International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347 - 6435 (Online) Volume 2, Issue 1, January 2014)

Spatio-Temporal Analysis of Urban Sprawl in Greater Hyderabad Region and Its Impacts on Rural Urban Fringe Areas Using Geoinformatics Technology.

T. Phanindra Kumar[1], Dr. P. Kesav rao[2], Dr. V Madhava Rao[3], Yuva Kishore[4]
Centre on Geoinformatics Application in Rural Development (CGARD), National Institute of Rural Development, Hyderabad

Urbanization is an index of transformation from traditional rural economies to modern industrial one. It is a progressive concentration of population in an urban unit. It takes place either in radial direction around a well-established city or linearly along the highways. This dispersed development along highways or surrounding the city and in rural countryside is generally referred as sprawl.

Sprawl is a term that is often used to describe perceived inefficiencies of development, including disproportionate growth of urban areas and excessive leapfrog development. Sprawl is a cumulative result of many individual decisions and it requires not only an understanding of the factors that motivate an individual landowner to convert land, but also an understanding of how these factors and individual land-use decisions aggregate over space. Some of the causes of the sprawl include - population growth, economy and proximity to resources and basic amenities.

The measurement and monitoring of land-use change are crucial to government officials and planners who urgently need updated information and proper planning tools. The entropy method is most popularly used method for the measurement and monitoring of urban sprawl by the integration of remote sensing and GIS. The advantages of the entropy method are its simplicity and easy integration with GIS.

GIS and remote sensing data along with collateral data help in analyzing the growth, pattern and extent of sprawl. With the spatial and temporal analyses it is possible to identify the pattern of sprawl and subsequently predict the nature of future sprawl. This project brings out the extent of sprawl taking place over a period of six years using GIS and Remote Sensing. An attempt was made to study the implications of urban sprawl on land-use & land-cover pattern of a typical regions located in Greater Hyderabad city & its surround rural-urban fringe areas in the state of Andhra Pradesh.

***KeyWords*-- Land Use Planning, classification, NDVI, Change Detection, Shanons Entropy, Compactness Index etc.**

I. INTRODUCTION

Urbanization is a process that always initiates the continual transformation of land from one use to the other. Land transformation is presently being experienced in and around fast growing towns.

It is also firmly stated that spatial and temporal changes in the unplanned growth of the built up area is impacting negatively on the environment. The process of urbanization is one of the most important drivers of economic, social and physical change in developing countries. Rapid urban population growth leads not only to an increasing demand for urban land, particularly for housing but also for various other uses. Increasing demand for land is affecting peri urban areas where urban expansion is already encroaching into the agriculture lands and small villages. Rural -urban fringes are characterized by diverse land uses which often vary in relation to their functional linkages to urban and to rural sectors.

Patterns of infrastructure initiatives like the construction of roads and service facilities (such as hotels, etc.) also often encourage the regional development, which eventually lead to urbanization. The direct implication of such urban sprawl is the change in land use and land cover of the region. The ability to service and develop land heavily influences the economic and environmental quality of life in towns (Turkstra, 1996). Identification of the patterns of sprawl and analyses of spatial and temporal changes would help immensely in the planning for proper infrastructure facilities. Patterns of sprawl and analyses of spatial and temporal changes could be done cost effectively and efficiently with the help of spatial and temporal technologies such as Geographic Information System (GIS) and Remote Sensing (RS) along with collateral data (such as Survey of India maps, etc.).

The spatial patterns of urban sprawl over different time periods, can be systematically mapped, monitored and accurately assessed from satellite data (remotely sensed data) along with conventional ground data (Lata et al., 2001). Mapping urban sprawl provides a "picture" of where this type of growth is occurring, helps to identify the environmental and natural resources threatened by such sprawls, and to suggest the likely future directions and patterns of sprawling growth.

Remote sensing applications are growing very rapidly with the availability of high-resolution data from the state of the art satellites like IRS-1C/1D/P4, LANDSAT, CARTOSAT and QUICKBIRD.

International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347 - 6435 (Online) Volume 2, Issue 1, January 2014)

The remote sensing satellites with high-resolution sensors and wide coverage capabilities provide data with better resolution, coverage and revisit to meet the growing applications needs. The advancement in computer hardware and software in the area of remote sensing also enhances the remote sensing applications. The image processing techniques are also quite effective in identifying the urban growth pattern from the spatial and temporal data captured by the remote sensing techniques. These aids in delineating the specific growth patterns of sprawl which could be linear, radial or both.

II. Location And Extent

Hyderabad is the capital of the Indian state of Andhra Pradesh. It is the sixth largest city of India and a sprawling metropolis. To analyze the urban sprawl the study area encircling Hyderabad metropolitan region and its surrounding rural area extends, from 17 °12'00" N to 17°37'00" N and 78 °16'00" E to 78°42'00" E covering an area of approximately 1500 sq km was taken. The study area was divided into five zones namely East zone, West zone, North zone, South zone and Central zone which includes the entire area of GHMC and Parts of Ranga Reddy district.

III. The Objectives Of The Study Are

- To identify and delineate different land use/ land cover categories using high resolution remote sensing data.
- To spatially map the built-up areas and identify the patterns of urban sprawl for Hyderabad region.
- To generate the statistics of the changes that occur in the areas of various land use/ land cover categories during the period 2005 to 2011
- To study the pattern of urban growth and measure the land use changes using Shannon's Entropy and Compactness index indicators.

Methodology and Analytical Framework:

- The following methodology is adopted in the present study to meet the above mentioned objectives. The base map is generated at 1:25,000 scale from the SOI Toposheet.
- The base layers like administrative boundaries, road network, mapping of water bodies, etc. were created from the SOI Toposheets.
- Cropping and mosaicing of data corresponding to the study area.
- Classification of remote sensing data (2005&2011): Land cover and land use analyses.
- Change detection analysis using different techniques (Image differencing, Image ratioing, etc.).
- Detection, visualization and assessment of change analysis.
- Computation of Shannon's entropy to detect the urban sprawl phenomenon.

Land Use/Land Cover Classification:

Thematic land classes were derived digitally by grouping pixels that have similar spectral signatures from the measurements of individual bands throughout the spectrum. Usually this classification is made with visible, near-infrared, and middle infrared part of the spectrum. Image interpretation was carried out with the help of nine elements of interpretation key.

Normalized Difference Vegetation Index (NDVI):

NDVI = NIR – Red / NIR + Red

NDVI values lies between -1and +1. Vegetation in good condition shows higher NDVI values. This is used to eliminate the seasonal sun angle difference and minimize atmospheric effects. Higher values indicate more density and vigor of the vegetation. NDVI is extensively used to detect seasonal variations among vegetation.

