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## DYNAMICS OF SPATIO-TEMPORAL CHANGES OF URBAN LAND USE/LAND COVER PATTERN IN TEMPLE CITY OF BHUBANESWAR, ODISHA, INDIA

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### ABSTRACT

The present study has been carried out in Temple city Bhubaneswar, Odisha which has been declared as a smart city in the recent past by the Indian Government. The objective of the study is to understand the spatio-temporal dynamics of population growth and land use pattern in the perspectives of its future growth and development. The population has grown from 16,000 at the time of its inception to more than 10 lakhs presently with an annual growth of 9.148 percent. The fast growth of population has led to expansion of the geographical area of the city from 28.7 sq.km to 148 sq.km. Of 13 different land uses recognized, residential area has increased from 6.20 to 23.04% of the total area. With increase in residential and commercial areas, agriculture and forest land areas are shrinking at a rate of 0.717% and 0.449% per annum respectively. Water bodies in the city are declining in area and getting polluted. Promotion of vertical growth of the city, rejuvenation of water bodies, availability of open space, development of sewage network and drainage systems were realized in order to make the city green, resident friendly and sustainable.

**Keywords:** Land use, Spatio-temporal changes, Population, Water bodies, Slum, Environment

### Introduction

Land is one of our most precious assets and its use in multidimensional. It provides basis of the life to terrestrial and aquatic flora and fauna in one way or another. Globalization and industrialization have brought rapid urbanization and fast growth of cities that are considered as engines of economic growth (Kumar and Chithra, 2012). Urbanization in India is no way different from the rest of the World. It is observed from the recent census that the number of urban centers in India has increased from 3769 to 9378 and around 285 million people are living in different urban centers constituting 27.8% of the total population. The United Nations in 2001 has predicted that the number of people in Indian towns and cities will reach at 814 million by 2050 (Stanley, 2008). It is said that urban population presently almost contributes 60% of India's GDP and is likely to reach at 70% in coming 15-20 years. Such a huge population in urban areas is likely

to pose various developmental problems urging India to stream like planning policies, setting growth pattern and master plans to guide development and above all regulating development to have better quality of life (Jain, R.K and Kumar Matindar , 2008). Realizing the need for transformation of the urban life, Government of India has launched the smart city mission in June 2015 for comprehensive development of physical, institutional, social and economic infrastructure and the quality of life of people in 100 selected cities in the country (Kulashrestha, 2016) at the first hand. Bhubaneswar ranks number one in the smart city pilot projects. As such it attracts the attention of policy makers, planners and researchers to make it a model city for others.

The capital city of Bhubaneswar that came into existence in 1948 with a total area of 510 ha has increased tremendously in recent times because of rapid growth of infrastructure such as housing

complexes, educational institutions, policy sectors units, small manufacturing industries, IT hubs etc (Anonymous, 2017). Bhubaneswar, the capital city at the time of its design was planned to accommodate about a population of 20,000. But its population has reached at 4.11 lakhs in 1991 and presently stands at more than 10 lakhs. The original master plan of 1946 that was based on the neighborhood concept of living is being replaced by Comprehensive Development Plan to address.

Though some study has been conducted by Geographers on the land use modeling and in the area of land use and vegetation of Bhubaneswar there is no comprehensive study that could throw light for the future planning and development of Bhubaneswar modern city (Smart City). Under this background the present study was conceptualized so as to study the land use changes in recent times. Apart from this, the disturbances caused due to capital city development in the previously existed dense vegetation in the large stretches of Bhubaneswar covered in the forest patches was also investigated.

The objectives of the present study are:

- a) to understand the spatio-temporal dynamic of Bhubaneswar city in terms of population and land use till time.
- b) to analyse the pattern and nature of land use.

### Concept of Land cover and Land use

**Land Cover:** Land cover is the biophysical state of the earth surface (Turner *et al.*, 1995). In other words, land cover describes the observed physical state of the land surface as seen on the ground at a given location and time. This includes the soil surface, vegetation or forest, mountains etc.

**Land use:** Land use refers to the way human beings employ and exploit land cover for several purposes such as farming, mining, housing, logging or recreation (Gupta *et al.*, 2015) Hence land use change is the exploitation of land cover through its conversion and/Urban sprawl refers to the aerial expansion of urban concentrations beyond what they have been. It refers to the continuous expansions around large cities, whereby there is always a zone of land that is in the process of being converted from rural to urban use or modification overtime primarily to serve human needs (Burley, 1961).

