URBAN PLANNING OF JIND CITY, HARYANA USING GEO-INFORMATICS

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Abstract: GIS (Geographical Information System) is a computer based integrated database management system that stores a large volume of spatial data along with its attribute or non-spatial data which are captured, stored, retrieved, processed and analyzed to provide answers to queries of a geographical nature as and when required The Geographical Information System is defined as "An automated tool to capture, store, retrieve, manipulate, display and query of both spatial and non-spatial data to generate various planning scenarios for decision making. Geographical Information System is essentially a comprehensive spatial decision supporting system of computer software and hardware, tool to merge spatial geo-referenced data with non-spatial attribute data for deriving meaningful information to be useful for Urban Planning and management. The assessment of physical parameters of land is possible by analyzing these parameters, and which is very much amenable to Geographic Information System (GIS) Analysis.

Index Terms – Geo-Informatics, Urban Sprawl, Remote Sensing (RS), Geographical Information Systems (GIS), Global Positioning System (GPS), Spatial Analysis.

I. INTRODUCTION

The present study "Urban Planning of Jind City, Haryana Using Geo-Informatics" does heavily rely on technological and scientific discipline for sensing, modeling, representing, visualizing, monitoring, processing, and communicating geo-information in support of urban planning. The main focus of the study is to stress on present status and scope of future planning & management of the selected urban area (Jind city, Haryana State) with the help of available Satellite Data consists of high resolution QuickBird(panchromatic).The study method is strictly based on the design standards, materials and methods of National Urban Information Systems (NUIS) Scheme.

II. OBJECTIVE

The objectives of the study are as follows:-

- To access the present status of urbanization with the help of remote sensing Geo-spatial data and GIS based Information system.

III. DATA BASE AND METHODOLOGY

The NUIS (National Urban Information System) Design Standards suggests that the Thematic Mapping Activity comprising geospatial database of both Primary themes and Incorporated or attribute Layers at scale of 1:10000.

Thematic Mapping and Data Preparation In the present study the whole procedure of Thematic Mapping is done in Personal Geodatabase in Arc Gis-10.3.1 software. Following steps were involved in the digitization and preparation of Thematic Mapping:

A. Geodatabase Creation and organization:

Geospatial data base contributes immensely in the management of various thematic databases under NUIS scheme. It meets the project requirements in terms of value added information in content, format, multiple thematic layers integration and analysis. The Object Oriented GIS data structures use simplified data types and can accommodate vector & raster data, data tables and others GIS objects / features in a single, central repository. The thematic mapping geospatial data structure to facilities feature capturing and mapping was created using the Geodatabase technology (Arc GIS 10.3.1 version).The Geo referenced and rectified satellite imagery was displayed as a raster in Arc GIS, with the Administrative boundaries of Jind as a vector overlay, the 2D based visual or onscreen Interpretation kept limited to the area outside the Urban Core and within the urban sable are boundary depending upon the theme to be mapped. We adopted different enhancement techniques on the terminal, which facilitated better delineation of thematic feature boundaries.

B. Satellite data: The satellite data consists of high resolution QuickBird (Panchromatic) stereo data has been used. The satellite data belong to 2006. The data of Indian Remote Sensing Satellite P-6 (also called Resource Satellite) LISS-IV (MS) of the same year has also been used for the study purpose.

The details of the satellite data and their characteristics are given below:

Table – 1, Satellite Sensor Data and its Characteristics

Sr. No.	Satellite	Sensor	Spectral bonds (microns)	Spatial Resolution (m)	Swath	Radiometric Resolution	Temporal Resolution	Format
1.	Quick Bird	Pan	0.45-0.90	0.61 (nadir) to 0.72 (25° off-nadir)	16.5 Km x 16.5 Km at nadir	11 bits	1-3.5 days	.TIFF
2.	Resource sat - 1	LISS-IV(MS)	0.52-0.59 (Green) 0.62-0.68 (Red) 0.77-0.86 (NIR)	5.8m	23.9km. (Multispectral Mode) 70km. (Mono-mode)	7 bits	24 days	Geo.Tiff

Auxiliary Data:

Surveys of India (SOI) Toposheets have been used on the scale of 1:50,000.

The number of toposheets used are-53C/2, 53C/3, 53C/4, 53C/6, 53C/7, 53C/8, 53C/11

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C. Ground Truth Data

Ground truth data collected from the field/site from an important source of information for verification, augmentation and accuracy estimation/validation of thematic details mapped from satellite imagery. It is vital for quality assessment and evaluation of the spatial information derived from satellite data. The sources for acquiring ground truth data under NUIS Thematic Mapping activity include – visual observations of sample doubtful points in field for verification / correlating image interpreted spectral signatures of thematic details; making field photographs and collecting GPS derived measurements in field. Ground truth should cover up to 40% of the study area. Care was taken to note observations of all the representative classes in the field and substantiate through field photos. The ground data also allows collecting the non-spatial or attribute information essential for integration with spatial data using GIS.

