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RESEARCH ARTICLE

Urban growth and development in Mandya taluk using GIS and remote sensing

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Abstract

Even though they are conceptually different, the terms urban growth, urban extension, and urban sprawl are occasionally used interchangeably. An increase in the urbanised land cover is referred to as urban growth. Urban extension is one method of urban expansion. Urban sprawl is the term for urban growth that occurs as a result of unplanned or spontaneous urban development. Urban sprawl usually has negative connotations, associated with the generation or intensification of complex urban problems, such as land, water, and air pollution, with their consequent negative impacts on human health (Alberti, 1999; Antrop, 2004; Dickson, Baker, Hoornweg, & Asmita, 2012; Kumar & Pandey, 2013; Marshall, Pielke, Steyaert, & Willard, 2004; Pathan, Shukla, Patel, Patel, & Mehta, 1991; Rivas, Hernandez, & Cueto, 2003;Claudia, Sandra, Sergio, Jorge, 2019). Manya tauk, in the Indian state of Karnataka, is one of the fastest growing urban centres. In the last three decades, the taluk has seen a surge in urban growth and development in all directions. And it is expected to grow at a faster rate in the future. The satellite images of LandSat 5 TM, LandSat 7 ETM+ and LandSat 8 OLI/TIRS sensors for years 1995, 2005 and 2018 respectively is collected from Earth Explorer provided by USGS. Using a shape file of the study area downloaded from Diva GIS, supervised classification was also performed for the study areas using ERDAS Imagine 2014, and finally an agricultural thematic map was created using Arc GIS 10.2 version.

Keywords: Urban Growth; GIS; Remote sensing

Introduction

It's also known as leapfrog development (Gordon and Richardson, 1977; K. Madhavi Lata, 2009), and it's seen in all of the world's major cities. The pattern of new urban and residential roads represents an essentially permanent backbone that shapes new urban form and land use in the world's cities (Christopher Barrington-Leigh and Adam Millard-Ball). Roads, for example, are a key spatial determinant of urban expansion, with significant implications for human activities, the environment, and socioeconomic development. Understanding the pattern

of urban road network expansion and the social and environmental consequences is a sensible way to improve comprehensive urban planning and keep the city sustainable. (Ge Shi et. al). Urban sprawl has been chastised for inefficient land use and energy consumption, as well as large-scale encroachment on agricultural lands. Many issues arise as a result of the fragmented conversion of agricultural land to urban use. Large-scale urban sprawl and changes in urban land use are the result of cities expanding in all directions. On the urban outskirts or in city peripheral rural areas, the spatial pattern of such changes is more noticeable than in the city centre. Inadvertently, this is leading to an increase in the built-up area and changes in spatial urban land use patterns, resulting in the loss of productive agricultural lands, forest cover, and other forms of greenery, as well as loss of surface water bodies, depletion of ground water aquifers, and rising levels of air and water pollution. Furthermore, it is widely acknowledged that land fragmentation is detrimental to biological conservation. There have been numerous discussions about how to limit urban sprawl while also conserving agricultural land resources (Bryant et al., 1982; Ewing, 1997; Daniels, 1997; Anthony Gar-On Yeh, 2001). The road network, the skeleton of the urban space structure, is an important driving force for space expansion and one of the key indicators of urban development (Yang, H., 1998; Lämmer, S., 2006; Ge Shi, 2019) There is a need to constantly monitor such changes and understand the processes in order to take effective and corrective measures in the direction of a planned and healthy urban development. Remote sensing data has become increasingly popular in recent years for mapping and monitoring city sprawl. Satellite data, combined with conventional ground data, can be used to systematically map, monitor, and accurately assess the spatial patterns of urban sprawl over time. In this study, a 'Entropy Approach' was used to investigate the urban sprawl patterns of Hyderabad over time scales ranging from years to decades. It is also attempted to use the GIS to quantify urban sprawl trends at various land use sites, such as commercial, industrial, residential sensitive, and mixed zones.

