



Study of temporal changes in land-use / land-cover in the villages near it parks using remote sensing: A case study of Talwade IT park

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Abstract: The expansion of urban areas is common in metropolitan cities of in India. Pune also has experienced rapid growth in the fringe areas. This is mainly on account of the development of the Information Technology (IT) parks in different parts of Pune city. Talwade IT park, located close to Pune Nashik Highway, has a huge impact on the neighbouring villages. This paper attempts to study the changes in land use / land cover which have taken place in these villages in the last two decades with the help of remote sensing and GIS techniques. The occupation structure of these villages is also related to the changes due to the development of the IT park. The land use of study area has been analysed using the ground truth data and the satellite images at decadal interval. Using the digital image processing techniques, the satellite images were then classified and land use / land cover maps were derived. The results show that the area under built-up land has increased by 14 per cent in the last 20 years. On the contrary, the land under agriculture, barren, pasture has decreased significantly.

Keywords: Land use / land cover, Remote sensing, GIS, Digital image processing

1. Introduction

The growth in the IT industry has transformed the areas around the cities like Bangalore, Hyderabad and Pune. In Maharashtra the city of Pune was chosen as an IT hub as it had certain advantages over other regions for setting up technology parks. These include the proximity to Mumbai, presence of prestigious academic institutions and a vast pool of human resources skilled in computer software and engineering. Other factors include the accessibility of the trade centres and the development of tertiary services. Around the major urban centres, the physical expansion of the built up areas beyond the municipal boundaries has been very conspicuous (Manomani, 2010).

The IT park in Pune has other advantages such as the availability of skilled workforce. The Maharashtra Industrial Development Corporation (MIDC) has provided a lot of infrastructural facilities like power, water, electricity, communication facility, hotel, shopping complexes and banks. These IT parks are located in the fringe area due to advantage of lower rent.

Today due to the process of urbanization cities are growing at an alarming rate. Rapid urban development and rapid land use changes due to increasing population and economic growth in selected landscapes is being witnessed of late in India and other developing countries (Madhvi Lata et al., 2007)

The continuing liberalization and economic reform programs in India since 1991 have given an impact to the Indian economy particularly in the information and communications sector. Steps taken by the State to

promote this sector includes the establishment of Information Technology parks in different parts of the country. It is often argued that the process of economic liberalization and associated structural reform would accelerate rural-urban (RU) migration and boost the pace of urbanization. Linking of India with global economy would lead to massive inflow of foreign capital as also rise in indigenous investment resulting in an increase in employment opportunities within or around the existing urban centres (Kundu, 2001).

The establishment of the Rajiv Gandhi Info-Tech park at Hinjewadi and IT parks in Kharadi and Talwade have resulted in the several changes of the area in the vicinity. The use of GIS for studying the urban sprawl becomes even more effective with the help of remote sensing. With the availability of multi sensor satellite data at very high spectral, spatial and temporal resolutions it is now possible to prepare up-to date and accurate land use / land cover maps in less time, at lower cost and with better accuracy (Dhorde et al., 2012)

2. Aim and objectives

The aim of the study is to assess the temporal changes in land use/ land cover in the surrounding area of Talwade IT park.

1. To evaluate the temporal change in the LULC for two decades using image processing techniques
2. To analyse the impact of IT industry on the socio-economic conditions of the surrounding villages using the primary survey data

3. Study area

Talwade ($18^{\circ}35'37.02''$ N, $73^{\circ}43'46.79''$ E) is close to Pune so its climatic conditions are similar to Pune. Land use patterns are influenced by Pune city. The elevation of Talwade is about 580 m above mean sea level (msl). This village is situated on north western side of Pune city along the right bank of the Indrayani river. The village is located in the north-west outskirts of Pune and within the commuting distance from the heart of the Pune city. Talwade IT park is close to Pune-Nashik highway and also closer to Pune-Mumbai express highway and Mumbai international airport is about 3 – 3.5 hours drive.

The study area is spread over three talukas namely Haveli, Khed and Maval. The villages which were selected were Talwade, Mahalunge, Khalumbare, Sudumbare, Chikhali and Nighoje.