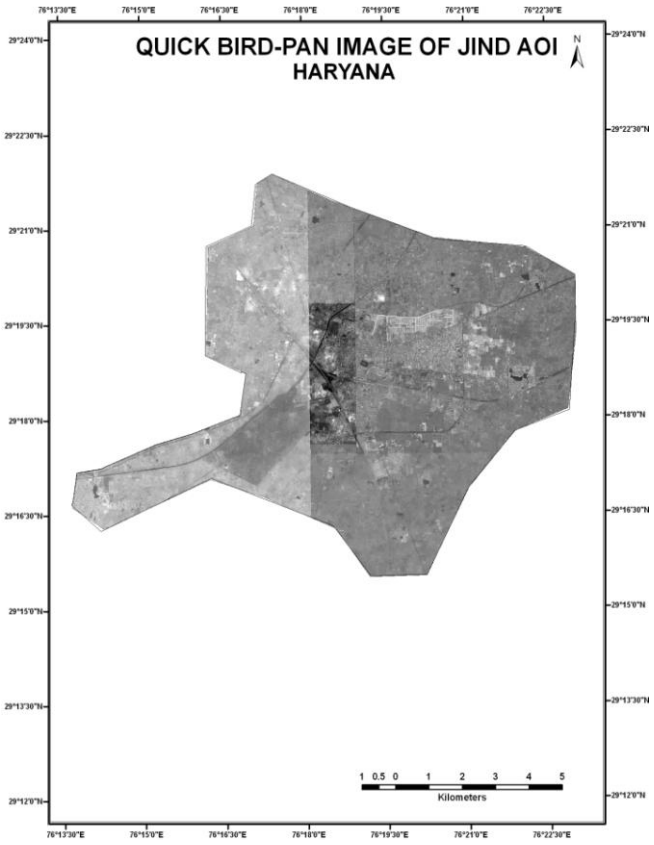

Figure 1 Quick Bird Pan Image of Jind AOI

D. Secondary Data

The information captured from the imagery would get enhanced in content and quality by use of secondary / ancillary data available both in spatial and non – spatial from published and unpublished sources. The secondary data under this heading broadly confirms to two types:

- Spatial data: Administrative and Town Boundary data is spatial in form. The administrative boundary would consist of different administrative limits such as district, Taluk, village cantonment, wards. Others would consist of forest, sanctuary, national parks and so on.
- Non-spatial data: This data would include as part of the city/town data useful to assist the development of urban indicators. This data would be made available as an attribute or as a statistical data. The data broadly include urban infrastructure (transportation), housing, demography, socio-economic, utilities; environment and land use. The land use includes details of urban land use of residential public/semi-public and so on.

IV. STUDY AREA:

Jind district lies in the North of Haryana between 29°15’30’’ and 29°21’51” North latitude & 76°13’40” and 76°23’10” East longitude. On its East and North-East lie the districts of Panipat, Karnal and Kaithal respectively. Its boundary line on the North forms the inter-state Haryana- Punjab border with Patiala and Sangurar districts of Punjab. In the West and South-West it has a common boundary with district Hisar & Fatehabad and in its South and South-East lies the district of Rohtak and Sonipat respectively. The area of the district is 2736 square kilometers, e.g. 6.20% of the state. The district is divided into three Sub-Divisionns, Jind Safidon and Narwana. The Jind Sub-Division comprises two tahsils, viz. Jind and Julana. While the Narwana, Safidon Sub-Divisions comprises the Narwana & Safidon tahsil respectively.
district.

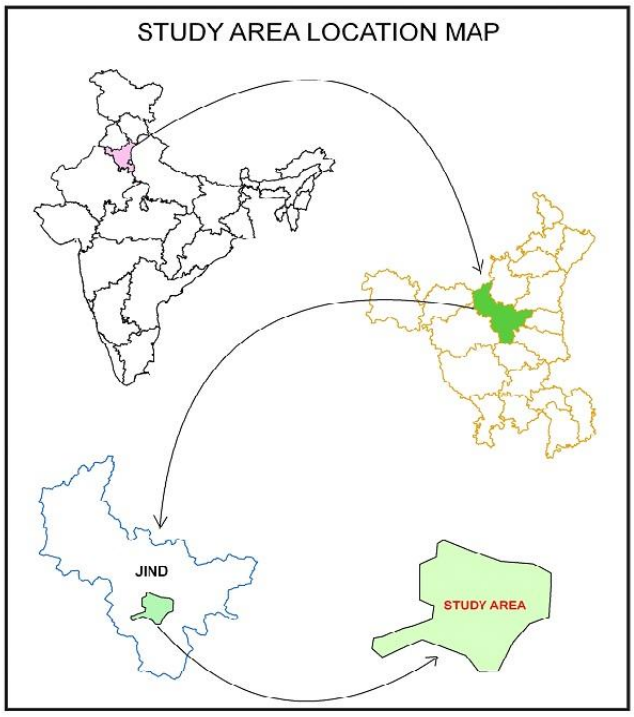

Figure 2

According to the Indian Census 2001, the total population of the district was 11, 89,827, e.g. 5.63% of the state population. The population growth in the decade of 1991-2001 was recorded as 21.36%, e.g. lower than the state average of 28.43%. The literacy rate of the district was 52.33%, e.g. lower than the state average 57.20%. The population density of the Jind district was recorded 440

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persons per sq.km that is lower than the average of the state density 478 persons per sq.km. Sex ratio of the district was 852, e.g. lower than the state average 861 females per thousand males. The level of urbanization in the district was 20.30% of the district population, e.g. lower than the state average of 28.92%, while in 1991 it was 17.20% and 24.63% respectively. According to the Indian Census 2001, Jind city comes under the category of A-class city(e.g. population more than 100000). Jind city & its agglomeration cover an area of 15.30 sq.km. Its population was recorded 135,855(e.g.0.64% of the state population). The density of the city was 8879 persons per sq.km while in 1991 it was 5516 persons per sq.km. Sex ratio of the city was 851, e.g. slightly lower than the averages of both state & country.

