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APPRAISAL OF SUITABILITY FOR URBAN PLANNING AND EXPANSION ANALYSIS USING QUICK BIRD SATELLITE DATA

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ABSTRACT

In the present study, we have taken the urban area of Jind district, of the Haryana state. The study has been done on the basis of Design Standards and Methodology formulated in “National Urban Information System” (NUIS) scheme by “Standing Committee on Urban Management” (SC-U) under the “Ministry of Urban Development” (MoUD), in 2006. The major objectives of NUIS scheme is to design, organize and establish a comprehensive information system. Urban planners require information related to the spatial datawithin the time frame. Remote sensing and GIS along with collateral data help of analysis the LU/LC mapping. The present study was carried out using very high resolution data (Quick Bird and Resources Sat-1 LISS IV and other secondary data such as census data (census of India 2011). The results obtained from the present study, has shown that the large study area was covered by agricultural land that covered around 71.31% of the total area. This highest agricultural area was optimised through RS and GIS based. The image was classified for the LULC scheme at the level IV and the results concluded that level II 19 category identify the best part of the study area. The study area occupies 9365.80 ha^{-1} lands and out of which only 17.48 % was taken up by the urban built up land.

Keywords: LU/LC, urban planning, quick bird, LISS-IV, RS and GIS approach.

1. INTRODUCTION

Land management for the urban sector requires planning not merely for residential, industrial and public utility, but also for purification of water, disposal of wastes at suitable site (Pandey *et al*., 2012), treatment of sewage water facilities (Hammer *et al*., 2006), hazardous wastes (Mishra and Pandey, 2005), urban greenery management (Chaudhry *et al.*, 2010), surface water pollution (Kam and Harada, 2001), urban growth (Cohen, 2004) etc. All these problems has transformed urban development and caused several burdens on management and planning authorities (Gugler, 1996). Over 30% of the India population resides in the urban areas, which are expanding day by day and increasing tremendously (Shukla, 1996; Sivaramakrishnan, 2007) putting population pressure and migration on the outskirts of the urban regions. All the urban areas gradually growing over populated and results in heavy pressure over itself, thus deteriorating into slums areas (Ravallion and Datt, 1996). These problems result due to failure of complying the proper policies and land use planning. Remote sensing has played major role in different corners of urban studies (Richards, 1999). Urban planning integrates land use planning and urban renewal to improve the built-up and social environments of communities, by adapting urban planning methods to existing cities suffering from decay and lack of investment. Sustainable development influence today's urban planners. The high resolution data with SOI toposheet has been used to create base map and for extracting the features used for study (Pandey and Nathawat, 2006). Sustainable development is a recent, controversial concept where eah parcel of land on the earth’s surface is unique in itself (Chakraborthy *et al.*, 1998). The heterogeneous climate and physiographic conditions has resulted in the development of different land use/ land cover in these districts mapping of Panchkula, Ambala and Yamunangar districts, Haryana State in India (Khan *et al.*, 2001) and Bhagalpur district of Bihar, India (Sharma *et al.*, 2012). Usng remote sensing and GIS, the main classes of land use/land cover types which can be easily identified are cropland, fallow, forest, land with scrub, land without scrub, sandy area, water bodies and other land use or land cover features (James *et al*., 1971; Sharma *et al.*, 2012). With the high resolution data, the information that can be inferred from satellite image goes to a higher level of details (Holmberg, 1994; Sohn and Dowman, 2001). To date, the most successful attempt in developing a general purpose classification scheme compatible with remote sensing data. Advantages of GIS is that a few number of ground truth points (control points located on ground that reveals the true features and materials, and can be used as calibration in RS and GIS) may be collected, and same data can be interpreted over large areas, e.g. land coverage, while at the same time complex relations and large amounts of data can become visualized in a graspable manner (Taubenböcka *et al.*, 2008; Kundu 2005). An evaluation by digital analysis of satellite data indicates that majority of areas in these districts are used for agricultural purpose. The hilly regions exhibit fair development of reserved forests. It is inferred that land use/ land cover pattern in the area are generally controlled by agro-climatic conditions (Pandey *et al.*, 2013), ground water potential and a host of other factors (Rani *et al*., 2011). In some instances, land use/

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land cover change may result in environmental, social and economic impacts of greater damage than benefit to great importance to planners in monitoring the consequences of land use change on the area. Such data plays a vital role in resources management and agencies that make plans, assess land use patterns and modeling and predicting future changes (Rani *et al*., 2011).

