ISSN 2229-5518

Modeling Urban Growth in Indian Situation - A Case Study of Bhubaneswar City

Ashis Chandra Pathy, Dr.G.K.Panda

Abstract— Increasing Urbanization and Industrialization is resulting in accelerating the growth of existing urban centers and causing faster rate of spatial Sprawl. Because of Sprawl of Urban centers, the increase of Population in hazardous areas and large-scale land conversion are matters growing concern. In particular urbanization in developing countries has produced large concentration of urban squatters and irregular developments which are settled in marginal locations and hazardous areas, exposed to periodic and seasonal flooding, prone to health hazards and other related problems. Bhubaneswar city is also experiencing similar problems, because the sites with their physical shortcomings (narrow valleys, low-lying areas and stream banks etc.) have been urbanized. The present study deals with Bhubaneswar, the capital city of Orissa which was planned in the year 1954 to shift the then capital of Orissa from Cuttack to Bhubaneswar. From the year 1954, the process of spatial growth of Bhubaneswar city was slow but gradually the city has emerged as one of the fastest growing city of the country.. In this study attempts has been made to develop a methodology focusing on monitoring of urban growth based on remotely sensed data and GIS. The study also attempts to highlight the pattern of rapid expansion and nature of growth of Bhubaneswar.

Key Words: Analytical Capabilities, Correlation, GIS, Remotely Sensed data, Urbanisation, Urban Sprawl.

1. INTRODUCTION

INCREASING Urbanization and Industrialisation is is resulting in accelerating the growth of existing urban centers and causing faster rate of spatial Sprawl. Sprawl. Because of Sprawl of Urban centers, the increase of Population in hazardous areas and large-scale land conversion are matters growing concern. In particular urbanization in developing countries has produced large concentration of urban squatters and irregular developments which are settled in marginal locations and hazardous areas, exposed to periodic and seasonal flooding, prone to health hazards and other related problems. Bhubaneswar city is also experiencing similar problems, because the sites with their physical shortcomings (narrow valleys, low-lying areas and stream banks etc.) have been urbanized. Secondly another effect of urban sprawl is haphazard development along major transportation network and along streams running east to west from the city. Faster land conversion process and the concentration of unplanned development in marginal locations are matters of growing concern of the city. (Mishra, 1991, 2008) . Because of the rapid urban growth, all major urban centres of India are expanding every year and on average 2000 hectares of productive agricultural land are converted to urban use. Govt. of India in 1987 constitute a "Urban Sprawl mission" for mapping and monitoring of Urban Sprawl of metropolitan cities to study its impact on the city and its environs, using remotely sensed data [Sharma; 87]. Remote sensing and GIS can be used separately or in combination for application in studies of urban sprawl. In the case of a combined application, an efficient, even though more complex approach is the integration of remote sensing data processing, GIS analyses, database manipulation and models into a single analyses system (Michael and Gabriela, 1996). The present study attempts to develop a methodology focusing on the monitoring of urban growth based on use of remotely sensing and GIS technology.

2. OBJECTIVES OF THE STUDY

- Development of methodology to generate time series data of urban areas
- To study the efficacy of remotely sensed data and GIS for monitoring Urban Sprawl.
- To study the under lying causes of rapid expansion and nature of growth for developing future strategies

- *Ph.D Scholar,Departmrnt of Geography,Utkal University,Bhubaneswar,Odisha,India-751004 E-mail: **ashis.pathy@gmail.com***
- *Professor,Departmrnt of Geography,Utkal University,Bhubaneswar,Odisha,India-751004 E-mail: **gopalkrishna_panda@yahoo.co.uk***

3. REMOTE SENSING FOR URBAN SPATIAL DATABASE DEVELOPMENT

The overwhelming advantages of remote sensing methods over tactile methods based on ground survey are the consistency which can be ensured in at least one stage of data collection, the rapidity of survey, the synoptic coverage, less time and manpower at the data collection stage. Remote sensing which is now universally recognized as a highly effective and versatile technology for mapping, estimating, and monitoring and integrated planning is adopted widely for urban area monitoring/management.

