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Alignment of Peripheral Ring Road Using Geo-Spatial Techniques

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ABSTRACT

Design of ring road deals with the development of a comprehensive plan for Construction and operation of transportation facilities. In order to develop efficient and better transport facility, it is necessary to have a proper procedure transport movement. This ring road helps to a great extent in improving the safe and fast movement of both human and goods traffic, thereby increasing the economy of the City. This improved economy contributes the growth of the country. The first and foremost step is reducing the traffic for the particular route by diverting the density of the vehicles to enhance the safe transport and environmental pollution. This project deals with the traffic problem of the Bangalore city and provides better transportation. In this project GIS is used for surveying, for preparing Contour maps, for developing three dimensional Digital Elevation Models, for various types of route alignments and for estimation of cutting and filling volumes.

***Keywords**: Ring road, transportation, traffic, GIS, Contour map, land use, land cover, Raster Modelling.*

INTRODUCTION

Transportation system is a vital part of any country as it contributes to the economic and social development. Effective and well-organized movement of people and freight depends on the connectivity and set-up of the transport system of any country. The land use characteristics and transportation system are inter-dependent as they contribute each other in improvement and expansion of transportation network. If the transportation system is safe, efficient and economical, the development of the place (city or country) improves as there is better accessibility. Based on the economic, social, cultural, commercial, residential and industrial patterns of the city or country, the transportation system is planned, designed, developed, maintained and improved. The transportation sector includes air, water and road transport systems. Roadway being the most important since it is used by a high percentage of population for movement from one place to another.

As one of the most important components of urban transportation system, the ring roads in the central districts have carried increasingly heavy traffic demands. The operating performance of these ring roads has been significantly deteriorated as the result; even congestions are generated frequently in some places.

Determining the best route through an area is one of the oldest spatial problems. This problem has recently been solved effectively using GIS and Remote Sensing technologies. During the last decade, a few attempts have been made to automate the route-planning process using GIS technology.

Study Area Description

Bangalore lies in the southeast of the South Indian state of Karnataka. It is in the heart of the Mysore Plateau (a region of the larger Precambrian Deccan Plateau) at an average elevation of 920 m (3,020 ft.). It is positioned at 12.97°N 77.56°E and covers an area of 1741 km2 (673 mi2) Currently, operational Outer Ring Road and NICE Ring Road are highly congested with the day-to-day traffic from the connecting road Bengaluru has been attempting to complete several large ring road projects to improve its city-region connectivity and alleviate traffic congestion. A series of ring roads namely, the Satellite Town Ring Road (STRR), Intermediate Ring Road (IRR), Peripheral Ring Road (PRR) and Town Ring Roads (TRR) have been envisaged. The NICE Corridor implementation was also undertaken of which the southern arc has been constructed.

The PRR which is the focus of this project and conceived by the Bangalore Development Authority (BDA) in 2005 too languishes, with the agency stating financial inability to meet the high costs of land acquisition related compensation.

