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GIS Applications in Construction: Planning for Disaster Relief

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ABSTRACT

Application of Geographic Information Systems (GIS) in construction disaster relief planning is presented. A case study of GIS developed for Fulton county in the state of Georgia is presented. The project identifies potential resource allocations and accessible roads network using TranCAD GIS computer program. This model could be used for a disaster relief project to identify the available resources which can support the decision making process in a viable manner. The necessary information can be extracted from the GIS database with the list of all the registered contractors and the available resources to efficiently expedite the relief measures.

1. INTRODUCTION

Geographic Information Systems (GIS) is becoming increasingly significant for construction planning and assessment in recent years. GIS provides an effective tool to compare a great number of location-related data describing the affected natural resources and their sensitivity related to the effects of impacts. Because GIS can be used to couple area-related data with their attributes, and to overlay them; it represents a highly efficient instrument for such planning tasks in construction management projects.

This paper describes application of GIS for planning disaster relief construction activities using TransCAD GIS package. The study has focused on the selection of appropriate locations for developing relief centers for planning disaster relief construction in Fulton county, Georgia.

In this study, a model is developed to assist the project managers in identifying the suitable and the shortest road links from the relief centers to the disasters area in the north west of Fulton county. The model is comprised of a GIS which is integrated with a database management system and includes the knowledge of different construction aspects required for disaster remedial relief measures.

2. OVERVIEW OF GIS

The importance of the GIS market suggest that it is of national and global significance which is growing at a rapid rate. GIS are integrating systems which bring together ideas developed in many areas including the fields of agriculture, botany, computing, economics, surveying, geography, and construction, to name a few. Inevitably, it is difficult to distinguish between the competing claims of different organizations and individuals all of whom wish to be represented in a vibrant and profitable field.

GIS emphasize the importance of map processing, databases and spatial analysis. The evolution of GIS is described as a three stage process encompassing resource inventory, analysis and management activities. There has been some debate about whether GIS should be defined in narrow technological terms, or whether a wider organizational/institutional perspective is more appropriate.

Many of the GIS definitions proposed so far are relatively general and cover a wide range of subjects and activities. Nevertheless, all such definitions purport the common single feature, namely that GIS are systems which deal with geographical information. In GIS, reality is represented as a series of geographical features defined according to two data elements. The geographical (also called locational) data element is used to provide a reference for the attribute (also called statistical or non-locational) data element. For example, administrative boundaries, river networks and point locations are all geographical features used to provide a reference for river water flows or site elevations. In GIS, the geographical element is seen as more important than the attribute element and this is one of the key features which differentiates GIS from other information systems.

The term "spatial" and "geographical" are often used interchangeably to describe geographical features. Strictly, the term spatial refers to any type of information about location and can include engineering and remote sensing, as well as cartographic information. On the other hand, geographical refers only to locational information about the surface of the earth at real world scales and in real world space. Similarly, the term "spatial data" is often used as a synonym for "attribute data."

3. INTEGRATED PLANNING INFORMATION SYSTEMS

The nature of the data distinguishes planning from other data business because virtually all planning data is intimately related to geography or spatial location. Since this concept and belief has become widely rooted in the community, it is not surprising that the planning profession has been greatly influenced by developments in GIS.

A set of GIS tools linked to an integrated database of the socio-economic and land use information enable the planners to conduct exploratory spatial analysis. In a optimal setting, GIS offers the possibility of supporting a sophisticated decision support system. The idealized planning process involves the following steps:

- Define the problem
- Determining objectives
- Inventing alternative solutions
- Evaluating alternatives
- Selecting the best alternative
- Implementing the systems or plan
- Monitoring the results

In summary, the nature of the planning process would appear to be a perfect setting for GIS to demonstrate their ability to manage a diverse set of spatial information and to form the information infrastructure of more efficiently and equitably operated communities.

4. MODEL DEVELOPMENT

The site location is an important pre-planning task that can either enhance or adversely affect construction productivity. The concept of searching by elimination to generate the potential and optimal site for the relief center. An efficient location of the relief center can significantly reduce construction constraints and improve the efficiency in the disasters areas in the Fulton county. The Fulton county is located in the Northwest of Georgia, in the city of Atlanta.

The study has implemented TransCAD (GIS software) for developing a forecasting model for the planning of disaster relief construction in the Fulton county. The optimal site location for the relief center and the database of the different types of construction contractors and suppliers working in the Fulton county.

