ANALYSIS OF LAND-USE LAND-COVER CHANGE IN RAJOURI DISTRICT, JAMMU AND KASHMIR

A Project work Submitted to the Central University of Punjab

For the award of

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In

Geography

BY

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May, 2018

DECLARATION

I declare that the dissertation entitled **"Analysis of Land-use Land-cover change in Rajouri District, Jammu and Kashmir"** has been prepared by me under the guidance of Dr. L.T. Sasang Guite Assistant Professor, Department of Geography, Central University of Punjab, Bathinda. No part of this thesis/dissertation has formed the basis for the award of any degree or fellowship previously.

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CERTIFICATE

I certify that Ishtiaq Ahmed has prepared his Project Report / thesis entitled **"Analysis of Land-use Land-cover change in Rajouri District Jammu and Kashmir"** for the award of Master's degree of the Central University of Punjab, under my guidance. He has carried out this work at the Department of Geography and geology, Central University of Punjab.

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ABSTRACT

Analysis of Land-use Land-cover change in Rajouri District Jammu and Kashmir

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An attempt was made in this study to detect the land use and land cover changes in Rajouri district of J&K during the period from November 2008 to December 2016. The LULC change over a span of 08 years (2008-2016) was investigated through remote sensing approach using two different time satellite images. Supervised classification in GIS software has been adopted in LISS-III (2008) and Landsat-8 (2016) images of the study area. To identify LULC changes from these pictures, post classification are used. The findings of Land-use Land-cover change shown that the study has experienced a decrease in forests by 6 percent and with an increase in agricultural land and open fields and settlement areas during the study period. These amendments in the land-use and land cover of the study area convey us that this change is due to rising anthropogenic burden on forests and high level of deforestation is responsible. Nonstop assessments of land-use/land-covers changes in this city and the implementation of proper land use planning are mandatory for ideal and systematic development.

Key Words: Land use and Land cover, supervised classification, Deforestation

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(Signature of Supervisor)

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(Ishtiaq Ahmed)

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LIST OF ABBREVIATIONS

Sr. No.	Full Form	Abbreviations
1	Land Use Land Cover	LULC
2	Remote sensing	RS
3	Geographical Information System	GIS
4	United States Geological Survey	USGS
5	Global Land Cover Facility	GLCF
6	Linear Imaging Self-scanning Sensor	LISS
7	Thematic Mapper	TM
8	Enhanced Thematic Mapper Plus	ETM+
9	Operational Linear Image	OLI
10	Visible and Near Infrared	VNIR
11	Shortwave Infrared	SWIR
12	National Aeronautics and Space Administration	NASA
13	Indian Remote Sensing	IRS
14	National Remote Sensing Centre	NRSC

CHAPTER 1

INTRODUCTION

1.1 Land use and land cover:

Land-use is defined as a series of operations on land, carried out by humans, with the intention to obtain products and benefits through using land resources. It leads to the purpose of land used, for example, agriculture or wildlife habitat; it does not represent the surface that covers the ground. For example, a recreational land use could befall in a forest, grasslands, shrub land, or on manicured lawns. Land cover is the solid material at the surface of the earth. Like vegetation (natural or planted) or man-made constructions (buildings, etc.) which happen on the ground surface. Ice, bare rock, sand Water, and like surfaces also count as land cover. Land use and land cover have some basic differences. The Land cover does not describe the use of land, and the use of land may be different for areas with the same cover type. For example, a land cover type of forest may be used, wildlife management or recreation; for timber production, it might be private land, a preserved watershed or a favorite state park. In short, land use designates how people are using the land, whereas land cover shows the real land type. Both types of data are most often acquired from analysis of either satellite or aerial images.

1.2 GIS and Remote Sensing in LULC study

Many studies have tried to use RS and GIS technology for LULC detection. Remote sensing is a method of procurement of data or information of objects or targets, which is situated on earth's surface. For this, sensors are used which are fixed on the satellite [Huete, 2010]. The combination of remote sensing and geographical information systems (GIS) is a focus of worldwide attention in the field of remote sensing and GIS. Uniting remote sensing images and other data in GIS may provide a way to produce more accurate Land-use and Land-cover maps. The union of remote sensing and geographical information system (GIS) are powerful tools to derive correct and timely data on the spatial distribution of land use-land cover changes over large areas [Singh, A. (1989). GIS provides a tranquil environment for collecting, storing, displaying and analyzing satellite data or any other multi-source data necessary for change detection. Remote sensing pictures are the most important data resources of GIS. Satellite imagery is used for recognition of synoptic data of earth's surface (Kumar, (2013), the most important reasons to use Satellite images, are easily data availability and their spectral resolution. Remote Sensing technology has been used as an essential tool to monitor land use and surface changes. Satellite Remote sensing images collect multispectral, multiresolution, multi-temporal data providing and observing the process of land cover changes.

Presently, with increased computer proficiency and data accessibility, Remote Sensing (RS) and geographic information systems (GIS) have become very useful tools for detecting objects and phenomena change. RS and GIS application can help a variety range of analysis, planning, and decision support systems operations that can make a stunning effect to the development and progress of study area. Instead of finding optimal solutions for the problem of that particular field, great approaches must be established. Temporal and spatial reservations permit scientists to monitor and detect changes over a large scale and support planners to obtain or maintain information on different phenomena, such as shifting agriculture patterns, urban expansion, industrialization, and Land use/Land cover changes (Malhotra. 2013).

Remote sensing technology has received enormous interest in the field of biological in the recent years. It is a tool offering well-documented benefits including a synoptic view, multispectral data, multi-temporal coverage and price effectiveness (Stoms, 1993. It is now broadly practiced on collecting and processing data. It has been declared to be a realistic approach to study complex geographic land types and diverse remote ecosystems. It provides a broad range of sensor systems including aerial photographs, airborne multi-spectral scanners,

Remote sensing technology has many qualities that would be very useful to detecting, mapping, and monitoring invaders. However, with its broad interpretation has the potential to provide the relevant information. Satellite imagery is accessible for most of the world since 1972. The multi-date nature of satellite imagery allows dynamic monitoring features of the landscape and thus provides a way to detect significant land cover changes and quantify the rates of change.

Linked GIS and remote sensing has superbly been utilized to map the distribution of several plants and animal species, landscapes, their ecosystems, bio-climatic conditions and agents promoting invasions (Stow et al.1989). Remote sensing provides a synoptic appearance of the surface of the earth. Aerial photography is the past remote sensing technique (Kiefer, 1994). Aerial photography has been used to procure vegetation and plant species features such as their ecosystems, canopy architecture, leaf pubescence and phonological stage (Everett et al., 2001). Today there are different types of systems available that also cover the near infrared (NIR) and infrared (IR) as well. Multispectral scanners register reflectance in some spectral bands throughout the visible, near to far infrared portions of the electromagnetic spectrum. Broad-band scanners have rare spectral bands of one hundred or more nm wide spectral bands. Hyperspectral scanners have more (tens up to several hundred) but narrower (from tens to a few nm wide) spectral bands. Broad-band scanners have been magnificently applied to differentiate between full land cover types such as forest versus built up area and bare soil. The higher spectral resolution of hyperspectral scanners permits discernment of more understated differences such as those between individual species.

