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LAND USE AND LAND COVER CLASSIFICATION BY USING GEOSPATIAL TECHNOLOGIES: A CASE STUDY OF DISTRICT BILASPUR IN HIMACHAL PRADESH INDIA

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Abstract

The growth of a society totally depends on its social and economic development. This is the basic reason why socio-economic surveys are carried out. This type of survey includes both spatial and non-spatial datasets. LULC maps play a significant and prime role in planning, management and monitoring programmes at local, regional and national levels. Therefore, this study sought to integrate the remotely sensed data and geographical information system (GIS) techniques to map and classify the area of district Bilaspur in Himachal Pradesh India . Multi-temporal satellite images of 1989, 1999, 2009 and 2019 were pre-processed, geo-referenced, and mapped using the supervised maximum likelihood classification to examine land use and land cover .This type of information, on one hand, provides a better understanding of land utilization aspects and on the other hand, it plays an important role in the formation of policies and programme required for development planning. For ensuring sustainable development, it is necessary to monitor the on-going process on land use/land cover pattern over a period of time. .

Key Words: Spatial and Non-Spatial Datasets; Geographical Information System (GIS); Multi-Temporal; Pre-Processed; Geo-referenced; Sustainable Development.

Introduction

Land is the most important natural resource for human settlements and nation as a whole which embodies soil, water, and associated flora and fauna involving the total ecosystem. In broader sense it includes cultivable land, water resources, climate and raw material etc. Land may take many physical forms: plains, swamps, hills, mountains, or valleys, it may have many kind of vegetation such as forests, grasslands, prairie or tundra, and it may have many kinds of climates, from hot to cold, and from humid to dry.[6]. Land use describes activities that take place on the land and represent the current use of property, while land cover describes the natural and anthropogenic activities that can be observed on the land [1,2] At present, understanding and mapping of LULC change have occupied an important position in policy-making with regards to the management of natural resources and monitoring of environmental changes. Changes in the LULC are a vital expression of human interactions with the environment [3].The use of satellite remote sensing (SRS) data and geographical information system (GIS) techniques have been long established for several decades as an efficient tool for land use and other natural resource management [4].

Material and Methodology:

Study area

Bilaspur district is located in the south western part of Himachal Pradesh, extending between latitudes 31˚12`30`` and 31˚35`45`` N and longitudes 76˚23`30`` E and 76˚55`40`` E. The study area is spread over an area of 1167 square kilometres which is 2.10 percent of whole Himachal Pradesh, with a total population of 3,81,956 persons (Census 2011) having 1061 villages (953 inhabited and 108 uninhabited) and 04 Urban centres. It is bounded by the districts of Mandi and Solan in the east, Hamirpur and Una in the west, Mandi and Hamirpur in the north and Nalagarh area of Solan district & Punjab state in the south. The maximum extent of the district is about 43 kilometers from north to south and about 51 kilometres from east to west. According to 2011 census, Aligarh district ranks 10th in terms of population in Himachal Pradesh out of twelve districts. The density of population is 327 persons per sq. km that is higher than the state average i.e. 123 persons per sq. km. The decadal growth rate of Bilaspur district is 12.05 percent and literacy rate is 84.59 percent.