Change Detection

Change detection analysis was carried out with the help of Change Detection Matrix provided with ERDAS imagine. By giving classified image of two different periods as input, the model automatically generates the area where changes are happened. For knowing changes happened in which type of land use classes statistical analysis were also carried out.

Shannon's Entropy Analysis

Quantifying the urban growth is not difficult from remote sensing data. However, quantifying the sprawl is challenging. The most efficient and commonly used approach in urban sprawl studies is to integrate Shannon's Entropy with GIS tools. In this study, in order to examine the spatial expansion of the built-up areas during the three time periods, the LULC maps were reclassified into built-up and non-built-up area. Shannon's entropy along with GIS tools was applied to measure the sprawl during the study periods.

Shannon's entropy was used to measure the degree of spatial concentration or dispersion of the geographical features on the surface of area of study (Theil, 1967; Thomas, 1981). The entropy space can be conveniently used to differentiate various kinds of urban growth patterns. The Shannon entropy (H) is computed by:

$$H = -\sum_{i=1}^{n} Pi \times Ln\ (Pi)$$

Where, H is the value of Shannon's entropy, Pi the ratio of constructed zones area (total housing density) to the total sum of zones area and n the total sum of zones.

International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347 - 6435 (Online) Volume 2, Issue 1, January 2014)

Compactness Index

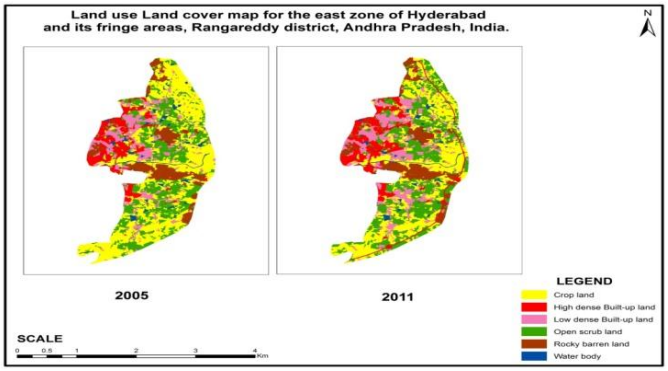
Urban land use per capita is a primary indicator of urban form, which distinguishes low density and high density settlement (CST, 2002a). Consumption of land describes that how is a city spatially spreading. It is well understood that riders from low density settlements or suburban areas need to travel great distance to achieve their travel goals. These also make public transportation less feasible and stimulate private vehicle use (CST, 2002a; Zhang and Guindon, 2006).

Compactness measure incorporates urban form and defined the intensity of density of urban concentration of the city. Compactness indicates the complexity of urban structure and design. If compactness is high it indicates regular shape (such as rectangle, square) of urban patch, which create better street and neighborhood design and this shape enhance the access to transit services. Low compactness indicates the zigzag pattern of urban patch and increase the access distance to transit services.

IV. Results And Discussion

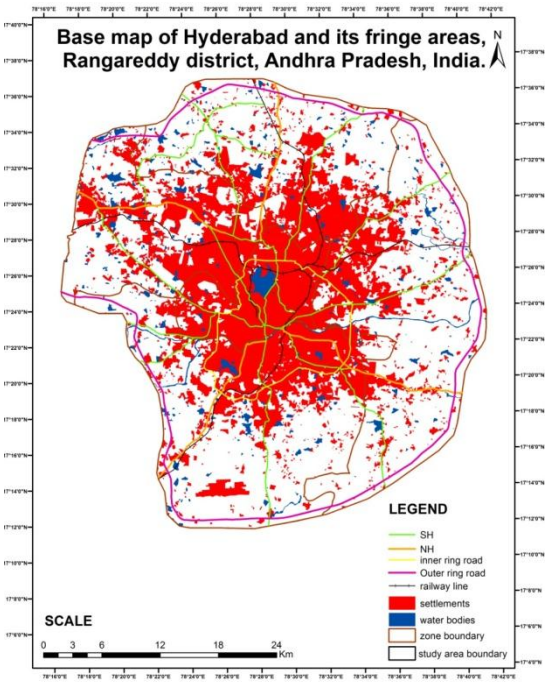
Base Map Of The Study Area

A base map is the frame to which all the ancillary data will be registered. Base map is prepared from Survey of India Topo-sheets on 1:25,000 scale and is updated with the help of satellite imagery to a scale of 1:4000. In the base map five zone boundaries, settlements, Water bodies, National highways(NH 9 & 7), State highways and other major roads(Outer & inner ring roads) in the city were identified.



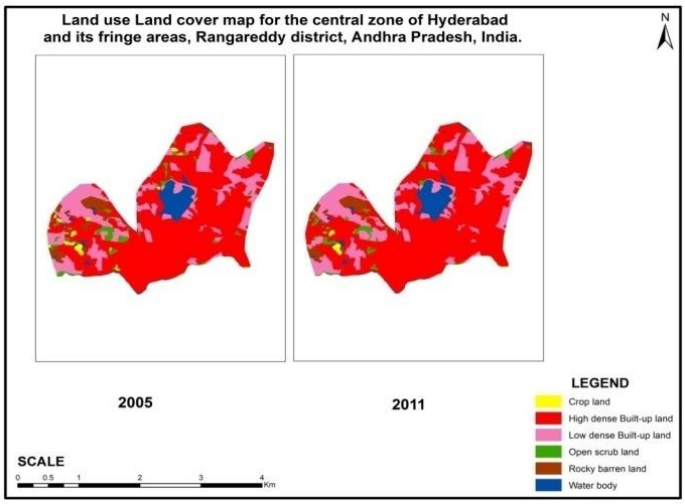
Land Use Land Cover:

The knowledge of spatial distribution of land cover/land use of large area is of great importance to regional planners and administrators. Conventional ground methods are time consuming and no uniform classification system was used in the preparation of maps with the advent of remote sensing technology the above problems have been solved to quite some extent. Satellite data can provide information on large areas and the temporal data can be utilized for change detection and updating old data.



