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# Application of an Analytic Hierarchy Process (AHP) in the GIS interface for suitable fire site selection: A case study from Kathmandu Metropolitan City, Nepal

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ABSTRACT

Kathmandu Metropolitan City, the capital city of Nepal, is prone to different types of disasters. Fire disaster is one of the most recurring in the city. Due to haphazard urbanization, poor fire services, few and old fire engines, insufficient skilled human resources combined with narrow road lanes, clustered households increase the fire vulnerability in Kathmandu Metropolitan City. This paper documents the fire station suitability zonation mapping in Kathmandu Metropolitan City using Group Decision Making Process (GDMP) in the GIS interface. Four different selection criteria factors such as distance from roads, land cover, distance from rivers and population density are considered for analysis and the Analytic Hierarchy Process (AHP) is used for Group Decision Making Process (GDMP). The results reveal that only 13.46% of the study area is highly suitable for fire station location. Hence, the fire station suitability zonation map is trustworthy and can be used for the construction of new fire stations in Kathmandu Metropolitan City.



## 1. Introduction

Kathmandu Metropolitan City (Fig. 1), the capital city of Nepal, is vulnerable to different natural catastrophes such as landslide, flood, climate change, earthquake etc. Besides these catastrophes, possible fire across Kathmandu Metropolitan City is one of them [1]. Determination of site selection of fire stations in a given area has been of significant interest to urban planners, policy makers and engineers as well.

In most of the countries, the overall layout of firefighting facilities is an important part of fire control planning in the cities. Reasonable construction of fire facilities and layout of fire stations can improve governments' ability to reduce or prevent fire disasters in cities considerably. Recently, with the rapid development of national economy and urban construction, city scale is much larger than before in the developing country like Nepal, but firefighting facilities are relatively lagging in Kathmandu Metropolitan City. The coordination between comprehensive ability to resist fire in the city and its development reveal gradually. Juddha Fire Brigade, located at a central core of the city i.e. on Basantapur (Fig. 1 (b)), was established in 1938 A.D. to serve 60,000 populations at that time with a limited man powers. Till now, the same fire brigade is serving for around one million population.

The principle of fire station location planning is to serve every area of responsibilities within 4 min after its occurrence [2]. However, most part of Kathmandu Metropolitan City cannot reach the specified standard. As the city continues to expand, the need of the fire station also increases. However, the number of fire station has not increased yet accordingly. The population of Kathmandu Metropolitan City is increased by 4.53% per year [3] but the number of fire station still remained unchanged [4]. In addition, when we discuss about completed fire stations, the problems arise due to (a) the uneven spatial distribution and (b) inappropriate planning. For

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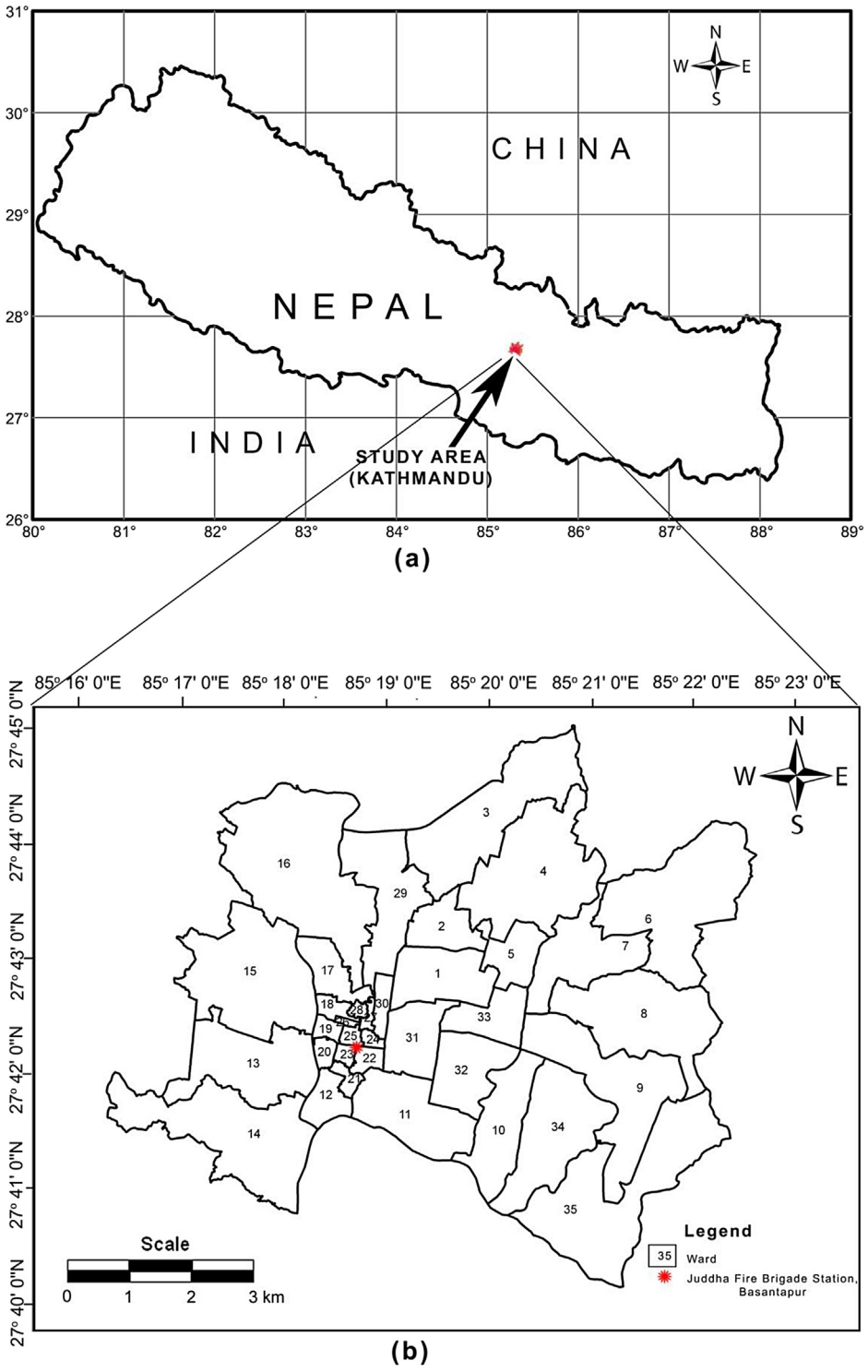


**Fig. 1.** (a) Location of study area, and (b) Map showing the 35 wards of Kathmandu Metropolitan city with Juddha Fire Brigade Station, Basantapur.

example, traffic congestion around fire sites and narrow roads definitely contribute to the delay the time for rescue operation because fire engines cannot get to the fire burning place on time.

Site selection for fire services is a typical multi criteria decision analysis (MCDA) problem in which preference among performance criteria plays a key role in the final decision. To assess the decision maker's preference with a preference model, many efforts have been made to develop the theory and methodology for preference assessment [5]. Different researchers have used different methodologies for site selection for fire services. Schreuder [6] determined the minimal number of fire stations, their locations and the number of first attendance pumpers, so that each point in town can be reached within a prescribed attendance time with sufficient equipment in Rotterdam, The Netherlands. Badri et al. [7] presented a multiple criteria modeling approach, via integer goal programming, to determine the location of fire stations in Dubai, the U.A.E.