

# **Determination of Fire Station Coverage Area Using Response Time Approach: A Case Study of Samsun**

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## **SUMMARY**

Fire and rescue stations play a key role in fire management. An early and aggressive primary attack will save more properties and lives in fire and rescue cases. A critical component in the control and mitigation of a fire incident is response time which includes travel time. Travel time is one of the most important elements of the response time and it is affected by various factors; such as traffic volume, road networks, time of day, driver habits, and the location of the incident. The strategic locations of fire stations are of paramount importance in achieving a minimal travel time. In this study, existing sites of fire stations in Samsun city were evaluated according to the location of emergency calls and the 5, 10, 15 minutes response time coverage area using the Geographic Information System (GIS) network analysis

## 1. INTRODUCTION

Flame, among the most important things discovered by humankind, is still one of the most important factors in our lives. Fire, appearing in our lives with flames and being described as big fire which causes harm, is an important potential danger (URL1). As a potential danger, the risk of fire has increased in parallel with changing living conditions. Humankind has first met with natural fires. With developing technology, fire has gained various dimensions. Right along with house fires, industrial facility fires, forest fires, means of transport fires depending on electrical, mechanical or chemical factors arising from increasing population and usage of different energy types; fire outbreaks occur because of substances like LPG, natural gas and nuclear substances as well.

When the number of fires which occurred in Turkey between 1922-2008 is examined, a general increase has been observed. Population increase and energy consumption have a direct effect on increasing fire numbers. While the number of fires occurring in our country was around 20.000 in 1988, this number approached 100.000 in 2008. Therefore, while loss of lives caused by fire was around 200 people per year in 1997, this number increased to 400 people in 2008 (Bekem, at al. 2011). According to data declared by Disaster and Emergency Management Presidency, %30 of the fires occurring in nationwide has resulted from factors caused by cigarette, %19 by the factors caused by electrical wiring and %14 by the factors caused by heating system like funnel, stove and heater (Bekem, at al. 2011).

For disaster, accident, illness, fire and any similar occasions requiring emergency action, the arrival time to the region and one who is in need of service is very critical in terms of safety of life and property. Efficient planning of emergency action services not only decreases the disability and mortality rate, but also facilitates to prevent economic losses (Çatay 2011). As all other emergency cases, response to fires whose first aim is preventing loss of lives and recovering the loss with minimum harm is carried out by fire stations. Examining the locations of current fire stations in parallel with population exchanges and settlement movements or determining the exact locations in the case of opening new fire stations will reduce the response time at any possible emergency call case and accordingly reduce the loss of life and property (Challands, at al. 2010). Although numerous studies related with medical first aid incidents about emergency response exist, limited number of studies is available on the subject of response to fires and locations of fire stations.

In consequence of examining the locations of fire stations by questioning and analyzing capabilities of Geographic Information Systems regarding to fire and rescue incidents occurring in service area, forming a more effective fire emergency response system should be aimed. In this study, cases which are recorded for 2013 at monthly statistic tables arranged by Samsun Metropolitan Municipality Department of Fire Brigade are examined. These cases are classified cases in groups such as fire, rescuing, response to road accident and water supply. Feature data belonging to responded cases are transferred from statistic tables to data base. In addition to this, so as to perform location analysis from these data, address details of responded fires are processed to Samsun map in ArcGIS software and associated with their features. Also, with the service area analysis, response capabilities of fire stations to cases at a particular time are examined.

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## 2. RESPONSE TIME

As all other emergency cases; in fire and rescue cases, “conscious” first response to be done as early and fast as possible is the most effective method to prevent loss of life and property (NFPA, 2010). This time frame named as “response time” in technical literature is crucial in emergency cases. In medical cases, along with different approaches to the response time, it is defined in various studies that, basically, during danger of a heart attack or respiratory tract diseases therapy, the first 4-8 minutes are important. While Peleg, et al. (2004) defines the first response time as 8 minutes, Cromley (2010) states it as 6 and 8 minutes in his study.