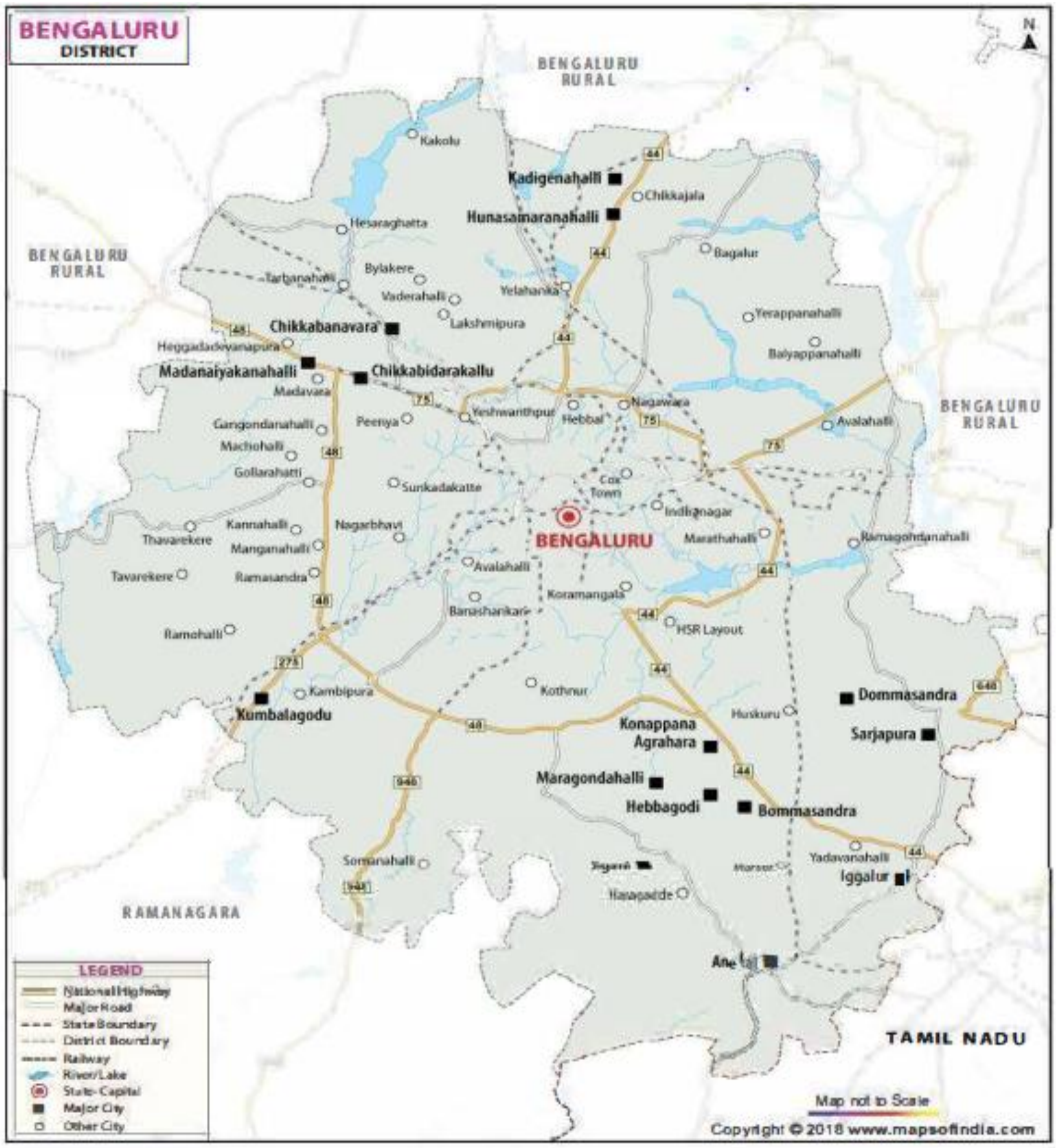

Fig 1. Location of Study Area – Bengaluru, Karnataka

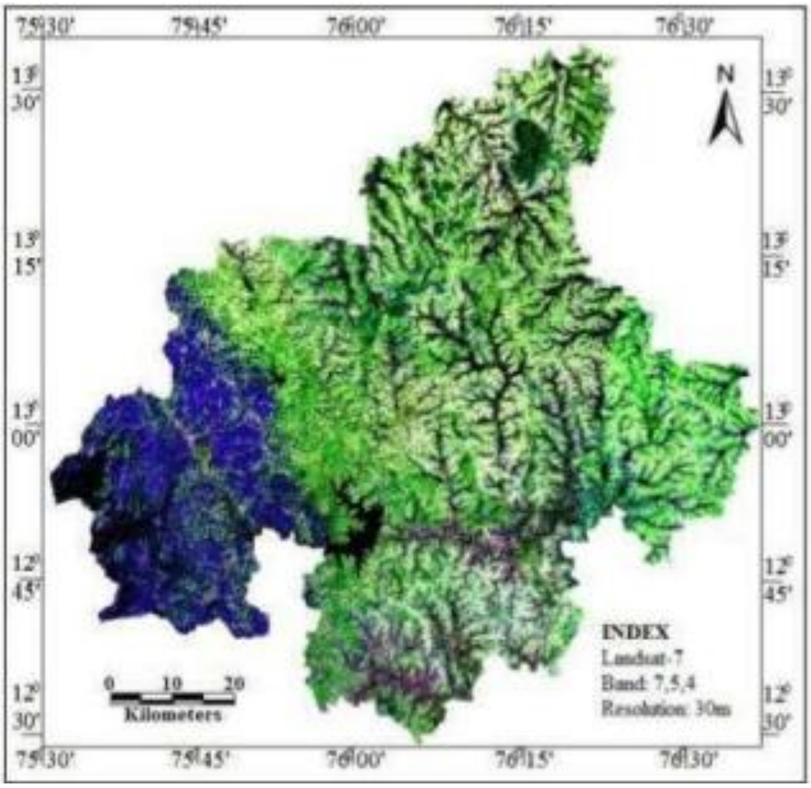

Fig. 2. Land Sat-7 Satellite Image of the Study Area

Data and Methodology

High resolution LANSA T satellite data of 2007 was used and by using Digital Image Processing techniques the following thematic maps such as geomorphology, Land use/ Land Cover were generated. The Digital analysis, such as overlay, raster network analysis. The DEM is used in order to understand the terrain condition, environmental factors and social economic status in this study area. Finally, possible / feasible