A Geographical Study In Jaunsar-Bawar Region Change Detection And Projection Of Natural Resources

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Abstract:

Change is a universal law of nature. A significant aspect of change detection is understanding what exactly is changing and in what forms. It is crucial to identify which land category is transforming into another. This information reveals both desirable and undesirable changes. Due to the rapidly growing population and changing patterns of economic activities (primary, secondary, tertiary), there are changes in land use and land cover.

The maximum area of Jaunsar-Bawar is situated in the Lesser Himalayas. To provide accurate and updated information on the land use and land cover of this region's natural resources, dynamic analysis was conducted using satellite data from the years 2000 and 2015, covering a period of 15 years. For the dynamic study of land use and land cover (LULC) in the study area, five land use categories (open land, dense forest, open forest, shrubs, and water) were defined.

To assess the changes in land use and land cover under the natural resources of Jaunsar-Bawar, data from two distinct years, 2000 and 2015, were used, employing Landsat-T.M for the year 2000 and Landsat-8 for the year 2015. The rates of change in land use and land cover in Jaunsar-Bawar from 2000 to 2015 were used to project the changes for the year 2025. Statistical analysis of change detection and projection was conducted to assess the changes in land use and land cover.

Key Words - Natural resources, land use, land cover, change detection technology, projection, remote sensing, dynamic analysis.

Introduction

The research area, the Jaunsar-Bawar tribal region, is made up of the Chakrata and Kalsi blocks in the Indian state of Uttarakhand. It spans a region of around 1000 km2 and extends between 30° 26' and 31° 2' North Latitude and 77° 38' and 78° 4' East Longitude. With an altitude range of 50–3000 m and a subtropical to cool–temperate climate, it is a hilly tract. While woods make up 44% of this region's territory, there is also cultivable waste land (28.14%), grazing land (8.28%), orchards (6.84%), and other tree crops (6.84%). Cropping is limited to less than 10% of the entire geographic area in this region. There are 1, 25,486 people living there, according to Census of India 2011 data. The Scheduled Tribes make up around 56% of the region's population, followed by the Scheduled Castes, who make up 34% of the total. As a result, area is mostly populated by underprivileged populations whose primary source of income is agriculture and related activities (75%). Despite having a higher than average sex ratio (923), the study region lags behind in socioeconomic development metrics because to its low literacy rate (55%) and subpar healthcare infrastructure, as well as its 70% poverty rate. Overall, both ecologically and economically speaking, this is a fragile territory (Government of Uttarakhand 2013).
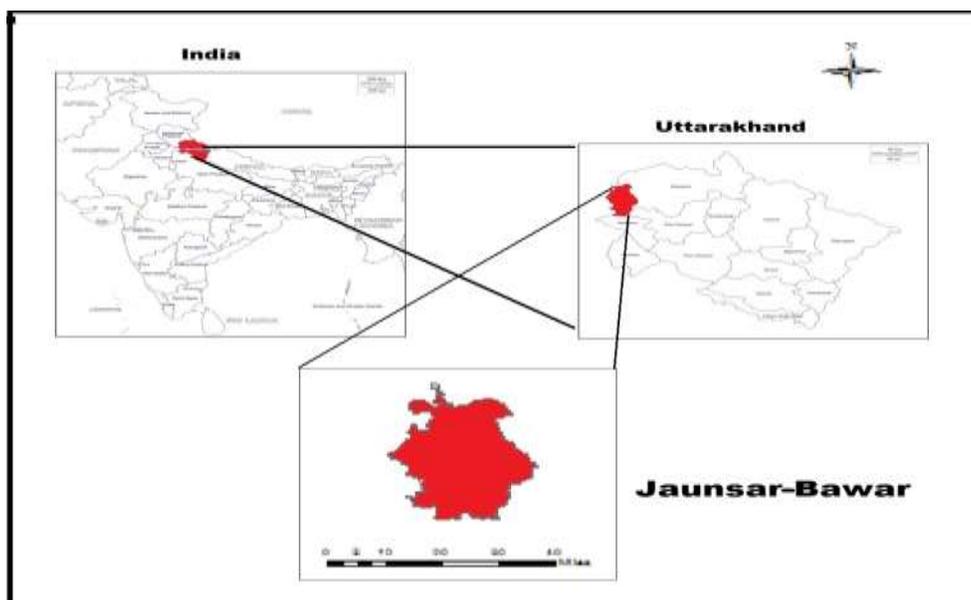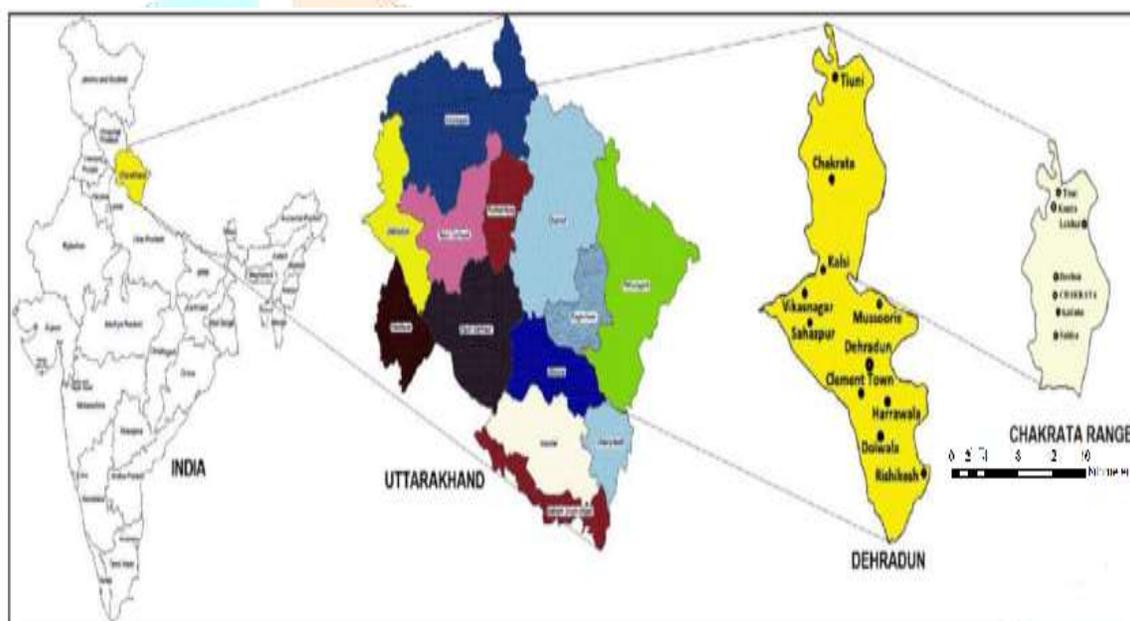
Fig: Location Map of Jaunsar-Bawar Region