The potential resources considered are as follows: 1) Construction material and supplies; 2) Construction equipments; and 3) Labor forces.

In the event of possible disaster, the following sites and utilities are generally considered for consideration: 1) Highways and roads; 2) Residential houses; 3) Bridges, 4) Public facilities; and 5) Utilities such as water lines, electricity, gas lines, and sewage lines.

The GIS model assist the project managers, at the selected relief centers, in decision-making and planning for the disaster relief construction. The project managers could have access to the data of all the different contractors who are dealing specifically in the above mentioned areas. Also their exact locations, shortest paths and road links to the disaster areas are modelled by interfacing optimization network solvers with TransCAD GIS. The following steps are undertaken to develop this GIS based application:

Step 1: U.S. Census Bureau has developed TIGER (Topologically Integrated Geographic Encoding and Referencing) system files. The geographic information is stored in TIGER files and thus are useful to accelerate map production. In order to display in GIS environment of TransCAD, the required Tiger files of Fulton County were processed by using TransCAD build utility. Area and line databases are developed to represent the county's boundary, census tracts and roads networks.

Step 2: Conditions are created to extract important primary features such as major highways, interstates, railway lines and MARTA routes using TransCAD data editor utility. These features were labeled as shown in Figure 1.

Step 3: Statistical representation of census tracts was extracted from the area database and is shown in Figure 2. The graph can be effectively utilized for apportioning different population density areas of Fulton county.

Step 4: Potential location of disaster affected area in the North West of Fulton county is selected and is displayed in Figure 3. The GIS database can be accessed to extract information of demography and the availability of services such as airports.

Step 5: The information obtained from the GIS database and the idealized location of the disaster affected area is utilized to set the proper allocation of the relief measures. The relief measures includes the above discussed facilities which can basically assist in relief measures.

Step 6: As shown in Figure 3, the potential site were allocated and the decision for such allocations can be based on factors such as roads accessibility and other sources which may assist in such remedial planning stage.

Step 7: TransCAD GIS database is efficiently incorporated with optimization algorithms to solve construction relief and management problems. TransCAD network solver and the shortest path optimization utilities are incorporated in the study to obtain optimal routes for the relief measures as shown in Figure 4.

5. CONCLUSION

The study has demonstrated the viable application of GIS for project management and for the selection and allocation of relief measures. The geographic information retrieved from the TIGER files is useful for developing spatial relationship between geographic entities and hence helpful for allocation of resource measures. Additional information databases such as earthquake fault lines or hazardous material sites can also be incorporated by the model.

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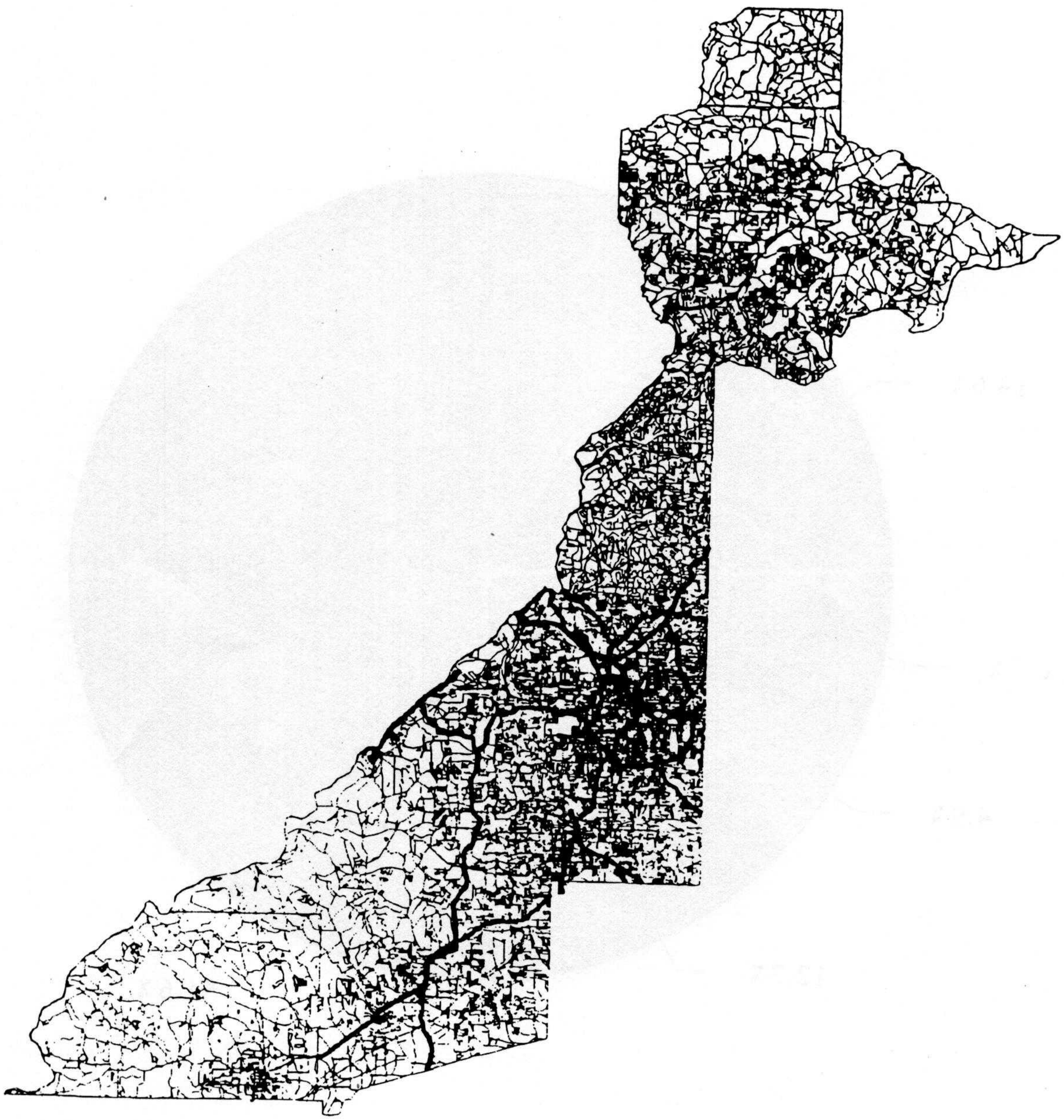

