedures are handled by the GDF with the help of FCC.

As part of these efforts a more comprehensive national database on forest fires is being developed.

Fire-prevention measures are an essential part of the fire management system in Ukraine. In the beginning of the fire season (April) the State Agency of Forest Resources of Ukraine and the forest enterprises take measures on increasing their preparedness. These include the regulation of public access to forests at times of increased or high fire danger at local and regional levels, the development and coordination of regional mobilization plans for better preparedness and fast response to large fires by different fire forces. Technical prevention measures include creation and maintenance of fire breaks, maintenance of fire suppression equipment, communication means, and fire fighter training. The effectiveness of Ukrainian fire management system were improved in 2010, when Russia under the same weather conditions had catastrophic fires while annual areas and number of fires in Ukraine did not differentiated from average. A weak side of the fire management system is the lack of information support for fire suppression. In particularly forest enterprises do not have electronic maps of vegetation, fire fuel models, fire behavior models, modern early warning systems and clear rules of interagency communication during fire operations, outdated system of fire hazard used as well as fire detection. All these factors increase risks of large fires under global climate change uncertainties.

Conclusions

1. Wildland fires are important factors that impact succession, biodiversity, health, economic and environmental values of unique and protected ecosystems in countries of the Black Sea Region on hundreds of thousands hectares that disturb everyday life and the security of millions of people, and also requires substantial human, technical and financial resources for their control.

2. Currently, the effectiveness of fire management in the Black Sea Region is insufficient in most cases during fire seasons especially during critical climatic condition when the number of fires and areas of burned grow exponentially.

3. Main directions that should be followed to increase the effectiveness of fire management and reduce environmental and economic losses due to fires are the

development and implementation of decision support systems based on innovative approaches, new technologies, comprehensive data sets based on GIS and remote sensing data. This system will utilize all the information required for the effective fire management - fuel models, fire behavior system, national, local and regional early warning systems, spatially explicit data about fire infrastructure, including fire detection system, fire ponds, fire stations and roads. This kind of informational system could be used in all countries of the region if the sufficient local data will be provided.

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