DETERMINING OPTIMUM AMBULANCE LOCATIONS FOR HEART ATTACK CASES WITH GIS

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ABSTRACT

Emergency Medical Services has a great importance on health sector because of its affective role on human life in response. Health care has been one of the basic human need since the beginning of the human life and if emergency medical services fails that will cause irreversible consequences. Well-defined system requirements and the organization of Emergency Medical Services must be fully established to perform their roles on time and effective way, especially in situations that require urgent intervention such as heart attack. In this context, needs and potential risk areas must be determined firstly. Relationship between disease density and location can be established by disease maps and as a consequence with specific reponse time, optimum ambulance locations can be determined to reach to the required position.

The aim of this study is to provide optimum distribution of ambulance stations without exceeding standard heart attack response time in Istanbul. In this context, existing ambulance service areas are determined with ArcGIS Network Analysis in order to understand which areas remained out of service zone. As a result, optimum ambulance stations and number of the ambulance vehicles are defined with respect to heart attack response time in İstanbul. The problems in using Emergency Medical Services resources and late responses will be decreased in this way.

1. INTRODUCTION

Needs aimed at management of health services are rised in parallel with the increase in population of the world. Work system in Emergency Medical Services (EMS) on the purpose of minimizing the loss of life have to be reorganized by means of providing maximal benefits in case of emergency considering criterias like popultaion, technology, social events and disasters (Coskun, 2007). Determining the case urgency and routing ambulance vehicle is the most important activity for EMS at the moment of taking emergency call. Response time and service quality generate the most important service parameters of EMS. In this scope, optimum location and a good few of ambulance stations must be determined to meet the demand (Blackwell and Kaufman, 2001).

Geographic Information Systems (GIS) can be used as Decision Support System for planning and managing the health services. Referencing data related to health geographically is possible with THE using of GIS (Cromley and McLafferty, 2002). Collection, storage, presentation, and analysis of geo-

based spatial and attribute data are provided in the scope of GIS and by this way a new approach to render the spatial decisions related to health has constituted for complex situations.

2. EMERGENCY MEDICAL SERVICES AND LEGISLATION IN TURKEY

Especially after the 1999 Marmara earthquake, public works to improve Emergency Medical Services are speed up in Turkey. Minestry of Health published the Regulation of Emergency Medical Services in 11.05.2000 at 24046 numbered Official Gazette to provide equal, accessible, high quality, fast and efficient emergency health services across the country. The regulation includes purpose, scope, foundation, management and administration, service units, service flow, personnel and training, communication system, archive and financing of emergency medical services with 41 articles (Official Gazette, 2000).

In Turkey, EMS is carried out by Provincial Health Directorates connected to Directorate of Basic Health Services in each province and Department of Emergency Medical Services connected to Provincial Health Directorates with coordination of Ministry of Health. Directorate of Basic Health Services is responsible management of EMS at county level. At province level EMS are controlled and coordinated by Departments of Emergency Medical Services. Management schema of province level EMS is shown at Figure 1 (URL-1, 2010).

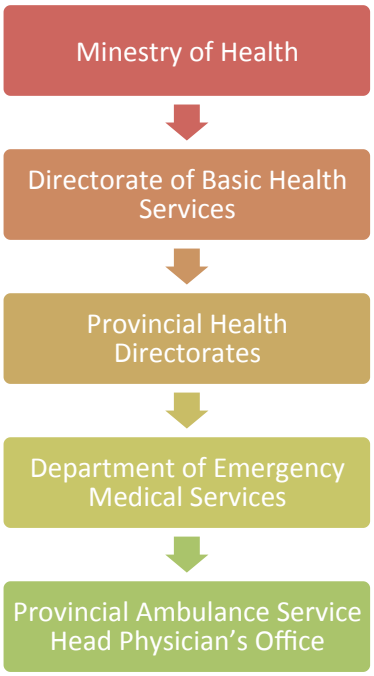

Figure 1: EMS Management in Turkey

An ambulance system comprises a range of operations starting with emergency health call, including evaluation of the call, diversion of the ambulance, meeting the demand and ends with patient transportation to the optimum health service unit (Figure 2).

Ambulance Response Time has been defined as a standart time in great number of country in the world whether studies about determining how long is the response time are going on. In the scope of this study, response time for two types of impending cases required emergency response and general emergency health cases are determined. Avarage response times obtained from studies are specified as;

2 min. Delay time + 6 min. Heart attack response time = 8 min.,

2 min. Delay time + 8 min. General health cases response time = 10 min.