International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347 - 6435 (Online) Volume 2, Issue 1, January 2014)

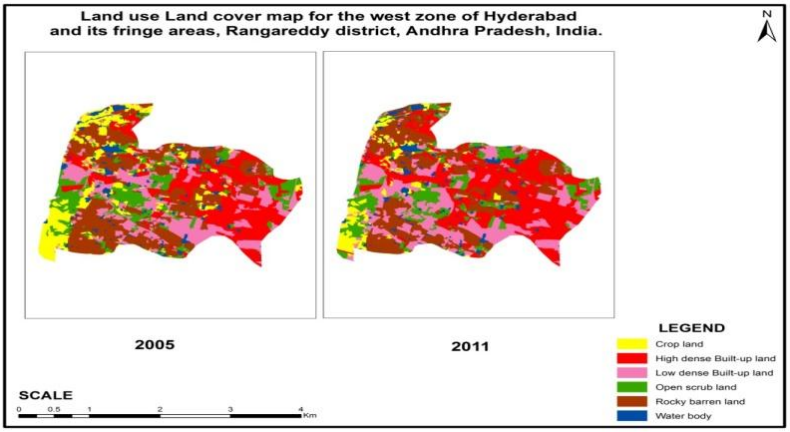
Land Use Land Cover Map Of 2005 And 2011 Image For East Zone:



Land use Land cover 2005-2011 for Central Zone:

Central zone	2005		2011	
Class name	**Area(Km^2)**	**Area (%)**	**Area(Km^2)**	**Area (%)**
Crop land	1.332	1.17	0.554	0.48
Low dense Built-up land	25.293	22.21	25.325	22.24
Open scrub land	4.175	3.66	3.579	3.14
Water body	5.871	5.15	5.829	5.12
High dense Built-up land	73.971	64.97	75.637	66.43
Rocky barren land	3.204	2.81	2.923	2.56
Total	**113.846**	**100**	**113.847**	**100**

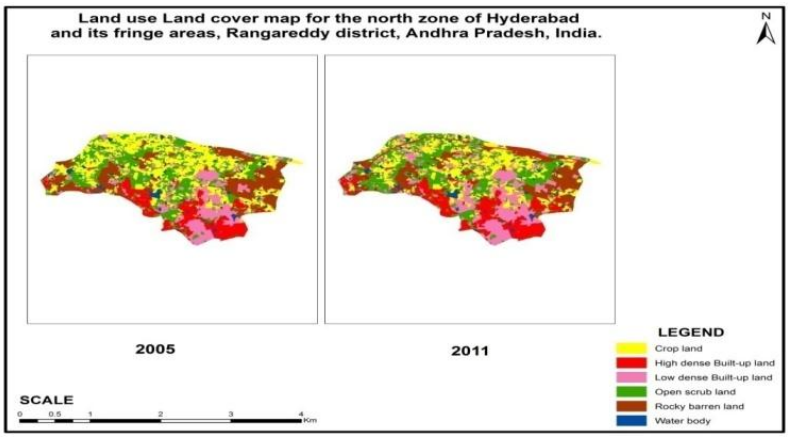
Land use Land cover 2005-2011 for West zone:



International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347 - 6435 (Online) Volume 2, Issue 1, January 2014)

West zone	2005		2011	
Class name	**Area (Km2)**	**Area (%)**	**Area (Km2)**	**Area (%)**
Crop land	27.991	11.58	13.41	5.55
Low dense Built-up land	47.972	19.85	56.897	23.55
Open scrub land	33.855	14.01	33.283	13.77
Water body	10.358	4.28	9.665	4.00
High dense Built-up land	53.774	22.25	72.832	30.14
Rocky barren land	67.629	27.99	55.492	22.97
Total	**241.579**	**100**	**241.579**	**100**

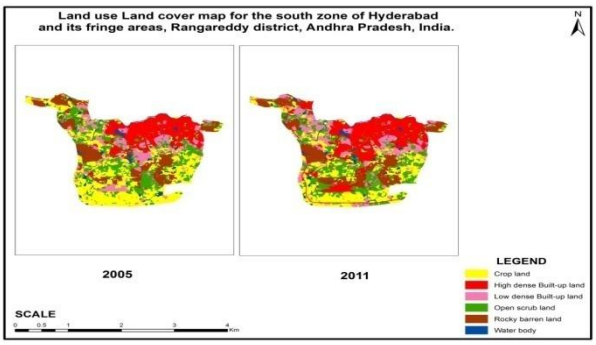
and Use Land Cover 2005-2011 For North Zone:



West zone	2005		2011	
Class name	**Area (Km2)**	**Area (%)**	**Area (Km2)**	**Area (%)**
Crop land	27.991	11.58	13.41	5.55
Low dense Built-up land	47.972	19.85	56.897	23.55
Open scrub land	33.855	14.01	33.283	13.77
Water body	10.358	4.28	9.665	4.00
High dense Built-up land	53.774	22.25	72.832	30.14
Rocky barren land	67.629	27.99	55.492	22.97
Total	**241.579**	**100**	**241.579**	**100**

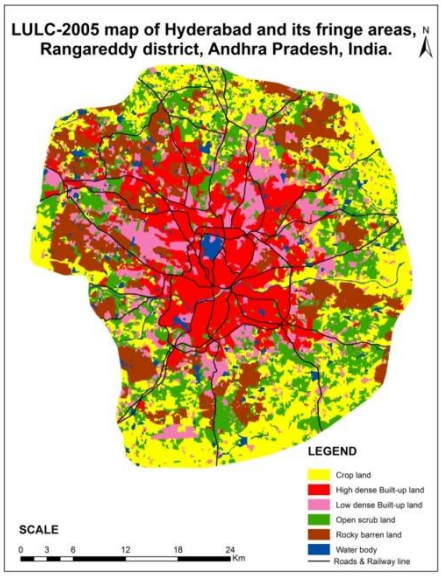
International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347 - 6435 (Online) Volume 2, Issue 1, January 2014)

Land use Land cover 2005-2011 for South zone:



South zone	2005		2011	
Class name	Area (Km2)	Area (%)	Area (Km2)	Area (%)
Crop land	127.92	29.77	91.753	21.35
Low dense Built-up land	62.449	14.53	66.296	15.43
Open scrub land	83.755	19.49	82.482	19.20
Water body	16.31	3.79	14.959	3.48
High dense Built-up land	76.456	17.79	112.493	26.18
Rocky barren land	62.684	14.59	61.591	14.33
Total	**429.574**	**100**	**429.574**	**100**

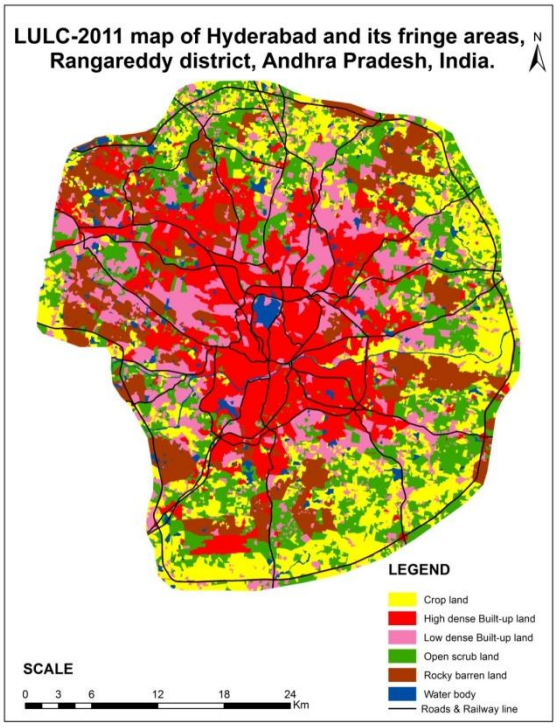
Land use Land cover map- 2005, of Hyderabad and its fringe areas:



International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347 - 6435 (Online) Volume 2, Issue 1, January 2014)

2005 Class Name	Area (Km^2)	Area (%)
Crop land	404.55	27.17
Low dense Built-up land	236.01	15.85
Open scrub land	291.16	19.55
Water body	55.28	3.71
High dense Built-up land	275.31	18.49
Rocky barren land	226.57	15.21
Total	**1488.88**	**100**

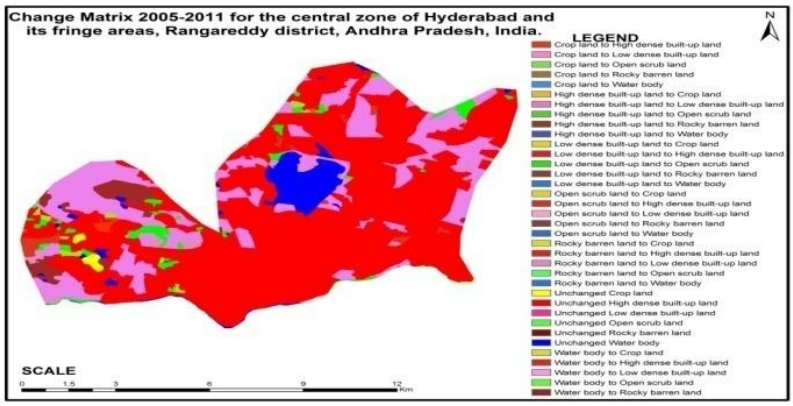
Land use Land cover map- 2011, of Hyderabad and its fringe areas:



2011 Class Name	Area (km^2)	Area (%)
Crop land	296.22	19.89552
Low dense Built-up land	280.028	18.80799
Open scrub land	303.49	20.38381
Water body	49.28	3.309875
High dense Built-up land	359.19	24.12488
Rocky barren land	200.67	13.47793
Total	**1488.878**	**100**

International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347 - 6435 (Online) Volume 2, Issue 1, January 2014)

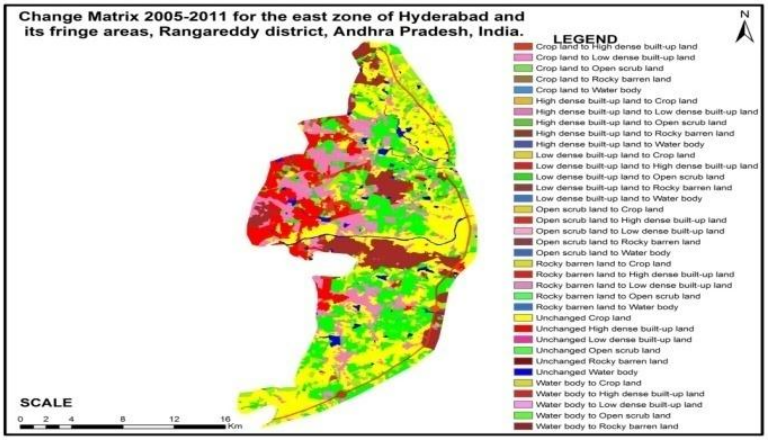
Change matrix between 2005 &2011 in Central zone of Hyderabad:



2005/2011 Class name	Crop land	Low dense Built-up land	Open scrub land	Water body	High dense Built-up land	Rocky barren land	Total
Crop land	0.551	0	0	0	0	0	0.551
Low dense Built-up land	0.100	24.225	0.941	0	0	0	25.267
Open scrub land	0.619	0.001	2.951	0	0	0	3.572
Water body	0	0	0	5.830	0	0	5.830
High dense Built-up land	0.051	1.010	0.279	0.033	74.054	0.291	75.720
Rocky barren land	0	0	0	0.008	0	2.924	2.932
Total	**1.323**	**25.237**	**4.171**	**5.871**	**74.054**	**3.215**	**113.875**

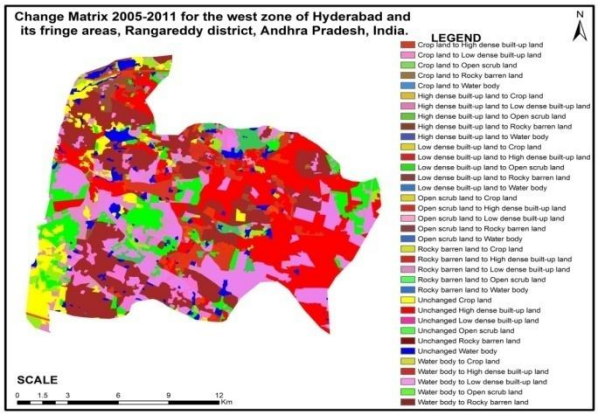
International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347 - 6435 (Online) Volume 2, Issue 1, January 2014)

Change matrix between 2005 &2011 in East zone of Hyderabad:



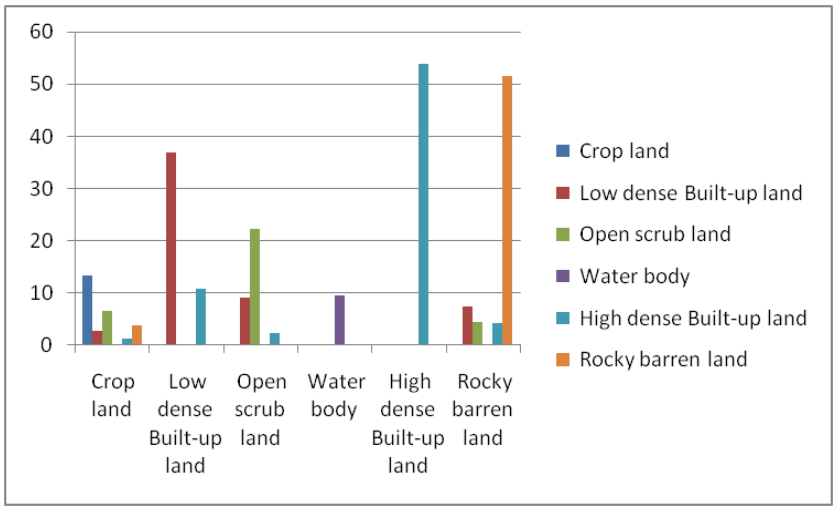
2005/2011 Class name	Crop land	Low dense Built-up land	Open scrub land	Water body	High dense Built-up land	Rocky barren land	Total
Crop land	129.726	0.000	0.043	0.955	0.000	0.000	130.725
Low dense Built-up land	6.287	47.207	12.284	0.115	0.000	0.884	66.779
Open scrub land	24.898	0.032	85.291	2.240	0.000	0.293	112.756
Water body	0.000	0.000	0.000	10.213	0	0.000	10.214
High dense Built-up land	5.746	5.342	3.734	0.134	36.196	0.959	52.114
Rocky barren land	0.385	0.000	0.318	0.030	0.000	39.417	40.152
Total	**167.045**	**52.584**	**101.672**	**13.689**	**36.197**	**41.554**	**412.743**

