MAPPING FIRE INCIDENTS AND EVALUATING SERVICE AREA OF FIRE STATIONS IN FATIH SUBPROVINCE

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Abstract

Fires in metropolitan areas cause different and diverse social and economic losses with numerous deaths, injuries and high number of estate and wealth loss. Even though it does not look possible to avoid fires events totally, it can be possible to decrease their damages by proper fire management policy. Fire management can be define as a set of activities that contains systematic analysis, planning, decision making, assignment and coordination of accessible resources to manage fire related risks. It is consist of prevention, preparedness, response and recovery. Geographic information technologies that have evolved rapidly in recently are also applied in fire management. Beside to the development of geographic information systems (GIS), it is possible to accomplish productive results in applications formed on spatial information. Since GIS can examine comprehensive data figures and is highly beneficial in responding to spatial problems that can be used in the of analysis data in the matter of fires occured in urban areas. When the cost benefit analysis of the establishment of GIS is set side by sided with economic losses that arised as a consequence of urban fire, it is clear that the formulation and management of a system build on GIS is more economic. In this study, one of the most congested subprovince of Istanbul has been examined according to quantity and location of the fire. Firstly, data collected from govermental institution have been spatially mapped and interpolated. Secondly, service areas of available fire response stations have been analyzed. In conclusion, acquired dataset interpreted simultaneously and future proposals and evaluations were made.

Keywords: Fire Mapping, Fire Incident, GIS, Fatih

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YANGIN OLAYLARININ HARİTALANMASI VE YANGIN İSTASYONLARININ SERVİS ALANLARININ DEĞERLENDİRİLMESİ: FATİH ÖRNEĞİ

Özet

Metropolitan alanlarda gerçekleşen yangınlar, çok sayıda ölüm, yaralanma ve yüksek miktarda mal ve zenginlik kaybı gibi farklı ve çeşitli sosyal ve ekonomik kayıplara neden olmuştur. Yangın olaylarını tamamen önlemek mümkün olmaksızın da, uygunsuz yangın yönetim politikası ile zararların azaltmak mümkün olabilir. Yangın yönetimi, yangına bağlı riskleri yönetmek için sistematik analiz, planlama, karar verme, erişim ve erişilebilir kaynakların koordinasyonu içeren bir dizi faaliyet olarak tanımlanabilir. Yangın riski yönetim politikası; önleme, hazırlık, tepki ve iyileşmeden oluşur. Son zamanlarda hızla gelişen coğrafi bilgi teknolojileri yangın yönetiminde sıkça kullanılmaktadır. Coğrafi bilgi sistemlerinin (CBS) gelişmesiyle mekânsal bilgi üzerinde oluşturulan uygulamalarla üretken sonuçların elde edilmesi mümkündür. CBS kapsamı veriyi inceleyebilmesi ve mekânsal sorunlara çözüm getirilmesi konusundaki potansiyeli sayesinde kentsel alanlarda meydana gelen yangın konusunda oldukça faydalıdır. CBS’nin kurulmasının maliyet fayda analizi, kentsel yangının bir sonucu olarak ortaya çıkan ekonomik kayıplara yüzleşirildiğinde, CBS üzerinde bir sistemin kurulması ve yönetilmesinin daha ekonomik olduğunu açıklar. Bu çalışmada, İstanbul’un en kalabalık ilçelerinden biri olan Fatih ilçesi yangının miktarına ve yerine göre incelemiştir. İlk olarak, kamu kurumlarından toplanan veriler mekânsal olarak haritalanmış ve enterpolasyon haritaları oluşturulmuştur. İkinci olarak, mevcut yangın cevap istasyonlarının servis alanları analiz edilmiştir. Sonuç olarak, edinilen veri kümesi birlikte yorumlanmıştır ve gelecek yönelik öneri ve değerlendirilmeler yapılmıştır.

Anahtar Kelimeler: Yangın, Coğrafi Bilgi Sistemleri, Fatih
1. INTRODUCTION

Today, damages because of disasters on human life, property and environment may arise in very large sizes. For this reasons studies on disaster management systems continue to increase rapidly in developed countries and developing countries. Disaster management can not only be done during a disaster or should not be limited to the intervention to be carried out afterwards. Preparedness and precautions before disasters occur are also very important to reduce risks and loses. When we look at the modern disaster management model, "risk reduction" and "preparedness" cycle are seen as the most important stages.