Figure 1. Fulton County Roads and Railway Lines

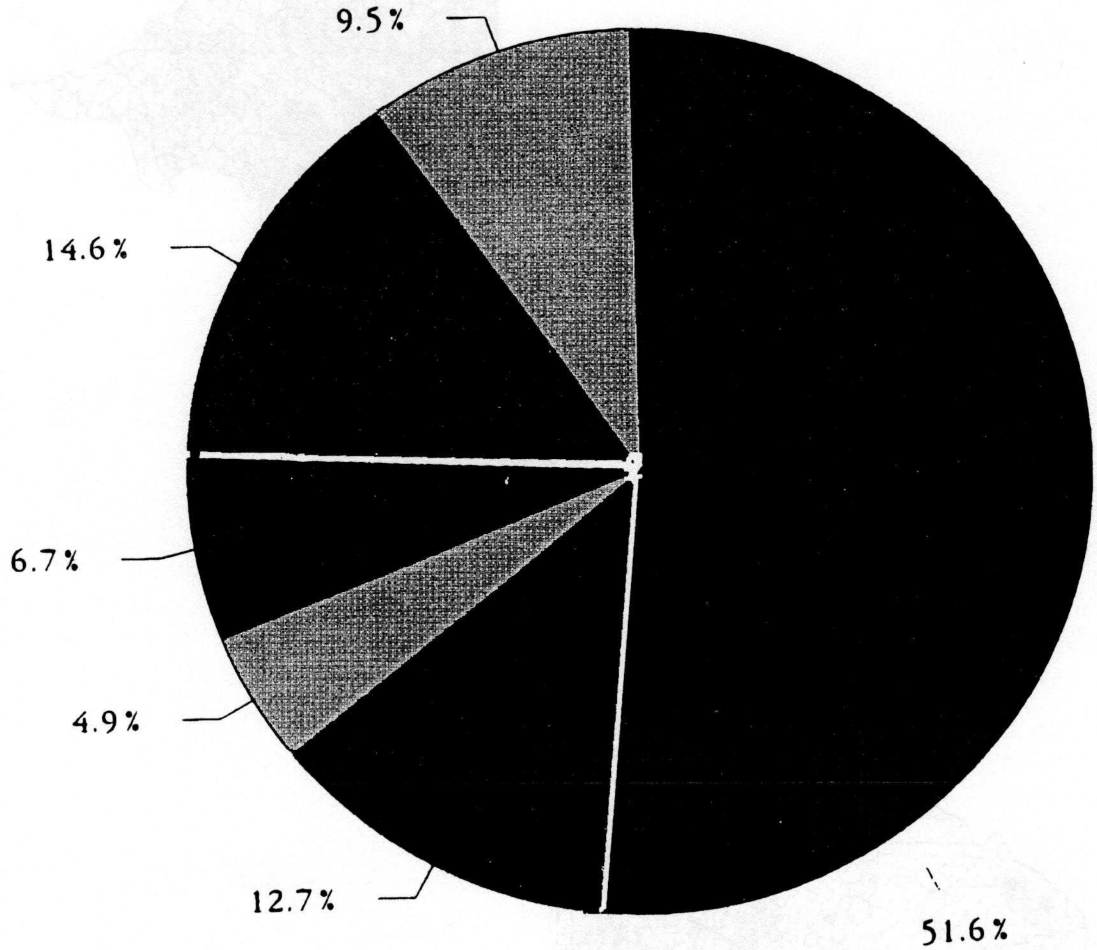

