GIS-based Accessibility Analysis Using Suitable Land for Public Parks in Larkana City Pakistan

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Abstract: Land-use plays an important role in social, cultural and physical development of human beings. A variety of recreational activities creates conducive living environment for humans. Accessibility is significant for land-use planning and use of suitable land for development. Uncontrolled expansion and unauthorized development has created serious urban environmental problems due to urban facilities extension. This fact affects the social behavior and physical development of residents. The aim of this study is to get a better urban environmental benefits and accessibility to parks by the inhabitants of the Larkana city. In finding the suitable land, geographic information system was adopted. Weighted model was integrated in GIS by using Analytical Hierarchy Process (AHP) in finding the suitable land. Based on suitability map, the Euclidean-allocation model was applied to determine the accessibility using GIS spatial analysis function of the ArcGIS software. The results of this study revealed that it is not enough only finding suitable land for allocation of facilities, whilst neglecting how these facilities should be accessed. Therefore, GIS spatial analysis technique is the viable method to analyze service area’s parks accessibility facilities.

Key words: Accessibility, AHP, euclidean-allocation model, GIS, suitability analysis

INTRODUCTION

Environmental and natural functions offer important quality of life for a large proportion of humanity with continuous expansion of urban population and urbanized lands (Jim and Chen, 2008). The benefits and services of open spaces and parks in urbanized areas have been increasingly accepted, leading to widespread augmentation of efforts in protection and provision for inhabitants (Hein and Jusuf, 2008). Less attention has been paid by the development authorities in developing countries to provide naturalization approach to people where they live and work such as a small-scale green areas in the cities (Chiesura, 2004). For the better infrastructure and healthy urban environment, urban parks are essential parts of the urban population. Urban parks do not only provide a pleasant and natural environment, but also improve the quality of life in urban areas and carry out essential environmental functions (Dunse et al., 2007). Public parks are classified according to the accessibility of population and size of a city. This study aims to add improving urban environmental benefits and importance of parks to the inhabitants of Larkana city. Subsequently, this study considered the relationship between accessibility to urban parks by the nearest residential areas. Larkana city is comprised of many old residential neighborhoods and some recent formal and informal housing extensions. If compared to the rapid population increase of the city, many new residential areas of the city are expanding to the north-west and south. This fact has created serious urban environmental problems due to urban development like overcrowding and unauthorized development. As presented in Table 1, are the national standards for urban open spaces in Pakistan, which shows the type, description and size of areas, allocated on the basis of each population.

If we compare open spaces of Larkana city with national standards, for one thousand population 0.25 acres of open spaces is recommended in the development plan (2000-2020), which does not meet the requirements of the city.

Over the past years there have been many developments in spatial data analysis, spatial data storage and retrieval, mapping and Geographical Information Science. GIS now supports various basic and advanced spatial analytic approaches in public facilities planning. GIS has a major impact on the field of Location Science in terms of model applications and model development (Church, 2002). GIS is a popular tool in decision making process in order to map visualization, which is a well-
Table 1: National standards for urban open spaces of Pakistan

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Type</th>
<th>Description</th>
<th>Allocation criteria (pop.)</th>
<th>Total (Acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>City Park</td>
<td>Wide range of amusement facilities, such as water fountains, lakes, landscaping, etc.</td>
<td>400,000</td>
<td>12-15</td>
</tr>
<tr>
<td>2.</td>
<td>Community Park</td>
<td>Selected amusement facilities, such as water fountains, Lakes, landscaping, etc.</td>
<td>100,000</td>
<td>4-5</td>
</tr>
<tr>
<td>3.</td>
<td>Neighborhood Park</td>
<td>Wide range of child park play fixture, walking and jogging paths</td>
<td>25,000</td>
<td>3.25-4</td>
</tr>
<tr>
<td>4.</td>
<td>Mohalla Parks</td>
<td>Tot-lots with slides, swings, seesaws; other spaces with some turning</td>
<td>6,250</td>
<td>1.6-3.6</td>
</tr>
</tbody>
</table>


liked platform to make decisions. GIS in planning plays vital role since in the past in land-use suitability mapping and modeling (Malczewski, 2004). This study is to evaluate the accessibility of land for the existing residents in Larkana city based on a GIS approach.

MATERIALS AND METHODS

The study area: Larkana is the most prominent settlement in western upper Sindh. Being the hometown of many political personalities it exercises a countrywide influence. It is centrally located on 27º33’- North latitudes and 68º12’-East longitudes. The average population growth rate of Larkana experienced an increase of about 3.0 to 3.2% per year in the period of 1951 to 1998. The population of Larkana increased from 270,283 in 1998 to 400,550 in 2010. Assuming the same growth rate, the population will increase to 544,200 in 2020 (Larkana development plan, 2000-2020).

Data acquisition: The spatial data is in form of base map and non-spatial data were acquired from the department of Town Planning, Hyderabad and municipal authority of Larkana, Sindh, Pakistan. The obtained data were rectified to revise the existing one. Analysis commenced after data collection by digitizing base map into the computer compatible set-up using Geographic Information System (GIS) software ArcGIS 9.2 in vector format as shape files to develop data layers. The vector data format was converted into raster data format for geo-computation (Zhou et al., 2005). The generated data sets were projected to Universal Traverse Mercator (UTM), WGS 84.