2. MATERIAL AND METHODS

The district lies in the North of Haryana between 29.03' and 29.51' North latitude and 75.53' and 76.47' East longitude shown in Figure-1. 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 total area of Jind district is 3606 Km^2. The soils of the Jind district, according to physical characteristics may be divided as sandy, clay, Kallar or Rehi. It is, therefore, evident that, for obtaining good yields, the soils need heavy manuring with nitrogenous and phosphatic fertilizers soils. The climate of the study area is on the whole dry hot in summer maximum temperature 48^0C rather than cold in winter minimum temperature 6^0C. The average rainfall over the districts as a whole is 55 cm. The study area is a flat monotonous upland plain. The area of Jind district is irrigated by the Western Yamuna (Jumna) Canal and the Bhakra Canal. The ground water table is a thick zone of saturation and ground water is alkaline of the study area shown in Figure-1.

2.1. Database

The NUIS (National Urban Information System) Design Standards suggests that the Thematic Mapping activity comprising a geospatial database of both Primary themes and Incorporated or attribute Layers at a scale of 1:10000. Satellite data: The satellite data consist of high resolution Quick Bird (Panchromatic) stereo data of during the year 2006. The data of Indian Remote Sensing Satellite P-6 (also called Resource Satellite) LISS-IV of the same year has also been used. The details of the satellite data and their characteristics are given in Table-1. Surveys of India (SOI) Toposheets have been used to the scale of 1:50, 000. The number of toposheets used are-53C/2, 53C/3, 53C/4, 53C/6, 53C/7, 53C/8, and 53C/11.

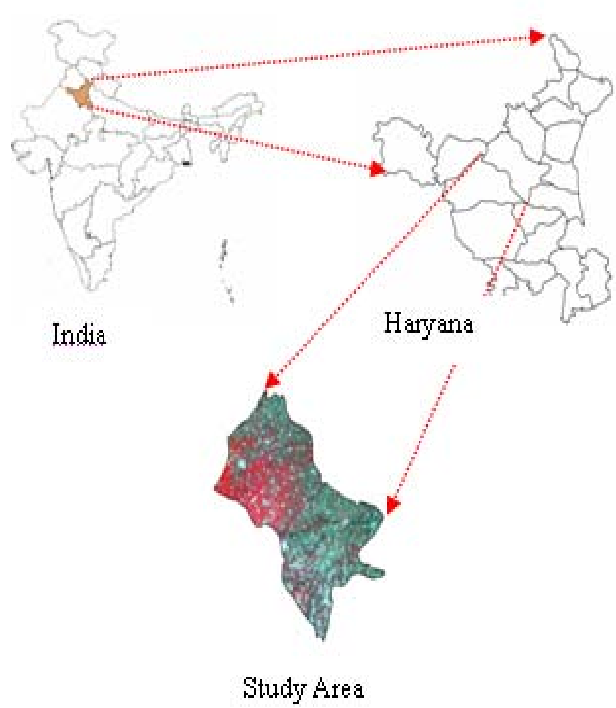

Figure-1. Location map of the study area.

Table-1. Satellite Sensor and its Characteristics.

Satellite	Sensor	Spatial resolution (m)	Temporal resolution
Quick Bird	Pan	0.61 at nadir	1-3.5 days
Resourcesat - 1	LISS-IV(MS)	5.8 m	24 days

The sources for acquiring ground truth data under NUIS Thematic Mapping activity include visual observations of doubtful sample points in field for verification/correlating image; interpreted spectral signatures of thematic details; making field photographs and collecting GPS derived measurements in the field. Ground truth should cover up to 40% of the study area. Secondary Data, The secondary data under this heading broadly confirms to two types: Spatial data, Administrative and Town Boundary data are spatial in forms such as district, Taluk, village cantonment, wards. Non-spatial data, Statistical Abstracts of Haryana have been used to collect some attribute information like urban infrastructure (transportation), housing, demography, socio-economic, utilities; environment and land use.

