RESEARCH ARTICLE

MONITORING URBAN GROWTH PATTERN AND ITS IMPACT ON NEIGHBOURING VILLAGES: A CASE STUDY ON RAJARHAT REGION, WEST BENGAL

Suman Paul

Post Graduate Department of Geography, Krishnagar Government College, Krishnagar, Nadia. Pin – 741101

ARTICLE INFO	ABSTRACT

Urban growth is a worldwide phenomenon. It is not only a haphazard physical explosion of urban population but also manifests a disorderly and discontinuous development of urban place. Urban growth is such a process which takes place slowly or rapidly to occupy the adjacent land of a city or a town and brings about socio-cultural changes in the land use pattern, demographic features (population growth, literacy rate, occupational structure etc.) and transforms the economic livelihood of the people of the concerned area. It is very much interesting to note that the adjacent villages of an urban place are influenced by a number of factors associated with urban growth and these factors make considerable impact on the village life. The present study focuses on the nature of urban expansion in Rajarhat region during the time period from 1981-2001. Based on the proximity of the Urban Municipality (i.e. Rajarhat-Gopalpur Municipality) three villages were selected to study the pattern of urban expansion and there from identify the factor responsible urban expansion. This area is under Kolkata Metropolitan Development Authority (KMDA) and Sector-V (IT Hub) area developed very rapidly. The study has indicated that the development of road transport in the 'Rajarhat-Gopalpur Municipality' and 'Rajarhat-New Town' area make an impetus for the rapid urban expansion during 1981-2001 though the region first experience urban growth in 1971. In addition, RS and GIS based analysis of the pattern of urban expansion over the demographic change and land use modifications has also indicated that urban growth mainly takes place linearly along the major roads in the study area.

INTRODUCTION

The process of urbanisation is a universal phenomenon taking place the world over, where human dwell. All countries are prone to this bewildering phenomenon chiefly responsible due the increase of population growth, economy and infrastructure initiatives (Sudhira et al 2004). The extent of urban growth or urbanisation is one such phenomenon that drives the change in land use patterns. The expanding network of roads and increasing reliance on the automobile, population began shifting from cities to fringe and thus the land use pattern of those adjacent areas changed very rapidly. The spatial patterns of urban growth over different time periods can be systematically mapped, monitored and accurately assessed from satellite data (remotely sensed data) along with conventional ground data. The recent technologies like GIS and remote sensing helps in identifying the pattern of growth and its rate. Mapping urban growth provides a picture of where this type of growth is occurring and to suggest the likely future directions and patterns of urban growth. However only a few studies were attempted to established the inter relationship between the road transport development and land use change in rural landscape at micro level (Saravanan, 2010). Hence by realizing the gap the present attempt has been

made at micro level by selecting three villages namely Ghuni, Rekjuani and Bishnupur of Rajarhat urban area of the district of North Twenty Parganas, West Bengal which shows a prominent sprawl. This paper is an attempt of understanding the impact of urban growth phenomenon.

Study Area

The study focuses on the impact on three villages (i.e. Ghuni, Rekjuani and Bishnupur) in Rajarhat region of North 24 Parganas, West Bengal, India, due to urban growth. The study area extends from $88^0 26'40''$ E to $88^0 33'$ E longitude and $23^0 35'$ N to $23^0 40'$ N latitude. Out of three villages, two villages namely Ghuni, Rekjuani are located within 2 km boundary whereas village Bishnupur is located 5 km away from the urban concentration. The total population and geographical areas of Ghuni, Rekjoani and Bishnupur are 15318, 13291 and 10293 respectively. The geographical areas of Ghuni, Rekjoani and Bishnupur are 3.23, 8.91 and 4.76 sq. km. A major portion of village Rekjuani and Ghuni has been taken for the development of Rajarhat-New Town urban area during 2001 – 2007 (HIDCO). The objectives of this study focus on some specific items which are:

- To identify the urban growth of the study area during last two decades (i.e. 1981-2001).
- To study and compare the demographic changes between three sample villages during 1991 – 2001 and

---

Corresponding author: suman.krish.2007@gmail.com

- To spatially map the land use changes of three selected villages during 2001 – 2011.

