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Research Article

EVALUATING THE LOCATIONS OF THE FIRE HELICOPTER PLATFORMS IN THE REGION OF BURSA Ψ

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Abstract

In Turkey, the General Directorate of Forestry (GDF) utilizes helicopters in various forestry activities such as firefighting, forest protection, wildlife management, shipping, and other activities. In firefighting activities, mostly Russian-designed "Mil Mi-8MTV-1" series helicopters are rented by the GDF during the fire season. These fire helicopters are designed to carry up to 20 people and 2.5 tons of water with a special bucket attached underneath. In this study, it was aimed to evaluate the location of the fire helicopter platforms in the border of Bursa Forestry Regional Directorate (FRD). In the solution process, the areas reached by the fire helicopters in the critical response time was determined using proximity analysis in ArcGIS. Accessible areas were also found for productive forest and degraded forest separately. The results indicated that 85.97 % of the total area of FRD was reached by the fire helicopter within the critical response time while it was 84.06 % for the forested areas. In terms of fire sensitivity degrees, 79.18 % of the first degree sensitive forests were accessed within the critical response time, while all of the second and third degree sensitive forests were reached on time. On the other hand, the accessible forest areas were 85.61 % and 81.21 % for productive forest and degraded forest. These results suggested that location of the fire helicopter platforms should be re-evaluate and possible new platforms should be located in Bursa FRD in order to improve the efficiency of the helicopter fleet and access the forest area in the critical response time. In this process, GIS techniques should be employed by the fire managers to evaluate the optimum locations for the fire helicopter platforms.

Keywords: Forest Fires, Fire Helicopter, GIS, Visibility Analysis

Araştırma Makalesi

YANGIN HELİKOPTERİ PLATFORMLARININ BURSA BÖLGESİNDEKİ KONUMLARININ DEĞERLENDİRİLMESİ

Özet

Türkiye'de Orman Genel Müdürlüğü (OGM), yangınla mücadele, orman koruma, yaban hayatı yönetimi, transport ve diğer faaliyetler gibi çeşitli ormancılık faaliyetlerinde helikopterlerden yararlanmaktadır. Yangınla mücadele faaliyetlerinde, yangın sezonu boyunca OGM tarafından genellikle Rus üretimi "Mil Mi-8MTV-1" serisi helikopterler kiralanmaktadır. Bu yangın helikopterleri, 20 kişiye kadar personel ve altına takılı özel bir kova ile 2,5 ton su taşıyabilecek şekilde tasarlanmıştır. Bu çalışmada, Bursa Orman Bölge Müdürlüğü (FRD) sınırındaki yangın helikopteri platformlarının konumunun değerlendirilmesi amaçlanmıştır. Çözüm sürecinde, ArcGIS yazılımında yakınlık analizi kullanılarak yangın helikopterlerinin kritik müdahale süresinde ulaştığı alanlar belirlenmiştir. Ayrıca verimli ormanlar ve bozuk ormanlar için ayrı ayrı erişilebilir alanlar bulunmuştur. Sonuçlar, yangın helikopterinin kritik müdahale süresi içinde toplam FRD alanının %85,97'sine ulaşıldığını, ormanlık alanlarda ise bu oranın %84,06 olduğunu göstermiştir. Yangına hassasiyet dereceleri açısından, birinci dereceden hassas ormanların %79,18'ine kritik müdahale süresi içerisinde ulaşılırken, ikinci ve üçüncü dereceden hassas ormanların tamamına zamanında ulaşılmıştır. Öte yandan, verimli ormanlar ve bozuk ormanlar için erişilebilir orman alanları sırasıyla % 85.61 ve % 81.21 olarak bulunmuştur. Bu sonuçlar, kritik müdahale süresinde helikopter filosunun verimliliğini artırmak ve ormanlık alana erişim sağlamak için yangın helikopteri konumlarının yeniden değerlendirilmesi ve olası yeni platformların Bursa FRD alanında yerleştirilmesi gerektiğini önermektedir. Bu süreçte, yangın helikopteri platformları için optimum konumları değerlendirmek için yangın yöneticileri tarafından CBS teknikleri kullanılmalıdır.