Pune ($18^{\circ} 32' N 73^{\circ} 51' E / 18^{\circ} 53' N, 73^{\circ} 85' E$), the cultural capital of Maharashtra is a rapidly growing urban city. Pune lies on the leeward side of the Sahyadri ranges also known as the Western Ghats at the confluence of Mula and Mutha rivers, which are tributaries of the Bhima river. The highest point just outside the urban area is Sinhagarh fort (1300m above msl). The climate of Pune is on the whole dry and invigorating. The cold season from December to February is followed by the hot season lasting up to early June. The period from early June to about the beginning of October is southwest monsoon period. The succeeding period up to November is post-monsoon season. The climate of Pune is pleasant and is an asset to its citizens. Pune experiences four distinct seasons: summer, monsoon, post-monsoon and winter. Tropical summer months are from March to May; with maximum temperature ranging from 35°C to 38°C .

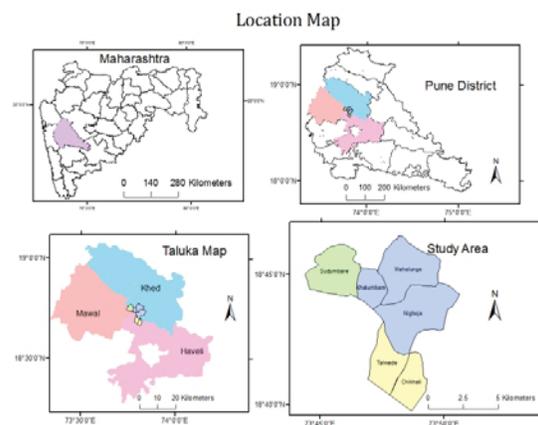


Figure 1: Location map of the study area

4. Data used and methodology

The change in land use and land cover for the time period 20 years was analyzed by using satellite images at around 10 year interval as given in table 1. The LANDSAT images were downloaded from internet.

After scanning topographical map of study area, images were geo referenced using Arc GIS 9.3 software (Toposheet no. 47 F/10, 47 F11, 47 F14 and 47F15). The satellite images were used to plan the ground truth data collection survey in the study area using FCC (False Color Composite) image. The villages in the study area were then surveyed and the ground truth sites for each land use class were located and used for the generation of the training signatures. Using these class signatures, supervised classification was performed and the classified output was derived (Figure 4).

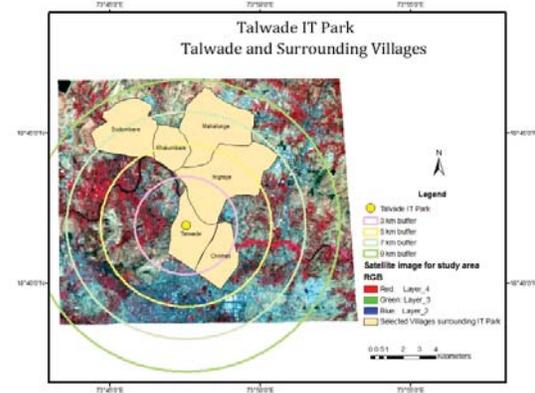


Figure 2: Study area with proximity circles

Table 1: Satellite data used

Path/ row and date of pass	Satellite/sensor
147/47, 12-02-1992	LANDSAT TM
147/47, 02-02-2000	LANDSAT ETM+
147/47, 08-02-2011	LANDSAT ETM+

The survey for the location was carried out using GPS (Global Positioning System) device. The GPS data was then used to locate the ground truth sites on the toposheet and satellite images. The Talwade IT park was identified as the centre of the study and proximity circles were drawn using the ArcGIS software to identify the nearest villages on the basis of distance from the IT park. The proximity circles having the distance of 3, 5, 7 and 9 km were used and the study area was identified for the further analysis (Figure 2). Villages to the west of Talwade are partially occupied by the military cantonment and therefore excluded from the study. To the east of the Chikhali the area is under the jurisdiction of Pimpri-Chinchwad Municipal Corporation (PCMC) and therefore not included.

The villages in the study area were surveyed and primary socio-economic data was collected for six villages with the help of the questionnaire method (20% sample collected for each village). The data then was compiled, tabulated and analysed for understanding the impact of IT park and related activities on the socio-economic behaviour of the villagers. Data was analysed based on selected socio-economic parameters.