Data Base

- *Satellite Data:* Landsat TM (P/R: 139/40) for 1991, Landsat ETM$^+$ (P/R: 139/40) for 2001 and Google Earth Map for 2011.
- *Census of India:* Primary Census Abstract, Rajarhat, North 24 Parganas, West Bengal Series, 1991 & 2001.
- Local Planning Report from Rajarhat Development Block.

MATERIALS AND METHODS

Landsat TM and ETM$^+$ satellites typically cover an area of approximate scene size of 170 km north–south by 183 km east–west with a sensor spatial resolution or pixel size of 30 m for all the spectral bands except band six (thermal band) which is 120 m. The study area covers only small portion the whole scene. It has been extracted from the scene; all bands except band six were stacked and clipped for further pre-processing in Geomatica 10.1. Effective image pre-processing is critical to successful urban LULC mapping and change detection. After selecting the subset of imagery, it has been calibrated to ensure that the observed change in signal is attributable to "true" changes in the land surface rather than a change due to non-surface factors. Moreover, the analysts made an automated image enhancement and contrast adjustments to the subset images of the study area.

eCognition Developer 8 was used for Land use mapping of villages for 2001 and 2011 time span due to the advantage of classifying image at image object level instead of pixel level. The real world is not made of pixels; rather it is arranged in objects. Object-oriented classification avoids mixed pixel problems which usually occur in urban area image classification. For example, at pixel level classification, bare sand soil and the impervious parts of urban areas usual create a mixed pixel problem. The advantage of object-based classification is that each image object represents a definite spatially connected region of the image. The pixels of the associated region are linked to the image object. In addition to the multispectral bands, the object-based approach takes advantage of all dimensions of remote sensing including spatial (area, length, width and direction), the morphological (shape parameters, texture), contextual (relationship to neighbors, proximity analysis) and temporal (time series). The resulting object-based features can then be incorporated into the classification process.

RESULTS

Spatio Temporal Analysis of Urban Growth during 1981 – 2011 in Rajarhat Region

Temporal database provided a visual and historical perspective of the urban growth experienced in Rajarhat region between 1971 and 2001. Past landscapes were reconstructed using block maps; satellite data, land use/ land cover maps and books/ reports to generate a georeferenced time series map documenting the changes in Rajarhat region. Database

development was limited to the temporal mapping of urban and built-up areas, principal transportation routes and natural drainage system to aid in understanding the spatial and temporal land transformation that occurred over time in Rajarhat.

Rajarhat region has experienced urban growth first in 1971. In 1971, Krishnapur Urban Agglomeration having three non-municipal growth (i.e. Krishnapur, Jyangra, Arjunpur) with an area of 11.9 sq. km holding only 33360 urbanites. During 1971 – 1981, three more urban areas have developed as non-municipal and out growth. Urban growth within this period was more than double whereas the urban area growth was just 12%. In 1991 the scenario was the same and population increases up to 119650 and urban area was 17.43 sq. km. But the whole scenario has changed drastically within 1991-2001. The urban population has bounced up in to 2.5 times in respect to 1991. Within this decade all the urban areas of Rajarhat merged under single municipality, i.e. Rajarhat-Gopalpur Municipality. Decadal growth rate of urban population within this time span found highest in comparison to other two decades.

The standard image processing techniques such as, image extraction, rectification, restoration and classification were applied in this current study. Basically two satellite data has been used for this study. First one is Landsat TM data of 1991 and other one is Landsat ETM$^+$ data of 2001. The Gaussian maximum likelihood classifier (MLC) was employed for classification. The original classification of land use of 16 categories was aggregated to built-up (residential and commercial), agricultural land and water bodies with canal. It has been found from the analysis that, the area is horizontally expanding along with vertical intensification. This vertical intensification has started in late 90's and added a new dimension in the urban growth process. This recent phenomena of high rise building in both commercial and residential sectors, clearly manifest the area to adopt this process to cope with the ever increasing population pressure and unavailability of land within the area.