There is no doubt now a day about the potential of remotely sensed data for urban information generation and other planning purposes. For the last forty years it has been regularly used in India as one of the most advanced method of spatial data acquisition, information updating and monitoring purposes. It has been used for various operational mapping and monitoring projects by various organizations under state and Central Government.

4. HANDLING AND ANALYSING IMAGE DERIVED URBAN SPATIAL DATA

It is self evident that collecting spatial data without analyzing them has little merit. Equally, it is obvious that handling large volume of spatial data necessitates use of new tools. In modern planning and management information demand is rapidly increasing. Even though the remote sensing technique is considered as most advanced method for obtaining spatial information; often indeed, the real problem of remotely sensed data interpretation appear to be problem of data processing or integrating the photo/image derived data with other attribute data, once the data is received and interpreted.

For planning and management of urban areas, various hardware and software are developed which are easy to install and cost effective for small organizations. Secondly quick map generation as per user need, map updating and manipulation options; facilities to use photo/ image derived data; analytical options like data quantification, combination, comparison, cross tabulation and catchment area analysis and statistical analysis of spatial data along with other data types makes computer a useful tool in planning and decision making.

One of the ways to associate the spatial data with other types of data for obtaining desired information for urban area management is the use of geo-information system. A GIS system contain mainly from major components.

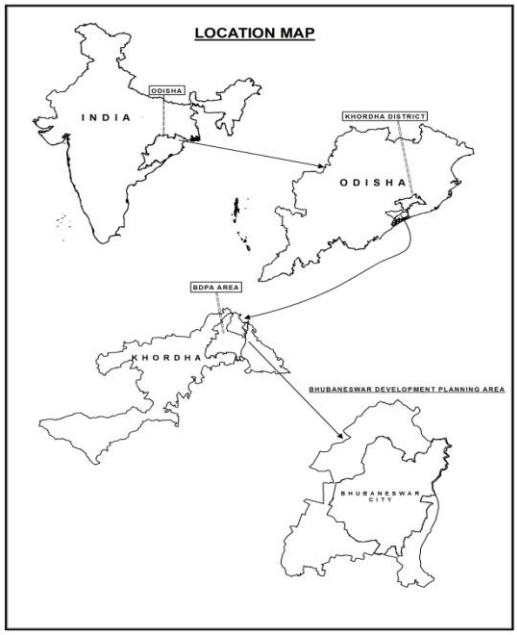
- Database structure
- Input routines
- Output routines
- Analytical operations

Essentially any GIS contain two types of data i.e. spatial objects or entities. Often stored in various layers of maps and attribute data that describe features related to the spatial Objects.

As urban area management requires integration and modeling of large volume of spatial and attribute data, computers are widely used now days for status survey, database development, monitoring, modeling and impact analysis and forecasting.

5. STUDY AREA

The capital city of Orissa- Bhubaneswar is located between $20^0 25'$N latitudes and $85^0 55'$E longitude on the western fringe of coastal plain across the main axis of Eastern Ghats in Khurda district of Orissa,India. The city lies on the low lateritic plateau and the erosion has made its topography a valley-and-ridge one, having series of drainage channels. The average elevation is 46m above MSL and morphologically it lies in the Deccan upland of Gonwana origin.



6. URBANISATION TREND OF BHUBANESWAR CITY:

1951. The population of Bhubaneswar was only 16,512 and increased to 38.211 in 1961. The city registered the highest increase of about 131 percent during the decade 1951-1961 owing to the shifting of the Capital City of the State from Cuttack to Bhubaneswar during the year 1954.The population growth rate of Bhubanerswar city during 61-71 and 71-81 was highest and second highest in India respectively. The growth rate is highest in all the three decades (61-81) in the state and among the cities constructed after independence of the country. Table no-5 shows the area, population, population Growth and population density of Bhubaneswar city.

Table 1 Area, Growth and Pop. Density of Bhubaneswar Municipality, 1951-2008

Census Year	Population	Decadal Growth (%)	Area (sq. km)	Density per sq. km
1951	16512		25.90	638
1961	38211	131.41	50.25	760
1971	105491	176.07	65.03	1622
1981	219211	107.80	92.91	2359
1991	411542	87.74	124.74	3299
2001	648032	57.46	135.00	4800
2008	1080000	66.65	146.60	7357

Source: Census Reports of Govt, of India; 1951 -2001 and Newsletter of BMC (Aahwan); CDP Report of IIT, 2009

The existing and projected population of Bhubaneswar Development Plan area as depicted in CDP report of Bhubaneswar by Govt. of Orissa in 2008 is given below.

