URBAN SPRAWL OF CUTTACK-BHUBANESWAR REGION USING REMOTE SENSING AND ARC-GIS

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

Bachelor of technology

In

Civil engineering

By

RUMAN RAHAMTULLAH

111ce0083

Under the guidance of

PROF. RAMAKAR JHA

DEPARTMENT OF CIVIL ENGINEERING, NATIONAL INSTITUTE OF TECHNOLOGY ROURKELA, MAY 2015

CERTIFICATE

This is to certify that the project entitled, “Urban Sprawl of Cuttack-Bhubaneswar region using remote sensing and ARC-GIS” submitted by “RUMAN RAHAMTULLAH” in partial fulfillments for the requirements for the award of Bachelor of Technology Degree in Civil Engineering at National Institute of Technology, Rourkela (Deemed University) is an authentic work carried out by him under my supervision and guidance.

To the best of my knowledge, the matter embodied in the report has not been submitted to any other University/ Institute for the award of any Degree or Diploma.

DATE: (PROF. RAMAKAR JHA)

ACKNOWLEDGEMENT

I express my appreciation and extremely grateful to Prof. Ramakar Jha for his direction and consistent consolation and backing over the span of my work. I really admire the quality and his regarded direction and consolation from starting to the end of the postulation, his organization and learning at the season of emergency would be recalled deep rooted.

My sincere on account of Prof S.K Sahoo, Head of the Civil Engineering Department, National Institute of Technology, Rourkela for giving a wide range of bolster and help. I am additionally appreciative to all the teachers of Civil Engineering Department.

I express my uncommon on account of Mr. Ray Sing Meena and Mr. Janaki Ballav Swain of NIT Rourkela for developing help when I required the most.

Ultimately I need to thank my parents for always supporting and empowering me at the season of disappointment and they are dependably at my back. They are my steady wellspring of motivation for these four years. These four years however being differentiated has conveyed me closer to them. I need to commit this bit of work of mine to my guardians.

RUMAN RAHAMTULLAH

111CE0083

CONTENTS

List of figures **page no.**

List of table **page no.**

ABSTRACT

The world around us is undergoing complete metamorphosis, which is boosted by the population explosion and technological expansion. The problem is more severe for India which has more towns which have to be transformed in to large cities to accommodate its ever-increasing population. In this study an analysis is done by using ARC-GIS (geographic information system) where map of the region was analyzed for recognizing the distribution of land use types throughout the area; land types considered are-Forest, Agricultural, Industrial, Residential, Water bodies. This analysis was performed for three years: 2005, 2010 and 2015. Results obtained show that the area of barren land, forest and agricultural land is continuously decreasing and that of residential land is rapidly increasing because of increase in demand.

Maps were again analyzed using Buffer analysis in which Acharya vihar was chosen as the point of interest and multiple circle buffer analysis was performed to study the spread of agricultural and residential areas over the buffers and identify the directions in which the city is expanding, and it was found out that north and north-west directions have undergone massive expansion over the span of 10 years.

CHAPTER-1

INTRODUCTION

INTRODUCTION

The world is experiencing the biggest rate of urban development today. Throughout 2008, more than a large portion of the world's populace was staying in towns. In 2012 this number has crossed the 7 billion imprint. The vast majority of this populace will be amassed in Africa and Asia. The megacities were the centre for the high development potential. Up to the mid time of twentieth century, area utilization change has come about into an enormous issue around the entire world (Lambin, 2001). With the development of our financial aspects and social upliftment, the extensity and force of area spread change had a tendency to be severer. The forecast and reenactment of urbanization is imperative among the investigations of area utilization. Demonstrating is crucial for investigating, particularly for the forecast of the elements of the urban development (Clarke & Silva, 2002). A few disappointments happen for demonstrating the utilization of area however later on there was resurrection in the two-three decades because of better accessibility of information. High registering capacity additionally gives impulse for demonstrating utilization. Various models developed in this time; these models included cell automata sort, recreation sort or some piece of it identified with specialists based sort. Cell automata are amazingly proficient to anticipate area utilization change (Dietzel & Clarke, 2006). Over the span of time, a few models were created to conjecture the future area utilization condition to assess and survey distinctive area use approaches.

Remote sensing and GIS are outfitting new devices for cutting edge administration of biological community. The remotely sensed information encourages the discriminating summary of earth's capacity designing and their progressions all through mainly, locally and internationally (Mishra and Subudhi, 2006). The radiant development in land data science has given us the accessibility of diverse sorts of area utilization models. They vary as far as information gathering, spatial displaying. The information can give a critical association between environmental, national and territorial protection and administration differing qualities (Willkie and Finn, 1996). GIS innovation is necessary piece of the all the area utilization models. The spatial and worldly process can be effortlessly taken care of by the capacity of the GIS innovation. The remote detected pictures give a great deal of information which can be helpful for the advancement of uncommon determination in remote sensing for a period arrangement.

Existing area utilization models fury from tenet based projects that give data and direction on the methodology of dispensing development to distinctive sub regions, to modern models that fuse financial hypotheses and business systems. The models utilize an extensive variety of methodologies, for example, spatial association, spatial data yield, and standard based (Waddell 2004). Spatial connection, spatial data yield, and straight programming models were utilized as a part of the early operational models of the 1960's and 1970's. Miniaturized scale reproduction was not into practice until 1980's despite the fact that it was produced amid the 1960's (wargon, 2010). The 1980's saw discrete decision models and cell automata turning into the most up to date displaying methodologies. In the 1990's, few area utilization models actualized a guideline based arrangement of techniques to allot populace, vocation and area use on the GIS (Geographic Information System) stage.