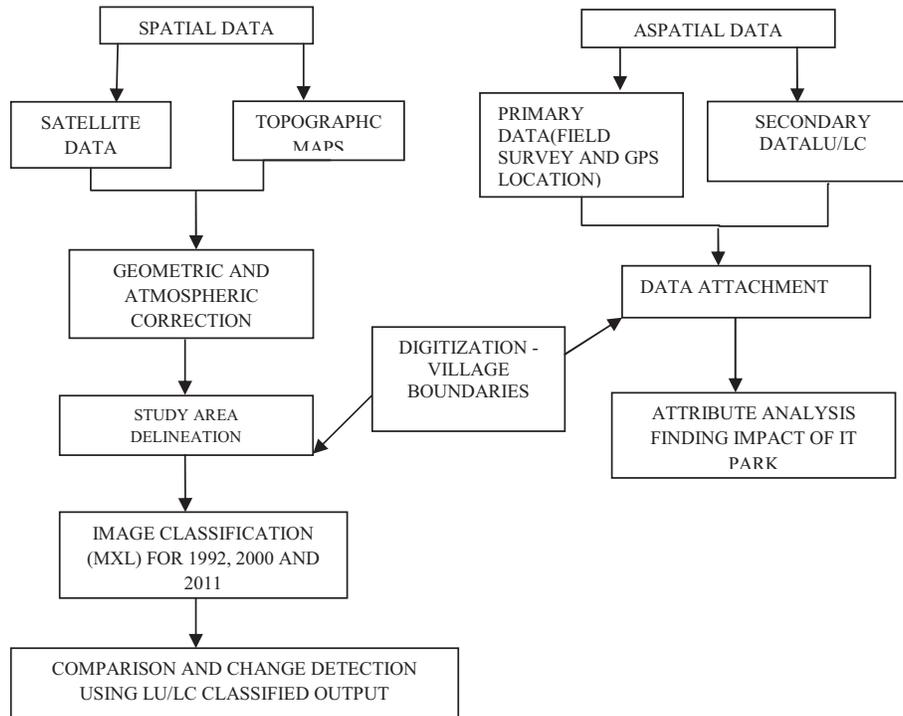


Figure 3: Flowchart of the methodology adopted

5. Results and discussions

Land- use/ land-cover classification

It is observed from figure 4 that land use in Talwade and surrounding village has undergone a significant change within a span of two decades. This may be mainly due to the establishment of IT park in Talwade. The changes can be mainly observed through changes in built up area, Industrial area, barren land and fallow land.

The growth of the IT park demands an increase in the built up area which is reflected in the category of the built up area. It can be seen that there is a phenomenal increase in the built up area and industrial area which is from 2.24% to 6.27% of total geographic area (TGA), 0.01% to 4.40% TGA in the time span of two decades (Table 2). The fallow land has declined from 24.22% to 4.48% TGA in the last twenty years. Agriculture and fallow together have lost 20 per cent of land in 20 years which is now under built up area and industrial land use.

Table 2: Land use/ land cover with TGA change (%) of Talwade and surrounding villages

Talwade and surrounding villages area under land use/ land cover							Change					
							1992-2000		2000-2011		1992-2011	
Classes	1992	TGA % 1992	2000	TGA % 2000	2011	TGA % 2011	Area	TGA %	Area	TGA %	Area	TGA %
Water	57.80	0.87	35.73	0.54	49.68	0.75	-0.33	-0.33	13.95	0.21	-0.12	-8.12
Industrial area	0.49	0.01	13.86	0.21	291.96	4.40	0.20	0.20	278.10	4.19	4.39	291.47
Built up area	148.64	2.24	308.07	4.64	415.89	6.27	2.40	2.40	107.82	1.63	4.03	267.25
Agriculture Land	1361.01	20.52	1389.33	20.95	1296.81	19.55	0.43	0.43	-92.52	-1.39	-0.97	-64.20
Pasture Land	723.06	10.90	474.57	7.15	812.97	12.26	-3.75	-3.75	338.40	5.10	1.36	89.91
Barren Land	2547.62	38.41	2294.55	34.59	3280.77	49.46	-3.82	-3.82	986.22	14.87	11.05	733.15
Fallow Land	1606.55	24.22	1929.06	29.08	297.09	4.48	4.86	4.86	-1631.97	-24.60	-19.74	-1309.46
Cantonment	187.92	2.83	187.92	2.83	187.92	2.83	0.00	0.00	0.00	0.00	0.00	0.00
Total	6633.09	100	6633.09	100	6633.09	100						