### Materials and Methods

**The study Area:** Bhubaneswar is located in the Khurda district of Odisha, India between 20°12'N to 20°25'N latitude and 85°44'E to 85°55'E longitude

on the Western fringe of the coastal plain across the main axis of the Eastern Ghats. It is situated on the South Eastern Railway line joining Howrah and Madras at a distance of 435 km South of Calcutta. The National Highway No.16 connecting Calcutta and Madras passes through Bhubaneswar. The city stands at the Western side of the "Mahanadi Delta" on the bank of river Kuakhai, a distributary of Mahanadi River, 30 km South-West of Cuttack city. The river Daya which has branched off from Kathojodi, flows along the South –eastern part of the city. The present study is confined to the Bhubaneswar city which is carried by Bhubaneswar Municipality Corporation (BMC) with an area of 146 Sq.km with 67 wards. However, Bhubaneswar Development Plan (BDP) spreads over an area of 419 Sq. km that goes beyond the BMC jurisdiction.

**The Study Design:** The present study has been carried out on Bhubaneswar city and it is based on multi source data base/ Analysis of secondary and primary data, collected through survey method has been used in the current study. The Primary data includes information's collected from personal physical survey of localities and wards, study of satellite images. The secondary data involves analysis of published research papers, maps, census reports, Government documents, cadastral sheets, newspaper, reports etc. The available satellite data has been visually interpreted and integrated with intensive field checks and land use maps available from BDA, BMC and revenue departments. Open-source data available on internet was also used. Year 1974 has been considered as the base year for the present study and land maps was developed in 1974 first time.

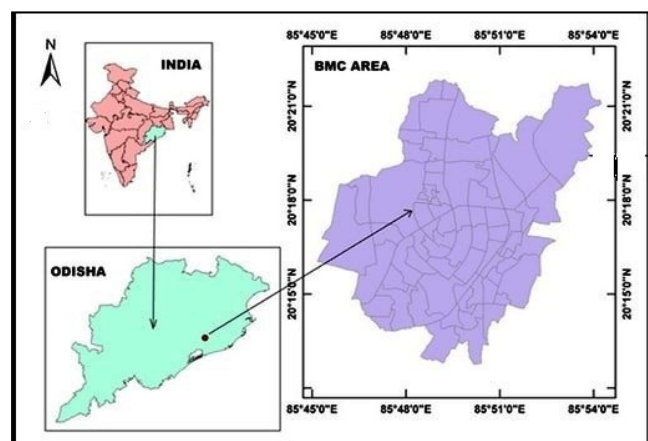


Fig. 1 : Location (GPS) of Bhubaneswar area

### Field survey:

Field survey was broadly divided into two phases.

- i) The satellite data and ancillary data were collected prior to the start of the field survey. ii) The second

phase of the field survey dealt with the collection of data through survey of the area(s) by the researcher(self) to understand the field scenario and collect information pertaining land uses (agriculture, housing, commercial, drainage, open space, recreation etc) .

For urban sprawl mapping and for temporal land use and land cover delineation, the following maps/ data base sets were used in the present study.

1. 1930: Survey of India maps in 1:63360 (in inch = 1 mile) (From SOI)
2. 1956: Directorate of Town Planning maps (From ORSAC)
3. 1968: Directorate of Town Planning maps (From ORSAC)
4. 1974: Aerial photographs of 1974 (Scale 1:25,000) (From ORSAC)
5. 1985: Thematic Mapper™ data of Oct. 1985, Land use map of BDA (From ORSAC)
6. 1977: IRS-ID-LISS-III and PAN (Panchromatic) BDA interim development plan maps. (From ORSAC)
7. 2000: IRS-ID PAN and LISS-III of Feb. 16, 2000(From ORSAC)
8. 2009: World view, CDP map of Directorate of Town Planning and BDA (From ORSAC)
9. 2011: Cartosat-II of March, 2011(From ORSAC)
10. Top sheet of BBSR and its surrounding area (From BDA)

The field data collected was matched with the field maps and satellite images to come out with conclusions.

