GIS MODEL FOR EFFECTIVE POLICE DEPARTMENT'S PERFORMANCE

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Abstract: Police department's (PD's) performance has become more and more important due to the increase in crimes and their fast spreading. In order to allow improved police services, modern technologies need to be utilized to serve this goal. In this work we are employing a Geographic Information System (GIS) to permit efficient planning, informed decision making and optimal performance, especially in emergencies. GIS creates an efficient database system that is easy to manage, manipulate, analyze, present and update for in action policeman as well as for a planner. All information is provided accurately and it is organized and located geographically in a timely manner. GIS provides a number of specialized tools to help dispatchers collect and relay all kind of information to the officers on the scene of crime, or in a natural disaster when help is needed desperately. The locations of schools, hospitals, gas stations or neighborhoods with different socioeconomic status influences the patterns and rate of incidents (road accident, fire, crime, burglar…etc). Hence, using GIS technology is a must if we need to save time and life.

Maps and analysis results provided by GIS can play a major role in reducing crime and improving the effectiveness of the Police activities. In this work, we built a GIS Model for the police stations in the city of Amman, Jordan, as an application to improve their efficiency, especially in emergencies. GIS allows informed decision making and better planning in different ways: relocation, redistribution, initiation of PD's etc. Multiple data sources were used to enrich the built GIS including available and field collected data (remotely sensed data with medium and high resolutions, LandSat ETM+ IKONOS images, and ground control points measured using global positioning systems etc.). A transportation network model was included to help in promoting the efficiency and to employ the state of the arts technologies and local based services in the PD's work. We analyzed the current locations of PD stations (we call them here PDs) and proposed better locations as well as proposed new ones (Sadoun, 2006; Al-Hanbali and Sadoun, 2006; Sadoun and Saleh, 2005; Saleh and Sadoun, 2006).

1 INTRODUCTION

The rates of crime, fire, burglar incidents are rising with time and new technologies are needed to be employed to promote people safety and provide ways to minimize their occurrences. In general, the distribution of incidents across the landscape is not geographically random since incidents are human phenomena. Police departments are on the duty of protecting the citizen's safety and taking safety measures to reduce the risk of breaking the law. It has long been common exercise for the police to identify locations and times that are more prone to criminal activities. GIS technology with the help of geodatabase of the PD's can definitely improve the effectiveness of police work in protecting cities and enhancing citizen security and safety (Sadoun, 2006; Al-Hanbali and Sadoun, 2006; Sadoun and Saleh, 2005; Saleh and Sadoun, 2006).

GIS is a technology that is used to observe and analyze data from a geographic perspective. It ties location to information (such as people to addresses, buildings to parcels, or streets within a network) and layers in order to give a better understanding of how it all interrelates according to a purpose. A GIS is most often associated with maps and an Information System for Geography. The Maps are constructed and used as windows into the database to support queries, analysis, and editing of the information (Sadoun and Saleh, 2005; Saleh and Sadoun, 2006).

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What can GIS do for emergency management and planning? Five Phases of emergency management were proposed (Donohue, 2002): alleviation protection from hazards and their effects, avoidance of any incident from occurring, vigilance plans to save lives and facilitating rescue, rapid response immediately after an event occurs, recovery and rebuilding communities to return to normal life and protection against future hazards. All phases rely on critical data from various sources which are simply managed using GIS.

The Louisiana Department of Transportation developed a GIS application (New Orleans Regional Planning Comission Agency, 2006) to identify city streets, highways, and infrastructures and to be used as a tool in analysis of traffic patterns, future construction projects, and land use. The utilization of this application was enormous after Hurricane Katrina ravaged the city of New Orleans. It was used by emergency responders linking street addresses with global position coordinates, in order to locate citizens during the Katrina storm and flooding. It was a critical, life-saving tool which was used by decision-makers and first responders in such unforeseen situations. Clearly, flexibility of GIS during unforeseen conditions is one of the benefits of such a dynamic tool.

GIS is very important in every day emergencies circumstance such as emergency health care provision, monitoring demands and intervention over time (Moore). It can determine the "response times" needed for individual stations to service their areas within target timescales or may be analyzing data from road traffic accidents to find the hot spots where more control is needed.

The global Internet and GIS can work jointly to provide access to distributed data (spatial & non-spatial) located at geographically isolated locations and shared dynamically for better decision making nationally or internationally in all times (Ghosh and Samaddar). A local preparedness objective is to accomplish and carry on risk-based target levels of capability in order to avert, protect against, respond to, and pull through from main human-caused or natural events in order to reduce the danger and shock to lives, property and the local economy (Oblinsky, 2007).

