GIS Applications in Optimum Site Selection for Tourist Site in Minnesota State.

by

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GIS Applications in Optimum Site Selection for Tourist Sites in Minnesota State, USA.

Abstract

Tourism has become one of the fast-growing economic activities in the world, and generates huge amount of revenue in communities where it is sited. Minnesota State is a potentiality viable state for tourist site location; however, selection of an appropriate site for this purpose is a critical decision which determines its success. GIS which is a powerful tool in spatial analysis can be utilized for this purpose efficiently and effectively.

This project applied vector based analysis in GIS software, with set of appropriately selected location criteria. Spatial data on accessibility, crime, accident, accommodation, existing recreation sites and urban areas were analyzed to select potential tourist sites for Minnesota State.

The result shows that four areas are suitable for the location of the tourist sites. Two of the areas in Clay County, one in Chisago County and the last one in Rock County.
1 Introduction

Tourism is one of the fastest growing areas within the world’s largest industry (0Hall, 2001). Tourism has blossomed into a prosperous, fast-growing activity, and has indeed turned out to be a significant factor for economic growth in the countries in which it has developed (OECD, 1994).

Capital intensive facilities are major, long-term investments for government or private investors. Selection of an appropriate site for these purposes is thus, a critical decision that could significantly affect the profit and loss of such projects (Neil and Eldrandaly, 2004). Geographic information systems are increasingly becoming sophisticated and user-friendly software systems used for site selection process. GIS creates efficiencies by utilizing a scientific process and quantifiable variables to gauge the desirability of prospective sites, using a set of appropriate criteria. GIS can speed up what otherwise would be extremely laborious and time-consuming processes.

The current project strives to determine the optimum location for tourist sites in Minnesota State, based on the satisfaction of the criteria adopted for the project.

1.1 Study Area

The study area is Minnesota. Minnesota is in the north central United States. Near the geographic center of North America, it is bordered on the north by the Canadian provinces of Manitoba and Ontario, on the west by North Dakota and South Dakota, on the south by Iowa, and on the east by Wisconsin and Lake Superior. Minnesota entered the Union on May 11, 1858, as the 32nd state. The area of Minnesota is 225,181 sq km (86,943 sq mi) [Minnesota is the 12th biggest state in the USA], of which 12,380 sq km (4,780 sq mi) is inland water and 6,594 sq km (2,546 sq mi) is a portion of Lake Superior under the state's jurisdiction. State Capital is St. Paul and the population is
4,919,479 (as of 2000) [Minnesota is the 21st most populous state in the USA]. Highest Point - Eagle Mountain - 2,301 feet (701 m) above sea level and the lowest point is 602 feet above sea level at Lake Superior. Major Minnesota Industries includes; Tourism, Agriculture, Computers and services, Healthcare and medical equipment, Forest and forestry products and Printing and publishing. This project is aimed at using the power of GIS software to locate most appropriate site for a tourist centre or/and commercial centre.

Figure 1: Location Map of Study Area.

2 Literature review

GIS has been used in several studies for optimum site selection purpose, especially tourist sites. Al-Ramadan and Aina (2004) has demonstrated the use of GIS for tourist site selection in Texas State. Neil and Eldrandaly (2004), integrates the capabilities of Expert Systems ES, GIS and Multi-criteria decision making, MCDM by using Microsoft® Component Object Model (COM). Mejía et al. (2000) describes the application of 3D analysis with ArcView GIS clients, ArcExplorer clients, and
MapObjects clients, on an MS Windows NT client/server environment for tourism facilities and resources planning in Zulia State, Venezuela. Regarding location criteria and models, Quirk et al. (1978), highlighted numerous factors worthy of consideration for site selection model. Factors enumerated include Region, State and Municipality policies, location factors, competition, utilities and municipal Services, to mention but few. Al-Ramadan and Aina (2004) listed criteria used for selecting and evaluating tourist sites. The project listed; proximity to urbanized area (not within 3km from urbanized area), accessibility and proximity to major roads and airport, crime rates, proximity to recreation/historic sites, proximity to water body and size of the site area.

3 Problem statement

Tourism has blossomed into a prosperous, fast-growing activity, for economic growth. Minnesota State, having a great potential for tourism can harness such potentiality for social, political and economic growth. However, selection of an appropriate site for this purpose is a critical decision which determines its success.

4 Project Objectives

The objective of this project is to make use of the GIS software, ArcGIS 9.0 to locate potential sites for tourism sites in Minnesota State, USA. The specific objectives of the project include:

- identifying the criteria needed for tourist / commercial site location,
- acquiring the necessary spatial and non spatial data needed for the project from appropriate data depot,
- applying these set of criteria in GIS software powerful tool to locate such suitable sites, using vector based approach,
• presenting the potential selected sites in map format with their respective location.