The study area of Jaunsar-Bawar is rich in natural resources, primarily including land resources, water resources, soil resources, and mineral resources. These resources make the region abundant in natural wealth, which, if utilized optimally, can lead to significant development. However, due to the geographical disparities of the area, the development of resources has not been achieved effectively. The study focuses on land resources, forest resources, and water resources as part of the natural resources in the area.

Land is a natural resource, a free gift to humanity and all living beings. The intensity of economic activities has accelerated the dynamics of change in land use and land cover. A rapidly growing application of remote

sensing is change detection. This process identifies changes in objects over different time intervals, made possible through the use of remote sensing data. This is because remote sensing provides consistent repetition of imagery cover and quality over a fixed time interval (McLeod and Congalton, 1998).

When managing natural resources, four aspects of change detection are essential:

1. Identifying the changes that have occurred.

2. Recognizing the nature of the changes.

3. Measuring the aerial extent of the changes.

4. Assessing the spatial pattern of the changes.

Change detection technology plays a significant role in understanding land use and land cover (LULC). Changes in LULC are driven by both natural and human activities. To properly understand and control environmental changes and natural resources, LULC changes have become a crucial component of current strategies. Change detection technology is a process that observes the changes in objects or events over different periods.

Research Methodology

In this research paper, data collection has been conducted using primary sources. For the Jaunsar-Bawar tribal region, geo-spatial technology, remote sensing, Geographic Information System (GIS), and GPS were used to classify land use. Land cover change analysis was carried out using satellite data from the years 2000 to 2015. Based on remote sensing and GIS technology, Landsat TM data for the year 2000 and Landsat 8 data for the year 2015 were utilized for analyzing land cover and land use changes through the creation of land maps.

Table 1-Details of landsat images

Satellite	Row/Path	Resolution	Year
Landsat TM	146/038,039	Band(1-7)30mt Band(6)-60 mt	2000
Landsat 8	146/038,039	Band(1-9)30mt Band (7) 60 mt Band(8) 15 mt Band(10-11)100mts	2015

Source*- Lillisand and Keifer, 1994*

Objectives

1. To conduct a dynamic analysis of land use and land cover under natural resources.

2. To classify land use and land cover into categories such as open land, dense forest, open forest, shrubs, and water.

3. To perform statistical analysis of change detection and projection to assess the changes in land use and land cover.

Detection and Projection

The maximum area of Jaunsar-Bawar is located in the Lesser Himalayas. To provide accurate and updated information on land use and land cover under the natural resources of this region, a dynamic analysis was conducted using satellite data from the years 2000 and 2015, covering a period of 15 years. To assess the changes in land use and land cover in Jaunsar-Bawar, data from the years 2000 and 2015 were used. For the year 2000, Landsat TM data with a spatial resolution of 30 meters was utilized, and for the year 2015, Landsat 8 data with a spatial resolution of 30 meters and panchromatic band data with a spatial resolution of 15 meters was used.

The changes that occurred over the 15 years from 2000 to 2015 were analyzed, and the results are presented in Table 4.4. These changes were represented through mapping and statistical methods. The rate of change in land use and land cover (LULC) was determined, and a projection for the next 10 years, i.e., until 2025, was made. Over these 15 years, an area of 108.61 square kilometers, or 9.46%, of Jaunsar-Bawar experienced changes in land cover. The relative change from 2000 to 2015 indicates both positive and negative changes. To

determine the rate of change, the total relative change for each category was divided by the 15-year interval. For instance, in the open land use and land cover category, a total positive change of 45.46 square kilometers occurred from 2000 to 2015. Dividing this positive change by 15 years gives a change rate of 3.03 square kilometers per year for open land cover. Similarly, the change rates for other land use and land cover categories, such as dense forest, open forest, shrubs, and water bodies, were determined by dividing the changes over the past 15 years.

To project the open land for the year 2025, the rate of change, 3.03, was multiplied by 10 and the result was added to the area of open land use and land cover in 2015, which is 194.06 square kilometers. This means that by 2025, it is projected to be 224.36 square kilometers. A similar methodology was applied to project the changes and the areas for other categories for the year 2025.

