Project Report

Geospatial Technology based approach for the tribal area development of Ganderbal District, Jammu and Kashmir-India

Submitted by

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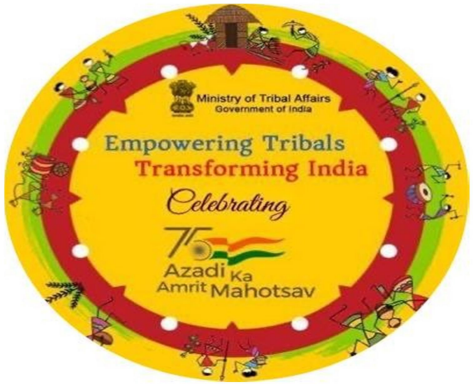

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Abstract:

The tribal area of Ganderbal, Jammu and Kashmir was studied for its geography, regional status, and development opportunities. The study used Geospatial technology, field surveys, existing data, satellite imageries, and census of India data. Geologically, the region has a diverse topography including river flows, mountain peaks, meadows, rich vegetation, glaciers, lakes, etc. The Gujjar and Bakerwal is a dominant tribe in the region and comprises about 46% of the total population. The literacy rate of the area is low compared to the neighboring non-tribal region which stands at approximately 21% lower and the female literacy is comparatively low with respect to male literacy. The study found a moderate to low economy in the area and the number of workers stands at 26% of the total population. Apart from the lack of awareness and motivation, low income plays a significant role in the low education rate. The study found a considerable change in the land use of the region from the year 1985 to 2020. The waterbodies show a decrease of 28.28% whereas the Perennial Snow shows a decrease of 31.71% and the forest area is showing a decrease of 30.55%. Further, Built-up has shown an increase of 44.97%, cropland has shown an increase of 56.30%, Scrubland/ Rock mass has shown an increase of 38.95%, and Grassland has shown an increase of 33.74 percent. The study suggests that the integration of scientific and non-scientific assessments and the use of geospatial applications will bring a broad understanding of tribal area development planning. The integrations can be dynamic for real-time assessments and therefore analyzing the present crisis, consequences, and mitigation policies.

Keywords: Geospatial Technology, Tribal Population, Tribal Development, Jammu and Kashmir.

1. Introduction:

Geospatial technology can be used for tribal area development for optimal management and better utilization towards improving the conditions of the tribal people. The National Aeronautics and Space Administration (NASA) has a long history of working with tribal nationals and tribal colleges and universities to build workforce capacities in science, technology, engineering, and mathematics (STEM). The two primary NASA programs involved are the applied science capacity building program (CBP) and the minority university research and education program (MUREP) (NASA, 2020; MAIANSE, 2020). The Bureau of Indian Affairs (BIA) is assisting tribal governments and Indian Affairs to manage cultural and natural resources by providing geographic information systems software, training, and technical support. The branch of Geospatial support (BOGS) is the technical support office to Indian Affairs (IA) and all federally recognized tribes for Geographic information systems (GIS) as part of the development of the interior- Bureau of Indian Affairs- ESRI enterprise license agreement. The significant role of Geospatial technology in tribal area development has been used by many researchers across the world (Les, 1991; Looney, 1997; Carr-Hill et.al, 1997; Ningapiah, 2001; Heredia, 2002; Mandayam, 2002; Maheswaran and Cragila, 2004; Hasnain, 2007). Further, the technology has proven its significance for the efficient management of land resources, tribal climate planning and resilience, energy potential on tribal lands, addressing tribal issues, tribal area development planning, promotional interventions, decision-making in tribal welfare, etc., (Sudeep, 2012; E. Doris et al., 2013; NABARD, 2014; Khalkho et al., 2015; Aruna Saxena, 2017; BIA, 2018). In 2015, the department of Geosciences and Natural Resources, western Carolina University, USA, published the guest editorial preface highlighting the Geospatial technologies and indigenous communities' engagement (Rebecca, 2015). The research highlighted that the intersection of Geospatial technologies and indigenous peoples is best considered in light of long-standing indigenous ontologies, innovative applications of Geospatial technologies, and advances in research ethics and participatory GIS approaches towards social justice. In general, Geospatial technology can be thought of as very useful for the tribal area development and spatial monitoring of the population, education, infrastructure development, climate change and mitigation policies, and all other related development factors, therefore immense interest in the suitable understanding of Geospatial technology and its applications.