Demographic Changes of the Sample Villages during 1991-2001

The term demography is used in the study of human population, its structure and change. Here in this study few demographic parameters like population size, population density, household density, family size cultivators, agricultural workers and non-agricultural workers are considered as urban growth indicators. The above mentioned parameters are obtained from Census of India report which helps to determine the growth and rate of change for the time periods. The change detection is done for the period of ten years (i.e. 1991-2001) for the sample villages. The demographic parameters and its change were clearly illustrated in table no. 3 and diagrammatically shown in figure no. 4. Ghuni village is sharing boundary with Rajarhat-Gopalpur Municipality showing a notable demographic change. The total population of Ghuni was 9332 in 1991 and 15381 in 2001 with an increase of about 64.82 per cent, eventually the household density also rises from 50.14 to 63.59 houses/ sq. km. which showing a remarkable expansion in residential area. There is a significant change found in occupation structure. The
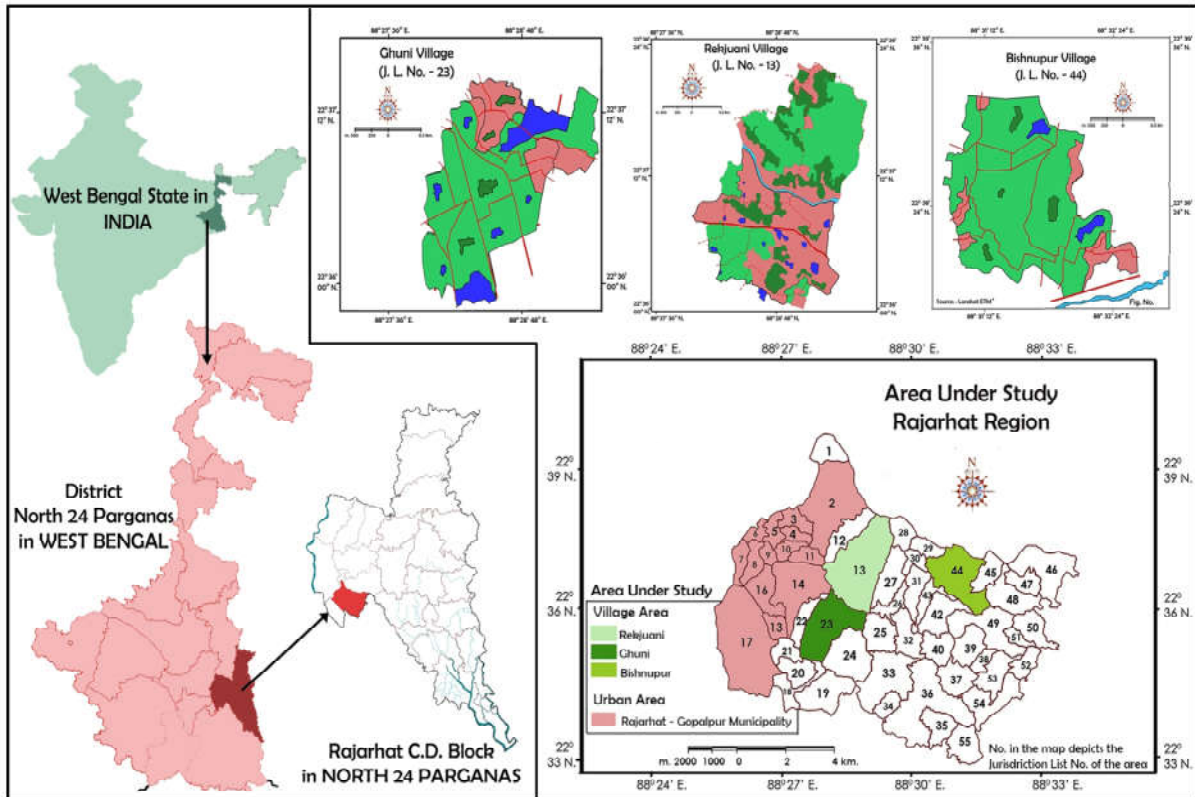
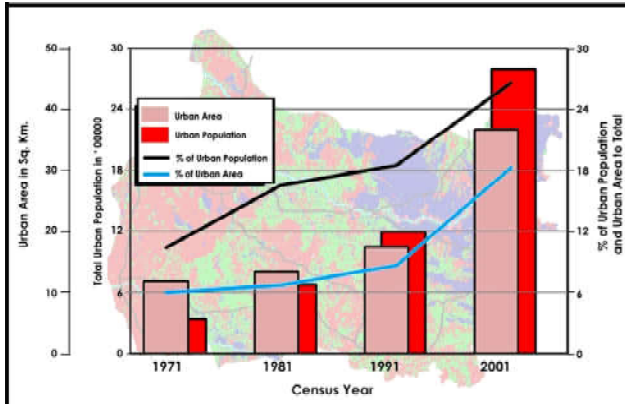Figure No. 1 showing the Locational Analysis of the Study Area.

