THE NATIONAL CAPABILITIES AND REQUIREMENTS OF TURKEY FOR BETTER WILDFIRES FIGHTING AND PREVENTION

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ABSTRACT

Natural disasters such as wildfires are continuous hazards that threaten forests all around the world. Wildfires cause massive environmental and economic devastation and they are considered a major risk in several parts of the world. Between 1990 and 2020 the world has lost 178 million hectares of its forest, and because of the current climate change there are expectations for wildfires to increase in frequency, extent, and severity. Wildfires have become an increasingly serious concern on a global scale, causing environmental and economic damage. The complexity of the wildfires can make a negative impact on the decision-making process, while the decision-makers are under the pressure of conditions that are limited in time, dynamic, uncertain, and contradictory. A decision support system (DSS) is an interactive computer-based information system developed to assist decision-makers. It integrates the theory of decision-making with interactive computer systems. GIS-based DSSs have been used to increase the efficiency of fire control processes such as planning, managing, and decision-making. Some countries have their own wildfire systems. In Turkey, the forests represent about 29% of the total area, the average burned area is more than 10 thousand hectares per year while the average of wildfire incidents is about 2200 incidents annually. Several tools and systems have been developed recently, they have varied between early warning systems and decision support systems or even only fire monitoring and detection tools and systems. However, most of these tools and systems were developed to do one specific task. There is an urgent need to develop an integrated GIS-based DSS system to meet the national requirements of wildfire fighting. In this study, the national capabilities and requirements of Turkey for better wildfire fighting and prevention are reviewed. Additionally, the available tools and systems for Turkey are reviewed and compared with the other national systems.

1. INTRODUCTION

Forests are one of the most important renewable natural resources because they help keep the environment clean and produce oxygen, which helps keep the ecosystem balanced (Pourtaghi et al., 2015). Illegal harvesting, increasing demand for land, climate-changing, wildfires, and many other factors are threatened forests (Akay et al., 2012). According to the Global Forest Watch (GFW) from 2001 to 2021, there was a total of 119 Mha of tree cover lost from fires globally and 318 Mha from all other drivers of loss. The year with the most tree cover loss due to fires during this period was 2016 with 9.61 Mha lost to fires — 32% of all tree cover loss for that year (Figure 1).

Climate change is the primary cause of wildfires, as a result of the warming climate, forests become drier and more vulnerable to fire. Since climate change extends the fire season with hot and dry days in a year it has a risk-increasing impact on the fire. However, climate change is not the only reason for wildfires. According to the World-Wide Fund (WWF) for Nature, in the Mediterranean region, wildfires are mostly caused by humans — either accidentally or deliberately (WWF, 2020). Despite its minor role in the overall picture, lightning strikes may result in massive forest cover losses, carelessness ss is also one of the significant causes of fires. Besides that, some other factors such as using fire in farming, burning coal seams, and sparks flying from railway or power lines could also be the possible reasons for wildfires (Hirschberger, 2016). Responding effectively and minimizing the danger of a wildfire requires as much as possible information before making decisions (Vásquez et al., 2021). The technology advances have led to support the decision-making by converting the huge heterogeneous information related to a wildfire into key data for scientists and authorities allowing them better choices. Kucuk and Bilgili (2006) indicated that by using Geographic Information System (GIS) technology, gathering and analyzing data and information is simpler, more cost-effective, and faster than classical approaches. Not only for firefighting efforts but also for pre-fire preventive measures and post-fire operations as well.

DSS is an interactive computer-based information system developed to assist decision-makers (Liu et al., 2010). In a very complex and highly risky phenomenon such as wildfire, the decision-makers are under the pressure of conditions that are limited in time, dynamic, uncertain, and contradictory (Zimmerman, 2012). These conditions make the wildfire DSSs precious techniques for managing and preventing forest fires (Sakellariou et al., 2017) and improving the quality of decisions (Lourenço et al., 2021). The aim of this research is to present the national capabilities and requirements of Turkey for better wildfire fighting and prevention through a general view of the forest and fire conditions. On the other hand, this research presents the current systems and tools that are used to combat wildfires in Turkey and compares these systems with other worldwide DSSs.
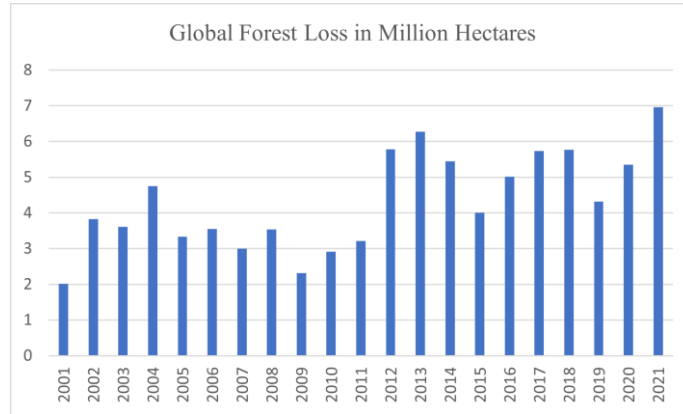

