Use of High Resolution Remote Sensing Data , GIS and GPS Techniques at Large Scale Urban Landuse and Infrastructure Mapping for Farrukhabad- Fatehgarh Regulatory Area, Uttar Pradesh, India

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Abstract- **High resolution remote sensing data provides a lucid and effective means for identification and mapping of small features on earth surface/urban area environment and its change at regular interval. It provide vital informatio on type and extent of uban landuse and infrastructure in any urban area. Over the years satellite based remote sensing data with its improved devices have been successfully utilized for urban area mapping , monitoring and proper landuse planning and management activietis and it is considerd as essential element for monitoring and modelling for understanding the earth as a system. This paper presents the results based on the use of Quickbird sattelite's (pan plus multispectral) 60 cm high resolution remote sensing data and Geographical Information System (GIS) and Global Positioning System (GPS) Techniques for Farrukhabad-Fatehgarh Regulatory Area , Uttar Pradesh, India, which is spread over an area of 100 sq km and lies between the lattitude $26^0 46'$N to $27^0 43'$ N and longititute 79^0 07'E to 80^0 02' E. In study area eleven landuse /landcover categories are identified and mapped. They are - Built-up (urban-7.3 sq km), Built-up (rural-2.26 sq km), Transportation/communication-0.25 sq km, Industrial area-1.39 sq km, commercial area-0.97 sq km, Institutional/utilities-4.06 sq km, Religious/cultural-0.20 sq km, Forest-1.40 sq km, Non-Built-up Land -Agricultural land-58.33 sq km, River/Water bodies-19.1 sq km and others-4.74 sq km accordingly and the percentage of each and every category is same as area estimates respectively. This database would be very useful for Farrukhabad-Fatehgarh Regulatory Authority for proper land use planning & management.**

Key Words- Quickbird Satellite High Resolution Data, Urban landuse and Infrastructure, GIS And GPS Techniques

INTRODUCTION

Landuse map is an important thematic map for all future planning exercises. As per census of India, 2011, 7933 cities are reported in our country, only few cities had up to date land-use map. In planning of cities or an urban area, a large part of work involved, often the major part is the determination of the relevant facts to base the plan. The plan or the base/existing urban Infrastructure and land use map has to be there to represent spatial information for providing accurate and authentic information for proper planning and management for developmental activities in any city. (Patkar, 2003) Remote sensing can provide an important source of data for urban landuse/land cover mapping and environmental monitoring. (Gopalan A.K.S. 2009) High resolution remote sensing data of various satellites including of our country and United States of America, coupled with Global Positioning System (GPS)/mobile mapper can be used to identify and delineate the small land parcels for generation of detailed information. (Kumar, V. et al 2009). In order to achieve such data in time, satellite based remote sensing techniques has proved its potentiality with high resolution data. The importance of this technique in urban settlement and landuse/landcover mapping is established and accepted worldwide too, to know the present actual status as well as trend of changes in city and its environs, Remote Sensing, GIS and GPS Technology is a vital tool to create the detailed information of any city and its changes. In the entire state of Uttar Pradesh 0.06 lakhs sq. km area comes under urban built up land, which is around 1.0% of the total geographical area of the state. The role of planning agencies is becoming increasingly more complex & is extending to a wider range of activities. (Minakshi Kumar et. al , 2002), Consequently there is an increased need for these agencies to have timely accurate & cost effectively data of various forms. Here we will discuss utility of on screen image interpretation and area estimation of detailed urban land use /land cover categories in study Area, which covers an area of 100 sq. km. Uttar Pradesh is most populous state in the country which has 724 cities as per census of India, 2011,i.e. Nagar Panchayat / Nagarpalika Parishad / municipal corporations including cantonment board & industrial township in a span of 110 years. Various cities/ towns of the state have achieved the status of first class towns/ cities in the recent years. (Kumar, V. 2012) Due to excessive pressure of population, rapid urbanization

took place and as resultant, numbers of colonies has been developed by development authorities. These colonies has been taken up by urban local bodies and as a results the urban density of the state is now reported around 4937 persons per sq. km, whereas overall population density of the state is only 473 person/sq. km. In the beginning of 20th century, 548 cities were reported in the state of Uttar Pradesh. An endeavor has been made to prepare a detailed digital database for the study area on various categories of urban landuse/landcover i.e. built-up-urban/rural-residential(lowrise/highrise buildings), commercial-hotel/marrige hall/godowns, industrial-industries and brick-kilns, others-wasteland cantonment/defence land, non-built-up land-agriculture land/orchard/plantation, transportation/communication-bus station/depot railway/roads, forest, religious/cultural-temple/mosque, graveyard, institutional/utilities-school/college, river/water bodies in GIS domain for Farrukhabad-Fatehgarh Regulatory Area of Uttar Pradesh. This database would be very useful for urban planners/decision makers, urban development authorities/Farrukhabad-Fatehgarh Regulatory Authority for future realistic land use planning & management.

OBJECTIVES

The broad objective of the present study is to prepare a digital database on urban landuse/landcover and infrastructural facilities with area estimation/statistics of Farrukhabad-Fatehgarh Regulatory area using high resolution remote sensing data of Quick bird satellite, Geographical Information System (GIS) and Global Positioning System (GPS) Techniques.

HISTORY OF STUDY AREA

The Farrukhabad district is under Kanpur commissionary of U.P. which is situated in the middle part of Ganga-Yamuna Doab, in shape, it is roughly rectangular it's length from east to west varying between 11 to 12 km and its breadth from North to South is about 14 kms. On the North it is bounded by the district of Badaun and Shahjahanpur and in South with Kannauj and in East Hardoi and in West it is bounded Etah and Mainpuri districts. The Ganga river forms its natural boundary on the east and separates it on the district of Hardoi. The total geographical area of the Farrukhabad-Fatehgarh city and its environs which has been taken up for the study is 100.00sq.km.