Anahtar kelimeler: Orman Yangınları, Yangın Helikopteri, CBS, Görünürlük Analizi

1. INTRODUCTION

In Turkey, approximately five million hectares of forest area, along the coastline starting from the east of the Mediterranean region and extending to the Marmara region, is primarily sensitive to fire (Akay et al., 2012). There must be detail archive information about the forest fires taken place in the area for accurate determination of fire sensitivity (Küçük and Ünal, 2005). In Turkey, the amount of forest area damaged by forest fires is about 10000 hectares and it has tended to increase in recent years. In 2021, a total of 16000 hectares of forest land were damaged in about 3000 forest fire incidences.

The teams working on forest firefighting are divided into five groups: first response team, ready force team, mobile team, fire truck team and air support team (helicopter and aircraft) (Akay et al., 2008a). Helicopters are preferred for forest fire suppression as they can fly in mountainous areas, reach the high speed in a short time, and hover in a certain point on the desired height (Ay and Ay, 2011). Especially in areas that are sensitive to forest fires, the fire helicopters carry water in the bucket and pour it to the fire areas to control the fire and cool down the perimeter. This is one of the most effective elements in controlling fires and reducing losses. In addition, forest fires in areas with no roads or limited means of transportation can be only accessed in a short time with the help of helicopters.

In Turkey, the GDF uses helicopters in various forestry activities such as firefighting, forest protection, wildlife management, shipping, and other activities. USA-designed "Eurocopter AS-355 F-2 Ecureuil II/Twin Star" and "Aerospatiale AS-365 Dauphin II" model helicopters are mainly used for monitoring and picture taking, Russian- designed "Mil Mi-8M" series helicopters are used for firefighting activities (Akay et al., 2008b).

In order to respond effectively to forest fires, fire extinguishing activities should start within the critical response time, in which the fire is likely to be controlled. Thus, it is essential to place the fire helicopter platforms in optimal locations that the forest areas can be reached by the fire helicopters within the critical response time. The critical response time varies depending on the fire sensitivity of the forest area. The fire sensitivity of a forest area is determined based on some factors including number of fires, the ratio of burned area and total area, and fire coefficient (Mol, 1994). The fire sensitivity degree map of Turkey has been developed by General Directorate of Forestry (GDF) based on the Forestry Enterprise Directorates.

Geographic Information Systems (GIS) technology has effective tools to collect, store, edit, analyze spatial data and present descriptive information about this data on digital maps (Gumusay and Sahin, 2009). GIS technologies are widely used in many forestry applications such as forest operations, forest management, watershed management, forest protection, forest transportation, and forest fires (Kiser et al., 2005; Manussaridis et al., 2007; Keenan, 2008; Wing et al., 2010). Kucuk and Bilgili (2006) reported that using GIS technology is easier, economical, and faster approach in obtaining and analyzing information for firefighting activities, pre-fire actions, and post-fire operations. However, there is limited number of studies in evaluation of helicopter platforms using GIS techniques. In of these studies, Akay et al. (2010) evaluated the efficiency of a single fire helicopter in Antakya Forest Enterprise Directorate by considering reaching time to potential fire areas in the critical response time. They suggested that that GIS based decision support systems can be effectively used to evaluate the efficiency of fire helicopter in the region of Antakya.

In this study, the efficiency of the fire helicopter platforms in Bursa FRD was evaluated by GIS technology, while considering the critical response time and fire sensitivity degrees in the region. Accessible areas with helicopters were also analyzed considering the productive forests and degraded forests in the region.

