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Identification of future urban development potential in Mangalore city based on Geographic Information System technology

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Abstract

Cities are engines of development and poverty reduction in both urban and rural areas, as they concentrate much of the national economic activity, government, commerce and transportation, and provide crucial links with rural areas, between cities. Over the last two decades, urban population of India increased from 217 million to 377 million and this is expected to reach 600 million, or 40 per cent of the population, by 2031 as per the Global Commission on the Economy and Climate. The current pattern of rapid urbanisation is largely taking place on the fringe of cities and much of it is unplanned. Unprecedented and unplanned growth leads to critical infrastructure shortages, service gaps, poverty, social unrest, environmental degradation, pollution, and making urban governance a difficult task. Most studies undertaken to assess the functioning of municipalities in India, point out that the municipalities are confronted with a number of problems, such as non-availability of data. Therefore, this is the need of time to adopt spatial analysis based technology of remote sensing which includes both aerial as well as satellite based systems, allow us to collect lot of physical data rather easily, with speed and on repetitive basis, and together with GIS which help in analysing problems spatially, more quickly and thoroughly, and formulate solutions. This paper presents a case study of Mangalore city and shows how city administrators or city planners can evolve as an expert at various decision making processes by using geographic information system and remote sensing and progress towards long term goals for the welfare of community. It carried out the site suitability analysis and social infrastructure service analysis to examine the future potential of urban development in Mangalore City based on weightage overlay and service network analysis by GIS technology.The purpose of this paper is also to venture out the possibilities of GIS application in urban planning.

Keywords: Geographic information system, satellite based system and infrastructure shortage, Site Suitability Analysis (SSA), Service Network Analysis (SNA)

Introduction

India is fastest growing major economy in the world, with a 7% GDP growth. Surging growth and employment in cities will prove a powerful magnet. India urban population grew from 290 million reported in the 2001 census to an estimated 340 million in 2008 and MGI projects that it could soar further 590 million by 2030 – 40% of total India population (Mekinsey Global institute report, 2010).

As urban cities are powerful magnet for rural population to migrate in cities, increasing loads in urban built up environment and leading emergence of urban problems such as inadequate infrastructure facilities, housing facilities, insufficient drainage and sewerage facilities and traffic congestion. Increasing urban growth putting pressure to accompany more land for urban development. As this time planners role becomes important to find out the future potential of urban development in cities in sustainable manners. In such cases for urban planners, Geographic Information System (GIS) can be powerful tool to manage and analyse the future urban land potential. Planners deal with spatial information such as land use, land cover, infrastructure facilities, and housing stock and transportation networks. This helps to forecast about future needs for strengthening the community and improve the quality of life in cities.

Urban population is increasing very rapidly in Indian Cities. So, for that demand for social infrastructure and land available for future development is increasing in same way. Urban planning and management of land resource and infrastructure for growing urban areas is complex task. GIS is very powerful and analytical tool in urban planning.it addresses the number of urban issues. It is helpful tool to do feasibility study of an area in terms of Land suitability analysis (LSA) .it also useful tool to check the feasibility of essential infrastructure such as schools and hospitals in an area. Using GIS, these studies have done by taking the case of Mangalore City.Suitability analysis for urban growth is considered one of the most important and effective techniques for identifyingthe best suitable locations for urban growth by taking different types of criteria and weights (Javadian et.al 2011 and Alexander et.al 2012). Land suitabilityevaluation involves the selection of suitable locations of development by mapping the suitability index of a specific area (Joren el.at 2001.)

Study Area and Methodology

Mangalore City is one of the highly urbanised cities of India with more than 4 million urban populations as per 2011 census. It is located about 352 kilometres from the state capital Bengaluru between the Arabian Sea and the Western Ghat mountain

ranges.Mangalore is the largest city in Dakshina Kannada district. It is one of the most cosmopolitan non-metro cities of India. It is also the largest city in the Malnad and Coastal regions of Karnataka, besides being anindustrial, commercial, educational and healthcare hub on the West Coast of India. Mangalore city urban agglomeration extends from Ullal in the south to Mulki in the north, covering a distance of over 40 km. Mangalore city's landscape is characterised by rolling hills, coconut palms, hard red-clay tiled-roof buildings and freshwater streams.

