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Investigation on Road Conditions of Sholinganallur Taluk, Chennai, using Remote Sensing and Geographic Information System

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Abstract: Recording of road surface distresses like depressions, ruts, cracks are of great prominence in process to make sure the safety and comfort of all road users from pedestrians to motorists. The conditions of road ground work have severe effects on the riding and passing resistance. Hence, roads must be supervised inclusively to identify damaged road segments. This challenge has made GIS to be used as a system which is easy, cost effective and deployable. Toposheets from survey of India, satellite imagery IRSP6 of the study area, secondary data from transportation officials, field surveyed with photographs has been used as data in this study. From satellite imagery, up-to date roads like location, type of road, number of lanes, their conditions and other attributes are taken and required road networks map is generated. Collected GPS points are georeferenced and input which is carried using shape file generated in ARCGIS 10.3 software. Photos of road distresses are collected, geotagged and attached to the map which gives quality to the road map. The RS and GIS data are combined and utilized as input to the GIS dataset and then spatial query analysis is carried out. Secondary data of road accidents using GIS is processed and analyzed and compared with road distresses, statistical analysis is carried out and accident hot spots are generated which gives comparative analysis between road damages and accidents. The main motive of this study is to collate valuable spatially referenced road related data with accident data that will provide information for effective road maintenance. With this road maintenance can be done at early stages which in turn reduces repair costs and also assists in better visualization of the areas through GIS maps which requires repair.

Keywords: Accident analysis, Field survey, GIS (Geographic Information System), Geo tagging, GPS (Global positioning System), Remote sensing.

I. INTRODUCTION

The spotting of distresses on road and their correct restriction assists in the advancement of driver's security and in the boosting of road sustention operations. Road quality evaluation has been taken as critical issue. The spotting and quantification of road distresses provides worthwhile particulars to the maintenance officials on the road system habitat and minimize maintenance costs [1]. For the systematic gathering of road condition data, different practices have been proposed which involves a labor exhaustive, time taking and a speculative procedure of data solicitation. The intention of this operation is to discover any distraint at initial phases in order to enforce alimony on time [7]. Roads in improper conditions rises accident rate. So, a prompt, easy going and cost-effectual method of setting up GIS dataset is projected in this paper. The time and cost accessibility of spatial data is required for supervising. Such data admit satellite images. The technology of remote sensing provides an illustrative and logical way for placing geographic lineaments [9]. Data on the position and discipline of the roads system is crucial for their effectual management. Engineering science is now usable to make the ground work performance process effective and remote sensing is one of those sciences. According to statistical data, 1.17 million demises happen every year across the world as a result of road accidents. Therefore, it will be desirable to minimize the conflicts and increase the competence of traffic management in handling road facilities. Improper road condition like skidding, potholes and ruts killed 11,386 people in the 4 years (2013-2017). The number of potholes related fatalities increased in India from 2,607 in 2013 to 3,039 in 2014 and 3,416 in 2015. Tamil Nadu stands in eight position in pothole deaths among the top 10 states registering 481 deaths between 2013 to 2016. Assessing the road conditions reduces the repair costs. It has become imperative to investigate the causes of such accidents with a view to limit their frequency and severity from a pavement condition viewpoint (Times of India, 21 Sep,2017).

At the end of last century, the number of human populations was 6 billion. Projections indicate that in 2050 the population will exceed 9.3 billion. Therefore, there is an emerging need to manage every asset. GIS have played a major role to develop spatial data information. Remote sensing has the capacity to give detailed road plotting and propose more reliable and economical methods to elevate transportation network surveillance. Recent developments in remote sensing technology have provided a variety of potential avenues for generic and systematic research on these problems [4]. Hence it become imperative to establish modern methods and technologies to track our roads. Hence, the interpretation of GIS and Remote Sensing in road investigation is a better alternative. [4] GPS and GIS applications helps in the maintenance of road database making use of common locational reference system (LRS) that combines road data. GIS helps in integrating all the GPS and RS data into one domain and to let spatial query and exploration of that data.