2. MATERIALS AND METHODS

2.1. The Study Area

The study area covers the Bursa Forestry Regional Directorate (FRD) in Turkey (Figure 1). The study area is 1574939,3 ha with 48.21% covered by forest lands (759318,60 ha) in which 64.73% was productive forest (491512.60 ha) while 35.27% was degraded forest (267806.00 ha). The region, which is generally dominated by the Mediterranean climate type, is also the transition between the Black Sea climate and the Mediterranean climate. In the region, the dominant coniferous tree species include Black pine (*Pinus nigra*) and Brutian pine (*Pinus brutia*) that are relatively sensitive to forest fires. There are three cities in the border of Bursa FRD; Bursa, Bilecik, and Yalova. In the study area, the forests are in the first, second and third degree sensitive to fires and there are eight fire helicopter platforms.

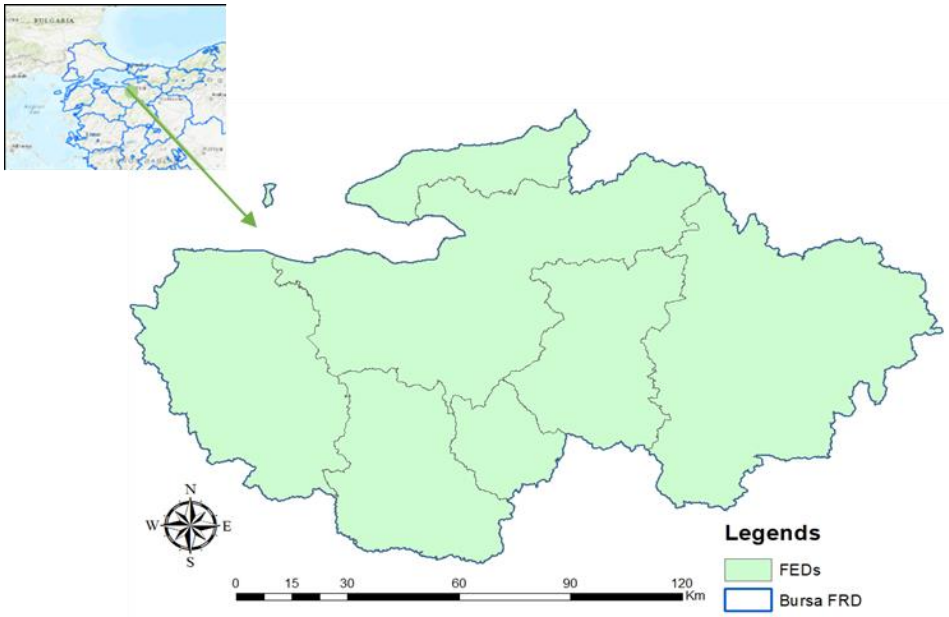

Figure 1. The Bursa FRD and border of Forestry Enterprise Directorates (FEDs)

2.2. GIS Database

The fire sensitivity layer of the study area was developed based on the fire sensitivity degree map of Turkey (Figure 2). The locations of the fire helicopter platforms were obtained from the Bursa FRD and associated layer was produced in ArcGIS program (Figure 3). The forest map of the study area was developed based on the forest management map of the study area, obtained from Bursa FRD. Then, digital layers for productive forests and degraded forests were generated also based on the forest management map.