5 Method of Study

5.1 Data Collection

Data is sourced from the internet from several data depot on the internet including these websites; The DNR data deli (http://deli.dnr.state.mn.us/data_catalog.html), ESRI, Minnesota Statewide Transportation Data (http://www.dot.state.mn.us/tda/basemap/county/statewide.html), Minnesota Department of Public Safety (http://www.dps.state.mn.us/bca/CJIS/documents/Page-15-02.html), and U.S. Census Bureau. The data are in ArcGIS supported formats mostly shapefiles, while few are just data table that required conversion.

Different categories of data collected include data on; Administrative Features, Facilities, Geology and Soils, Hydrography, Land Cover use, Ownership and Imagery, Topography, Transportation, Events and Sitings, Crime Information (annual report) and the Metadata.

5.2 Data Selection

The data, haven been sourced from different data depot, have different and/or conflicting format especially georeferencing. Other data like excel tables were also not in ArcGIS recognized format and thus needed to be converted. ArcCatalog was used to organized, verified, convert and select the necessary and appropriate data for the project.
5.3 Criteria Selection for Data analysis

ArcGIS has a lot of powerful tools capable of relating data spatially and by attribute, by set of instructions input in form of "Query". Query can be built based on selected important and necessary criteria. For optimum site selection for tourist site, all factors that could possibly have any bearing on the decision should be considered carefully. Selected criteria for this project are listed below.

5.3.1 List of Selected Criteria

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<tr>
<th>Considered Factors</th>
<th>Selection Criteria</th>
<th>Justification</th>
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<tr>
<td>Accessibility</td>
<td>within 5km from a major road</td>
<td>The tourist resort needs to be accessible to people for high patronage (Al-Ramadan and Aina 2004).</td>
</tr>
<tr>
<td>Crime rates</td>
<td>&lt; 7 crime /100 people</td>
<td>An area with high crime rate will receive low patronage (Al-Ramadan and Aina 2004).</td>
</tr>
<tr>
<td>Accident Rate</td>
<td>&lt; 1 Accident / 100 people</td>
<td>Safety of the tourist is an important factor in selecting a tourist site and an area with low accident rate will be an ideal location.</td>
</tr>
<tr>
<td>Sexually Transmitted Diseases (STD) rate</td>
<td>&lt; 5 STD / 1000 People</td>
<td>Interaction of people from across different region may enhance spread of STDs or other diseases, thus an area with low STDs rate will be an ideal location.</td>
</tr>
<tr>
<td>Accommodation Availability</td>
<td>&gt; 40 Available Accommodation</td>
<td>Tourists needs accommodation for the duration of their stay, hence, an area with more available commercial accommodation is more desirable.</td>
</tr>
<tr>
<td>Proximity to airport</td>
<td>within 10km from airport</td>
<td>This may attract tourist from other regions and even other countries (Al-Ramadan and Aina 2004).</td>
</tr>
<tr>
<td>Proximity to water body</td>
<td>within 2km from water body</td>
<td>This also attracts tourist (Al-Ramadan and Aina 2004).</td>
</tr>
<tr>
<td>Proximity to existing recreation/historic sites</td>
<td>within walking distance of 1km</td>
<td>Closeness to recreation, parks and historic sites enhances patronage. 1km distance is recommended so that it will be trek-able for the tourist from the recreation/parks or historic sites. (Al-Ramadan and Aina 2004).</td>
</tr>
</tbody>
</table>
Distance from Urbanized Areas | Not within 3Km of Urbanized Areas | To avoid urban noise and congestion of Urban areas, and thus create a serene environment (Al-Ramadan and Aina 2004).
---|---|---
Distance from Floodways and ditches | not within 1km of floodways and ditches | For safety of tourist, tourist site should be at a reasonable distance away from floodways and ditches.
Distance from wildfire incident areas | not within 1km of wildfire incident areas | For safety of tourist, tourist site should be at a reasonable distance away from persistent wildfire incident areas.
Distance from Military Facilities | not within 500 meters from Military Facilities | Military facilities should be avoided for safety, political and security reasons.
Indian Reservation | Indian Reservation should be excluded | Tourist site should not be located on private or tribal land when it can be avoided.
Size | Area not less than 1 sq.km | Due to the activities expected at the tourist site (Al-Ramadan and Aina 2004).

| Table 1 Criteria for locating the optimum tourist site |

### 5.4 Tools of Study

The tool of the study is the ArcGIS 9.0 software, due to its ability to perform spatial analyses on the location and attributes of features from one theme in relation to the location and attributes of features from another theme, to reach a conclusion about this relationship.