Study Area

The Mandya Taluk lies between North latitude 12° 44' 42.6" to 12° 25' 50.7" and East longitudes 76° 42' 05.6" to 77° 0' 22.9" falling in the survey of India degree sheet Nos -57 H and 57D. The total geographical area of the Taluk is 705 km^2. The taluk is divided into one town and 175 villages distributed around the Mandya city. The soils in Mandya taluk are thin gravelly and underlain with marram zone containing weathered rock. The soils are highly leached and poor in bases. The taluk enjoys a sub-tropical climate with temperatures ranging between 160 and 350 C. April is the hottest month and with the onset of southwest monsoon in June, the temperature drops considerably. December is the coldest month. The rainfall is generally uniform in the district except in the western sector where it is slightly higher.

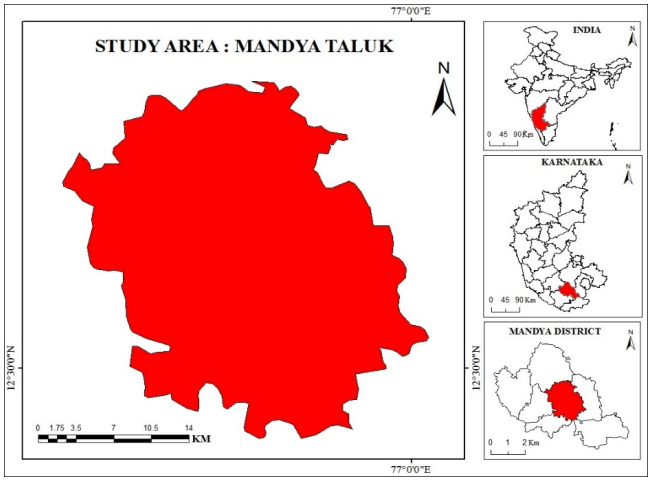

Fig. 1. Location map

Objective

- To assess the Urban Growth and Development Changes in Mandya Taluk.

Research Method

The satellite images for Mandya Taluk are obtained from the Global Land Cover Facility provided by the United States Geological Survey for three different decades. The subsisted satellite images of Mandya Taluk are shown below.

Table 1. Different year Landsat Satellite Imagery of Mandya Taluk

Source	Sensor	Spatial Resolution	Path and Row	Date of Capture
USGS	Landsat 5 TM	30m	141/51	22/01/1995
USGS	Landsat 5 TM	30m	141/51	10/02/2005
USGS	Landsat 8 OLI/THIR	30m	141/51	16/01/2015

The data used for the present study are based on secondary sources. The satellite images of Landsat 5 TM, Landsat 7 ETM+ and Landsat 8 OLI/TIRS sensors for years 1995, 2005 and 2018 respectively is collected from Earth Explorer provided by United States of Geographical Survey. The images were subsisted using Arc GIS and classified for different years using ERDAS Imagine. The Urban growth of Mandya Taluk in different decades is also analysed. Downloaded data are layer stacked, subsetted using shape file of the study area which is downloaded from Diva GIS, supervised classification was also

carried out for the study areas using ERDAS Imagine 2014, finally agricultural thematic map derived from this. Using ARC GIS 10.2 location map and layouts of thematic maps are prepared.

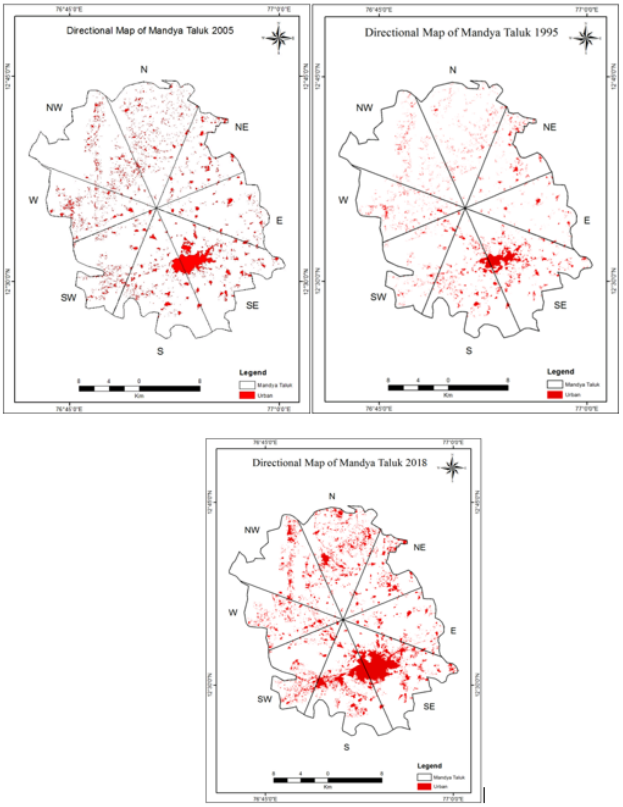

Fig. 2. Directional map of Mandya Taluk (1995-2018)