Geospatial Technology includes Geographic Information systems (GIS), Remote Sensing (RS), and Global Positioning System (GPS). Geospatial technology allows us to obtain data that is referenced to the earth and can be for analysis, modeling, simulations, and visualization (Kamel and Elsirafe, 1994; Arlegui and Sorino, 1998; Suzen and Toprak, 1998; Lillesand and Kiefer, 1999; Saraf, 2000; Dell and Gamba, 2012; Anwar et al., 2013; Dar, 2015; Ayaz and Bukhari 2019). The ability to obtain information about any object or phenomenon has made Remote sensing applications significant across the globe with huge demand. The nature of Remote sensing applications has made the leading space agencies touch the skies with theis increasing technologies. The space agencies like the National Aeronautics and Space Administration (NASA), European Space Agency (ESA), Indian Space Research Organization (ISRO), China National Space Administration (CNSA), and others have shaped the digital world

significantly. Further, the advancement in software technologies has reached efficient satellite image analysis and has made remote sensing studies most preferable with vast applications. The basic mechanism of remote sensing is that it uses the part of the electromagnetic spectrum to record the reflections or emissions by the surface. However, the interpretation of satellite data depends upon the nature of the study and the type of imagery. The number of bands, band ratio, resolution, and georeferenced system are directly linked to the image quality, image analysis, and observations of the study. The use of high-resolution satellite imageries and digital elevation models has been proven significant for large-scale field investigation within less time and with high precision. Remotely sensed data enables large-scale investigation of the land features and mapping using satellite imageries is important for different studies in design perspectives in engineering, geology, climate, and landscape evolution and monitoring. In the present study, the attempt was made to use Geospatial technology for the tribal area development of Ganderbal District, Jammu and Kashmir.

2. Data and Methods:

The satellite data, census of India, geospatial software's, Ground truthing, and Vocal conversations are the main datasets that are used for this study. The remote sensing analysis was used to study and estimate the land cover and to understand the features by digital and visual interpretations of satellite imagery. Based on our study, the Panchromatic and Multispectral satellite imageries were used for these interpretations. The aim of obtaining the remotely sensed data was based on considering algorithm transformations and networking analysis, and therefore suitable imageries were used for the study. The study used LANDSAT 8, EO-1 Hyperion, SENITAL-II, LISS IV, and Digital Elevation Models for appropriate outcomes (Nagy, 1972; Sabins, 1987; Cracknell and Hayes, 1993; Jensen, 2005; Lu and Weng, 2007; Fonseca et al., 2009; Qi et al., 2015; Ayaz and Bukhari, 2020). The description of the datasets used for the study is given in Table 1. The geometric correction methods were used to correct the satellite imageries and to represent their position for exact locations related to the earth's surface. These methods were used to fix the displacements produced by images and to match the pixel locations of the earth's surface. The techniques of Geo-rectification and Ortho-rectification methods were used to define the coordinate system and to correct the distortions produced by images. The images were digitally operated and precisely matched with the projection of the study area. The referencing system of WGS-1984-UTM-ZONE43N was set as an internal coordinate system and stored within the image file for all obtained datasets. The reference maps collected for the study area were georeferenced by control point methods and polynomial techniques for further analysis. Image classifications were used to identify the surface features based on digital interpretation, visual interpretation, and quantitative techniques. Our study used a combined classification method for land use, and land cover classification in the region. The combined classification method is a combination of unsupervised and supervised classification and recoding techniques. The spectral analysis workstation, target, and anomaly detections were used for spectral recognition of surface features. The object-based classification, classification of mixed pixels,

neural networking, and principal component analysis were also tried for better recognition of surface features. Further, the census of India data was used and the database for the study area was created and imported to the GIS software. The software's including ArcGIS, Erdas Imagine, and Google Earth Engine was mostly used for this study. The decadal land changes were assessed via EarthData (NASA database) and Bhuvan (ISRO database) and were integrated with the LULC digital map calculated by convenient methodology from our study.