1.3 Change Detection

Change detection is the method of identifying alterations in the form of an object or phenomenon by detecting it at different times or the process of discovering and observing the difference in a body or event by visualizing at two different times. In change detection application, it is very important to use different time datasets to investigate the temporal impressions of the object or phenomena. Geographic information system is a beneficial tool for measuring the change between two or more time periods. It has the capability to join multi sources of data into a change detection platform, for example, the use of satellite data, multiple layers, classified images, maps, topo sheets from which we extract beneficial information about the evolution of a particular area.

1.4 Statement of the problem

Land use and cover are intermixed with each other. In Jammu and Kashmir state highly diversity state in India. In Rajouri district J&K detection of land use and lover cover area last few years main changing the following broad categories such as Build up area, agricultural land ,forest, water area, snow covered area. Today the changes in the environment or in Rajouri district are because of the changes brought in land use by the man (anthropogenic).Therefore, land use change leads to environmental change and which in turn affects the land use practices. Built-up area expanded annually whereas vegetation cover declined at a faster rate from last decade. Also it was observed that bare land has increased. The slopes of the surrounding mountains around the Rajouri are gentle. Settlement has also spread over the higher elevations having rich soil with nitrogenous content. A large number of streams are snow fed and flow from the higher elevations which are also thickly forested. It was observed that the heterogeneous climate and physiographic conditions in these districts has resulted in the development of different land use/land cover in these districts. It was inferred that land use/land cover pattern in. The main problem in Rajouri District Forest area decreasing day by day. Changing in other categories like agriculture land Build up area.etc.so, in this research we see changing in District Rajouri J&K through GIS and remote sensing from last decade.

.5 Research Objectives

- To prepare LULC Map of district Rajouri of 2008-2016.
- To analyze the LULC changes between 2008-2016.

1.6 Study Area

The study area is the Rajouri district of Jammu and Kashmir. It came into being in 22nd September 1967, when it was carved out of Poonch district. It has an area of 2630 Sq. Kms. It is situated 154 Kms away from Jammu, the winter capital of Jammu & Kashmir. On the East, the Rajouri town is bounded by district Reasi and Jammu, on the West by Poonch District, Pulwama District is in the North, and the Line of Actual control passes on the Southern side.

It is resided in the foothills of Peer Panchal Range of Himalaya, situated between the geographical coordinates of latitude 33.38°N and longitude 74.3°E. It has an average elevation of 915 meters (3001 feet). The climate alters from semitropical in the Southern part to temperate in the mountainous Northern region. The summer temperature does not exceed 41 degrees. Winters are cool and chilly characterized with rainfall due to western disturbances. The average rainfall is 769 millimeters (26.3 in) in the wettest months. Snowfall is scanty but may occur in cold months from November to February. The average temperature varies from 7.42 degree Celsius to 40 degree Celsius.

The total population of Rajouri as per the census of 2011 by Govt. of India is 642,415, Out of the total population, 8.14 % which is around 52,314 people lives in urban regions of district. And around 91.86 % of total population i.e. 590,101 people lives in rural areas, and consequently, and most of the population are highly dependent upon forests for their livelihood (Gouri et al. 2004)

Local communities of these regions are mostly staying on the slopes of the mountains they own small pieces of land for agriculture, Kachha houses to live in and cattle for enhancing their economy. Most of them are nomadic tribes and rare herds of goat and flocks of sheep. They are dispersed in the District and migrate from one place to another in search of pastures for their cattle. The majority of the population is living below poverty line. These local peoples depend on forests use wood for fuel, fodders for animals and Grazing for their cattle. On the one hand, the forest resources are decreasing due to growing population and deforestation to obtain fuel-wood and fodder for animals as well as on the other hand agricultural land narrow and fragmented.

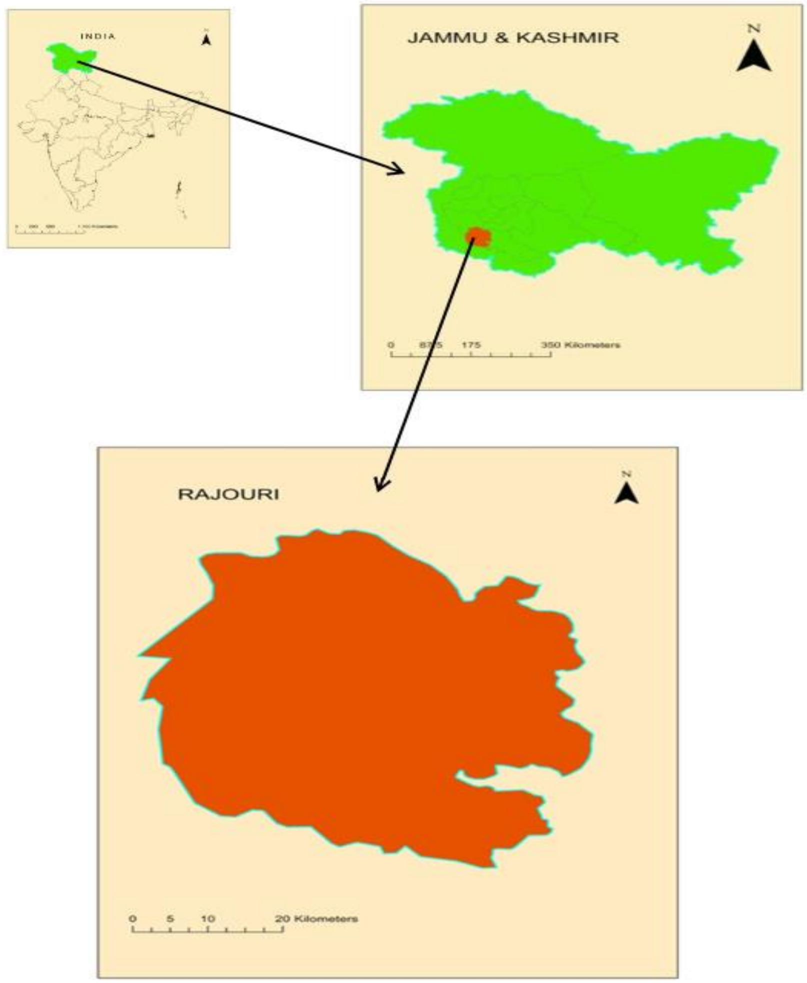


Figure 1: Location of the study area

CHAPTER 2

REVIEW OF LITERATURE

2.1 (Chase et al. 1999) The authors in this journal article points out that GIS is proficient of assembling, manipulating, storing, and displaying geographically referenced information i.e. data identified according to their location on earth. It can provide information on the relative richness, dominance, fragmentation, patch density at the landscape level. Remote sensing is defined as the sciences of acquiring processing and interpreting images and related data acquired from aircraft and satellite that record the interaction between matter and electromagnetic radiation. For mapping biodiversity, it can provide information about habitat type, vegetation structure of a particular area, and landscape geometry. With the help of high-resolution satellite imageries, vegetation of any region can be studied in both time and space. Land use and land cover (LULC) changes are one of the chief drivers of local and regional climate change. Soil degradation, biodiversity decline, poverty, population growth, and rapid economic development have been identified as the leading causes of LULC change resulting in land degradation and deforestation.