In modern disaster management system, prevention activities such as Loss Reduction, Preparation, Prediction and Early Warning, considered as risk management. Impact Analysis, Intervention, Post-disaster remediation considered as crisis management. Where risk management is neglected, crisis management can not be successful [1].

The way to minimize the negative effects of fire only be possible with early rescue movements. It includes fire fighting, planning, coordination, analysis and decision making processes. However, the most important issue in the fight against fire is the prevention of fire incidents and the precautions. It focuses on fire fighting investigations, station locations and transportation problems. Firefighting stations' locations and accessibility problems are issues to be addressed within the scope of the intervention [2].

The main goal of the fire services in urban areas is to keep safe life, property, and natural resources from fire and other emergencies. As demands raise, the fire service needs to apply the better tools, techniques, and training methods to answer public expectations. For this reason, it is highly important of site selection and number of fire station facilities. Fire station mostly located in a historical evolution of a city. Accessibility, coverage area, the size of plot, population, the directions of city expansion are the main criteria for selecting fire station location [3]. There many studies in literature focuses on how to select location on fire stations [4-11].

Emergency services such as fire systems have to offer a high level of service for the public safety. These services, usually carried out by vehicles sent from fixed places. Since reaching the people who need the service is main aim the duration is vital. So the location planning of fire
stations are very important [12].

Risk management, preparedness, and mitigation have taken on new significance with confrontation facing the fire service today. Efficient reaction cannot be continually accomplished without sufficient planning and preparedness. One of the useful tools that is assisting the fire service optimize its emergency services performance is geographic information system technology. GIS (geographic information system) supports planning, preparedness, mitigation, response, and incident management. GIS broaden the potential of intelligent and interactive maps with access to all types of information, analysis, and data. More critical, GIS supplies the demanded information when, where, and how it is wanted [13-14].

In general, the fire is an uncontrolled exothermic chemical reaction between flammable substances in the natural environment and air. Development of technology while making people's daily lives easier, the urban area is enriched with organic materials with different properties. It increase the presence of flammable and combustible material (LPG, Gasoline, Paper, Plastic, Electronics, Goods, etc.) in the living spaces. Especially increasing number of multi-storey buildings in urban areas the concept of fire become more important to secure of life and property [15].

In general, fire causes substantial losses that can be decreased by taking proper masure promoted by sophisticated systems maintained by information technologies. To decrease the damaging effects of fires, fire risk management is a essential element for decission makers such as local governments and municipalities which is connected with fire policy. To this end, geographical information systems (GIS) via effective spatial data storage and query can composee fire maps [16].

In the scope of this article, the Fatih District of Istanbul in Turkey was selected as the pilot area for the constitution of a sample fire database based on GIS and as the basis of sample spatial queries in support of fire management. Firstly, the fire records of the Fatih district for the year 2016 were obtained and examined. After that, related fire data were implicated into a computer environment as a GIS supported database. Lastly, the data in the database was visualized, analyzed and queried. Specifically, an network analysis for service areas of fire stations which located in the Fatih district was carried out, and the related needs were specified.
2. MATERIAL AND METHOD

2.1. Study Area

Selected study area Fatih subprovince of Istanbul is located in the centre of the Istanbul. Eyüp district in the north, the Golden Horn in the northeast, Marmara Sea in the south, Zeytinburnu in the west and Bayrampasa district in the northwest are the neighboring areas of the Fatih. The Fatih subprovince consists of 57 districts.

![Map of the study area](image-url)

**Figure 1.** Geographic Location of the Study Area

The Fatih district is one of the relatively less populated subprovince as it is the central business area of Istanbul. While the population of the subprovince decreased from 2006 until 2016, the increasing course is observed as of 2017.
Figure 2. Population Change of Fatih Subprovince [17]

According to 2017 census, the most populated neighborhoods are Seyyid Ömer, Akşemsettin, Hırka-i Şerif, Şehremeni, Kocamustafapaşa, Mevlanakapı, Dervişali, Molla Gürani, Yavuz Sultan Selim, Ayvansaray and the least populated neighbourhoods are Sarıdemir, Tahtakale, Rüstempaşa, Sururi, Mercan, Hobyar, Beyazıt, Taya Hatun, Molla Ferari, Balabanağa, Mesihpaşa, Demirtaş, Yavuzsinan, Hocapassa and Mimar Kemalettin.