Shannon (1948) did the origination of entropy. The second law of thermodynamics expresses that thermodynamic corruption is unalterable over the long haul, e.g., a smoldered log can't be un-blazed and tepid water can't be differentiated unmistakably into boiling hot water and cool water (Jha and Singh, 2008). The issue, disorder or arbitrariness of association of a system is known as its entropy (Miller, 1969). The entropy worth can be taken as the estimation of uncertainity. An irregular variable's entropy is determined regarding its likelihood conveyance and is a decent measure of irregularity or instability (Aggarwal and Rahman, 2011). Urbanization has turned into one of the fundamental elements of area debasement, basically because of the nature of the rural terrains that have been urbanized (Santibanez & Royo, 2002). Urban development without legitimate arranging has brought about major issues in environment. This prompts deficient framework offices, water lack and activity blockage. Late land utilization changes will be useful to interchange foundation and administrations, for example, legitimate zoning transport, medicinal offices, and outlining of schools. Further land use studies can be confirmed to topography, mapping of soils, and other hydrologic highlights. The motivation behind this study is to examine area utilization change in the Bhubaneswar City range and to think that its urban sprawl heading. The goal is to survey the area utilization change and to utilize the entropy way to deal with discover the level of arbitrariness.

SOFTWARE USED - Esri's ArcGIS is a geographic information system (GIS) for working with maps and geographic information. It is used for: creating and using maps; compiling geographic data; analyzing mapped information; sharing and discovering geographic information; using maps and geographic information in a range of applications; and managing geographic information in a database.

CHAPTER-2

LITERATURE REVIEW

Literature review-

Daniel lozzi sperandelli, Francisco Antonio dupas(2013) performed a case study in Atibaia (a city situated in the metropolitan edge of São Paulo) with the accompanying objectives: (1) comprehend urban sprawl and the spatial advancement of green spaces and empty land in five distinctive time periods (1962, 1972, 1978, 1995, and 2009), (2) examine arrangements that would add to a requested urban improvement, and (3) serve as rules for urban-planning studies, neighborhood powers, and analysts. The consequences of this study demonstrate the accompanying: (1) urban sprawl is a consistent methodology (even in 2009, when 21% of the area was empty) and is energized by an admissible end-all strategy, and (2) the increment of green spaces is the aftereffect of development upon the remaining timberlands in periurban areas.

In many nations spatial control systems went for controlling city development have sober-mindedly been supplanted by methods to oversee development, since development is inescapable at any rate (Urban Foundation 1993, p. 4).Mapping urban sprawl serves to recognize regions where natural and regular assets are basically debilitated and to propose likely future bearings and examples of sprawling development(Simmons, 2007). Various researchers have tended to the issue of precisely checking area cover and area utilization change in a wide variety of situations (Muchoney and Haack, 1994; Singh, 1989; Shalaby and Tateishi, 2007). Diverse sorts of models are utilized to anticipate the urban sprawl in times of time. Brett Hazen (1996) utilized a model called LUCAS to asses area utilization change in Little Tennesse River Basin of western North Carolina. Robert Johnston (2000) utilized another model called UPLAN to help in future urban situation of the city Espanola in New Mexico. While John Landis (2001) went over with a model called Curba which consolidated bio assorted qualities consider urban development pattern. Patterson (2008) anticipated urban sprawl by utilizing URBANSIM model in Brussels.

Merwe (1997) utilized IDRISI GIS package to calculate development for area utilization sorts with an accentuation on their deliberate and weighted criteria. H P Samant (1998) took multi date information of geological maps and Landsat TM information to discover the area Use change in Navi Mumbai. Silva et. Al anticipated urban development in European urban areas utilizing Sleuth model. Carlson (2002) utilized Sleuth model coupled with Landsat Tm imagery to anticipate future changes in surface spillover coming about because of the urbanization. Liu (2003) et. al utilized cell automata calculation with conjunction with fuzzy set technique to

model urban development and discovered sensible and reasonable situations. Liu (2005) et. al utilized the joining of remote sensing, geographical systems and multivariate mathematical models to anticipate urban development. Hu and lo (2006) connected the logistic regression for displaying urban development in Atlanta for better comprehension the variables influencing it. Andrew Manu et. al utilized remote detecting innovations to study the urban development of three noteworthy Sahelian cities.

Jansen et. al gave a spatially explicit land-cover/utilization change flow in the period 1991–2001 utilizing the UNEP Land Cover Classification System for classes with object-oriented geo-database approach to deal with handle changes in the advancement of area spread items, i.e. polygons, with time to withstand change flow investigation. Haack and Rafter (2006) utilized KVGIS layer to locate the urban development in Kathmandu. A lot of this development has happened without successful planning bringing on significant issues including natural contamination, utilizing unemployment, deficient foundation offices and clashing area utilization requests. At the same time, late land utilization change data is helpful for procurement of different frameworks and administrations, for example, transportation, utilities, restorative offices and schools. Henriquez and Azocar (2006) discovered the area spread change in Chillan and Los Angeles through the computerized understanding of flying photos from distinctive time sets. Their study investigated the principle main thrusts that clarify the development of these medium sized urban communities utilizing model for area use and the spatial examinations as prescient instruments. Jha and Singh (2008) utilized entropy approach for examination of urban development in Haridwar which is a vital city along the banks of River Ganga, to create future arrangement for urbanization advancement ranges and urbanization control regions. Rahmann and Aggarwal utilized the Shannon's entropy to model the urban extension of Hyderabad city, India. They discovered wonderful sprawl or urbanization in the city. Mohajeri created urban road designs conduct utilizing the entropy and discovered great relationship among them. Remote sensing, GIS and entropy methodologies were coordinated to satisfy the destinations of the present work. Taubenbock connected multi fleeting remote detecting and time arrangement of Landsat information for checking and comprehension of urban sprawl prepare in India. Ibrahim and Sarvestani (2009) utilized diverse satellite pictures between 1976-2005 and populace statistics of Shiraz city in Iran to show urban sprawl design. Four primary area utilization sorts, for example, developed ranges ,water, vegetation and exposed area zones were arranged from

satellite pictures of Shiraz city. From their work it is encouraged that the urban arrangement will be more centered around security of accessible vegetation and pay of decimated coverage.