V. THEMATIC MAPPING

The present study "Urban Planning by Geo-Informatics" clearly demonstrates the importance and role of GIS based Information System and potentialities of Satellite Remote Sensing technique for preparation of more updated and reliable information. Here we are going to discuss the results & interpretation of study of Quick Bird (Panchromatic) and LISS-IV (Multispectral data) adhering to guidelines of NUIS Scheme supported by ground truth (secondary & non-spatial data) and quality checks.

Classification Schema:

The urban land use classification can be delineated from QuickBird and LISS-IV MS data up to Level-IV on 1:10,000 scales. The classes as mentioned in the classification may or may not reflect in Jind town/city and vice-versa. Similarly all land use classes observed in a Jind town/city might not have been incorporated in the classification schema. This classification schema is indicative and flexible. Any new or additional classes delineated during the process of interpretation can be suffixed against the appropriate classes which would also enable to strengthen the classification schema in Geodatabase Structure in ArcGIS 10.3.1 Software.

The results & discussion can be done on the basis of materials and methodology as described in earlier in the following manners:

Diagram Showing the Distribution of Thematic layers.

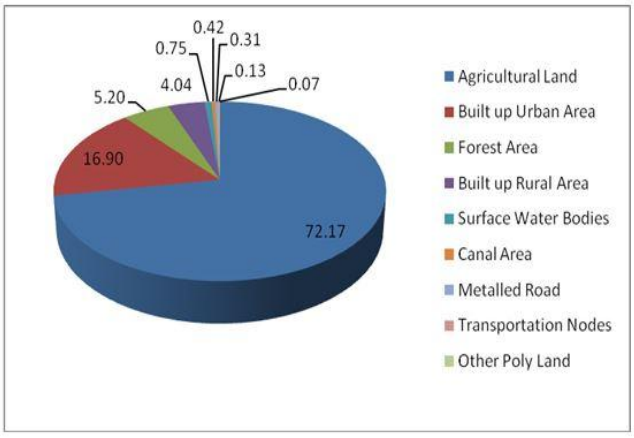

Figure 3

The present study "Urban Planning by Geo-Informatics" clearly demonstrates the importance and role of GIS based Information System and potentialities of Satellite Remote Sensing technique for preparation of more updated and reliable information. Here we are going to discuss the results &interpretation of study of QuickBird(Panchromatic) and LISS-IV (Multispectral data) adhering to guidelines of NUIS Scheme supported by ground truth (secondary & non-spatial data) and quality checks.

Classification Schema:

Thematic map of AOI of District Jind.

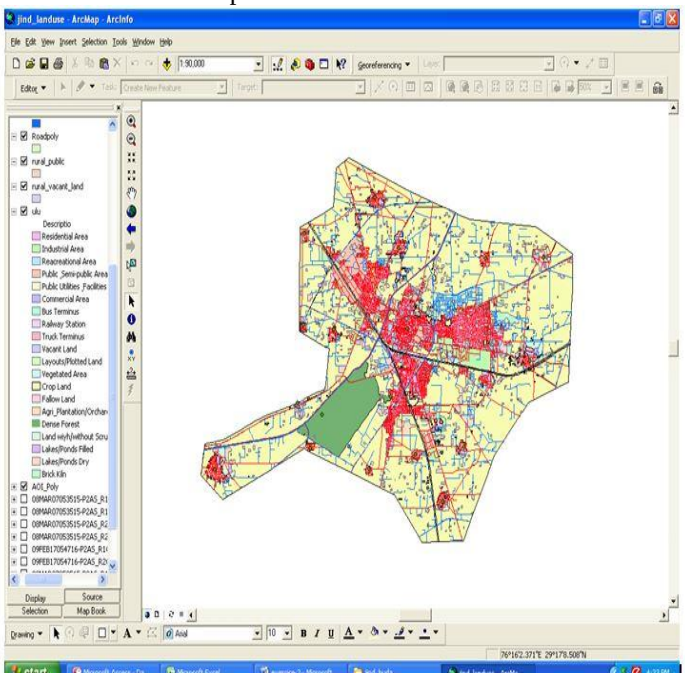

Figure 4

The urban land use classification can be delineated from QuickBird and LISS-IV MS data up to Level-IV on 1:10,000 scales. The classes as mentioned in the classification may or may not reflect in Jind town/city and vice-versa. Similarly all land use classes observed in a Jind town/city might not have been incorporated in the classification schema. This classification schema is indicative and flexible. Any new or additional classes delineated during the process of interpretation can be suffixed against the appropriate classes which would also enable to strengthen the classification schema in Geodatabase Structure in ArcGIS 10.3.1 Software. The results & discussion can be done on the basis of materials and methodology as described in earlier in the following table:

Table 2 Distribution of Thematic layers in Jind Study area

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Sr.No.	Thematic Layers (polygon feature)	Area in Hectares	Area in Percentage
1	Agricultural Land	6759.25	72.17
2	Built up Urban Area	1582.95	16.90
3	Forest Area	486.97	5.20
4	Built up Rural Area	378.50	4.04
5	Surface Water Bodies	70.30	0.75
6	Canal Area	39.00	0.42
7	Metalled Road	29.38	0.31
8	Transportation Nodes	12.36	0.13
9	Other Poly Land	7.00	0.07
	Total	9365.71	100.00

VII. URBAN LAND USE

In the present study, the Thematic Mapping of Urban Land use is the main theme. All other thematic layers' data is used in conjunction with the urban land use thematic data, while deciding on the future land management, suitability and allocation proposals for Jind town/city to meet the growing population needs or demands. Under NUIS, the urbanizable areas of each town are to be mapped for urban land use using high resolution satellite data.