Figure No. 2a. Growth of Urban Population, Urban Area and Percentage of Urban Population and Urban Area to Total.
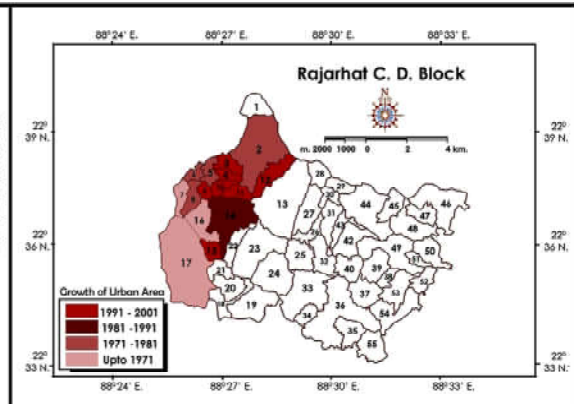
Figure No. 2b Phase-wise Growth of Urban Area in Rajarhat Region during 1971 - 2001.
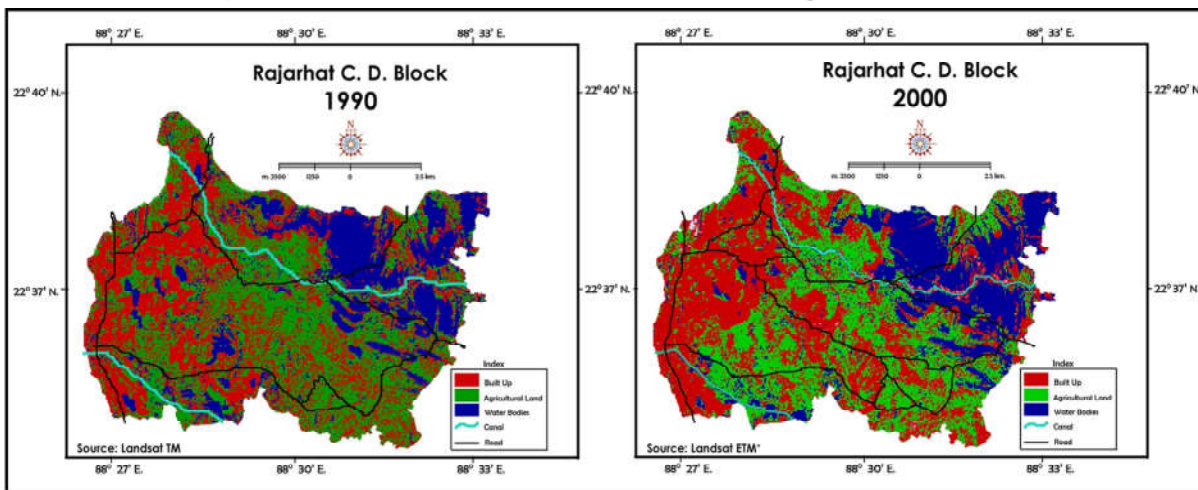

Fig. No. 3 Showing the Landuse / Landcover of the Study Area.

Table 1: Data Base used for the Study

Type of the Data	Source	Scale	Path / Row
Landsat TM (1991)	www.landsat.org	28.5 m	138 / 44
Landsat ETM[+] (2001)	www.landsat.org	28.5 m	138 / 44
Google Image (2011)	Free downloadable	5 m	---
Rajarhat Block Map	Rajarhat C. D. Block Office	1: 20000	---
Village Cadastral Map	Rajarhat C. D. Block Office	1 inch to 16 mile	---
Census Data of 1991, 2001	Census of India, Salt Lake, West Bengal	----	----

Table 2: Urban Growth Scenario in Rajarhat Region during 1971 – 2001

Census Year	Population			% of Urban Population to Total Population	Urban Area in Sq. Km.	% of Urban Area to Total Area	Decadal Growth of Population
	Total	Rural	Urban				
1971	128478	95118	33360	25.97	11.9	14.89	---
1981	163193	95567	67626	41.44	13.3	16.65	102.72
1991	258358	138708	119650	46.31	17.43	21.81	76.93
2001	417192	138652	278540	66.77	36.54	45.73	132.8

Source: Primary Census Abstract, Census of India, 1971 – 2001.