Finding and Discussion

Determine Directional Growth

One of the most powerful perspectives on growth is direction; it provides an ideal view of both the rate and direction of growth at the same time. ArcGIS was used to create the directional map and the cover area for the directions. North, North-East, East, South-East, South, South-West, West, and North-West are the eight sections of the directional map. From the heart of the Mandya Taluk, the directional change in built-up area was calculated. The most directional change is seen in the last decade in between 2005-2018. The south east and south directions have the most fluctuation and expansion of urban growth, followed by the north, north east, and North West directions. The fluctuations of urban growth in south particularly are because of its closeness to Mysore City. The urban expansion, on the other hand, appears to be uniform in all directions of the taluk. Between the years 2005 and 2018, the rate of urban area expansion spikes the most, whereas the rate of expansion does not spike much in the first decade.

Table 2. Directional expansion of urban area (km^2) during 1995-2018

Year	Directions							
	N	NE	E	SE	S	SW	W	NW
1995	2.39	2.42	1.61	11.15	6.29	2.16	2.54	2.06
2005	5.62	3.50	3.02	14.33	7.46	6.50	5.32	4.78
2018	12.51	5.56	4.08	24.86	16.56	8.11	5.62	6.85
1995-2005	3.23	1.08	1.40	3.18	1.17	4.34	2.77	2.72
2005-2018	6.89	2.05	1.06	10.53	9.09	1.60	0.30	2.06
Rate (sq.km/year) 1995-2005	0.32	0.10	0.14	0.31	0.11	0.43	0.27	0.27
Rate (sq.km/year) 2005-2018	0.62	0.18	0.09	0.95	0.82	0.14	0.02	0.18

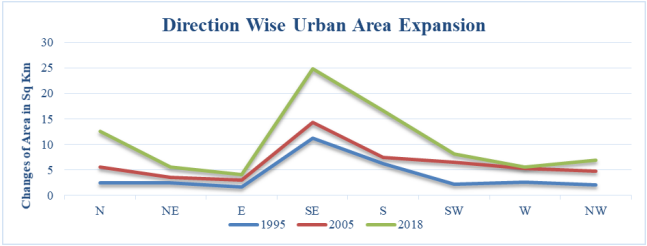

Fig. 3. Direction wise Urban Area Expansion of Mandya Taluk (1995-2018)

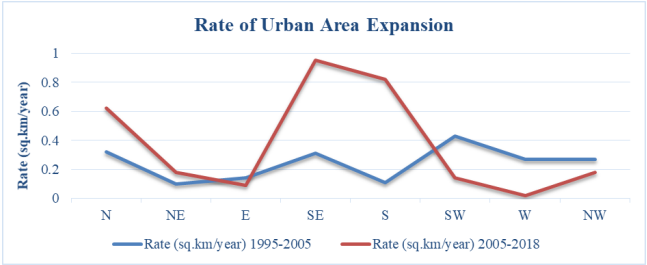

Fig. 4. Rate of Urban Area Expansion of Mandya Taluk (1995-2018)

Determine Growth along Major Roads

The transportation network is one of the most important ways to connect cities, and the road is the most common mode of transportation for connecting them. For ease of communication and transportation, people prefer to live near major highways and road networks. In the Mandya taluk, there are two major roads, according to India's transportation map. The main road in Mandya taluk connected Mysore and

Bangalore taluks, and the second major road in Mandya city crossed the first and went to Hassan taluk. The growth seems to be more within 500 sq.km and tends to increase to 2000sq km till 2018.

