

Identification of Accident Hotspots in Madurai using GIS

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Abstract— Road transportation system is one of the key features for the development of a country. With increasing number of vehicles every day, road safety has become a major concern. The traffic accidents are predictable and can be avoided by improving prevention. It is an urgent task to reduce accidents by performing analysis and suitable countermeasures. Several statistical methods can be used to determine the most critical points, called hot spots. The accident patterns can be easily monitored using Geographic Information System (GIS). The objective of this paper is to identify the accident prone zones in Madurai city using GIS and to analyze the accident pattern associated with it. With the help of GIS it is easy to manipulate and visually display numerous types of data for easy comprehension. For this purpose the accident data for the year (2007-2011) of Madurai city has been used. The density and Extraction functions in spatial analyst extension of Arc GIS software were applied to identify the accident prone areas. In those functions both point and kernel densities were applied in identifying accident patterns. The analyzed information would be useful for the Traffic police department and civic authorities to take the necessary and precautionary steps to avoid such accidents and to save many more lives.

Keywords— GIS, Spatial analyst, Kernel Density, Query analysis, Hotspots.

I. INTRODUCTION

A. Importance of the problem

The city of Madurai and its urban environment continue to experience rapid growth, which is characterized by increasing population, trade, vehicle ownership and transport systems. But the development of urban transport system has not kept pace with the traffic demand both in terms of quality and quantity. The disproportionate growth in the traffic sectors along with lack of lane discipline and deficiencies in traffic control have contributed to the increasing problem of congestion in urban areas. This situation has created a challenge in dealing with the road safety problem in the city.

The Paper explains the method of using GPS and GIS together to accurately reference an accident location on a GIS map. The advancements in these fields have been an effective use in accident analysis. In addition to promoting linkage between various types of data and maps, GIS is able to manipulate and visually display numerous types of data for easy comprehension. GIS is a technology for managing and processing location and related information. Also GIS would make analysis less time consuming and less tedious which otherwise would become very labor sensitive. Thus GIS will offer a platform to maintain and update accident record database and use it for further analysis.

B. Problem formulation

The city of Madurai and its urban environment continue to experience rapid growth, which is characterized by increasing population, trade, vehicle ownership and transport systems. Madurai with the most of the roads being laid on the national highway stretch connecting many districts, a glance at the data available with the police department reveal that the fault of drivers has been a major factor for rise in fatal accidents. The problems of bad weather, bad road and fault of mechanical defects were negligible when compare to the fault of drivers. Officials also added that on many incidents, the fault of passengers and pedestrians had been attributed as cause for fatal accidents.

According to the data(2007-2011), 1600 accidents reported were due to the fault of drivers. While the number of vehicles hitting the roads had raised manifold, the number of road accidents too had risen. This problem which is growing everyday has made us to pursue the analysis of accident patterns so as to reduce the number of accidents. The deaths of persons and serious economic loss caused by road accident demand a continuous attention in accordance with the spectacular growth in the road transportation. The results in turn can be fed in to systems and so provide accurate recommendations to vehicle drivers, the police, motoring organizations and local authorities.

II. STUDY AREA & DATA USED

A. Study area

In this study Madurai city is chosen as the study area which has an area of 52 km² and a population of 14,65,625.

Geographic location of Madurai city

Longitude 78 04' 47" E - 78 11' 23" E

Latitude 90 50' 59" N - 90 57' 36" N



Fig 1. Study area

B. Data used

Instead of using toposheet or scanned maps of minimum scale, we are going for satellite images for identification. The available toposheets are surveyed at different years sometime back. Therefore latest information of roads is available in satellite images only.

i) Imagery used

The satellite data used in this paper is a raster data taken from the RESOURCESAT IRS (P6) satellite.

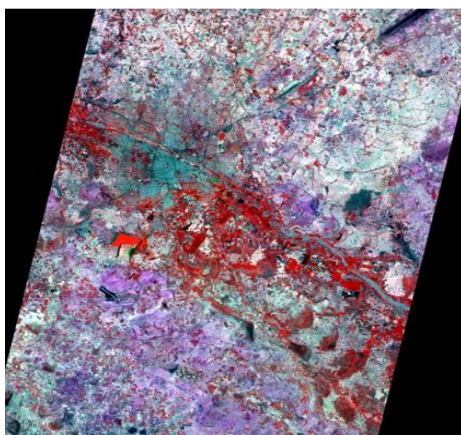


Fig 2: IRS-P6 Satellite image of Madurai city

ii). Accident/crash data

Crash data for the year 2007-2011 are collected and analyzed. Obtained from the traffic investigation department of Madurai city. The obtained information contains certain details about crashes, such as the type of crash, severity, time of occurrence, crash location, direction of movement of the vehicle prior to the crash, information about the people involved in the crash as well as vehicle information.

iii) Location data

To identify the position of the hotspots collected, Global Positioning System Device (GPS) was used.