In this paper, we are building a GIS Model for the PD's in part of the city of Amman, the capital of Jordan, as a case study. The chosen parts are the regions of Shafa Badran, Abu Nsair and Swieleh (Fig.1), which are located in the north part of the city.

Figure 1: The study areas: Shafa Badran, Abu Nsair and Swieleh regions of Amman.

These regions represent the highly populated regions which include middle and lower-class population with a medium rate of incidences and crimes. The population of the area under study exceeds 600,000 inhabitants and it covers about 60 km^2. The location, service boundary and many attributes are included in the database to allow analysis and improvement, in addition to immediate reflections (response time) and guidance in emergencies. The ultimate goal of a law enforcement GIS is to use the power of analysis and planning to reduce crime. City planners and engineers can establish a visible police presence in troubled areas by monitoring crime sources and reacting immediately in case of emergency.

2 METHODOLOGY AND DATA PROCESSING

The methodology starts by collecting data from satellite images, aerial photographs and paper maps, then building a transportation network using GIS. Next step is to perform analysis on data; see flowchart depicted in Figure 2.

Data Acquisition. The data were collected in analog form then encoded in our computer. Spatial data from IKONOS and LandSat images, topographic maps, ground control points (GCPs), Amman tourist map (scale 1:25000) and from the field attribute data were used. Four IKONOS images resolution 1 meter covering an area of 10*10 km for the north of Amman were used in this work to produce the studied area (Fig. 3). Medium resolution satellite images LandSat ETM+ are shown in Figure 4. Ground Control Points were taken using hand held GPS with an accuracy of 5-6 m for Georeferencing

and registration of the satellite images and the PD's locations.

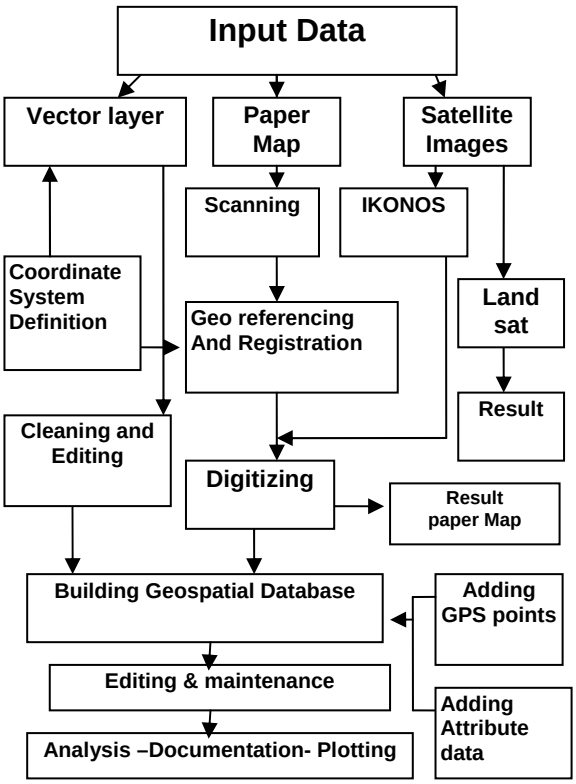

Figure 2: Flowchart of our methodology.

Attribute data obtained from maps include roads names, districts names, land marks and administrative units. Field data about police stations were collected from each police station such as: police station area of coverage, area of specialization, population within the administrative boundaries, among others. Additional field data was needed such as the census data especially about streets, addresses and locations. From the acquisition phase we should know the needed data and how it will be entered and used (import of existing data, digitizing or scanning). Data entry and development goes through edits and several stages of quality control. Then, Geo-referencing is to put the data in a geographic reference system that is meaningful to the organization (after the data entry and edits procedures). The processing procedure is summarized by the flowchart shown in Figure 5.

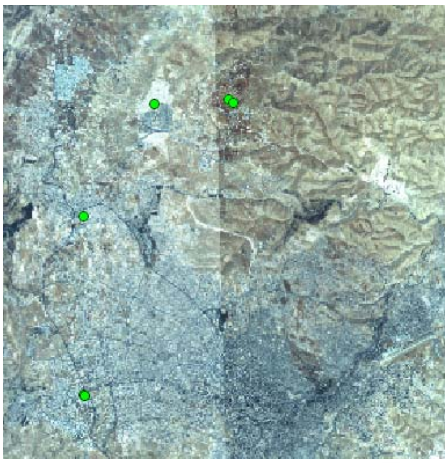

Figure 3: The produced single image from 4 IKONOS images (PD's locations).