Belal and Moghanm (2011) discovered the urban sprawl in twomajor areas in the Egypt. Landsat images like Multispectral Scanner (MSS) in the 1972 and Enhanced Thematic Mapped (ETM) in the 2005 were utilized to survey the progressions of urban infringement, agrarian terrains and water ranges amid this period with coordination by GIS. The primary target of their study was to translate sprawling of urbanization and its effect on farming area utilizing coordinating remote detecting and GIS. Rahman and Aggarwal (2011) utilized the Shannon's entropy model to discover urban sprawl utilizing IRS P-6 information (Rahman, 2011) and topographic sheet in GIS environment for Hyderabad and its Surrounding Area. This study is very applicable as in with the quick city development the urban biological community is changing and it has a negative effect on the vegetation and in addition on human well-being in this locale. Jing and Jianzhoung (2011) utilized multi-temporal TM/ETM+ pictures to foresee the urban extension in Lianyungang City between 1987 to 2009. The examination to the model of urban development demonstrated that the urban extension was clearly bicentric, and takes activity streets as development hub.

Chen Zhan-long, Xie Zhong,Wu linag(2008) analyzed the map projection and the math of buffer analysis in light of the summarization of the previous buffer analysis and map projection, and improved the arithmetic of buffer analysis, and after that dissected the problem of the buffer analysis utilizing map projection as a part of the first run through. During the time spent the building of the buffer polygon, this article fundamentally examined how to solve the distortion issue caused by not considering the map projection when made the buffer analysis in the large-scale zone. As per the result of the simulated test, this method is handy and productive.

CHAPTER-3

THE STUDY AREA

About the study area -

Bhubaneswar and cuttack are the focal point of all the major activities in Odisha, popularly known as the twin city are undergoing exponential expansion day by day.

Bhubaneswar is arranged on the Howrah -Chennai principle south Eastern Railway line at 435km from Howrah and 1215km from Chennai and the NH.5 uniting Chennai and Kolkata goes crosswise over urban focus. The city is in the west piece of the "Mahanadi Delta" on the bank of the stream Kuakhai and the South west of Cuttack city. The stream Daya which has cut off from Kuakhai moves along the south eastern piece of the city. After the autonomy, Bhubaneswar locale has experienced a great deal of development and development. Managerial and institutional exercises have added to the increment in the volume of exchange and trade action. The city lies in the middle of 21° 15' latitudes and 85° 15' longitudes. The normal temperature in winter is 12 degree Celsius and the most extreme temperature is 43 degree Celsius (Figures 1 and 2). The south-west storm shows up in June. Bhubaneswar has a great atmosphere. The city has three distinct seasons. They are summer (from March to June), Monsoon (July to October) and winter (From November to February). As indicated by Kopppen order the city goes under savanna (ISDR Report, 2002). The normal yearly precipitation of the city is 1498 mm (Bhubaneswar primary report). The mean yearly temperature of bbsr lies between 270C to 410C. The atmosphere stays humid for the month of June to month of October.

Cuttack is the former capital and the second largest city in the eastern Indian state of Odisha. It is also the headquarters of the Cuttack district. Cuttack is located at 20°31′23″N 085°47′17″E[16] and has an average elevation of 36 metres (118 ft). The city is located at the central point of four rivers which are the distributaries of River Mahanadi; namely Mahanadi, Kathajodi, Kuakhai, Birupa and further Kathajodi is distributed into Devi and Biluakhai.

Demography –

According to Bhubaneswar Demographics, Census 2011 figured the number of inhabitants in the Bhubaneswar to be roughly 837,737. Around 56% of the aggregate populace are male while44% are female. Hinduism is the significant religion took after by the individuals living in Bhubaneswar. As indicated by the 2011 registration of India, populace of Cuttack City in 2011 was figured at 606,007; of which male and female are 303,530 and 302,477 separately. Its urban/ metropolitan populace is 658,986 of which 331,246 are guys and 327,740 are females. Downright youngsters (0–6) in Cuttack City are 48,585 according to figure from Census India cover 2011. There were 25,358 young men while 23,227 are young ladies.

Figure-1, Aerial view of study area

CHAPTER-4

METHODOLOGY

Methodology –

4.1 Geo-referencing –

Base map is taken, which is the map of Odisha taken from the survey of India. Geo-referencing is the process in which a given map which doesn't have specified units is aligned with the natural coordinates. this can be done if the coordinates of at least four points in the map are known and the geo-referencing tool is used to specify the unit of the map.

4.2 Creation of shape files –

This process is also called digitization of the map, in this process a part of the map which is required for the analysis can be converted to raster by making shape file of that portion using data management tools present in the ARC catalog menu. This gives the polygon map for study area.

4.3 Extraction by mask –

Aerial image of the study area for the years 2005, 2010 and 2015 captured by LANDSAT 8 are obtained from http://earthexplorer.usgs.gov/. bands 1,2,3,4,5 and 7 should be added to the ARCmaps and then the shape file data superimposed on it, extraction by mask tool is used to extract from LANDSAT image, only the area required for analysis.

4.4 Supervised classification –

This is a process where the masked data is worked upon to differentiate various land use types. This process includes: creation of training samples;creation of signature file; supervised classification.

Various land use types taken in to consideration are –

1. **Forest**
2. **Residential**
3. **Industrial**
4. **Agricultural**
5. **Barren land**
6. **Water bodies**

1.forest – land area covered by dense plantation and a habitat for wild animals is classified as forest area.

2.**residential-** the build-up area except the industrial ones which is used by people for residential purpose, recreational buildings, malls, office spaces etc.

3.**industrial –**land area which is used for commercial purposes such as manufacturing, quarrying, warehouses etc.

4.agricultural – land area where crop is grown and also the plantation areas present in the city.

5.barren land –land which is not used for any purpose yet.

6.water bodies – area which is covered by water resources, it includes: river, pond, lake etc.

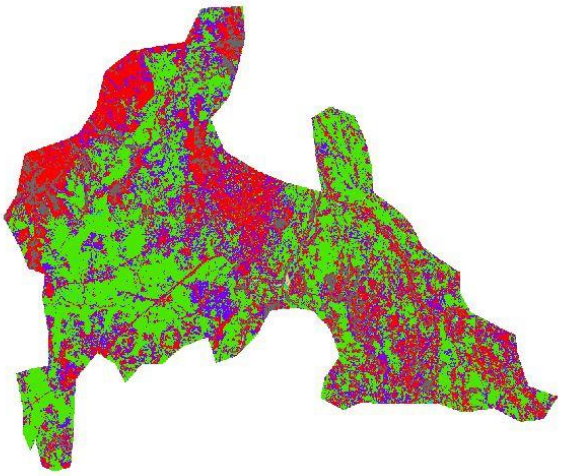

Fig2. Supervised classification

fig3. Color codes for various land types

4.5 Buffer Analysis –

This can be done by using 2 methods

1.the multiple buffer analysis feature in ARCGIS. In this process a center of interest is chosen at Acharya Vihar, and buffers are drawn with an increment of 2km in radius per circle, 2 land use types are considered for buffer analysis, which are-

1. Agricultural
2. Residential

This analysis gives us the knowledge of direction in which the city is growing so that we can anticipate correctly and accordingly direct our resources.