Figure 1. The global forest loss between 2001 and 2021 (GFW, 2021).

2. WILDFIRE IN TURKEY

According to data derived from the General Directorate of Forestry (OGM), Department of Wildfire Combating, 2021 was the worst year in Turkish history in terms of wildfires, where the total burnt area was 139503 ha, and the number of fires was 2793 in the same year (Table 1). In Turkey, the coastline which starts from Hatay and extends through the Mediterranean and Aegean up to Istanbul has the highest fire risk. In other words, approximately 57% of Turkey's forest area (12.5 Mha) is located in fire-sensitive areas. Although climate change is the main cause of wildfires, human activities were responsible for about 40% of the total wildfire incidents, while natural causes were responsible for 13% and unknown causes for 47% (Figure 2) (OGM, 2021). Wildfires mostly occurred during the period of March-December, particularly in June, July, August, and September. When we look at the number of wildfires in 2020, August was ranked the highest with 797 fires but in terms of burnt area, while September was the highest with 9029.70 ha. 67.3% of the wildfires occurred in four months (between July to October) and 19954.07 hectares of forest area were damaged in this period (table 2).

Table 1. The burnt area and number of fire incidents between 2001 and 2021 in Turkey (OGM, 2021).

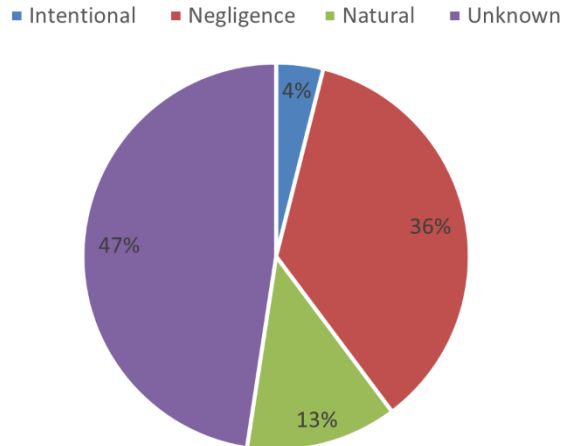| Year	Hectare	Number	Year	Hectare	Number
2001	7394	2631	2012	10454	2450
2002	8514	1471	2013	11456	3755
2003	6644	2177	2014	3117	2149
2004	4876	1762	2015	3219	2150
2005	2821	1530	2016	9156	3188
2006	7762	2227	2017	11993	2411
2007	11664	2829	2018	5644	2167
2008	29749	2135	2019	11332	2688
2009	4679	1793	2020	20968	3399
2010	3317	1861	2021	139503	2793
2011	3612	1954			

Figure 2. The causes of wildfires in Turkey through 2021 (OGM, 2021).

Along with the great impacts of wildfire on the environment and ecosystem, they also cause a big economic loss. Wildfire fighting takes a significant place in the budget of OGM (Eker and Abdurrahmanoğlu, 2018). In 2017, wildfire fighting activities cost about 21.2% of the total budget of OGM (OGM, 2021).

Table 2. Monthly distribution of wildfires in Turkey during 2020 (San-Miguel-Ayanz et al., 2021).

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Hectare	22.85	10.09	165.52	183.7	281.11	182.09	1725.92	6748.56	9029.7	2446.89	83.74	87.34
Number	37	33	157	187	179	242	474	797	608	410	157	118