2.2 The authors illustrate the concept of LULC mapping in the 1960s and the concept of vegetation mapping earned momentum steadily, leading to an increase in studies of LULC change universal (Yang, 2001). It is globally acknowledged that declining forest cover triggers ecological problems like habitat degradation and rare species extinction and changes in global climate (Goldsmith, 1998). Atmospheric carbon dioxide concentration is now higher than at any time in the past 10 million years. It is estimated that forests (including related soils, peat deposits, and lake sediments) hold 62–78 % of the world's terrestrial biospheric carbon (IPCC 2001). Forest clearing is one of the primary drivers of global warming and climate change. The world's forests particularly those in the tropics are shrinking at an extraordinary rate activity linking forests, such as land use change can alter the amount and temporal distribution of Carbon storage (Haynes et al.1994). It is imperative that regular periodic assessments of forest cover change in tropical regions are carried out to recognize past patterns, assist proper planning and foresee future trends. The use of remote sensing data has been instrumental in monitoring the changing pattern of vegetation across different views. The range for large geographical coverage, high temporal frequency and a wide selection of spatial and spectral resolution sorption, further enhances the use of remotely sensed imagery for LULC change detection. To catch the uniqueness of each region, it is important that LULC studies are carried at local to regional scales to completely understand the total impacts at multiple scales (Sohl et al. 2004).

2.3 The author bring out the LULC classification of features and change detection process to study the LULC of a particular region. Land use/land cover change detection process of identifies the differences in the state of an object or phenomenon by observing it at different times (Singh, 1989). Change detection is an important process in monitoring and managing natural resources and urban development because it provides quantitative analysis of the spatial distribution of the population of interest.

2.4 The author lists four aspects of change detection which are important when monitoring natural resources (Macleod, 1998). They include; firstly, detecting the changes that have occurred; secondly, identifying the nature of the change; thirdly, measuring the area extent of the change and lastly, assessing the spatial pattern of the change. The basis of using remote sensing data for change detection is that changes in land cover result in changes in radiance values which can be remotely sensed. Techniques to perform change detection with satellite imagery have become numerous as a result of increasing versatility in manipulating digital data and increasing computer power.

2.5 In this paper the writers talks about the classification system in LULC. There are several studies that have straight compared the accuracy of supervised and unsupervised classification. (Bourghuls et al. 2007) is exceptional in that it is one of the rare studies to find unsupervised classification to be more true than supervised classification A larger number of studies, however, found that supervised classification to be more correct.

2.6 The authors said that the classification system is essential for change detection and calculation of area. In this supervised and unsupervised classification methods for the highly heterogeneous landscapes in the northern regions of Jordan (Alrababah, 2006). Since the authors found paper LULC maps to be lacking in spatial coverage, level of detail, and temporal resolution, they sought to find an effective way to produce accurate and timely electronic LULC maps. Using Landsat Enhanced Thematic Mapper imagery conducted supervised and unsupervised classification, both with and without spatial enhancement procedures, using 8 land cover classes and 278 sample points. The land cover classes were water, urban, agricultural land, forest land, shrub land, rangeland, olive farms, and bare soil. (Alrababah, 2006) found that unsupervised classification had an overall accuracy between 69.1% without spatial enhancement and 73.7% with spatial enhancement. The overall accuracy for supervised classification without and with spatial enhancement was 78.8% and 82.7%, respectively.

2.7 The authors pointed out that the DEM and digital classification is necessary for LULC. For compared supervised and unsupervised classification schemes in the mountainous regions of Nepal. (Bahadur, 2009) used five land use classes in his study: forest, scrubland, lowland agriculture, upland agriculture, and vegetables. Using multiple classification schemes, Bahadur (2009) found that the accuracy for unsupervised classification ranged from 45 to 68 percent. An overall accuracy of 82.86% was obtained for supervised classification. Bahadur (2009) noted that supplementary data such as, slope decreased, aspects, and Digital Elevation Model the difficulty in differentiating between land use classes.

2.8 In this study the authors illustrate the need for classification system and accuracy measurement in remote sensing and GIS data. They used pixel-based and object-based approaches to analyze urban structures in Vijayawada, India. The authors derived ground truth data for their study from in situ measurements. Four land cover types were used in this study: urban areas, water, vegetation, and rocky areas. (Mohammed, 2008) attained 87.67% overall accuracy for unsupervised classification versus 97.5% overall accuracy for supervised classification. While directing forest inventory estimation in India, (Mukherjee, 2009) used a subpixel analysis method called Spectral Mixture Analysis in both supervised and unsupervised approaches. This study featured only three land cover classes: dense forest, sparse forest, and open bare soil. The authors used 30 training sites (10 for each land cover class) in their supervised classification and 60 spectral classes (20 for each land cover class) in their unsupervised classification. The authors found the overall accuracy to be 76.67% for supervised classification and 53.33% for unsupervised classification. The most common misclassifications occurred in areas of sparse forest.

CHAPTER 3

MATERIAL AND METHODOLOGY

3.1 Data

To execute the objectives of this study, the following data and methodology were adopted.

3.1.1 LANDSAT-8 Data

For the purpose of studying the region, following multi-spectral and multi-temporal Landsat satellite imagery were procured from United States Geological Survey (USGS) (www.usgs.gov) of the year 2016.

Operational land imager OLI collects data from nine spectral bands. Seven of the nine bands are consistent with the Thematic Mapper (TM) and Enhanced Thematic Mapper Plus (ETM+) sensors found on earlier Landsat satellites, providing for compatibility with the historical Landsat data, while also improving measurement capabilities. Two new spectral bands, a dark blue coastal/aerosol band, and a shortwave-infrared cirrus band will be collected; allowing scientists to measure water quality and improve detection of high, thin clouds.

Table 1: Characteristics of Landsat Sensors

Sensor	Resolution			
	Spectral	Radiometric	Temporal	Spatial (m)
Landsat	Band 1- Visible (0.43-0.45 µm)			30
	Band 2- Visible (0.450 - 0.51 µm)			30
	Band 3- Visible (0.53 - 0.59 µm)			30
	Band 4- Red (0.64 - 0.67 µm)			30
	Band 5- NIR (0.85 - 0.88 µm)			30

OLI/TIRS	Band 6- SWIR 1 (1.57 - 1.65 μm)	12 bit	16 days	30
	Band 7- SWIR 2 (2.11 - 2.29 μm)			30
	Band 8- PAN (0.50 - 0.68 μm)			15
	Band 9- Cirrus (1.36 - 1.38 μm)			30

3.1.2 LISS-III

IRS LISS-III data are well suited for agricultural and forestry monitoring tasks. LISS-III data are ideal for coloring IRS PAN Products. The LISS-III is a multi-spectral camera working in four spectral bands, three in the visible and near infrared and one in the SWIR region, as in the case of IRS-1C/ 1D. The new feature in IRS-P6 LISS-III camera is the SWIR band (1.55 to 1.7 micron), which provide data with a spatial resolution of 23.5m unlike in IRS- 1C/ 1D (where the spatial resolution is 70.5 m). Uncorrected Linear Imaging Self-scanning Sensor (LISS)-III of Resourcesat-1 is a multi-spectral camera operating in four spectral bands, three in the visible and near-infrared (VNIR) and one in the shortwave infrared (SWIR) region with a spatial resolution of 23.5 m at the base.