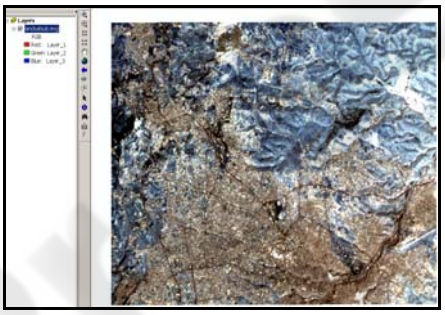

Figure 4: Landsat image.

By using LandSat image shown in Fig. 6, we were able to trace the main streets due to the high resolution of 30 m. Then we traced the local streets from Amman tourist map. Next, we built a main and secondary streets layer as depicted in Fig. 7.

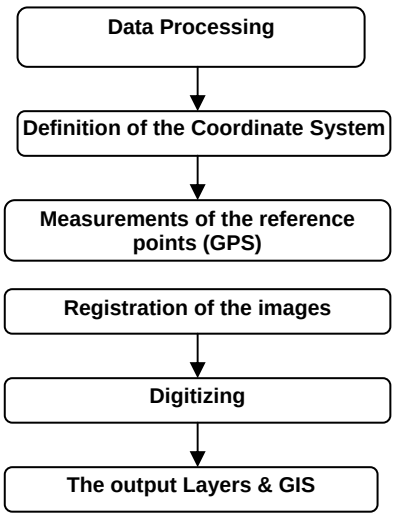

Figure 5: The flowchart of the processing procedure.

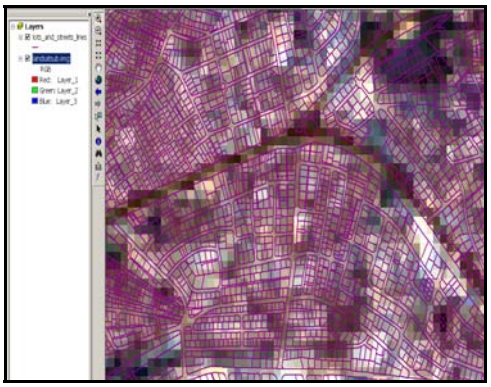

Figure 6: Landsat image shows only main streets.

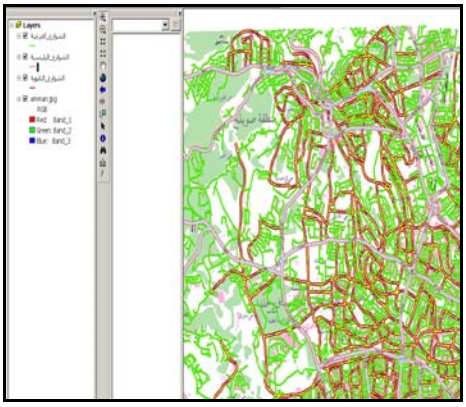

Figure 7: Main, Secondary, and Local Streets layers Built from Amman tourist map.

A rectification of this map was made using map to image registration. A transportation layer was extracted (streets edges) from the rectified and scanned tourist map. We used the produced street layers from the tourist map and overlaid it with IKONOS images; see Fig.8. We found that some local streets were missing and in other cases the streets were larger than realty. We needed to trace a street centerline layer from a high precise registered image. Then IKONOS images were chosen to carry on this project.

Building the Geodatabase. Image Registration: We used four IKONS images to be one georeferenced image (Fig. 3) in order to produce the street network; the image was registered using Ground Control Points (GCPs).

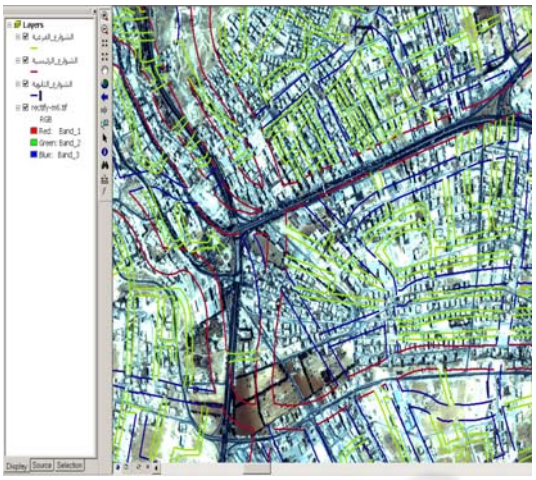

Figure 8: IKONOS images overlaid by the street layers from the tourist map.