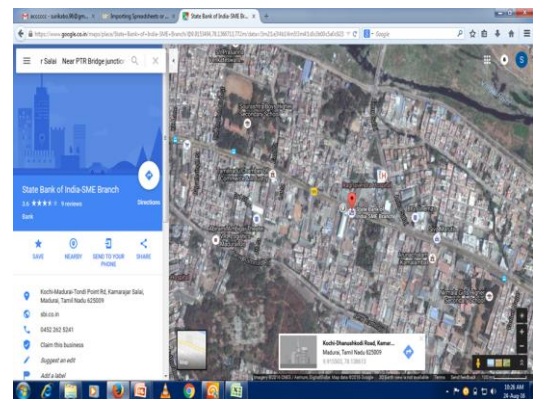


Fig 3: Google map

iv). Software used

ArcGIS is a suite consisting of a group of geographic information system (GIS) software products produced by ESRI. ArcMAP section provides an introduction and overview to ArcMap, which is the central application used in ArcGIS. ArcMap is where you display and explore the datasets for your study area, where you assign symbols, and where you create map layouts for printing or publication. ArcMap is also the application you use to create and edit datasets. ArcMap represents geographic information as a collection of layers and other elements in a map. Common map elements include the data frame containing map layers for a given extent plus a scale bar, north arrow, title, descriptive text and symbol legend.

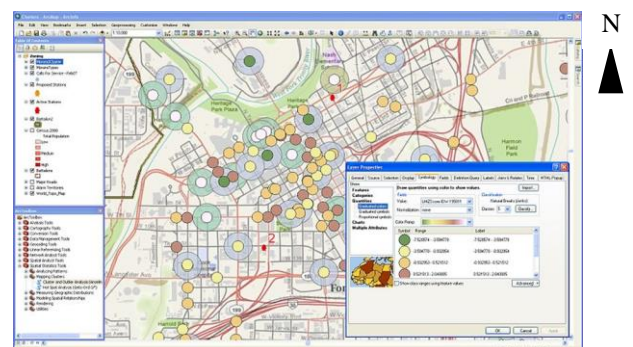


Fig 4: Arc View software

III. METHODOLOGY

A. Introduction

This study methodology comprises of different stages. The initial stage is the **data collection** stage where in **accident data are collected from the traffic investigation department**; the satellite data of Madurai city which is an IRS-P6 resourcesat imagery is obtained from National Remote Sensing Centre(NRSC) Hyderabad. The **location information** for the corresponding hotspots obtained earlier where found **using Google map**. A next stage is adding **spatial data and attributes data** to the geo-referenced input image using Arc-GIS software. In the software, digitization of various layers are done with various tools. Hotspots were digitized as point features and road networks were digitized as line features. Several attributes given by the traffic police department were integrated to the respective hotspots identified earlier. Then in the final stage, with the query analysis obtained from the results of database, Kernel density is found. Kernel density calculates the density of point features around each output raster cell. Conceptually, **a neighborhood is defined around each raster cell center, and the number of points that fall within the neighborhood** is totaled and divided by the area of the neighborhood a report is prepared and submitted to the Madurai corporation and traffic authorities. The detailed methodology is given as a flowchart.

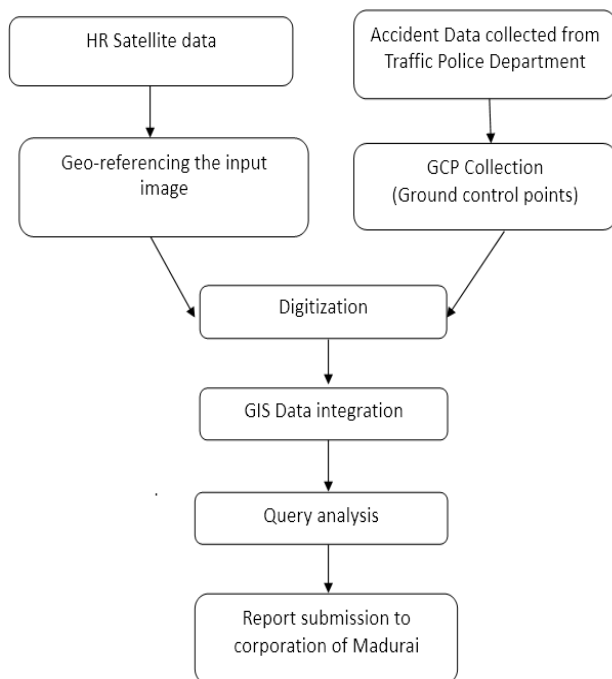


Fig 5: Methodology

B. Data collection

The Satellite data used for this project IRS-P6 of Madurai city, Tamil Nadu which is of 2.5m resolution image. The study area includes the regions are i) Thallakulam & Anna nagar, ii)Thilagar Tidal and iii) Town ranges. The accidents that happened in all those ranges are collected from the traffic investigation department, Madurai city

C. GCP calculation

The accident location details were collected with the help of Google map. Then the details obtained were integrated in Arc-GIS software with respective to their latitude & longitude values.