Table 2: Spectral resolutions of the sensor (LISS-III)

Band No.	Bandwidth	Sensor(s)
2 (Green)	0.52-0.59	LISS-III
3 (Red)	0.62-0.6	LISS-III
4 (NIR)	0.77-0.86	LISS-III
5 (SWIR)	1.55-1.70	LISS-III

The LISS-III data from the visible and near-infrared (VNIR) bands are digitized to 7 bits, and the data from SWIR band are digitized to 10 bits. The latest feature in LISS-

III camera is the shortwave infrared (SWIR) band, which provides data with a spatial resolution of 23.5 m unlike in IRS-1C/1D, where the spatial resolution is 70.5 m.

3.2 Methodology

LISS-III satellite data was acquired for winter months, November 2008 from the central Government of India, Hyderabad. And landsat-8 satellite data procured from United State Geological Survey (USGS) December 2016 (Fig 5) Obtaining images at nearby anniversary dates is well-thought-out for change detection studies (Jensen, 2007).

In the next step, LISS-III data was registered with the Landsat-8 data using image-to-image rectification method.

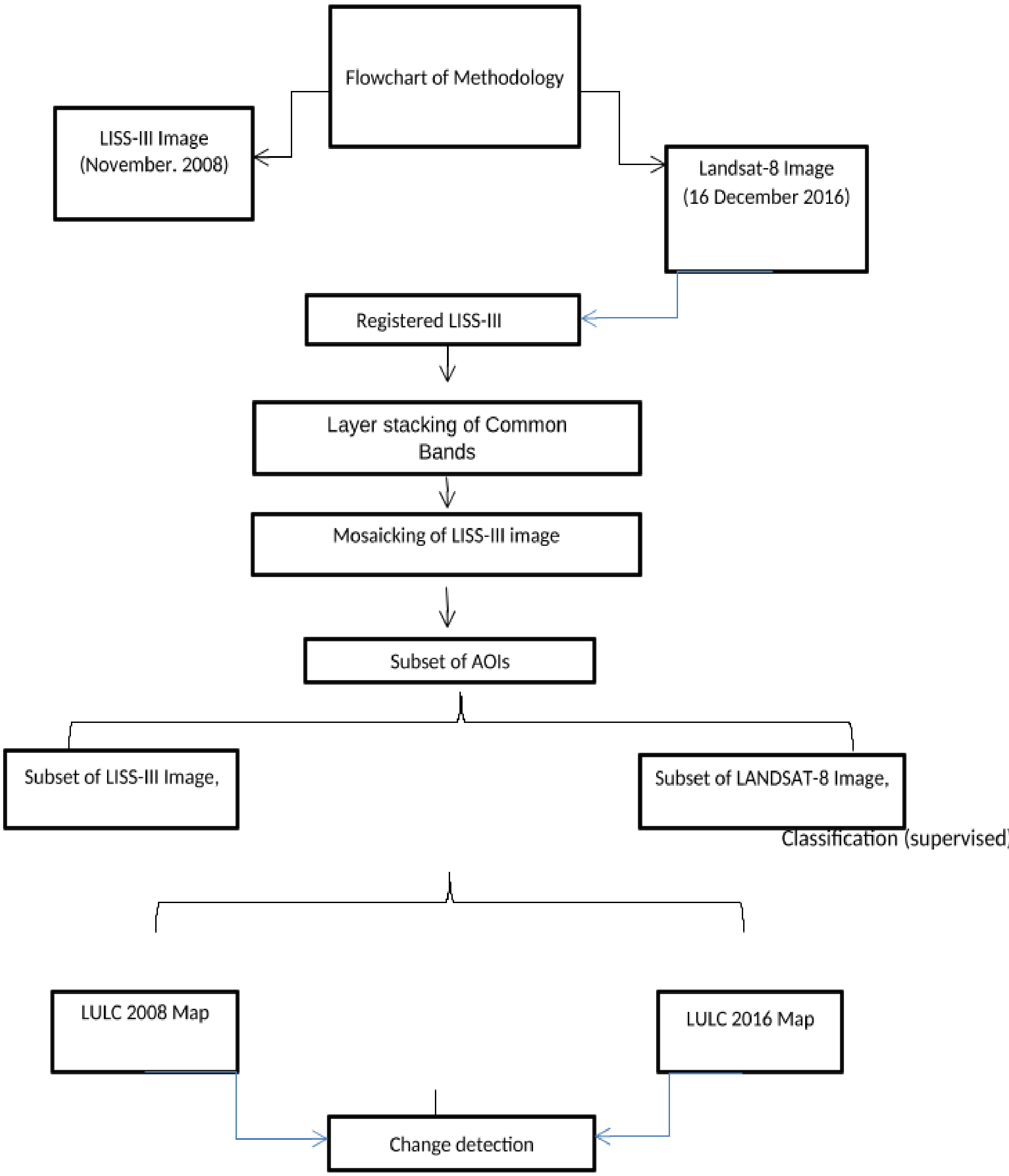
For the LISS-III tiles firstly layer stacking of conventional band is performed, and then a composite colour image is formed. After that the mosaicking of the different tiles of area of interest is carried out as seen in (Fig; 4).

For the landsat-8 image layer stacking of conventional band is performed and a Colour composite image is formed. For better visual interpretation many image improvements techniques, such as median filtering, histogram stretching, and compositing are used. Colour composite images permit us to view the reflectance information from three separate bands in a single image and were produced by using the bands which had the largest amount of information, low relativity and least redundancy, and. A vector or shape file of the study area was procured from the survey of India and used to clip both of the images. The subsets of both the pictures of LISS-III (2008) and LANDSAT-8 (2016) were made. Fig.5 and (Fig; 6) respectively. No alteration of the spatial, spectral or radiometric resolution was made on the imagery.

A supervised classification was performed on both images The supervised classification technique is chosen, because The data of the study area is readily available and The study area was categorized into five classes namely Forests, Water, Agricultural land and open fields, Snow and Built-up land. As a result, the LULC map representing five different categories of LISS-III satellite image (2008) and

LANDSAT-8 satellite image (2016) were derived. The flowchart clarifying the development of land use maps is given in

Flow chart of the Procedure followed to produce Land-use/land-cover map for district Rajouri.



CHAPTER 4

Land Use Change in Rajouri from 2008 – 2016

4.1 Mosaic image of (LISS-III) Area of Interest, 2008

The first image taken for area of study is the LISS III Nov. 2008 MSS image, which is further stacked and a supervised classification is done for generating a total area of Rajouri district the images are processed in software for mosaicking and the area is generated. The study area covers different type of LULC features like vegetation, built up, waterbody, snow covered area and others. The prime purpose of classifying of the images is to bring out the changes of LULC cover of Rajouri district in J& K. IRS LISS-III data are well suited for agricultural and forestry monitoring tasks. LISS-III data are ideal for coloring IRS PAN Products. The LISS-III is a multi-spectral camera working in four spectral bands, three in the visible and near infrared and one in the SWIR region. Uncorrected Linear Imaging Self-scanning Sensor (LISS)-III of Resourcesat-1 is a multi-spectral camera operating in four spectral bands, three in the visible and near-infrared (VNIR) and one in the shortwave infrared (SWIR) region with a spatial resolution of 23.5 m at the base.