Geo-Referencing. Raster data is obtained by scanning maps or collecting aerial photographs and satellite images. The location information delivered with aerial photos and satellite imagery is often inadequate. Thus, in order to establish the relationship between an image (row, column) coordinate system and a map (x, y) coordinate system, we need to georeference the raster data (image). Ground Control Points (GCPs) were used to establish a relationship between the image coordinate system and the geographic coordinate system.

Digitizing. This is the process of encoding geographic features into a digital form. It is carried out to create spatial data from existing hardcopy maps and documents. Our geo-referenced raster images were digitized using Arc View 9.1(on-line digitization) package. A road network of the area under study was digitized as line features; see Fig. 9. Administrative units, forests, gardens, are digitized as polygon features to create the needed layers. Gas stations, Governmental facilities, hospitals, hotels, hydrants, ministries, mosques, schools-universities, and trade (shopping) centers were digitized as point features; see Fig 10. The PD's were located on IKONOS images using GPS and were made into a layer. Then, the service area of each PD's (Abu Nsair 39 km^2, Sweileh 22 km^2 and Albeader) was created in another layer; see Fig.11.

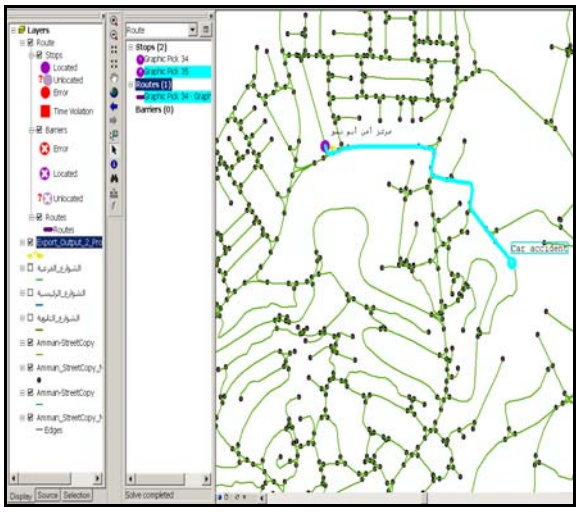

Figure 9: The network layer analysis showing the best route.

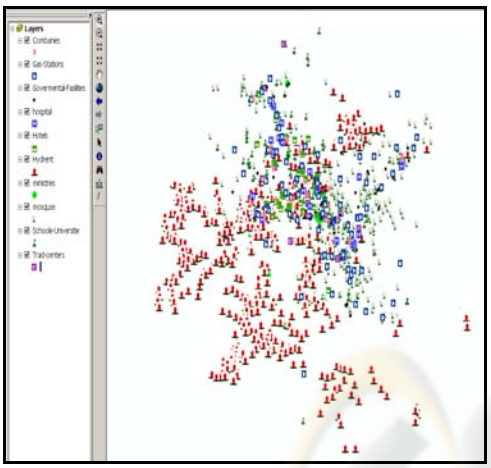

Figure 10: Point land marks.

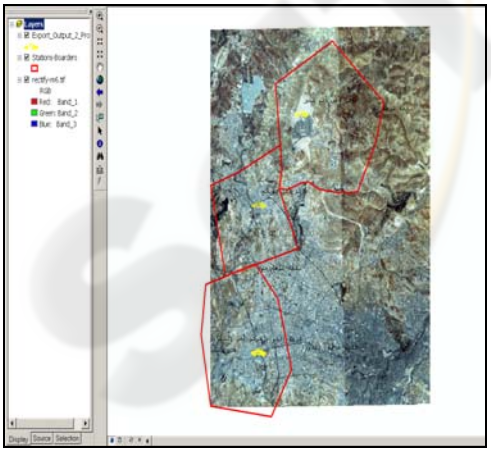

Figure 11: Police stations and service boundaries layers.

3 ANALYSIS AND DISCUSSION

GIS analysis is the process of looking at geographic patterns in the GIS database and the relationships between features, which is done by making a map, models or by combining many data layers.

The location of the PD's were analyzed and found to be distributed arbitrary meanwhile, their locations should be in the center of their administrative boundaries measured using the street length and not direct distance to the edges; see Fig.12.