In studies that take part in literature as first response time in fire cases, 3 and 8 minutes time frames are defined. While Yang, et al. (2007) defines the first response time as 5-8 minutes, Habibi, et al. (2008) defines it 3-5, Challands, et al. (2010) 4-7 minutes and Catay (2011) as 8 minutes.

It is understood from these approaches that first response time is the most critical parameter to control emergency case (Hacıoğlu 2010). First response time includes the periods of taking emergency call, interpreting it, leaving the station, travel time and preparation of response time (NFPA, 2010). Except from travel time, all time frames among all of these may be managed at their best rate with well-educated and having high sense of mission staff; however, travel period depends on numerous uncontrollable factors such as case's location being in the first place, road condition, traffic volume and driver attitudes. Controlling all of these factors is impossible, but determining the fire station's location at the most proper area will facilitate to reduce travel time.

## 3. STUDY AREA

In this study, cases which occurred in 2013 in Atakum, İlkadım, Canik and Tekkeköy (Figure 1) districts which are located in Samsun city Centrum and responded by Samsun Metropolitan Municipality Department of Fire Brigade are mentioned. Cases have been recorded at monthly statistic tables by Department of Fire. In this study 1013 cases were determined listed in statistic tables. The addresses of the cases were examined and allocated in map (Table 1, Figure 2.). These cases are classified cases in groups such as fire, rescuing, response to road accident and water supply.

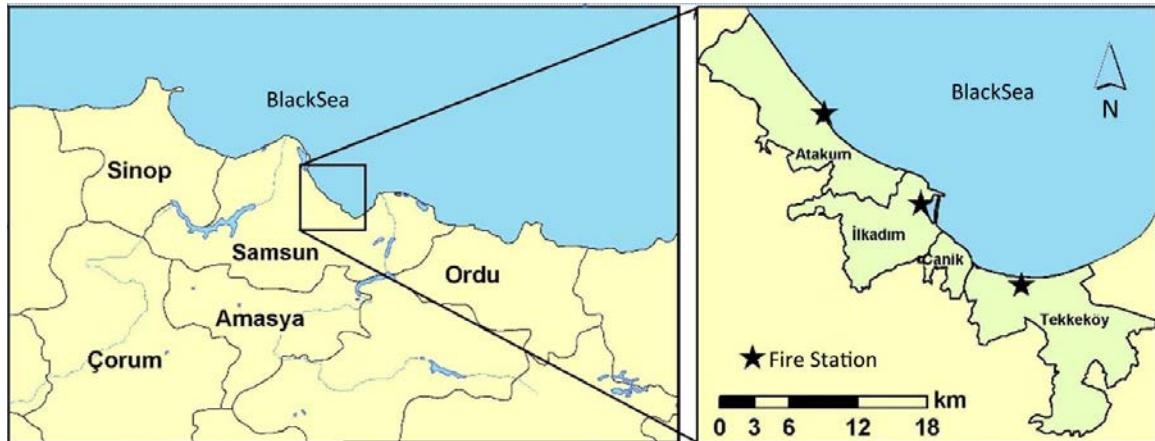


Figure 1. Study area

Reason of cases	Count
House, workplace, roof fires	338
Resque human and animals	232
Traffic accident, vehicle fires	152
Trash and weed fires	178
Precaution, water supply	85
Others	28

Table 1. Types of cases

In the first stage of study, road network belonging to working area was organized by digitizing the map which constitutes the transportation infrastructure of Samsun. While organizing road network, roads were classified as avenue, main street, street and side street, besides, different average speed is determined for each class and transferred to data base. Locations of cases which are mentioned in the study as a separate layer are indicated by digitizing on the map and feature information of all cases was provided.

#### 4. APPLICATION

Main purpose of this study was analyzing the present fire stations' response sufficiency and capability at a particular time frame according to responded cases by Samsun Metropolitan Municipality Department of Fire in 2013.

In accordance with road network map, network analysis is performed in GIS network analysis and according to determined road speeds of present three fire stations, coverage areas within 5, 8, 10 minutes' time frames which are in first response time and referred as travel time are examined by network analysis.