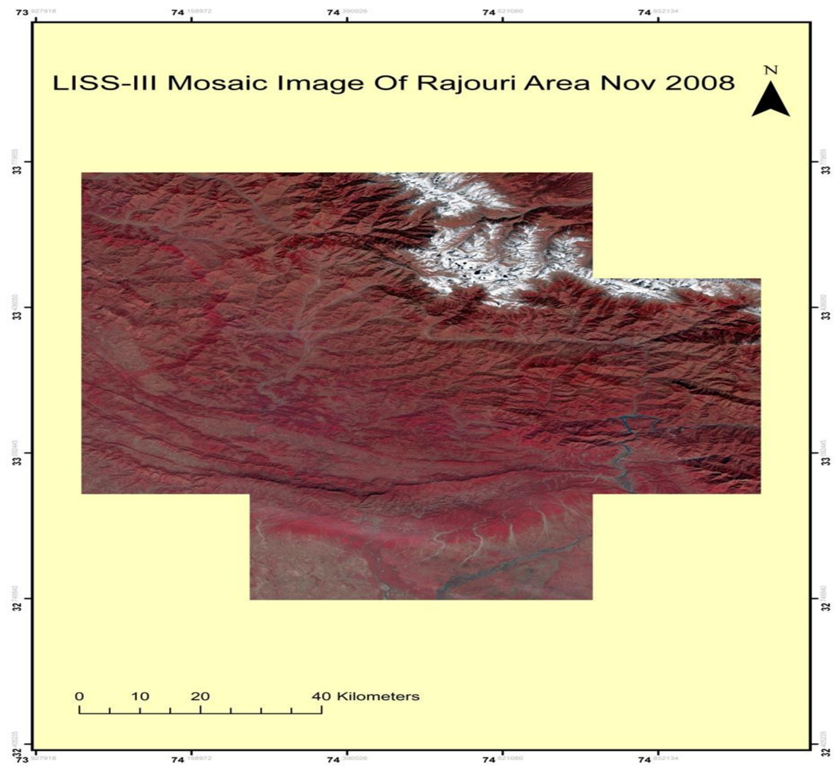


Figure 2: the Mosaic image of (LISS-III) Area of Interest.

4.2 Landsat 8 Image of Rajouri Area, 2016

The Landsat 8 image taken for the purpose of studying the region, following multi-spectral and multi-temporal Landsat satellite imagery were procured from United States Geological Survey (USGS) (www.usgs.gov) of the year 2016 and a supervised classification is done for generating a total area of Rajouri district the images are processed in software for subset and the area is generated. The study area covers different type of LULC features like vegetation, built up, waterbody, snow covered area and others. The prime purpose of classifying of the images is to bring out the changes of LULC cover of Rajouri district in Jammu and Kashmir.

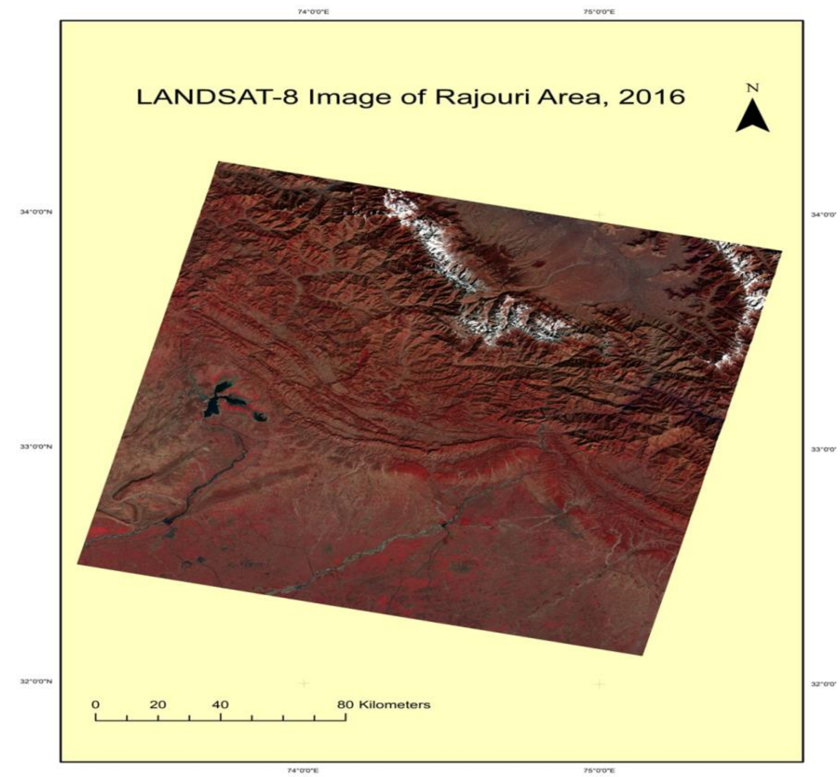


Figure 3: A Raw image of (LANDSAT_8) Area of Interest.

4.3 Subset Image of Rajouri, 2008 (LISS III)

A subset image of LISS III Nov. 2008 is created for generating a district boundary for the purpose of study. The image covers various types of LULC features and it's also gives us total area of the Rajouri district as well as the area under different LULC features. The supervised classifications give us the area and classify it to various features.

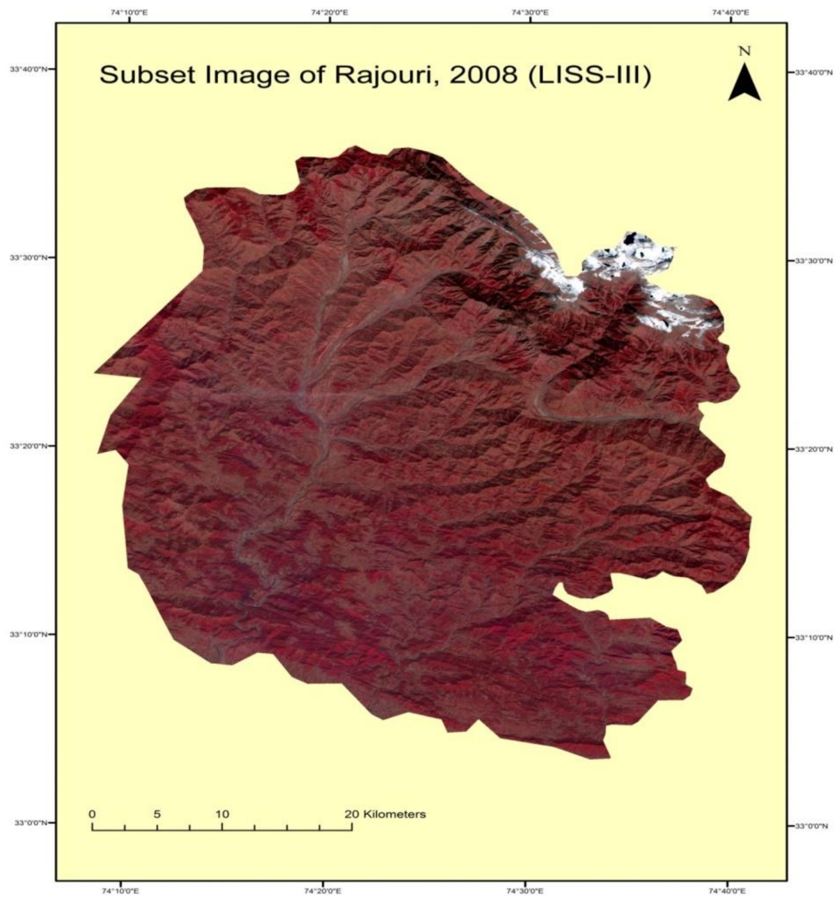


Figure 4: Subset of Rajouri (LISS-III) Image

4.4 Subset Image of Rajouri, 2016 (LANDSAT-8)

A subset image of Landsat 8 Dec.2016 is created for generating a district boundary for the purpose of study. The image covers various types of LULC features and it's also gives us total area of the Rojouri district as well as the area under different LULC features. The supervised classifications give us the area and classify it to various features