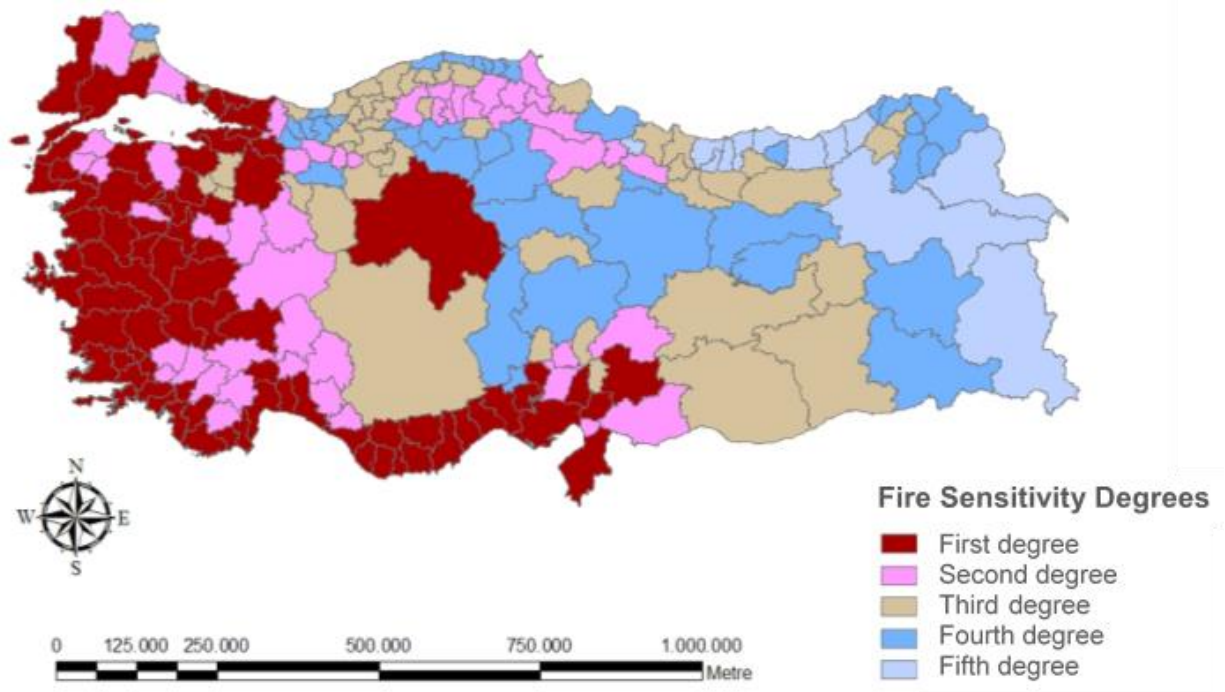

Figure 2. Fire sensitivity map based on Forest Enterprise Directorates (Akay et al., 2011)

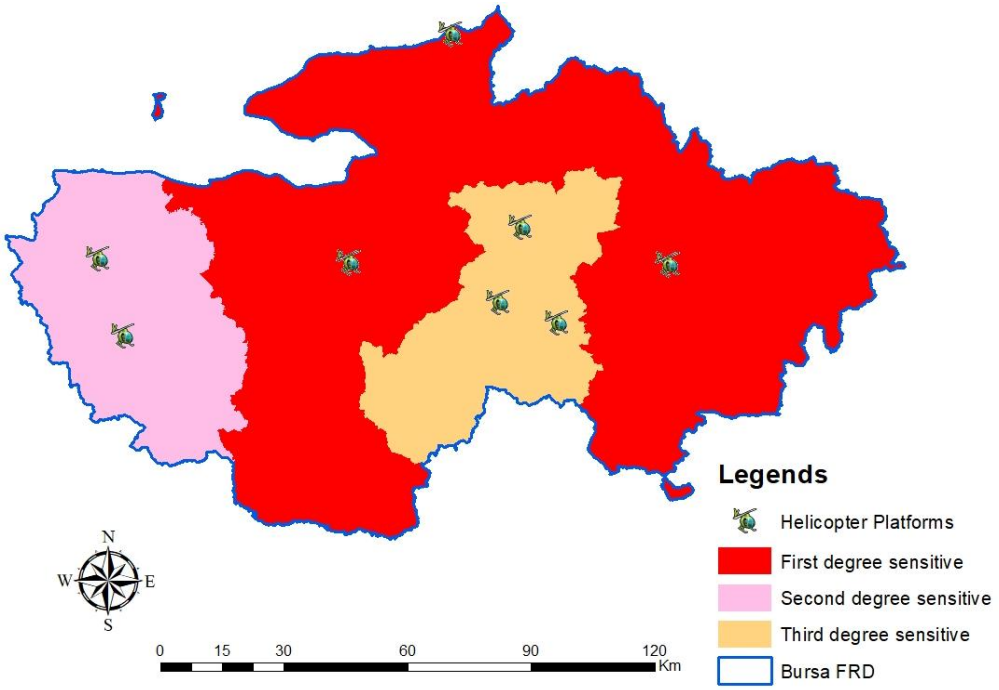

Figure 3. Fire helicopter platforms located in Bursa FRD

2.3. Proximity Analysis

The efficiency of the fire helicopter platforms located in Bursa FRD was evaluated by considering the critical response time. In the solution process, buffer feature under Proximity in ArcMap module of ArcGIS 10.4 was used. By considering the fire sensitivity degrees of the first, second, and third degree sensitive forest areas in the Bursa FRD, circular areas that can be reached by the helicopter in 20, 30, and 40 minutes (flight time + preparation time) were determined. Table 1 indicates critical response time according to fire sensitivity level.