route was identified based on various physical and cultural parameters and their inherent properties

Flow Chart Depicting the Methodology followed for the Study

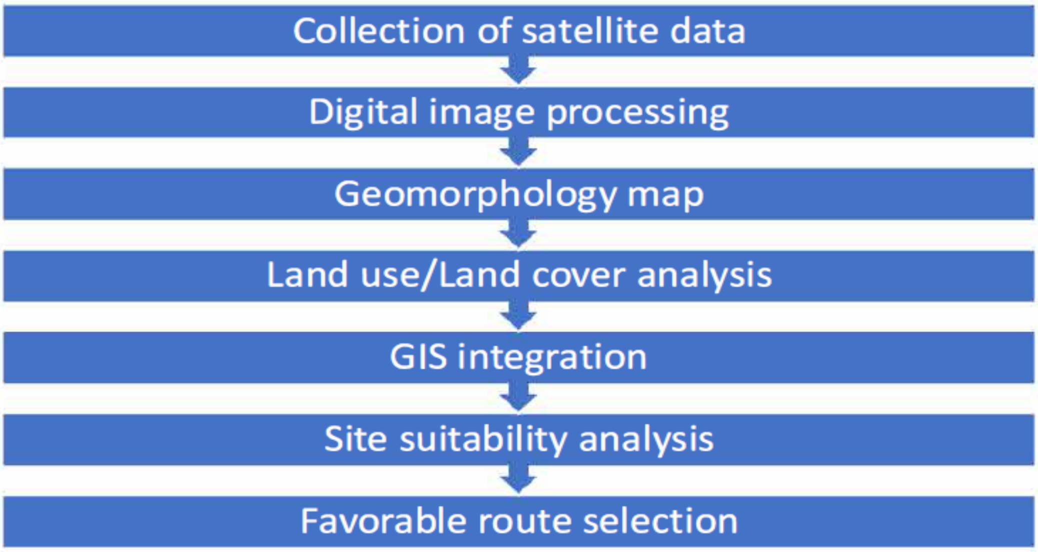

Table 1: Satellite Images and their Characteristics Used in the Study

Sl No.	Date	Sensor	Spectral Composition	Spectral Resolution	Source
1.	Dec 2000	Landsat 7 ETM+ C1 L1	Band 1 to band 8	30m	USGS Earth explorer
2.	Jan 2010	Landsat 7 ETM C1 L1	Band 1 to band 8	30m	USGS Earth explorer
2.	Feb 2020	Landsat OLI/TIRS C1 L2	Band 1 to band 11	30m	USGS Earth explorer
3.	Sep 2014	SRTM 1 ARC-Second Global	(DEM)	30m	USGS Earth explorer