Table 1. Population of Neighbourhoods

| Neighbourhood Name | Population | Neighbourhood Name | Population | Neighbourhood Name | Population | Neighbourhood Name | Population | Neighbourhood Name | Population |
|--------------------|------------|--------------------|------------|--------------------|------------|--------------------|------------|--------------------|------------|
| Seyyid Ömer Mah.  | 26,773     | Şümbül Elendi Mah.  | 17,016     | Çerahişpaşa Mah.    | 9,147      | Molla Hürev Mah.   | 1,301      | Demirtaş Mah.      | 242        |
| Akşemsettin Mah.  | 24,856     | Silivrikapı Mah.    | 16,823     | Cibalı Mah.        | 8,057      | Ernin Sinun Mah.   | 1,225      | Mesihpaşa Mah.     | 206        |
| Hırka-İ Şerif Mah. | 24,649     | İskenderpaşa Mah.   | 16,686     | Nişanca Mah.       | 6,866      | Mirar Hâyettin Mah.| 888        | Balabanağa Mah.    | 146        |
| Şehremeni Mah.    | 22,028     | Atikali Mah.        | 15,133     | Katip Kasım Mah.   | 3,069      | Sultan Ahmet Mah.  | 783        | Molla Fenari Mah.  | 135        |
| Koca Mustafapaşa Mah. | 21,851 | Zeyrek Mah.        | 14,769     | Küçük Ayasofya Mah.| 2,594      | Sülçümuhiye Mah.   | 709        | Taya Hatun Mah.    | 131        |
| Mevlanakapı Mah.  | 20,470     | Balat Mah.         | 13,802     | Mahsiye Hatun Mah. | 2,576      | Hoca Gıyasettin Mah.| 697       | Beyazıt Mah.       | 114        |
| Derviş Ali Mah.  | 18,632     | Aksaray Mah.       | 11,758     | Şehsusar Bey Mah.  | 2,557      | Kemâlpaşa Mah.     | 618        | Hobyar Mah.        | 82         |
| Molla Gürani Mah. | 18,296     | Karagümürük Mah.   | 11,640     | Cankurtaran Mah.   | 1,909      | Akendar Mah.       | 488        | Mercan Mah.        | 48         |
| Yavuz Sultan Selim Mah. | 18,294 | Topkapı Mah.       | 11,429     | Saraz İskik Mah.   | 1,700      | Hacı Kadın Mah.    | 414        | Sururi Mah.        | 30         |
| Ayvansaray Mah.  | 17,777     | Haseki Sultan Mah.  | 11,377     | Kalenderhane Mah.  | 1,673      | Mirar Kemalettin Mah.| 411      | Rüstempaşa Mah.    | 25         |
| Yedikule Mah.    | 17,399     | Ali Kuçu Mah.      | 11,253     | Binbirdirek Mah.   | 1,671      | Hocapasa Mah.      | 360        | Tahtakale Mah.     | 24         |
|                   |            |                    |            |                    |            | Yavuz Sultan Mah.  | 252        | Sarıdemir Mah.     | 14         |
2.2. Data

The data of number of fire incidents by neighbourhood level obtained from Istanbul Fire Department for year of 2016. The data is shown on table 1. When the table is examined, it is seen that the most fire occur for 2016 is realized in Aksaray neighbourhood with amount of 99. After Aksaray neighbourhood Kocamustafapaşa, Atikali, Aksamsettin, Mollagüranı, Karagümrük, Şehremini and Yavuz Sultan Selim are other neighbourhoods more fire counts.

| Neighborhood      | Count | Neighborhood      | Count | Neighborhood      | Count |
|-------------------|-------|-------------------|-------|-------------------|-------|
| Aksaray           | 99    | Beyazıt           | 8     | Hobyar            | 17    |
| Aksamsettin       | 39    | Binbirdirek       | 1     | Hoca Gıyasettin   | 28    |
| Alemdar           | 18    | Cankurtaran       | 20    | Hocapaşa          | 7     |
| Ali Derviş        | 22    | Çeraflapaşa       | 28    | İskenderpaşa      | 75    |
| Ali Kuşçu         | 12    | Cibali            | 15    | Kalenderhane      | 10    |
| Atikali           | 48    | Demirtaş          | 25    | Karagümrük        | 33    |
| Ayvansaray        | 6     | Emin Sinan        | 5     | Katip Kasım       | 16    |
| Balabanağa        | 33    | Haci Kadın        | 15    | Kemalpaşa         | 19    |
| Balat             | 4     | Haseki Sultan     | 29    | Koca Mustafa Paşa | 52    |
| Küçük Ayasofya    | 12    | Muhsine Hatun     | 12    | Süleymaniye       | 7     |
| Mercan            | 5     | Nişanca           | 20    | Sümülb Efendi     | 10    |
| Mesihpaşa         | 8     | Rüstempaşa        | 11    | Şehremini         | 36    |
| Mevlanaçapı       | 31    | Saraç Işhak      | 14    | Şehsuvar Bey      | 3     |
| Mimar Hayrettin   | 17    | Sarıdemir         | 1     | Tahtakale         | 7     |
| Mimar Kemalettin  | 9     | Seyyid Ömer      | 34    | Tağa Hatun        | 1     |
| Molla Fenari      | 13    | Silivrikapı       | 32    | Topkapı           | 27    |
| Molla Gürani      | 39    | Sultanahmet       | 8     | Yavuz Sinan       | 8     |
| Molla Hüsrev       | 11    | Sururi            | 2     | Yavuz Sultan Selim| 33    |