Table 2 PROJECTED POPULATION OF BDPA AREA

Administrative Area	Area (SqKm)	Population 2001	Population 2008	Population 2030	Density 2001 (Popn./SqKm)	Density 2008 (Popn./SqKm	Density 2030 (Popn./SqKm)
BMC	146.80	658220	1080000	2000000	4484	7357	13624
Khurda	29.19	42695	59000	150000	1463	2021	5139
Jatani	25.74	57957	70000	130000	2252	2720	5051
BDPA Rural	217.37	98534	163200	720000	453	751	3312
Total BDPA	419.10	857406	1372200	30,00,000	2046	3274	7158

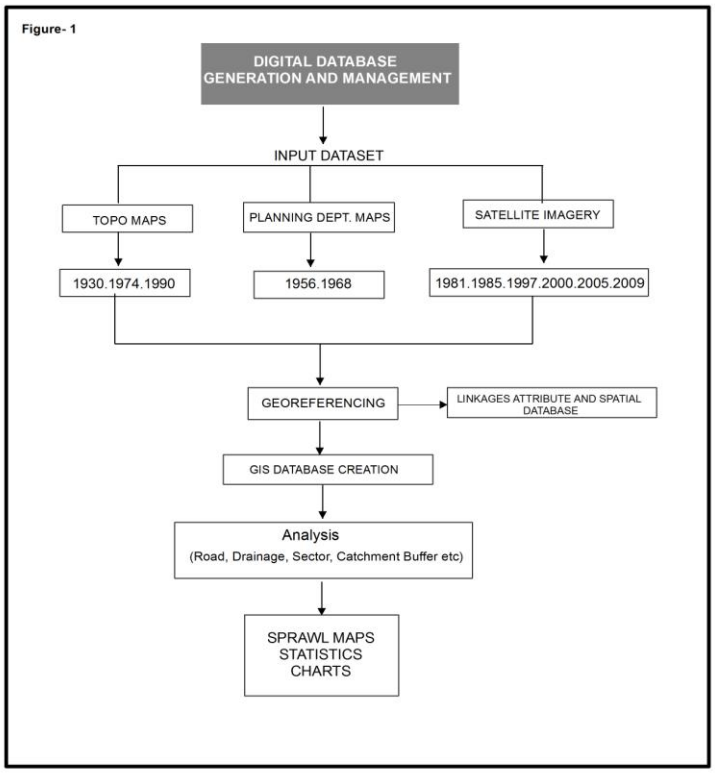
Source: Census of India, 2001

7. DATABASE USED

- Aerial Photographs of 1974 (Scale=1:25,000), March 1989 (Scale=1:4,000),
- satellite data of 1981 (MSS), 1985 (TM), 1997(IRS1-D), 2000(Resourcesat/IRSP6), 2005 (Cartosat, Quick Bird), 2009(Cartosat)
- Planning Dept. maps (Dir. Of Town Planning and BDA) of 1956, 68, 1974,SOI Topodata of 1930, 1981 etc.

8. METHODOLOGY

Remotely sensed data are visually interpreted and use to prepare urban area maps and Arc GIS-10 package was used for inputting, storage, analysis, processing and map generation. Various other maps from Planning Dept, Odisha (1956,1968), Census office are also used for the sprawl study. The Maps prepared by Remote Sensing techniques are stored in the computer and modeling analysis was done by various GIS analytical capabilities and SPSS Package. The methodology flow chart is given in Fig.1.



9. ANALYSIS & RESULTS

POPULATION GROWTH TREND ANALYSIS

Tthe population growth of Bhubaneswar is very high among various capital cities of India. It is a fast growing city as per as population is concerned. Table 1 shows the population growth of city since 1921 to 2010.

