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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 olmaktadır. Yangın olaylarını tamamen önlemek mümkün olmasa da, uygun yangın yönetim politikası ile zararlarını azaltmak mümkün olabilir. Yangın yönetimi, yangına bağlı riskleri yönetmek için sistematik analiz, planlama, karar verme, erişim ve erişilebilir kaynakların koordinasyonunu 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 uygulamalarda üretken sonuçların elde edilmesi mümkündür. CBS kapsamlı 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 kayıplarla yüzleştirildiğinde, CBS üzerinde bir sistemin kurulması ve yönetilmesinin daha ekonomik olduğu açıktır. Bu çalışmada, İstanbul'un en kalabalık ilçelerinden biri olan Fatih ilçesi yangının miktarına ve yerine göre incelenmiştir. 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 yorumlanmış ve gelecek yönelik öneri ve değerlendirmeler yapılmıştır.

Anahtar Kelimeler: *Yangın, Coğrafi Bilgi Sistemleri, Fatih*

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1. INTRODUCTION

Today, damages because of diseasters 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 ocur 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 facilites. 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 fort 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

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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 accompolished 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 masures 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.

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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.

Figure 1. Geographic Location of the Study Area

The Fatih district is one of the relatively less populated subprovincce 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.

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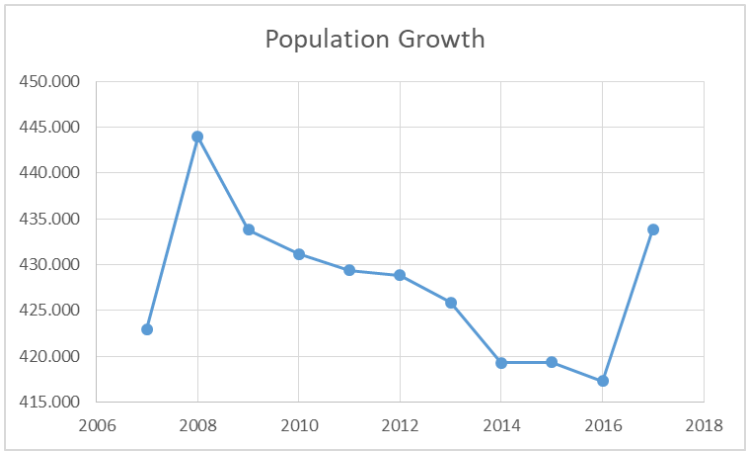

Figure 2. Population Change of Fatih Subprovince [17]

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

Table 1. Population of Neigbourhoods

Neigbourhood Name	Population	Neigbourhood Name	Population	Neigbourhood Name	Population	Neigbourhood Name	Population	Neigbourhood Name	Population
Seyyid Ömer Mah.	26.773	Sümbül Efendi Mah.	17.016	Cerrahpaşa Mah.	9.147	Molla Hüsrev Mah.	1.301	Demirtaş Mah.	242
Akşemsettin Mah.	24.856	Silivrikapı Mah.	16.823	Cibali Mah.	8.057	Emin Sinan Mah.	1.225	Mesihpaşa Mah.	206
Hırka-İ Şerif Mah.	24.649	İskenderpaşa Mah.	16.686	Nişanca Mah.	6.866	Mimar Hayrettin Mah.	888	Balabanağa Mah.	146
Şehremini 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	Süleymaniye Mah.	709	Taya Hatun Mah.	131
Mevlanakapı Mah.	20.470	Balat Mah.	13.802	Muhsine Hatun Mah.	2.576	Hoca Gıyasettin Mah.	697	Beyazıt Mah.	114
Derviş Ali Mah.	18.632	Aksaray Mah.	11.758	Şehsuvar Bey Mah.	2.557	Kemalpaşa Mah.	618	Hobyar Mah.	82
Molla Gürani Mah.	18.296	Karagümrük Mah.	11.640	Cankurtaran Mah.	1.909	Alemdar Mah.	488	Mercan Mah.	48
Yavuz Sultan Selim Mah.	18.294	Topkapı Mah.	11.429	Saraç İshak Mah.	1.700	Hacı Kadın Mah.	414	Sururi Mah.	30
Ayvansaray Mah.	17.777	Haseki Sultan Mah.	11.377	Kalenderhane Mah.	1.673	Mimar Kemalettin Mah.	411	Rüstempaşa Mah.	25
Yedikule Mah.	17.399	Ali Kuşçu Mah.	11.253	Binbirdirek Mah.	1.671	Hocapaşa Mah.	360	Tahtakale Mah.	24
						Yavuz Sinan Mah.	252	Sarıdemir Mah.	14

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2.2. Data

The data of number of fire incidents by neigbourhood 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 neigbourhood with amount of 99. After Aksaray neigbourhood Kocamustafapaşa, Atikali, Akşemsettin, Mollagürani, Karagümrük, Şehremini and Yavuz Sultan Selim are other neigbourhoods more fire counts.