Methodology

Suitable Sites Analysis (SSA) is very useful to meet the need of land for future development and population. This is combination of Land Potential Analysis (LPA) and Land suitability Analysis (LSA) with help of overlay weightage tool of GIS. There is need to estimate the requirement of future demands for schools, colleges, community hall and hospitals for growing urban population. For this, there is need to check on the coverage area of existing socialinfrastructure. As we know good social infrastructure is backbone of an urban area. Service and network tool of GIS is used to see the coverage area of existing essential social infrastructure.

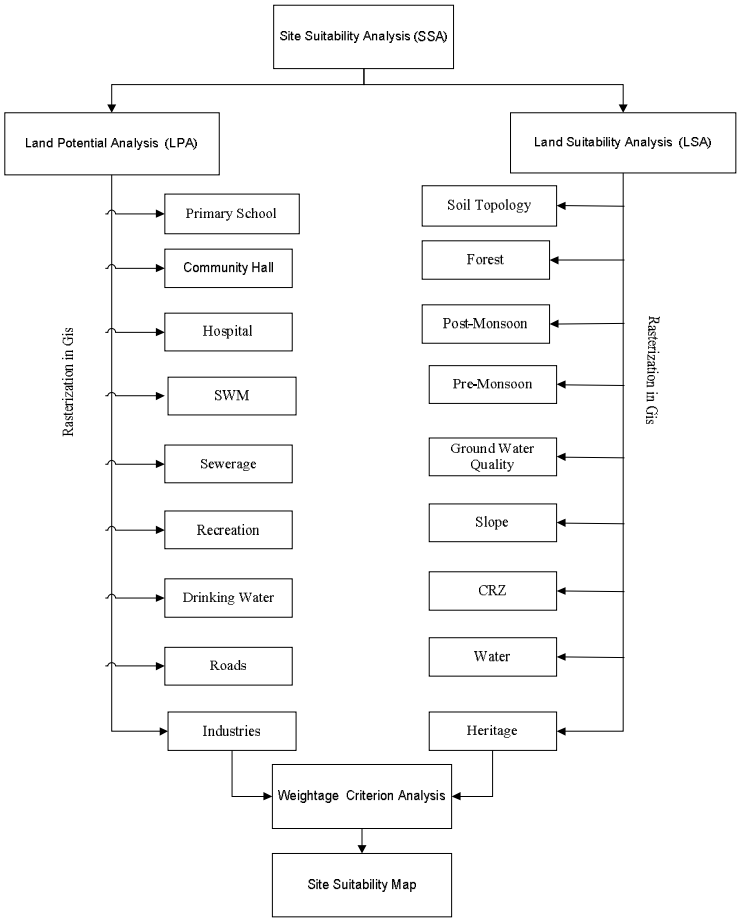
There are two main analysis are done with help of geographic information system to solve the issues of urbanised Mangalore city.

1) Site Suitability Analysis (SSA) with help of Overlay weightage Tool
2) To check the coverage of existing social infrastructure with the help of network as service tool

Site Suitability Analysis (SSA)

GIS based Site Suitability Analysis (SSA) is based upon a set of local criterion. The sites of characteristics such as water availability, forest cover, geology, hydrology, geomorphology, elevation, land use and land cover influence the suitability of land for specific use of land .It is process for understanding the site quality for particular kind of development. Scoring and weighted method is used for assessing the site suitability.

Site Suitability Analysis (SSA) for Mangalore city is divided into two stages; Land Potential Analysis (LPA) and Land Suitability Analysis (LSA).First stage deals with Land Potential Analysis (LPA) considering urban development factors and the second stage deals with Land Suitability Analysis (LSA), considering the environmental concerns factors.All the thematic maps have been converted in raster form, so that for each pixel, a score can be determined. These maps are then combined into a composite suitability map by simple addition of recorded maps with weight system.Board methodology is described in below Diagram:



There is a set of parameters has taken such as primary school, community hall, hospital, SWM, Sewerage, drinking water and recreationfor Land Potential Analysis (LPA). Highest rank is given to nearest available facility. In this study, higher weightage has been assigned to that parameter as per theirimportance role in the urban development as in Table 1and Figure 1.