The population growth v/ith respect to time period can be mathematically expressed as follows. (Correlation 0.92)

$y = m * X + c$ where $c = 114.4$ $m = -4147.19$ & S.D. =1025

or $y = a_0 + a1 * x + a_2 * x^2 + a_3 * x^3$

$a_0 = 3025.9$ $a1 = -159.6$ $a_2 = 2.28$ and S.D. = 466.4

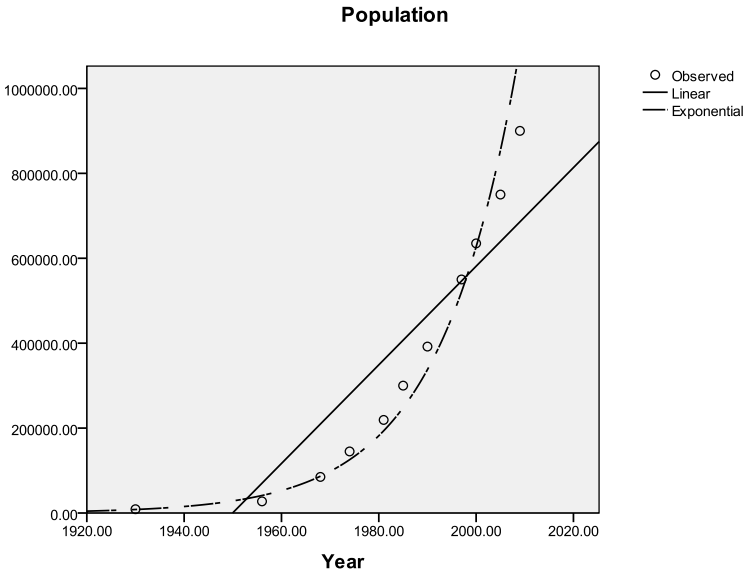


Fig.2 Population growth of Bhubaneswar city

URBAN AREA GROWTH TREND ANALYSIS

The urban area maps of 1930, 56, 68, 74, 81, 85, 1990, 1997, 2000, 2005 and 2009; prepared by the above process were digitized and GIS data base is generated. The aerial extent of urban area in different periods is given in table 3. The Arc-GIS package and SPSS sw was used (mainly the statistical submodules) to study the relationship between urban area growth with respect to time period. The following mathematical relationship was observed between two variables.

$$Y = a_0 + a, * x + a_2 * x^2 + ...$$

Where, for the second order polynomial the values of the coefficients are as follows.

a_0 = 3025.9 a, = -159.66

a_2 = 2.2 8

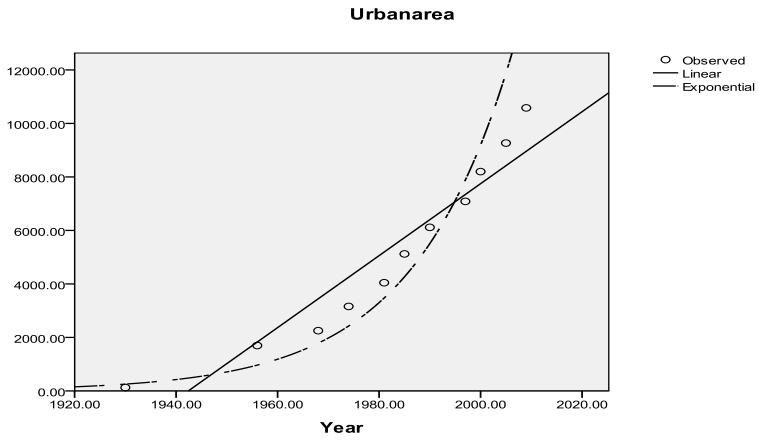
And Standard deviation = 466.4 and Correlation = 0.93

Table-3 URBAN AREA GROWTH OF BHUBANESWAR CITY

YEAR	URBAN AREA IN HECT.	% GROWTH	POPULATION	% GROWTH
1930	104.9		8940	
1956	1654.9	1478	27,400`	206
1968	2237.9	35	85,000	210
1974	3234.2	45	145000	71
1981	4077.7	26	219211	51
1985	5091.8	25	300000	37
1990	5767.1	13	3,92000	31
1997	5958	3.31	5,50000	40
2000	6524	9.4	6,35000	15
2005	8052	23.4	8,00000	26
2009	8600	7	9,80000	23

URBAN GROWTH AND POPULATION GROWTH

Fig.3 Urban area growth of Bhubaneswar city



The correlation study made above explains the urban sprawl trend. During the first three decades of capital construction, population is four times the urban area growth and became proportional during 1968-74, But from 1981 onwards the rate of area growth is constantly increasing whereas the population growth is decreasing. Again after 2005 the population growth and urban area growth are proportional.