TGA-Total Geographic Area; Area in Hectares

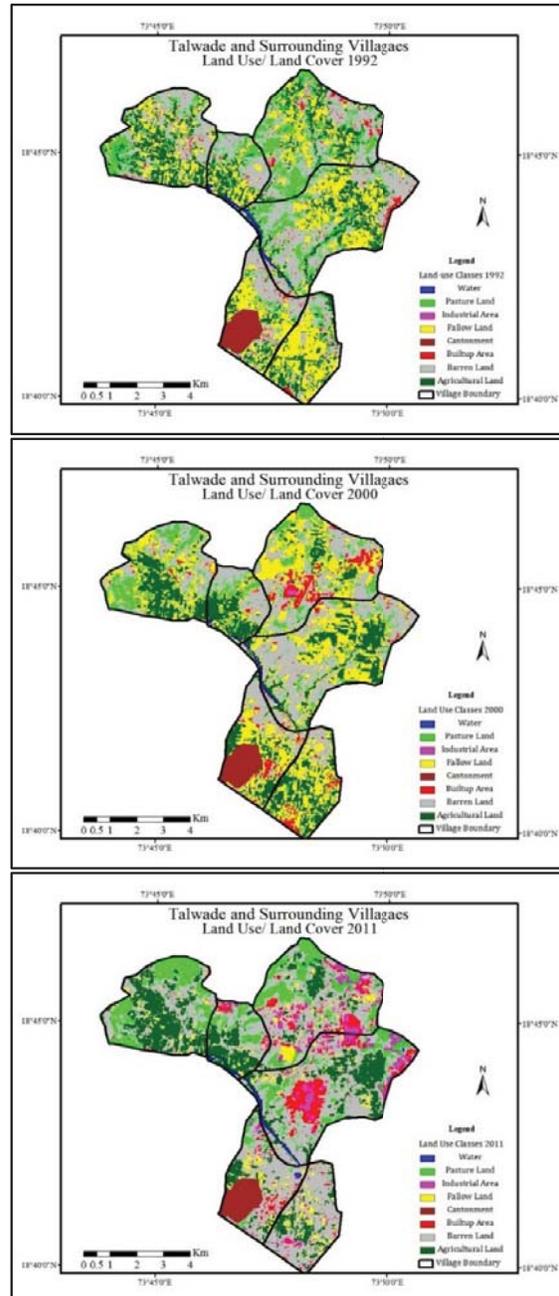


Figure 4: Supervised classifications of the study area for the years 1992, 2000 and 2011

During the time span of 20 years, Talwade and surrounding region has shown enormous increase in built up land. Figure 5 shows that built-up land has increased in the central southern and western parts in first decade and overall increase in built-up in last decade.

Socio economic analysis

Using the primary surveyed data, the nature of employment has been taken as one of the socio-economic parameters for understanding the impact of

IT park on the occupational structure of the selected sample from each village.

Table 3: Accuracy report

Accuracy Report		
Year	Overall classification accuracy	Overall Kappa statistics
1992	89.45%	0.8501
2000	90.41%	0.8609
2011	90.20%	0.8545