Table 2: Statistical Distribution of Changes in Land Use and Land Cover under Natural Resources in Jaunsar-Bawar from 2000 to 2015

Land Use	Year 2000		Year 2015		Relative Change 92000-2015)		Rate of Change	Relative Change to 2025	
	Area		Area		Area		Area	Area	
	Km^2	%	Km^2	%	Km^2	%	Km^2/Year	Km^2	%
Open Land	148.60	12.94	194.06	16.91	45.46	3.96	3.03	224.36	19.60
Dense Forest	531.19	46.27	477.54	41.42	(-)53.65	4.67	3.57	(-)441.8	(-)38.50
Open Forest	76.38	06.65	76.78	06.69	0.40	0.03	0.02	76.78	6.70
Shrubs	386.45	33.66	394.54	34.38	8.09	0.70	0.53	399;84	34.85
Water	5.33	0.46	4.32	0.37	(-)1.01	0.08	0.06	(-)3.72	(-)0.35
Total	1147.95	100.00	1147.95	100.00	-	-	-	1147.95	-

Source- Based on Land Set Thematic Mapper and Land Set 8

Land use and Land cover under naturl resources from 2000 to 2015
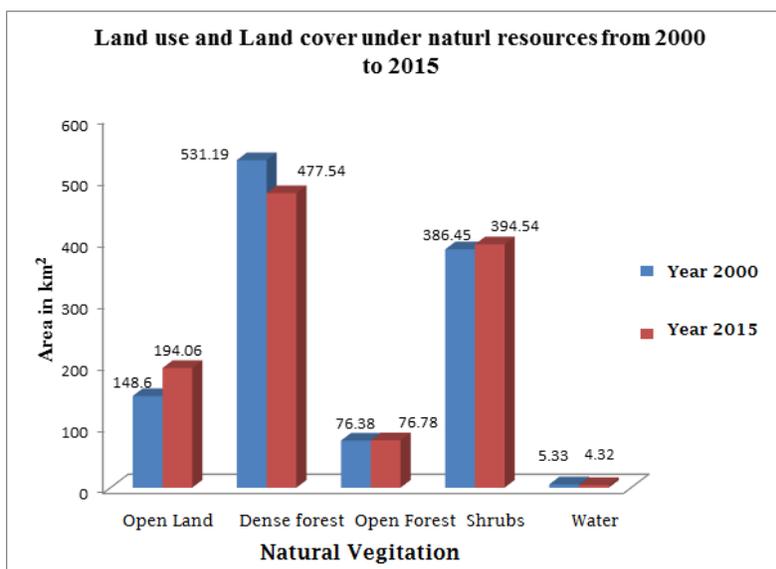
Graphical description of land use and land cover under natural resources of Jaunsar Bawar area from year 2000-2015 (Based on Landsat Thematic Mapper and Landsat 8)

A brief description of the change detection and projection for land use and land cover under natural resources across the five categories is as follows:

1. **Open Land**: Using the rate of change, the projected area for open land in 2025 was calculated.

2. **Dense Forest**: Similar analysis and projection methodology was applied to predict the changes in dense forest cover.

3. **Open Forest**: The rate of change was used to project the open forest area for 2025.

4. **Shrubs**: Change detection and projection techniques were used to determine the future extent of shrub land.

5. **Water Bodies**: Projections were made for the area of water bodies based on the changes observed over the past 15 years.

These projections provide a detailed understanding of the dynamic changes in land use and land cover within Jaunsar-Bawar under the influence of natural resources.

Open Land

In the Jaunsar-Bawar region, the geographical distribution of changes in open land use and land cover from 2000 to 2015 has been analyzed. In the years 2000 and 2015, the open land use and land cover areas were 148.60 square kilometers and 194.06 square kilometers, respectively. Over the 15-year interval from 2000 to 2015, there was an increase of 45.46 square kilometers in open land use and land cover in the Jaunsar-Bawar region. This indicates a 3.96% increase in open land cover over these 15 years.