The Urban land use classification at 1:10,000 scales has been designed with a three tier hierarchy levels. Each level contains information of increasing content and specificity. The content of land use information in the urbanizable areas of city/town is designed to enable subsume with that of land use content of the urban core area. The process of urban land use mapping consist of other important activities like finalization of classification schema and interpretation of urban land use classes and their finalization up to Level-III require detailed collection of information which is provided under NUDBI by SNA and ULB's (Table 3). During heads up interpretation, the image data is displayed on 1:3000 scales for area delineation and then compressed to 1:10,000 scales for spatial representations.

The urban land use classification at 1:10,000 scale is designed with classes hierarchically arranged with increasing informing content as the levels increase from Level I to Level-III .The classification also consists of certain land cover classes up to Level II designed to accommodate the rural classes noticed within the urban administrative limits. The description of the classes is given below:

3.1.1 Built-up Urban

The Built up Urban area alone covers 16.90% of total area of Jind AOI. It is an area of human habitation developed due to non-agricultural use and high density of population and which has a cover of buildings, connectivity by transport, communication and have utilities in association with water, vegetation and vacant lands in the selected urban area of Jind district.

Table 3 Distribution of Built up Urban Area in Jind AOI Area

Sr. No.	Built up Urban Area	Area in Hectares	Area in Percentage
1	Residential area	707.25	44.68
2	Public semi-public area	237.34	14.99
3	Layouts/Plotted Area	206.03	13.02
4	Industrial area	185.03	11.69
5	Vacant Land	125.06	7.90
6	Commercial area	88.50	5.59
7	Recreational Land	28.66	1.81
8	Public Utilities & Facilities	5.08	0.32
	Total	1582.95	100.00

"All places with a municipality, corporation or cantonment or which are declared as notified town areas and which satisfy the criteria of a minimum population of 5000, at least 75 per cent of whose male working population is non-agricultural and with a population density of over 400 persons per Sq. Km. are classified as Urban (Census 2001)". Urban or built up Land is comprised of areas of intensive urban land use. Included in this category are cities, towns, industrial, townships, villages, strip developments along transportation corridors, areas occupied under construction activity, public/semi public complexes, institutions, recreation and so on. The urban built up areas are generally bigger in spatial extent than the rural built up area.

Diagram showing distribution of Built up Urban Area in Jind city Area.

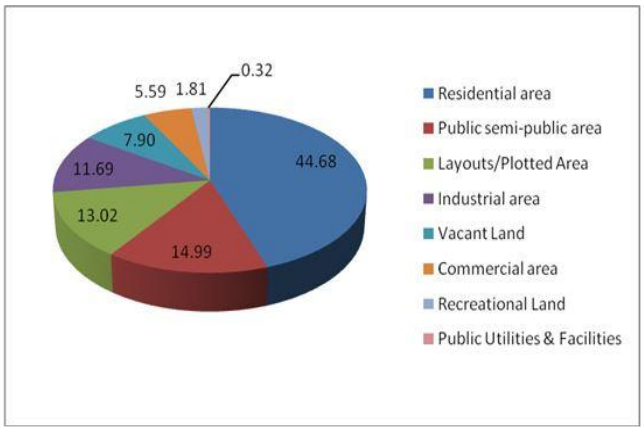

Figure 5

A.Residential:

In the Urban area of Jind AOI the residential development is of circular form in core area, linear along transportation corridors extending outward from city centre and planned & rectangular shape in sectors & outer region of the city. The residential areas in a planned locality have a uniform size and spacing of structures unlike the unplanned with less spacing for open areas and roads. Areas of single or sparse residential land use with farmhouses or new housing developments in proximity to agricultural areas can also be classified as residential which are located in peripheral area of the city. Some of the important residential colonies are Shiv colony, Loco colony, Hakikat Nagar, Krishana colony, Housing Board colony, Defence colony and Urban Estate.

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B. Industrial

The study area consists a few industrial units, covering 11.69% of the urban built-up area. Some of the important small industries are BPD India, Gypsum, HAIC Cattle Feed Plant, Jind Co-operative Sugar Mills Ltd., Vita Milk Plant, HSID Industrial Area, HPCL LPG Botteling Plant and KC Thread Mill. VITA Milk Plant, Jind was the first modern dairy plant set up in public sector by Haryana Dairy Development Corporation in 1971 with the objective to provide market for surplus milk in the state. Haryana is rich in milk production and surplus milk in the state can play vital role in improving socio-economic conditions of farmers in general and that of landless farmers in particular.

