



Environmental consideration in Route Selection Using GIS

(Term Paper)

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OUTLINE

Abstract

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Abstract

During the past few decades, there has been an increasing concern that human interruption and action have been negatively impacting the environmental and affecting the natural resources. A growing on environmental quality has forced and encouraged many countries to implement legislation and guidelines that will ensure the consideration of natural environment in land-use planning and site selection processes.

Transportation network expansion is one of factors influencing the environment including the natural resources. This concern has led to an increased emphasis on environmental studies all over the world. They start looking for powerfully technique to minimize the negative side affect of social development such as the transportation network expansion. GIS was the best selection technique in this field.

This paper shows how the GIS can be used to reduce the environmental impact by proper railway route selection. Finally a brief case study has been included to demonstrate the successful role of GIS in railway rout selection. An area in Gilan province in north of Iran was selected for this study.





1 Introduction

Nowadays, transportation network expansion is very important for economic and social development. A construction new route is very critical because of the affect of this project on the environment. New route construction or expansion projects are one of the main sources that damaged the environment. It is very important to consider the impact of any project on the environment. This consideration leads us to a process called Environmental Impact Assessment (EIA). This can be defined as a method of identification and evaluation of the impacts of any proposed projects on the environment components and recourses.

It is essential to combines the need of developing with minimizing the impact of this development on the environment. This thought makes the route selection process very difficult by utilizing the traditional mode. To achieve this today, Geographic Information Systems (GIS) is being implemented in the following aspects of environmental planning.

- Environmental Risk Management
- Environmental Monitoring
- Environmental Standards
- Environmental Impact Assessment

Combining GIS and EIA in construction new route have significant benefits. One of these benefits is the fast and accurate decision taking by decision makers.



In view of the above, GIS was the best selected software to deal with the construction of new rout. GIS is software used for storing, retrieving and presenting both spatial and non-spatial data in an efficient, quick, and structured way. GIS considered as an important and useful tool in the field of transportation engineering and providing the capability to perform transportation analyses. By using GIS the transportation engineers and planners have the ability to organize, store, and analyze spatial information about transportation systems. Furthermore, it considered as on of useful tool in transportation planning because of its abilities to display information to the public or decision makers about the transportation system.

2 Objective

The main objective and consideration of this paper is to explain and illustrate the effectiveness and the capability of GIS technology in optimal route selection for reducing the impact of the selected route on the environment. It shows how the GIS usefully used in conjunction with other data sources to find the best selection for the new route. **The study area of railway is the Gilan province in north Iran.**



3 Review of Literature

Several studies have been conducted to show the importance of using the application of GIS in environmental consideration in any developing projects. N.Muthus and Dr.Ramalingam (2003) used GIS to evaluate the environmental impact assessment (EIA) for urban planning and development. They show that GIS can handle large data related to EIA and representing them in accurate way with less time consuming process. They start with EIA definition then they show the advantages of using the GIS with EIA. They conclude that GIS is considered as one of the important technique that can be used for environmental scoping.

Agrawal and Dikshit (2002), shows the GIS is a useful technique that can be implemented to evaluate the environmental impact assessment of constructing a new Highway. This type of projects has a disaster affect on the environment, constructing new road can be considered as a major source of damage to the surrounding environment. The authors present the benefits of using GIS for EIA of highway projects which can help to select the optimal road location with less impact on the environment. Veldic Vlado has shows in his paper that how GIS efficiency can be improved in optimal site selection when it is integrated or linkage with Knowledge Based System (KBS). The aim of this integration is to produce a powerful computer technique that can be used to support site optimal analysis for urban development.

4 Case Studies

Gilan province in north of Iran was selected as a case study to show the effectiveness of using GIS in railway route selection and environmental consideration in land use and management. The main two reasons behind this selection are the unique environmental characteristics of this area as well as the industrial nature of Rasht city which is the main city in the Gilan province. It is an agricultural land, forest, wetlands, grand rivers and sea shores. In addition to that it is one of very important wildlife habitats and scenic landscapes in the world. Because of this Gilan is very attractive area to a large number of tourists which require a clean and safe transportation system but we should keep in our mind that Gilan is very sensitive to the urban and regional development because of the regional scale which is easily affected by any human activities. The main task in this case is to find optimal route for constructing new railway which has least environmental impact.