LOCATION OF STUDY AREA

Farrukhabad-Fatehgarh city is located in central part of Uttar Pradesh. It lies between latitude $26^0 46$'N to $27^0 43$' N and longitude $79^0 07$'E to $80^0 02$' E. **(Fig.1).** Farrukhabad-Fatehgarh city and its regulatory area are spread over an area of 100.00 sq km. The city and surrounding area is almost a level plane, varied only by a few gentle undulations and slopes and highest elevation of the area is 167 m from mean sea level at Mohammadabad and the lowest 145.69 at Mau-Rasulpur in the trans-Ganga flats of tehsil Farrukhabad.The upland of doab and the low lands or tarais, cut away from the upland by the erosive action of the river.
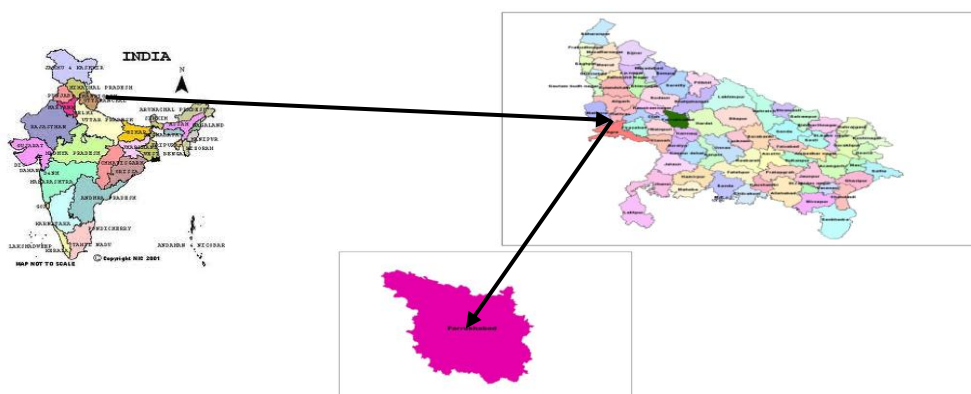
Location Map of Study Area

Figure: 1

MATERIALS & DATA USED

- Survey of India topographical sheet No.54M/11 & 7, 10, 12 & 15 of Farukhabad-Fatehgarh & its environs on 1:25,000/ 1:50,000 scales surveyed between 1974-75.
- Guide map of Farrukhabad city on 1:20,000 scale.
- Regulatory area/ boundary map of Farukhabad-Fatehgarh.
- Ground truth data collected from study area.
- Quickbird satellite's 60 cm. high resolution data acquired on 18th June, 2008

METHODOLOGY

The procedure followed for identification and mapping on 1:1,000 scale and for preparation of digital database using remote sensing GIS and GPS techniques is discussed in brief as under: The Farukhabad-Fatehgarh city settlement and environs of Uttar Pradesh, India, is selected to prepare a digital database on urban landuse and infrastructure map using Remote sensing, Geographical information System (GIS) and Mobile Mapper/Global Positioning System (GPS) Techniques. At first city/regulatory area boundary map provided by Farukhabad-Fatehgarh Regulatory Authority has been geo-referenced in conjunction with Quick bird satellite's (pan plus multispectral merged) 60 cm. resolution data acquired in 2008, to carry out this work for the study area. After geo-referencing of boundary map and high resolution data using digital image processing software (ERDAS IMAGINE)/Arc-GIS, all available/ collected maps are corrected and referenced to real earth coordinates. The road /transport-network/ city major/minor roads/ streets, railway line, river/water bodies, drainage/nala features etc. were identified and interpreted as a linear, polygon feature using Quick bird 60 cm. resolution data and Arc-GIS software 10.0 v. and area names and important locations has been included in base/transport-network map. After preparation of base map, land use categories existing in the study area were identified and mapped in study area using high resolution data. The rectified data and map overlaid on it, has also been further checked /verified on the ground for conducting field survey. Different land use /land cover categories i.e. urban built-up, rural-built-up- residential, commercial, industrial, Non built-up, forest, river/waterbodies, religious places and in others wastelans and restricted areas are identified and mapped as broad categories, govt. offices-central/state, semi govt. institutions- govt./semi-govt., retail shopping complex and places of facilities are also identified and mapped in city core and its surroundings. Vector layers were overlaid on satellite image/ have been used in ground surveying for collection of field information. A detailed ground truth verification/field survey has been carried out with the help of single frequency Global Positioning System /Mobile Mapper (GPS) to know the exact location of various urban land use/land cover categories and facilities with their actual extent and purpose of use. The individual polygons have been given attributes coding in GIS environment. After field survey of the study area through Mobile Mapper/GPS, the necessary corrections are incorporated before finalization of the land use map in reference of data collected during field survey. The Mobile Mapper/GPS field data was converted in to tabular format and it has been linked and matched with digitized map in GIS domain for preparation of final map of study area on 1:8,000, 1:16,000 scales.

RESULT AND DISCUSSIONS

To create the digital database on urban land use/land cover of Farukhabad-Fatehgarh city and surroundings as a base map for master plan map of the area, the high resolution 60 cm. imagery of Quick bird satellite (Pan plus multispectral) has been used to identify and demarcate the different landuse/landcover categories. Apart from this survey of India topographical map sheet no. 54M/11 & 7, 10, 12 & 15 on 1:50,000 scale has also been used for identification, mapping and ground truth/G.P.S. data collection purpose for the study area. At first base map including road/ transport-network, city major/minor roads, railway line, canal/distributaries, river, drainage/nala, water bodies were prepared on 1:1,000 and the final landuse maps has been composed on 1:8,000 and 1:16,000 scale (**Fig.3**). After preparation of base map eleven land use/ land cover categories are identified and mapped in the study area (**Fig.7**). They are - Built-up (urban), Built-up (rural), Transportation/communication, Industrial area, commercial area, Institutional/utilities, Religious/cultural, Forest, Non-Built-up Land -Agricultural land, River/Water bodies and Others (**Fig.4 & 5**). These eleven categories are further subdivided up to three levels (**Table-2**). They are built-up Urban (residential area)- low-rise buildings(up to four storeyed) and high-rise buildings (above four storeyed), Transportation/ communication- bus station/depot, roads/transport-network- primary roads-state/national highway/ major/minor roads, railway line/railway station/railway land/railway yard , Institutional/ utilities/facilities- government /semi govt. offices/educational institutes, power house, petrol pump, govt./private hospitals, police thana and policeline, banks/atm and clubs, Commercial- market/bazar, dairy, godowns, mandi samiti and marriage hall and hotels, Religious/cultural places- temple, mosque, church and graveyards/burial grounds, Industrial area- industries like fertilizer, cloth printing and brick kilns,Nonbuilt-upland-agricultural/ cropland, orchard/plantation, land with/without infrastructure, Forest- forested area, Rural built-up-rural settlement/villages are mapped outside the urban area surrounded by agricultural land, Water bodies-river, canal/distributaries, drainage/nala and ponds/lake has been identified and mapped, similarily in Others category-Restricted/ cantonment area and in Wastelands- open scrub are identified and mapped in the study area. (**Table-1 & 2**) shows the different landuse/landcover categories with statistics detail and their percentage has also been given before their name as Built-up land (urban)- The areas identified and mapped under lowrise buildinds are occupying an area of 7.3% and high rised building area is negligible, that's why the statistics of high-rised buildings