Table1: Weightage Criterion Analysis for Land Potential Analysis (LPA)

Layers	**No. of criteria's**	**Criterias (Ranks)**					**Relative Score**
		1	2	3	4	5	
Primary School	4	<600	600-1200	1200-1800		>1800	10
Community Hall	4	0-1000	1000-3000	3000-5000		>5000	10
Hospital	4	0-2000	2000-4000	4000-6000		>6000	10
SWM	3	Served		Unserved		Outside	10
Sewerage	3	Served		Unserved		Outside	10
Drinking Water	3	Served		Unserved		Outside	15
Recreation	3	Buf1		Buf2		leftover	10
Roads	3	Buf1		Buf2		leftover	15
Industries	3	leftover		Buf2		Buf1	10
Marks		5	4	3	2	1	100

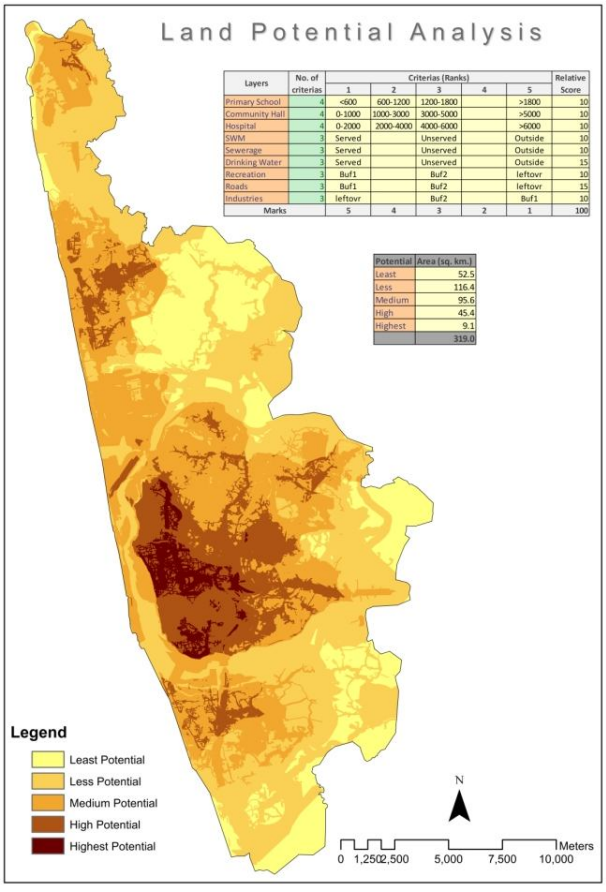


Figure 1: Land Potential Analysis

Land Suitability Analysis (LSA) is considering the environmental concerns factors such as soil typology, forest cover, post-monsoon and pre monsoon water table depth, ground water quality, slope, CRZ, water and heritage. In this study, higher weightage has been assigned to that parameter as it has very sensitive to environment. Highest priority is given to the slope, and then to CRZ due to Mangalore city is having costal line. For Land suitability analysis (LSA), it is necessary to give some score to each of the category as per their suitability for environment concern since each category will not have the same weightage or usefulness for environment sensitivity as in Table 2 and Figure 2.

Table 2: Weightage Criterion Analysis for Land Suitability Analysis

Layers	No. of Criterias	Criterias (Ranks)					Relative Score
		1	2	3	4	5	
Soil Topology	3	Red Soil		Sandy Soil		Alluvial Soil	10
Forest	2	Not there				There	10
Post-Monsoon	3	<2 mtr		2-5 mtr	5-10 mtr		10
Pre-Monsoon	3	<2 mtr		2-5 mtr	5-10 mtr	10-20 mtr	10
Ground Water Quality	3	TDS-500		TDS-1000		Nitrates	10
Slope	5	1	2	3	4	5	20
CRZ	4	No CRZ		CRZ 3	CRZ 2	CRZ 1	10
Water	2	Not there				There	10
Heritage	2	Not there				There	10
Marks		5	4	3	2	1	100