2.buffer along highway

In this method buffers of 3 km are taken on both the sides of the national highway and analyzed for four land use types, namely-

1. agricultural

2 .residential

3. vacant land

4. water

CHAPTER-4

RESULTS AND DISCUSSIONS

Results and discussions –

The first step involves the geo-referencing of base map which is taken, then the shape file of the require portion of the base map is created for further analysis. Shape file is shown in fig2.

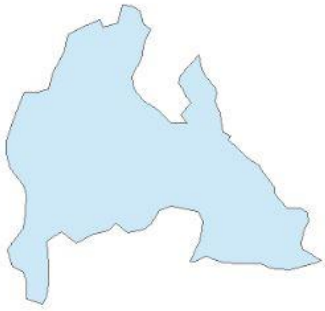

Fig4. Shape file of the region

Next process is to get the landsat data which is superimposed on the shape file of the region and consecutively supervised classification is carried out.

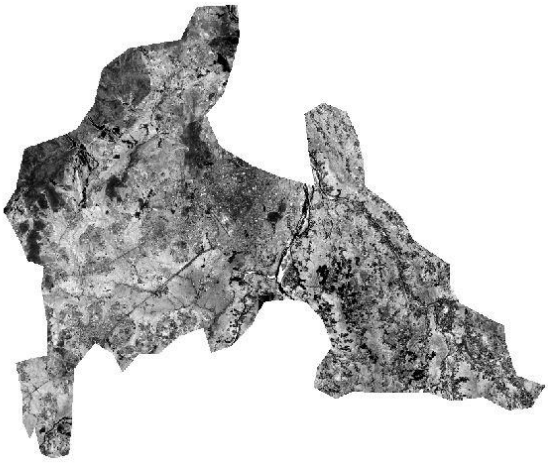

fig5. Masked data

Classification data obtained for years 2005, 2010 and 2015

From the below data we can see that land distribution has changed drastically while in the year 2005 distribution was more uniform among all the types of land use, residential area was highest followed by agricultural land and the difference in percentage points between the 2 was not too high. As we move towards 2015 we see that residential land covers about half of the city area because more and more people flocked to cities in search for better opportunities hence, demand for residential land which was compensated at the cost of forest and agricultural land, which show a continuously decreasing trend, while residential land increased from 32.8% to 49.41% over the span of 10 years

Table1. land classification data for year 2005

LAND TYPE	AREA(in hectares)	%AREA
Forest	**150812.38**	**21.16**
Agricultural	**190935.6**	**26.9**
Industrial	**34568.78**	**4.88**
Residential	**234961.35**	**32.8**
Barren land	**48375.68**	**6.90**
Water bodies	**68124.07**	**7.36**

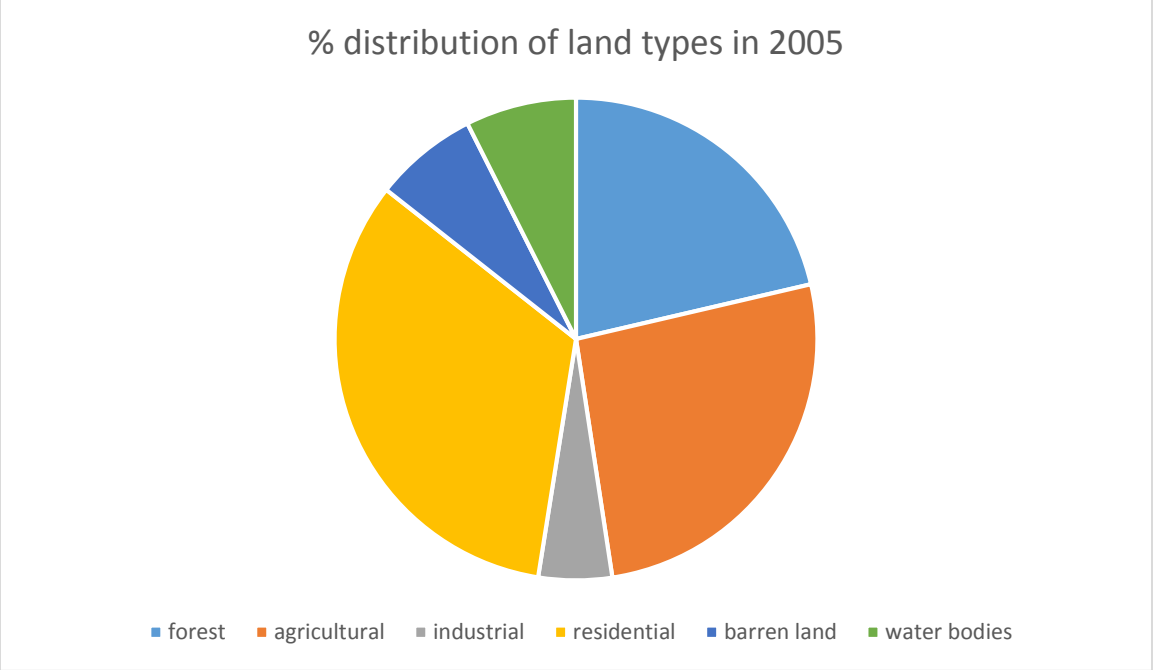

Figure6.