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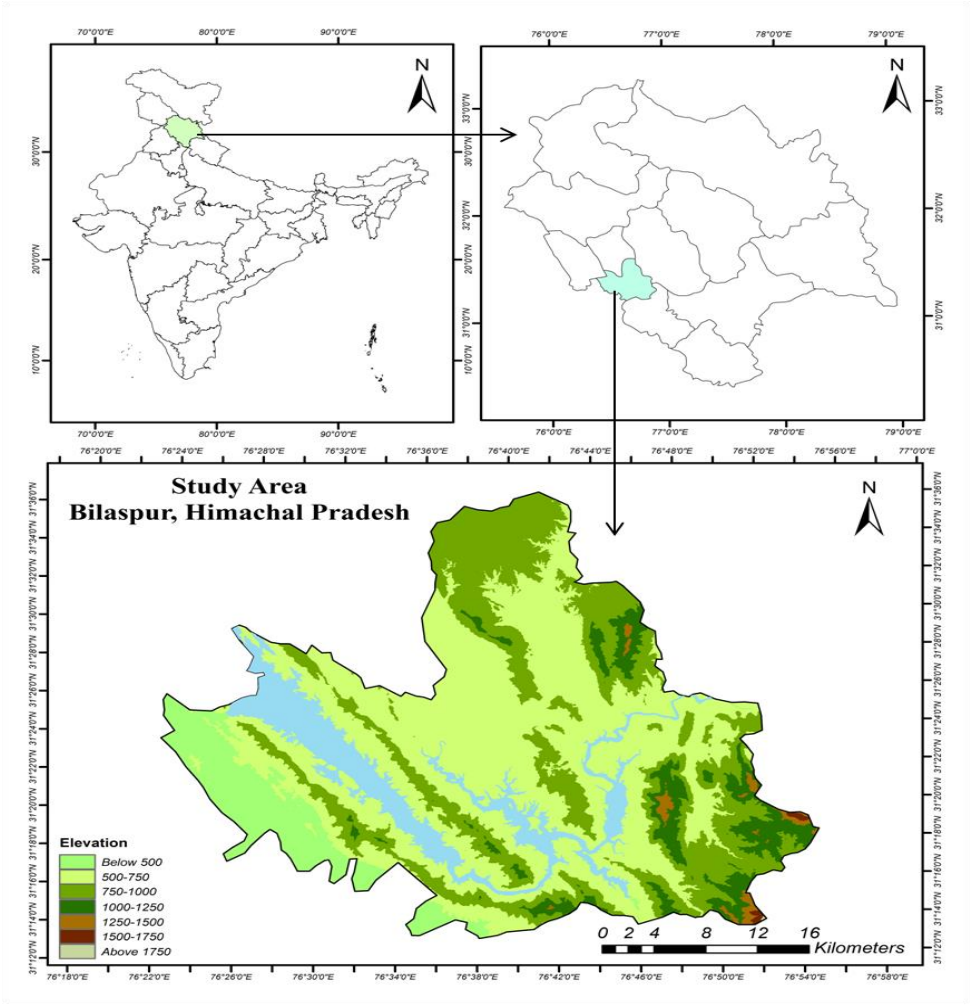
Fig.1 Location Map of Study Area.



Satellite Data

To study Land use /Land cover, secondary data for 30 years (1989-2019) of Bilaspur district were collected. In this investigation Landsat imageries are used primarily due to their high spatial and radiometric resolution and availability of uninterrupted multispectral dataset from 1972 onwards which make them suitable for spatio-temporal study. A set of four Landsat 8 OLI/TIRS, Landsat 7 ETM and Landsat 5 TM land surface reflectance product images from 2019, 2009 ,1999 and1989 were chosen to map and extract the dynamics of land use/ land cover change in the region.. In total 4 imageries of Landsat sensor were selected for this study. The required imageries were downloaded in L1TP land surface reflectance data type and GeoTIFF format from USGS's Earth Explorer website (http://earthexplorer. usgs.gov).

Table 1: List of Landsat satellite images with their specification, used during the research work.

Year	Satellite	Sensor	Path	Date of Acquisition	Projection	Datum	UTM zone	Cell Size
1989	Landsat 5	TM	147/38	06-08-1989	UTM	WGS84	43	30
1999	Landsat 7	ETM	147/38	13-10-1999	UTM	WGS84	43	30
2009	Landsat 5	TM	147/38	16-10-2009	UTM	WGS84	43	30
2019	Landsat 8	OLI/TIRS	147/38	12-10-2019	UTM	WGS84	43	30

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As orbital remote sensor multi temporal data were demonstrated to be essential [5]. so data from multi-temporal 4 satellite imageries were analyzed for the present study. In this study, satellite data were used with four types of sensors namely MSS-Multispectral scanner, TM-Thematic mapper, ETM-Enhanced thematic mapper and OLI TIRS-Operational land imager and thermal infrared sensor. All the multi-spectral bands were used in this study. Satellite and sensor details are given below:

1. Landsat TM with 7 bands and 30m resolution was acquired from 06 August, 1989(Path-147 Row-038) .
2. Landsat ETM with 8 bands and 30m resolution was obtained from 13th October, 1999 (Path-147 Row-034)
3. Landsat TM with 7 bands and resolution 30m was acquired from 16th October 2009 (Path-147 Row-038)
.4. Landsat OLI/TRS with 11bands and 30m resolution was acquired from 12th October 2019 (Path-147 Row-038).

Data Analysis

Pre classification Information about Land Use /Land Cover

The red, green and blue (RGB) are basic colors were used to prepare FCC image which was very useful to differentiate various land cover types. Here RGB in FCC, bands 4, 3, 2 were chosen. From the satellite image thematic maps are derived with 7 land use classes. The present study followed the scheme of classification of land use and land cover used by NRSA (1989) and ICAR (1982) with slight modification. The following seven class i.e. Built-up land, Agricultural land, Forests, Wastelands, Water bodies, Pastures, Barren land selected for the present study. Detail description is given in Table No.2

Table 2. Different Land Use Classes and Descriptions

LU/LC classes	Class Name	Description
1	Agricultural/Horticultural Land	Area under crops, fruits, vegetables and gardens
2	Barren Land	Rocky, rocky knobs, rocky outcrops without vegetation cover
3	Built-up Land	Settlements, commercial area, industrial area, roads etc.
4	Forest Cover	Area under forests with dense and sparse vegetation.
5	Pasture/Open Land	Thorny bushy areas and areas with grass.
6	River/Stream Channel	Rivers, Streams, Lakes and Ponds are under this body
7	Sandy surface	Dry river bed full of sand and sand accumulated area

Classification and mapping of LULC

Preparation of Base Map is done by delineation of the study area boundary by using QGIS Software with the help of SOI Toposheets. Image pre-processing (a) Ortho-rectification: Geocoded image in WGS84, UTM Zone 43N (b) Radiometric correction and enhancement (c) Subset and mosaic process.

Image classification refers to grouping pixels from the image into classes to prepare thematic information. Two methods generally are applied for image classification like supervised and unsupervised classification. Here supervised classification with maximum likelihood method was applied. In supervised classification, image is classified using polygons which describe sample areas of different land use to be classified. It is called training samples. Training samples (10 to 15) were collected from each LU class and finally all were merged to produce thematic map of LU. The training samples were selected on the reference of Google Earth, Google image, ground truth.

After image classification some isolated pixels are found. These isolated pixels belong to one or more classes which creates some noise in the image. It is called salt and pepper effect [7]. So, it is necessary to remove the isolated pixels and image has to be generalized. For this purpose 3*3 mode filter was applied here to replace isolated pixels into most common neighbouring class.

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Results and Discussions

The land use and land cover classification of the study area has provided valuable information about the characteristics of the area. The data extracted through various satellite imageries are reflected in Table 3 and maps for the selected years.

Table 3: Land Use Land Cover Classification in District Bilaspur of 1989-2019

LULC Classification (1989-2019)								
Class_ Name	**Area (1989)**	Per Cent	**Area (1999)**	Per Cent	**Area (2009)**	Per Cent	**Area (2019)**	Per Cent
Agricultural/Horticultural Land	78.76	6.75	176.01	15.08	181.80	15.58	139.02	11.91
Barren Land	15.40	1.32	20.86	1.79	16.84	1.44	32.15	2.75
Built-up Land	6.78	0.58	25.44	2.18	31.31	2.68	68.77	5.89
Forest Cover	722.19	61.88	666.14	57.08	642.04	55.02	660.97	56.64
Pasture/Open Land	229.42	19.66	158.24	13.56	178.28	15.28	135.70	11.63
River/Stream Channel	99.09	8.49	119.82	10.27	102.19	8.76	114.06	9.77
Sandy surface	15.36	1.32	0.49	0.04	14.54	1.25	16.33	1.40
Total	**1,167.00**	**100.00**	**1,167.00**	**100.00**	**1,167.00**	**100.00**	**1,167.00**	**100.00**