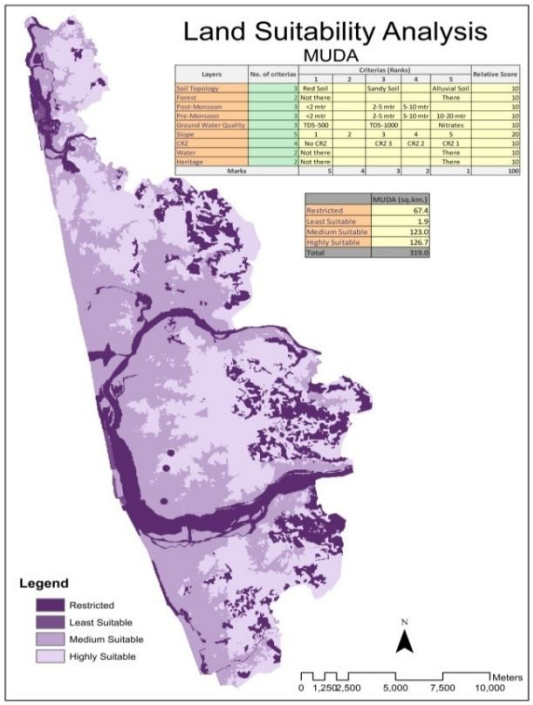


Figure2: Land suitability Analysis

Site Suitability Analysis (SSA) for urban development is necessary to overcome the problem with limited land availability against drastic phase of growth of urbanization. This study helped to identify highly suitable and restricted area for future urban development. This study will be very useful for urban planners and urban development authorities to plan development of the city.Composite analysis of LSA and LPA helpful to decide most prominent site for development as in Table 3 and Figure 3.

Table3: Composite Analysis of Land suitability and Land potential Analysis

Layers	**No. of Criterias**	**Criterias (Ranks)**					**Relative Score**
		1	**2**	**3**	**4**	**5**	
LSA	**4**	**Highest**	**Medium**	**Least**		**Restricted**	**50**
LPA	**5**	**Highest**	**High**	**Medium**	**Less**	**Least**	**50**
Marks		**5**	**4**	**3**	**2**	**1**	**100**

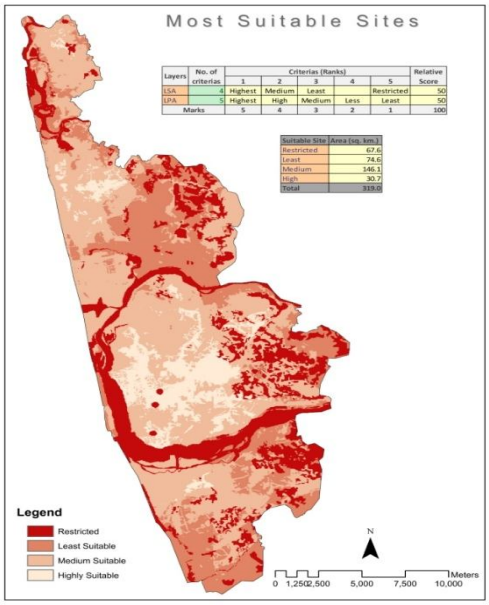


Figure 3: Site Suitability Analysis

Social infrastructure Services analysis

GIS based service network analysis tool is very powerful tool for urban planners to check the coverage of existing social infrastructure (e.g., hospitals, community hall, school and college).It helpful to assess the demand and suitable location to establish social infrastructure in future .It is helpful to identify the closet facility in nearby areas. In this study, estimation of service area of social infrastructure for Mangalore city is calculated.

The literacy rate of Mangalore Urban Area is 79.14% (2001 Census) as against the state literacy of 66.60%. No population standards have been formulated for the educational institutions. There are 265 primary schools in Mangalore urban area. As per URDPFI standard, there is inadequacy of 22 primary schools .Spatial distribution of primary schools is shown by Figure 4. According to neighborhood concept of planning, primary school should be within 500 mtrs. Only 10% area of the Mangalore city is covered under 500 mtrs radius service of Primary schools. There are 25 % and 30 % area of the Mangalore city is cover under 1 km and more than 1.5 km services of primary schools. There are 22 more Primary schools are required to achieve 100% of that.