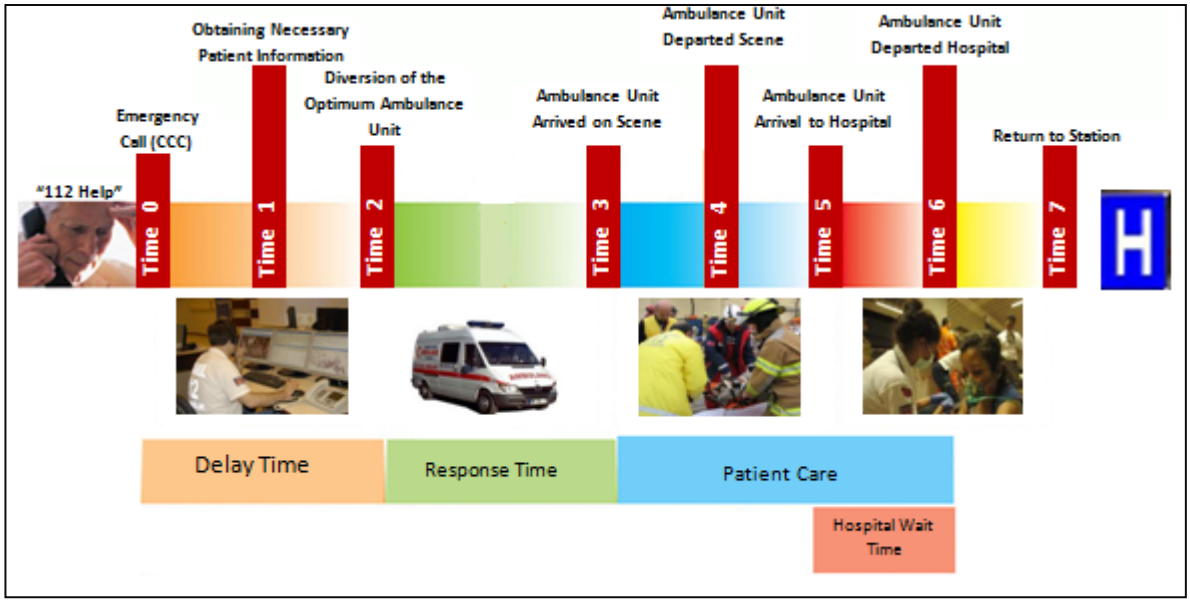

Figure 2: EMS Service Flow (adapted from URL-2, 2009)

3. CASE STUDY

Istanbul province of Turkey is selected as a pilot study area because of its different socio-demographic structure and the high population. The city of Istanbul has large transportation and traffic problems with dense urban areas containing 40 municipalities and the crowded population. In this context, access to emergency services in the most optimal time and search for a solution has become an important requirement.

Geographic data used in the scope of study are composed of 4 different groups (Figure 3); Health (SA), Administrative Unit (IB), Transportation (UL), and Land Cover (AO). Administrative boundaries of study area (province, county, district), road network, locations of existing ambulance stations, population and acute mycardial infarction (AMI) patient data are the basis of database design. According to database design, IB, UL, AO, and SA datasets are produced and integrated in the databases.

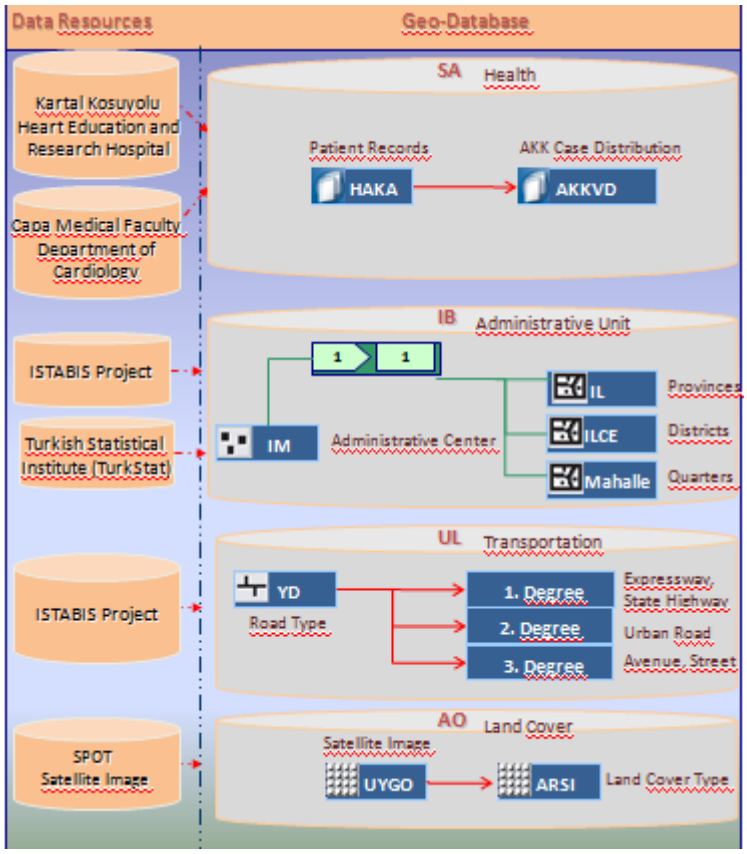

Figure 3: Geo-Database design (adapted from Aydinoglu, 2009).