Figure 2. Percent Population by Area Code

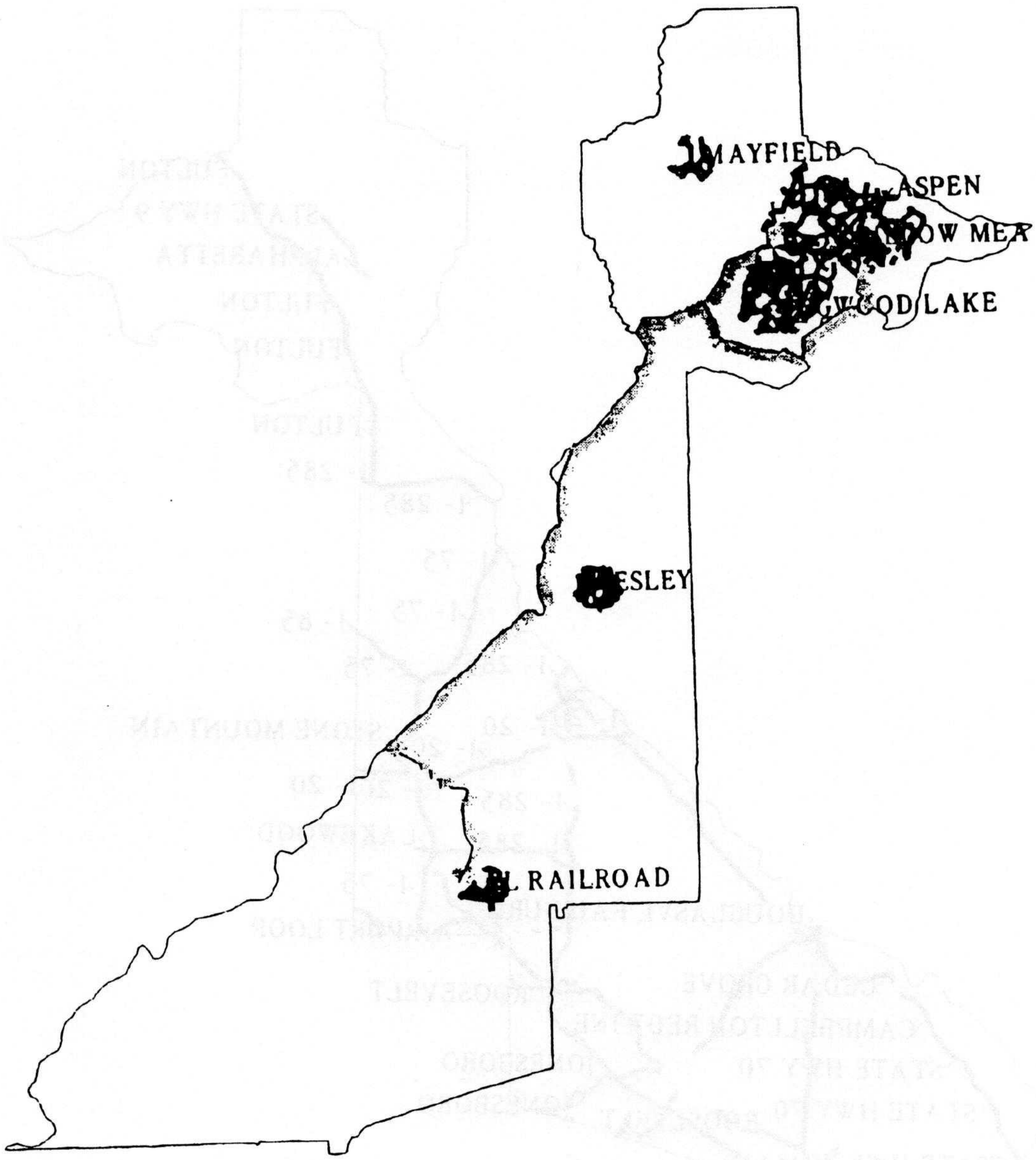

Figure 3. Potential Disaster