are not given in the table, during field survey/GPS data collection, almost low-rise/high rised residential buildinds/ colonies locations has been taken and their name has also Narvasa, Bangaspura, Shivnagar, Awas Vikas Colony, Christian colony, Railway colony, Forest Deptt. colony, Nawadia, Kasimbagh and Civil court colonies, in Built-up(rural)- it estimate as 2.26%, Transportation/communication category- bus station/depot (0.02%), roads/transport-network under state highway/national highway and major roads in city and its environs area are estimated (1.52%), railway station/railway land(0.25%), railway yard(0.26%) and chauk/chauraha area percentage is negligible. In Commercial category-maket/bazar (0.2%), dairy(0.01%), godowns(0.53%), mandi-samiti (0.2%), marriage hall(0.02%), hotel/general business(0.01%), Public utilities/facilities/govt. offices/Educational institutes category is further sub-divided into govt./semi-govt. offices like district collectrate, public works deptts. and other offices are identified and mapped in the study area which occupies 0.31%, college/degree colleges/inter college/schools occupy 0.51%, police station/police line(0.83%), power house(0.05%), petrol pumps(0.01%), govt./private hospital(0.21%), club occupy an area of (0.01%) of total geographical area and area of post office, cinema hall and bank/atm are negligible, in Religious/cultural places-temple, mosque and graveyard occuppies an area of 0.02%, 0.03% and 0.15% respectively and the area of church is negligible and parks/playgrounds occupy (0.1%) . Industrial- in this category- factory of cloth printing, iffco fertilizers and brick-kilns are occupying an area of 0.08%, 0.02% and 1.29% accordingly. Non Built-up land-in this category agricultural land/cropland occupy (53.79%) and orchard/plantation (4.52%) and land with/without infrastructure in environs of city area, is occupying an area of 0.02% in total geographical area. Forest category occupies 1.58%, Water bodies/river (19.01%) and drainage/nala occupy (0.04%),

been given in geodatabase as P.W.D colony, Shyamnagar, Kashiram awasiya Yojna, Civil Lines area, Navlakha,

Ganga is the main river of study area. In others category- Wasteland (open scrubs) and restricted/cantonment (army/defence area) has been identified and demarcated, these categories are occupying an area of 0.76% and 4.01% respectively. Non-built up land, river/waterbodies and urban built-up land are the major categories in study area. **Table-3 & Fig.6** shows the name of different object/locations in polygon/as point location, has been collected during field survey with the help of Global Positioning System (GPS) to know the exact location of the particular object, the details of data collected during field survey, which has been converted into tabular format, matched and linked with map in GIS domain.

<div align="center">RECOMMENDATIONS:</div>

Before preparation of Master Plan map of city, the following should be considered.

- Prime Agricultural land should be avoided for future urban growth/ expansion.
- To develop any colony in urban periphery, at first wastelands should be used if non availability of wastelands, the 'c' quality of land(less fertile land) can be used for residential use as well as for commercial use.
- From environmental point of view, all large scale industries should be at a minimum distance of five kilometers and wastelands should be used for establishment of industry.
- Govt. /semi-govt. institutions / schools / college / universities, which also occupy large area, should also not be established in fertile land.\
- Landfill site selection should be in low lying area/unfertile or wastelands

<div align="center">TABLE-1: LANDUSE/LANDCOVER STATISTICS OF STUDY AREA</div>

Sl.No	Landuse Name	T.G.A.=100 sq. km(Area in sq.km)	%
1	Urban Built -up	7.3	7.3
2	Rural Built-up	2.26	2.26
3	Transportation/ Communication	0.25	0.25
4	Commercial Area	0.97	0.97
5	Institutional/ Utilities	4.06	4.06
6	Religious Place	0.20	0.20
7	Industrial	1.39	1.39
8	Non Built Up Land	58.33	58.33
9	Forest	1.40	1.40
10	Waterbody/River	19.1	19.1
11	Others	4.74	4.74
Total		100	100

TABLE-2: LANDUSE/LANDCOVER STATISTICS OF STUDY AREA AT LEVEL-III

Sl.No.	LANDUSE/LANDCOVER CLASSIFICATION LEVEL			T.G.A. 100 Sq. km(Area in sq.km)	%
	L-1	L-2	L-3		
1	Built-Up Urban	Residential	Low rise building (up to 4 storey)	7.3	7.3
			High rise building(above 4 storey)	-	-
2	Built up Rural	Rural	Built up rural	2.26	2.26
3	Transportation/ Communication	Transportation/ Communication	Bus station/depot	0.02	0.02
			Roads/Transport-network	1.52	1.52
			Railway station/railway land	0.25	0.25
			Railway yard	0.26	0.26
4	Commercial	Commercial And Storage	Bazar/market	0.2	0.2
			Dairy	0.01	0.01
			Godowns	0.53	0.53
			Mandi samiti	0.2	0.2
			Marriage hall	0.02	0.02
			Hotel/ general business	0.01	0.01
5	Institutional/ Utilities	Public Utilities/ Facility	Govt./semi govt. offices	0.31	0.31
			Degree/P.G. colleges	0.26	0.26
			Inter college	0.08	0.08
			School	0.17	0.17
			Police station/police line	0.83	0.83
			Power house	0.05	0.05
			Petrol Pump	0.01	0.01
			Hospital govt./private	0.21	0.21
			Club	0.01	0.01
6	Recreational/ Cultural/ Religious	Recreational/ Cultural/ Religious	Temple	0.02	0.02
			Mosque	0.03	0.03
			Park	0.05	0.05
			Play ground	0.05	0.05
			Graveyard	0.15	0.15
7	Industrial Area	Industries	Industry/Cloths printing	0.08	0.08
			IFFCO Fertilizer	0.02	0.02
			Brick kilns	1.29	1.29
8	Non Built -Up Land	Agricultural Land	Agricultural Land	53.79	53.79
			Orchard/Plantation	4.52	4.52
			Land with/without infrastructure	0.02	0.02
9	Forest	Forest	Forest	1.58	1.58
10	Water bodies	Water bodies	Waterbody/River	19.1	19.1
			Drainage/ Nala	0.04	0.04
11	Others	Defence land/ Wasteland	Restricted/Army area	4.01	4.01
			Open Scrub	0.76	0.76
	Total			100	100

TABLE-3:G.P.S LOCATION OF VARIOUS URBAN LANDUSE/ LAND COVER CATEGORIES/INFRASTRUCTURE & FACILITIES AT FARRUKHABAD FATEHGARH REG. AREA