Change matrix between 2005 &2011 in West zone of Hyderabad:

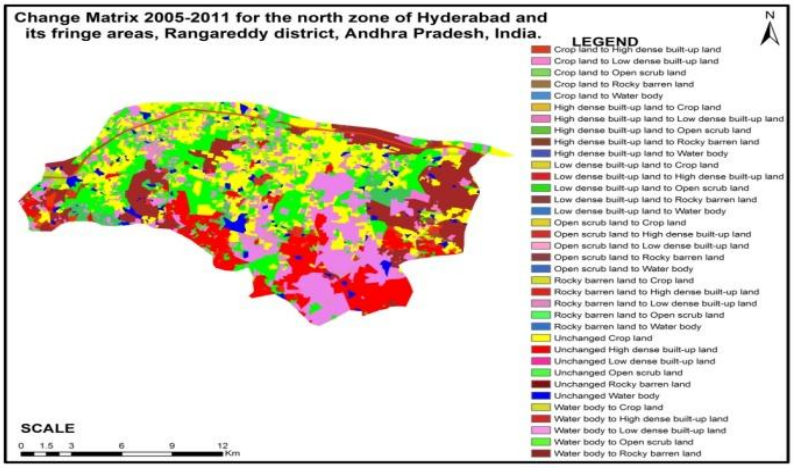


International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347 - 6435 (Online) Volume 2, Issue 1, January 2014)

2005/2011 Class name	Crop land	Low dense Built-up land	Open scrub land	Water body	High dense Built-up land	Rocky barren land	Total
Crop land	13.311	0.000	0.044	0	0	0.000	13.357
Low dense Built-up land	2.810	36.962	9.203	0.255	0.000	7.526	56.759
Open scrub land	6.470	0.005	22.161	0.200	0.000	4.466	33.305
Water body	0.000	0.000	0.000	9.640	0.000	0.023	9.664
High dense Built-up land	1.424	10.866	2.427	0.102	53.832	4.244	72.898
Rocky barren land	3.884	0.005	0.049	0.167	0.005	51.521	55.634
Total	**27.901**	**47.840**	**33.886**	**10.366**	**53.838**	**67.783**	**241.62**

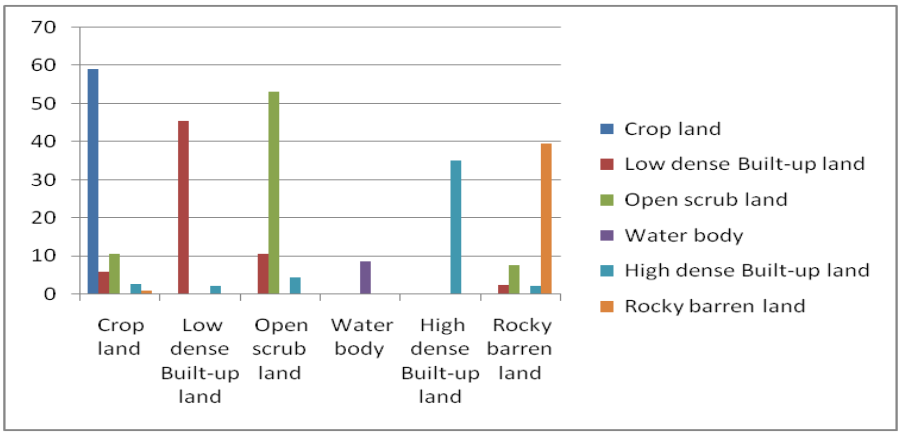


Change matrix between 2005 &2011 in North zone of Hyderabad:

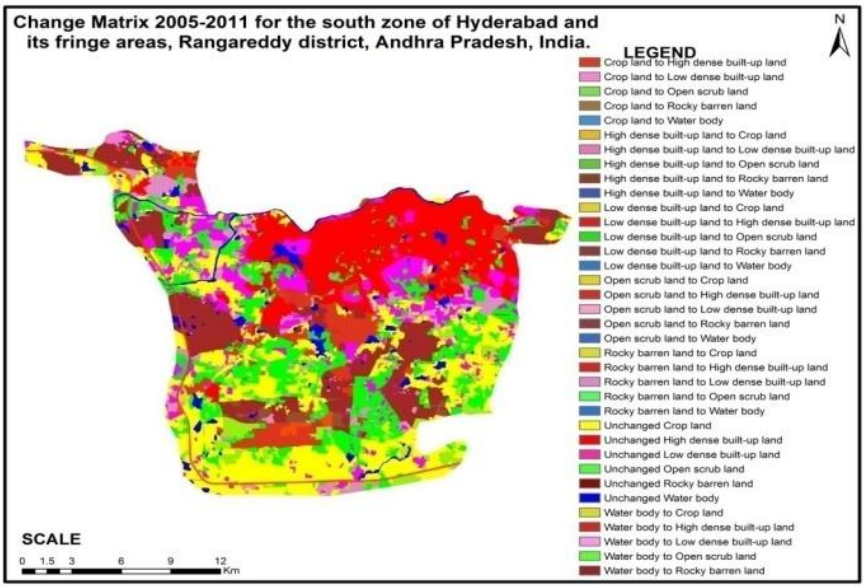


International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347 - 6435 (Online) Volume 2, Issue 1, January 2014)

2005/2011 Class name	Crop land	Low dense Built-up land	Open scrub land	Water body	High dense Built-up land	Rocky barren land	Total
Crop land	59.098	0.000	0.013	0	0.00	0.000	59.112
Low dense Built-up land	6.058	45.464	10.562	0.026	0.00	2.473	64.585
Open scrub land	10.752	0.016	53.219	0.252	0.000	7.552	71.792
Water body	0.000	0	0	8.674	0.000	0.006	8.681
High dense Built-up land	2.707	2.139	4.266	0.127	35.063	2.045	46.349
Rocky barren land	0.944	0.000	0.075	0.052	0.000	39.605	40.679
Total	**79.560**	**47.621**	**68.138**	**9.133**	**35.064**	**51.684**	**291.201**