Table2.land classification data for year 2010

LAND TYPE	AREA(in hectares)	%AREA
Forest	**115191.06**	**16.14**
Agricultural	**101284.28**	**17.11**
Industrial	**39875.80**	**6.73**
Residential	**295839.57**	**49.80**
Barren land	**18956.39**	**3.23**
Water bodies	**58307.26**	**9.87**

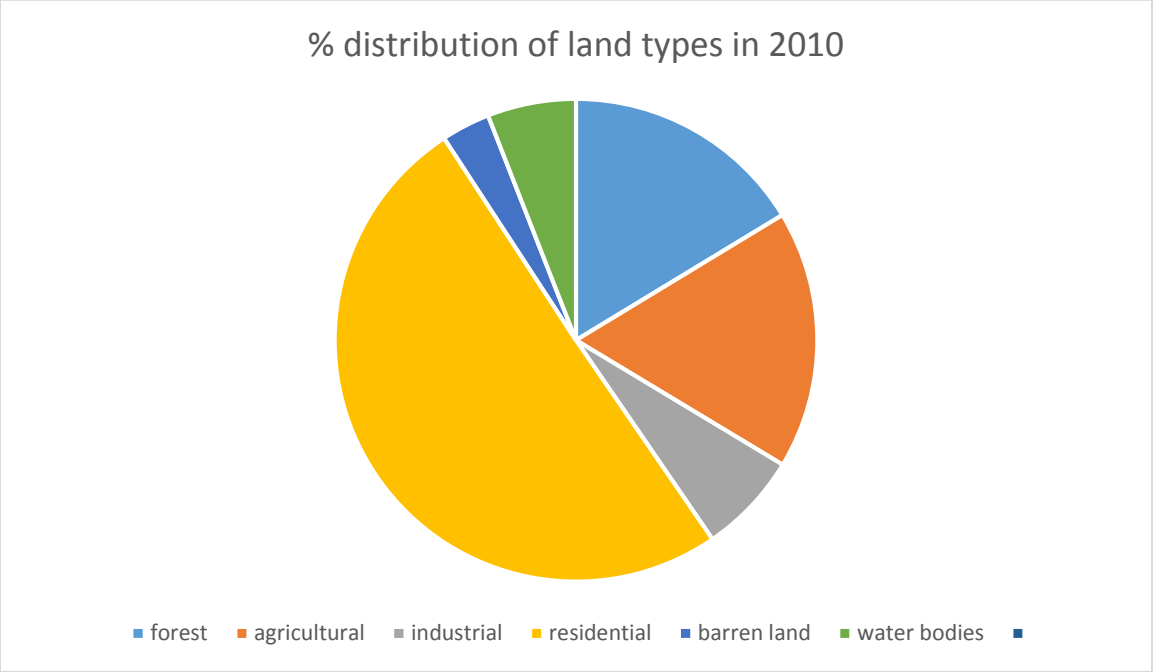

Figure7.

Table3. land classification data for year 2015

LAND TYPE	AREA(in hectares)	%AREA
forest	90181.3	14.9
Agricultural	98284.6	16.3
Industrial	46485.7	7.7
Residential	334121.5	56.71
Barren land	13149.76	2.18
water bodies	19146.66	3.5

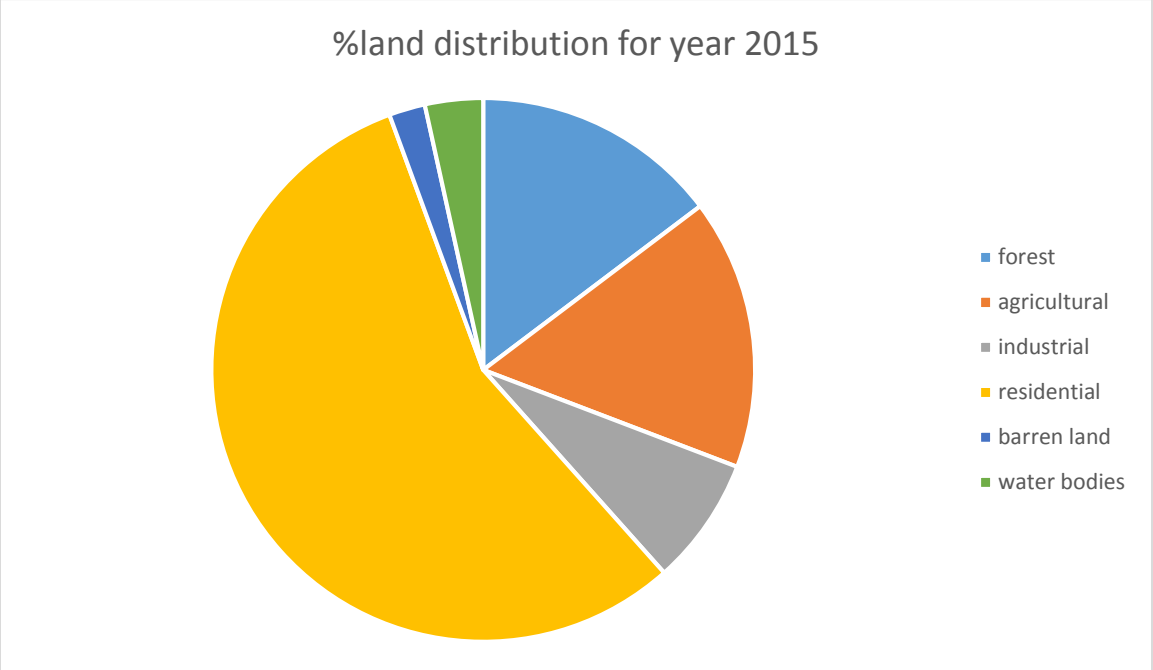

Figure8.