The rate of change in open land use and land cover is 3.03 square kilometers per year. If this rate of change continues at 3.03 square kilometers per year, by 2025, the open land cover in the Jaunsar-Bawar region will be 224.36 square kilometers. This would account for 19.60% of the total area of Jaunsar-Bawar (1147.95 square kilometers). The main reason for the increase in open land is the reduction in agricultural land areas, which are being converted into barren land and open land cover. The increase in open land cover in the Jaunsar-Bawar region is particularly noticeable in the southern Jaunsar area and the north-western Jaunsar (Devdhar Khat) direction. This is because a significant amount of agricultural land in these areas has been converted into barren land, leading to an increase in open land use and land cover.
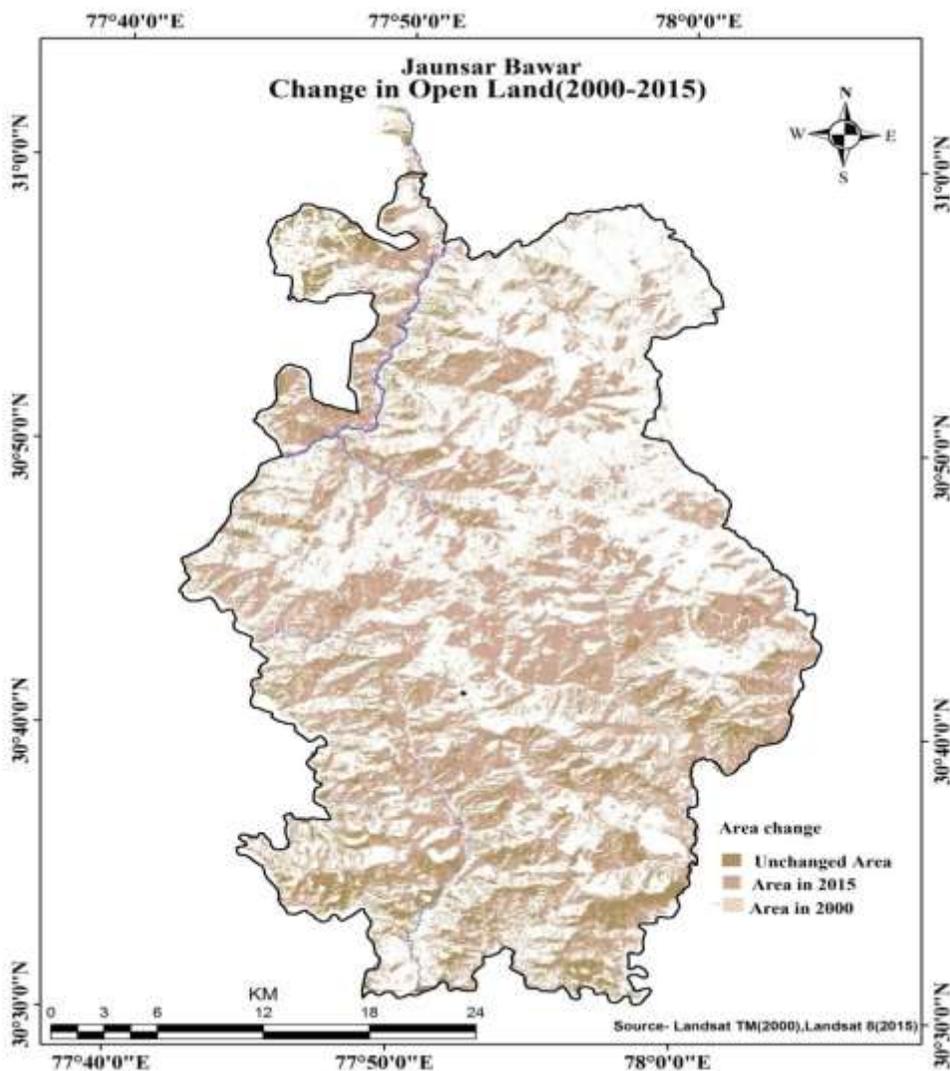
Fig:- Jaunsar Bawar Distribution of Open land Change in (2000-2015)

Dense Forest

In the study area, the dense forest cover accounted for 531.19 square kilometers and 477.54 square kilometers in the years 2000 and 2015, respectively. The geographical distribution of changes in dense forest cover from 2000 to 2015 was analyzed. Over the 15-year interval from 2000 to 2015, there was a decrease of 53.65 square kilometers in dense forest cover in the Jaunsar-Bawar region, representing a 4.67% reduction in dense forest area.

The rate of change in dense forest cover from 2000 to 2015 was -3.57 square kilometers per year. The primary reason for the decrease in dense forest area is the indiscriminate logging by mafias, targeting valuable trees such as deodar, oak, and rhododendron, which fetch high prices. Local tribal villagers also contribute to deforestation by using wood for cooking fuel and livestock fodder. Additionally, destructive fires set in the forests