## Results and Discussion

### Development of Bhubaneswar city

Bhubaneswar is one of the growing cities of the country. The overall special structure of the city is presented under the divergent stages of growth to reach at present day development of urban agglomeration through analysis of maps published by Government of Odisha from time to time (Das, 2016).

### Dynamics of Bhubaneswar city

Population in an urban area is very important as it determines the rate and pattern of growth of the city which in turn demands for various resources, facilities and services. The population of Bhubaneswar for last 90 years has been presented in Table 1. The population was only 8170 in the year 1921 and in touched a size

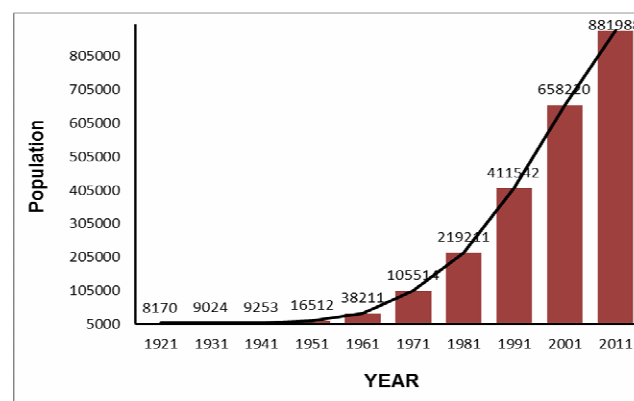
of 16,512 just after declaration of the capital. The population reached at a number of 2.2 lakhs after 30 years in 1981. In 2011 the number touched at 8.81 lakhs (Fig.2). Presently (2016) the population about 971120 lakhs.

**Table 1** : Year, Population and its decadal growth in Bhubaneswar city (1921-2016)

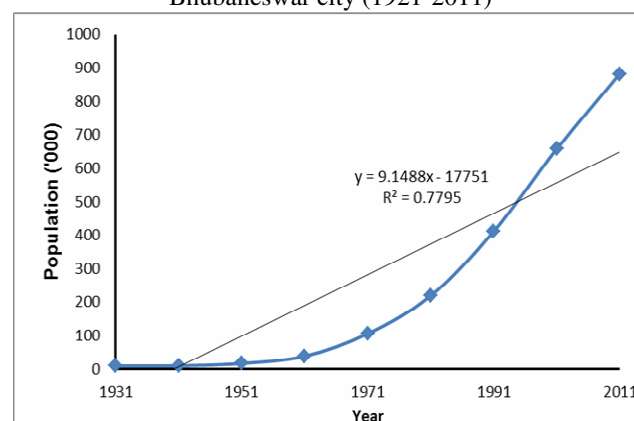
Year	Population	Decadal growth (%)
1921	8170	
1931	9024	10.4
1941	9253	2.5
1951	16512	78.4
1961	38211	131.4
1971	105514	176.0
1981	219211	107.8
1991	411542	87.5
2001	658220	60.0
2011	881988	34.0
2016	971120*	

\*Calculated Value

It is observed that the population grew at a rate of 9.148 percent units per year, as per the log logistic model (Fig. 3) with a  $R^2$  value of 0.779.



**Fig. 2** : population growth over the years thousands in Bhubaneswar city (1921-2011)



**Fig. 3** : Increase of Population number in thousands in Bhubaneswar city During (1921-2011) of Bhubaneswar city.

As per the decadal growth of population, growth was minimum between 1931- 41 and the highest during 1961-71. Further there is increase in absolute number, the decadal growth in population has decreased after 1971 (Fig. 4) reaching at 34.0% between 2001-11. As per the statistical calculations, the rate of decrease in decadal population is by 24.45 units per year ( $R^2 = 0.807$ ) (Fig. 5)