Table 1. Details of multiple datasets used for monitoring and mapping in the study.

Dataset	Acquisition Date	Spatial Resolution or scale	No. of bands	Source
ASTER Level 1T	2007/11/27	15 m	14	https://earthexplorer.usgs.gov/
Linear Imaging Self-Scanning Sensor (LISS III)	2008/10/03	23	04	https://bhuvan-app3.nrsc.gov.in/data/download/index.php
Landsat-8 Operational Land Imager	2017/10/04	30m	11	https://earthexplorer.usgs.gov/
Sentinal-2A	2018/09/20	10, 20, 60	13	https://earthexplorer.usgs.gov/ https://glovis.usgs.gov/
Google Earth	2018/12/02	15m-15cm		https://www.google.com/intl/en_in/earth/
Hyperion EO-1	2017/06/01	30m	242	https://earthexplorer.usgs.gov/
ASTER GDEM		30		

3. Study Area

The study area lies in the northern extent of India, at the foothills of the great Himalayan Mountains. The region consists of an area of approximately 1370 km^2 and has a diverse topography. The area has a total population of approximately 297446 including 61070 of the tribal population which makes up approximately 25% of the total tribal population. The geographic location of the study area is represented in Fig. 1.

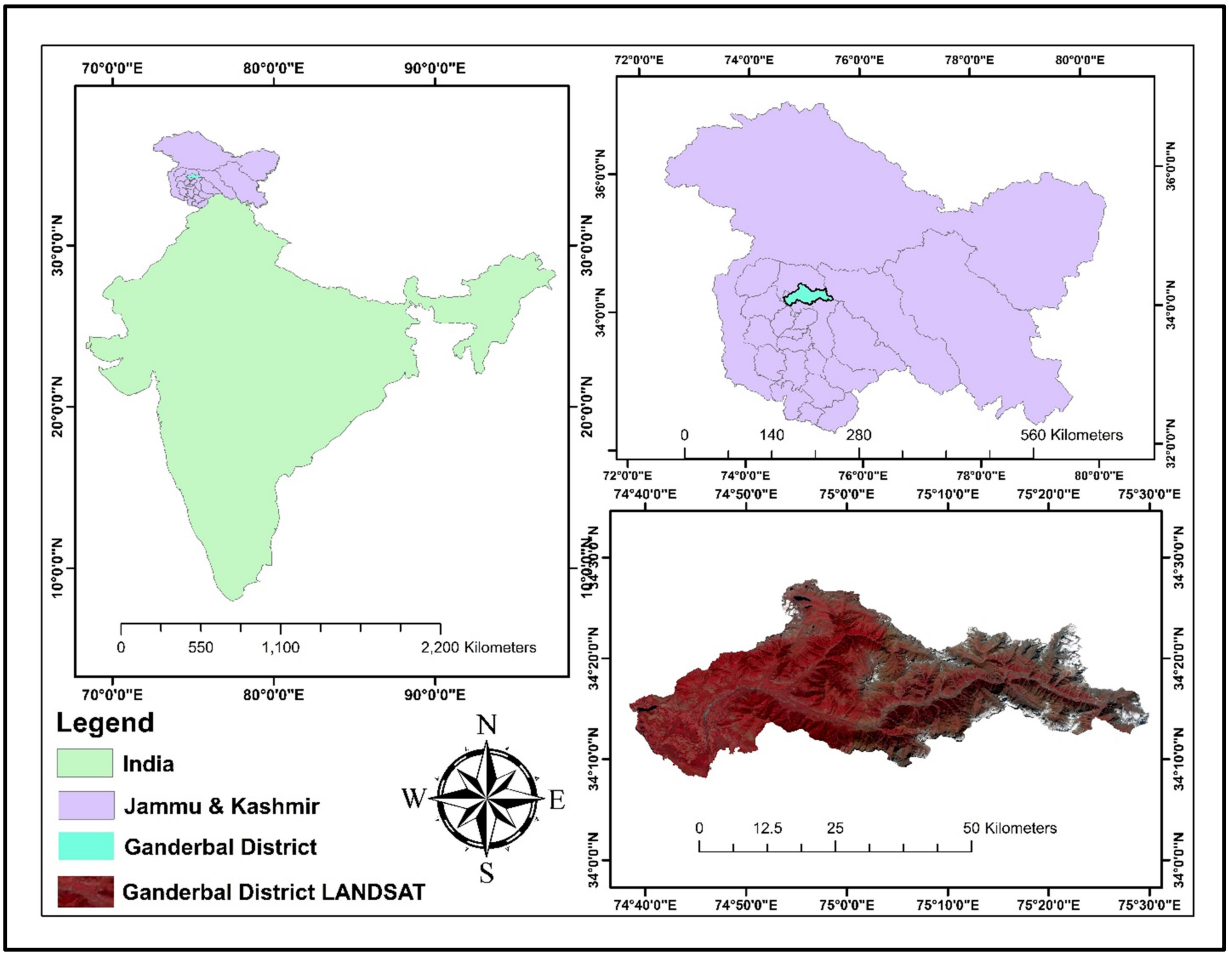

Fig. 1 Geographic location of the study area.

The topography of the area is wide-ranging consisting of high mountain peaks and low-lying areas. The elevation map was projected using a digital elevation model (ASTER DEM) which was assessed via the United States Geological Survey portal. The model represents that the area is consisting of high peaks of approximately 5000m above mean sea level, as well as low-lying areas of approximately 1500m above main sea level as represented in Fig. 2. The highest mountain peaks including the Harmukh mountain ranges and Panjtarani mountains, lie towards the northeast of the region. The area contains the rigged topography and features some of the most important glaciers of the region including Harmukh glaciers and Thajwas glaciers.

The area also consists the low lying areas including the wetlands at an elevation of 1500m above main sea level, therefore featuring the varied regional slopes in the area.