Table 3: Demographic Changes between 1991 and 2001

	Name of the Villages	Ghuni			Rekjuani			Bishnupur		
		1991	*2001*	*Change*	*1991*	*2001*	*Change*	*1991*	*2001*	*Change*
Demographic Profile	*Population Size*	9332	15381	*+ 64.82*	11004	13291	*+ 20.78*	7700	10293	*+ 33.67*
	Population Density	2327	3836	*---*	1717	2075	*---*	1954	2612	*---*
	Households Density	50.14	63.59	*+ 13.45*	29.97	37.16	*+ 7.19*	22.20	29.87	*+ 7.67*
	Family Size	4	5	*+ 1*	5	6	*+ 1*	5	5	*0*
	% of Cultivators	34.12	23.11	*- 11.01*	15.23	11.76	*- 3.47*	21.8	11.9	*- 9.9*
	% of Agri.-Workers	9.76	1.7	*- 8.06*	8.98	1.9	*- 7.08*	6.3	3.9	*- 2.4*
	% of Non-Agri. Workers	49.42	71.48	*+ 22.06*	70.59	82.92	*+ 12.33*	68.19	80.92	*+ 12.73*

** + Increase and – Decrease in Percentage.
Source: Primary Census Abstract, 1991 & 2001, North 24 Parganas, West Bengal.

Table 4: Village-wise Percentage of Land use Pattern & Changes during 2000-2010

	Name of the Villages	Ghuni			Rekjuani			Bishnupur		
		1991	*2001*	*Change*	*1991*	*2001*	*Change*	*1991*	*2001*	*Change*
Land Use Catego	*Agricultural Land*	77.5	24.7	-52.8	65.3	28.4	-36.9	78.3	69.3	-9
	Settlement	10.3	67.3	57	18.4	63.7	45.3	10.4	21.5	11.1
	Water Bodies	9.4	6.5	-2.9	5.1	2.1	-3.0	8.1	4.2	-1.1
	Vegetation	2.8	1.3	-1.5	11.2	8.6	-2.6	3.2	2.7	-0.5

** + Increase and – Decrease in Percentage; Source: Landsat ETM[+] 2001 & Landuse Survey, 2010

percentage of non-agricultural workers + 22.06 per cent (in 1991 it was 49.42 % and turn into 71.48 % in 2001) and decrease in cultivators (-11.01 %) and agricultural workers (-8.06 %) which clearly explains the conversion of agricultural land use to urban land use. Similarly in Rekjuani village also experienced the change in total population between 1991 and 2001 was 2287 persons with an increase of 20.78 per cent and population density increases from 1717 to 2075 during 1991-2001 as per census of India report. The changes in non-agricultural workers rises +12.33 per cent and it reached into 82.92 per cent in 2001 and decrease in cultivators (-3.47) and agricultural labourers (-7.08). The change shows the conversion of cultivators and agricultural labourer is low than Ghuni but if only per cent of non-agricultural workers is considered, the per cent is very high. The last village is Bishnupur located in the eastern part of the Rajarhat urban area and has a less influence on all respect. The population growth rate has been found 33.67 per cent during 1991-2001. Same scenario is also found in respect of working structure.

+ 12.73 % increase in non-agricultural workers has took place whereas the percentage drops from cultivators (-9.9 %) and for agricultural workers (-2.4 %).