We proposed new boundaries for the PD's using point circle buffers around each PD's (2,800 m radius) and fitting buffers with main streets edges to get easy access as shown in Fig.13.

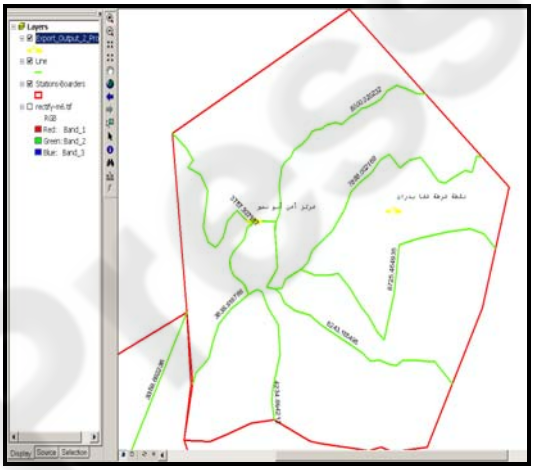

Figure 12: The main streets length from each PD to the edges of its boundary.

We suggested the initiation of new police stations and upgrading the already existing ones by considering urban and population growth (Aljbaihah) or newly established areas such as the Hussein Gardens/Park, which has an area of about 20 km^2 and serves 50,000 residents. The selection was based on fitting circular buffer of service area with the main streets axis from the region; see Fig.14.

We created the new service areas using the network analysis provided by GIS. Suggestions for one way streets were made. Endless functions could be used for providing protection and safety.

Amman Network was created as well to find the best route considering roads directions, the time or distance. Figure 9 illustrates the shortest route between a police station and an assumed accident with directions to quickly and accurately reach the place; see Fig. 15.

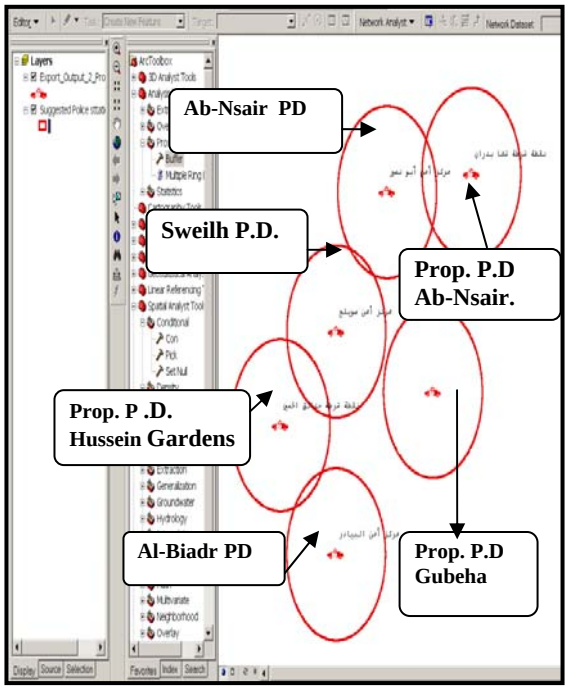

Figure 13: Old and new PD's according to best fit boundary to the buffer zone and streets.

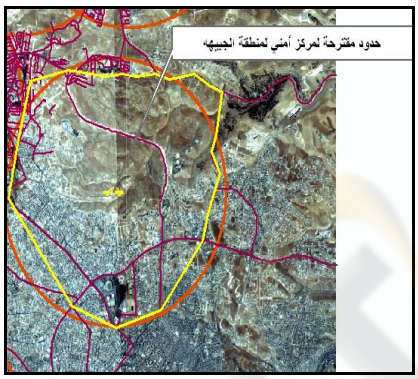

Figure 14: The best fit boundary to the buffer zone and streets.

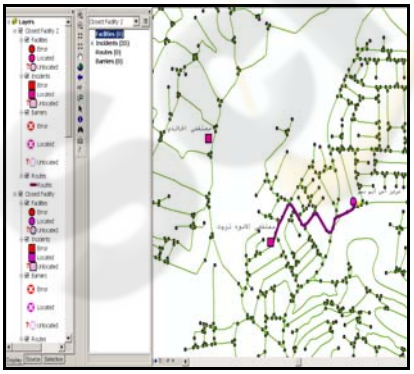

Figure 15: The direction to be followed to reach the assumed accident.