RESULTS AND DISCUSSION

Land Use/Land Cover

The land use map was prepared from Digital LAN SAT satellite data and the features were classified as per Integrated Mission for Sustainable Development (NRSA,1995) classification system and following land use pattern were identified as agricultural land, forests, mining area, water body, plantations, barren rock area and urban areas. Most of the area is being occupied by urban and agricultural area. Besides these two major categories, the crop land is also sporadically distributed in the study area

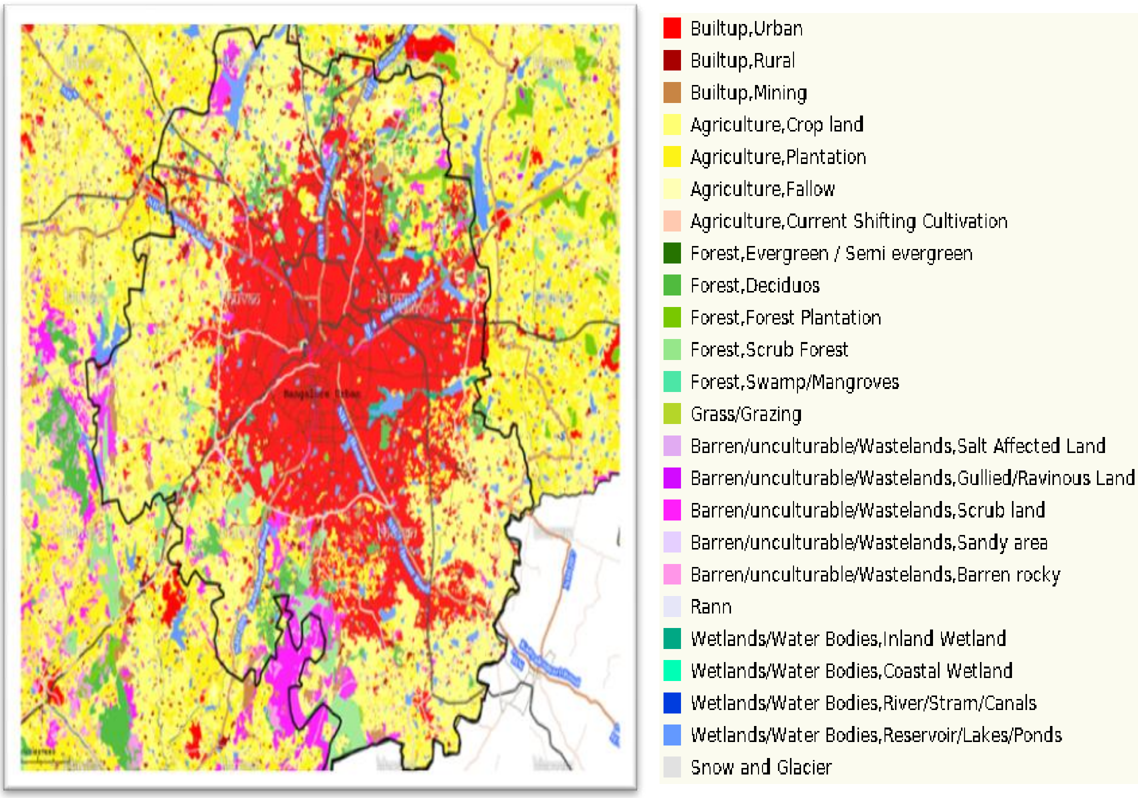

Fig 3. (Land use/Land covers (50K) 2015-2016)

The Raster Modelling

Topographic maps are collected to generate multi-layered, geo-referenced digital maps on a GIS platform, with the basic inputs of available information. This done using SOI toposheet of study area in the scale of 1:50,000. The boundary is traced over a tracing sheet. Traced boundary is converted to digital format using digitization in ArcGIS9.2.