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This method also consists of site inspection, intuition and computations in assessing condition of roads. Therefore, introduction of GIS and RS will be better, faster and accurate. This investigation is focused at utilizing GIS and RS technologies in predicting road conditions [9] using Sholinganallur taluk, Chennai, Tamil Nadu as the area of the study.

II. STUDY AREA

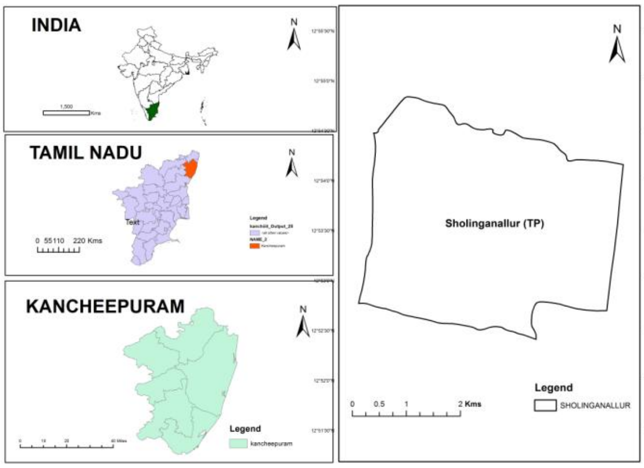

Figure 1 Sholinganallur Area

Sholinganallur is a part of Chennai, India, our study area is situated on latitude 12° 50′ North to 13° 00′ North latitudes and 80° 10′ East to 80° 16′ East longitudes. The fast growth of Sholinganallur's providence, community and infrastructure can be aspect to IT business parks and committed special economic zones. Sholinganallur is enclosed by other information technology-based outskirts such as Siruseri, Perungudi and Taramani. TIDCO is constructing a commercial City in Sholinganallur to dwell global commercial corporations. Sholinganallur is the considerable assembly constituency in Tamil Nadu in point of voters. Sholinganallur was adjoined in to Chennai Corporation in 2011, and it is the 200th zone of Chennai city, governed as a department of Chennai Corporation. Government is building up a Metro Train-Phase 2 along Sholinganallur route from Madhavaram till Siruseri IT park (expected to be functional by 2024). If Metro train is functional, it will be a boost up for overall development in OMR road. Due to the fast-industrial development with more employment opportunities, it is treated as The Next Guindy in Chennai. Sholinganallur comes under Zone-1(Madhya Kailash to Sholinganallur) of OMR Road.

III. DATA COLLECTION

The data used in this study include primary data and secondary data.

A. Primary Data

1. Geographic coordinates of control points were used for associating locations on physical space and for correlating the road map and remote sensing image. These inputs were accessed by ground survey with the utilization of the GPS gadget. This GPS was put to use to collect points (Lat, Long) of discrete road distresses as a channel to confirm their positions (spatially and aspatially) in the remote sensing image.

2. Attribute data: For the objective of elucidation and authentication of results, plot checks together with photographs (ground truthing) were accomplished.

B. Secondary Data

1. Surveyed street design map of Chennai metropolitan was sourced from Land Records at Chennai as a base data.

2. Toposheets will be collected from Survey of India.

3. IRS P6 high resolution satellite image of January 24th, 2008 and 2016was sourced. All datasets were acquired and georeferenced.

4. Accident Analysis Data of road distresses is collected from TNRDC pvt.ltd.

Figure 2 Satellite Imagery

This Fig.2 shows the satellite imagery of road networks in the study area with which digitization in ARCGIS 10.3 is carried out.