Table 1. Critical response time according to fire sensitivity level (GDF, 2008)

	Fire Sensitivity Degrees				
	I	II	III	IV	V
Critical Response Time	20 min	30 min	40 min	50 min	50 min

"Mil Mi-8MTV-1" series helicopter, mostly rented by the GDF during the fire season, was evaluated in the study. The average flight speed and preparation time of the helicopter were estimated as 225 km/hour and 10 minutes, respectively. Then, the radius of each circle was computed as 37.5 km, 75 km, and 112.5 km based on the actual flight times of 10, 20, and 30 minutes (excluding preparation time) and average flight speed. Finally, the circular areas were merged to determine the accessible areas by helicopters in critical response time, considering fire sensitivity degrees. Accessible forest areas were also found for productive and degraded forests.

Figure 4. Mil Mi-8MTV-1 model helicopters

3. RESULTS AND DISCUSSION

In this study, the location of the fire helicopter platforms in the border of Bursa Forestry Regional Directorate (FRD) were evaluated using GIS techniques. The proximity analysis in ArcGIS was employed to determine the areas reached by the fire helicopters in the critical response time considering fire sensitivity degrees of the forests (Figure 5). Besides, the accessible areas were found for productive forest and degraded forest separately. In the region, 64.77% of the forests were productive while rest was the degraded forest (Figure 6).