Figure 4 shows number of fire incidents by neighbourhood. As seen from the figure, especially central district of the study area are relatively most populated by fire incidents.
2.3. Methodology

The Fatih District of Istanbul City in Turkey was chosen as the pilot area and the records related with fire fighting and prevention kept by the administration of Istanbul municipality were the main data source for this study. In the urban information system that was created through an Arcgis program by Esri and some Open Street Maps and other Open sources are used (Figure 1). First the fire records were included in a spatial database. With this study, in the first step, through a specially developed interface all the existing fire records for the year 2016 from fire authority records were added to the database. Fire counts by neighborhood centers at that year is included in this information. In the second step, fire address records were matched with the neighborhood centers in database. The number of fires distributed very diversely at different neighborhoods (Table 2, Figure 3). After that by using kriging interpolation technic fire incident density created for study area (Figure 4). The map shows number of incidents by using 30*30 meters size pixels. Using kriging interpolation method it can be more obvious where is the most risky and where is the less risky area. After creating interpolated fire incident map, the exact location of fire stations in study area have defined (Figure 5). Service areas of each fire station visualized thanks to network analysis function of geographic information system. 500 meters, 1000 meters and 2000 meters service area for each fire station obtained by using Open Street Map road network by using this methodology (Figure 6,7,8,9).
2.3.1. Mapping Fire Incidents in Fatih Subprovince

Figure 4. Fire Incident Density of Fatih Subprovince

2.3.2. Service Areas of Fire Response Stations in Fatih Subprovince

Figure 5. Location of Fire Response Stations in Fatih Subprovince
Figure 6. 500 Meters Service Area of Fire Response Stations

Figure 7. 1000 Meters Service Area of Fire Response Stations
Figure 8. 2000 Meters Service Area of Fire Response Stations

Figure 9. Historic Civil Building and Service Areas of Fire Stations
2. RESULTS AND DISCUSSION

Analysis of accessibility to fire in shortest time access to a fire incident and making an intervention in the shortest time has the great importance for extinguishing a fire.

In this study, the service areas that fire truck can reach according to certain lengths determined. The speed of fire truck did not used in the analysis, Instead the distance of fire site to the fire station were examined. The areas to be accessed in 500m, 1000m, 2000m, 3000m were determined. It was discovered that in particular, In the south of the district, territories between Kocamustafapasa and Yenikapı and in the North of the district Ayvansaray has the most serious risk in terms of the lack of rapid accessibility to the fire location.

If we consider that the damages that the cultural assets that are to be protected must suffer in the fire are irreversible, especially Ayvansaray district is quite vulnerable.

3. CONCLUSION

In the scope of this study, the fires occurred in Fatih District of Istanbul were recorded according to numbering system and on neighbourhood center basis in a GIS database. In addition, it is possible to facilitate a more developed analysis by associating the fire site database with the
building and cadastral parcel database in further studies. There are missing informations in the existing records of fire reports, such as exact locations and address, however, these errors can be reduced to a minimum proper using of the prepared interface. Furthermore, it has also been observed that a standard for spatial and attribute data with respect to fire records has not been developed. It has been monitored that the measures required has not been taken especially in the intensive fire areas found at the end of GIS analysis although it is evident from fire records that the intensity of fires in these regions are high.

A small fire station can be built in the vicinity of area where fires are considered to be intensive in the south of the district, territories between Kocamustafapasa, Ayvansaray and Yenikapi for effective fire fighting.

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