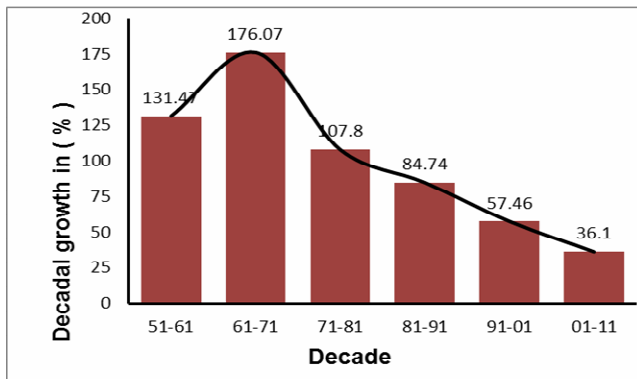


Fig. 4 : Decadal growth in population of Bhubaneswar city

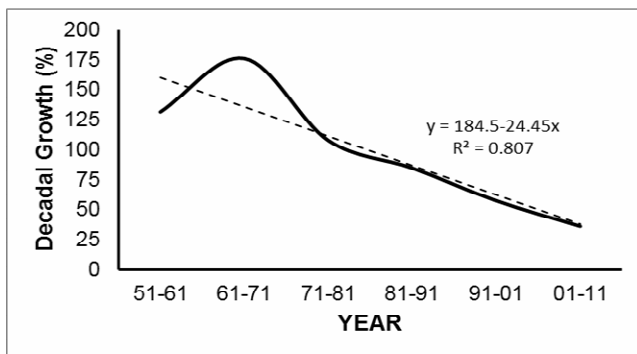


Fig. 5 : Decadal growth in population of Bhubaneswar city

As per 2001 census the population density of the city works out to about 4444 persons per sq.km in the municipality area. However, in the present population projection, the present density stands at 7292 persons

per sq.km. The three most populous wards are 53(Bapuji Nagar area), 59(Lingaraj Nagar area, Raushapatna area) and 43(Laxmi sagar area). The increase in population density showed that there is an annual increase of 110 persons per sq. km. as reflected from linear logistic model ( $R^2= 0.923$ ) Fig. 6.

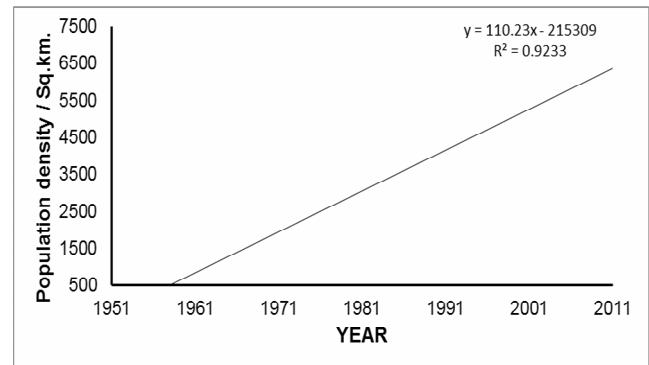


Fig. 6 : Increase in Population density (per Sq. Km.) in Bhubaneswar city over the years

**Land use Pattern**

Bhubaneswar started its master plan since 1968 and the city had only a geographical area of 9621 ha. Seven functional land use zones are identified keeping specific land uses in view. These zones are residential, commercial, industrial, public and semi-public, open space, green belt and transportation zones. During this period residential zone covered the maximum area (22.93%) followed by green belt zone (19.54%) and open space area (14.47%). Commercial zone covered only 2.72% of the total geographical area.