Sl No.	LU_Name	Latitude (N)	Longitude(E)	Purpose
1	Police Chauki	$27^0$22'18" N	$79^0$37'7" E	Govt. office
2	P.W.D	$27^0$22'5" N	$79^0$37'33" E	Res./offices
3	Govt. Hospital	$27^0$22'3" N	$79^0$37'44" E	Institutional/facilities
4	Temple	$27^0$21'56" N	$79^0$36'21" E	Cultural/Religious
5	Temple	$27^0$22'44" N	$79^0$35'6" E	Cultural/Religious
6	Chhote singh Inter College	$27^0$22'42" N	$79^0$34'46" E	Cultural/Religious
7	S.D.A Girls. Jr. High School	$27^0$23'9" N	$79^0$35'16" E	Institutional
8	Mosque	$27^0$23'7" N	$79^0$34'24" E	Cultural/Religious
9	Temple	$27^0$23'19" N	$79^0$34'25" E	Cultural/Religious
10	Hazrat Bade Peer Sahib (Mosque)	$27^0$23'28" N	$79^0$34'12" E	Cultural/Religious
11	Mohanlal Shukla High School	$27^0$23'43" N	$79^0$34'17" E	Institutional/facilities
12	Mosque	$27^0$23'43" N	$79^0$34'21" E	Cultural/Religious
13	Police Station	$27^0$23'41" N	$79^0$34'29" E	Govt. office
14	Mosque	$27^0$23'38" N	$79^0$34'33" E	Cultural/Religious
15	U.P. State Cold Storage(Office)	$27^0$23'32" N	$79^0$34'38" E	Commercial/storage
16	Govt. Homeopathic Hospital	$27^0$23'31" N	$79^0$34'35" E	Institutional/facilities
17	All Sons Convents School	$27^0$23'36" N	$79^0$34'43" E	Institutional/facilities
18	Neha Nursing Home	$27^0$23'31" N	$79^0$34'46" E	Institutional/facilities
19	Swami Ramanand Nagarpalika Inter college	$27^0$23'14" N	$79^0$34'24" E	Institutional/facilities
20	Surya Hotel	$27^0$23'13" N	$79^0$34'31" E	Commercial
21	Modern Public School	$27^0$23'1" N	$79^0$34'18" E	Institutional/facilities
22	Water Tank	$27^0$22'47" N	$79^0$34'23" E	Utilities
23	Shri. Mahaveer Cold Storage	$27^0$22'49" N	$79^0$34'2" E	Commercial/storage
24	Shubhash Cold Storage	$27^0$22'45" N	$79^0$33'57" E	Commercial/storage
25	Tata Kisan Centre	$27^0$22'2" N	$79^0$34'17" E	Commercial
26	IFFCO Fertilzers	$27^0$22'13" N	$79^0$35'42" E	Industrial
27	Navin Mandi	$27^0$22'13" N	$79^0$33'57" E	Institutional/facilities
28	Primary School Satanpur	$27^0$22'17" N	$79^0$35'32" E	Institutional/facilities
29	Tiles Factory	$27^0$22'29" N	$79^0$35'13" E	Industrial
30	Dr.yogesh Chand Katiyar Nursing Home	$27^0$22'34" N	$79^0$35'17" E	Commercial
31	Tata Motors (Shyam Nagar)	$27^0$22'38" N	$79^0$35'14" E	Institutional/facilities
32	Saraswati Vidya Mandir High School	$27^0$22'49" N	$79^0$35'11" E	Commercial
33	Waterbody	$27^0$22'53" N	$79^0$35'8" E	Waterbody
34	Vaisnav Cold Storage	$27^0$22'51" N	$79^0$34'57" E	Commercial/storage
35	Temple	$27^0$23'15" N	$79^0$34'52" E	Cultural/Religious
36	Sarin Nursing Home	$27^0$23'36" N	$79^0$34'52" E	Commercial
37	Green Garden (Marriage Hall)	$27^0$23'45" N	$79^0$35'23" E	Commercial
38	Haji Akhtar Husain Rahmani School	$27^0$24'0" N	$79^0$35'8" E	Institutional/facilities
39	Kashiram Awasiya Yojna Colony	$27^0$24'26" N	$79^0$34'49" E	Residential
40	Bangaspura	$27^0$24'16" N	$79^0$35'21" E	Residential

41	Gram Dharanagri	$27^0 24'23''$ N	$79^0 35'43''$ E	Residential
42	Luxman Gandhi Ashram	$27^0 24'14''$ N	$79^0 36'11''$ E	Commercial
43	Khanpur Ka Nagla	$27^0 23'54''$ N	$79^0 36'9''$ E	Residential
44	Sadi Chapai Godowns	$27^0 23'55''$ N	$79^0 35'42''$ E	Commercial/storage
45	Geetika Rastogi Hr. Sec. School	$27^0 24'4''$ N	$79^0 36'8''$ E	Institutional/facilities
46	Police Chauki Narvas	$27^0 23'50''$ N	$79^0 35'5''$ E	Govt. office
47	Mosque	$27^0 23'49''$ N	$79^0 35'11''$ E	Cultural/Religious
48	Chapai Karkhana	$27^0 23'44''$ N	$79^0 35'20''$ E	Commercial
49	Narayan Arya Girls Inter College	$27^0 23'40''$ N	$79^0 34'56''$ E	Institutional/facilities
50	Narayan Arya Girls P.G College	$27^0 23'40''$ N	$79^0 35'3''$ E	Institutional/facilities
51	Mosque	$27^0 31'49''$ N	$79^0 35'5''$ E	Cultural/Religious
52	U.P. Bus Depot	$27^0 23'9''$ N	$79^0 35'21''$ E	Transportation
53	TVS Showroom	$27^0 22'51''$ N	$79^0 35'47''$ E	Commercial
54	Stechu	$27^0 22'51''$ N	$79^0 36'0''$ E	Commercial
55	Joyal Hospital	$27^0 22'55''$ N	$79^0 36'8''$ E	Commercial
56	Army Colony	$27^0 22'14''$ N	$79^0 37'35''$ E	Defence/Residential
57	Play Ground	$27^0 21'45''$ N	$79^0 38'0''$ E	Recreational
58	Ajmatpur	$27^0 22'17''$ N	$79^0 33'39''$ E	Residential
59	Gram Pachfukra	$27^0 22'40''$ N	$79^0 33'29''$ E	Residential
60	Gram Arhibazpur	$27^0 24'48''$ N	$79^0 32'33''$ E	Residential
61	Food/Fruits Mandi	$27^0 24'0''$ N	$79^0 32'54''$ E	Commercial
62	O.P.Lawn	$27^0 23'27''$ N	$79^0 35'53''$ E	Recreation
63	Police Help Centre	$27^0 23'53''$ N	$79^0 35'53''$ E	Govt. ofice
64	Rajkiy Polytechnic College	$27^0 22'2''$ N	$79^0 36'40''$ E	Institutional/facilities
65	Power House	$27^0 22'2''$ N	$79^0 36'40''$ E	Institutional/facilities
66	Smt. Krishna Devi Cold Storage	$27^0 21'41''$ N	$79^0 35'28''$ E	Commercial/Storage
67	Kashiram Awasiya Yojna Colony	$27^0 23'54''$ N	$79^0 34'22''$ E	Residential
68	Temple	$27^0 21'36''$ N	$79^0 35'58''$ E	Cultural/Religious
69	Shyam Cold Storage	$27^0 23'26''$ N	$79^0 36'25''$ E	Commercial/Storage
70	Dr.Virendra Sawarup Educational Centre	$27^0 23'22''$ N	$79^0 36'30''$ E	Institutional/facilities
71	Brick kilns	$27^0 23'53''$ N	$79^0 32'54''$ E	Industrial
72	shri. Thakurji Maharaj Temple	$27^0 22'49''$ N	$79^0 35'11''$ E	Cultural/Religious
73	Girls Primary School Shyam Nagar	$27^0 22'49''$ N	$79^0 35'11''$ E	Institutional/Facilities
74	Railway Crossing	$27^0 22'44''$ N	$79^0 35'12''$ E	Transportation
75	Kailash Motors	$27^0 22'38''$ N	$79^0 35'15''$ E	Commercial
76	IFFCO Fertilizer Shop	$27^0 22'8''$ N	$79^0 35'35''$ E	Commercial
77	Primary School Bhupatipatti	$27^0 22'33''$ N	$79^0 35'18''$ E	Institutional/Facilities
78	H.P. Petrol Pump	$27^0 21'40''$ N	$79^0 35'25''$ E	Commercial/facilities
79	Shri. Ram Cold Storage	$27^0 23'46''$ N	$79^0 37'27''$ E	Commercial/Storage
80	Orchard/Plantation	$27^0 24'14''$ N	$79^0 37'56''$ E	Agriculture Land
81	P.K Cold Storage	$27^0 27'12''$ N	$79^{040}22''$ E	Commercial/Storage
82	Ram manohar Lohiya Hospital	$27^0 22'51''$ N	$79^0 36'5''$ E	Commercial/facilities
83	Hero Showroom	$27^0 22'51''$ N	$79^0 35'47''$ E	Commercial
84	Bharat Petrol Pump	$27^0 23'10''$ N	$79^0 35'23''$ E	Commercial
85	Mosque	$27^0 23'49''$ N	$79^0 35'11''$ E	Cultural/Religious