by the state government have caused significant damage, turning entire insect communities to ash and creating ecological crises.
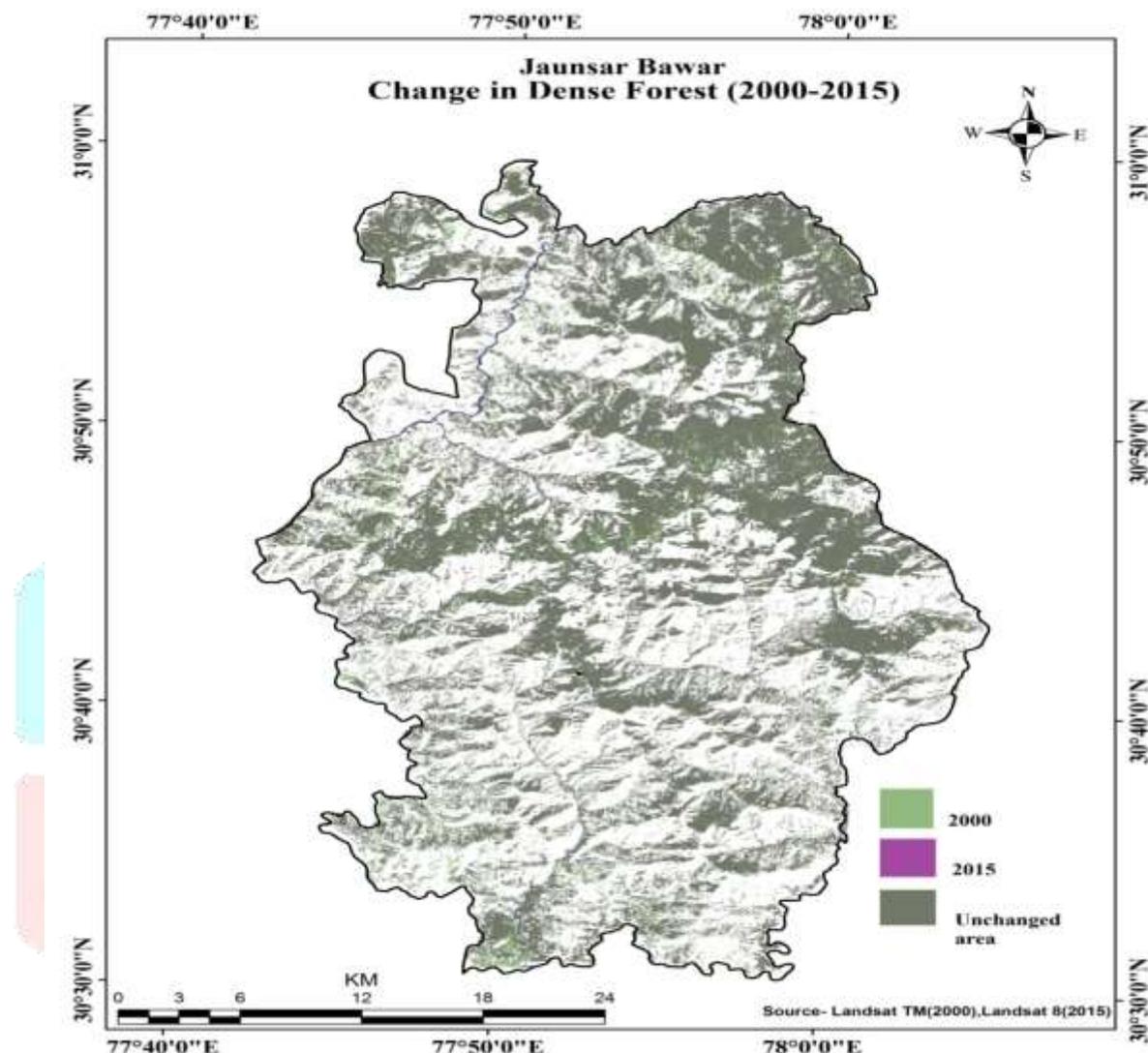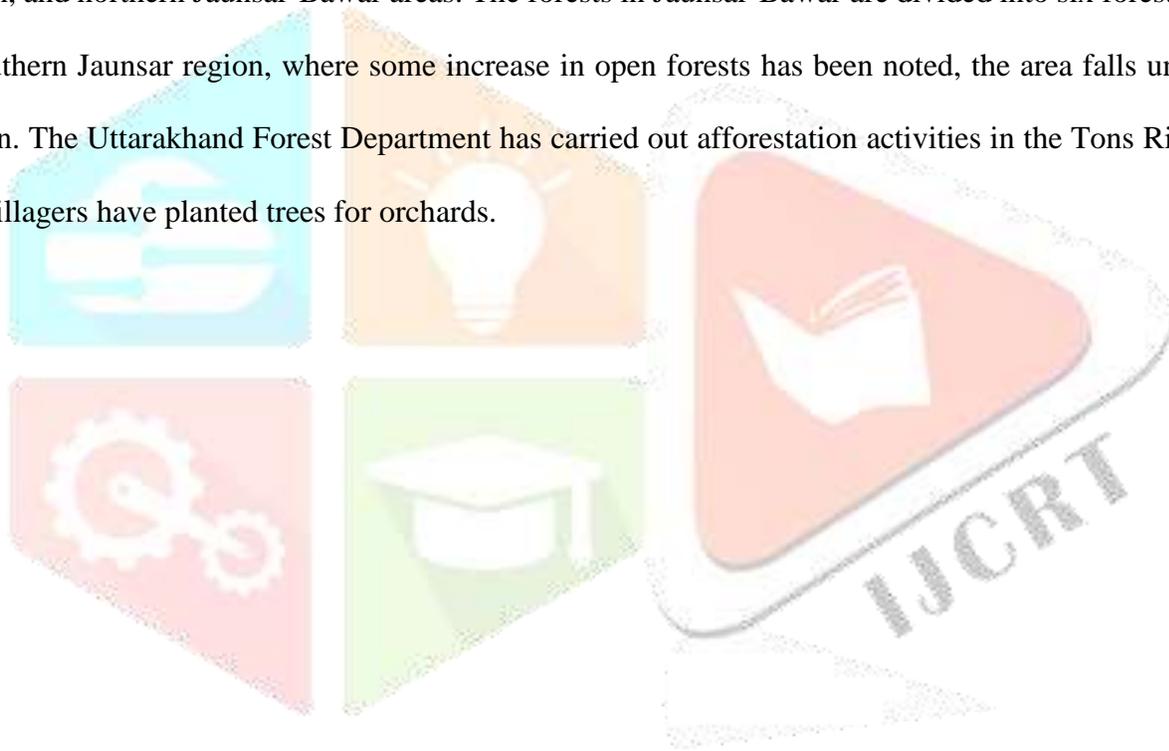

Fig- Jaunsar Bawar Distribution of Dense Forest Change in (2000-2015)

If the rate of change continues at -3.57 square kilometers per year, by 2025, the dense forest cover in Jaunsar-Bawar will be reduced to 441.84 square kilometers. This will account for only 38.50% of the total area of Jaunsar-Bawar. As depicted in Figure 4.8, the maximum dense forest cover is located in the central Jaunsar and northeastern parts of the study area. These areas are the highest regions of Jaunsar, with the Khadamba mountain being the tallest peak in central Jaunsar, standing at an elevation of 3,089 meters above sea level.

Open Forest

The geographical distribution of changes in open forest cover in the Jaunsar-Bawar region from 2000 to 2015 has been analyzed. The open forest cover accounted for 76.38 square kilometers in 2000 and 76.78 square kilometers in 2015. Over the 15-year interval from 2000 to 2015, there was a 0.40% increase in open forest cover, with a rate of change of 0.02 square kilometers per year. If this rate continues, by 2025, the open forest cover in the Jaunsar-Bawar region will be 76.98 square kilometers, which will constitute 6.70% of the total area.