Locations and Optimum Path

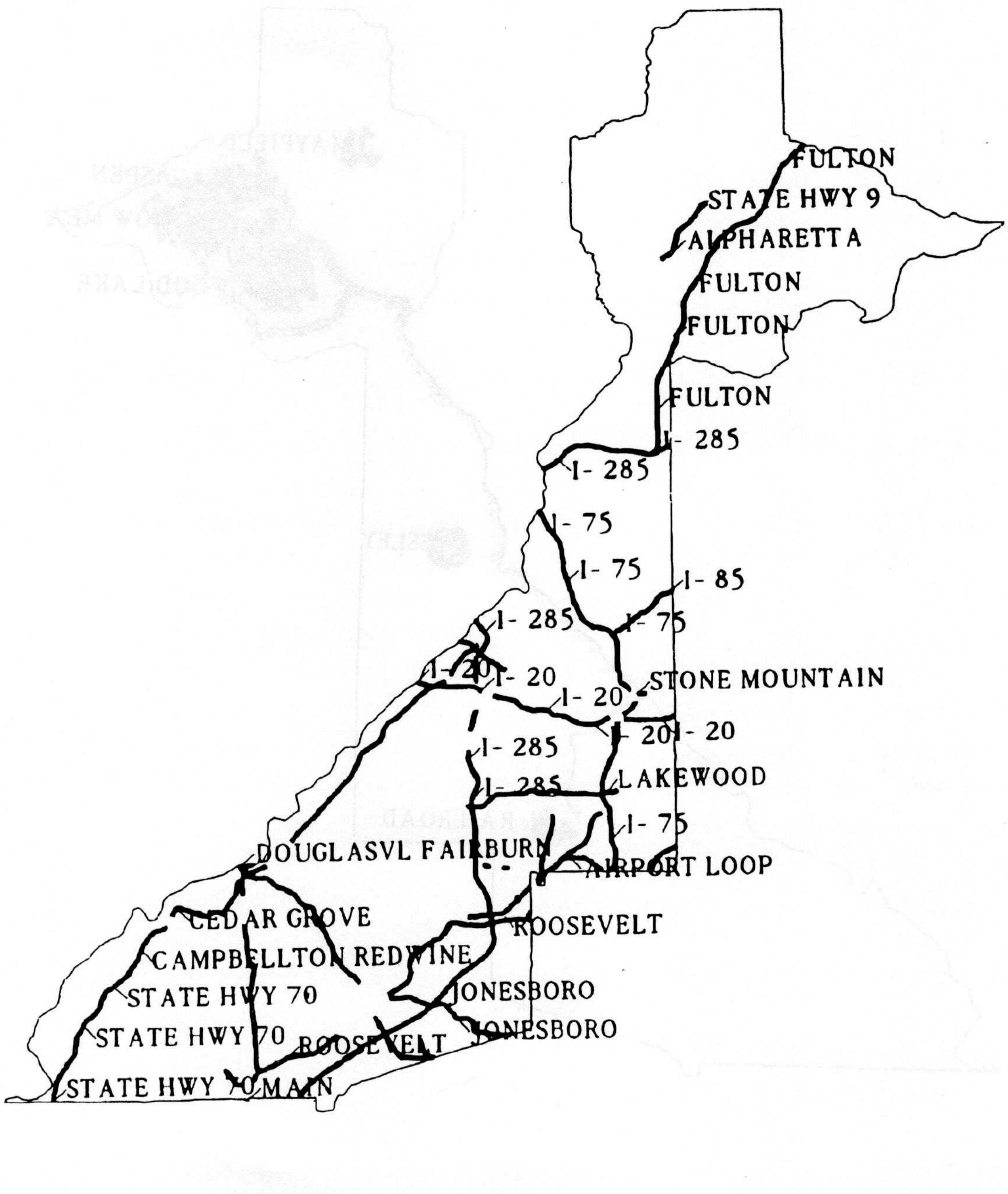

Figure 4. Path Optimization Routes