Figure 1: Location of the study area in Iran and its Landsat color composite image 321(RGB)

5 Methodology of study

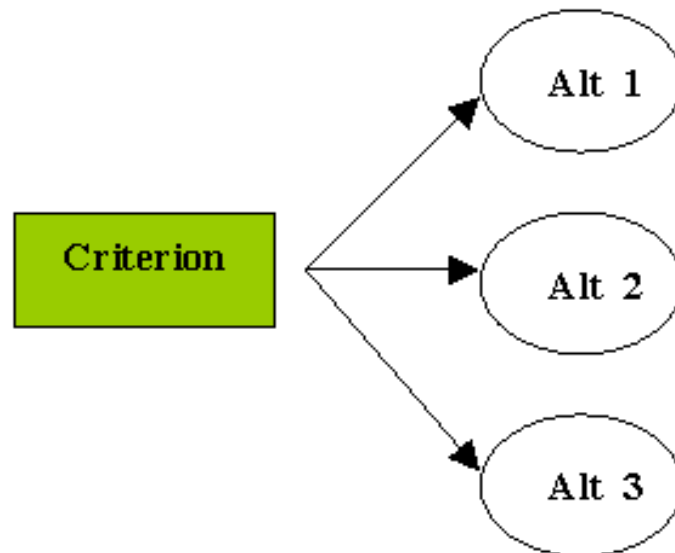
5.1 Data Collection

To achieve the above task, it is very important to study the surrounding environment such as land cover, river, road and soils. The most important parameters that were considered in this project can be listed as follow.

- Land covers maps. They are used to extract some important information on the land to be used in railway route area. Several techniques and methods were used to produce these maps and to utilize the data produced from them.
- River: the railway routs should be selected far from the river to minimize the environmental impact and to reduce the cost of construction the routs near the river which need to build bridges over the river. The map of the rivers in Gilan area was collected from digital topographic map at the scale of 1:25000.
- Road: the aim of the project team is to decreases the cost of the project and to grantee the safety of the transportation by reducing the number of road intersection the railway. The map of this road was extracted from the existing digital map.
- Culture heritage: the documents and existing maps were studied.
- Geology: the properties o rocks and its resistance underlying superficial layers were done by geological studies and the geological maps of the area were digitized.
- Soil: the properties of soil is very important to identified for this aim, a reliable soil map of the area digitized and used for producing desired classified soil map.

5.2 Analysis and Discussion

The optimal route selection process can be summarized into few steps first, different parameters such as land cover; river, road, geology and soil were determined and considered in the railway route selection. Second, Pairwise Comparison Method (PCM) has been used to determine the comparative weight of each parameter.



Third, each parameter weight was attributed to relevant maps. Fourth, friction map was produced by overlaid all weighted map in GIS. Friction map inhibits the route selection through the area. Fifth, two origins (Rasht city) and two destinations points (Anzaly city) were identified. Figure 2.



Figure 2. Two Rasht-Anzali alternative railway routes (computed in GIS) overlaid on the Land cover map of the study area

The decision maker has to select one of the four routs (Figure 2) and they should keep in minds to select one with minimum environmental impacts. Analytical Hierarchy Process (AHP) was used to evaluate the four routs and chose the optimal one. The Analytic Hierarchy Process (AHP) is a powerful process applied to help the decision maker to take a correct decision. AHP was first developed by Saaty. Since its beginning, this process has been employed to overcome a variety of problems related to decision making. AHP is applicable in different field it ranges from finance to land use planning. The fundamental concept of AHP lies in proceeding from a pairwise comparison of criteria to evaluate the weights that assign relative importance to these criteria (Figure 3).