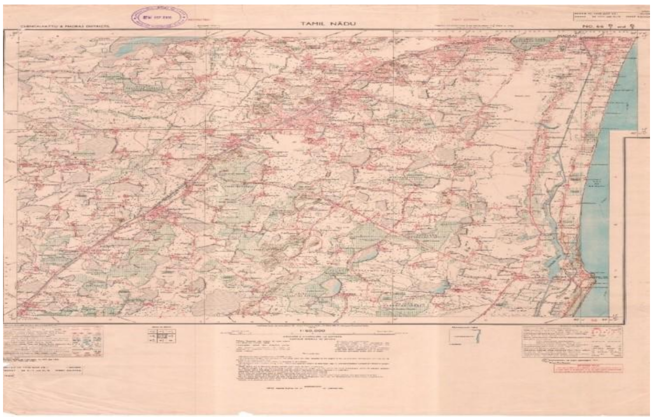

Figure 3 Topo Sheet of Sholinganallur Taluk, Chennai from SOI

IV. METHODOLOGY

The database of the roads used in the study are taken from the toposheet of survey of India and the updated roads are taken from satellite imagery IRSP6 and google earth, then georeferenced to ensure all the lineaments are in the same co-ordinates and then digitized using ARCGIS 10.3 which was a contributing factor to achieve the digital inventory quickly.

Ground truthing with photographs was done to check and verify locations. Accident analysis data due to road distresses is collected from TNRDC Chennai. This data is inputted into GIS and Hot spot analysis followed by density analysis is carried out. Location based coupled parameter querying system is done. Finally, maintenance action maps with present conditions of roads is generated with the distress photos geotagged to the locations which helps in the further process of reporting and recording.

Data processing is the abstraction in computerized form of physical data to be used for investigation or envision. For producing GIS output, accurate geographical and characteristic data is crucial. Attribute data includes road inventory and condition data, accident data, whereas spatial data includes topo sheets, road networks and thematic maps. These data are integrated into GIS and analysis are done to generate a planning and monitoring output. The below table shows the methodology in step by step process.

1. DATA PROCESSING → ATTRIBUTE DATA; SPATIAL DATA
2. ANALYSIS MODULUES
3. PLANNING
4. MONITORING OUTPUT

A.Spatial Input Formulation and Entry

The remote sensing image of study area was digitized by encrypting the requisite input into the GIS domain. The road database was the primary collection encrypted from the hard copy maps collected. The lineaments were altered and compatible characteristics joined into the system. In GIS domain, applicable data taken to form the basis of the database of the roads were generated. The following characteristics are carried out in the geodata set

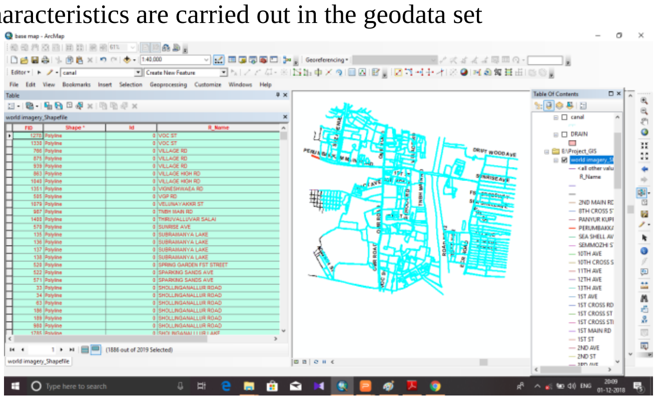

Figure 4 Attribute Database Table

This fig.4 shows the databases like type of road, name of the road, number of roads and location of roads.

V. RESULTS AND DISCUSSIONS

The detailed roads are visible on the remote sensing images. The road surface conditions can be detected from these images. Fig.5 shows the digitized road networks overlaid on the study area map. ARCGIS 10.3 is utilized for digitizing the roads and overlaid them on study area. An outline of the road networks is acquired.

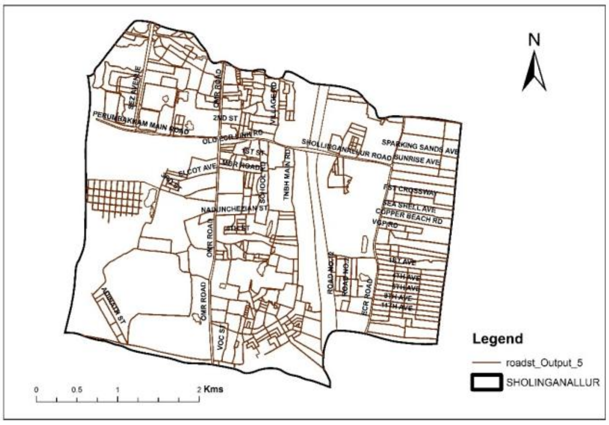

Figure 5 Digitized Map of Study Area

A. Geographical Distribution of Road Distresses

Road distress locations of the study area are taken, the dimensions of the distresses are measured by tape and input into the GIS and overlaid on the map. The classification, extent and amount of the distresses are input in the database. In this note, road pavement failures in a GIS database become a physical record detailing both the extent and the position of the distresses.