Changes in Land Use Pattern of the Selected Villages

The spatial and temporal pattern of sprawl on landscapes can be detected, mapped and analyzed cost effectively with the efficient use of remotely sensed data and geographical information system. To understand the effect of urban growth on the selected village land use map is an essential tool. The drastic change in land utilization clearly depicts the impact of urban growth in the selected three villages. The temporal analysis of land use/ land cover of the selected villages were done for the period of 2001 and 2011 using Landsat ETM[+] and Google images and verifying those facts with Panchayat staff and local people of the same village. The land use pattern of Ghuni village has been changed heavily during 2001 – 2011. A major portion of the agricultural land has been taken by the
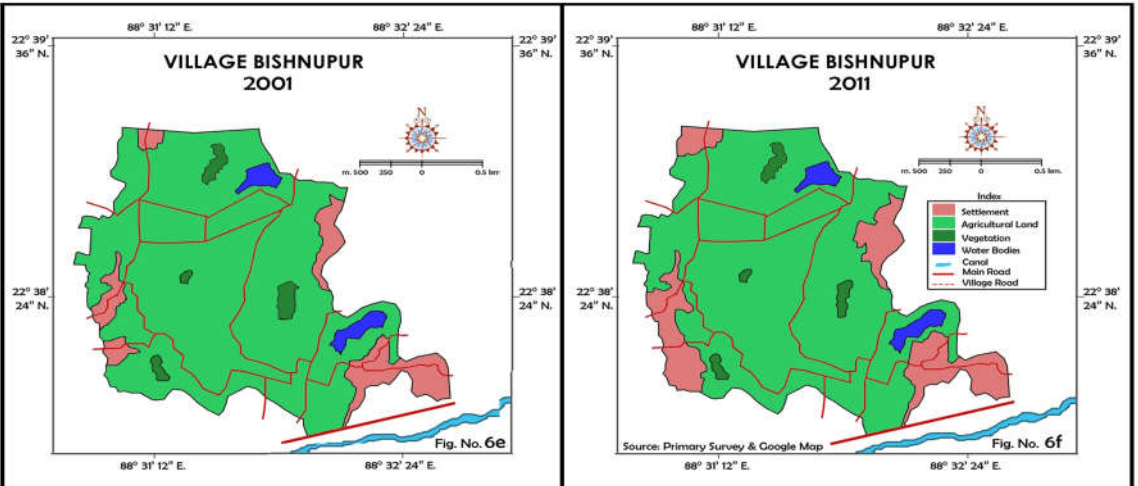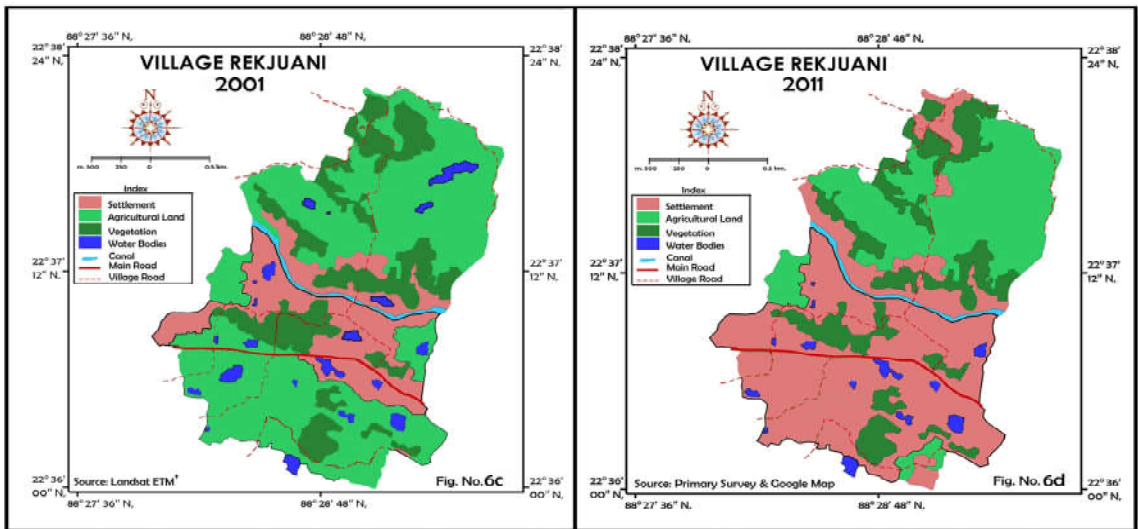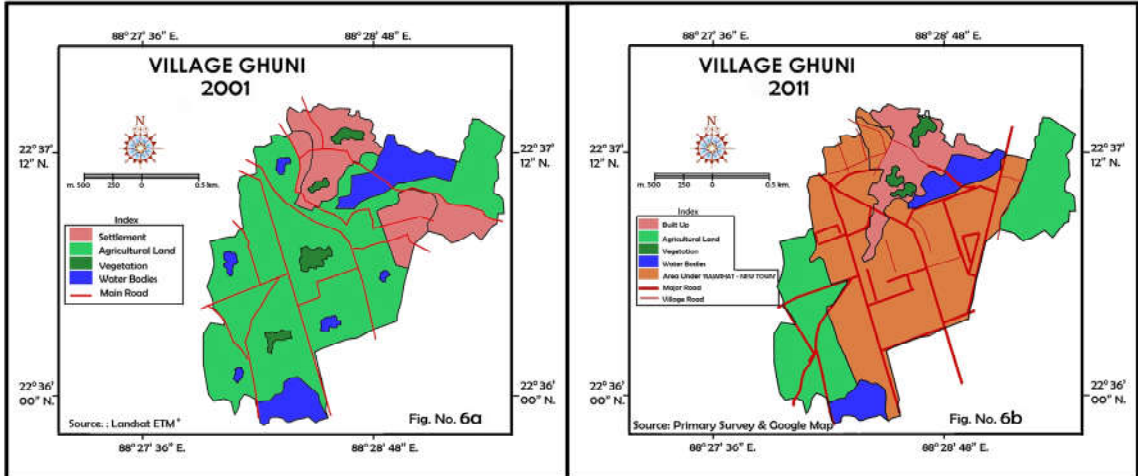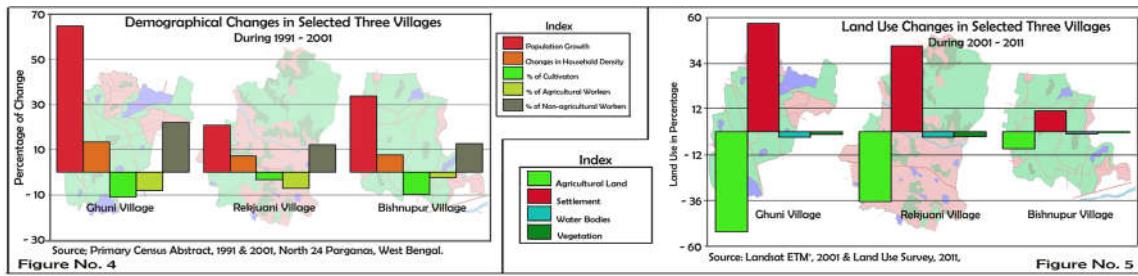
Figure No. 4