86	Brick kilns	27^{0}23'54" N	79^{0}35'58" E	Industrial
87	Kharbandi Nagla Vajeer	27^{0}24'6" N	79^{0}34'39" E	Residential
88	Gayatri Shakti Pith	27^{0}23'58" N	79^{0}33'32" E	Cultural/Religious
89	Temple	27^{0}23'58" N	79^{0}33'22" E	Cultural/Religious
90	Sarojni Cold Storage	27^{0}23'3" N	79^{0}33'46" E	Commercial/Storage
91	Chandra Cold Storage	27^{0}22'51" N	79^{0}33'38" E	Commercial/Storage
92	Police Chauki	27^{0}23'8" N	79^{0}33'51" E	Govt. office
93	Brick kilns	27^{0}22'31" N	79^{0}33'53" E	Industrial
94	Purv Madyamic Vidhyalay Ajmatpur	27^{0}22'20" N	79^{0}33'39" E	Institutional/Facilities
95	Railway Crossing	27^{0}21'52" N	79^{0}34'11" E	Transportation
96	Poultry Farm	27^{0}22'6" N	79^{0}34'20" E	Commercial
97	Jila Udyog Centre	27^{0}22'47" N	79^{0}34'44" E	Govt. Office
98	Mosque	27^{0}21'59" N	79^{0}37'55" E	Cultural/Religious
99	Electrical Transformer	27^{0}21'59" N	79^{0}37'55" E	Facilities
100	Rajkiy Jila Pustkalay	27^{0}21'38" N	79^{0}38'3" E	Institutional/Facilities
101	New Blue Heavel Hotel	27^{0}21'39" N	79^{0}38'1" E	Commercial
102	Water Tank	27^{0}21'40" N	79^{0}38'1" E	Facilities
103	Nirwachan Office	27^{0}21'41" N	79^{0}38'4" E	Govt. Office
104	Purvi Primary School	27^{0}21'39" N	79^{0}37'59" E	Institutional/Facilities
105	Durga Narayan Hr.Sec. School	27^{0}21'41" N	79^{0}38'5" E	Institutional/Facilities
106	Axis Bank ATM	27^{0}21'59" N	79^{0}37'55" E	Commercial/Facilities
107	Indian Oil Petrol Pump	27^{0}22'0" N	79^{0}37'55" E	Commercial/Facilities
108	National Public School	27^{0}22'1" N	79^{0}37'56" E	Institutional/Facilities
109	Open Space	27^{0}21'54" N	79^{0}37'50" E	-
110	Rajkiy Girls Inter College	27^{0}21'54" N	79^{0}37'49" E	Institutional/Facilities
111	Nagar Palika Shopping Complex	27^{0}21'53" N	79^{0}37'51" E	Commercial
112	Shriji Hospital	27^{0}21'58" N	79^{0}37'46" E	Commercial/Facilities
113	Office City Police	27^{0}22'16" N	79^{0}37'36" E	Govt. Office
114	Cantt. Primary School	27^{0}23'25" N	79^{0}37'43" E	Institutional/Facilities
115	V.M.Public School	27^{0}231'25" N	79^{0}37'42" E	Commercial/Facilities
116	Dairy(Milk)	27^{0}23'55" N	79^{0}37'17" E	Commercial
117	Primary School	27^{0}23'55" N	79^{0}37'12" E	Institutional/Facilities
118	Govt.Hospital Khanpur	27^{0}23'31" N	79^{0}36'7" E	Institutional/Facilities
119	A.K Rice Mill (Closed)	27^{0}23'39" N	79^{0}36'58" E	Commercial
120	Neha Filing Station (HP Petrol Pump)	27^{0}23'37" N	79^{0}36'57" E	Commercial
121	Temple	27^{0}23'51" N	79^{0}23'51" E	Cultural/Religious
122	Open Space	27^{0}24'0" N	79^{0}35'8" E	-
123	Temple	27^{0}24'11" N	79^{0}35'2" E	Cultural/Religious
124	Primary School Haiwatpur Gathiya	27^{0}24'56" N	79^{0}35'3" E	Institutional/Facilities
125	Water Tank (Bilawarpur)	27^{0}25'8" N	79^{0}35'30" E	Institutional/Utilities
126	Temple	27^{0}25'12" N	79^{0}35'22" E	Cultural/Religious
127	Primary School Bilawarpur	27^{0}25'19" N	79^{0}35'22" E	Institutional/Facilities
128	Nakasa	27^{0}26'1" N	79^{0}35'15" E	Residential
129	Orchard/Plantation	27^{0}25'59" N	79^{0}35'20" E	Agriculture Land
130	Gram Kundakmadaiya	27^{0}26'5" N	79^{0}35'29" E	Residential

