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Temporary Shelter Site Selection in Khorramabad City Using Geographic Information System (GIS) Software

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Detailed abstract

Introduction

Natural disasters and human-induced crises-including earthquakes, floods, storms, volcanic eruptions, tornadoes, technological failures, and political conflicts-are occurring with growing frequency and severity, causing extensive damage to both human populations and the environment. The interaction between natural hazards and anthropogenic activities such as deforestation, desertification, pollution, and climate change has further intensified these catastrophic outcomes. Site selection is a systematic search process that involves gathering, integrating, and analyzing large volumes of spatial and descriptive data to evaluate and rank potential locations based on predefined criteria. Post-disaster housing must not only ensure physical safety and psychological comfort but also enable rapid construction, adapt to environmental conditions, and meet the basic needs of affected populations for a transitional period of approximately six months to two years, allowing adequate time for the reconstruction or development of permanent housing.

Methodology

This research adopts a descriptive-analytical framework. In the descriptive phase, relevant criteria were identified through a comprehensive review of academic literature and official documents. In the analytical phase, fuzzy modeling techniques were applied to assign weights to the various spatial layers, drawing on the expertise of urban planning and design specialists. Subsequently, fuzzy overlay operators within GIS software were employed to generate suitability maps for temporary shelter placement across Khorramabad.According to Aysan and Davis's studies, the success of temporary or transitional housing projects depends not solely on structural stability, but on four key practical criteria: rapid assembly, resistance to variable weather conditions, ease of transport across difficult terrain, and the capacity for recycling or reuse without compromising quality.

Characteristics of an ideal shelter

- Installation possible by the household without the need for expertise
- Protection against weather conditions
- Easy portability / Easy to transport
- Responsive to the social and physical functions of the household

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- Preservation of privacy and mental peace
- High-quality, economical, and recyclable response
- Expandability and convertibility into permanent housing
- Structural resistance and sustainable operation
- Protection of the household's remaining belongings
- Desirable shelter characteristics

Based on the research foundations and literature, three approaches—physical, health-related, and urban services—can be envisioned for this study.

- Site accessibility
- Permanent design
- Water supply system
- Healthcare centers / Medical facilities
- Urban arterial roads
- Government service centers
- Transportation system
- Physical / Spatial approach
- Sanitary / Health approach
- Urban services

Study Area

Khorramabad is a city in western Iran and the capital of Lorestan Province. According to the 2016 census of the Statistical Center of Iran, the population of Khorramabad was 373,416. The city is situated at an altitude of 1,147.8 meters above sea level, nestled within the Zagros mountain valleys. The distance from Khorramabad to Tehran is 459 kilometers, and due to its location on the Tehran–south corridor, it holds significant communicational and strategic importance. Iran's Freeway No. 5 passes through this city. At the present site of Khorramabad, there existed a city named "Khaidalou" during the Elamite period, and the city of Shapur-Khwast was built upon its ruins by order of Shapur II, roughly on the current location of the city

Findings

Implementation Method of the Fuzzy Analytic Hierarchy Process (FAHP)

As a mathematical approach to formalizing uncertainty in human thought processes, fuzzy logic—and its underlying fuzzy set theory—has become a widely adopted tool in information system decision-making. Fuzzy sets permit partial membership, capturing gradations of belonging rather than binary categories. In this research, a multi-criteria decision-making framework was employed, and the relative importance of each criterion was determined through expert evaluations, with urban planning specialists rating criteria on a seven-tier scale ranging from extremely important to unimportant.

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A: Extremely important,

B: Very important,

C: Important,

D: Moderately important,

E: Of little importance,

F: Very little importance,

G: Unimportant.

The Fuzzy Analytic Hierarchy Process (FAHP) is a multi-criteria decision-making tool that can structure complex problems hierarchically, thereby simplifying the evaluation of all criteria relevant to the decision to be made.

Determining the Criteria

To choose the best locations for post-disaster temporary shelter, planners must consider a range of environmental, social, and infrastructural factors. The initial step in this process involves defining the specific criteria and indicators that will guide site evaluation and ensure the resulting housing meets the needs of affected communities.