Figure No. 5

Fig. No. 6a

Fig. No. 6b

Fig. No.6c

Fig. No. 6d

Fig. No. 6e

Fig. No. 6f

Figure No. 6a – 6e showing the Changing Land use Pattern of Three Selected Villages during 2001 – 2011.

HIDCO for the development of Rajarhat-New Town project. The area has been compartmentalized by HIDCO into residential, commercial and industrial purposes. But some portions were not sold for creating roads, greeneries and open space as a measure of urban ecology. There is an increase of percentage in built up area to 57 % and notable decrease in agricultural land to 52.8%. The decrease of water bodies found 2.3%. The expansion of built-up area takes place mainly in agricultural land. Rekjuani village falls in the northern portion of this region which is 2 – 3 km away from 'Rajarhat-Gopalpur' and sharing boundary with 'Rajarhat-New Town' urban area. A major portion has been taken by HIDCO for the development of Rajarhat-New Town and it makes an influence for population growth during 1991 – 2001. The land price has been increased very sharp and some portion of this village has experience 12 – 15 times of price hike. Table No. 4 illustrate the change in land use pattern of the village. The residential expansion is inversely related to agricultural land use, where residential area increases agricultural land decreases. The residential area has increased by 45.3% where as agricultural land, water bodies and vegetation has been reduced by 36.9%, 1.7% and 2.6% respectively. This clearly depicts a part of agricultural land; water bodies and vegetation have been converted as settlements. The major conversion of land use take place in southern part of the village along the main road. Bishnupur Village located in extreme north eastern part of the region and land use change is very nominal in comparison to other two villages analyzed earlier. The settlement development found here just 11.1% and decreases of agricultural land and water bodies are 9.0% and 1.1% respectively. Settlement development has been found in the eastern part of the village from where the villagers can easily commute to the urban area.