131	Primary school Katribhimpur	$27^0 25'42"$ N	$79^0 36'0"$ E	Institutional/Facilities
132	Primary School Shikarpur	$27^0 26'35"$ N	$79^0 34'56"$ E	Institutional/Facilities
133	Temple	$27^0 25'22"$ N	$79^0 34'7"$ E	Cultural/Religious
134	Dargah /Mosque	$27^0 24'15"$ N	$79^0 34'24"$ E	Cultural/Religious
135	Dev Rampur Choraha	$27^0 22'44"$ N	$79^0 34'50"$ E	Transportation
136	D.U.P.Cold Storage	$27^0 22'48"$ N	$79^0 34'40"$ E	Commercial/Storage
137	K.T. Cold Storage	$27^0 22'49"$ N	$79^0 34'38"$ E	Commercial/Storage
138	Sabha Bhavan	$27^0 22'49"$ N	$79^0 34'36"$ E	Facilities
139	Navbharath Cold Storage	$27^0 22'50"$ N	$79^0 34'36"$ E	Commercial/Storage
140	Krishna Palika Inter College	$27^0 225'50"$ N	$79^0 34'28"$ E	Institutional/Facilities
141	khad Godowns (closed)	$27^0 22'54"$ N	$79^0 34'26"$ E	Commercial/Storage
142	Malgodowns	$27^0 22'54"$ N	$79^0 34'15"$ E	Commercial/Storage
143	Kanhaiyalal Rastogi Inter college	$27^0 22'58"$ N	$79^0 34'17"$ E	Institutional/Facilities
144	Police chauki	$27^0 23'5"$ N	$79^0 34'22"$ E	Govt. office
145	Temple/Statue	$27^0 23'18"$ N	$79^0 34'35"$ E	Cultural/Religious
146	Water tank	$27^0 23'22"$ N	$79^0 34'30"$ E	Utilities
147	Jawaharlal Nehru Memorial School	$27^0 23'19"$ N	$79^0 34'34"$ E	Institutional/Facilities
148	Parla Park	$27^0 23'21"$ N	$79^0 34'30"$ E	Recreational
149	Temple	$27^0 23'20"$ N	$79^0 34'37"$ E	Cultural/Religious
150	GIC School	$27^0 23'11"$ N	$79^0 34'48"$ E	Institutional/Facilities
151	GIC School Property	$27^0 23'11"$ N	$79^0 34'49"$ E	Institutional/Facilities
152	School Play Ground	$27^0 23'9"$ N	$79^0 34'59"$ E	Institutional/Facilities
153	Pandit Durga Prasad High School	$27^0 23'8"$ N	$79^0 34'59"$ E	Institutional/Facilities
154	Vijaya Bank	$27^0 23'20"$ N	$79^0 34'37"$ E	Govt. Office
155	Primary School	$27^0 23'24"$ N	$79^0 34'40"$ E	Institutional/Facilities
156	State Bank Of India	$27^0 23'25"$ N	$79^0 34'41"$ E	Govt. Office
157	Saligram Jagannath Prashad Sanskrit Vidyalaya	$27^0 23'26"$ N	$79^0 34'43"$ E	Institutional
158	Ganga Hospital	$27^0 23'31"$ N	$79^0 34'48"$ E	Commercial
159	Manisha Nursing Home	$27^0 23'35"$ N	$79^0 34'52"$ E	Commercial
160	T.R.Public School	$27^0 23'37"$ N	$79^0 34'53"$ E	Commercial
161	Bharthi V.V.D.College	$27^0 23'39"$ N	$79^0 34'55"$ E	Institutional/Facilities
162	Water Tank	$27^0 23'32"$ N	$79^0 35'24"$ E	Utilities
163	Pump House	$27^0 23'31"$ N	$79^0 35'25"$ E	Utilities
164	Govt. Hospital	$27^0 23'33"$ N	$79^0 35'22"$ E	Govt. Office
165	Ambedkar Satsang Bhavan	$27^0 23'28"$ N	$79^0 35'31"$ E	Religious
166	Banti Seed Shop(Ambedkar Nagar)	$27^0 23'23"$ N	$79^0 35'44"$ E	Commercial
167	Police Chauki (Kadrigate)	$27^0 23'22"$ N	$79^0 35'40"$ E	Govt. Office
168	Temple (Shanti Nagar)	$27^0 23'21"$ N	$79^0 35'47"$ E	Cultural/Religious
169	Baba Vishvnath Public School	$27^0 23'21"$ N	$79^0 35'46"$ E	Institutional/Facilities
170	Galla Mandi	$27^0 23'29"$ N	$79^0 35'24"$ E	Commercial/Storage
171	Ratan Cold Storage	$27^0 23'19"$ N	$79^0 35'34"$ E	Commercial/Storage
172	Prakash Cold Storage	$27^0 23'18"$ N	$79^0 35'33"$ E	Commercial/Storage
173	BSNL Office	$27^0 23'12"$ N	$79^0 35'20"$ E	Govt. Office
174	B.S. Garden (Marriage Hall)	$27^0 23'11"$ N	$79^0 35'22"$ E	Institutional/Facilities