The increase in open forest cover has been slow and is primarily observed in the southern Jaunsar region, central-western, and northern Jaunsar-Bawar areas. The forests in Jaunsar-Bawar are divided into six forest divisions. In the southern Jaunsar region, where some increase in open forests has been noted, the area falls under the river division. The Uttarakhand Forest Department has carried out afforestation activities in the Tons River area, and local villagers have planted trees for orchards.
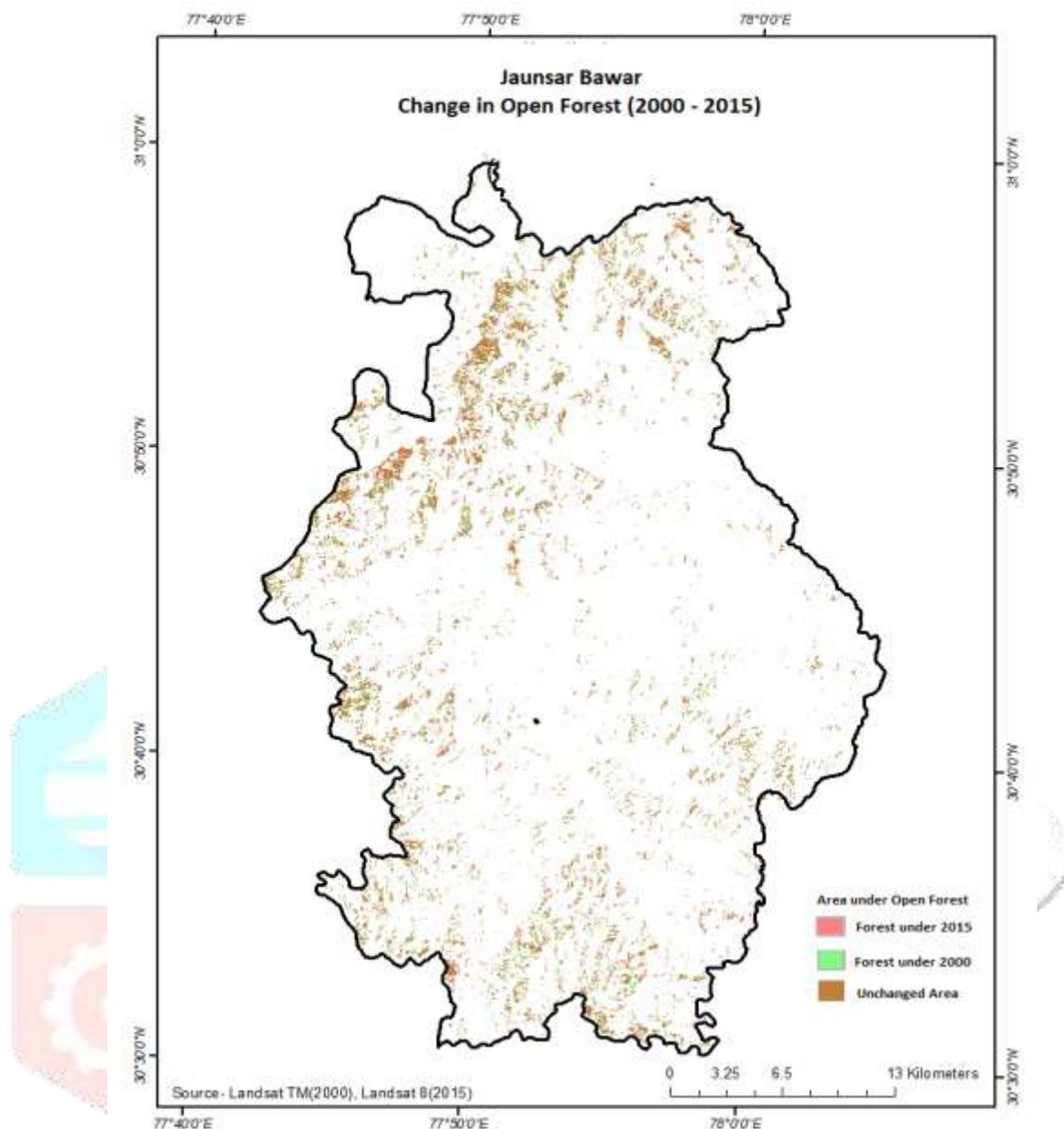
Fig:- Jaunsar Bawar Distribution of Open Forest Change in (2000-2015)

In the north-western Jaunsar region, which falls under the Devdhar forest division, various departments have conducted afforestation activities, and local villagers have planted fruit-bearing trees for horticulture. The north-western Jaunsar region has favorable conditions for horticulture, contributing to the increase in open forest cover.