D. Geo referencing

Geo-reference means to define its existence in physical space. Therefore establishing its location in terms of map projections or coordinate systems. Different maps may use different projection systems. When data from these different sources need to be combined and then used in a GIS application, it becomes essential to have a common referencing system.

E. Digitization

It is a Process of converting features on the satellite image into digital format. The x , y coordinates of these features are automatically recorded and stored as spatial data. To digitize several layers in a GIS map, ArcGIS has several inbuilt tools. The use of these tools to digitize the various features are essential in creating & visual displaying of the database. Creating an empty shape file, wherein here new point and line features are created in Arc catalog.



Fig 6: Digitized map

F. Assigning attributes

All vector data (i.e line, polygon and point features) will contain separate attribute tables. Here each road is labeled with its corresponding name with the help of the city map obtained from the authorities. Similarly the accident location attribute table contains the following data i) Peak or non peak Hour, ii) Gender, iii) Month and date of occurrence, iv) Vehicles Involved, v) Type of injury, vi) Exact area of occurrence.

IV. RESULTS AND DISCUSSION

A. Identification of hotspots

The results obtained from this work are mainly Geodatabases, Queries and Density maps considering various criteria. The geo-database created with the attributes will be useful for officials monitoring traffic to visually interpret what would have happened and take precautionary steps. From queries, it is easy to create innovative ideas in reducing the accidents. One of the hotspots were identified through the GIS analysis.

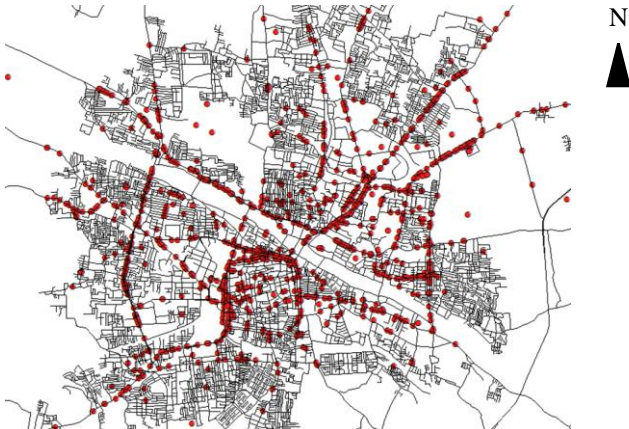


Fig 7: Accident hotspots(2007-2011)



Fig 8: Accident hotspot at central madurai

B. Preparation of density maps

In this study the analysis has not been confined to any particular class or type of accidents. Hence it is decided to consider all the crashes irrespective of type of vehicle involved and to determine accident locations by developing Kernel density maps. It shows the repeated zone of the accidents

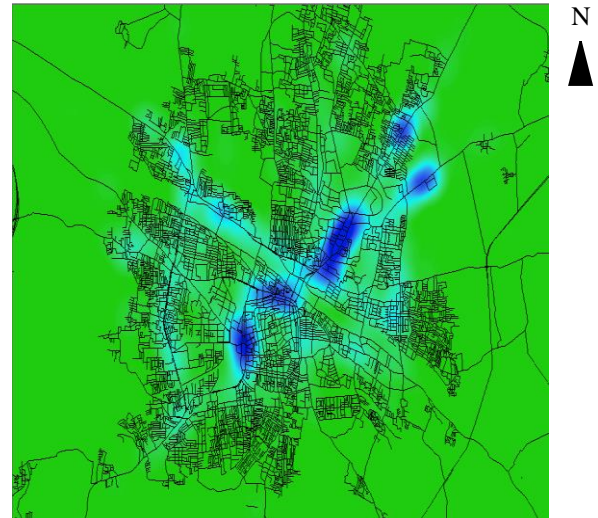


Fig 9: Accidents prone zone

C. Steps for preventing accidents

- Wear seat belts Seat belts are life saving.
- Obey traffic rules. Traffic rules have been designed with safety foremost in mind. It takes into account safety for all, including pedestrians.
- Pedestrians and children come first – Preference is to be given to pedestrians and children crossing the road.
- Read caution signs: Caution signs are very important as they warn about accident prone spots so that the driver can reduce the speed of the vehicle.
- Air bags in vehicles are a must to cushion the impact in case of accidents.
- Reflectors to be used on the rear of the vehicle. Ensure all lamps are in working condition.
- Vehicle must be in good working condition- there should be no compromise on the quality of brakes and tires.
- Drugs and alcohol while driving should be avoided. Drugs and alcohol can slow down reflexes, disrupt accurate judgments, and cause mental alertness to dip. They have been the reason behind many fatal road accidents.