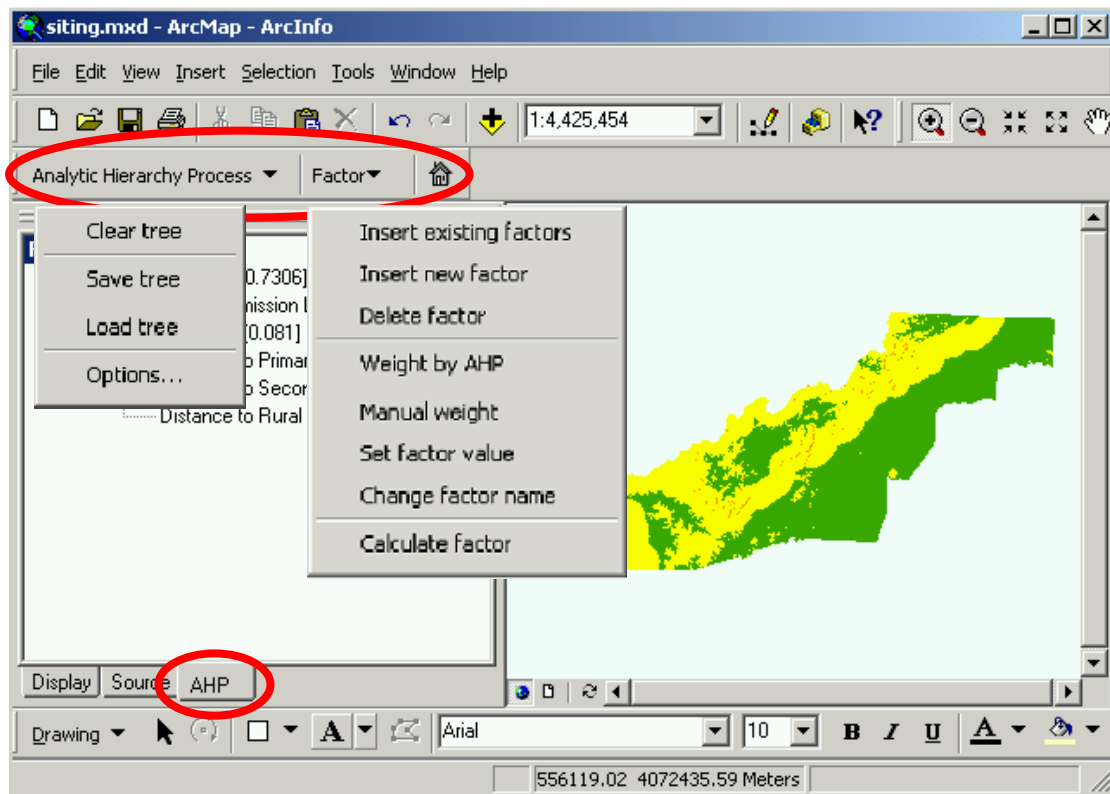


Figure 3. AHP integrated in ArcMap

The parameters were attributed to relevant maps, then fraction map (raster map) including all parameters map layers overlaid in GIS. This fraction map helps the routes selection through the area and it consists of cells and each cell has a value that refers partial or absolute obstacle in determination of the route. It is recommended for automatic route selection to specify two origins points and two destination points. The origins point was Rashat city and the two destinations was Anzaly city. By using Least Cost Pathway Analysis (Eastman R.J., 1995) different cost surface were derived from friction map and the above mentioned points and four routes were determined. The decision makers were able to choose one of suggested four routes with the help of geographic information system (GIS).



6 Conclusion

The purpose of the paper was to present a practical example of environmental consideration in railway construction using GIS. Utilizing the GIS in this project apart from direct benefits, GIS has clearly demonstrated its usefulness to find a best location for the railway route between Rasht and Anzaly cities in Gilan province with the help of AHP and PC methods. GIS has considered not only the economic parameters (Low cost route) in achieving this goal but also environmental parameters were in mind. This research shows that the railway routes resulted from GIS method comparing with the routes resulted from traditional method is more environmentally sound. It shows how the GIS can be used as a source of information to enhance and assist the decision makers in decision making. It was shown clearly in the case study that the human activities, actions and urban developing can be controlled and directed towards the protection of environment.



7 Recommendations

The following points are highly recommended:

- It is always recommended to utilize the technology such as using the GIS application in conjunction with environmental requirements in order to minimize the environmental impacts.
- It is preferable to establish and maintain a citywide natural resources inventory that catalogs and monitors the location and condition of natural resources. This inventory should cover all facets of urban ecology, environmental quality, and should be used as a benchmark to evaluate the success of environmental programs and the impacts of land use and development decisions.
- It is recommended to add more parameters to the study to insure about the best railway route selection such as the weather.
- It is recommended to documented all environmental information or analysis used in the process and the environmental impact assessment to avoid and or minimize actions taken during the project. This will make the information visible and can be used again as guidance in any future projects.
- It is highly recommended to keep monitoring the area by conducting environmental audit of the same project at a later stage. This is possible by using GIS based data base which can be integrated with remote sensing data.



8 Acknowledgement

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