175	Badri Vishal V.V.P.G.College	27^{0}23'7" N	79^{0}35'28" E	Institutional/Facilities
176	Centpitars Pripretri School	27^{0}23'3" N	79^{0}35'27" E	Institutional/Facilities
177	Christian Inter College Badpur	27^{0}23'0" N	79^{0}35'35" E	Institutional/Facilities
178	Christian College Field Play Ground	27^{0}22'53" N	79^{0}35'34" E	Institutional/Facilities
179	Sant Nirankari Satsang Bhavan	27^{0}23'0" N	79^{0}35'40" E	Cultural/Religious
180	Hotel Hindustan	27^{0}22'48" N	79^{0}35'53" E	Commercial
181	Dr. Uday Raj Singh Hospital	27^{0}22'47" N	79^{0}35'55" E	Commercial
182	Aavas Vikas Colony	27^{0}22'44" N	79^{0}36'22" E	Res. Planned
183	Park	27^{0}22'59" N	79^{0}35'59" E	Utility
184	Lakula Agriculture Farm	27^{0}23'13" N	79^{0}36'0" E	Non-Built up Land
185	Kishan Centre	27^{0}23'12" N	79^{0}36'1" E	Facilities
186	Rastogi Cold Storage	27^{0}22'59" N	79^{0}35'3" E	Commercial/Storage
187	Axis Bank	27^{0}22'59" N	79^{0}35'4" E	Facilities
188	Shri. Laxmi Cold Storage	27^{0}23'1" N	79^{0}35'6" E	Commercial/Storage
189	Shushila Cold Storage	27^{0}22'56" N	79^{0}35'10" E	Commercial/Storage
190	Godowns	27^{0}23'2" N	79^{0}35'9" E	Commercial/Storage
191	St. Lowrent Public School	27^{0}22'54" N	79^{0}35'16" E	Institutional/Facilities
192	Mazar Kalekha Cabristan	27^{0}22'51" N	79^{0}35'36" E	Cultural/Religious
193	Police Chauki(ITI)	27^{0}22'57" N	79^{0}34'56" E	Govt. Office
194	State Bank Of India	27^{0}23'0" N	79^{0}35'5" E	Govt. Office
195	Indian Oil Petrol Pump	27^{0}23'1" N	79^{0}35'6" E	Commercial
196	K.M.House-2nd	27^{0}23'5" N	79^{0}35'9" E	Residential
197	Farrukhabad Cold Storage	27^{0}22'58" N	79^{0}34'21" E	Commercial/Storage
198	Modern Public School	27^{0}22'59" N	79^{0}34'19" E	Institutional/Facilities
199	Farrukhabad ticket Counter	27^{0}22'58" N	79^{0}34'14" E	Transportation
200	City Hospital	27^{0}22'47" N	79^{0}35'55" E	Institutional/Facilities
201	Post Office	27^{0}23'12" N	79^{0}35'20" E	Govt. Office
202	Temple	27^{0}23'20" N	79^{0}35'35" E	Cultural/Religious
203	Kishan Science Centre	27^{0}23'11" N	79^{0}36'1" E	Institutional/Facilities

CONCLUSION

The remotely sensed data and Geographical Information System (GIS) have proved an effective tool in urban land use/land cover mapping, monitoring and analysis. The spatial extent of various urban land use/land cover categories prepared for the study area will be useful for planners and decision makers at city level planning & management. Furthermore, the development of intelligent GIS with high resolution panchromatic & multispectral data from Quikbird, IKONOS, Worldview-2 & 3, Resourcesat-I, Resourcesat-2, Cartosat-I & Cartosat-2 & Geoeye may enable generating parcel level land use/land cover inventories necessary for future/ sustainable development of land resource and may facilitate monitoring the input of implementation of suggested land use programs in urban areas.