C. Recreational

It includes all recreation facilities and areas which are used for recreation and entertainment. They include playgrounds, stadium, racecourse, gold course, garden/parks, beaches, historical monuments, theatres / hall etc, e.g. Nehru Park, Rani Talab, Jayanti Devi Temple and Park, Officers colony Park etc. Recreational land covers 1.81% of the study area.

D. Vacant Land

Vacant land is the area left unutilized or kept for future development. The availability of the vacant land in an urban area determines its future development projects. Such lands may be plotted or developed as layouts under construction. Only 7.90% percent of area is vacant land in Jind study area.

E. Public and Semi-Public

These are the areas used for place of work, education, religious activities, health, cantonment, social, and cultural centres. Educational institutions such as schools, colleges, universities are also included. All buildings and grounds that are places of work are included within the institutional areas. They cover 14.99% of total area.

Rani Talab Temple

Figure 6

F. Public Utilities and Facility

These constitute water supply, sewerage, waste disposal/landfill, electric power, inland gas supply and so on. It includes water pumping and treatment plants; gas and oil storage tanks and pipelines, and power plant, transmission lines and so on. This area is 0.32% of the total study area..

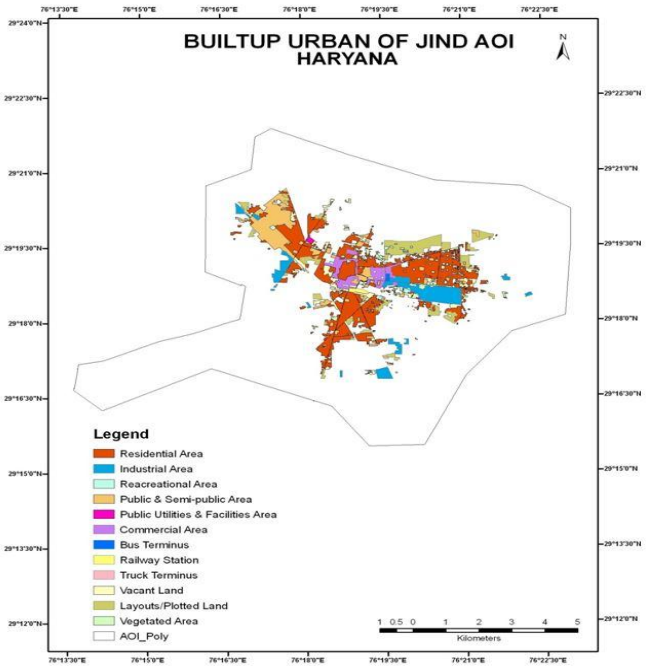

Figure 7

Distribution of Built up Urban Area Map of Jind AOI Area.

G. Commercial Area

Commercial areas are those used predominantly for the sale of products and services. They often develop mixing with the residential, public and semi-public or along the main roads/streets. Commercial category includes Central Business District (CBD); retail and wholesale business and hospitality outlets, shopping malls, warehouse market yards and others in JInd study area they also occur as mixed built-up class. They cover 5.59% of the study area

VIII. BUILT-UP RURAL

These are the built-up areas in village (Rural areas), smaller in size, mainly associated with agriculture and allied sectors and non-commercial activities with population size less than 5000, generally lacking in facilities that are unique to urban areas like public utilities, commercial areas, recreational areas, institutes etc. They are spatially discreet in distribution and have less connectivity and are surrounded by agriculture lands, forests and water-bodies. Most of the study area Villages are facilitated with well metalled roads and having proper water, schools, anganwadis, medical & health facilities, etc. The built-up rural class alone constitutes 4.04% of total area of the study area.

Table-4 Distribution of Built up Rural Area in Jind AOI Area.

Sr. No.	Built up Rural Area	Area in Hectares	Area in Percentage
1	Settlement	213.00	56.26
2	Public & Semi-Public	92.00	24.30
3	Brick Kilns	46.58	12.30
4	Vacant Land	27.00	7.13
	Total	378.58	100.00

Built-up Rural of Jind AOI, Haryana

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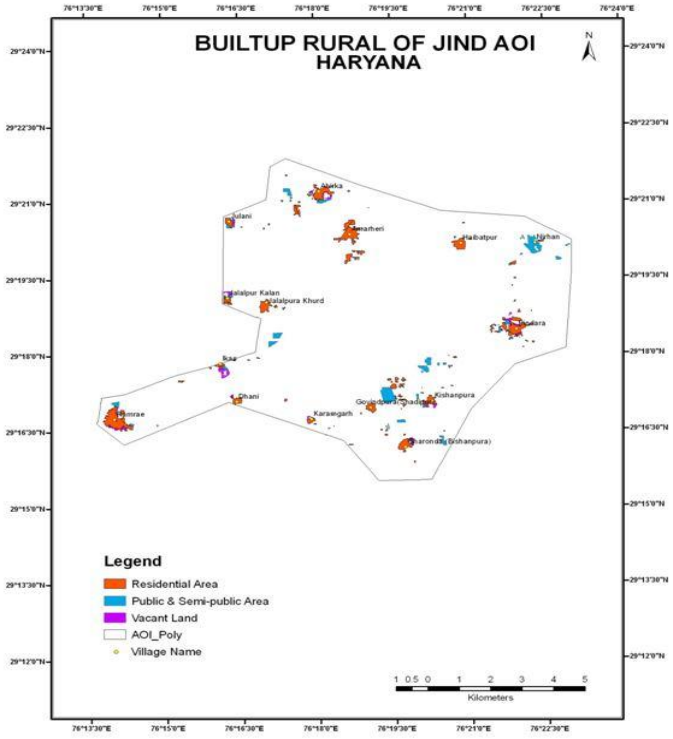

Figure 8

Transportation Map of Jind Study Area.