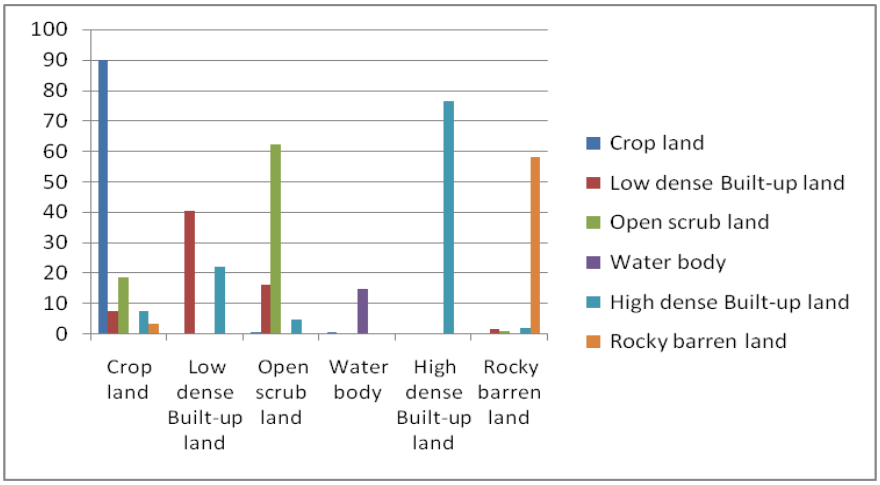


Change matrix between 2005 &2011 in South zone of Hyderabad:

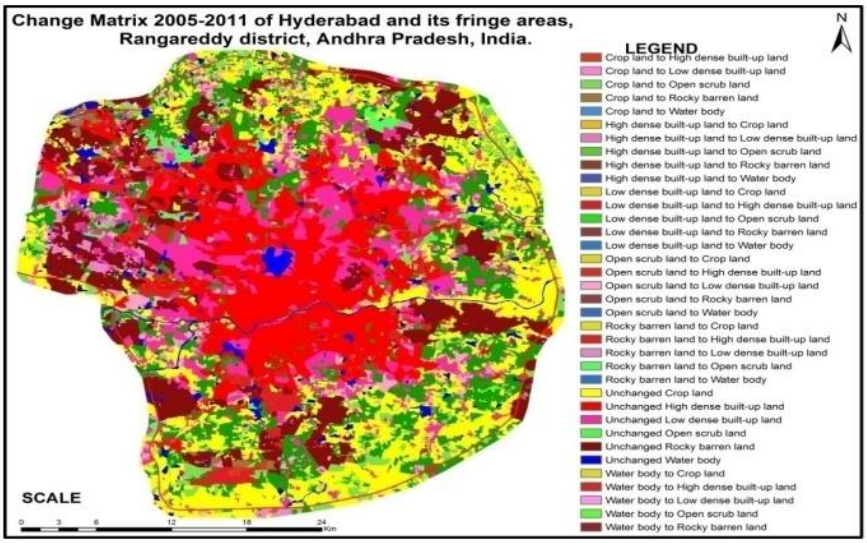


International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347 - 6435 (Online) Volume 2, Issue 1, January 2014)

2005/2011 Class name	Crop land	Low dense Built-up land	Open scrub land	Water body	High dense Built-up land	Rocky barren land	Total
Crop land	90.020	0.000	0.605	0.836	0.000	0.000	91.462
Low dense Built-up land	7.600	40.400	16.287	0.100	0.000	1.820	66.208
Open scrub land	18.725	0.012	62.398	0.370	0.000	1.083	82.591
Water body	0.089	0.000	0.000	14.909	0	0.002	15.001
High dense Built-up land	7.532	21.971	4.624	0.085	76.553	1.876	112.643
Rocky barren land	3.618	0.000	0.001	0.061	0.000	58.026	61.708
Total	**127.586**	**62.386**	**83.918**	**16.362**	**76.553**	**62.808**	**429.615**

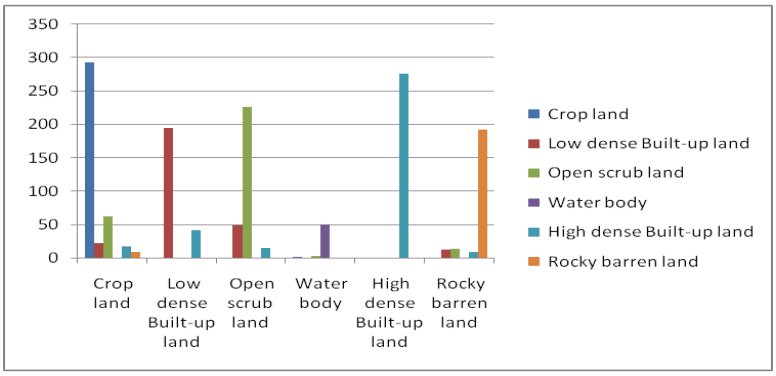


Change matrix between 2005 &2011 in Hyderabad & its fringe areas:



International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347 - 6435 (Online) Volume 2, Issue 1, January 2014)

2005/2011 Class name	Crop land	Low dense Built-up land	Open scrub land	Water body	High dense Built-up land	Rocky barren land	TOTAL
Crop land	292.687	0	0.707	1.79	0	0	295.184
Low dense Built-up land	22.855	194.244	49.277	0.496	0	12.703	279.575
Open scrub land	61.457	0.068	226.022	3.064	0	13.394	304.005
Water body	0.089	0	0	49.276	0	0.033	49.398
High dense Built-up land	17.464	41.324	15.334	0.482	275.667	9.417	359.688
Rocky barren land	8.831	0.007	0.444	0.319	0.007	191.485	201.093
TOTAL	**403.383**	**235.643**	**291.784**	**55.427**	**275.674**	**227.032**	**1488.94**



V. Shannon's Entropy Analysis

Shannon's entropy analysis is computed for Hyderabad and its fringes areas. The study area is divided into five zones viz., Central zone, East zone, West zone, North zone, and South zone. This sets us the number of zones n is 5, Hence the maximum value of Entropy is now Ln(5) is 1.6094.

Considering these five zones, the shannon's entropy is calculated for both the years 2005 and 2011 respectively. The independent entropy value so obtained for both the years are then compared with the Ln(5) value 1.6094, which gives us the urban growth pattern of that particular year.