Source: Data calculated by author from Landsat Imagery

Classification of Land Use Land Cover in District Bilaspur

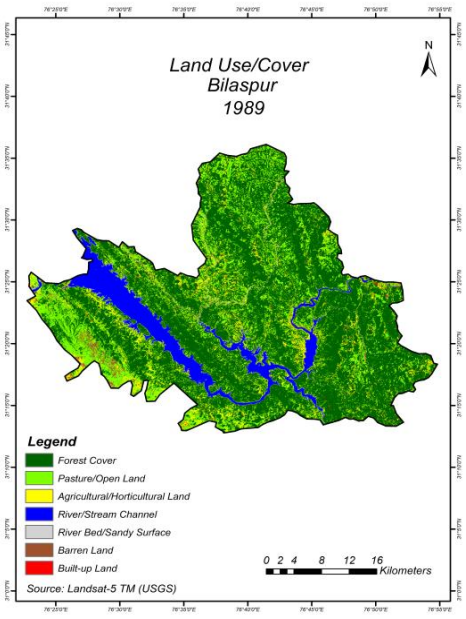

Fig 2

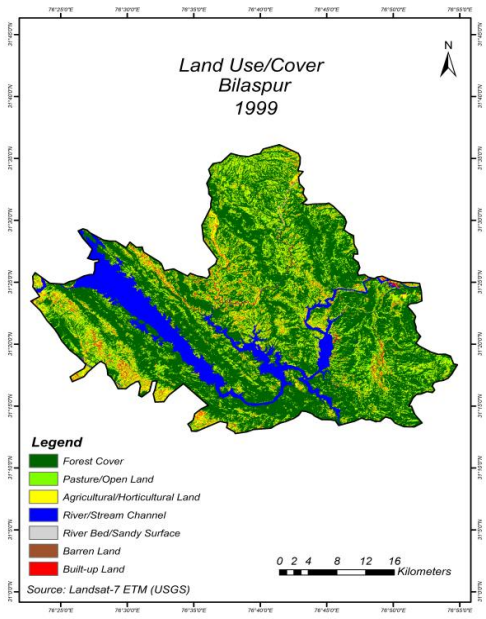

Fig.3

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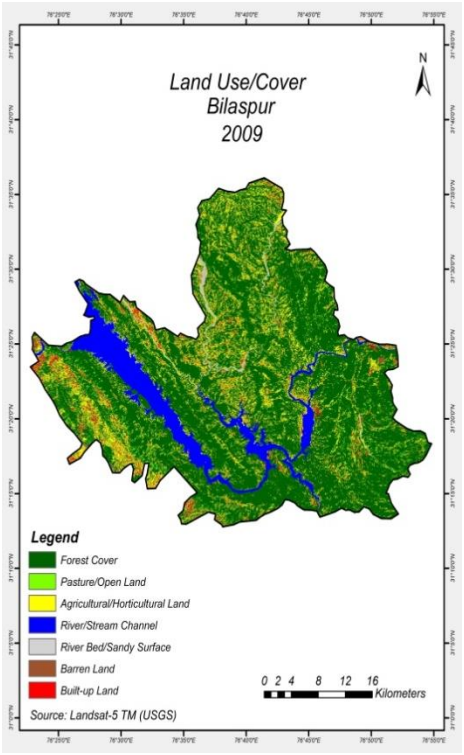