Shrub land

In the Jaunsar-Bawar region, the shrubland cover was 386.45 square kilometers in 2000 and increased to 394.54 square kilometers in 2015. Over the 15-year interval from 2000 to 2015, the shrubland cover in the Jaunsar-Bawar region increased by 8.09 square kilometers, which represents a 0.70% increase in the shrubland area. The geographical distribution of this change has been analyzed. The rate of change in shrubland cover from 2000 to 2015 was approximately 0.53 square kilometers per year.
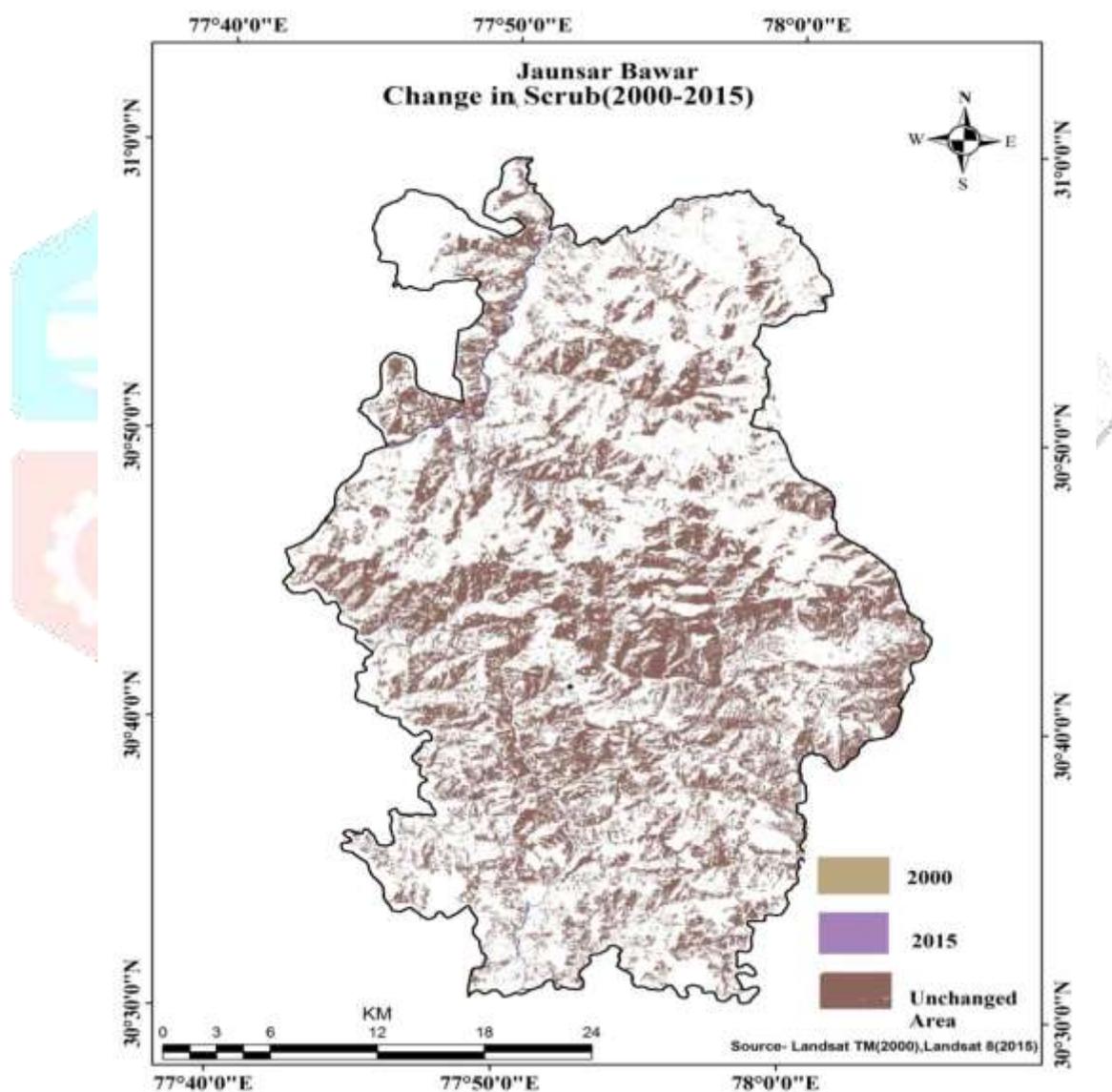

Fig- : Jaunsar Bawar Distribution of Open Forest Change in (2000-2015)

The primary reason for the increase in shrubland area is that rural people are abandoning agricultural activities, leading to the conversion of agricultural land into shrubland. This change is particularly evident in the

central Jaunsar area, southern Jaunsar, and northern Devdhar region. Agricultural land is being converted into barren land, and subsequently, barren land is transforming into shrubland.

If the rate of change in shrubland cover continues at 0.53 square kilometers per year, by 2025, the shrubland cover in the Jaunsar-Bawar region will be 399.84 square kilometers. This means that by 2025, 34.85% of the Jaunsar-Bawar region's area will be covered by shrubland.