According to Regulation of Emergency Medical Services Article Number 11, to determine ambulance station location criterias listed below must be taken into account (Official Gazette, 2000);

a) Target population planning to serve (will be maximum 50 000),

b) Difficulties in transportation,

c) The frequency of events requiring emergency service,

d) The number of traffic and work accidents and the frequency of similar events.

In this study, final distribution of ambulance stations provide an ambulance for every 50 000 people in built-up areas with respect to the Regulation of Emergency Medical Services. Events requiring emergency assistance are taken into account with the density of the Heart Attack (AKK) cases. Emergency Medical Services are located close to main transportation arteries.

In the study, optimum locations of the ambulances are determined at district level. Determining ambulance locations to provide adequate service for every district is done with following steps as seen on Figure 4;

1) Regions that have high number of AKK cases and not accessible in 6-minute response time are determined within urban areas obtained from land cover image data.

2) Three types of editing process are performed to serve regions that have high number of AKK cases and not accessible in 6-minute response time. Some existing ambulance stations are removed, some of ambulance locations are changed or new ambulance locations are recommended. In this scope, ambulance locations that are within the health services like hospitals are definite. Location change of the existing ambulances is the prior process to provide whole service coverage for urban areas in the district. If location change is not possible, new ambulance location is recommended according to 6-minute response time, density of AKK cases and built-up areas (Figure 5).

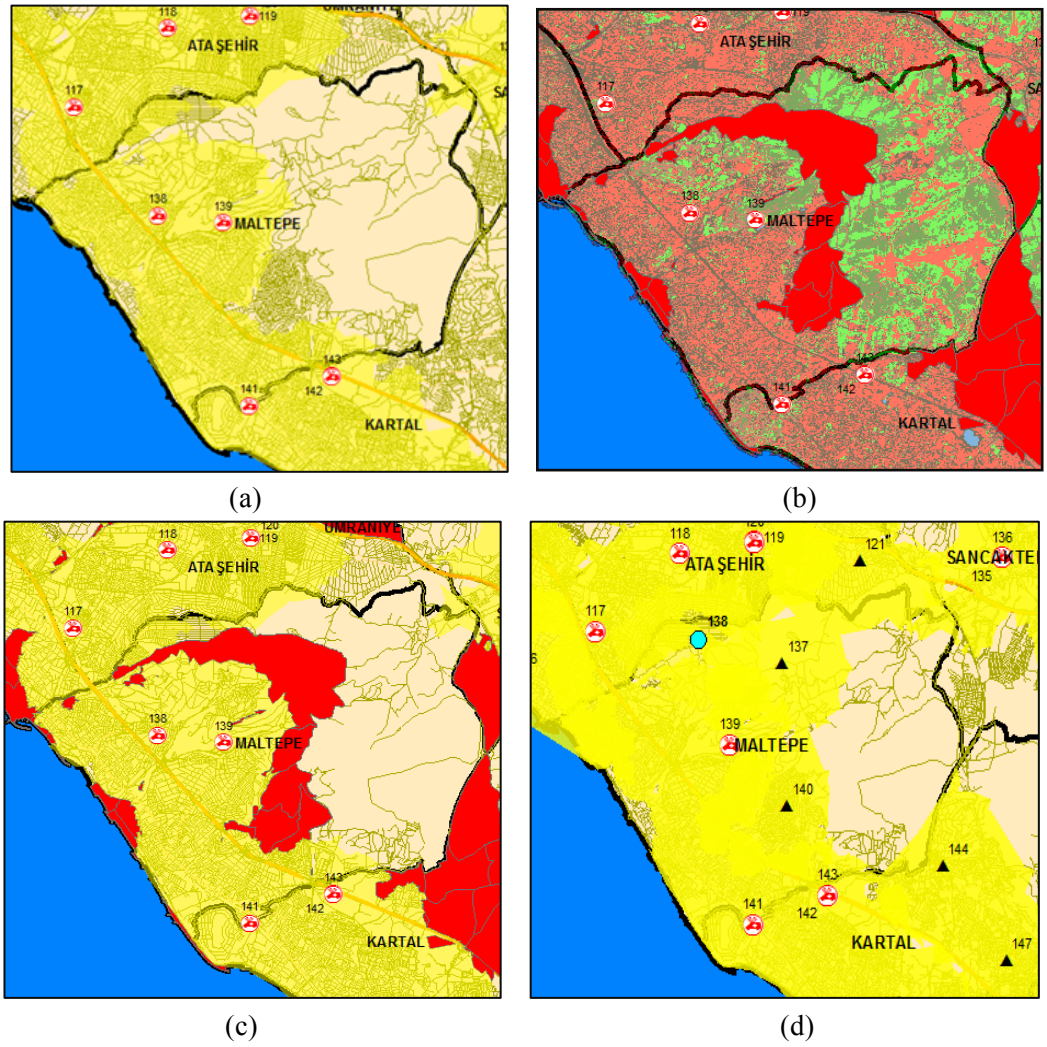

Figure 4: (a) Service area of existing ambulances, (b) Land cover of the region, (c)Non-access regions in 6-min response time, (c) New service area after distribution.