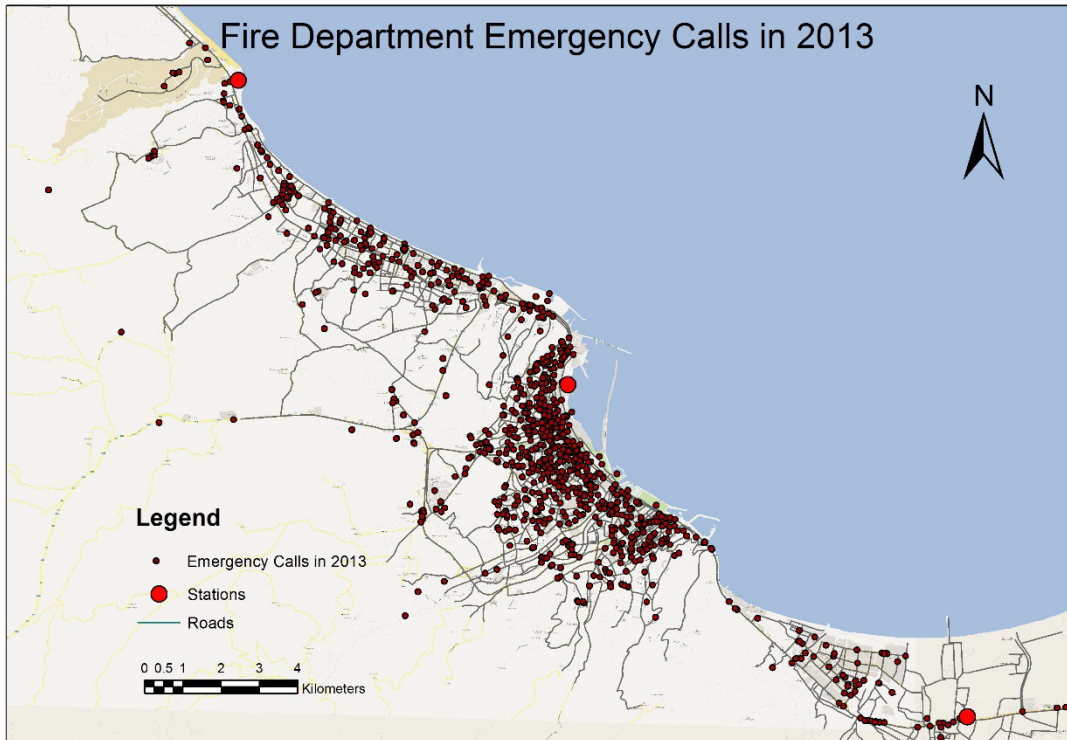


Figure 2. All of Fire Department Emergency Calls in 2013

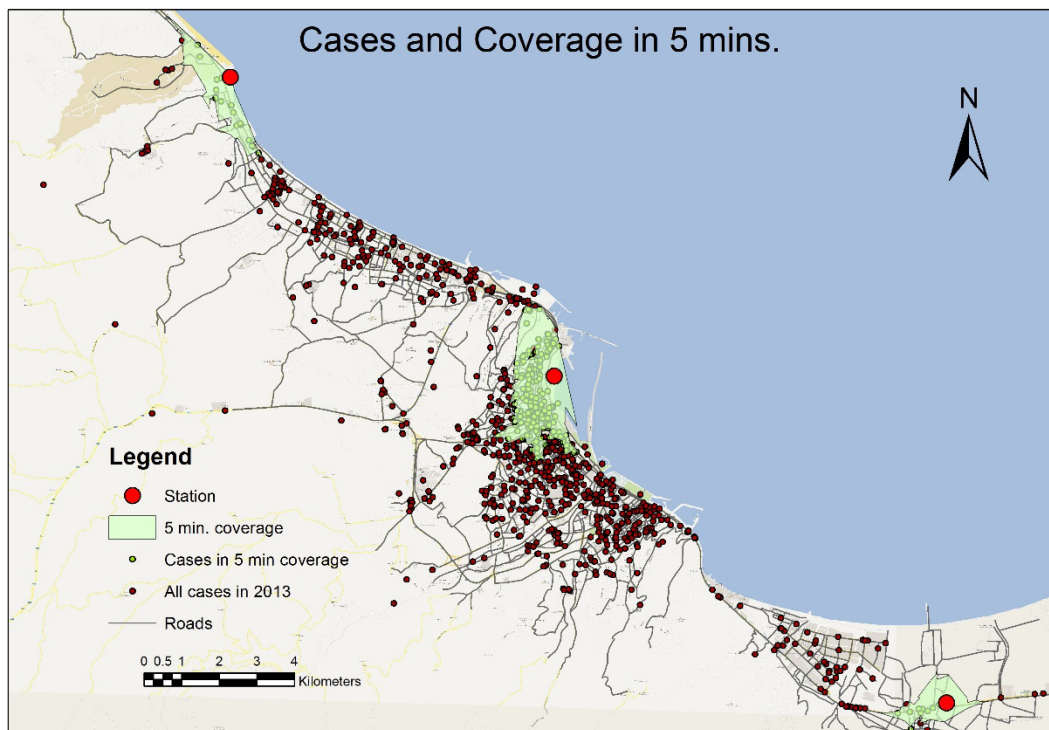


Figure 3. Coverage area of 5 minutes and cases in 5 minutes coverage area

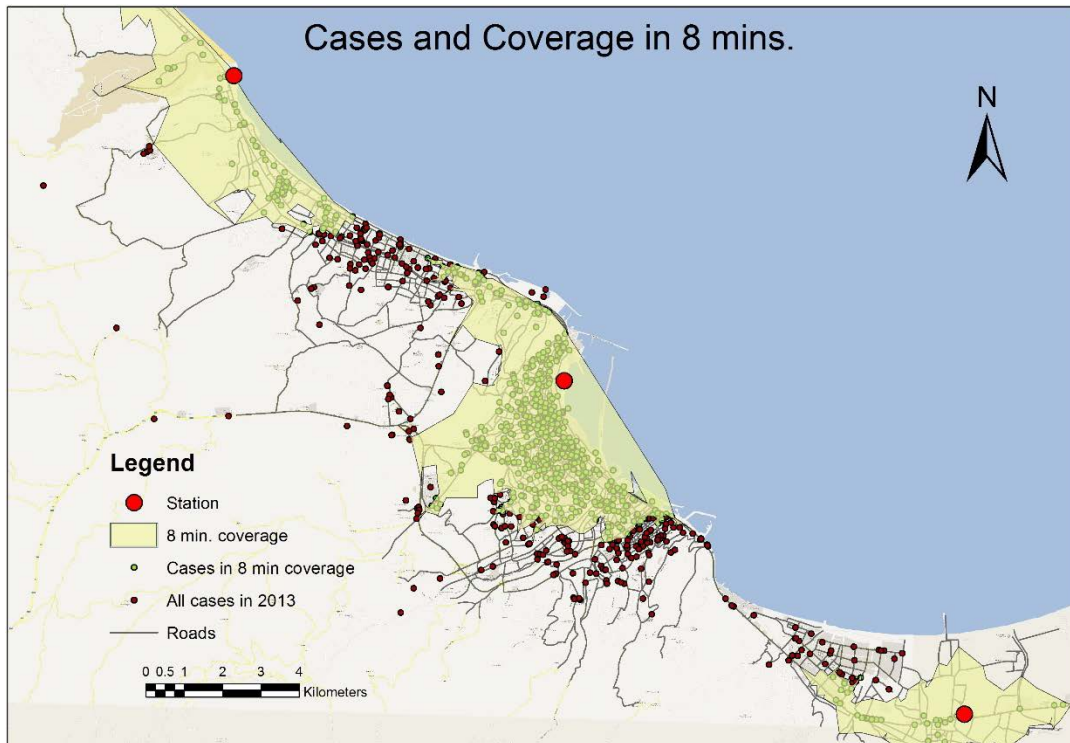


Figure 4. Coverage area of 8 minutes and cases in 8 minutes coverage area

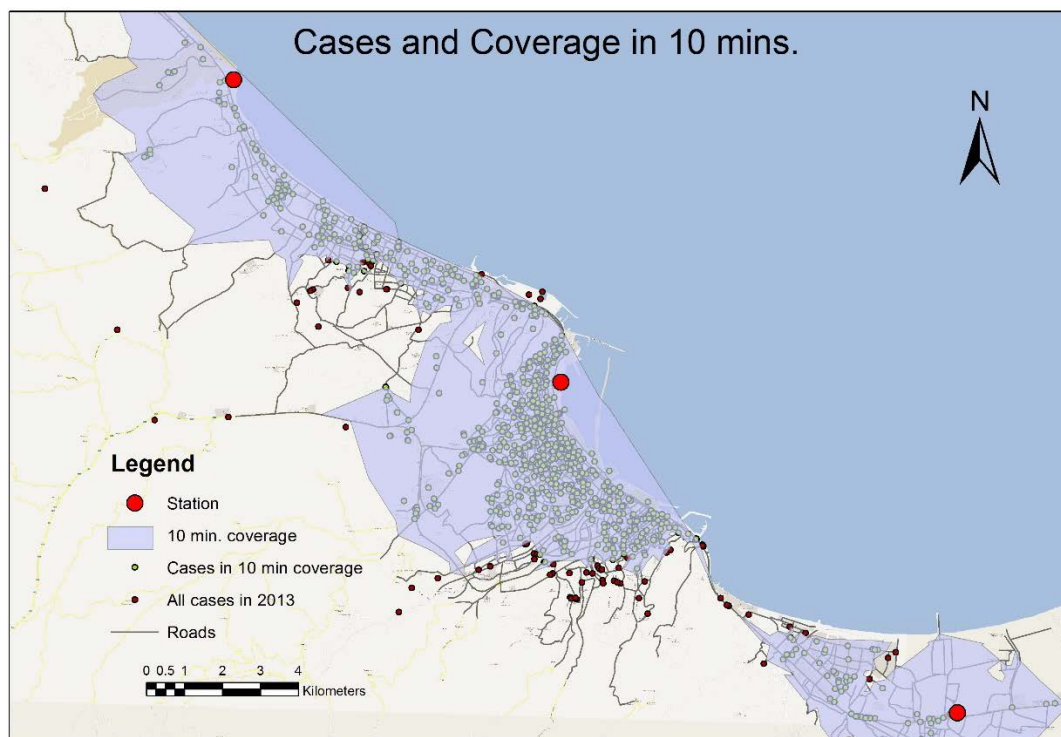


Figure 5. Coverage area of 10 minutes and cases in 10 minutes coverage area



## 5. RESULTS

As a result of examining the locations of fire station units and fire cases in 2013, it is seen that fires are become dense in İlkadım and Atakum districts and response of Department of Fire Brigade to the fires occurring in İlkadım district is sufficient due to the location of department.

An increase in number of fires should be expected in Atakum district because of growing population and settlement. For this reason, with the 5 minutes' analysis of Kurupelit platoon, Atakum district's being distant from fires in center is observed. As a consequence of this, need of movement of Kurupelit Platoon's location to the Atakum site or need of additional platoon to the Atakum district is observed.

With urban transformation projects, it is determined that in the regions that are fast growing and having increased density as Kazım Karabekir Quarter, Derebahçe Quarter, 200 Evler Quarter and Belediye Evleri, more fires are occurring and a new platoon which is close to these areas is a need.

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## BIOGRAPHICAL NOTES

I was born in 1988 in Samsun. I finished Karadeniz Technical University Geomatics Engineering in (2013). I began graduate education in Ondokuz Mayıs University Geomatics Engineering in (2013). I have been working as a research assistant in Ondokuz Mayıs University Geomatics Engineering since January 2014.

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