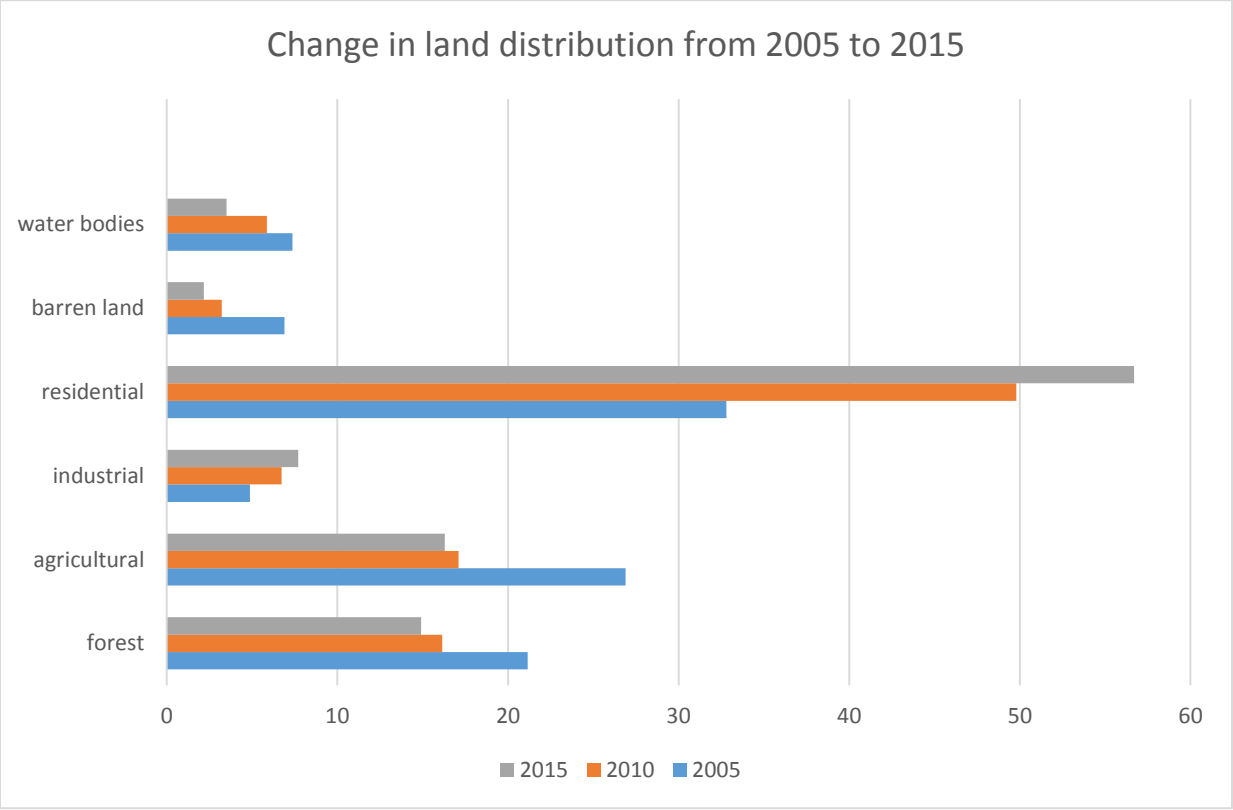
Change in land distribution from 2005 to 2015
water bodies
barren land
residential
industrial
agricultural
forest
0
10
20
30
40
50
60
2015
2010
2005

Figure9.

.

BUFFER ANALYSIS

Along the highway

6 buffer zones are taken to the right and left of the highway each buffer zone of 3km each. Left side is mancheswar ,chandrasekharpur region and the right part is master canteen to pipli region region.We see that that is a steep increase in residential areas towards chandrasekharpur as well as towards pipli.

Table4. Area (in hectares) in left buffer region in year 2005

LAND USE TYPE	A1 (LEFT)	A2 (LEFT)	A3 (LEFT)	A4 (LEFT)	A5 (LEFT)	A6 (LEFT)
AGRICULTURAL	1063.1	1109.2	905.56	1298.6	1478.21	1568.69
RESIDENTIAL	241.8	272.16	315.56	220.41	183.7	145.23
VACANT LAND	152.1	83.32	194.2	321.5	392.12	240.5
WATER	30.6	4.8				

Table5. Area (in hectares) in right buffer region in year 2005

LAND USE TYPE	A1 (RIGHT)	A2 (RIGHT)	A3 (RIGHT)	A4 (RIGHT)	A5 (RIGHT)	A6 (RIGHT)
AGRICULTURAL	1133	966.58	1186.23	735.24	528.58	361.29
RESIDENTIAL	518.7	419.2	32.1	18.5	11.44	24.5
VACANT LAND				96.3	169.48	
WATER			287.5	710.6	620.03	299.8

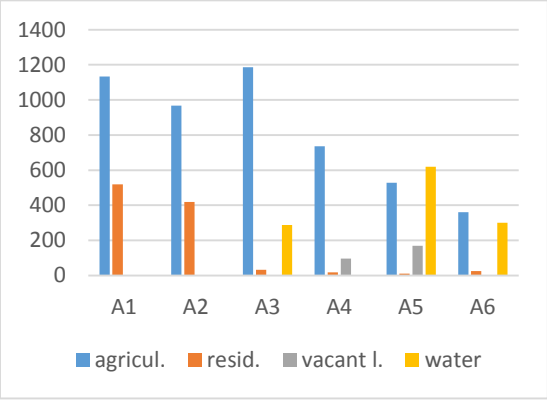

Fig10. Area dist. R 2005

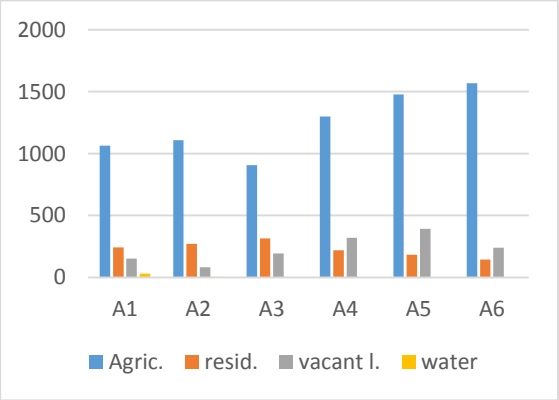

fig11. Area dist. L 2005

Table6. Area (in hectares) left buffer regions in year 2010

LAND USE TYPE	A1(LEFT)	A2(LEFT)	A3(LEFT)	A4(LEFT)	A5(LEFT)	A6(LEFT)
AGRICULTURAL	272.1	200.58	209.39	148.22	695.36	811.2
RESIDENTIAL	1292.69	2457.28	1211.1	1440.35	320.8	364.39
VACANT LAND	38	460	83		299	117
WATER						

