# 論文の内容の要旨

**Development of a GIS-based Model for Spatial Distribution of Evacuation and Temporary Shelter Sites:**
**Case Study of Fatih District in Istanbul**

（地震時の避難性及び避難場所の空間配置に関する研究

－イスタンブールのファーティヒ地区の事例研究－）

セノル　バラバン　メルテム

Scientists agree that Istanbul, which is the most populous city of Turkey, will be confronted by a destructive earthquake (M≥7) in the following decades with an increasing probability of occurrence. Although there have been several attempts like renewing of master plans and retrofitting of selected public buildings after 1999, when Turkey was hit by two devastating earthquakes, there are still many actions need to be undertaken to prepare Istanbul for the upcoming earthquake. One of these actions is reconsideration of emergency management activities, evacuation scenarios and emergency shelter allocations. Currently, the Provincial Disaster and Emergency Directorate of Istanbul City asks the District Governorates to determine 'potential sites' among publicly owned lands in order to be used as 'tent shelter areas'. Even though similar attempts have been made by provincial and municipal governments across the city, the need for a comprehensive assessment of potential local areas, where local people can be organized effectively to confront the possible emergency situations, still prevails.

This study focuses on Fatih, a district in the historical core of Istanbul, as a case study area, as it is known to have high risk of earthquake losses due to highly vulnerable building stock and high population density. The main purposes of this research are to analyze the spatial distribution of possible evacuation areas and temporary shelter sites in Fatih, and evaluate whether they are sufficient to meet the needs of evacuee population in case of an earthquake. In other words, this study intends to develop a method to measure the 'gap' between required and actual open spaces in Fatih including school yards, parks, public gardens, and sport areas that can be used as evacuation areas and temporary sheltering sites. The 'gap' is not only measured and assessed in terms of 'capacity' based on likely evacuee population but also considered in terms of 'accessibility' of the evacuee population during emergencies.

To fulfill the aims of the research, several spatial analyses were conducted by using geographical information systems (GIS). The use of ordinary 'Voronoi Diagrams' and network 'Voronoi Diagrams' on

current circumstances provided us with the opportunity to identify the 'gap' based on the scenario of 'none of the roads are blocked'. The results based on ordinary Voronoi diagrams determined by positioning of point locations show that some areas have oversupply of evacuation sites considering their service area population, whereas in some other areas, evacuation sites are inadequate for their catchments. On the other hand, the interpretation of Voronoi diagrams generated for evacuation sites through road network gave an opportunity to find out the longest path within the service area of an evacuation site that needs to be followed to access that site and calculate the total number of people who have access to a particular evacuation site.

In case of the scenario of 'several roads are blocked' due to building collapses, measurement of the 'gap' depends on 'probability of road blockages', as road blockages affect the number of population that can 'safely' access the nearest 'evacuation site'. The preliminary findings of the analysis conducted in one of the neighborhoods of Fatih indicated that five of the six evacuation sites in the neighborhood have sufficient capacities (in $m^2$ terms) to serve for their catchments determined by 'ordinary Voronoi diagrams'. On the other hand, as per the analysis, alternative routes to access to the evacuation sites in the neighborhood would be limited since there are plenty of fully blocked road segments according to several cases of collapse scenarios. The analysis method is then extended to district-wide to assess the spatial distribution and sufficiency of 'selected evacuation sites' in entire Fatih considering both night and day populations per buildings.

The spatial analyses in this research are highly affected by the actual coverage size of debris that is determined by the ratio of building height. The assumptions regarding the relationship between building heights of particular construction types and 'size' of debris occupancy on the surrounding roads require more elaboration on actual collapse situations of the previous earthquakes. Then, the method proposed in this study can be adjusted and improved based on renewed assumptions.

The findings of this study and the methodology developed would be useful for decision-making for disaster management and preparedness. The method proposed in this study can be used to identify which parts of a city are rich or poor in provision and accessibility of post-disaster emergency facilities like evacuation areas and temporary shelter sites. Moreover, the method can help public policy and decision-makers to reorganize spatial distribution of emergency facilities by supporting them with other relevant and alternative land-uses in order to meet the minimum standards for management of emergency response activities. In order to provide more policy implications to the latter issue, current challenges in disaster and emergency management framework and practices in Istanbul are investigated through semi-structured interviews with some key institutions and actors.

All in all, this study is an attempt to contribute to disaster management and preparedness by developing a method to evaluate 'spatial distribution' of evacuation sites and recommending 'policy implications' for an 'emergency plan', as part of disaster preparedness in Istanbul.