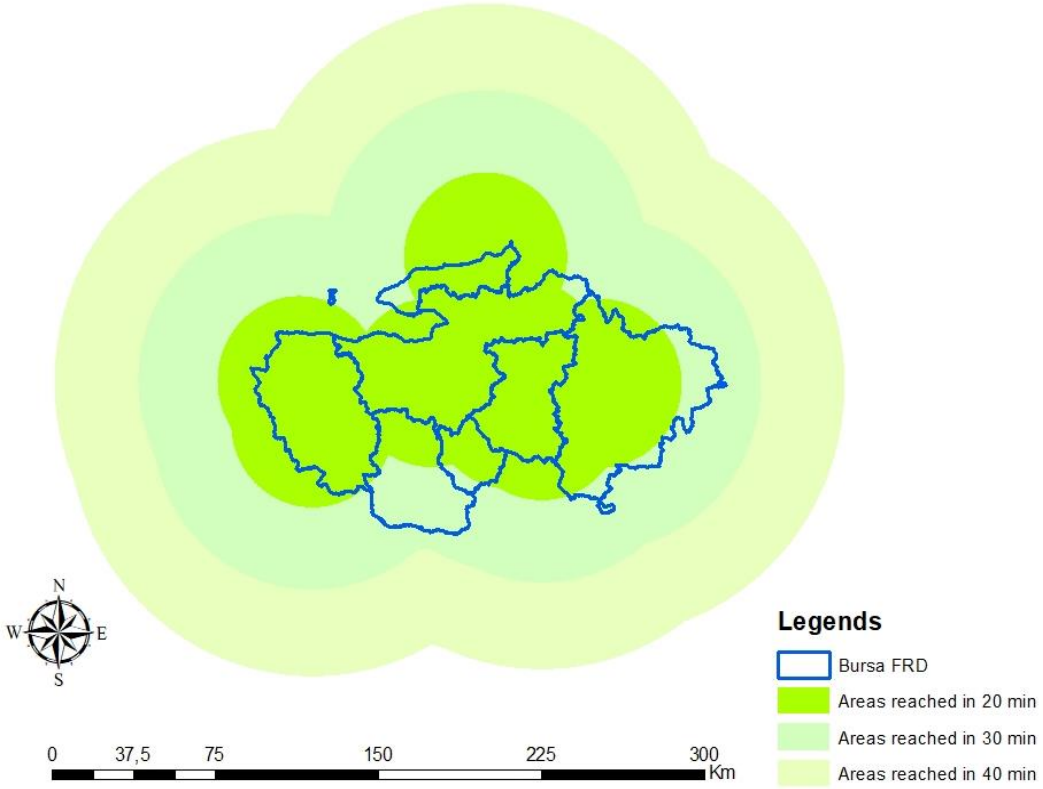

Figure 5. The areas that are reached in the critical response times

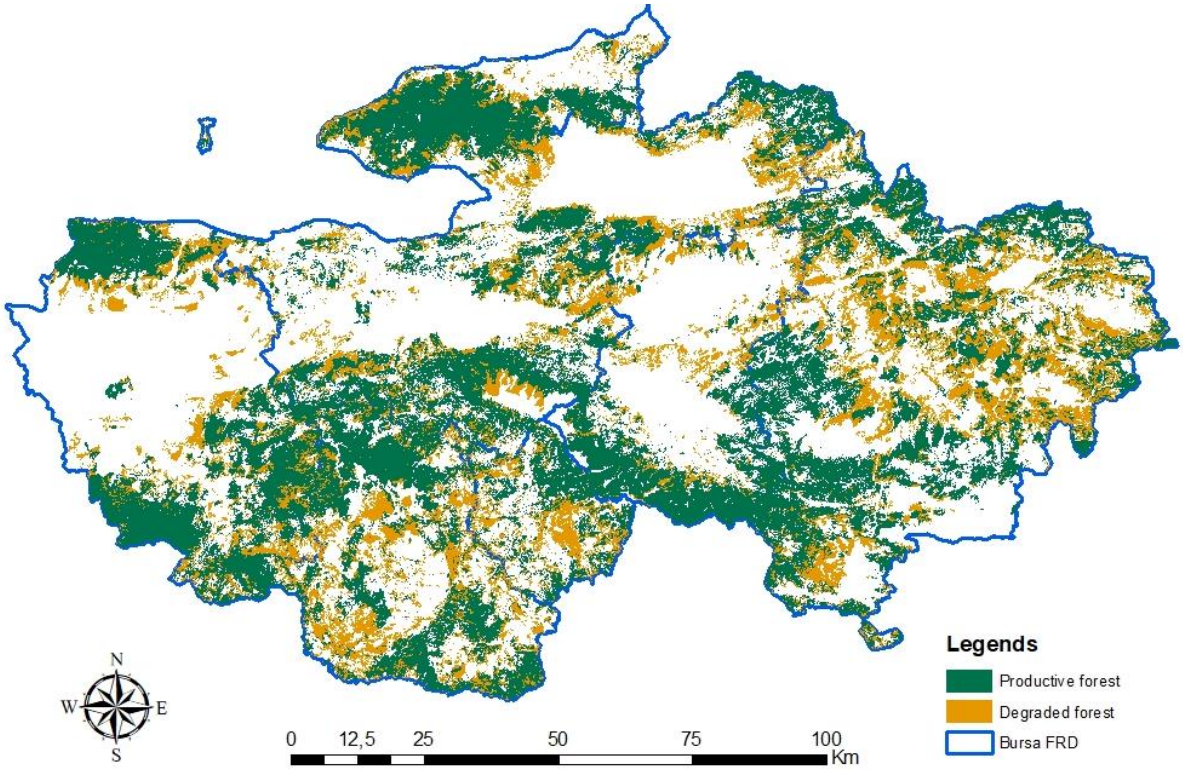

Figure 6. Productive and degraded forest areas in Bursa FRD

In terms of fire sensitivity degrees, the first, second, and third degree fire sensitive areas were 67.32%, 17.30%, and 15.38%, respectively. It was found that fire helicopters can reach to the 85.97% of the study area in the critical response time while rest cannot be accessed promptly (Figure 7).