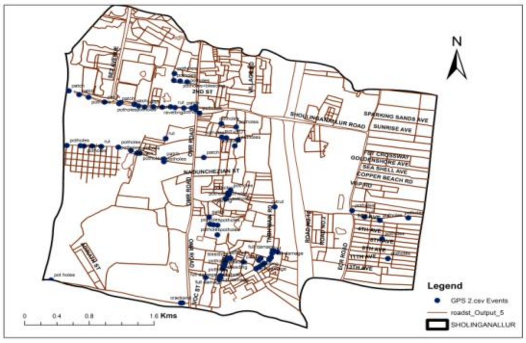

Figure 6 Points Locating Distresses

B. Geographical Identification

Geographical identification i.e. geo tagging is the process of adding spatial coordinates (Lat, Long) to the photographs. Geo tags which are automated are inserted in pictures taken with phones using GPS. The process of geo tagging includes following steps.

1. Selecting the feasible spatial element.
2. Capturing GPS location.
3. Capturing the photograph.
4. Filling necessary attribute information.
5. Sending to the server.
6. Visualization.

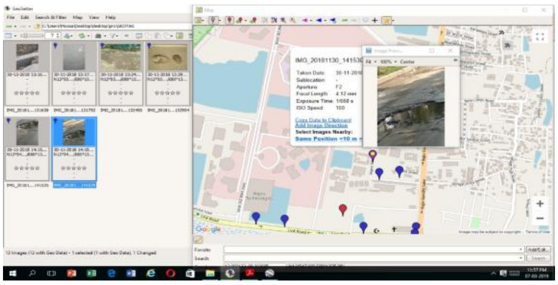

Figure 7 Geo tagged Points

. ***Spatial Analysis***

The GCP (Ground Control Points) were collected and the accident spot locations are converted into shapefiles using ARCGIS software. The accident details were added as attribute data.

C. Accident Spots

The accident spots are visualized by overlaying the accident location with the road Networks. Figure 8 shows the various types of accidents involved in the form of simple, Grievous and fatal with the respective years.

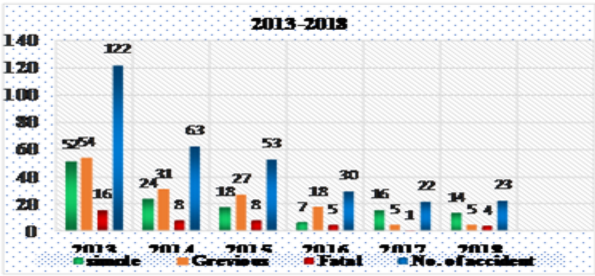

Figure 8 Graph Showing the Variation of Severity of Accidents

Fig.8 shows that in 2018, fatal accidents compared to 2017 has increased from 1 to 4 because of road distresses.

Figure 9 Spots Locating Accidents

E. Accident Hotspots Analysis

A hotspot can be defined as places which are the areas of more accident occurrence. Hotspot maps were generated based on where accidents are historically more concentrated. From a map's perspective, the motive is to find "actual" hotspots information that are liable to cause of accidents under identical assets and combine data to the map as shown in fig.10