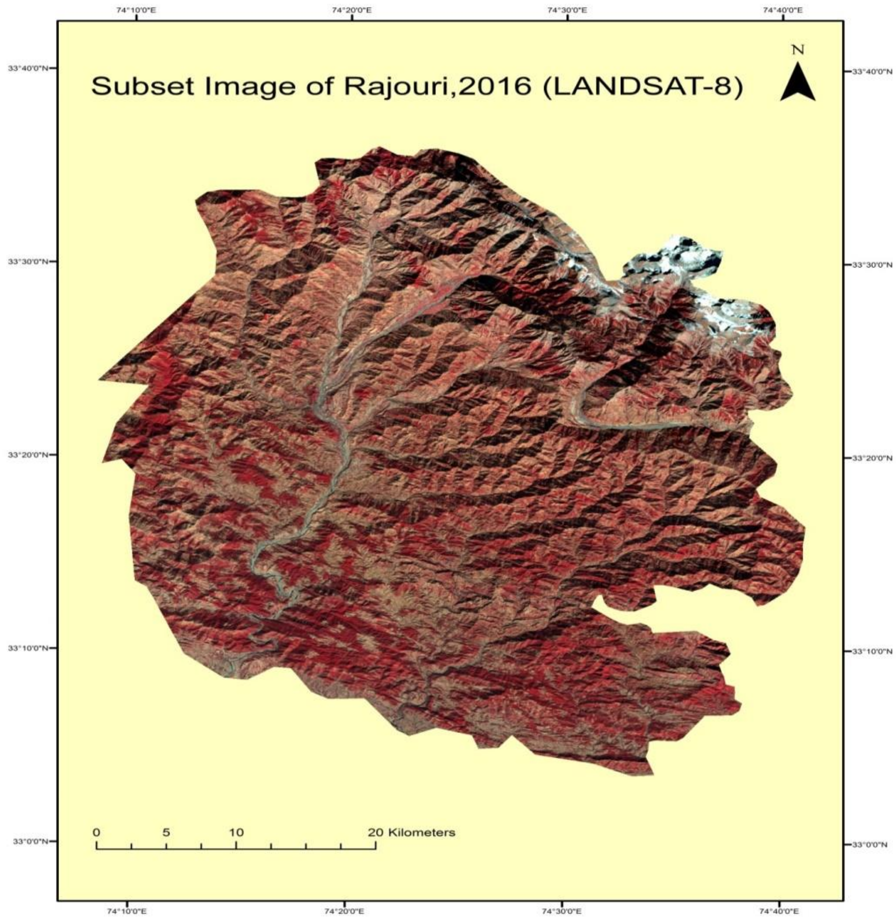


Figure 5: Subset of Rajouri (LANDSAT-8) Image

4.5 Supervised LULC Map of Rajouri District 2008-2016

A supervised classification was performed on both images LISS III satellite image (2008) and LANDSAT-8 satellite image (2016) was derived. The supervised classification technique is chosen, because The data of the study area is readily available and The study area was categorized into five classes namely Forests, Water, Agricultural land and open fields, Snow and Built-up land.

In 2008, agricultural and open Field class constituted the largest category with spatial coverage of 49.84 percent of the total study area. Forests 39.45 percent and water 7.82 percent occupied second and third position respectively in terms of total area coverage. Where is snow 1.56 percent and built-up land 1.33 percent occupied fourth and fifth position respectively.

In, the second time period, 2016, Agricultural land and open fields constituted the largest category with spatial coverage of 52.64 percent with an increase of 2.8 of the total study area as compare to 2008. Forests and water remains second and third largest class occupied 33.72 percent and 8.33 percent respectively. Where is snow 3.60 percent and built-up land 1.66 percent occupied fourth and fifth position respectively.