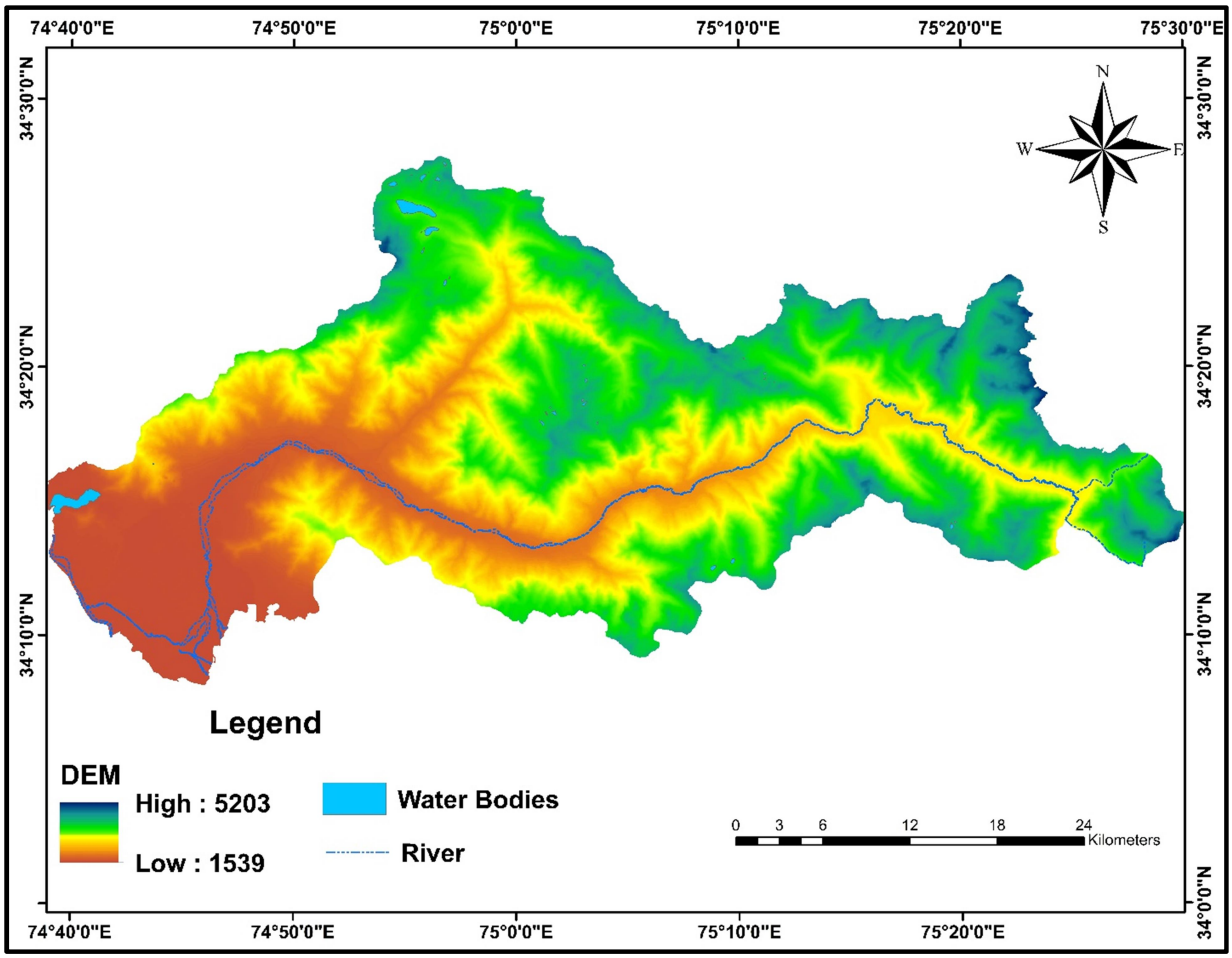

Fig. 2 Elevation map of the study area.

4. Results:

The Ganderbal district reflects a green land with the majority of the region covered with lush green forests (Fig. 3). About approximately 46% of its total land is occupied by forest cover and the low-lying areas are dominated by agriculture and horticulture. The dense settlement is present on the western side of the region as well as the lesser settlement distributions along the highland regions. Detailed information about the land use and land cover can be viewed in the map represented in Fig. 4.