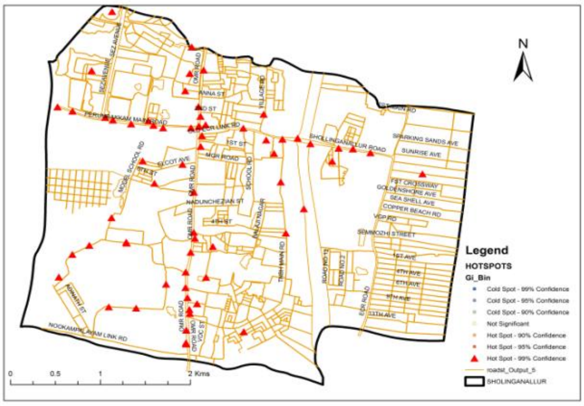

Figure 10 Accident Hotspots

F. Kernel Density Analysis

Kernel density analysis is carried out to find the zones which has the more accident chances. This analysis calculates the density. The accident-prone zones are classified into High, Medium, and Low. It displays the dangerous zone in red Color. Yellow color indicates medium accidents. Green color indicates very less chances of accidents.

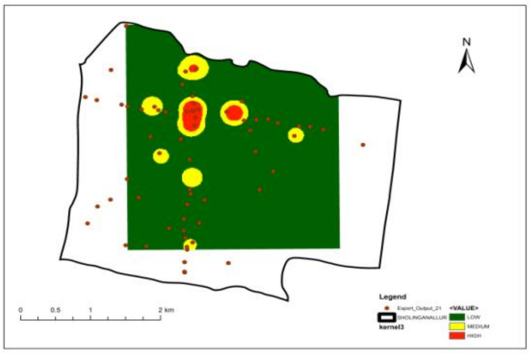

Figure 11 Kernel Density Map

Fig.11 shows that Sholinganallur junction (shown in red) is having the more probability of accident occurrence.

VI. CONCLUSIONS

This study was carried out to explore the use and effectiveness of emerging technologies like GIS and RS in the road condition monitoring. Toposheets showing the road networks in Sholinganallur taluk were utilized. Field survey using hand held GPS and Camera was also carried out to check the locations and features. 109 points of distresses are located. Remote sensing images were associated to the physical locations(georeferenced). The updated roads were obtained from satellite imagery IRSP6 and spread out as layer in the ARCGIS 10.3 software and integrated with the data set generated. Hence, the roads could be supervised and inquired. The final outcome of the research is a process developed for recording of road distresses and outlining for achievable efficient maintenance. It is an arrangement that can project where there are failures on roads that needs rehabilitation. It is evident that RS (remote sensing) and GIS can be utilized to investigate roads completely.

Analysis was also made to determine the accident spots that come under the local authorities so that the they can take up necessary measures like widening of roads, construction of speed breakers, medians etc. to reduce the accidents. Results have shown that it is possible to build a road condition monitoring system that can evaluate the road surface distresses and update them using GIS.

1. RS (Remote sensing) and Geographic information system (GIS) are the emerging technologies that are required to be incorporated by highways department, IRC, NHAI and corporate institutions that are contracted in designing and maintenance of roads
2. Conclusions of this research are expected to be benefitable for authorities and researchers. Future work may include the process of automating the road conditions.

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AUTHORS PROFILE

Dr. M.M Vijayalakshmi has about 27 years of Teaching, Construction and Research experience in the field of Intelligent Transportation System, Application of Remote Sensing and GIS, Performance of materials, Energy Efficient Building, Air and Noise pollution and Environmental Engineering. She is also involved in the design, fabrication and testing of concrete and other pavement materials for a tropical climate. She has her Under-Graduation at Vellore Institute of Technology VEC in Civil Engineering, Post-Graduation in the Urban and Transportation Engineering and Doctorate Research in Performance of Materials with Energy Saving Potential at Anna University, Guindy, Chennai. She is a recipient of Best Alumni Award-2010 for Research and Publication from VITAA, VIT, Vellore. She has received Bharat Ratna Award - 2017 for her Contribution in Education and Research by IFFS, New Delhi. She has awarded Best Women Engineer-2019 Award, CV Division by Institute of Engineers, India, Tamilnadu. She has guided 73 UG Projects, 11 PG Projects and 5 PhD Research works with 103 publications in reputed International, National Journals and International, National Conferences. She has contributed her technical knowledge in convening and organising many International, National conferences, workshops, conventions and seminars. She has been sharing her knowledge as a reviewer in indexed journals, for the past eleven years

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