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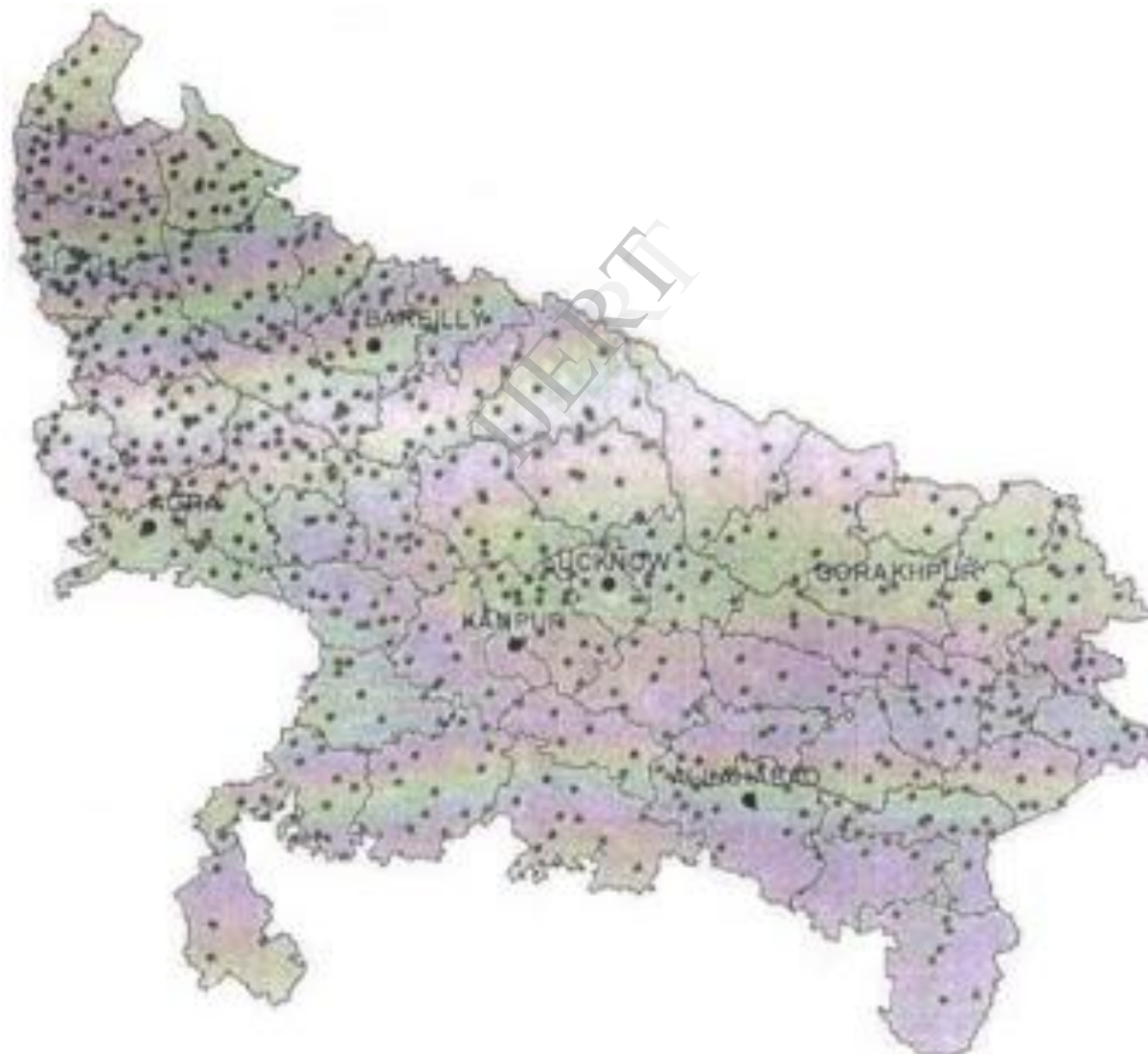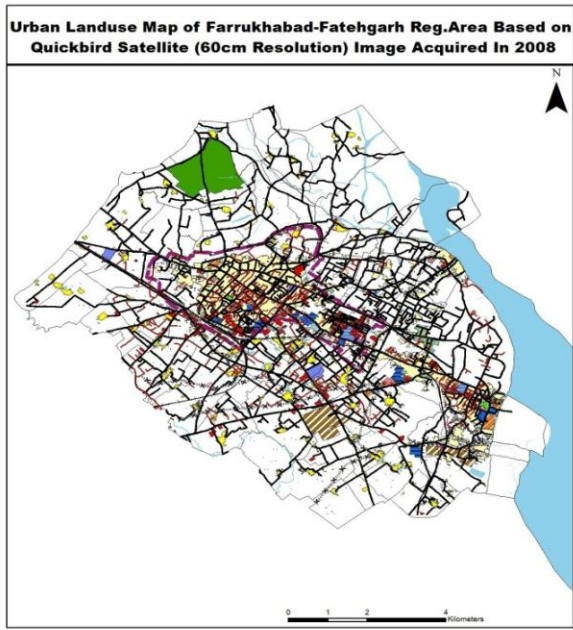
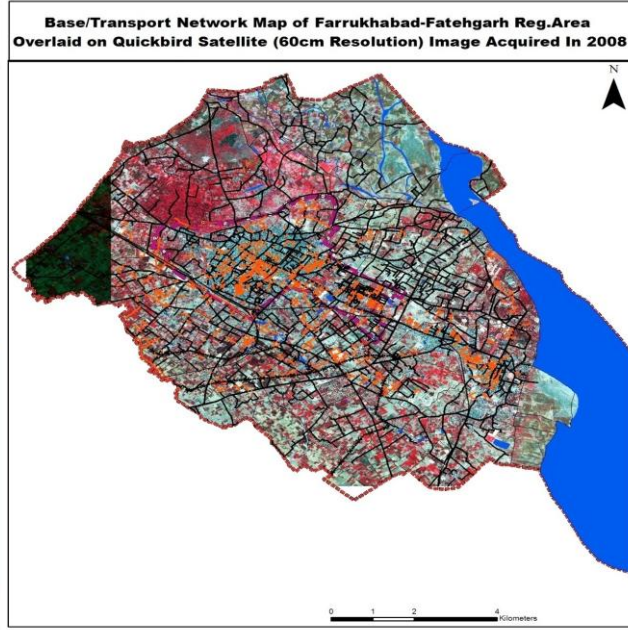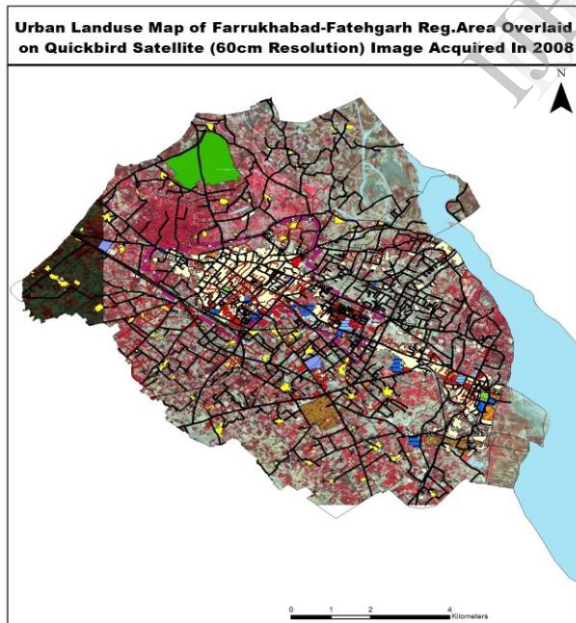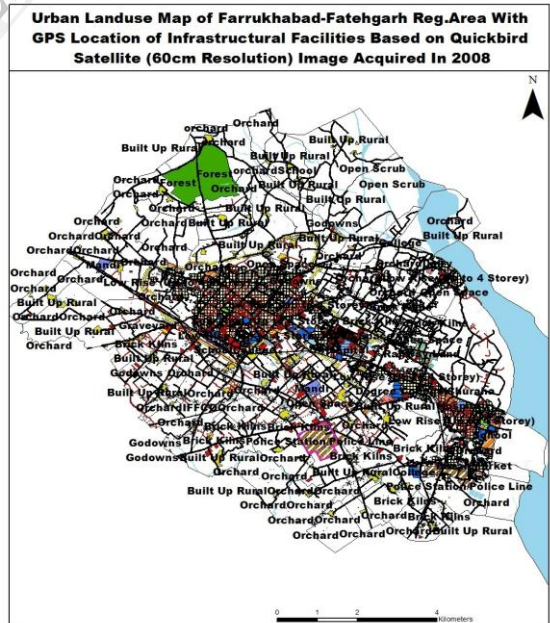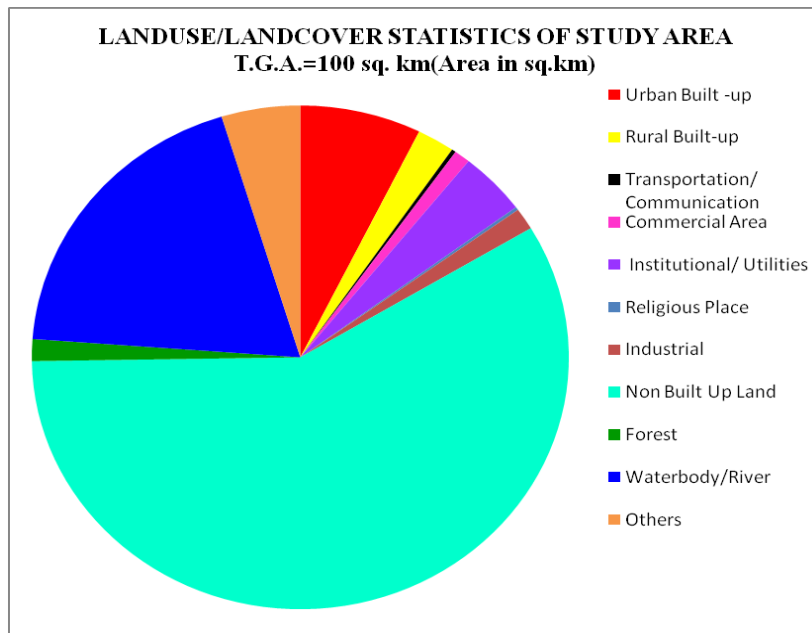## URBAN CENTRES IN UTTAR PRADESH

Figure: 2

Figure: 3

Figure: 4

Figure: 5

Figure: 6

Figure: 7