Table 3. Expansion of urban area through roads (Sq. km) during 1995 to 2018

Year	Roads			
	0-500	500-1000	1000-1500	1500-2000
1995	7.7	4.2	2.7	1.7
2005	13.0	6.8	4.0	3.0
2018	19.7	12.5	8.5	5.4
Change 2005-1995	5.4	2.5	1.3	1.4
Change 2018-2005	6.7	5.8	4.5	2.4
Rate (Sq.km/year) 1995-2005	0.5	0.3	0.1	0.1
Rate (Sq.km/year) 2005-2018	0.5	0.4	0.3	0.2

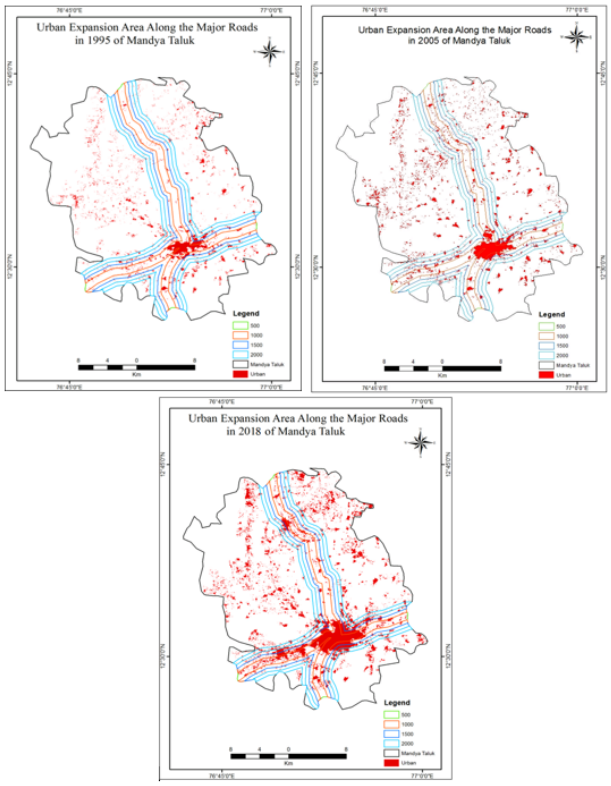

Fig. 5. Urban Expansion Area along the major roads of Mandya Taluk (1995-2018)

Road Changes

During the research period, the urban area has maximally extended towards the 0-500 m buffer of major roads by about 19.73 km2 in 2018 and 13.03 km2 in 2005 and 7.67 km2 in 1995, while the minimum expansion has occurred towards the buffer 1500-2000 m, which was about 5.42 km2 in 2018 and 2.99 km2 in 2005 and 1.64 km2 in 1995. The expansion of road network within a buffer of 0-500 m seems to be denser as compared to the distance. During the study period (1995-2018) the urban growth increases as the table.

Table 4. Expansion of urban area through road (km^2) during 1995-2018

Year	Roads			
	0-500	500-1000	1000-1500	1500-2000
1995	7.66	4.24	2.69	1.67
2005	13.02	6.76	4.03	2.99
2018	19.73	12.53	8.49	5.41
Change 1995-2005	5.36	2.52	1.34	1.35
Change 2005-2018	6.70	5.77	4.46	2.42
Rate (sq.km/year) 1995-2005	0.53	0.25	0.13	0.13
Rate (sq.km/year) 2005-2018	0.60	0.52	0.40	0.22