3) In the study area, number of required ambulance vehicles for all districts are determined with respect to regulation. (one ambulance for every 50 000 people)

4) As a result ambulance station distribution is determined with respect to 6-minute reponse time, built-up areas, density of AKK cases and transportation network. Ambulance vehicles of all stations are determined according to population of districts.

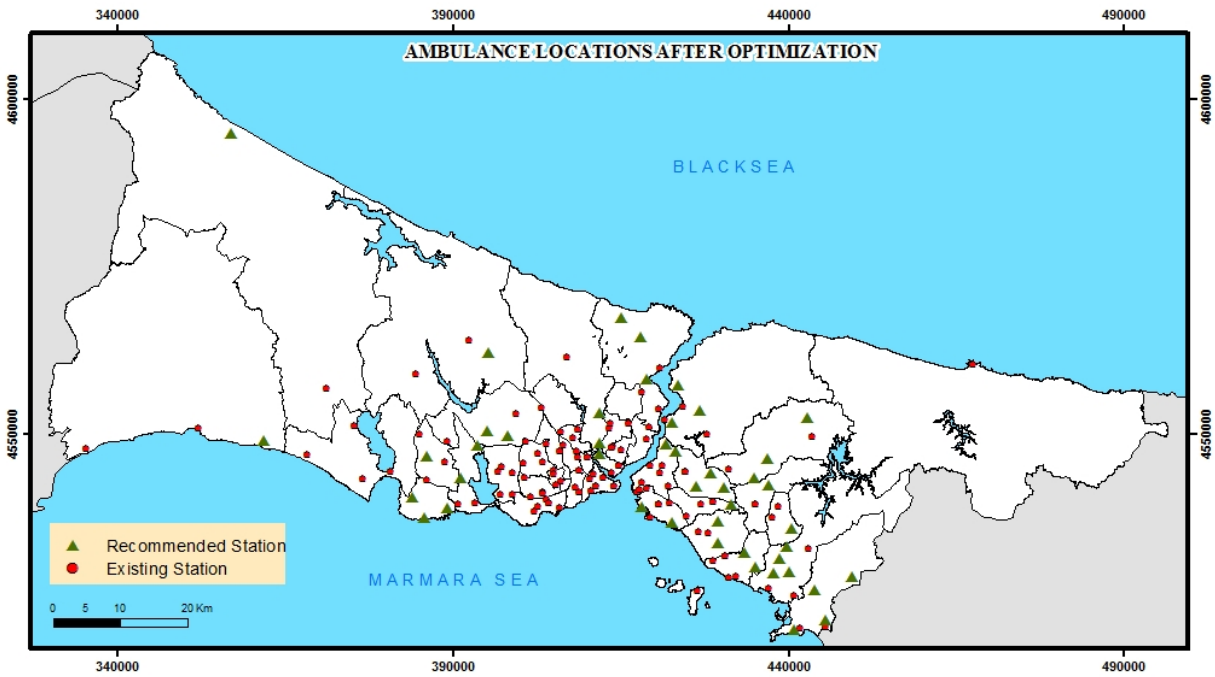

Figure 5: Ambulance locations after optimization.

4. CONCLUSIONS

As a result of optimization process, 1 station is completely removed, 4 stations locations are changed from existing 120 ambulance station and 41 new ambulance stations are recommended. In this context, the new system has 160 ambulance stations which will provide 279 new ambulance vehicles added in the scope of regulation.

As can be seen in the study, obtaining updated data is the most effective component of decision support for emergency services and other health GIS applications.Updating transportation network data continiously is important for response time, which is the most important criteria for emergency medical services, to provide real like results from analysis. It is aimed to document information for all cases of the diseases with health information system applications in Turkey. In this context, public institutions are carried out many projects, but the information representing each case with identity and address can not provided because the coordination between e-government applications has not been possible yet.

As we see in applications for emergency situations, it is required GIS based, up to date and adequate road information to represent address data spatially. A system will be installed in this context can provide more optimum solutions with Command Control Center that has up to date road data and a GPS integrated emergency call system that determine the location of the cases quickly.

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