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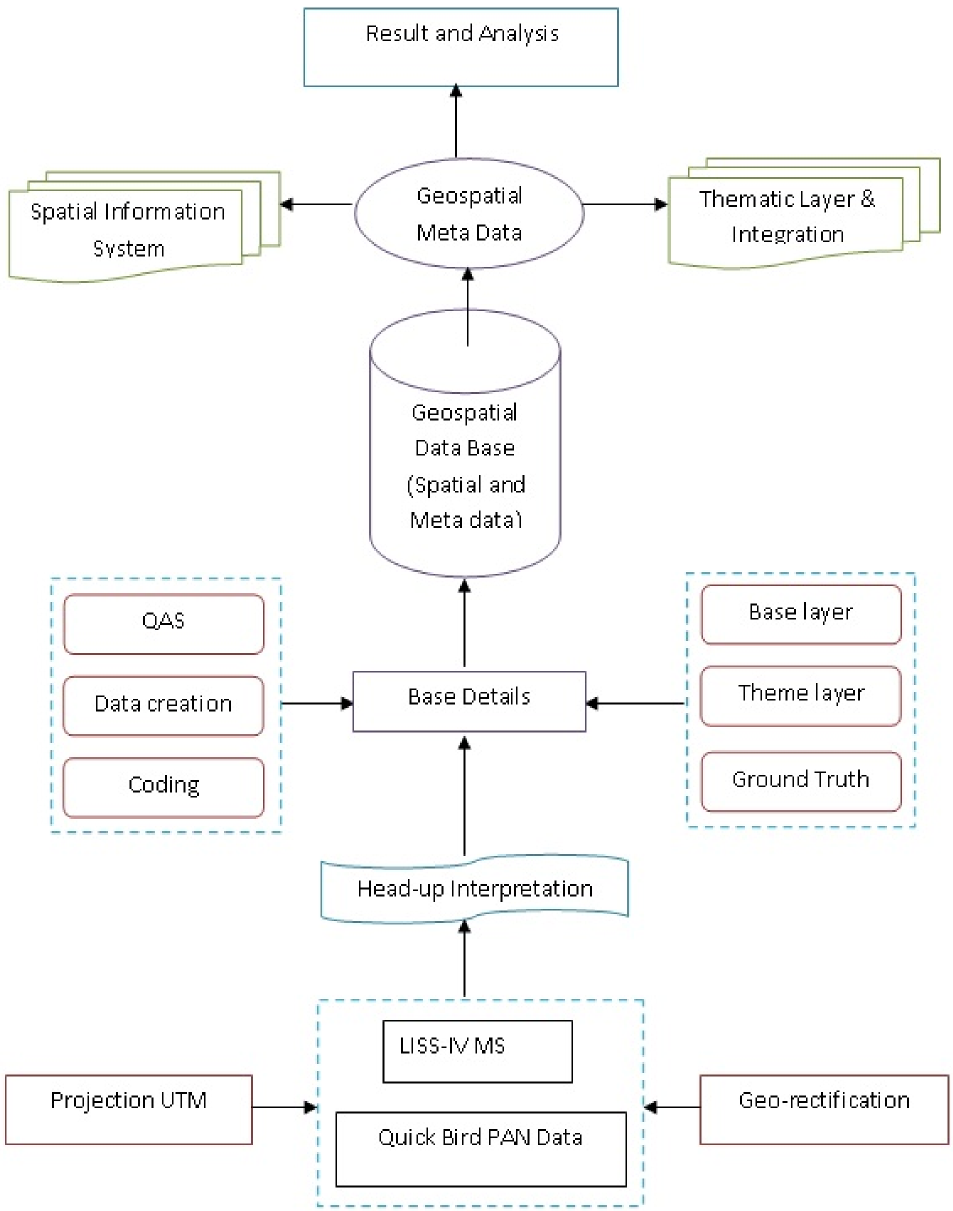

Figure-2. Methodology of thematic mapping.

The methodology adapted to the Generation of Urban Planning Thematic layers database is accomplished through a series of procedural steps. The first of all the quick bird and LISS- IV images georeferenced with the help of SOI toposheet and recognized properly UTM and datum (Kumar *et al*., 2013; Kumar *et al*., 2012; Tomar *et al*., 2013; Bisht *et al*., 2014; Rani *et al*., 2011; Kumar and Tomar, 2013; Kumar *et al*., 2010; Singh *et al*., 2013). After that, with the help of ARC GIS package different type of layers were created and used for the quality assessment. The approach to 1:10, 000 scale thematic mapping is given in Figure-2.

3. RESULTS

At the moment, India is among the countries of low level of urbanization. The number of urban agglomeration /town has grown from 1827 in 1901 to 5161 in 2001. Number of population residing in urban areas has increased from 2.58 crores in 1901 to 28.53 crores in 2001. Only 27.78% of the population were living in urban areas as per 2001 census. Thus, we are likely to face a scenario where a large number of people would have live in compact geographical areas. In 1991, India had 23 million plus cities and a decade later in 2001; this number has increased to 31.6 according to census of India

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2011.The current scenario of urban population density 382 persons/ Km^2 in India.