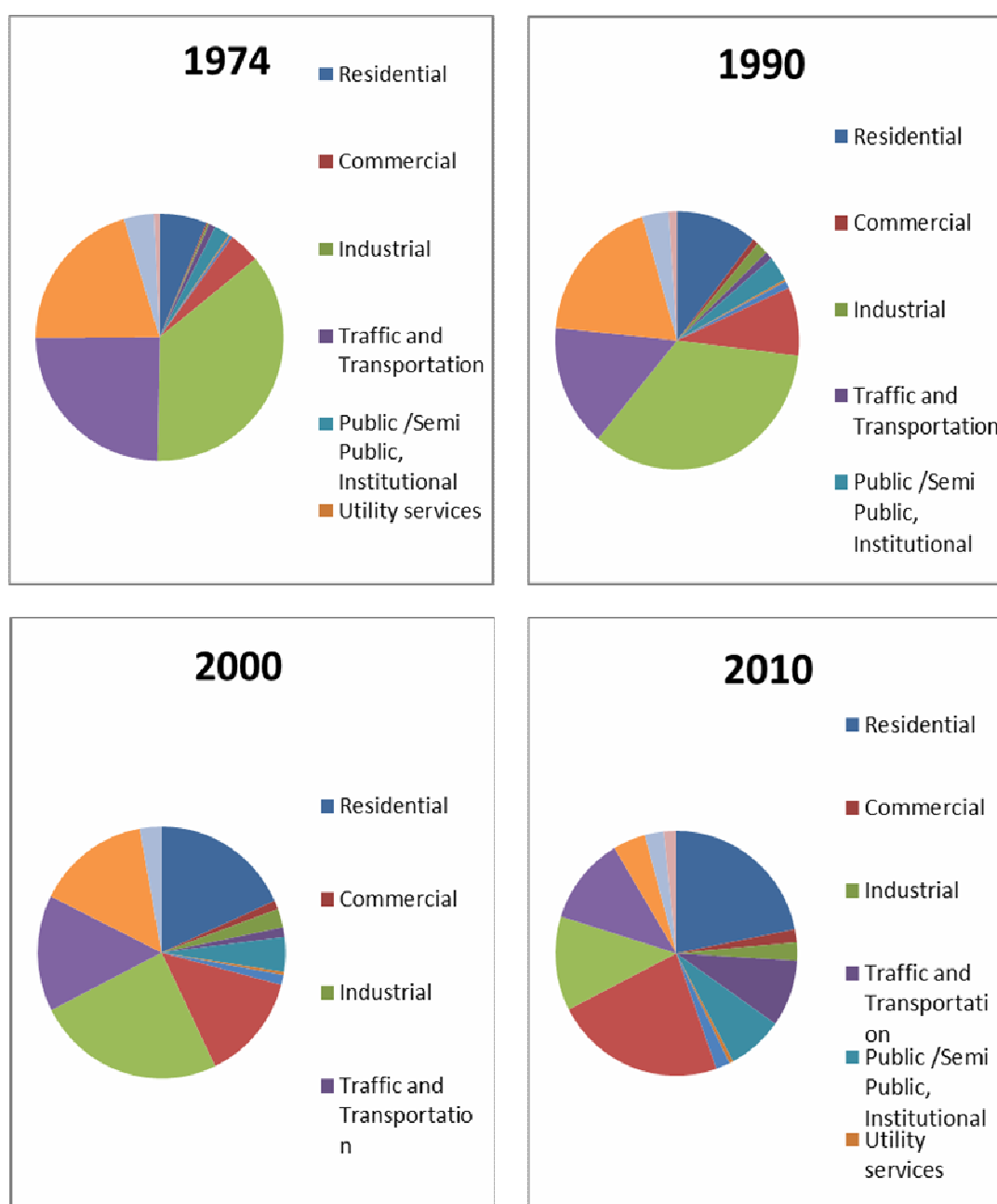
After 1968, the city expanded at a fast rate and new zones such as utility services, vacant land, recreation services, and waste land were created. Presently a total of 13 types of land uses have been recognized. The details of change in pattern of land use have been shown in Table 2 and Fig. 7

Table 2: Changes in land use pattern over the years from 1974-2016 in Bhubaneswar city\*

Sl. No.	Land use type	1974		1990		2000		2010		2016	
		Area (Sq.km.)	Area (%)	Area (Sq.km)	Area (%)	Area (Sq.km.)	Area (%)	Area (Sq.km.)	Area (%)	Area (Sq.km.)	Area (%)
1.	Residential	4.30	6.2	13.41	10.74	23.97	17.59	31.61	21.85	32.29	23.04
2.	Commercial	0.131	0.19	0.957	0.77	1.472	1.08	2.474	1.71	----	----
3.	Industrial	0.159	0.23	1.928	1.55	3.14	2.31	3.47	2.4	3.69	2.48
4.	Traffic and Transportation	0.596	0.86	1.219	0.98	1.635	1.2	12.73	8.8	----	----
5.	Public /Semi Public, Institutional	1.422	2.05	3.893	3.13	5.82	4.27	10.79	7.46	12.2	8.2
6.	Utility services	0.131	0.19	0.335	0.27	0.517	0.38	0.781	0.54	----	----
7.	Recreational	0.242	0.35	1.094	0.88	1.690	1.24	2.691	1.86	----	----
8.	Vacant land	2.86	4.13	10.68	8.59	18.04	13.24	32.99	22.8	----	----
9.	Agricultural land	25.33	36.5	42.70	34.33	32.24	23.66	18.01	12.45	16.07	10.8