Fig. 4

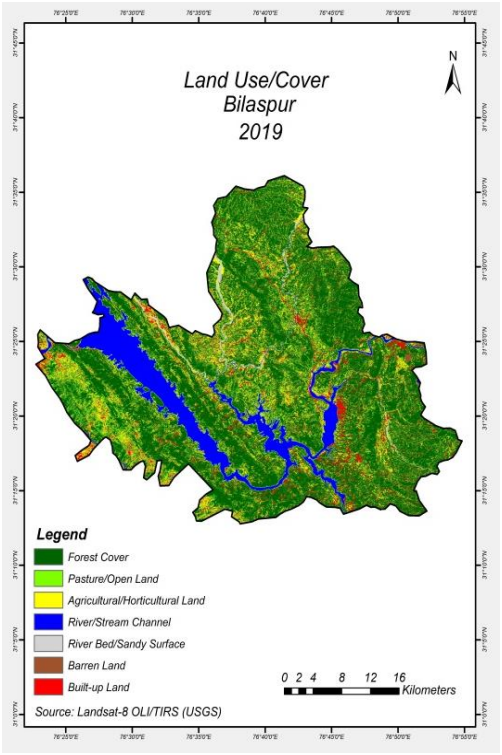
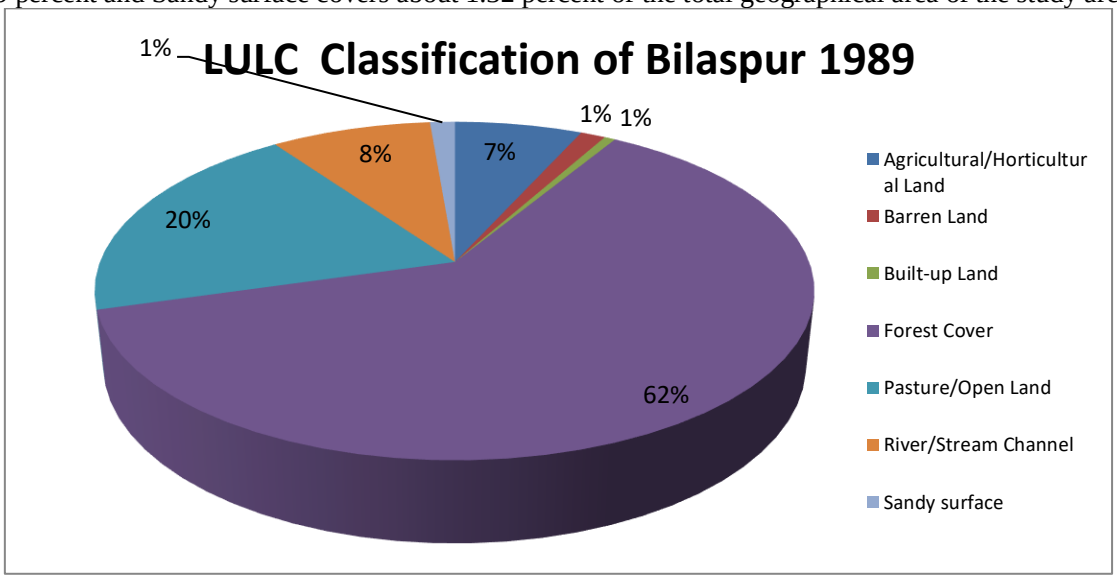


Fig. 5

Land Use / Land Cover Classification 1989

For the classification of 1989 image, Landsat -5 TM satellite image was used. The land use land cover status is given in the **table 3** and also shown through LU/LC map **(Fig.2)**. The analysis of Landsat image, data shows that forest occupies more than half of total land and it is the most important land use land cover of the study area. The Agricultural/Horticultural Land occupies about 6.75 percent of the total geographical area , Barren Land covers 1.32 percent, Built-up Land occupies 0.58 percent, Forest Cover area is 61.88 percent, Pasture/Open Land occupies 19.66 percent , River/Stream Channel covers about 8.49 percent and Sandy surface covers about 1.32 percent of the total geographical area of the study area.