2005				
Zone	**Area**	**Pi**	**Ln(Pi)**	**PiXLn(Pi)**
Central	99.264	0.1941	-1.6394	-0.3182
East	88.729	0.1735	-1.7516	-0.3039
West	101.746	0.1990	-1.6145	-0.3212
North	82.674	0.1617	-1.822	-0.2946
South	138.905	0.2717	-1.3031	-0.3540
Total	**511.318**	**1.0000**	**-8.1306**	**-1.5920**

International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347 - 6435 (Online) Volume 2, Issue 1, January 2014)

2011				
Zone	**Area**	**Pi**	**Ln(Pi)**	**PiXLn(Pi)**
Central	100.962	0.1592	-1.8376	-0.2925
East	118.81	0.1873	-1.675	-0.3137
West	129.729	0.2046	-1.5867	-0.3246
North	110.916	0.1749	-1.7435	-0.3049
South	173.789	0.274	-1.2946	-0.3547
Total	**634.206**	**1.0000**	**-8.1374**	**-1.5905**

Table (b): Shannon's entropy of Hyderabad & its fringe areas in 2011.

The Shannon entropy (H) is computed by:

$$H= -\sum_{i=1}^{n} Pi \times Ln(Pi).$$

Therefore Shannon entropy (H) for 2005 is **1.5920** and for 2011 is **1.5905.**

These values are closer to the upper limit of Ln(5), i.e **1.6094,** showing the higher degree of dispersion of built up in the city. This means that, over a period of six years the urban growth has been taken place in an 'incompact' form.

Study area	Year	Shannon's Entropy (H)	Ln(5)
Hyderabad and its fringe areas	2005	1.5920	1.6094
	2011	1.5905	1.6094

The measurement of the difference on entropy between time (t) and t +1 was also obtained by using the formula:

$\Delta H= H(t+1)-H(t)$.

The difference on the entropy between 2005 and 2011 was 0.09%, which is quite negligible, revealing the fact that the city is in consistent sprawl through those years.

Polsby-Pooper Compactness Measure:

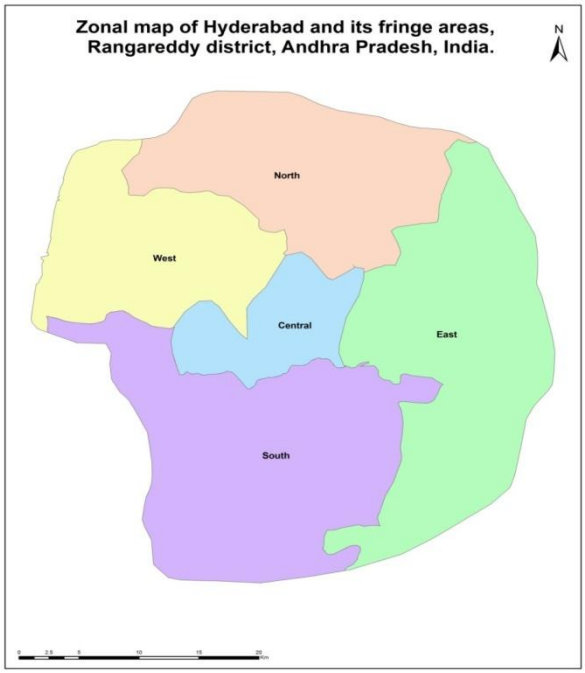
The compactness of land development is estimated according to the average comparison between the perimeter of each developed cluster/zone and that of a circle which has the same area.

This comparison is useful for standardizing the data. The compactness index (CI) is calculated by using 'Polsby-Pooper compactness measure', which is given by:

$$CI= (4\pi * Area)/ Perimeter^2$$

It is convenient to calculate the index because the total area and perimeter of developed clusters/zones can be automatically obtained by using GIS functions.

International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347 - 6435 (Online) Volume 2, Issue 1, January 2014)



Zone Name	Area (Km^2)	Perimeter (Km)	Compactness Index (CI)
East	412.687	122.934	0.3432
West	241.581	80.933	0.4635
North	291.162	84.001	0.5185
South	429.617	120.068	0.3745
Central	113.849	57.244	0.4366

The compactness index can determine whether land development is compact or not. The larger the value if CI is, the more compact the development. A perusal of the above table reveals that the North zone of Hyderabad and its fringe areas has the maximum compactness index (CI) of 0.5185 and the East zone being the less compactness zone with the CI of 0.3432. and the next less compactness zone to the East zone was the South zone having the CI value 0.3745. The compactness index (CI) of West and central zones were found to be close to each other recording 0.4635 and 0.4366 respectively.

As stated above, the compactness index can determine whether land development is compact or not. But more sophisticated indicator to measure urban morphology is based on the concept of entropy. Entropy can be related to the concentration or dispersion of a phenomenon.

The method has advantages in reflecting the orientation and configuration of spatial patterns because it is easily incorporate spatial variables from GIS in the calculation. The measurement is directly carried out within GIS to facilitate the convenient access to GIS spatial databases.

VI. Conclusions

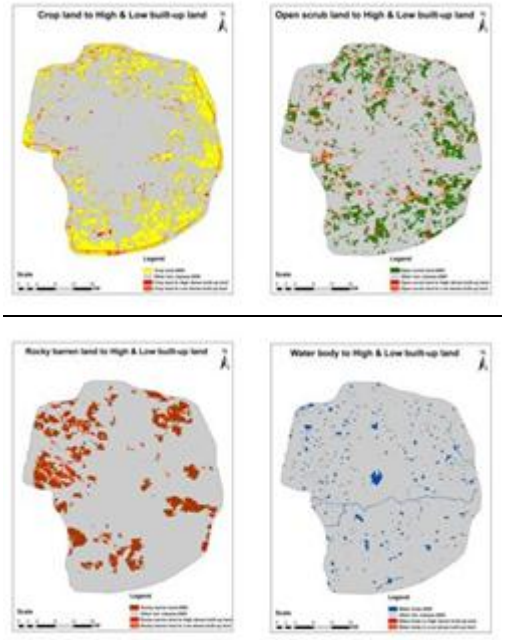
Urban sprawl has increasingly become a major issue in the global trend towards urbanization. Faced not only by developed countries but also by developing countries, and by large urban centers and medium and small cities alike, urban sprawl raises social and environmental concerns at the same time that shows a multiplicity of divergent trajectories that somehow defy the dominance of homogeneous characteristics around the world.

International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347 - 6435 (Online) Volume 2, Issue 1, January 2014)

With the population of India increasing as ever, the pressures on land and resources are also increasing. The urban sprawl is seen as one of the potential threats to sustainable development where urban planning with effective resource utilization and allocation of infrastructure initiatives are key concerns. This study attempts to identify such a sprawl and quantify it by few metrics. The study was carried out along the Hyderabad city and its fringe areas. Using the techniques of GIS and remote sensing the sprawl is identified from the merged images of PAN and LISS IV images of the study area. The processed spatial data along, aided to analyze statistically few urban sprawl metrics. Further, the statistical analyses helped in quantifying the same.