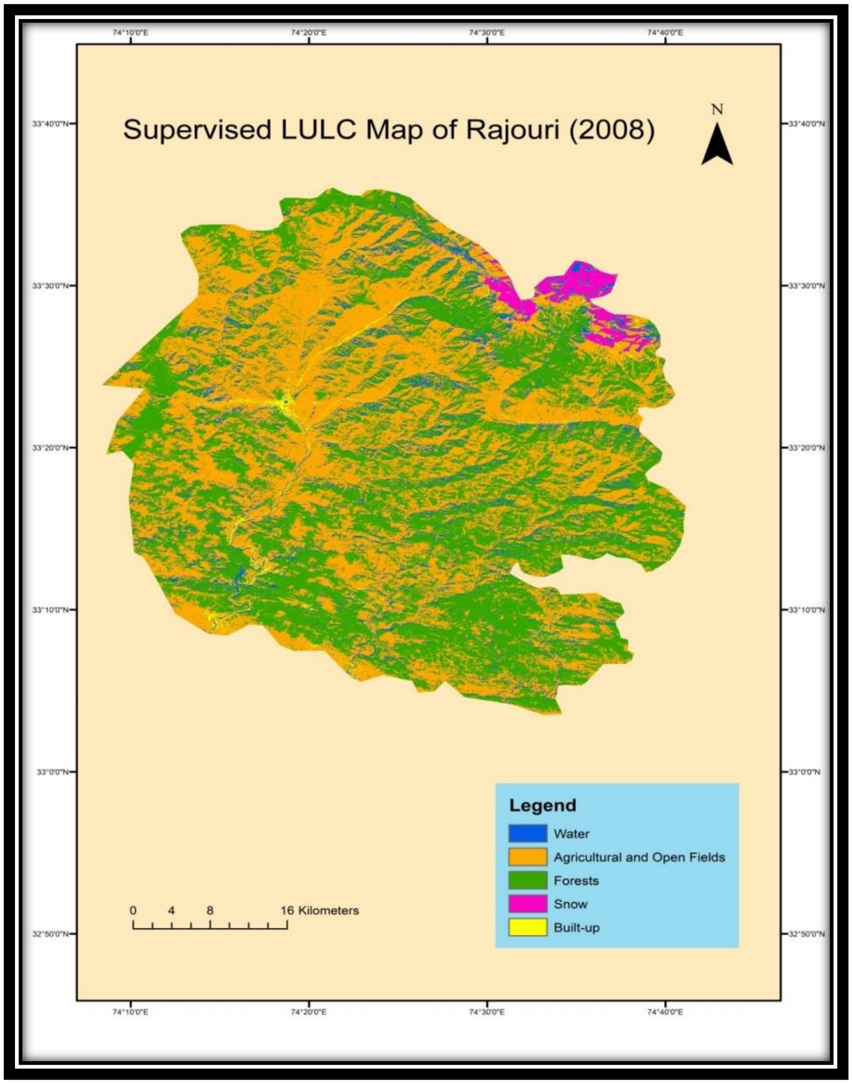


Figure 6: Supervised LULC Map of Rajouri 2008

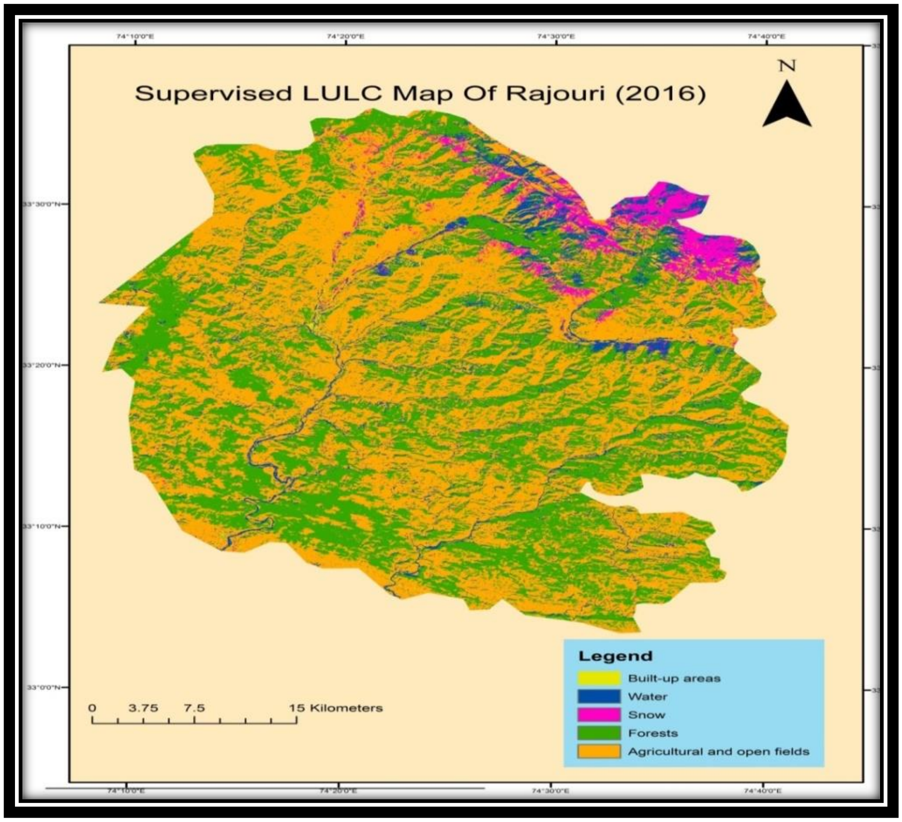


Figure 7: Supervised LULC Map of Rajouri (2016)

CHAPTER 5

RESULT AND DISCUSSION

5.1 In 2008 classified image the overall accuracy of 86%. In terms of producer's accuracy, all the classes ranged between 70-100%, while for the user's accuracy all classes ranged between 73-100%. In 2008, agricultural and open Field class constituted the largest category with spatial coverage of 49.84 percent of the total study area. Forests 39.45 percent and water 7.82 percent occupied second and third position respectively in terms of total area coverage. Where is snow 1.56 percent and built-up land 1.33 percent occupied fourth and fifth position respectively.

In, the second time period, 2016, Agricultural land ad open fields constituted the largest category with spatial coverage of 52.64 percent with an increase of 2.8 of the total study area as compare to 2008. Forests and water remains second and third largest class occupied 33.72 percent and 8.33 percent respectively. Where is snow 3.60 percent and built-up land 1.66 percent occupied fourth and fifth position respectively.

Figure 7 and 8 represent the changing pattern of land use and land cover of Rajouri District of study period. LULC of Rajouri has undergone significant changes during the study period. Agricultural land and open fields class has gained substantial area, i.e. an increase of 2.8 per cent compared to the previous period. During the same period Forests category has lost the maximum coverage i.e. 5.23 per cent, similarly snow, water, and Built-up land also witnessed positive growth in spatial coverage with increase in 5.35 percent. (See table 6)

Land use Categories	2008 %	2016 %	Change in percentage
Water	7.82	8.33	0.51
Forests	39.45	33.72	-5.73
Agricultural land and Open fields	49.84	52.64	2.8
Snow	1.56	3.6	2.04
Built-up land	1.33	1.66	0.33

Table 6 Land use and Land cover of District Rajouri (2008 and 2016)