Land Use / Land Cover Classification 1999

For the classification of 1999 image, Landsat -7ETM satellite image was used. The land use land cover status is given in the **table 3** and also shown through LU/LC map **(Fig.3)**. The analysis of Landsat

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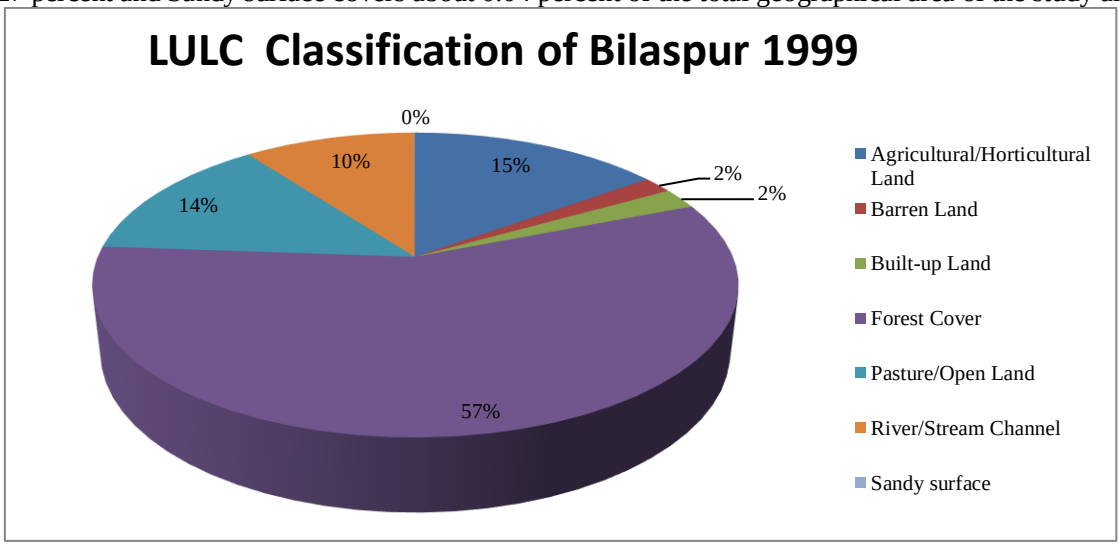
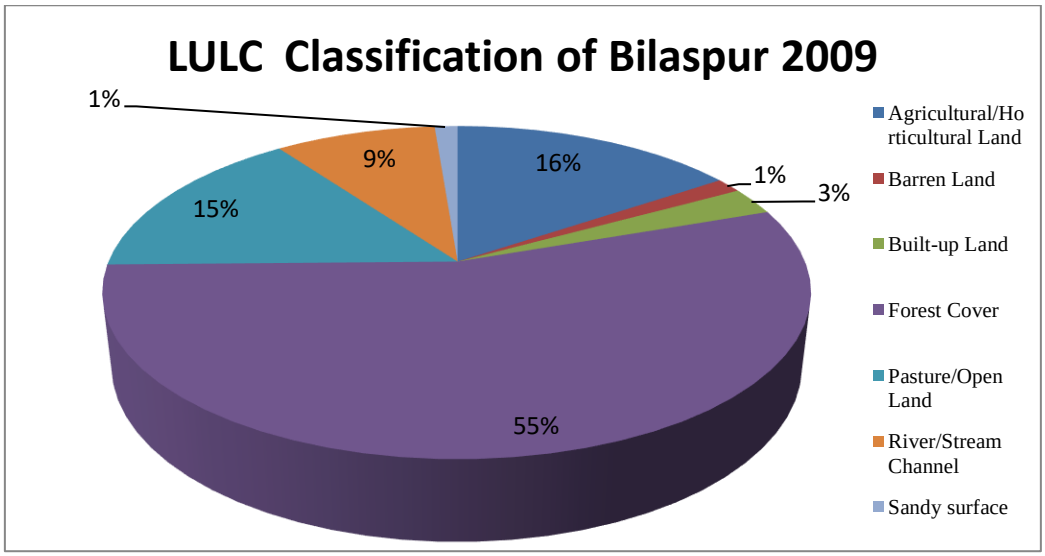
image, data shows that forest occupies more than half of total land and it is the most important land use land cover of the study area. The Agricultural/Horticultural Land occupies about 15.08 percent of the total geographical area , Barren Land covers 1.79 percent, Built-up Land occupies 2.18 percent, Forest Cover area is 57.08 percent, Pasture/Open Land occupies 13.56 percent , River/Stream Channel covers about 10.27 percent and Sandy surface covers about 0.04 percent of the total geographical area of the study area.