Conclusion

This paper demonstrates urban expansion of Rajarhat region of North 24 Parganas and identifies the temporal and spatial development patterns by using multi-temporal remote sensing images and GIS tool. Various analysts have been considerable progress in quantifying the urban sprawl pattern (Theobolt, 2001; Lata et al 2001, Barry et al., 1999, Barnes et al, 2001). All these studies have come up with different methodologies in quantifying urban sprawl. However, the present study determines:

- The pattern of urban expansion in Rajarhat region is manifested like in ribbon and low density nature and rapid expansion is happened based on communication network and the development of 'Rajarhat-New Town' project and the IT Hub's located in Sector-V. The major development of New Town Highway, some flyover (work in progress) makes the rural region accessible.
- It has been found from the study that, villages have shown a high population growth rate with the increasing number of household density. The family size has also increased during 1991-2001 which is also a characteristic of urban growth. A change in occupational structure depicts a clear view of changing demographic structure within the study area.
- While considering the residential development of the villages, development in Ghuni and Rekjuani are more prominent to that of Bishnupur village due to it is the

vicinity of Rajarhat urban area as well as these two villages is well connected with the urban area.

The urban growth is one of the potential threats to sustainable development where urban planning with effective resource utilization and allocation of infrastructure initiatives are key concerns. Thus identification and analysis of the urban growth would help in effective land use planning in urban area. It is also important to study the trend and direction of urban growth, which ultimately focus for urban landscape planning and environmental management.

REFERENCES

1. Benz, U.C.; Hofmann, P.; Willhauck, G.; Lingenfelder, I.; Heynen, M., (2004) Multi-resolution object-oriented fuzzy analysis of remote sensing data for GIS-ready information. Journal of Photogrammetry and Remote Sensing, Vol. 58, pp. 239-258.
2. Carter. H, (1995), The Study of Urban Geography, Arnold Publisher, London.
3. Definiens eCognition Developer 8, 2009, Reference Book User Guide; Version 1.2.0; Definiens AG: München, Germany, pp. 34-38.
4. Epstein. J, K. Payne and E. Kramer, (2002), Techniques for mapping suburban sprawl, "Photogrammetric Engineering and Remote Sensing", Vol. 62(9), pp. 913-918.
5. Huang. B, Li Zhang and Bo Wu, (2009), Spatio-temporal analysis of rural-urban land conversion, "International Journal of Geographical Information Science", Vol. 23(3), pp.379-398.
6. Jensen. J.R, and D.L. Toll, (1982), Detecting residential development at the urban fringe, "Photogrammetric Engineering and Remote Sensing", Vol. 48(4), pp. 629-643.
7. Mucher, C.; Steinnocher, K.; Kressler, F., (2000), Land cover characterization and change detection for environmental planning of Pan-Europe, International Journal of Remote Sensing, Vol. 21, pp. 1159-1181.
8. Moller-Jensen, L. and Yankson, P.W.K. (1994): Assessing the Land cover Change of Accra Using Landsat-TM data, Danish Journal of Geography, Vol.94, pp. 21-26.
9. Mussie G. Tewolde and Pedro Cabral, (2011), Urban Sprawl Analysis and Modeling in Asmara, Eritrea; Journal of Remote Sensing, Vol. 3, pp. 2148-2165.
10. Saravanan. P and P. Ilangovan, (2010), Identification of Urban Sprawl Pattern for Madurai Region Using GIS, "International Journal of Geomatics and Geosciences", Vol. 1(2), pp. 141-149.
11. Sudhira.H.S, T.V. Ramachandrana and K.S. Jagadish, (2004), Urban sprawl: metrics, dynamics and modeling using GIS, International Journal of Applied Earth Observations and Geoinformation", Vol. 5, pp. 29-39.
12. Yeh, A.G.O. and X. Li (2001). Measurement and monitoring of urban sprawl in a rapidly growing region using entropy, Photogrammetric Engineering and Remote Sensing, 67(1), pp. 83-98.