3.1. Land use/land cover

The present study "Urban Planning of Jind City, Haryana, Through Geo-Informatics", clearly demonstrates the importance and role of GIS based information system and potentialities of satellite remote sensing technique for the preparation of a more updated and reliable information. The features of the first level as depicted in the LU/LC Classification Schema in Table-2 and Figure-3 (Kumar *et al*., 2013). It includes the features of built-up urban, built-up rural, agricultural land, forest, wasteland, water bodies, transportation and other poly features.

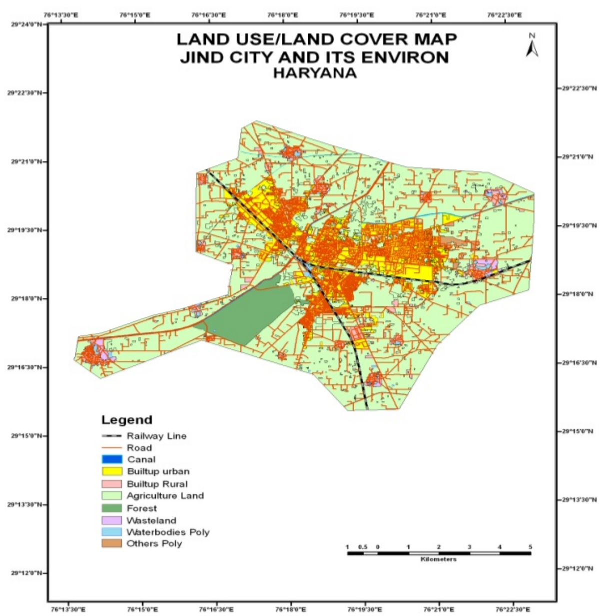

Figure-3. Land use/land cover map.

Table-2. Area of LU/LC of Jind City and its environ.

S. No.	LU/LC	Area in ha	Area in %
1	Agriculture land	6678.82	71.31
2	Built-up urban	1637.28	17.48
3	Forest	445.01	4.75
4	Built-up rural	332.00	3.54
5	Water bodies	109.31	1.17
6	Waste land	80.43	0.86
7	Other features	46.58	0.50
8	Transportation	36.38	0.39
	Total	9365.80	100.00

It is dominated by the agricultural land that covers its 71.31%. Other features, e.g. built-up urban, forest, built-up rural, water bodies, waste land, other poly features and transportation cover 17.48, 4.75, 3.54, 1.17, 0.86, 0.50 and 0.39 percent of the total study area. (Table-3).

3.2. 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 the natural course of a drainage network of a catchment or river basins. The pond is the accumulation of water in a topographical Depression or low lands and are generally small in size with or without water. 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). Canals are man-made channels constructed mainly for the purpose of irrigation, navigation or to drain out excess water from agricultural lands. There is one main canal named Hansi Branch (Western Yamuna Canal) and some branch canals in Table-3.

Table-3. Area of water body and drainage system.

S. No.	Water body	Area in ha	Area in %
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

3.3. Agricultural land

In Jind study area, the total agricultural land comprises 71.31%of total area. There is no grazing and saline land. It is a land over which the crop is grown of 66.8% of the study area. The predominant crops grown are wheat, rice, cotton, bajra, sugarcane; fodder etc. The land which is left uncultivated for one to three years is called the fallow land. In the study area fallow land comprises 2.14% in Table-4.

Table-4. Area of agriculture land.

S. No.	Ag. Land	Area in ha	Area in %
1	Crop land	6251.09	93.60
2	Ag. plantation	203.91	3.05
3	Fallow land	142.9	2.14
4	Land without scrubs	80.9	1.21
	Total	6678.8	100

ARPN Journal of Engineering and Applied Sciences

3.4. Forest

There is a Birbaraban that is declared as a reserved forest, covers an area of 4.75% of the study area. Apart from it there is an 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 forest area is 5.20% in Table-5.

Table-5. Forest covers area.

S. No.	Forest cover	Area in ha	Area in %
1	Reserved	445.01	4.75
2	Unreserved	41.96	0.45
	Total	486.97	5.20

3.5. Built-up rural

The built-up rural class alone constitutes 4.04% of total area of the study area. In this category four feature classes are included, e.g. settlement, public and Semi-Public, brick Kilns and vacant land that cover 2.27%, 0.98%, 0.50% and 0.29% respectively in Table-6.

Table-6. Distribution of built up area.

S. No.	Built up area	Area in ha	Area in %
1	Residential	213.00	2.27
2	Public	92.00	0.98
3	Brick Kilns	46.58	0.50
4	Vacant Land	27.00	0.29
	Total	378.58	4.04

3.6. Urban land use and infrastructure mapping

The urban land use classification can be delineated from Quick Bird 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 is shown in Table-7. Similarly, all land use classes observed in a Jind town/city might not have been incorporated in the classification schema. 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 in Figure-4.