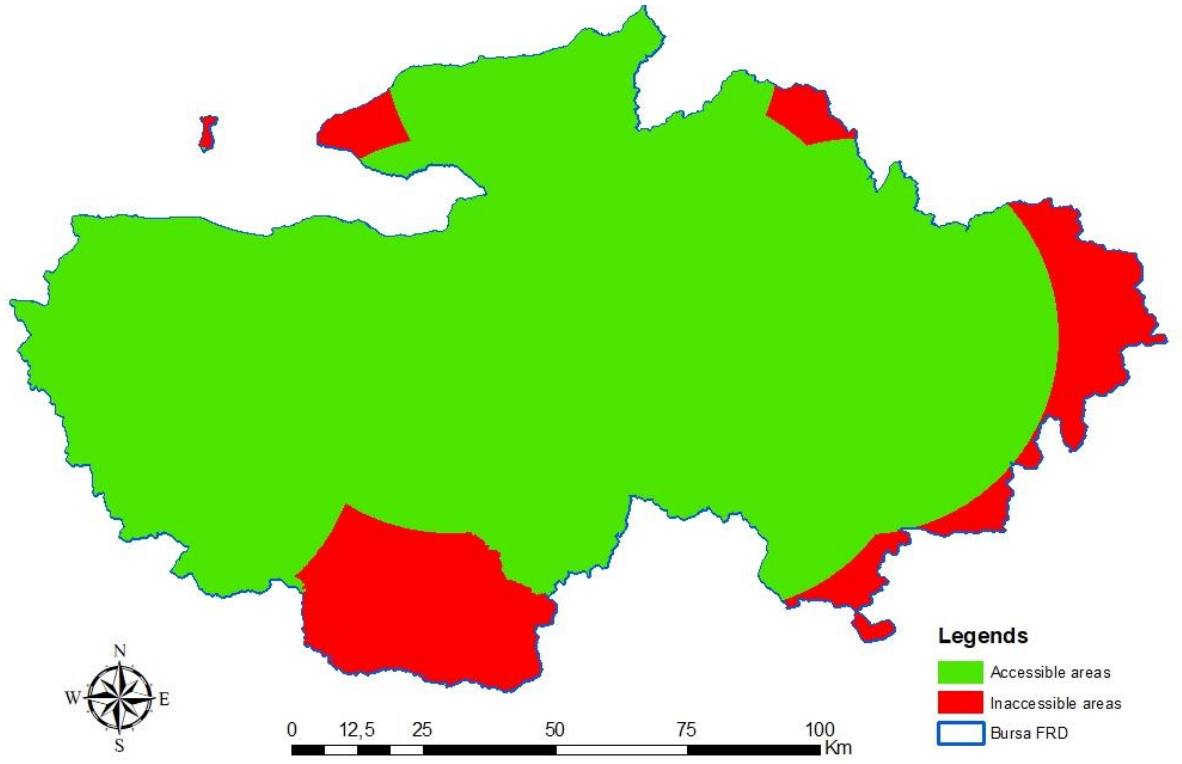

Figure 7. Accessible and inaccessible areas in the study area

In terms of sensitivity degrees, it was found that 79.18% of the areas with the first degree sensitivity degree was reached in the critical response time, while all of the areas with the second and third degree sensitivity were reached on time. On the other hand, the total forest areas that can be reached within the critical response time was 84.06%, while 14.39% and 18.79% of the productive and degraded forests were not reached on time, respectively (Figure 8). In a similar study conducted by Akay et al. (2010), it was reported that about %99.86 of the study area (Antakya Forest Enterprise Directorate) can be reached in the critical response time of 20 minutes.