Source: Image Processing of LISS-3 & Landsat-8,

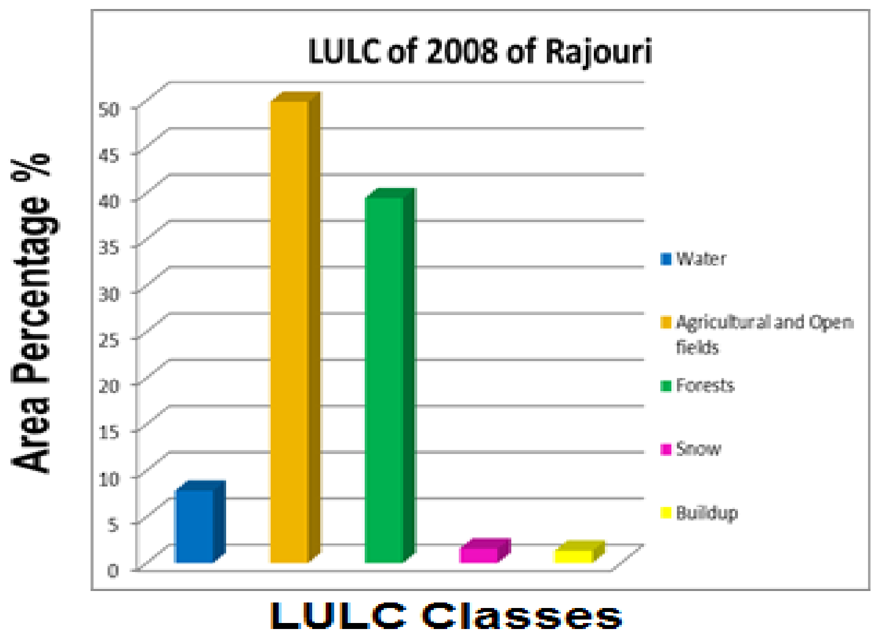


Figure 8: LULC of 2008 of Rajouri

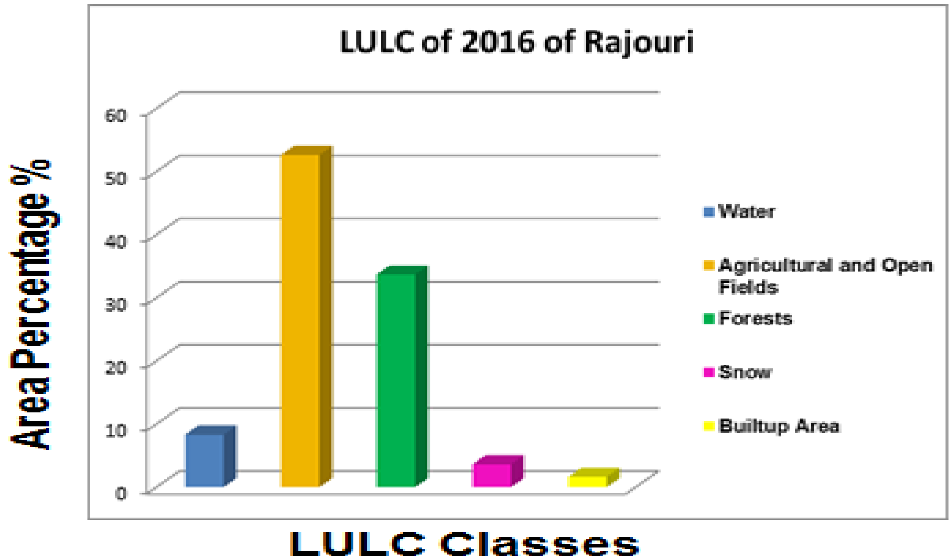


Figure 9: LULC of 2016 of Rajouri

5.1.1 Change in Land use and Land Cover (2008-2016)

Land use classification was first done for the whole area of district Rajouri which is spread over 2630sq km. The LULC map is produced by using data of LISS-III (2008) and Landsat-8 (2016) and then from these classified images, to assess the land use change in the distribution of the various land use categories i.e. Forests, Agricultural and Open Fields, Snow, Water, and Built-up land. In 2008 these categories covered, 39.45 %, 49.84 %, 1.56 %, 7.82 %, and 1.33 % respectively. And in 2016 these categories covered 33.72 %, 52.64 %, 3.60 %, 8.34 %, and 1.66 % of the total area respectively. (Figure 10). During the period of 2008 to 2016 the land use change observed in the distribution of various land use categories. In 2008 the forests cover was 39.45 % and agricultural land and open fields was 49.84% and in 2016 the forests covers decreased to 33.72% and the agricultural land and open fields increased to 52.64 % of total area. The findings of Land-use Land-cover change shown that the study has experienced a decrease in forests by 6 percent and with an increase in agricultural land and open fields and settlement areas during the study period. Where is in other categories like water, snow and built-up land also show slightly increased during the period.

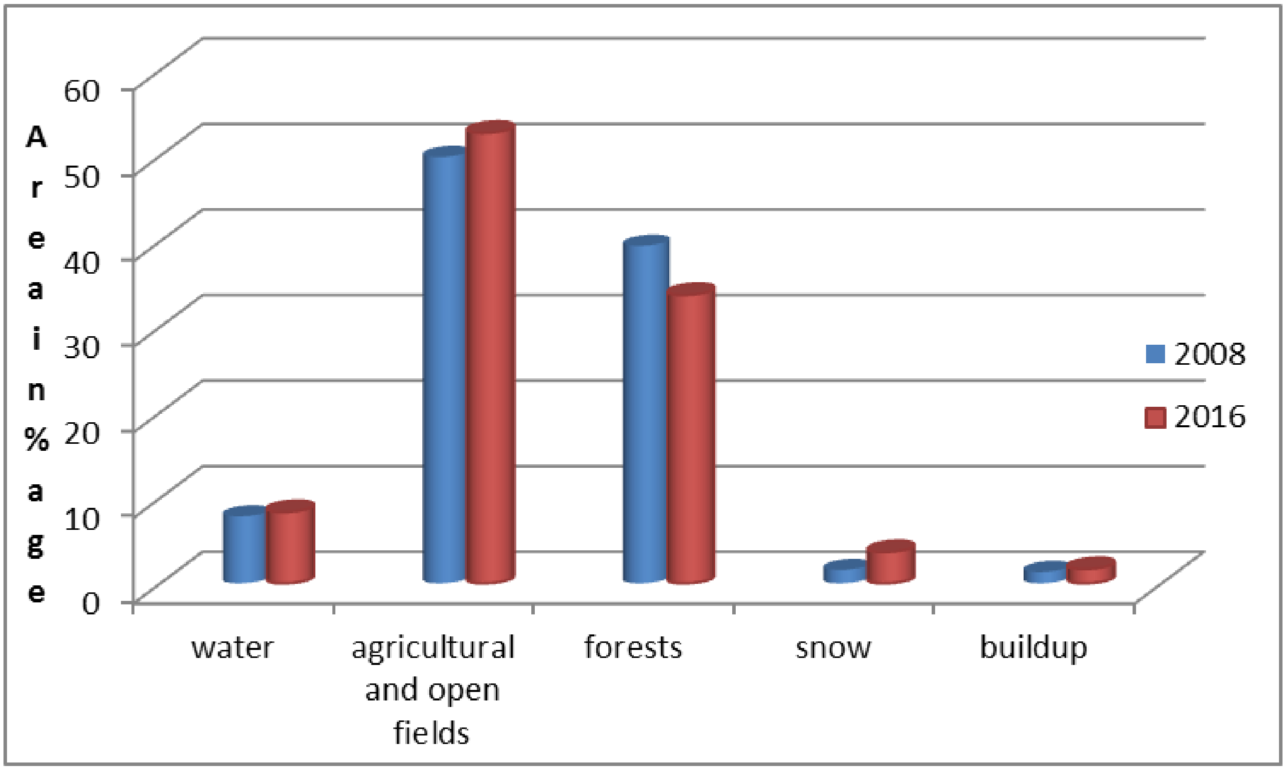


Figure 10: Comparison of LULC 2008 and 2016

5.2 Discussion

Rising population pressure and inappropriate policies of the government have further threatened forest sustainability and are contributing to deforestation and forest degradation. Nautor is an ancient right under which landless people are permitted to break fresh agricultural land in common land areas by village elders (ODA 1993).

In 1968 the Himachal Pradesh Nautor Land Rules came into force whereby the government started granting nautor land (redistributed land) upto one acre to landless and other eligible people for agriculture and horticulture (Chowdhry, 2008). The un-demarcated forest is the land that was designated for allocation under nautor rights. This practice of giving away un-demarcated forest land to landless cultivators under the provisions of the said rules has resulted in deforestation in the Himalayan state (Gupta 2007).

The calculated accuracies of the classification process were realistic which can be described by the fact that the total number of correctly classified pixels was high. User accuracy as a result of maximum likelihood classification ranged between 74-93 % in 1998 and 85–92 % in 2010; while producer accuracy ranged between 79–96 % in 1998 and 86–92 % in 2010. Pareta (2014) in a study on land use and land cover change in Baddi district of Solan, has reported user accuracy for various lands cover classes between 93–100 % while producer accuracy between 83–100 %. Sharma and Leon (2005)) while working on land cover classification of Solan district using IRS (LISS III) data of different seasons reported a user accuracy ranging between 64–89 %, 32 and 68 %, 23–62 %; and producer accuracy between 46–100 %, 33

CHAPTER 5

Conclusion

The findings of Land-use Land-cover change concluded that the study has experienced a decrease in forests by 6 percent and with an increase in agricultural land and open fields and settlement areas during the study period. Where is in other categories like water, snow and built-up land also show slightly increased during the period.The findings of LULC change revealed that the study had experienced a decrease in forests and with the increase in agricultural land, open fields and settlement areas during the study And around 91.86 % of total population i.e. 590,101 people lives in rural areas, and consequently they are highly dependent upon forests for their livelihood Majority of the peoples are living below poverty line. These local populations depend on forests for fuel-wood, fodders for animals and Grazing for their cattle. On one hand, the forest resources are decreasing due to rising population and deforestation to obtain fuel-wood and fodders for animals as well as on the other hand agricultural land limited and fragment.

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