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 9.2 Software. In the present study, the Thematic Mapping of Urban Land use is the main theme. All other thematic layer's data are used in conjunction with the urban land use thematic data, while deciding on the future land management, suitability and allocation proposals for the 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 utilities under the study area is very low which is total 0.05 % out of 17.86 % urban built-up rather than a semi- public area 2.53 % of the study area. Other hand the current population of Jind 12% of Haryana and urban population 22.90%. Road analysis in an integrated social and economic approach to transportation. There were 155.13 km state highway, 51.96 km major districts, and 699.01 km other district road in the Jind district in 2003-04 (India Disaster Resource Network, http://Idra.gov.in), while in 2010-11 the total length of National Highway 124 km, 995 km state highway of the Jind shown in Table-8

Table-7. Area of Urban Infrastructure.

S. No.	Urban infrastructure	Area in ha	Area in %
1	Residential Area	707.25	7.55
2	Public Area	237.34	2.53
3	Plotted Area	206.03	2.2
4	Industrial Area	185.03	1.98
5	Commercial Area	88.51	0.94
6	Road	29.38	0.31
7	Recreational Land	28.66	0.31
8	Railway station	7.67	0.08
9	Railway Line	7	0.07
10	Public Utilities	5.08	0.05
11	Bus Terminus	3.67	0.04
12	Truck Terminus	1.02	0.01
	Total	1506.64	16.09

Table-8. Transportation Network area.

S. No.	Transportation	Area in ha	Area in %
1	Road	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

3.7. Built-up urban

The Built up Urban area alone cover 16.90% of the 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, connected by transport, communication and have utilities in association with water, vegetation and vacant lands in the selected urban area of Jind district.

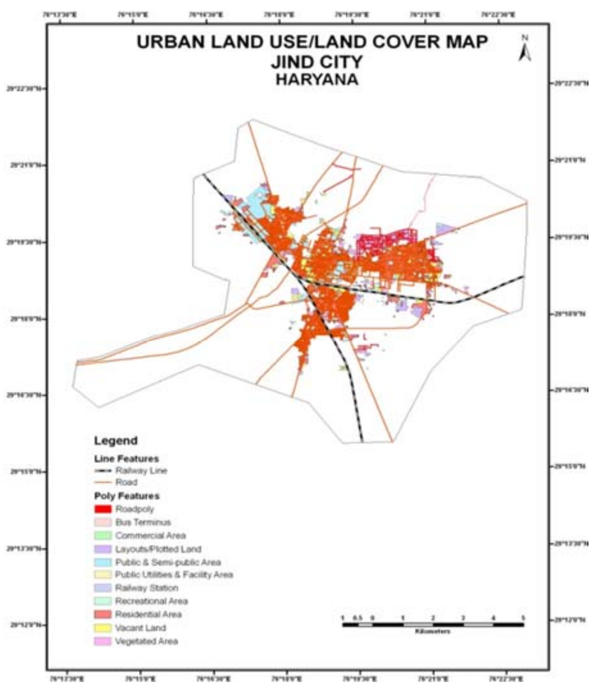

Figure-4. Urban land use/land cover map.

4. DISCUSSIONS

The study demonstrates the importance and potentiality of 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 development of any area, The present study is derived on the basis of interpretation of the Jind city with the help of satellite data- Quick Bird (Panchromatic) and IRS LISS-IV (Multispectral data).

The hypothesis referring that the growth of the Jind urban area is relatively lower than the state growth is true. The above interpretation of results has been derived on the basis of satellite data at a scale of 1:10000 with ground and secondary data.

After the image interpretation and data analysis, we come to know that the growth of the Jind City and its environ is relatively lower than that of the state. Since the city surrounds an agricultural productive land so the expansion of the city urban area will be at the cost of agricultural land. So concern must be taken at the time of planning. There are some factors responsible for its low urban growth like lack of industrial share in its economy; the city lacks the higher educational institutes, slow growth of other social urban infrastructure development.

Considering the above problems, following recommendations can be done for the future development planning purposes like the agro-industry should be developed in the city so that the potentials of the city environ would be harnessed; some national and state level educational institutes should be set up there that can foster the economy of the city; public infrastructure, e.g. roads, flyovers, planned residential colonies, hotels, restaurants etc., should be developed with combined effort of the city municipality authority and the HUDA (Haryana Urban Development Authority) ., The only available land that can be utilized for the purpose of urban infrastructure development is the vacant land that covers an area of 125 hectares. So this available land can be used for the different required purposes.

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