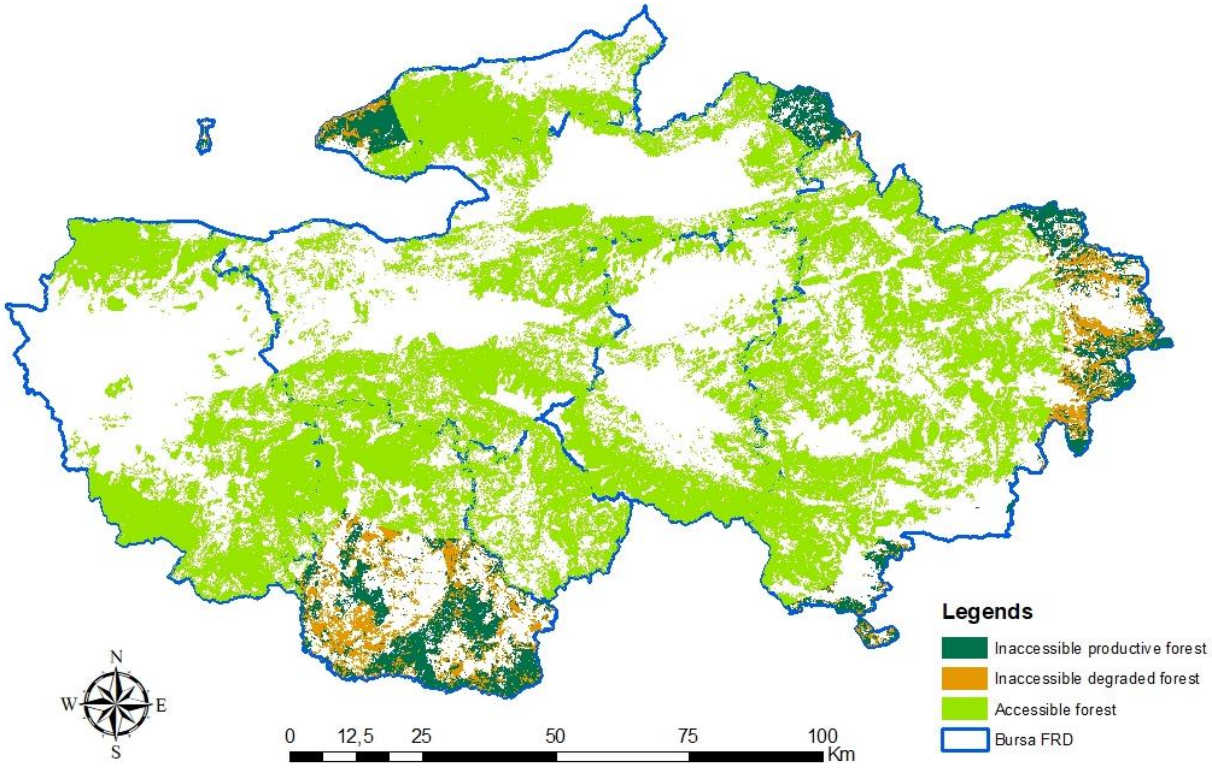

Figure 8. Accessible forest areas and inaccessible areas for productive and degraded forests

4. CONCLUSIONS AND RECOMMENDATIONS

By using GIS technology, the efficiency of the helicopter aerial support team operating in Bursa FRD was evaluated, considering critical response time and fire sensitivity degrees in the region. The findings of the proximity analysis indicated that 15.95% of the forest area was not reached by the fire helicopters within the critical response time. The fire helicopter fleet was not able to reach 20.82% of the first degree sensitive forests were accessed within the critical response time, while all of the second and third degree sensitive forests were accessed on time. The inaccessible forest areas for productive forest and degraded forest were 14.39% and 18.79%, respectively. It was found that location of the fire helicopter platforms in Bursa FRD should be re-evaluate and possible new locations should be determined to improve the accessible forest areas in the critical response time. GIS techniques can provide fire managers with effective tool to evaluate the optimum locations for the fire helicopter platforms.

AUTHOR CONTRIBUTIONS

Abdullah E. Akay: Concept and design of the manuscript, supervision, resources, analysis, writing manuscript, critical review. **Ebru Bilici**: Concept, resources, literature search, data collection, analysis, writing manuscript.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest

ETHICS COMMITTEE APPROVAL

This study does not require any ethics committee approval.

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