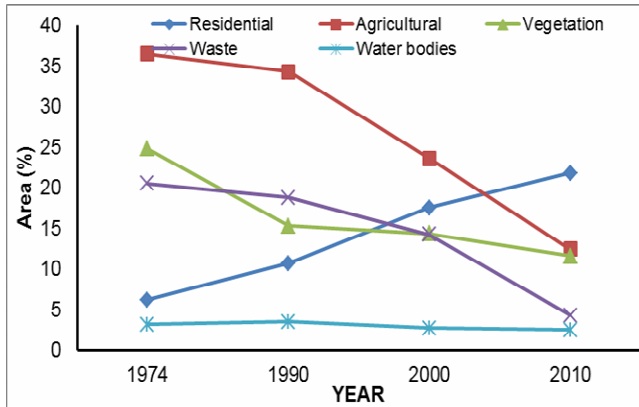
10.	Vegetation /Forest land	17.21	24.8	19.07	15.33	19.57	14.36	16.78	11.6	16.60	11.2
11.	Waste land	14.28	20.58	23.38	18.8	19.45	14.27	6.279	4.34	5.23	3.52
12.	Water bodies/ Wet land	2.22	3.2	4.366	3.51	3.70	2.72	3.646	2.52	3.60	2.42
13.	Others	0.499	0.72	1.39	1.12	5.01	3.68	2.416	1.67	-----	----
Total		69.4	100	124.4	100	136.3	100	144.7	100	148.8	

\*= Data from BMC and BDA reports

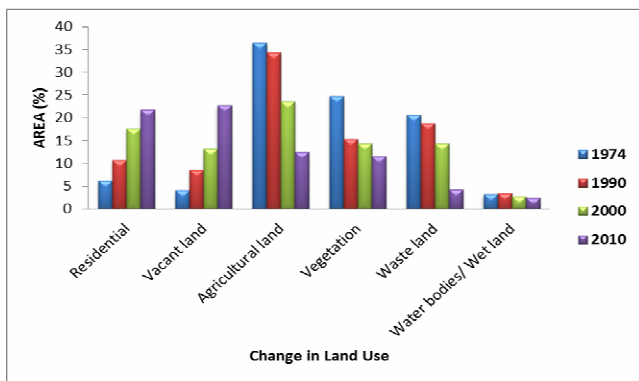


**Fig. 7 :** Change in land use pattern over the city (%) in Bhubaneswar from 1974-2010

The overall land use of different types of residential, agricultural, vegetation, wasteland and water bodies in terms of area (in %) from 1974-2016 in Bhubaneswar city has been presented in Fig. 8 and Fig. 9.



**Fig. 8 :** Change in land use area for residential, agriculture, vegetation, wasteland and water bodies over the years in Bhubaneswar city.



**Fig. 9 :** Change in land use for residential, vacant land, agriculture, vegetation, and wasteland, water bodies over the years in Bhubaneswar city.

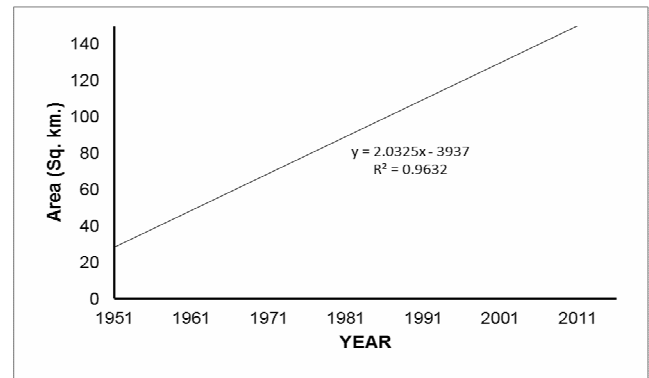
**The CDP 2010 for BDPA 2030**

The open space under CDP 2010 for BDPA 2030 included open space as recreational zone that involved i) Playground, stadium and sports complex, ii) Parks and gardens, iii) Special recreation zone (Archeological sites) and iv) multipurpose open space. (Perspective Plan – VISION, 2030)