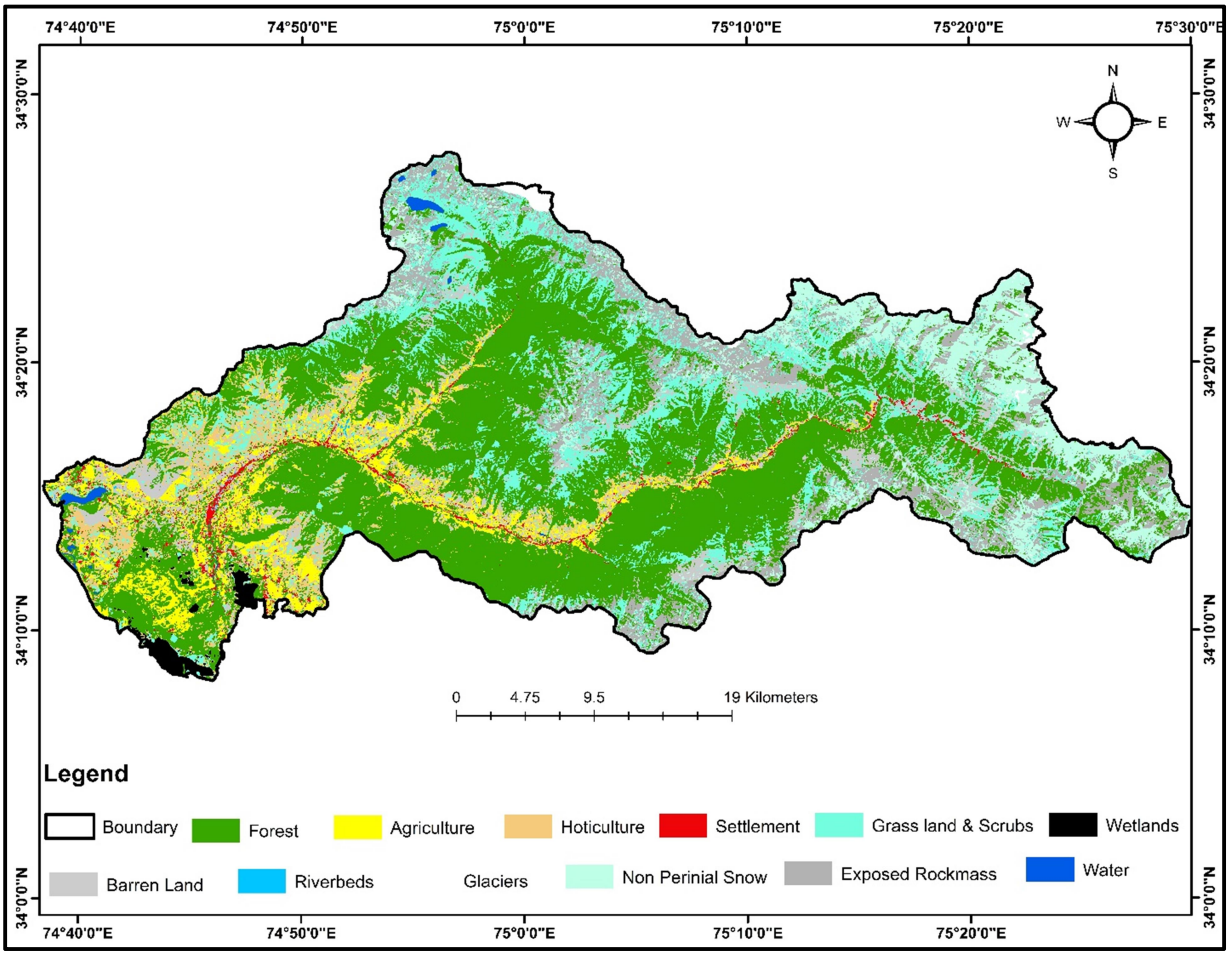

Fig. 3 Land use Land cover map of district Ganderbal.