Temporary Shelter Site Selection Criteria

- Access to communication routes
- Access to water and electricity resources
- Proximity to healthcare and service centers
- Land slope and topographic conditions
- Population density and regional capacity
- Access to open spaces and parks
- Proximity to or distance from river pathways
- Regional population and the possibility of accommodation without causing overcrowding

A total of seven evaluation criteria formed the basis of the temporary shelter site selection process in Khorramabad, from which three principal factors emerged as paramount: accessibility to transportation networks and basic services (with a maximum allowable distance of 500 meters from major roads), flood-safe positioning relative to rivers (maintaining 50–100 meter setbacks and slopes of 3–8%), and adequate healthcare infrastructure. To quantify these factors, GIS-based distance modeling was applied to both healthcare centers and residential concentration zones, employing Euclidean distance, nearest-neighbor metrics, and network accessibility routines. Residential land-use polygons, mapped at a scale

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of 1:2000, were linked to census-derived demographic data and intersected with environmental hazard layers—including flood corridors, slope gradients, and fault lines—to delineate high-exposure areas. Meanwhile, accessible open spaces and parklands were evaluated for their suitability as temporary encampment sites, with population density and site carrying capacity also considered to prevent congestion and support sustained occupancy. Ultimately, the integrated analysis produced a comprehensive zoning map that highlighted optimal shelter locations, with healthcare facility access and residential proximity ranked as the top-weighted factors within the fuzzy decision-making framework.

Fuzzy Analytic Hierarchy Process (FAHP) Methodology

Although the Fuzzy Hierarchical process is designed to capture expert opinions on specific topics, it does not perfectly reflect human reasoning because it uses precise numbers in pairwise comparisons.

- Hierarchy of Criteria

Number	Criterion	Importance
1	Roads & Routes	High
2	Government Centers	Moderate
3	Healthcare Services	Very High
4	Slope & Soil	High
5	Residential Centers	Very High
6	Green Spaces	Low

Normalization Process: Raw weights were divided by the total sum of all weights. The final normalized weights sum to exactly 1 (or 100%), which is a fundamental principle in all multi-criteria decision-making methods.

- Fuzzy Weighting Scores

Number	Criterion	Weight Score
1	Roads & Routes	0.22
2	Government Centers	0.08
3	Healthcare Services	0.25
4	Slope & Soil	0.20
5	Residential Centers	0.22
6	Green Spaces	0.02

Application of Fuzzy Model for Khorramabad

Given the discrepancies between flood risk maps—which place several neighborhoods in moderate-to-high hazard zones—and the city's established urban development benchmarks, this research applied a fuzzy modeling approach to address these inconsistencies.

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Operational **Output:**

The final map was classified into three categories: moderate, suitable, and highly suitable.

Priority	Location	Final Score (0–100)	Class
1	East – Imam Reza Neighborhood	89.4	Highly Suitable
2	Northeast – Farhangian Quarter	84.1	Suitable
3	South – Masur Neighborhood	78.6	Moderate

Discussion and conclusion

Khorramabad, nestled within the limestone formations of the Zagros Mountains, faces five major obstacles for emergency shelter planning: scarce flat terrain (merely 15% of the city's area has slopes under 8%), irregular population dispersion, road accessibility that fluctuates with seasons, conflicting land-use patterns, and limited infrastructure capacity. These complexities make fuzzy logic a particularly suitable approach for site selection in this context. The weighting analysis uncovered a dual functional framework, wherein "life-safety priorities"—encompassing healthcare access, road networks, and slope conditions—significantly outweighed "supportive-infrastructural factors" such as government facilities and green spaces. Healthcare services received the highest weighting (0.25), underscoring that during emergencies, ensuring access to medical care is more critical than enhancing quality of life—a finding consistent with the "golden window of relief" principle. Roads and residential areas were assigned equal importance (0.22 each), suggesting that the most advantageous sites are those that balance accessibility with proximity to affected populations. The substantial weight given to slope and soil characteristics (0.20), in contrast to the negligible values assigned to green spaces (0.02) and government centers (0.08), highlights that topographic safety takes precedence over both administrative convenience and aesthetic considerations. By incorporating flood modeling via HEC-RAS and seismic assessments per Iranian Standard 2800, the fuzzy model pinpointed three locations with safety ratings exceeding 0.8 under both hazard scenarios; the eastern site in the Imam Reza district, with a score of 89.4, emerged as the top choice. This disaster-focused hierarchical framework offers practical guidance for emergency responders, while also pointing to the potential for future refinements through the adoption of seasonally adjusted weights and the inclusion of psychosocial recovery indicators.

Declarations

The author declares no conflict of interest.

Keywords: Temporary Shelter. Crisis Management / Disaster Management. Fuzzy Logic.Geographic Information System (GIS).