Table7. Area (in hectares) right buffer regions in year 2010

LAND USE TYPE	A1(RIGHT)	A2(RIGHT)	A3(RIGHT)	A4(RIGHT)	A5(RIGHT)	A6(RIGHT)
AGRICULTURAL	142.5	60.1	172.3	203.2	94.6	115.56
RESIDENTIAL	979	1030.26	986.51	523.7	150	19.2
VACANT LAND	586	112	49.8	0	0	118.96
WATER				186.49	232.6	83.45

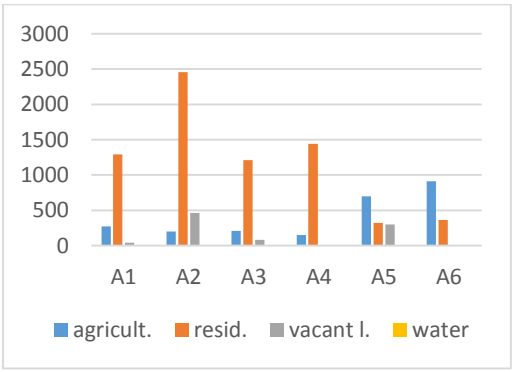

Fig.12 area dist. L 2010

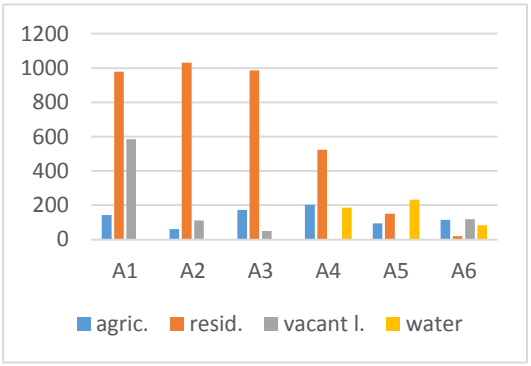

Fig13. Area dist. R 2010

Table8. Area (in hectares) left buffer regions in year 2015

LAND USE TYPE	A1(LEFT)	A2(LEFT)	A3(LEFT)	A4(LEFT)	A5(LEFT)	A6(LEFT)
AGRICULTURAL	235.49	157.3	186.58	109.5	578.37	770.59
RESIDENTIAL	1468.69	2986.2	1491.1	1786.35	386.8	423.39
VACANT LAND	27	409.35	76.23		257.74	96.4
WATER						

Table9.Area (in hectares) right buffer regions in year 2015

LAND USE TYPE	A1(RIGHT)	A2(RIGHT)	A3(RIGHT)	A4(RIGHT)	A5(RIGHT)	A6(RIGHT)
AGRICUKTURAL	106.23	49.26	148.28	186.9	91.5	103.6
RESIDENTIAL	1045.2	1178.23	1023.5	578.8	184.9	25.8
VACANT LAND	557.64	101.23	42.38	0	0	106.9
WATER				175.6	226.9	78.23

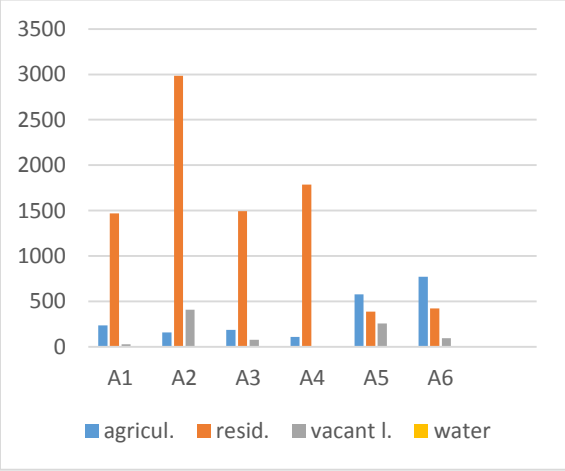

Fig14. Area dist. L 2015

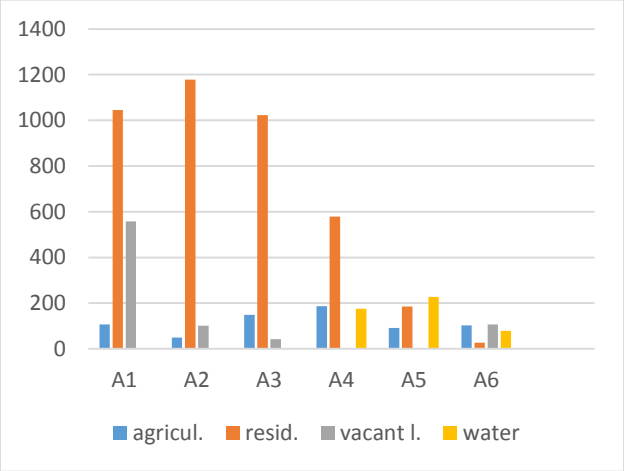

Fig15. Area dist. R 2015

BUFFER ANALYSIS WITH A POINT OF INTEREST

This is a process where the entire region is divided in to 12 buffer zones and the area occupied by residential and agricultural type of land is observed for each region for the years 2005, 2010 and 2015.