Table 2. Amount of Fire Incidents in Neigbourhood Level in Fatih Subprovince

Neıghborhood	Count	Neıghborhood	Count	Neıghborhood	Count
Aksaray	99	Beyazıt	8	Hobyar	17
Akşemseddin	39	Binbirdirek	1	Hoca Gıyasettin	28
Alemdar	18	Cankurtaran	20	Hocapaşa	7
Ali Derviş	22	Cerrahpaşa	28	İskenderpaşa	73
Ali Kuşçu	12	Cibali	15	Kalenderhane	10
Atikali	48	Demirtaş	25	Karagümrük	33
Ayvansaray	6	Emin Sinan	5	Katip Kasım	16
Balabanağa	33	Hacı 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	Sümbül Efendi	10
Mesihpaşa	8	Rüstempaşa	11	Şehremini	36
Mevlanakapı	31	Saraç İshak	14	Şehsuvar Bey	3
Mimar Hayrettin	17	Sarıdemir	1	Tahtakale	7
Mimar Kemalettin	9	Seyyid Ömer	34	Taya 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 neigbourhood. As seen from the figure, especially central district of the study area are relatively most populated by fire incidents.

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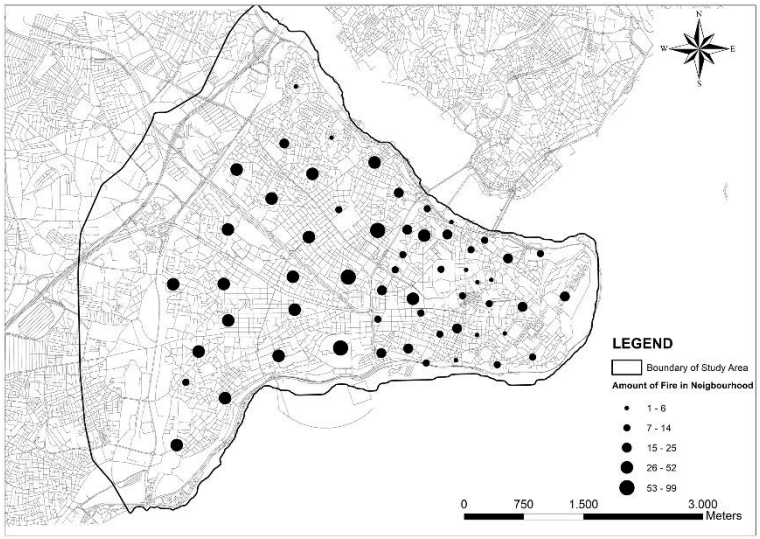

Figure 3. Amount of Fire Incidents in Neigbourhood Level in Fatih Subprovince

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 a 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).

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2.3.1. Mapping Fire Incidents in Fatih Subprovince