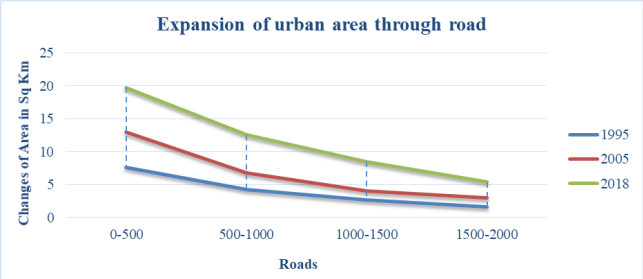

Fig. 6. Line graph showing expansion of urban area through road

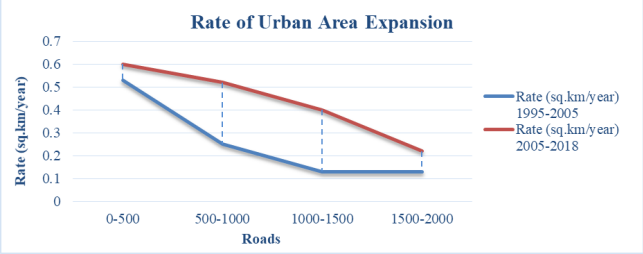

Fig. 7. Rate of Urban Area expansion

Table 5. Land use/cover change rate and area in the future

Year	Rate	Area in km2
1995	0.1	30.7
2000	0.1	33.7
2005	0.7	52.5
2010	0.4	71.5
2015	0.6	82.3
2020	0.9	152.6
2025	1.2	178.1
2030	1.5	207.9
2035	2.0	242.7
2040	2.4	283.2
2045	3.0	330.5
2050	3.7	385.8

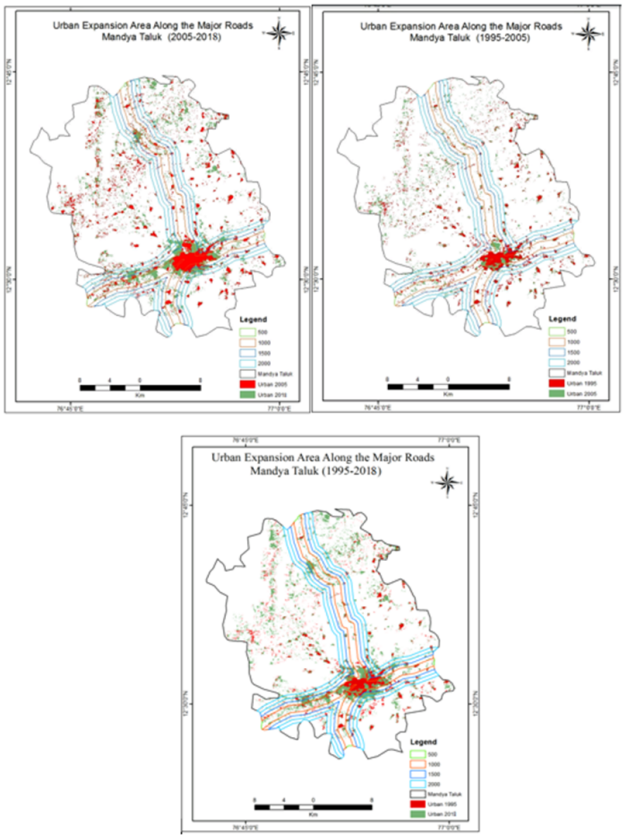

Fig. 8. Urban expansion area along the major roads of Mandya taluk (1995-2018)

Future Change

According the equations as per calculations of the rate and area of urban growth, it is found that, the urban growth tends to increase according to the result of change in land use/land cover between 1995 to 2018. The rate of expansion of land use and landcover area tends to double in every decade. As per prediction of rate of change is 3.7% in year 2050. The average increase rate is 0.64 sq. km/year, which the increase of built-up area was calculated till 2050 as shown in the table below. The area of expansion and change in land use and land cover covers an area of 30.7 sq. km in 1995 which is now increased to 152.6 sq. km in 2020. The future prediction seems to double in the year 2050 which will be 385.8 sq. km.

Conclusion

Half of the world's population has begun to settle in towns and cities as the world becomes increasingly urbanised. In terms of population and urban area expansion, the taluk of Mandya had experienced a remarkable rate of urban growth. After all of the debate over Mandya taluk's urbanisation growth, it is clear that the taluk has maintained a high level of urbanisation for the past three decades. The majority of people migrated from rural to urban areas for trade, jobs, and education, which is the main reason for urban expansion and growthThe most significant changes occurred in the south east and south directions, with expansions ranging from 3.2 square kilometres to 10.5 square kilometres in 1995 to 2005 and 1.2 square kilometres to 9.1 square kilometres in 2005 to 2018. The directions of south west, west, and north west, on the other hand, result in a very slow rate of urbanisation. In 1995, the rate of urban growth and changes in land use/landcover was only 0.1 percent, covering an area of about 30.7 square kilometres, which has now grown to about 152.6 square kilometres. Every ten years, the growth rate tends to double, rising to 1.5 percent in 2030 and 3.7 percent in 2050, respectively.