Evaluation method: In GIS environment, the word allocation indicates the process of identifying specific public facilities and should supply the service regarding the movement of population, generally known as demand. Location-allocation modeling is not new in locating public facilities. This concept was conducted during the 1960s and early 70s in relation to the growth of urban areas (Møller-Jensen, 1997). In addition, accessibility to public facilities is an important aspect in effective land-use planning for people in urban areas of developing countries (Murauskri and Church, 2009). ARC/INFO 9.2 offers useful spatial analysis functions for the calculation of land and cost distance allocation. It was used to analyze service areas of suitable land for public parks in providing facilities for the residential areas (Fortheringham and Rogerson, 1995). Obtained suitable land is classified according to land parcels size applying allocation model comprising Community parks, and Mohalla (Neighbourhood) parks.

\[ d_{ij} = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2} \]  

where,  
‘i’ locations or facility of parks;  
‘j’ supply centre  
\( d_{ij} \) = distance between demand point i and supply centre j

Euclidean-allocation model was chosen to determine the accessibility using GIS spatial analyst tool for allocating parks is presented in Eq. (1). This modelling process was used by ArcGIS 9.2 in this study. Yeh and Chow (1996) described that, supposed that any movement between two points \((x_i, y_i)\) and \((x_j, y_j)\) is continuous and able to take place freely.

RESULTS AND DISCUSSION

Recreation plays an important role in social, cultural and physical development of human beings. A variety of recreational activities create a living conducive environment for human habits.

It is not feasible to utilize the existing developed land for planning of parks in future and existing population. Existing facilities of parks are (2.74 ha) available out of total area in the city, which are located in the center of the city and do not meet need of existing population. To allocate land for optimal locations of parks, a suitable
Table 2: Most suitable land for Parks

<table>
<thead>
<tr>
<th>Land for parks development</th>
<th>Grid cell nos.</th>
<th>Area (ha)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not suitable</td>
<td>383320</td>
<td>958.3</td>
<td>98.6</td>
</tr>
<tr>
<td>Least suitable</td>
<td>514</td>
<td>1.2</td>
<td>0.2</td>
</tr>
<tr>
<td>Most suitable</td>
<td>4543</td>
<td>11.3</td>
<td>1.2</td>
</tr>
</tbody>
</table>

Fig. 1: Most suitable land

Fig. 2: Optimal locations of neighborhood and community parks

allocation model was selected in GIS. Therefore, Euclidean-Allocation model was used to determine the service area or (accessibility) of facilities. Most suitable land was found (1.2% or 11.3 ha) of the total area (98.6 % or 958.3 ha) as shown in Table 2. Suitable land was classified i.e. not suitable, least suitable, and most suitable as illustrated in Fig. 1. Most suitable lands were found for allocating parks. In addition, the optimal locations were selected on the basis of the most suitable land size as depicted in Fig. 2. Suitable land was classified into three land parcels out of nine suitable land parcels for neighborhood parks and only one suitable land parcel was selected for Community Park.

The reason for these categorizations was based on suitable land parcel’s sizes and its accessibility better than other two selected land parcels for community parks. These two suitable land parcels for community parks that come under the service area of neighborhood parks are displayed in Fig. 3.
All the most suitable lands falls in the north-west side of the city and only one suitable land parcel fall in the eastern side of the city. Planned neighborhood and community parks facilities in the city are limited because of poor concentration given by the government. Meanwhile, the service area of the neighborhood parks is allocated to be 500 m as shown in Fig. 3. Similarly, the service area of the community parks is 800m, which is in accordance with the function of the park as illustrated in Fig. 4. The results show that southern part of the city could be affected by the shortage of suitable land for allocating neighborhood parks. Overlay of community and neighborhood parks’ accessibility on existing land use of the city are shown in Fig. 4.

CONCLUSION

Euclidean-allocation model was adopted using spatial analyst tools of the ArcGIS 9.2 in determining the service area of the suitable land for parks development. However, it is considered to achieve the given objectives, which is to locate accessibility of public parks facility, which assesses the service area of suitable land (Peng et al., 2007). The suitable land was categorized into two neighbourhood parks and community parks based on land sizes. Each category was derived into three land parcels out of nine suitable land parcels by spatial analysis model. The service area of neighborhood and community parks were considered to be 500 and 800 m, respectively. The
A sustainable approach was considered to allocate service area because it should have a balance between facility and demand. Most suitable lands were found to be in the north-west side of the city and only one suitable land parcel was found in the eastern side due to the uncontrolled development. Planning standards, for suitable facilities are not only important to consider in planning process, but also it should as well considered sustainable distances to facilities by the people. Location-allocation approach was applied in this study for the accessibility evaluation and planning of park facilities for Larkana city. The outcome of this study will be made to serve as an important role in the field of urban planning, development authorities and stakeholders to implement GIS in their decision making process for future developments.

REFERENCES