### 5.5 Site selection procedures

A systematic approach is adopted for the selection process, which involve three stages, based on similarity in the procedure. The first stage is based on selection by attribute, second stage is based on buffer operation and the last stage is based on buffer with erase.
5.5.1 Selection by Attribute

Data tables with crime, Sexually transmitted diseases (STD), accident rates and accommodation availability (attribute) information were related with the spatial data in ArcMap and "Query builder" is used to select desirable counties based on attributes, using criteria listed above. Figures below shows the selected counties in each query run based on the criteria selected.

Figure 2: Selected Counties based on crime rate factor
Figure 3: Selected Counties based on STD rate criteria

Figure 4: Selected Counties based on Accident rate.
Figure 5: Selected Counties based on Available accommodation factor

An Overlay Operation (intersect) is then performed on the layers above to select those counties satisfying all the criteria used altogether. Figure 6 shows the result of the overlay.

Figure 6: Selected Counties after stage one overlay (intersect) operation.
5.5.2 Buffer

In the second stage, buffer operation is performed on spatial data based on the criteria selected using ArcToolbox. The figures below show the results of the buffer.

Figure 7: 10 km buffer of airport.

Figure 8: 5 km buffer of Major roads
Figure 9: 2 km buffer of water body.

Figure 10: 1 km buffer of pre-existing recreation/parks
An Overlay Operation (intersect) is then performed on the layers above to select those areas satisfying all the criteria used altogether. Figure 11 below shows the result of the overlay.

![Intersect Diagram](image)

Figure 11: Selected areas after stage two overlay (intersect) Operation

### 5.5.3 Buffer and Erase

In the final stage, buffer operation is performed on spatial data based on the criteria selected and followed with "erase" operation using ArcToolbox. The erase tool, removes the unwanted areas from the current layer. The figures below show the results of the buffer with erase operation.
Figure 12: Selected areas after buffer and erase operation on urbanized areas.

Figure 13: Selected areas after buffer and erase operation on floodways.
Figure 14: Selected areas after buffer and erase operation on ditches.

Figure 15: Selected areas after buffer and erase operation on wildfire incident areas
Figure 16: Selected areas after buffer and erase operation on Military and Indian reserved areas.

An Overlay Operation (intersect) is then performed on the layers above to select those areas satisfying all the criteria used altogether. Figure 17 below shows the result of the overlay.

Figure 17: Selected areas after the last stage overlay operation.
5.5.4 Final Overlay

Final overlay operation is then performed on the results of overlays of all the three stages, to finally select only those areas satisfying all the criteria altogether. Figure 18 below shows the result of the final area and the selected areas for the tourist site.

![Final Overlay by Intersection](image)

Figure 18: Selected tourist sites after the final overlay operation.

6 Study Limitations/Constraints

This project is limited by data availability which necessitates a lot of relentless effort at sourcing for appropriate and applicable data, from several sites on the internet. Another important limitation is that of software license which is not covering some important tools needed for the project especially erase.

Constraints faced in the project include; problem encountered in relating and superposing data from different source due to differences in their georeference coding, converting excel data tables to ArcGis software recognized formats like *DBF(IV), and
lack of a personal computer system where the data can be loaded and guaranteed safety. For instance, the system I was using in the department is recently reformatted, and all my data deleted. I am only relying on my backup data file.

These problems/constraints were solved or alleviated by incessant effort and some manipulations used. For instance, the problem of lack of "erase" tool was solved by using completely white symbols for those layers to be erased, therefore depicting the function of erase.

7 Results

Four sites were selected as satisfying all the criteria, 2 sites in Clay County, 1 site in Chisago County and 1 site in Rock County. The detail of the result is shown in figures below.

![Figure 19: The two selected sites in Clay County.](image)
Figure 20: The selected site in Chisago County.

Figure 21: The selected site in Rock County.
8 Conclusions

The process of site selection begins with the recognition of an existing or projected need. This recognition triggers a series of actions that starts with the identification of geographic areas of interest.

Site selection is a crucial, multifaceted process that could significantly impact the profit and loss of capital investments. The proposed process for the current project includes: establishment of suitability criteria, data acquisition, site screening and selection of suitable locations.

9 Recommendations

The current project makes the following recommendations:

- that necessary data should be sought for and collected for meaningful site selection.

- that the selected criteria should be considered carefully for its bearing on the decision making.

- criteria which relates to the environmental, social, politics and rule of law governing the project area should also be considered.

- that the process should be approached systematically as done in this project to ensure adequate and reliable results.

- public participation and opinions should also be sought for necessary feedback on site selection matters.

- conflicting or contradicting criteria should be eliminated or avoided.
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