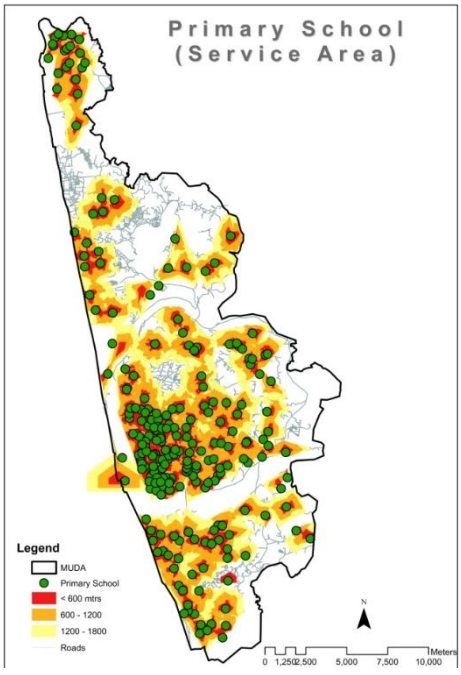
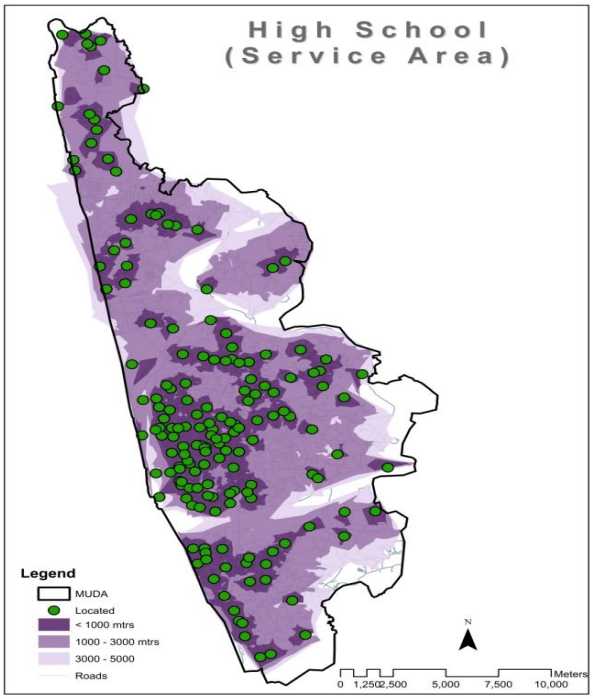


Figure 4: Spatial Distribution and Service Area of Primary Schools

There are about 185 High schools in Mangalore City. As per URDPFI standard, there should be 1 high school for 10000 populations .There are 72 more high schools required. Almost 90% area is covered by the service of high school within 5 km

radius as shown in Figure 5.but in case of 3km and 1 km radius about 80 % and 10 % area is covered under service of high schools. There needs to be more high schools between 1 km to 2 km radius.



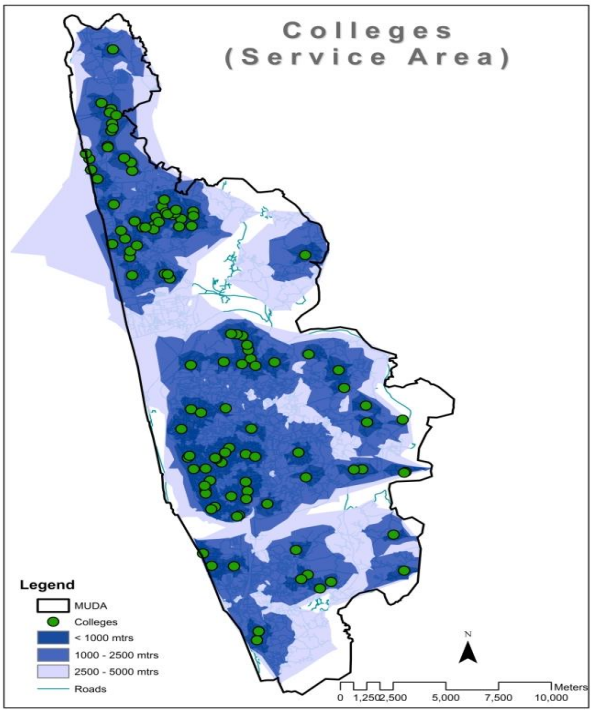
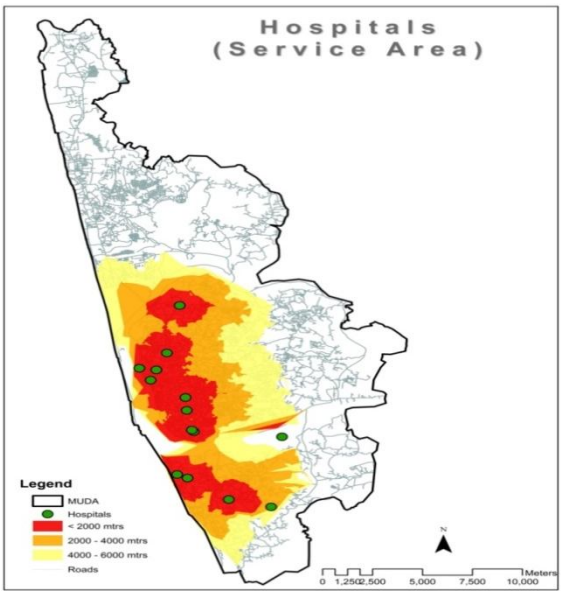