SECTORAL GROWTH OF BHUBANESWAR CITY

The urban area in diffarent city directions are analysed by GIS union and buffer analysis technique. (Fig.-4)

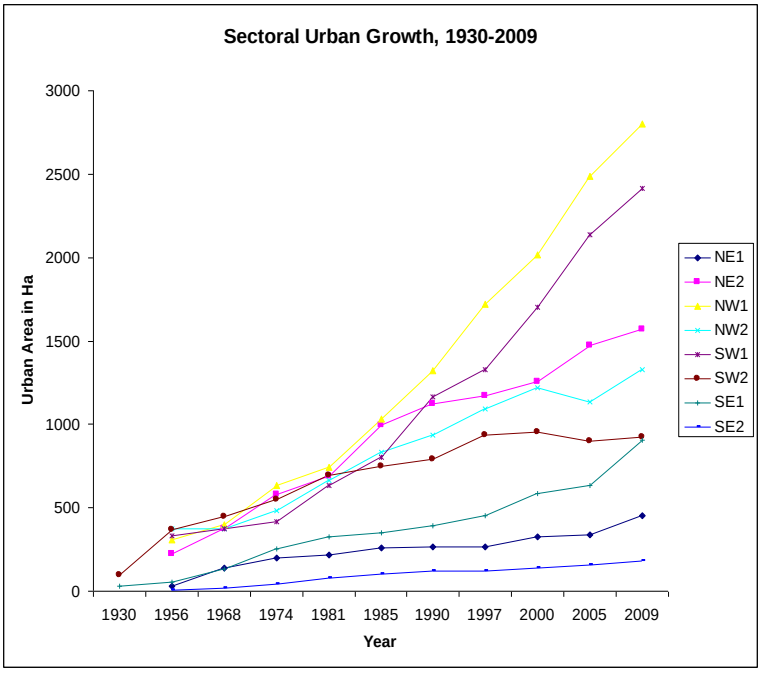


Fig.4 Growth of Bhubaneswar city in different direction

The city has a high growth trend in Northwest (along the NH towards Khurda) and Northeast direction (along Chandrasekharpur-Patia) from 1985 onwards.

GROWTH ALONG ROAD CATCHMENT

The table 4 depicts the urban area growth in 4 major roads radiating from city central area i.e NH5, Khandagiri-Chandaka road, Jayadev vihar to Nabdankanan road and NH-203 to PURI. A network map was prepared showing the above roads and its catchment area. Catchment areas around the transportation networks were generated at the intervals of 0—1 k and 1—2 km.

Table-4 Urban Area Growth of Bhubaneswar City along the Road Catchment.

C\Y	2009	2005	2000	1997	1990
1 km	6323.75	5154.30	4777.24	4056.48	3514.51
2 km	3917.85	3134.55	2679.32	2412.13	2069.66

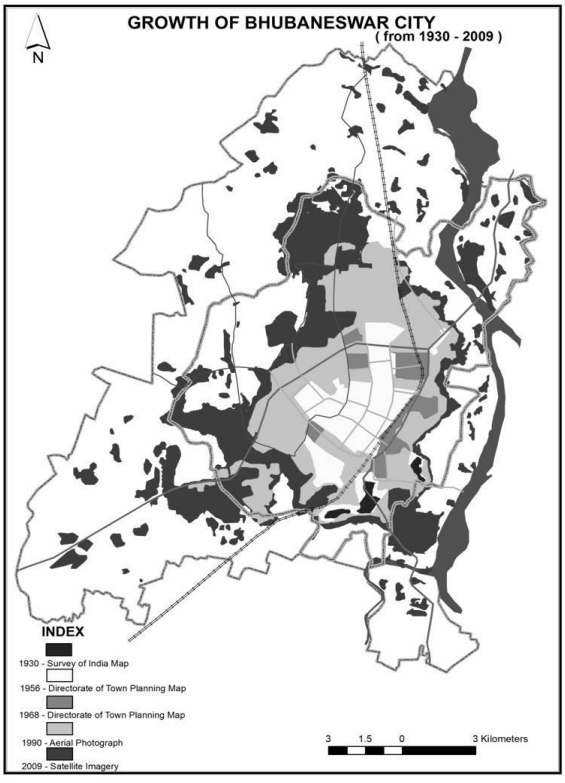
C\Y	1981	1974	1968	1956	1930
1 km	2367.74	1829.52	1230.84	724.85	68.63
2 km	1381.58	1087.49	827.76	808.40	54.99