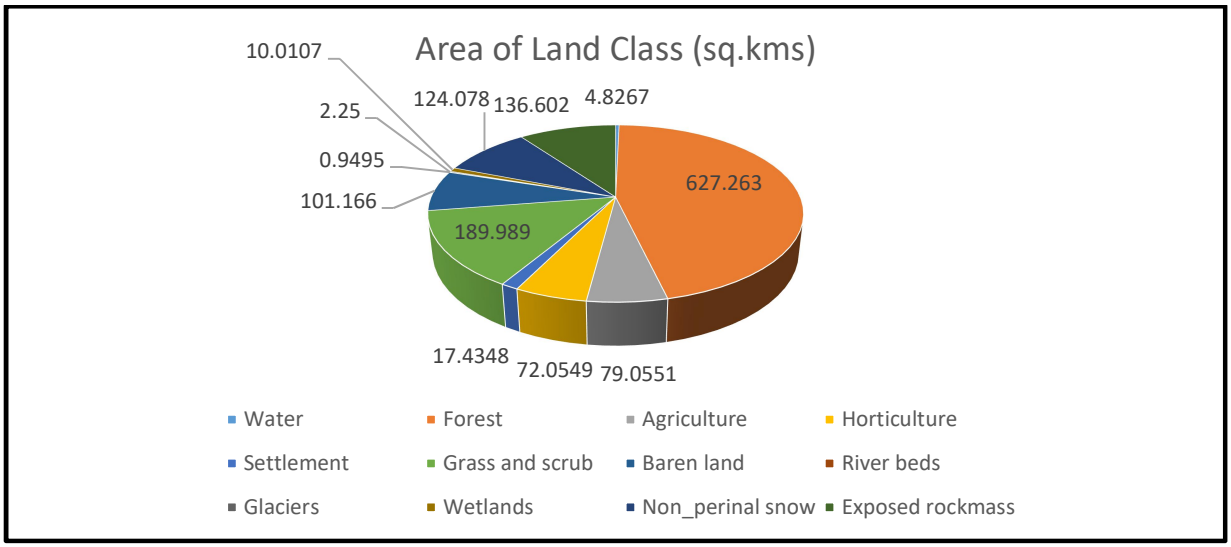

Fig. 4 Statistical description of Land use Land cover in district Ganderbal.

The district Ganderbal is dominated by the forest cover which consists of approximately 627 km^2 of the total land followed by approximately 189.9 km^2 of grass and scrubland. The region has agricultural land of 79 km^2 and horticulture land of 72 km^2. The water bodies of the region consist of 4.8 km^2 which include the greater Himalayan lakes in the upper region and the Manasbal Lake in the low-lying region. The region has glaciers spread over 2.2 km^2 and plays a larger role in river dynamics during the melting of these glaciers. Apart from glaciers, the region covers widespread areas of Non-Perineal snow which make a total of 124 km^2 and provides considerable water flow during the summer season for agricultural activities. The Ganderbal district also gives space to the wetlands in its low-lying areas including the Shallabugh wetland, a Ramsar site, and the total wetland areas are spread over an area of approximately 10 km^2. The region also covers the large exposed rock mass at its upper reaches which makes a total area of approximately 136.6 km^2.

The agricultural section of the region is mostly restricted to the lower regions whereas the lesser distributions can be seen ranging towards the upper regions which follow the linear pattern. In the upper regions, the agricultural land is mostly lying along the banks of river Sindh and Naranag Nalla, a tributary of the Sindh River. Further, the horticulture of the region is also following the agricultural pattern and is spread within the periphery of agricultural land. The pattern of agricultural and horticultural land shows that these sections are only spread to a smaller extent and are mostly affiliated with the drainage network of the region. Contrary to these sections, the forest cover in the region is wide-ranging and dense except in the areas of exposed rock mass and less frequent in the settlement region. Further, the settlement of the district Ganderbal also follows the path of lower slopes and is dense in low-lying areas and linearly distributed towards the upper reaches.

4.1. Tribal region of Ganderbal District:

This study was carried out to evaluate the populous tribal villages of Kangan Tehsil, district Ganderbal and to fetch prevailing developments using geospatial approaches and field surveys. In this study, 26 villages of Tehsil Kangan, consisting of a high percentage of schedule tribes, were studied via ancillary data and geospatial technology. The study area is located in the northeast of Kashmir valley and is part of the topography related to the great Himalayan mountain ranges (Fig. 5).