Figure 5: Spatial Distribution and Service Area of High SchoolsFigure6: Spatial Distribution and Service Area of colleges

There are about 61 colleges in Mangalore city as shown in figure 6. This is not enough to serve the all the people of Mangalore cities. According to URDPFI standard, there should be 1 college for 10000 populations. Almost 11 more colleges are required .Only 10% is covered within 1 km radius service of college. Highest area is about 85 % within 2.5 km radius.

Mangalore has adequate number of each type of health institutions such as dispensary, nursing home, child welfare and maternity centre, primary health Centre and intermediate hospitals. But the spatial concentration of these facilities is along the central part of city.The Town hall adjacent to the Nehru Maidan is the central community hall in the heart of the city. There are a few other community buildings.These are Puthushet hall, Don Bosco hall, Acharya's hall, C.V. Nayak hall, P.V.S. Kalakunja, .T.M.A.Pai convention hall and Catholic club. Most of the community halls are located in the central parts. Only 5 % area is covered by community hall within 1 km. 30% area is covered by community hall within 5 km as shown in Figure 7.



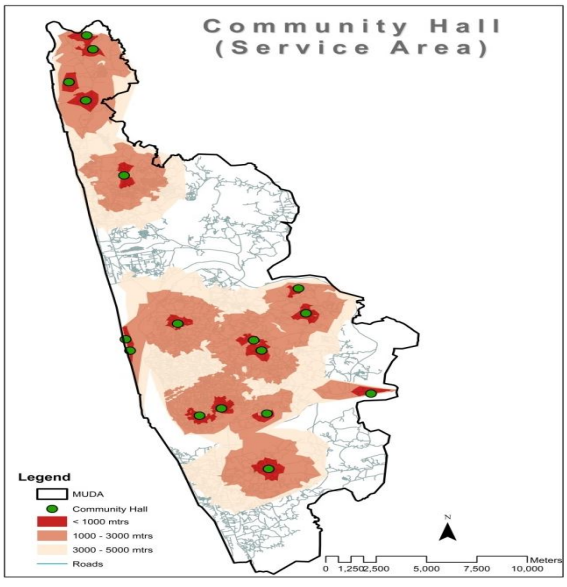


Figure 7: Spatial Distribution and service area of Hospitals

Figure 8: Spatial Distribution and Service Area of community hall

Conclusion

GIS use both as a spatial database tool as well as analysis and modelling tool also. The non-availability of data is the main constraints of GIS use in urban planning. But day-by-day the use of GIS is increasing in urban planning departments in India. Using GIS tools to do Site suitability study is very useful to manage the future urban development, both in planned and systematic way. The Urban network analysis tool is very helpful in showing spatial service area of social infrastructure. Urban planning deal with spatial information and GIS is tool to make that possible in planning field.

Land suitability analysis is very prominent tool for sustainable urban development taking consideration of environmental sensitive parameters. We considered environment sensitive area as "restricted zone" for future urban development that is 67.4 sq. km. and highly suitable area is only 30.7 square km for future urban development. There also 74 sq. km and 147 sq. km area comes under least and medium suitable sites for urban development of Mangalore city. Service Infrastructure service analysis indicates that the spatial distribution and services coverage of most of the services in central area of city that ignore to serve uppermost and southernmost south areas.

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