Raster Calculations

Build expressions in the Raster Calculator by using Map Algebra to weight raster and combine them as part of a suitability model, to make selections on your data in the form of queries, to apply mathematical operators and functions, or to type Spatial Analyst functions. Multiline expressions can be typed into the raster calculator. It is useful to build multiline expressions for complex functions, such as cost path, or to chain processes together. The output dataset shows how suitable each location is for highway alignment, according to the criteria set in the suitable model. A higher value indicates the locations that are more suitable.

Table 2. Alignment length

Stretch No	Start Chainage	End Chainage	Length in (km)
1	0.0 km (Tumkur road)	Km 18.37 (Bellary road)	18.37
2	18.37 km (Bellary road)	Km 36.32 (Old madras road)	17.95

[Cost] = ([land use] + [slope])
[Dist.] = cost distance ([source], [cost], back link)
Path = cost path ([destination], [dist.], back link)

Performing Shortest Path

It is almost ready to find the shortest path from the source. We have already performed cost weighted distance, creating a distance dataset and a direction dataset using the source point. However, it is necessary to decide on, and then create, the destination point for the road. Hence this requires the creation of destination point on study area which is used in the calculation of shortest path to the highway. The shortest path is calculated using the function shortest path in the Spatial Analyst. Specifying the destination point as input along with the distance and direction theme, calculates the optimal path through which Highway has to run. It represents the least cost path-least cost meaning avoiding steep slopes and on land use types considered to be least costly for constructing the Highway from source to destination.

Alignment

Stretch 1: The alignment starts at Makali, adjacent to Tumkuru Road and then it moves towards Thammenhalli and Soladevanahlli. After moving towards DoddaBylakere, it passes through Mavallipura sewage treatment plant, before entering Jarakabandekaval forest. The road intersects Doddaballapur Road near BMS Institute of Technology, around 3 km from the periphery of Yelahanka Satellite Town. The road intersects Bellary Road at Hosahalli.

Stretch 2: After entering agricultural areas in Kogilu, residential and industrial areas in Agrahara, Thirumenahalli, Bellahalli, Doddagubbi it touches Rampura. After moving in south-east direction, it intersects Old Madras Road near Sree Mahalakshmi Venkateshwara School in Avalahalli