Land Use / Land Cover Classification 2009

For the classification of 2009 image, Landsat - 5TM satellite image was used. The land use land cover status is given in the **Table 3** and also shown through LU/LC map **(Fig.4)**. The analysis of Landsat image, data shows that forest occupies more than half of total land and it is the most important land use land cover of the study area. The Agricultural/Horticultural Land occupies about 15.58 percent of the total geographical area, Barren Land covers 1.44 percent, Built-up Land occupies 2.68 percent, Forest Cover area is 67.29 percent, Pasture/Open Land occupies 3.00 percent, River/Stream Channel covers about 8.76 percent and Sandy surface covers about 1.25 percent of the total geographical area of the study area.



Land Use / Land Cover Classification 2019

For the classification of 2019 image, Landsat – 8 OLI/TIRS satellite image was used. The land use land cover status is given in the **Table 3** and also shown through LU/LC map **(Fig. 5)**. The analysis of

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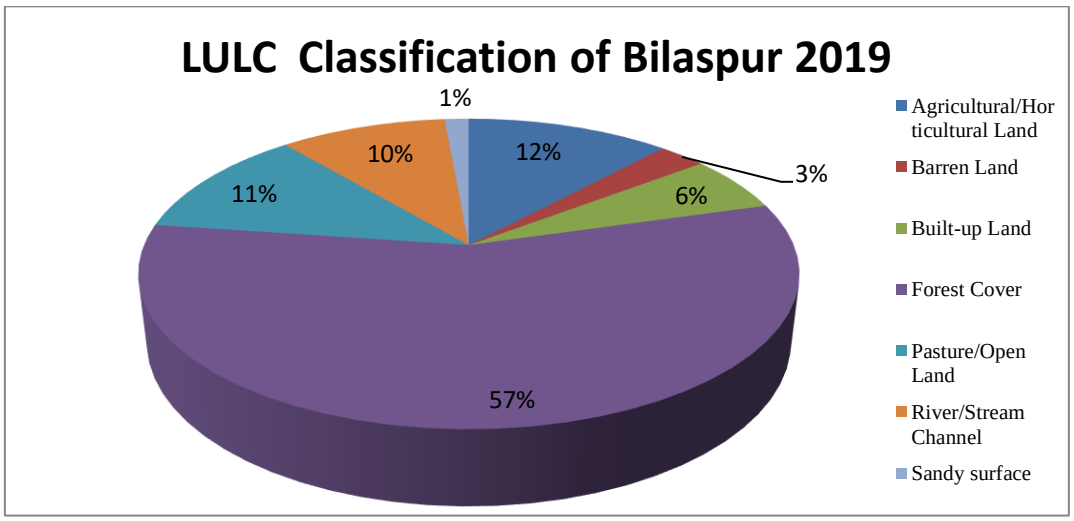
Landsat image, data shows that forest occupies more than half of total land and it is the most important land use land cover of the study area. The Agricultural/Horticultural Land occupies about 11.91 percent of the total geographical area, Barren Land covers 2.75 percent, Built-up Land occupies 5.89 percent, Forest Cover area is 56.64 percent, Pasture/Open Land occupies 11.63 percent, River/Stream Channel covers about 9.77 percent and Sandy surface covers about 1.40 percent of the total geographical area of the study area.



Conclusions:

LULC classification is a critical tool for understanding and managing our natural resources and the environment. The geospatial techniques provide useful information for assessing the land use / land cover of any region. With the increasing availability of remote sensing data and the development of advanced image analysis techniques, LULC classification is becoming more accurate, efficient, and accessible, enabling us to better understand and protect our planet. The change in landscape of the study area is mainly dominated by human in terms of substantial increase in area under built up area through construction activities related to road, building and infrastructure development.

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