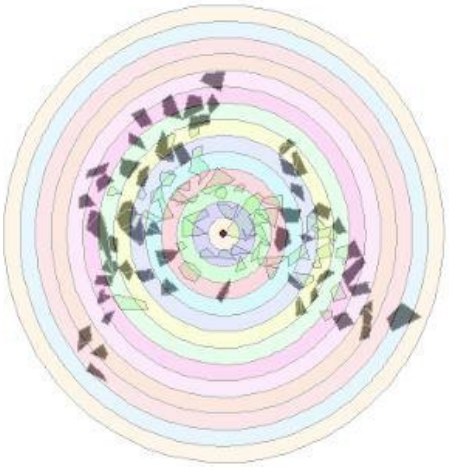

Fig16. Multiple buffer for 2005

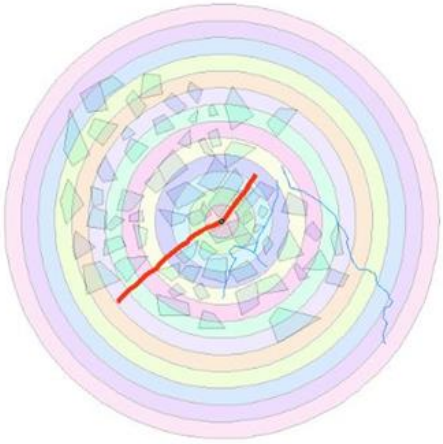

fig17. Multiple buffer for 2010

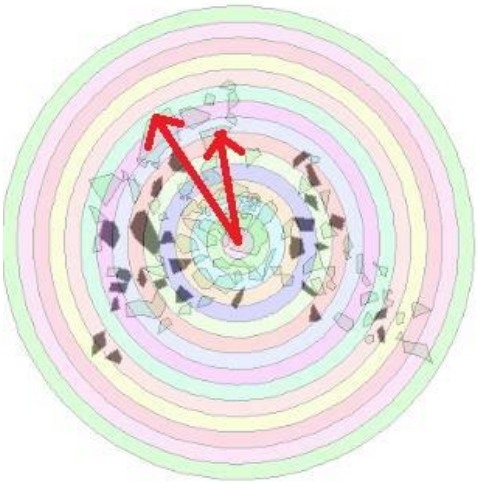

Fig18. Multiple buffer for 2015

The figures show the spread of agricultural and residential land. The red line is NH and the center for this buffer is taken along it at Acharya Vihar. Buffer is created with an incremental radius of 2km.

This shows that city is developing more in the north-west region which is the region towards Chandrasekharpur and Nandankanan and also towards northern direction which is towards Phulnakhara.

CHAPTER-6

CONCLUSION

Conclusion-

1. Decrease of agricultural land by 10.6 percent points, a decrease in forest land by around 5.2 percent points and an increase in residential land by 24 percent points was observed.

2. After the buffer analysis along the highway it was confirmed that the area towards master canteen was more densely populated compared to the area of Mancheswar and Phulnakhra. As we moved on towards 2015 residential lands increased drastically both in Mancheswar region and towards Pipili.

3. Multiple ring buffer analysis showed that area in the north-west region which is towards Chandrasekharpur and Nandankanan has seen most amount of growth in the span of 10 years, and area towards north which is towards Phulnakhra region also has a great potential for growth.

REFERENCES

1. Hazen B., "Distributed Implementation of the Land-Use Change Analysis System (LUCAS) using PVM", Master's thesis, University of Tennessee, Knoxville, 1995.

2. Landis J., "Imagining Land Use Futures: Applying the California Urban Futures Model", Journal of the American Planning Association, Vol No.61, 438-457, 1995.

3. Merwe V. and Hendrik J., "GIS-aided land evaluation and decision making for regulating urban expansion: A South African case study", GeoJournal, Springer, Vol No. 43, 136-145, 1997

4. Samant H. and Subramanyan V., " Land use change in mumbai-Navi Mumbai Cities and its effects on the drainage basins and channels- A study using GIS", Journal of the Indian society of Remote sensing, Vol No. 26,137-178, 1998.

5. Wadell P., " The Oregon prototype metropolitan land use model", ACSE Conference, Portland, Oregon, 1998.

6. Batty M., Xian Y., and Sun Z., "Modeling urban dynamics through GIS-based cellular automata, Computer, Environment and Urban Systems", Vol No 23,205-233, 1999.

7. Carlson T., "Satellite imagery is used to predict urban sprawl and its impact on surface hydrology", Dept. of Meteorology in Penn State University, 2002.

8. Silva T. and Clarke K., "Calibration of the SLEUTH urban growth model for Lisbon and Porto, Portugal ", Computer, Environment and Urban Systems, Vol No. 26, 526-540, 2002.

9.Manu A., Twumasi Y., Coleman T. and Baptiste T., " Investigation of the impact of urban sprawl in three sahelian cities using Remotely-Sensed Information", Geoscience and Remote Sensing Symposium , Vol No.2, 421-434, 2003.

10. Liu T. and Phinn S., "Modelling urban development with cellular automata incorporating fuzzy-set approaches", Computer, Environment and Urban Systems, Vol No. 27, 640-645, 2003

12. Jansen L., Carrai G., Morandini L.and Spisni A., " Analysis of the spatio-temporal and sematic aspects of land cover change dynamics 1991-2001 in Albania at national and district levels ", Environmental Monitoring and Assessment, Springer, Vol No.119, 108-135, 2006.

13. Henrique C., Azocar G. and Romero H., "Monitoring and modelling the urban growth of two mid-sozed Chilean cities", Habitat international, Vol No.30, 955-961, 2006.

14. Liu H. and Zhou Q.," Developing urban growth predictions from spatial indicators based on multi-temporal images", Computer, Environment and Urban Systems, Vol No. 29, 582-592, 2006.

15. Haack B. and Rafter A., "Urban growth analysis and modeling in the kathmandu region, Nepal", Habitat International, Vol No.30, 1057-1067, 2006.

16. Hu Z. and Lo C., "Modelling urban growth in Atlanta using logistic regression", Computer, Environment and Urban Systems, Vol No. 31, 668-679, 2007.

17. Z. Patterson and Bierlaire M., "An UrbanSim model of Brussels within a short timeline", Proceedings of the 7th Swiss Transport Research Conference, Monte Verita, Switzerland, 2007.

18. Jha R., Singh V. and Vatsa V. , " Analysis of Urban development of Haridwar, India, using Entropy Approach", KSCE journal of Civil Engineering, Vol No. 12, 282-287, 2008.

19. Rienzo F., Oreste P. and pelizza S.," 3D GIS supporting Underground Urbanization in the City of Turin(Italy)", Geotechnical and Geological engineering, Springer, Vol No. 27, 539-543, 2009.

20.Ibrahim A. and Sarvestani M.," Urban sprawl pattern recognition using remote sensing and GIS- case study shiraz city, Iran", Urban remote sensing joint event, 2009.

21. You L., Ku Y., Kai L. and Jin Z.," Study on the urbanization area expansion monitoring of Jiaozuo using Landsat images", Urban remote sensing joint event, 2009.