Conclusion

This result of this work gives an insight into the present scenario of the traffic condition of the area and shows out the most accident prone roads in Madurai district. This geo-database in turn can be fed into “expert” systems and so provide accurate recommendations to vehicle drivers the police, motoring organization and of course local authorities. The future work in this paper is to develop queries regarding the hotspots by which measures like traffic signals, speed breakers, toll booths could be modeled to minimize the accidents.

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References

- [1]Anitha Selvasofia.S.D and Prince Arulraj. "Identification of hotspots of traffic accidents using GIS" Vol.8/Issue 3/July-sep16.
- [2]Wong, D. W. S., and J. Lee. 2005. "Statistical Analysis of Geographic Information with ArcView GIS and ArcGIS". Hoboken: Wiley.
- [3]Somalia Saleh, journal of Traffic and Logistics Engineering Vol. 2, No. 2, June 2014. Anderson, T. K. 2009. Kernel density estimation and K-means clustering to profile road accident hot spots. Accident Analysis & Prevention 41(3): 359-364.
- [4]Thomas, I. 1996. Spatial data aggregation: Exploratory analysis of road accidents. Accident Analysis & Prevention 28 (2):251-264.
- [5]Geurts, K., G. Wets, T. Brijs, and K. Vanhoof. 2004. Identification and ranking of black spots: Sensitivity analysis. Transportation Research Record 1897: 34-42.
- [6]A GIS based traffic accident data collection, referencing and analysis framework for Abu Dhabi.
- [7]Alind Saxena, Environmental & Road Traffic Safety, CRR, GIS as an aid to identify accidents patterns, www.gisdevelopment.net
- [8]Enhancing Road Traffic Safety: A GIS Based Methodology to Identify Potential Areas of Improvement.
- [9]Environmental Systems Research Institute (2006) 'Getting Started with Map Objects 2.4.
- [10]A case study for identification of accident zones on kannur district, International journal of Geomatics, Volume 1.
- [11]M.Renganathan, R.Baskaran, Asima Chaudari and K.V.Satyanarayana, "Preparation of digital maps using GIS tools", Geomatics 2002.
- [12]Kamalasudhan, National University of Singapore, An analysis of expressway accidents in Singapore using GIS, www.gisdevelopment.net
- [13]Vanjeeswaran, Identification and ranking of High Pedestrian Crash zones using GIS, 2005 Annual ERI International User Conference, ASCE.
- [14]Menno-jan Kraak & Ferjan Ormeling "Cartography-visualization of Geospatial data", Second Edition, Pearson Education – 2003.
- [15]Reshma E.K, Sheikh Umar Sharif, "Prioritization Of Accident Black Spots Using GIS" in International Journal Of Emerging Technology And Advanced Engineering (ISSN 2250-2459, Volume 2, Issue 9, September 2012)
- [16]Josphat K., Z. Mwatelah, "Application of Geographical Information Systems (GIS) To Analyze Causes of Road Traffic Accidents (RTAS) – Case Study of Kenya" in International Conference on Spatial Information for Sustainable Development Nairobi, Kenya 2–5 October 2001
- [17]Prastacos, P. (1992): "Integrating GIS Technology in Urban Transportation Planning and Modeling" Transportation Research, 1305, pp 123-130
- [18] P.S.Bhargavi & N. Kannaiya Raja., A Study On The Effective Traffic Management Of Roads To Reduce Road accidents In Tamilnadu in International Journal of Enterprise Innovation Management Studies(IJEIMS) Vol2. No2. July-Dec 2011 ISSN: 0976-2698 Pp: 172-190
- [19] T Kiran Kumar¹, R Srinivasa Rao² "Traffic Accident Analysis Using GIS- A Case Study" in International Journal Of Scientific Research And Education||Volume ||2|| Issue||9|| Pages 1813-1823||September-2014|| ISSN (e): 2321-7545
- [20] B.Ganeshkumar, D.Ramesh "Emergency Response Management and Information System (ERMIS) – A GIS based software to resolve the emergency recovery challenges in Madurai city, Tamil Nadu" in international journal of geomatics and geosciences volume 1, no 1, 2010
- [21] Deepthi Jayan.K , B.Ganeshkumar "Identification of Accident Hot Spots: A GIS Based Implementation for Kannur District, Kerala" in international journal of geomatics and geosciences volume 1, no 1, 2010