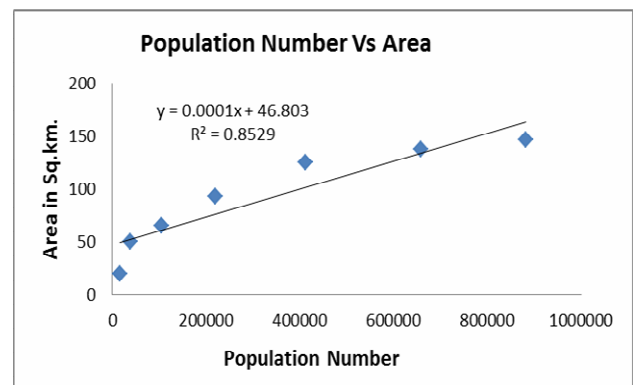
Presently the existing number of parks and playground in the BDPA region are 161 and about 80 in the BMC area. It has been observed that there has been an increase in the developed parks in the city in terms of area from 180.30 ac. in 1993 to 356.54 ac. presently.

The overall increase in area of Bhubaneswar city (Fig.10) shows through linear logistic model ( $R^2=0.963$ ) that there is an average increase of 2.032

sq.km. area per annum. Further a positive correlation was noted between population growth and expansion of city area (Fig. 11)



**Fig. 10 :** Increase in geographical area in Bhubaneswar city over the years



**Fig. 11 :** Correlation between Population number and Area (in Sq. Km.) in Bhubaneswar city

**Conclusion**

Global human population is growing and rural to urban migration is increasing. This urbanization trend will continue to happen left for another few decades. The United Nations estimates that 4.9 billion inhabitants out of 8.1 billion will be living in cities by 2030. Bhubaneswar is no exception. Its population is estimated to touch 15 lakhs in next 4-5 years. This continued urbanization pattern will increase land and resource consumption besides putting stress on the environment. So, the state and local governments, planners and policy makers should acknowledge these problems immediately and put environment perspective(s) into land use planning and decision-making process effectively and promptly to bring visible changes. Bhubaneswar is historically known as a Temple city and recently it has been declared as the Smart city. It is therefore most essential to ensure that utilization of available land is judicious while extending modern facilities and techniques to its people in terms of better mobility, waste management and citizen centric services. The tradition and heritage

of the city is not compromised as Bhubaneswar has become a city of both tradition and modernity.

### Recommendations

From the discussion and conclusion made on the piece of work in the previous pages, the following recommendations are made to promote proper urban planning and sustainable development leading to a people friendly city.

1. Instead of horizontal growth in North-South direction, vertical growth of the city needs to be promoted in order to reduce land area utilization (more people in less area) besides reducing stress on natural resources such as water, energy and also global warming.
2. Planning for development of satellite cities with all basic facilities close to capital city (Bhubaneswar) could help in reducing migration of people from other places.
3. Proper planning and segregation of residential and commercial areas will help in reducing traffic jam, noise pollution and unhygienic environment. Domestic animals with cattle sheds are to be kept away from the residential areas. Conservancy lands meant for utility services always be kept clean.
4. Sewerage disposal, sanitation and solid waste management need urgent attention. Sewerage treatment plants (STP) are to be constructed on priority basis. About 600 metric tons of solid wastes produced per day from the city needs to be converted into energy.
5. To promote communication and reduce traffic jam, ring road, service road, over bridge/ fly over and multi-level parking need to be constructed.
6. Desilting and renovation of water bodies and ponds are necessary to influence microclimate of the city. Funds for the purpose could to be arranged from Orissa Urban Improvement Development Fund, Water Resources, Orissa Environment Management Fund etc.
7. Cleaning of natural drainage and their maintenance will stop stagnation and water logging in the city areas.
8. To promote healthy life style, there is a need for increase provisions of public urinals, subways, foot paths, community toilets, park, gardens and playgrounds. Increase number of burial grounds, cremations ground and electric crematorium are need to be constructed. Open defecation needs to be stopped by creating awareness.
9. As water table is going down with reduction of rainy days, BMC should give stress on water conservation. Digging well along natural streams will not only help to store water but also will help to recharge ground water.
10. As green environment of Bhubaneswar has been lost, massive plantation programme is necessary to save the residents from heat waves during summer. Plantation of suitable broad leafed wind resistant fruit trees in the waste lands and along the road side is need of the hour. During construction and expansion of roads, translocation of trees to new localities is necessary for a better, cleaner and greener Bhubaneswar.

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