The data above indicates urban growth is more along 1 km of catchment, than away from 2km from the major transportation networks.

CONCLUSION

Monitoring and quantification of urban spatial growth can be successfully carried out by the help of multidate, multi-sensor remotely sensed data along with historical data by using a geo information system. Multidate remotely sensed data can provide (depending on the definition of urban area) the extent of urban area (gross estimates in case of low resolution satellite data); which is very much essential for monitoring the urban growth.

URBAN SPRAWL MAP OF BHUBANESWAR DEVELOPMENT AREA



REFERENCES

[1] A. Atkeson, P.J. Kehoe, Modeling the transition to a new economy: Lessons from two technological revolutions, Amer. Econ. Rev. 97 (2007) 64–88.

[2] Abdel-Rahman H Fujita M (1990) Product variety, Marshallian externalities and city size, *Journal of Regional Science* 30: 165-183.

[3] Anselin L, Bera AK, Florax R and Yoon MJ (1996) Simple diagnostic tests for spatial dependence, *Regional Science and Urban Economics* 26: 77-104.

[4] Barnes, K. B., Morgan III, J.M., Roberge, M.C., Lowe, S. (2001) Sprawl development: its patterns, consequences and measurement, Towson University, Towson, USA.

[5] Buera, F. and J. Kaboski, The rise of the service economy, Northwestern University Working Paper, 2006.

[6] Civco, D. L., Hurd, J. D., Wilson, E. H., Arnold, C. L., and Prisloe, M. (2002) Quantifying and describing Urbanising Landscapes in the Northeast United States. **Photogrammetric Engineering and Remote Sensing, Vol. 68, No. 10**, 1083-1090.

[7] Epstein, J., Payne, K., Kramer, E. (2002) Techniques for mapping suburban sprawl. **Photogrammetric Engineering and Remote Sensing, Vol. 63, No. 9**, 913–918.

[8] Eastman, J. R. (1999) **Idrisi32**: Guide to GIS and Image Processing. Volume 1 and 2, Clark Labs, Clark University, USA.

[9] Florax R and Folmer H (1992) Specification and estimation of spatial linear regression models: Monte Carlo evaluation of pre-test estimators, *Regional Science and Urban Economics* 22: 404-432.

[10] Fujita M, Krugman P and Venables A (1999) *The spatial economy: cities, regions, and international trade*. MIT Press, Cambridge, MA.

[11] Harris R and Lau E (1998) Verdoorn's law and increasing returns to scale in the UK regions, 1968-91: some new estimates based on the cointegration approach, *Oxford Economic Papers* 50: 201-219

[12] Mishra Debajit (1990) Monitoring and Modelling Urban Sprawl by Remote Sensing and Geoinformation System, *Msc Theses, ITC, Netherland*

[13] Moreno R and Trehan B (1997) Location and the growth of nations, *Journal of Economic Growth* 2: 399-418.

[14] Pathy Ashis Chandra (2009) Spatial Growth and Land use Change of Bhubaneswar City, *M.Phil Dessertation, Utkal University, Odisha. India*

[15] Rivera-Batiz F (1988) Increasing returns, monopolistic competition, and agglomeration economies in consumption and production , *Regional Science and Urban Economics*18: 125-53.

[16] Ying L (2003) Understanding China's recent growth experience: a spatial econometric perspectiva, *The Annals of Regional Science* 37: 613-628.