Change Detection of urban sprawl

By examining the land use land cover changes, it was found that the percentage change in built-up area over the period of six years increased by 24.03%. The percentage change in cropland decreased by 26 82%. The percentage change in the water bodies also decreased by 10.88%, the rocky barren land also decreased by 11.42% and finally the percentage change in the open scrub land was increased by 4.18%. From the result it can be said that all the natural resources such as water bodies, rocky barren lands and the crop land are getting degraded year after year due to the urban growth or being transformed into open scrub lands that are going to be future settlements area.



Measurement of urban Sprawl

Shannon's entropy computed for the Hyderabad and its fringe area for the years 2005 and 2011 are 1.592 and 1.5905 respectively. These values are so close to the upper limit of Ln(5) that is 1.6094, showing the higher degree of dispersion of built up in the city . Compactness index computed for the Hyderabad and its fringes reveals that the North zone has the maximum compactness index (CI) of 0.5185 and the East zone being the less compactness zone with the CI of 0.3432. And the next less compactness zone to the East zone was the South zone having the CI value 0.3745, and the compactness index (CI) of West and central zones were found to be close to each other recording 0.4635 and 0.4366 respectively.

Impacts of Urban sprawl:

Encroachment of built up areas on the agricultural land rendering agricultural worker jobless or displaced to move to other areas for different occupation. The unplanned Metropolitan growth has a number of serious adverse effects. Large areas become characterized by the initial scattered land uses so that balanced planning of the areas become impossible. The lack of planning is also reflected in the high cost and poor quality of public facilities serving the urban fringe areas. Land resources are also wasted because the land is divided in small parcels which are difficult to utilize efficiently (Bosselman, 1968).

In studying interactions between human and ecological processes, considering solely the aggregated interactions cannot help explain the outcomes. A complex set of social, political, economic, and biophysical factors drive urbanization and affects when, where, how, and at what rate urban development proceeds (Alberti et al., 2005).

The table below represents the impacts of sprawl on the economic, natural, and aesthetic aspects of the region. Each aspect is divided into minor headings and the corresponding region to each of these phenomena is described.

International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347 - 6435 (Online) Volume 2, Issue 1, January 2014)

Aspects	Cost of sprawl	Examples substantiating the fact
Economic	Loss of open space	34.32% in West zone (i.e.) RC puram, Patancheru, Kukatpally and Serilimgampally (North-south)
	Increased cost of infrastructure	Central zone (i.e.) Circles 7, 8, 9 &10.
	Loss of farm and forest	Parts of south zone (Rajendranager) and west zone (Kukatpally)
	Fragmentation of farms	15.17% in West zone again
	Urban decay and increase in energy consumption	Places connected by city bus services at remote areas like Upparpelly etc.
	Higher tax burden	Conversion tax on land by HUDA & State Government
	Higher land prices	Along major transport arteries- Secunderabad, Ameerpet, Koti etc
	Higher human and wildlife conflicts	Shamshabad, Langar house, etc
	Adverse impact on environmental resources	Construction of built-up areas along green belts
	Greater fiscal disparities among localities	Comparison of Jubilee hills region Vs SR nagar etc
Physical	Congested roads and heavy traffic	JNTU Cross roads, Banjara hills etc
	Overcrowded market and lanes	Abids, Koti, Dilsukhnagar etc
	Longer commuting time with increased distances	ECIL, LB nagar, Patancheru etc
	More aggressive driving	Road crossings, Highways and Expressways.
Social	Decreased social interaction	Distant residential settlements- Chevella, Moinabad, parts of Bachupalli etc
	Limited meaningful consumer choice	About where and how to live at outer limits of Hyderabad urban region
Emotional	Loss of community spirit	Shift if Muslims from old city to Mehdipatnam. Shift of hindus from charminar area to other places
	Loss of sense of ownership and land	Multistoried regions at KPHB 6th phase near JNT University road
Aesthetic	Decreased leisure time	Influx of IT corporate sector
	Monotonous landscape	Banjara hills, Jubilee hills etc.

REFERENCES

[1] Aggrey Daniel Maina Thuo(2010): Community and social responses to land use transformations in the Nairobi rural-urban fringe, Kenya, Field actions science reports(online), special issue(2010, online since 19 March2010,connectinon 12 October 2010.

[2] Alberti M (2005) the effects of urban patterns on ecosystem function. International Regional Science Review. 28, 168– 192.

[3] Barnsley, M.J., and. Barr, S.L. (1997). Distinguishing urban land use categories in fire spatial resolution land cover data using a graph-based, structural pattern recognition system. Computers environment and urban systems 21(3/4): 209-225.

[4] Barr. S., and Barnsley, M. (2000). Reducing structural clutter in land use mapping. Computers and geosciences 26:433-439.

[5] Bosselman, Fred P (1968): Alternatives to Urban Sprawl: Legal Guidelines for Governmental Action, the National Commission on Urban Problems, Research Report No 15, Washington, D.C 1968

[6] Burrough, Peter A, and Rachel A. McDonnell. 1998. Principles of Geographic Information Systems. New York: Oxford University Press.

[7] Batty M., Xie Y., Sun Z. The dynamics of urban sprawl. Working Paper Series, Paper 15, Centre for Advanced Spatial Analysis, University College, London (1999).

[8] Cervero, R. and Kockelman, K. (2002) Travel demand and the 3Ds: density, diversity and design, Transportation research part D, 2(3), 199-219.

[9] Cheng, J., Masser, I. Urban growth pattern modeling: a case study of Wuhan City, PR China. Landscape Urban Plan. (2003). 62, 199–217.

[10] Civco, D.L., Hurd, J.D., Wilson, E.H., Arnold, C.L., Prisloe, M, Eng. Remote Sensing, (2002).68 (10), 1083–1090.

[11] CST (Centre for sustainable transportation), (2002) Sustainable transportation performance indicators (STPI) Project report on phase 3 http://www.cstctd.org/CSTTThomepage.htm

[12] Elena G.I., and Nancy E.B (2004). Land use externalities, open space preservation, and urban sprawl. Regional science and urban economics 34: 705-725.

[13] Epstein, J., Payne, K., Kramer, E., 2002. Techniques for mapping suburban sprawl. Photogrammetry. Eng. Remote sensing. 63(9), 913–918.

[14] Fan, F., Wang, Y., Qiu, M. and Wang, Z. (2009) Evaluating the temporal and spatial urban expansion patterns of Guangzhou from 1979 to 2003 by remote sensing and GIS methods, International Journal of Geographical Science 23, 1371 – 1388.

[15] Fung, T. and LeDrew, E. Application of principal components Analysis change Detection, photogram metric Engineering and Remote sensing of Environment (1987).