

Investigation of Spatial Distribution of Urban Parks and Site Selections of New Parks Using Fuzzy Logic and Analytical Hierarchic Process (Case Study: Babolsar)

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Introduction

Provision of mental-social needs of citizens and enforcement of social cohesion are dependent to the quality of using urban open and green spaces of cities which evidently requires deliberate planning and designing. For example parks have wide benefits for cities such as personal (physical and mental), social (recreational opportunities and a place for meeting), environmental (reduction of pollution, biodiversity for plant and animal species), economic (increased property value, enhancing the attraction of properties for business), and structural (urban design and transport). Offering equal opportunity of accessibility to Parks is one of the important issues of park distribution, as all residents could have access to green space and spatial justice would be apparent regarding to this land use. By accepting the fact that green space acts as lung of cities and its absent means lack of physical and mental health then the necessity of paying attention to parks could be quite vital. In this paper, first the distribution of Babolsar parks would be studied and then site selection of new parks would be done using Analytical hierarchical process and fuzzy logic (FAHP) with the aid of GIS.

Materials and methods

Analytical Hierarchical Process (AHP) is a quantitative flexible method for selection based on relative in comparison to each other. There is a hierarchical framework for complicated decisions in AHP, this hierarchy pairwise alternative instead of prioritization of all alternatives in one time. Saaty proposed a measuring scale of pairwise comparison of alternatives, so that oral judgments are stated on their priority. These degrees are reflected in following table. The main focus of the present paper is on FAHP model and further explanation about AHP is avoided due to prolongation.

The study area

The city of Babolsar has located in the southern coast of the Caspian Sea in the central part of Mazandarn province. This city with 345.7 km² area makes up 1.4 percent of the province. The general gradient of the city has been spread from south towards north which is less than 0.5 percent or one in thousand and ends to the Caspian Sea. According to the most recent national census, this city has a population of 175305 in 2006.

Distribution of parks in Babolsar

The city has 13 parks which cover about 93800m² of its area and it stands 1.95 m² for each person. Regarding to the different scale of city's parks, 10 of them is in small neighborhood scale, 2 in neighborhood scale and finally one of them in district scale. There are not any parks in region's scale. The following table illustrates the number and area of existing parks of the city (Table 1).

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Table 1: Number and area of parks in Babolsar

| Park Scale | No | Area m^2 | Per capita m^2 |
|--------------------|----|------------|------------------|
| Small Neighborhood | 10 | 30300 | 0.63 |
| Neighborhood | 2 | 27600 | 0.57 |
| District | 1 | 36000 | 0.75 |
| Regional | -- | -- | -- |
| Total | 13 | 93800 | 1.95 |

The per capita mean of urban parks is $1.95 m^2$. Table 2 shows the per capita of all different scales of parks which reveals a considerable gap between the standard and the existing condition. Therefore the city lacks proper park space for its residents.

Table 2: A comparison between the existing per capita with the national standard

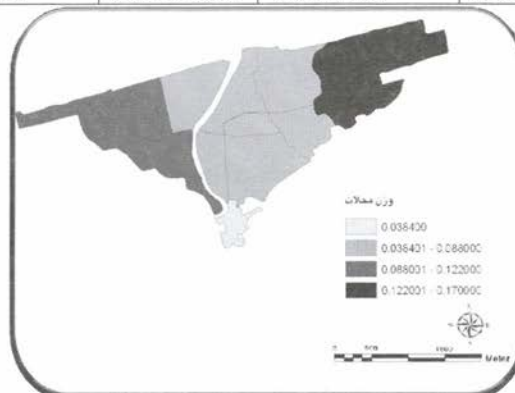
| Park scale | Existing per capita m^2 | Standard per capita m^2 |
|--------------------|---------------------------|---------------------------|
| Small Neighborhood | 0.63 | 3 |
| Neighborhood | 0.57 | 2 |
| District | 0.75 | 1.5 |
| Regional | -- | 4 |
| Total | 1.95 | 10.5 |

Results and Discussion:

The results obtained from tables and maps illustrated a large gap between the standards and the existing per capita of parks. Also, urban parks were not distributed evenly in different levels from neighborhood to the whole city. The research criteria for comparison were; availability of land, access to transport network, population density, neighborhood needs to parks, distance of neighborhood center to sea. In this model, the sites were the neighborhoods which were considered in the detailed plan of Babolsar in 2005. In this section, site selection was done by FAHP to prioritize of 11 neighborhoods of the city for new parks.

Table 3: Weight of neighborhoods by each criteria

| Priority for park establishment | Final weight ranking Defuzzification | Integrated weight of each neighborhood in FAHP | | | Neighborhoods |
|---------------------------------|--------------------------------------|--|-----------|-----------|---------------|
| | | | | | |
| 2 | 0.122 | 0.20088545 | 0.122332 | 0.0434857 | 1 |
| 3 | 0.108 | 0.17808018 | 0.1076859 | 0.0386024 | 2 |
| 8 | 0.073 | 0.12091391 | 0.0737007 | 0.0255447 | 3 |
| 10 | 0.061 | 0.10092959 | 0.0612207 | 0.0219036 | 4 |
| 5 | 0.087 | 0.14437646 | 0.0873766 | 0.0301199 | 5 |
| 1 | 0.17 | 0.27671439 | 0.1657043 | 0.0694555 | 6 |
| 7 | 0.075 | 0.12377419 | 0.0758518 | 0.0256772 | 7 |
| 9 | 0.071 | 0.11592568 | 0.0719488 | 0.0262549 | 8 |
| 4 | 0.088 | 0.14531046 | 0.087348 | 0.0328208 | 9 |
| 6 | 0.083 | 0.13581356 | 0.0840347 | 0.0304282 | 10 |
| 11 | 0.0384 | 0.06322804 | 0.0387101 | 0.0144527 | 11 |

**Fig. 1: The priority of region on the base of the scores of table 3**

Conclusion

The study revealed that the city of Babolsar needs more parks in all levels i.e. from neighborhood to regional level. And also the per capita area of park stays quite below the existing standard. Investigation of using FAHP shows that neighborhood 6 has the highest priority for establishing new park. The field study also recommends that neighborhoods 2 and 3 are quite appropriate for park design, because these two areas are usually used by tourists due to its amenities. The margin neighborhoods of the town had the least per capita of green space which is resulted from the unplanned physical expansion of the city. However there are other neighborhoods with dearth of parks but the peripheral areas now need an especial attention by the local authorities to allocate more financial support for developing new green space and parks.

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Key words

Urban parks, spatial distribution, analytical hierarchical process, fuzzy logic, Babolsar