References

1) Alberti M. Modeling the urban ecosystem: a conceptual framework. *Environment and Planning B: Planning and Design*. 1999;26:605–630. Available from: https://dx.doi.org/10.1068/b260605. doi:10.1068/.
2) Yeh AGO, Li X. A Constrained CA Model for the Simulation and Planning of Sustainable Urban Forms by Using GIS. *Environment and Planning B: Urban Analytics and City Science*. 2001;28(5):733–753. Available from: https://doi.org/10.1068/b2740.
3) Bryant CR, Russwurm LJ, McLellan AG. The City's Countryside: Land and Its Management in the Rural-Urban Fringe. 1982.
4) Barrington-Leigh C, Millard-Ball A. Global trends toward urban street-network sprawl. *Proceedings of the National Academy of Sciences*. 2020;117:1941–1950. Available from: https://dx.doi.org/10.1073/pnas.1905232116.
5) Dickson E, Baker JL, Hoornweg D, Tiwari A. Urban Risk Assessments: Understanding Disaster and Climate Risk in Cities. *Urban Development*. 2012. Available from: https://openknowledge.worldbank.org/handle/10986/12355.
6) Daniels T. Where Does Cluster Zoning Fit in Farmland Protection? *Journal of the American Planning Association*. 1997;63(1):129–137.
7) Ewing R. Is Los Angeles-Style Sprawl Desirable? *Journal of the American Planning Association*. 1997;63(1):107–126. Available from: https://dx.doi.org/10.1080/01944369708975728.
8) Shi G, Shan J, Ding L, Ye P, Li Y, Jiang N. Urban Road Network Expansion and Its Driving Variables: A Case Study of Nanjing City. *International Journal of Environmental Research and Public Health*. 2019;16(13):2318. Available from: https://dx.doi.org/10.3390/ijerph16132318.
9) Gordon P, Richardson HW. Are Compact Cities a Desirable Planning Goal? *Journal of the American Planning Association*. 1997;63(1):95–106. Available from: https://dx.doi.org/10.1080/01944369708975727.
10) Lata KM, Prasad VK, Badarinath DKVS, Raghavaswamy V. Measuring urban sprawl: A case study of Hyderabad, National Remote Sensing Agency (NRSA), Department of Space, Government of India , Hyderabad. Hyderabad. 2009.
11) Kumar A, Pandey AC. Spatio-temporal assessment of urban environmental conditions in Ranchi Township, India using remote sensing and Geographical Information System techniques. *International Journal of Urban Sciences*. 2013;17(1):117–141. Available from: https://dx.doi.org/10.1080/12265934.2013.766501.
12) Marshall CH, Pielke RA, Steyaert LT, Willard DA. The Impact of Anthropogenic Land-Cover Change on the Florida Peninsula Sea Breezes and Warm Season Sensible Weather. *Monthly Weather Review*. 2004;132(1):28–52. Available from: https://dx.doi.org/10.1175/1520-0493(2004)132<0028:tioalc>2.0.co;2.
13) Pathan SK, Shukla VK, Patel RG, Patel BR, Mehta KS. Urban land use mapping: A case study of ahmedabad city and its environs. *Journal of the Indian Society of Remote Sensing*. 1991;19(2):95–112. Available from: https://dx.doi.org/10.1007/bf03008125.
14) Rivas S, Hernandez R, Cueto JL. Evaluation and prediction of noise pollution levels in urban areas of Cdiz (Spain). *The Journal of the Acoustical Society of America*. 2003;114(4):2439. Available from: https://dx.doi.org/10.1121/1.4779173.
15) Yang H, Bell MGH. Models and algorithms for road network design: a review and some new developments. *Transport Reviews*. 1998;18(3):257–278. Available from: https://dx.doi.org/10.1080/01441649808717016.
16) Lämmer S, Gehlsen B, Helbing D. Scaling laws in the spatial structure of urban road networks. *Physica A: Statistical Mechanics and its Applications*. 2006;363(1):89–95. Available from: https://dx.doi.org/10.1016/j.physa.2006.01.051.