3. GLOBAL SCALE WILDFIRE DECISION SUPPORT SYSTEMS

European Wildfire Information System (EFFIS) is a comprehensive system that encompasses the whole cycle of wildfire management, from prevention and readiness to post-fire damage assessment. EFFIS services include fire danger estimation, active fire detection, rapid damage assessment, and post-fire modules that analyze land cover damage, post-fire soil erosion, smoke plume emissions, and dispersion, and finally, vegetation recovery. (Kalabokidis et al., 2016). Global Wildfire Information System (GWIS) is a bridge for countries that have not developed a forest fire information system yet, while it is an independent source for complementary and harmonized information in countries that have already developed their forest fire information systems. GWIS has several services including fire danger estimation, active fire detection, burned area mapping, emissions assessment, and Background and ancillary for researchers (GEO, 2019). Virtual Fire is a web-based GIS platform developed for controlling forest fires. The platform enables sharing and utilizing of information and tools among firefighting forces promptly (Kalabokidis et al., 2013). Virtual Fire allows locating fire service vehicles and other resources online and in real-time, enabling to share vehicle's locations to the platform directly. Different indices are used to map and represent high-risk areas daily. In addition, Virtual Fire provides real-time weather forecasting serves as an early warning system. Lourenço et al (2021) have designed a DSS based multi-sensor and GIS technologies for minimizing the effects of forest fires. The system consists of an ArcGIS Online feature service that enables sharing operational data in near real-time, a mobile application to interact with the system and visualize data, and a multi-sensor device for collecting field data and sharing it with external services.

4. WILDFIRE DECISION SUPPORT SYSTEMS IN TURKEY

Several tools and systems have been developed recently in Turkey, they have varied between early warning systems and decision support systems or even only monitoring and detection tools and systems, all of which aim to assist in preventing, managing, and suppressing wildfires. Wildfires whether natural or man-made caused cannot happen without suitable meteorological conditions (MGM, 2018). Precisely measured weather observations are required at each stage of fire control, the effects of these conditions may vary according to topography, forest area, and fuel type (MGM, 2018). Temperature, relative humidity, precipitation, wind direction and speed, and the stability of weather are critical for any early warning system. Wildfire Meteorological Early Warning System (MEUS) has been developed by the Turkish State

Meteorological Service (MGM) as a wildfire meteorological early warning system through five stages including Weather forecast analysis, Forest map-based data processing, Topography analysis, and blow-dry effect, Danger results classification, and Generating danger maps. Fire Monitoring Tool for Eumetsat's Active Fire Product Over Turkey Using Google Earth (FOOGLE) is a satellite-based wildfire visualization system in Turkey, developed also by MGM to assist in firefighting efforts. Foogle is based on the near-real-time FIR product of EUMETCast (a system for distributing environmental data operated by EUMETSAT) probable and possible fires are generated in the type of ASCII and Google Earth file (KML) formats. Where ASCII files contain the coordinates and KML files provide areal representation (Sönmez et al., 2011). Forest Information System (ORBIS) was a project developed by OGM in 2011 to create an informatics infrastructure for the effective protection, planning, and management of Turkey's environment and forest ecosystem (OGM, 2018). ORBIS consists of three modules, each module contains several modules, and each module has several functions. Akay et al., (2012) introduced a GIS-based DSS developed by utilizing the Network Analyst extension within ArcGIS for determining the shortest and safest route to forest fires.

5. CONCLUSIONS

Wildfires have become an increasingly serious concern on a global scale, causing environmental and economic damage. The main causes behind this increase are the persistently hotter and drier weather, as well as other human activities like land conversion for agriculture and inadequate forest management. According to WWF between 2010 and 2021, the world lost 25.3Mha of tree cover. the main causes behind this increase are the persistently hotter and drier weather, as well as other human activities like land conversion for agriculture and inadequate forest management. Climate change leads to an increase in the number, severity, and area burned by wildfires. Since the early 1990s, "megafires" – wildfires that are larger than the existing firefighting capabilities have been more common in Europe with an expectation to further increase in their frequency as a result of climate change.

The forests cover an area of about 12 million hectares in Turkey, according to the last statistics from OGM between 2011 and 2021, the average burned area is about 10,000 hectares each year without considering 2021, while the average number of wildfire incidents is about 2650 incidents per year. When evaluating the previous situations, it is clear that there is a national need to develop GIS-based decision support systems that can contribute to the analysis of both the ecological and economic effects of wildfires. This system should assists the decision-makers effectively to prevent and suppressing wildfires and improving the fire policy for better management of forests and fires. Most of the available systems in Turkey serve for one specific task. However, there is a need in Turkey for an integrated system that has functions and tools for early warning, preventing, controlling, suppressing wildfires, and post-fire analysis. there is a need for a system that can gather the efforts of the different institutions to manage wildfire disasters in a way that ensures reducing vulnerabilities, enhancing readiness, improving capabilities, and making better responses and decisions.

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