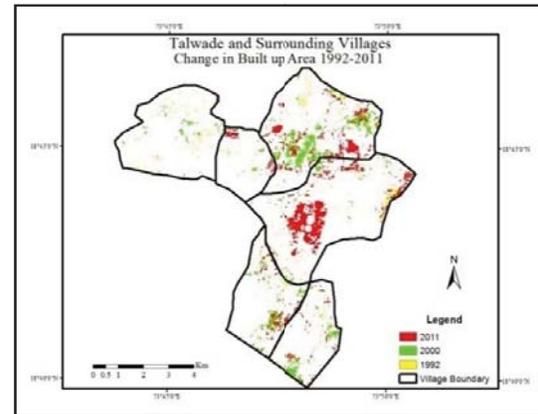


Figure 5: Change in built up area in 1992, 2000 and 2011

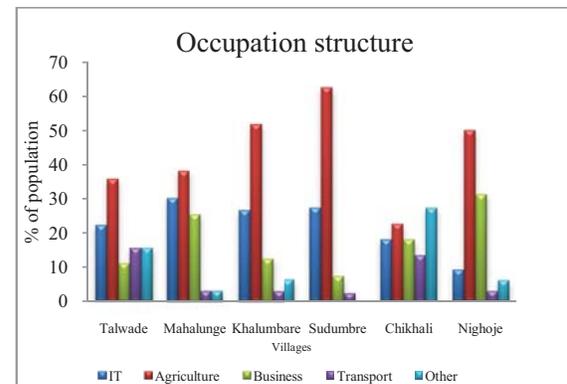


Figure 6: Occupation structure of Talwade and surrounding villages

The occupation structure defines the economic activities in the villages, and it has helped to realize the impact of IT park and industrial sector on these rural areas. Talwade village has a lower proportion of persons in the occupation of agriculture. This is probably because a large part of the land in Talwade has been converted into commercial land use within the IT park. The persons working in the IT sector are not very high and it is similar to the villages of Khalumbare and Sudumbare. However in the transport sector there are higher numbers of persons due to the fact that the requirement of this service is essential in the areas of the IT park (Table 4).

Table 4: Occupation structure of villages

Village---> Occupation ↓ V	Talwade	Mahalunge	Khalumbare	Sudumbre	Chikhali	Nighoje
IT	22.2	30.2	26.6	27.5	18.2	9.4
Agriculture	35.6	38.1	51.6	62.5	22.7	50.0
Business	11.1	25.4	12.5	7.5	18.2	31.3
Transport	15.6	3.2	3.1	2.5	13.6	3.1
Other	15.6	3.2	6.3	0.0	27.3	6.3
Total	100.0	100.0	100.0	100.0	100.0	100.0

In Mahalunge, 38% of the people are engaged in agriculture which is a primary activity. The remaining 62% people residing in the village are involved in tertiary occupations, 30% being in IT. 3% people serve as transport in the area and 26% people are running private businesses. Rest of the people are working in jobs other than IT sector.

In Khalumbare half of the persons of the representative sample are occupied in agricultural activities. Compared to the other villages of Talwade the persons employed in the IT sector is fairly high.

The percentage share of the persons engaged in the IT sector is similar to that of Sudumbare. But the major share of occupation is found in the agricultural sector which is 62%. Persons engaged in transport related activities and business is very negligible.

In Chikhali 23% of the people are engaged in agriculture which is a primary activity. The remaining 77% people residing in the village are involved in tertiary occupations, 18% being in IT. 14% people serve as transport in the area and 18% people are running private businesses. Rest of the people are working in jobs other than IT sector

Nighoje also has more than half of the population engaged in the primary activity of agriculture. It is found that 32% of their persons have some business in this village which is higher than the other villages around the IT park.

6. Conclusions

Urban growth remains a major topic concerning GIS and remote sensing application. RS and GIS have proved to be an effective means for extracting and processing of spatial information for monitoring urban growth. The present study shows that

1. The area under fallow land has reduced to their half in the last two decades whereas the industrial and built up land has increased to cover 14 percent of TGA.
2. Considering individual villages, all the villages have shown increase in urban area (industrial + built up) i.e. covering 2 to 14 per cent of the TGA. And similarly there was decrease in the agricultural land by 5 to 20 per cent.
3. Though there is development of IT park in Talwade, only people from the nearby villages

benefit from those developments. Only 22% are engaged with the IT related services in Talwade. This shows the disparities in the development of the surrounding areas in terms of employment in the IT sectors. There are significant number of people engaged in agriculture and other activities.

4. The villages like Talwade and Nighoje were purely agricultural in nature. With the advent of the IT park, the diversity in the occupation was initiated. The infrastructural facilities improved and people began to gain employment in transport, business and other industrial sectors. However the number of persons employed in agriculture remained the same over two decades. This is reflected in the LU/LC conditions of the area.

The further scope of the study would entail a detailed analysis of all the socio- economic factors and their impact on the villages.

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