Water Bodies

The geographical distribution of changes in water bodies in the Jaunsar-Bawar region from 2000 to 2015
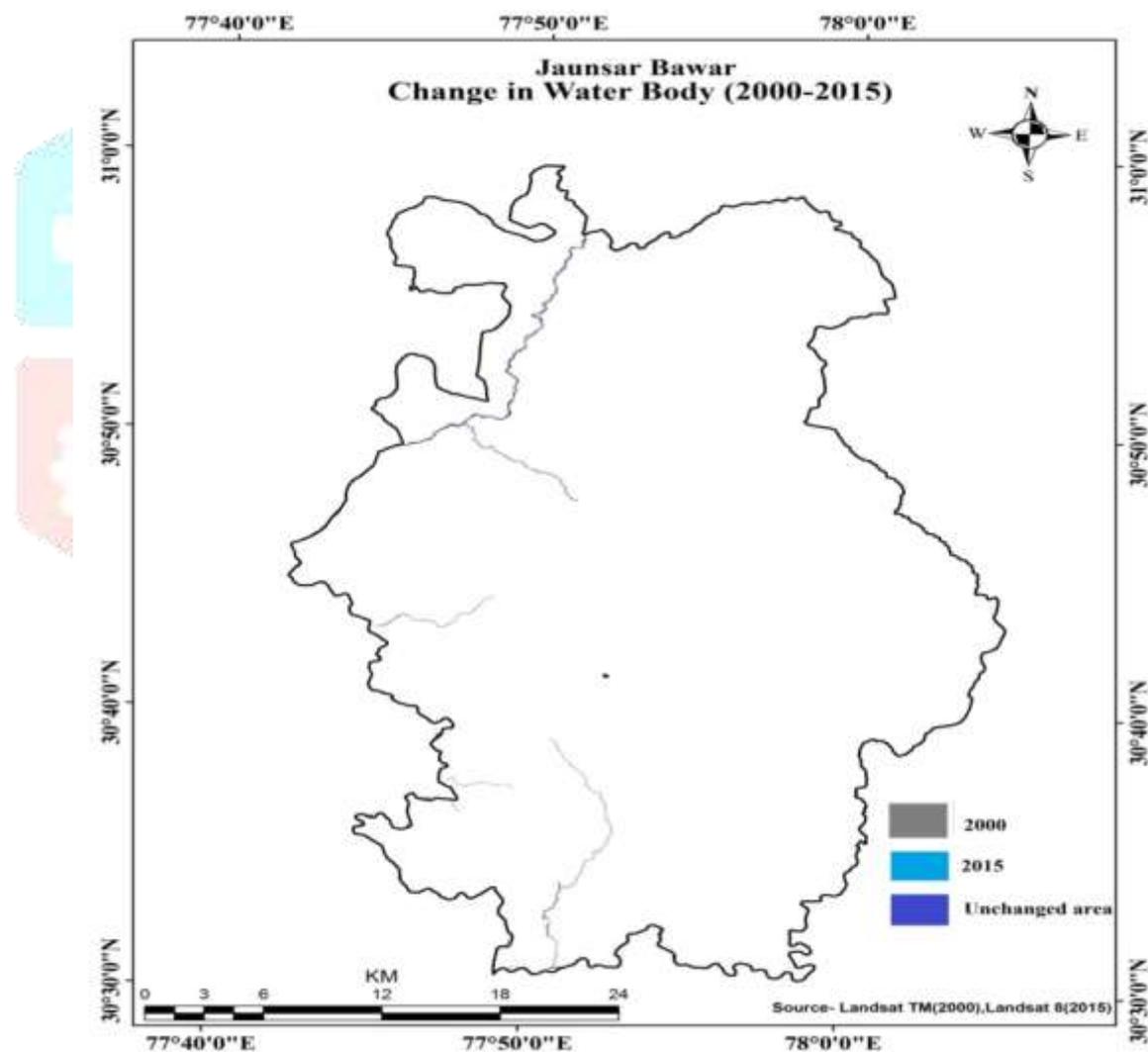

Fig- : Jaunsar Bawar Distribution of Water Body Change in (2000-2015)

has been analyzed. In 2000, the area under water bodies was 5.33 square kilometers, which decreased to 4.32 square kilometers by 2015. Over the 15-year interval from 2000 to 2015, the water body area in the study region decreased by 1.01 square kilometers, representing a 0.08% reduction in water bodies.

The rate of change in water body area from 2000 to 2015 was -0.06 square kilometers per year. If this rate continues, by 2025, the area covered by water bodies in the Jaunsar-Bawar region will be 3.72 square kilometers. This decrease in water body area is primarily due to the drying up of water streams, such as the Yamuna and Tons rivers. Additionally, terrestrial and underground water reservoirs are depleting, putting the existence of these lifeline rivers at risk.

Conclusion

Land Use and Land Cover (LULC) changes in any region are influenced by various natural and human activities. Studying LULC provides insights into the rate of change, nature of change, and spatial pattern of change. Change is a continuous process in nature. In the Jaunsar-Bawar region, statistical analysis of change detection and projection has been performed to assess changes in LULC under natural resources.

In the Jaunsar-Bawar region, the area under open land cover increased from 148.60 square kilometers in 2000 to 194.06 square kilometers in 2015. The primary reason for this increase is the reduction in agricultural land, which has been converted into barren and open land cover. Dense forest cover decreased from 531.19 square kilometers in 2000 to 477.54 square kilometers in 2015. The main reason for the reduction in dense forest area is the indiscriminate felling of trees by the mafia, targeting valuable trees like deodar, surai, oak, and rhododendron. Local tribal communities also use these forests for fuel and grazing. Destructive fires set by the state government in forests have further damaged the area.

The area under open forest increased slightly from 76.38 square kilometers in 2000 to 76.78 square kilometers in 2015. This increase is due to afforestation efforts by the forest department and local communities planting fruit trees for horticulture. Shrubland increased from 346.45 square kilometers in 2000 to 394.54 square kilometers in 2015. The area under water bodies decreased from 5.33 square kilometers in 2000 to 4.32 square kilometers in 2015.

Based on the LULC change rates from 2000 to 2015, projections for 2025 have been made. The rate of change for open land cover was 3.03 square kilometers per year. If this rate continues, by 2025, the area covered by open land will be 224.36 square kilometers. The rate of change for dense forest cover was -3.57 square kilometers per year, projecting a decrease to 441.84 square kilometers by 2025. The rate of change for open forest cover was 0.02 square kilometers per year, leading to an area of 76.98 square kilometers by 2025. The rate of change for shrubland and water bodies was 0.53 square kilometers per year and -0.06 square kilometers per year, respectively. By 2025, the area under shrubland will be 399.84 square kilometers, and the area under water bodies will decrease to 3.72 square kilometers.

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