Figure 16 illustrates how to find the closest facility application such as; closest hospital to Abu Nsair PD, the closest hospital to a car accident, etc. GIS offers more than we can ask

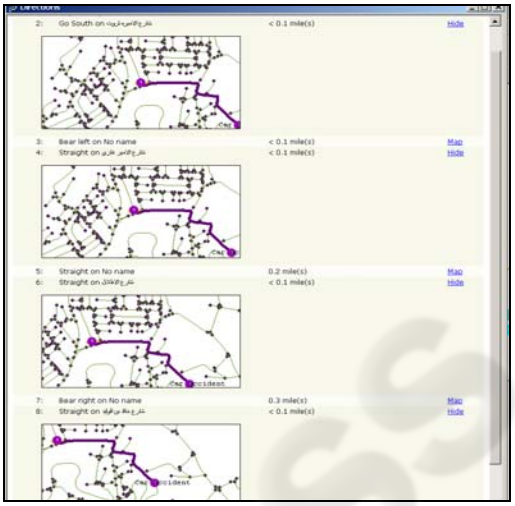

Figure 16: The closest hospital to an accident location.

4 CONCLUSIONS

In this paper, we applied GIS technology to help in planning and optimizing police station locations in the city of Amman. This is important in order to have the optimum and bets locations as well as to make sure that these stations are distributed properly and can meet future growth of the city, demands and situations.

The principal spatial and non spatial data obtained from the Police Directorate, governmental organizations and private sectors were organized and managed using ArcGIS 9.1 software package. The latter is efficient as it helps us to make accurate and proper analysis and presentation.

Basically we developed a GIS and Geodatabase for the PD's in the northern part of the city to allow the improvement of the PD's work. A road network for the capital city was created using different technologies (Land sat and IKONOS images, remote sensing etc.) in order to improve the PD's efficiency and planning. Clearly with the obtained GIS system, maintenance and enhancement of base maps can be performed easily with almost no time.

The created GIS will be useful in the development of any web-based GIS application such as vehicle crash location, safety analysis, etc. It also permits data sharing and partnership with national or international agencies.

State of the art applications such as tracking, traffic management, and location based services will be possible.

Accurate Geo-referenced high resolution digital image archive of the road network is created to allow real efficiency and services.

The analysis of the PD's locations in their zone of influence led to the suggestions for new better locations according to international criteria. In addition, suggestions to establish new stations were made. The system provides quick and accurate search engine. This is very useful in matters related to finding the shortest path to a hospital or the closest gas station facility based on the selected criteria such as distance or cost.

Finally, GIS can be used by law enforcement agencies and community planners as will as by private citizens to decrease crime and enhance police work awareness with local communities.

REFERENCES

Balqies Sadoun, "GIS Applications to City Planning Engineering," Encyclopedia of Human Computer Interaction, Idea Group Inc., pp. 234-241, January 2006.

Nedal Al-Hanbali and Balqies Saodun," A GIS-Based Interactive Database System for Planning Purposes, "Encyclopedia of Human Computer Interaction, Idea Group Inc., pp. 242-255, January 2006.

Balqies Sadoun and Bassam Saleh," Geographic Information System (GIS) for Tourism Planning Purposes," Proceedings of the 2005 International Conference on Information Technology, ICIT 2005, pp. 306-313, Amman, Jordan, May 2005.

B. Saleh and Balqies Sadoun," Design and Implementation of a GIS System for Planning," Journal of Digital Libraries, Springer-Verlag, Vol. 6, No. 2, pp. 210-218, April 2006.

Keith Donohue, "Using GIS for all-hazard emergency management", NRS 509, fall 2002 http://www.edc.uri.edu/nrs/classes/NRS409/509_2002/Donahue.pdf

New Orleans Regional Planning Commission Agency, "GIS Use in the Hurricane Katrina Response and Recovery Efforts", March 10, 2006. http://coastal.lic.wisc.edu/urpl969-katrina/urpl969-spring06-NORPC-paper.pdf

David Moore, "GIS in Emergency Planning: A Spatial analysis of Ambulance services. Spatial planning solutions", http://www.spatial.ie/downloads/GIS%20in%20Emergency%20Planning.pdf.

Subrato Ghosh and Arun B Samaddar, "Distributed and Interoperable GIS for Planning and Emergency in Indian Mines", http://gsdidocs.org/gsdiconf/GSDI-7/papers/TSsdSG.pdf .

Michelle Tilley Oblinsky, "GIS as a Tool for Emergency Management", Emergency planner/GIS coordinator city of Cheasapeak, VA. http://www.scag.ca.gov/rtptac/pdf/2007/tac051707_SecurityPreparednessWhitePaper.pdf.