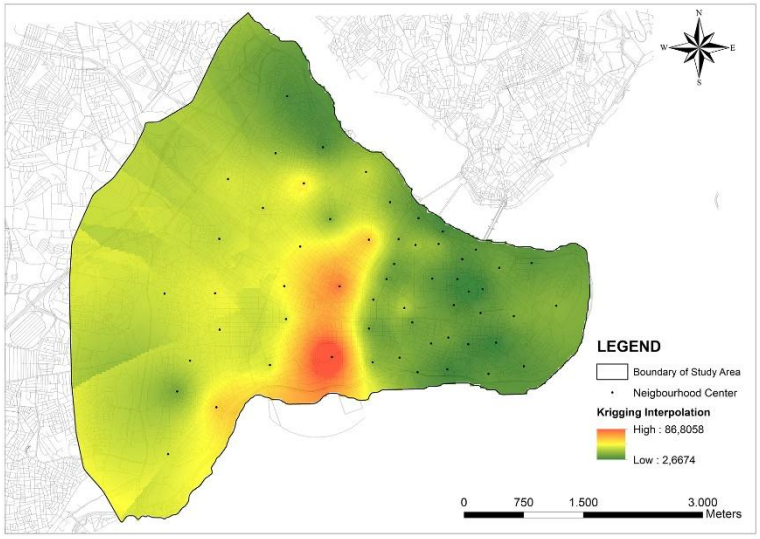

Figure 4. Fire Incident Density of Fatih Subprovince

2.3.2. Service Areas of Fire Response Stations in Fatih Subprovince

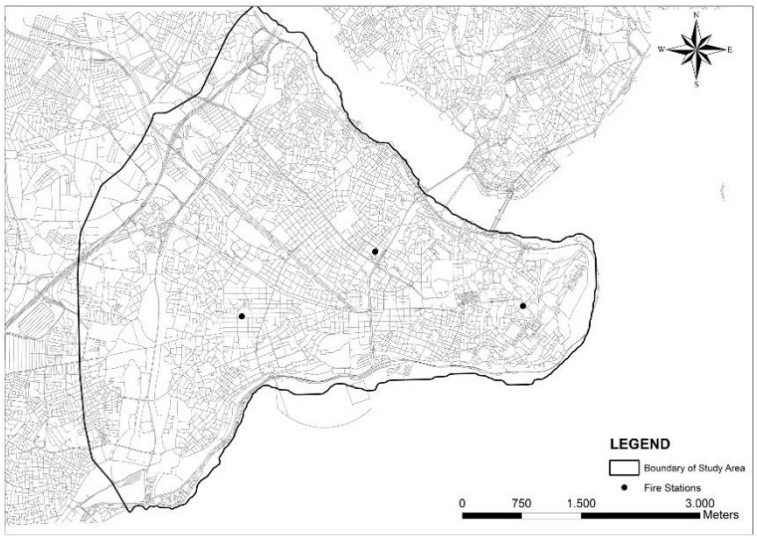

Figure 5. Location of Fire Response Stations in Fatih Subprovince

DOI: 10.34186/klujes.476239 *Geliş Tarihi:30.10.2018 Kabul Tarihi:30.12.2019*

Figure 6. 500 Meters Service Area of Fire Response Stations

Figure 7. 1000 Meters Service Area of Fire Response Stations

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Figure 8. 2000 Meters Service Area of Fire Response Stations

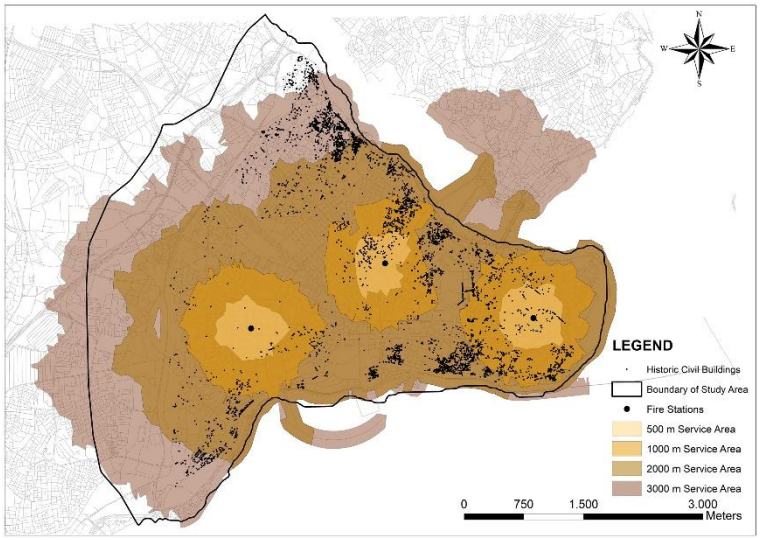

Figure 9. Historic Civil Building and Service Areas of Fire Stations

DOI: 10.34186/klujes.476239 *Geliş Tarihi:30.10.2018 Kabul Tarihi:30.12.2019*

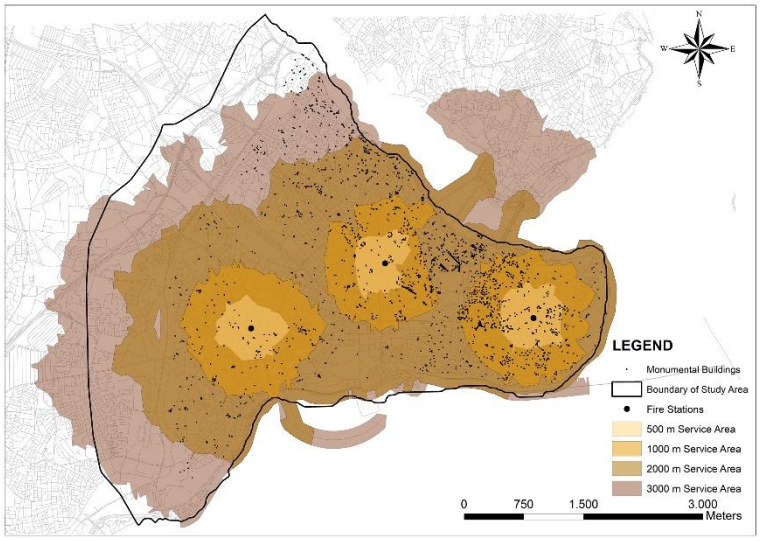

Figure 10. Monumental Buildings and Service Areas of Fire Stations

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 lenghts 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 vulnarable.

3. CONCLUSION

In the scope of this study, the fires occured 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

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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 Yenikapı for effective fire fighting.

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