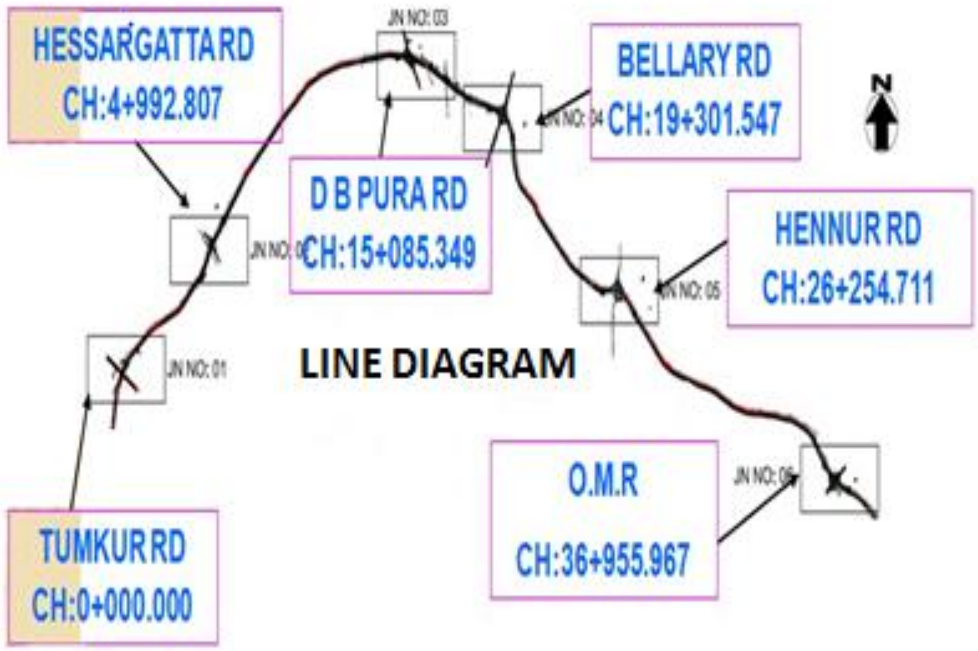

Fig.2. Line Diagram of the Alignment

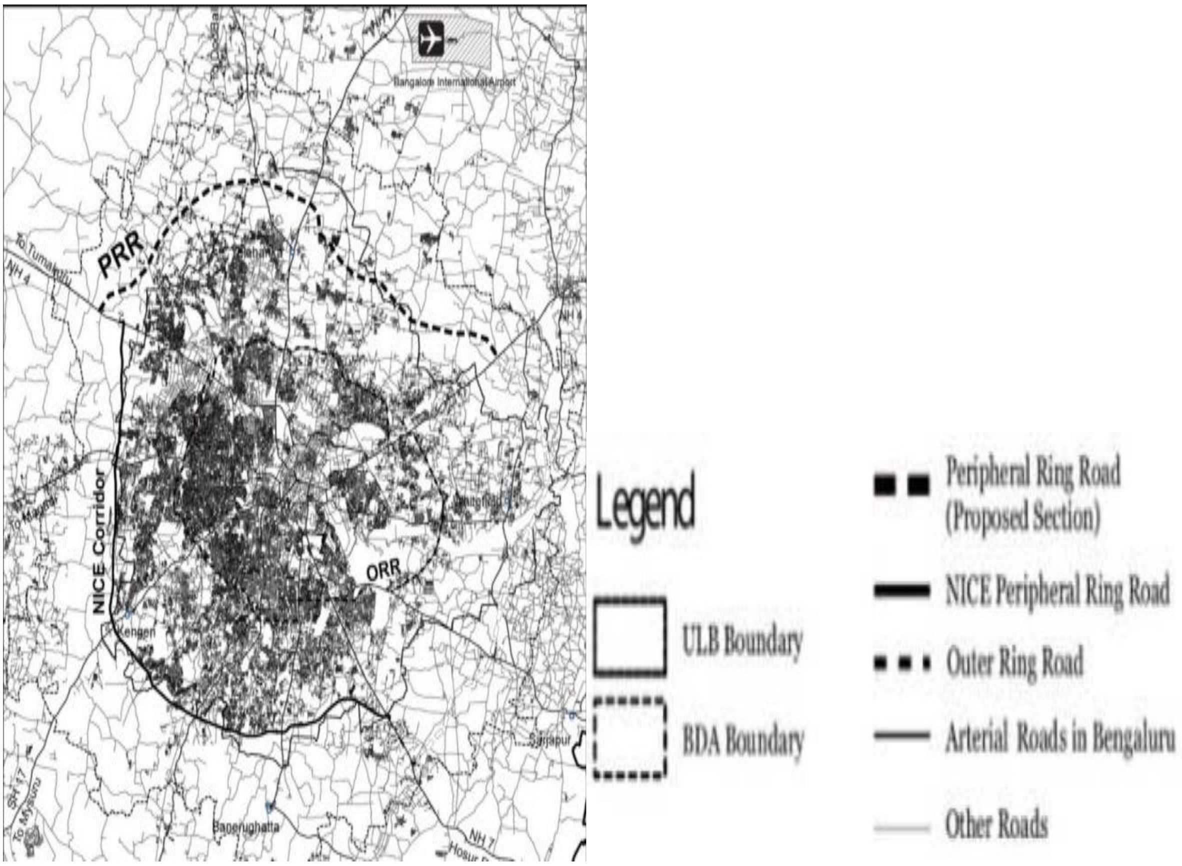

Fig 3. Road Network Map of the Study Area

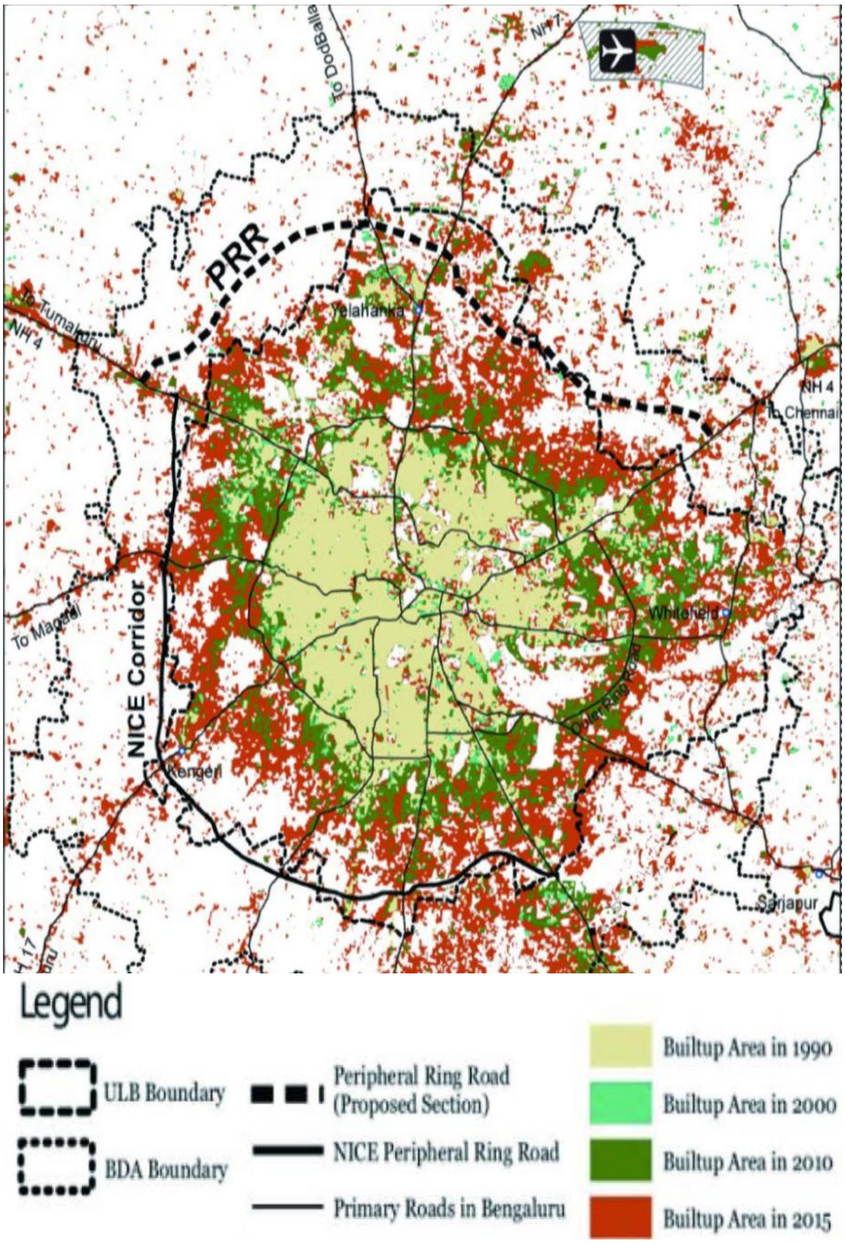

Fig. 4. Growth of the Study Area and PRR Alignment

CONCLUSION

GIS technology has opened up new horizons in transportation. It provides the tool a transportation planner would need to convey ideas and present implications of planning decision for non-planners visually. GIS provides a means of communication that allows for an interactive understanding between the public and transportation professionals. This technology has developed an essential tool for the most effective use of spatial data yet. The purpose of this study was to develop a tool to locate a suitable route between two points. The GlS approach using ground parameters and spatial analysis provided to achieve this goal. Raster based map analysis provide a wealth of capabilities for incorporating terrain information surrounding linear infrastructure. Costs resulting from terrain, geomorphology, land use, drainage and elevation resulting the shortest routes for the study area. This has shown a potential savings which can be obtained by automating the route selection process. GIS method can also be used for route determination for irrigation, drainage channels, power lines and railways.

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