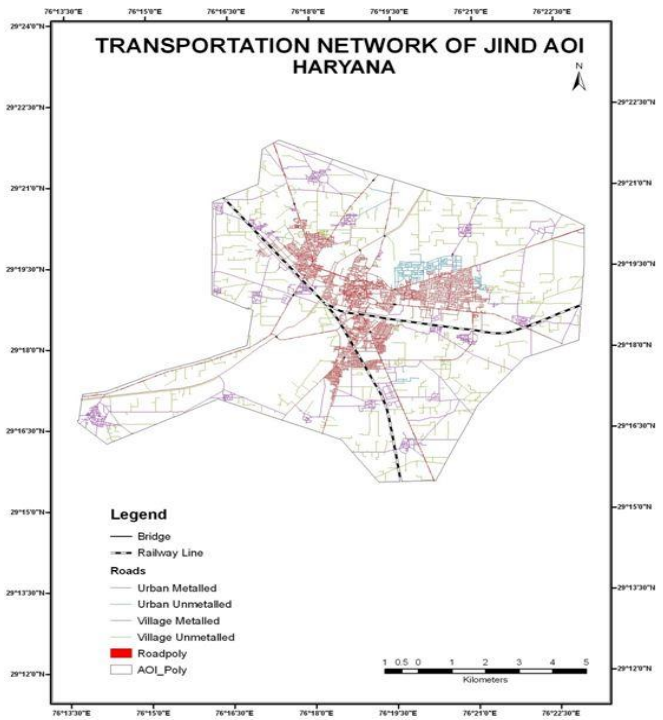

Figure 9

IX. OTHER

A. Transportation

It includes the areas under use for the movement of people, goods and material. It is a measure of accessibility, speed, usage / carriage way (IRC-2007) and connectivity (IRC-2007). It includes railway, roads, airports, seaports, railway stations and bus terminus. Major transportation routes influence other land uses in their location and distribution. The roadways include major and minor roads / streets, bridges / flyovers, expressway, ring road and traffic islands. Rail facilities include broad and meter gauge service and terminal facilities like stations, sidings, and repair and maintenance yards. There are airport facilities in the city. There is a bus stand, railway station having broad gauge rail facility, some flyovers / bridges, & tuck terminus in Jind.

B. Road

Metalled Road: These roads are black topped (BT) or with Bitumen Paved or concrete surfaced roads. The important one is NH -71, SH-10, 12, 14 and about 85% of road is metalled in Jind

Unmetalled Road: These roads are not metalled or Black Topped but are paved roads with hard surface. The others under this category which are unpaved or unsurfaced consist of Earthen / Gravel roads. Only about 15% of road is Unmetalled passing through fields or small villages.

Table- 5: Transportation Network area coverage of Jind AOI Area

Sr. No.	Thematic Layers (polygon feature)	Area in Hectares	Area in Percentage
1	Road Major	29.38	0.31
2	Railway station	7.67	0.08
3	Railway Line	7.00	0.07
4	Bus Terminus	3.67	0.04
5	Truck Terminus	1.02	0.01
	Total	48.74	0.52

C. Rail

The rail facility in Jind is Broad Gauge running for length of 19 km through urban area. It is classified as Broad gauge (1.5m width) and Meter gauge (1.0m width). The classification of the railway track is determined by the width. They are easily identifiable and their shape and geometry are well defined on the image.

D. Surface Water Bodies

It comprises areas with surface water, either impounded or in the form of lakes/ponds, tanks/reservoirs or cooling ponds and abandoned quarries with water. There are clearly identified and delineated on the satellite image based on size and shape characteristics. Rivers/streams are natural course of a drainage network of a catchment or river basins. The river systems are bigger in length and width than the streams. They flow from higher reaches and may join in lakes or sea. Depending upon the nature of availability of water, rivers are classified into perennial or non-perennial or dry. The bigger river systems are associated with dry river sands and islands with or without vegetation cover. They are distinctly identified on the imagery.

E. Lake / Pond

These are accumulation of water in a topographical Depression or low lands and are generally small in size with or without water. The pond is smaller in size than a lake. They may be natural or man-made natural or man-made and may also occur amidst settlement areas or outside. Lakes are the important aspect of urban landscape or urban recreation while the ponds are distinctively associated with the rural morphology. They are identified by their size and geometry on the image. In Jind city there is an important lake surrounding the Rani Talab. The village ponds cover an area of 0.75% of the study area(0.69% of filled ponds and 0.06% of the dry ponds).

F. Canal

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There is one main canal named Hansi Branch (Western Yamuna Canal) and some branch canals

Canals are man-made channels constructed mainly for the purpose of irrigation, navigation or to drain out excess water from agricultural lands.

Table-6 Distribution of Water Bodies in Jind AOI Area

Sr. No.	Water Bodies	Area in Hectares	Area in Percentage
1	Lakes/Ponds	70.30	0.75
2	Main canal	27.00	0.29
3	Branch Canals	12.00	0.13
	Total	109.30	1.17

G. Agricultural Land

The agricultural land can be under crop, fallow land, agriculture plantation, grazing and saline land. In Jind study area, the total agricultural land comprises 71.31%of total area. There is no grazing and saline land.

H. Crop Land

It is a land over which the crop is grown. It covers an area of 67.05% of the study area. The predominant crops grown are wheat, rice, cotton, bajra, sugarcane, fodder etc.

I. Fallow Land

The land which is left uncultivated for one to three years is called the fallow land. In the study area fallow land comprises 2.08%. From the agriculture point of view, the fallow land is an important indicator of the agriculture development; the more the fallow land, more is the possibility for growth of the crop area.

Table-7 Agriculture Land Distribution in Jind Area

Sr. No.	Agriculture Land	Area in Hectares	Area in Percentage
1	Crop Land	6280.06	67.05
2	Agriculture plantation	203.91	2.18
3	Fallow Land	194.86	2.08
4	Land with/without Scrubs	80.43	0.86
	Total	6759.25	72.17

J. Forest

The forest is community of several trees together. Forest can be reserved and unreserved. There is a Bir Baraban, that is declared as a reserved forest, covers an area of 4.75% of the study area. Apart from it there is absence of forest cover in the study area, in spite of some patches of tree plantation. Unreserved forests cover an area of 0.45% of the total area. The total coverage of the forests area is 5.20%.

Sr. No.	Forest Cover	Area in Hectares	Area in Percentage
1	Reserved	445.01	4.75
2	Unreserved	41.96	0.45
	Total	486.97	5.20

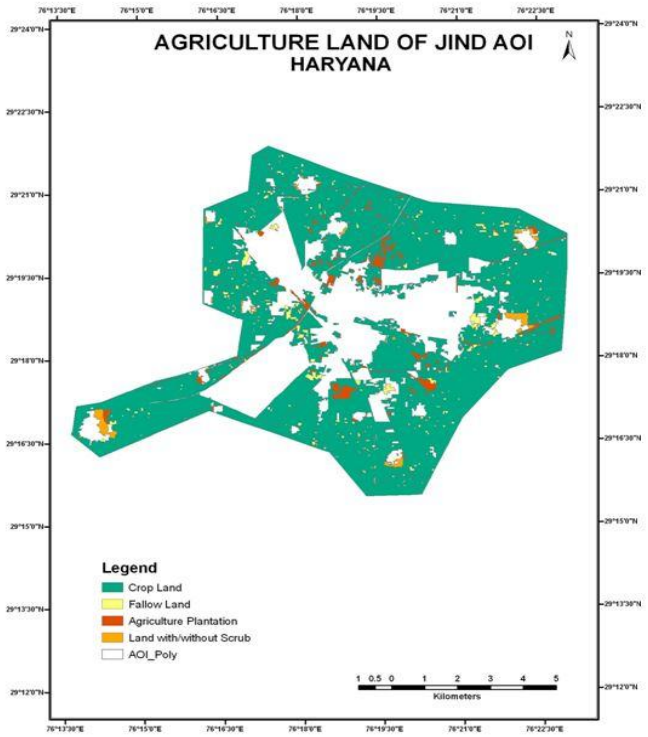

Figure 10

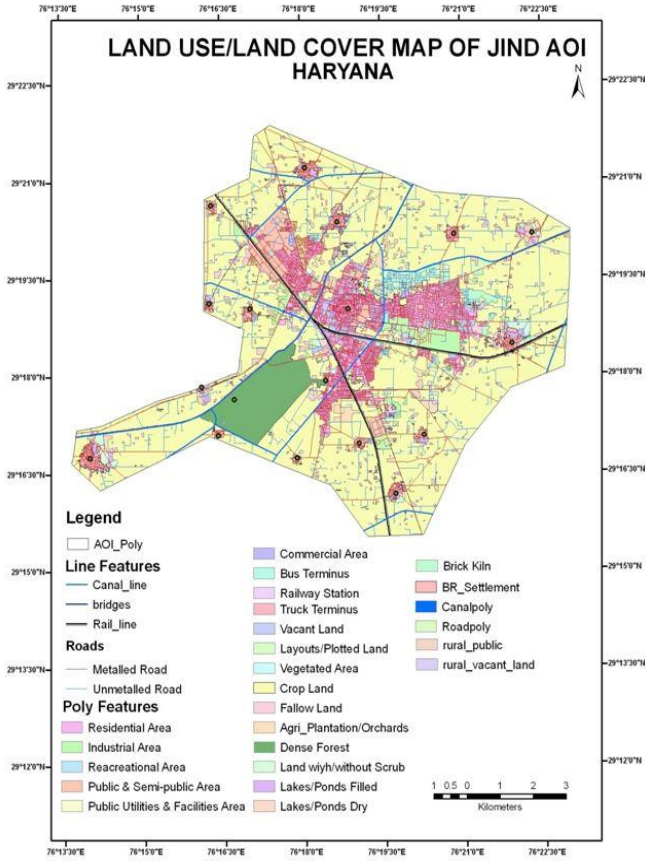

Figure 11

X. CONCLUSIONS

The study demonstrates the importance and potentiality Satellite Remote Sensing technique for preparation of more consistent, accurate and up-to-date baseline information on urban land use for future planning, management and

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development of any area, The present study is derived on the basis of interpretation of Jind city with the help of satellite data- QuickBird (Panchromatic) & IRS LISS-IV (Multispectral data). The study together with satellite data incorporated with ground truth data and secondary data revealed that there are total 28 layers in altogether created in two Datasets of Geodatabase, namely-

a) Urban Land use

b) Base Layers

On the basis of the results and discussion, that has been derived on the basis of interpretation of satellite data at scale of 1:10000, incorporation of ground data & secondary data, according to the NUIS. Scheme format, we can conclude in following manner:

A. Built up Urban

It comprises of residential area, industries, public-semi-public utilities, communication, etc. The built up area alone covers 16.90% area. In overall the built up area is well planned. The area is well connected with metalled roads. Though the area is facing some congestion and greenery problem.

B.Built up Rural

The built-up rural covers an area of 4.04% of the study area.The interesting thing in Jind AOI town is that even villages have modern facilities like- roads, school facilities, health and sanitation facilities. There are few un-metalled roads.

C. Industries

The study area consists a few industrial units, covering 11.69% of the urban built-up area. Some of the important small industries are BPD India, Gypsum, HAIC Cattle Feed Plant, Jind Co-operative Sugar Mills Ltd., Vita Milk Plant, HSID Industrial Area, HPCL LPG Botteling Plant and KC Thread Mill.

D.Commercial Areas

Commercial areas are those used predominantly for the sale of products and services. They often develop mixing with the residential, public and semi-public or along the main roads/streets. It covers 5.59% of the study area.

E.Agricultural Area

The agricultural land in the study area includes crop land, fallow land and agriculture plantation. The total agricultural land comprises 71.31%of total area. Crop land covers an area of 67.05% of the study area. The predominant crops grown are wheat, rice, cotton, bajra, sugarcane, fodder etc. While the fallow land covers 2.08%. From the agriculture point of view, the fallow land is an important indicator of the agriculture development; the more the fallow land, more is the possibility for growth of the crop area.

F. Water bodies

The study area has many water bodies, including- one major canal and some branch canals in Jind AOI area cover 0.42%, hence has good water facilities. In rural built up area the water bodies consists of ponds and lakes cover 0.75% area.

G. Forest land

There is a Bir Baraban that is declared as a reserved forest, covers an area of 4.75% of the study area. Apart from it there is absence of forest cover in the study area, in spite of some patches of tree plantation. Unreserved forests cover an area of 0.45% of the total area. The total coverage of the forests area is 5.20%.

H. Recreational sites

It includes playgrounds, stadium, racecourse, gold course, garden/parks, beaches, historical monuments, theatres / hall etc, e.g. Nehru Park, Rani Talab, Jayanti Devi Temple and Park, Officers colony Park etc. Recreational land covers 1.81% of the study area.

XI. REFERENCES

[1] Batnagar, V.S. (1996), "Chandigarh – The City Beautiful (Environment Profile of A Modern Indian City)" ,A.P.H. Publishing Corporation New Delhi

[2] Amarsaikhan.D&Ganzorig, M (2002) Urban Change Study Using RS And GIS, ACRS, Institute of Informatics and RS, Mongolian Academy of Sciencesav.Enkhtaivan-54B,Ulaanbaatar-51 Mongolia.

[3] Sudhira.H .S,Ramachandra T V,Jagdish K.S. et.al,Urban Sprawl Pattern Recognition and Modeling Using GIS, Centre for Ecological Sciences, Indian Institute of Science, Bangalore 560 012, India.

[4] V.P. Mehta, S.K. Sharma, "Chandigarh- The City Beautiful" Vishvas Publications Pvt. Ltd. - 167 Industrial Area, Phase -2, Chandigarh .

[5] Yeh, A.G.O, and Xia Li, (2001), "Measurement and Monitoring of Urban Sprawl in a Rapidly Growing Region Using Entropy", Photogrammetric Engineering and Remote Sensing, vol.67 (1): pp 83.

[6] Gopal Krishan (January 1999), "Inner Spaces – Outer Spaces of a Planned City (A Themetic Atlas of Chandigarh)".

[7] Baker, T. R. & Bednarz, S. W. (2003), "Lesson Learned from Reviewing Research in GIS Education",Journal of Geography, Vol-102, Page-231-233. National Council for Geographic Education.

[8] Burrough, P.A & McDonnell, R.A. (1998), "Principles of Geographical Information Systems", Oxford University Press.

[9] Kaushik, S.P.,(2001), " Spatial and Structural Pattern of Urban Population and Its Social and Economic Attributes in Haryana", Indian Journal of Geography and Environment, Vol.8 and 9:2003-2004, Vidya Sagar University, Medinipur West Bengal, India, pp.34-32.

[10] Rajeev,(2015), "Role of GIS in Utility Projects, 2015.", Unpublished scientific Project Report, Department of Science, Uttarakhand Open University, Haldwani, Uttarakhand.

XII. INTERNET

- Web1.hry.nic.in/jind/
- http://jind.gov.in/disatglance.htm
- www.satimagingcorp.com/gallery-ikonos.html
- http://www.diva-gis.org/Data
- USGS Earth Explorer

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