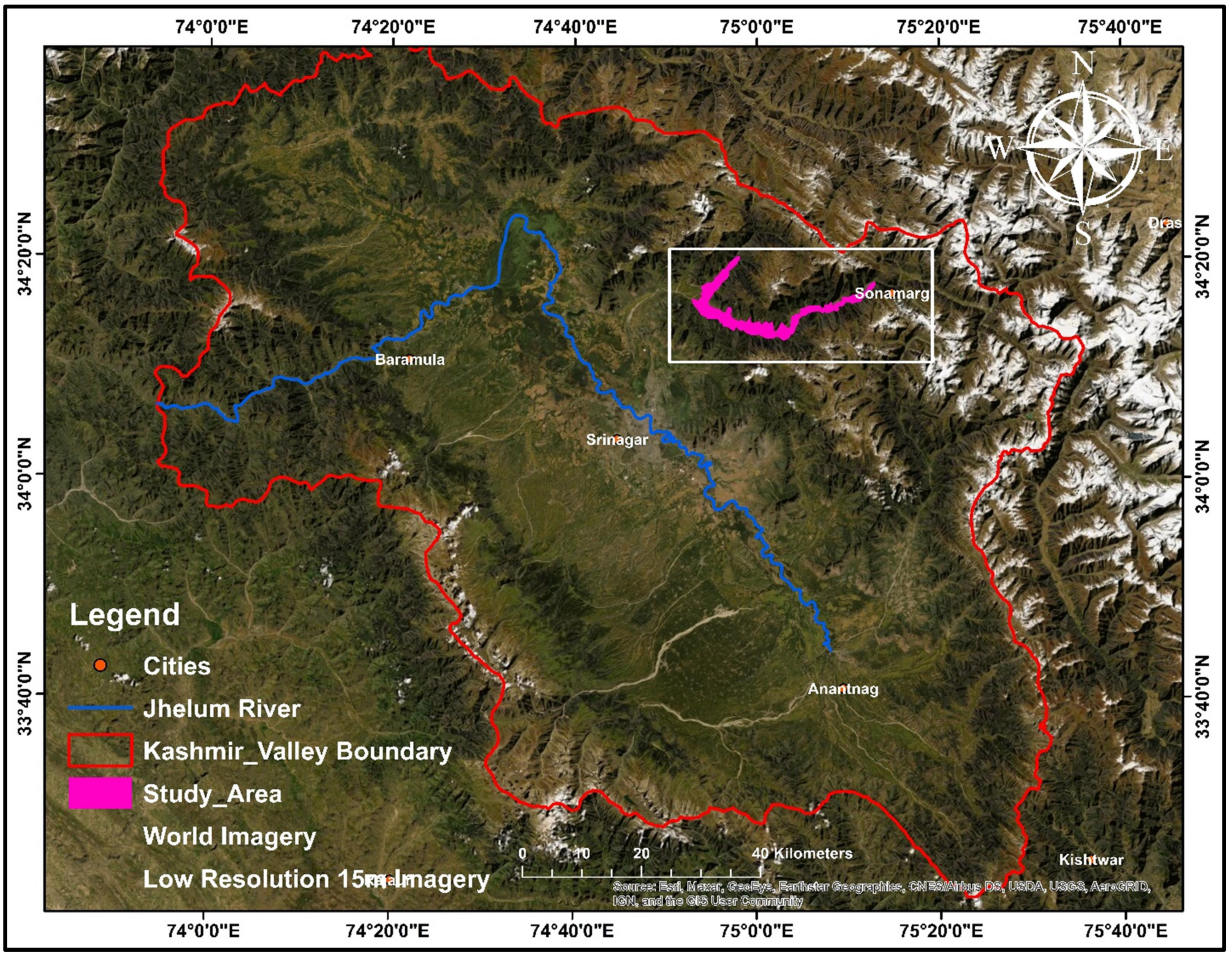

Fig. 5. Geographic location of the tribal region of Ganderbal. The pink polygon enclosed in a white rectangle represents the study area. The red line represents the boundary of the Kashmir basin.

4.2. Geographic identity and population distribution:

The study area is consisting of 26 villages and represents a settlement of approximately 70 km^2 in a curvi-linear stretch. It is geographically located at 34^o 16' 54"N, 74^o 53' 21"E to 34^o 17' 08"N, 75^o 22' 18"E with topographic variations of approximately 6000ft to 9000ft above main sea level. The villages fall in mountain topography and are attributed to the greater Himalayas and Sindh Nallah in particular. The region has a total population of approximately 70 thousand which includes 33 thousand population of schedule tribe (ST) i.e. 46% of the total population (Fig. 6). The Gujjars and Bakarwals dominate the tribal population and are characteristic in their culture and social communication.

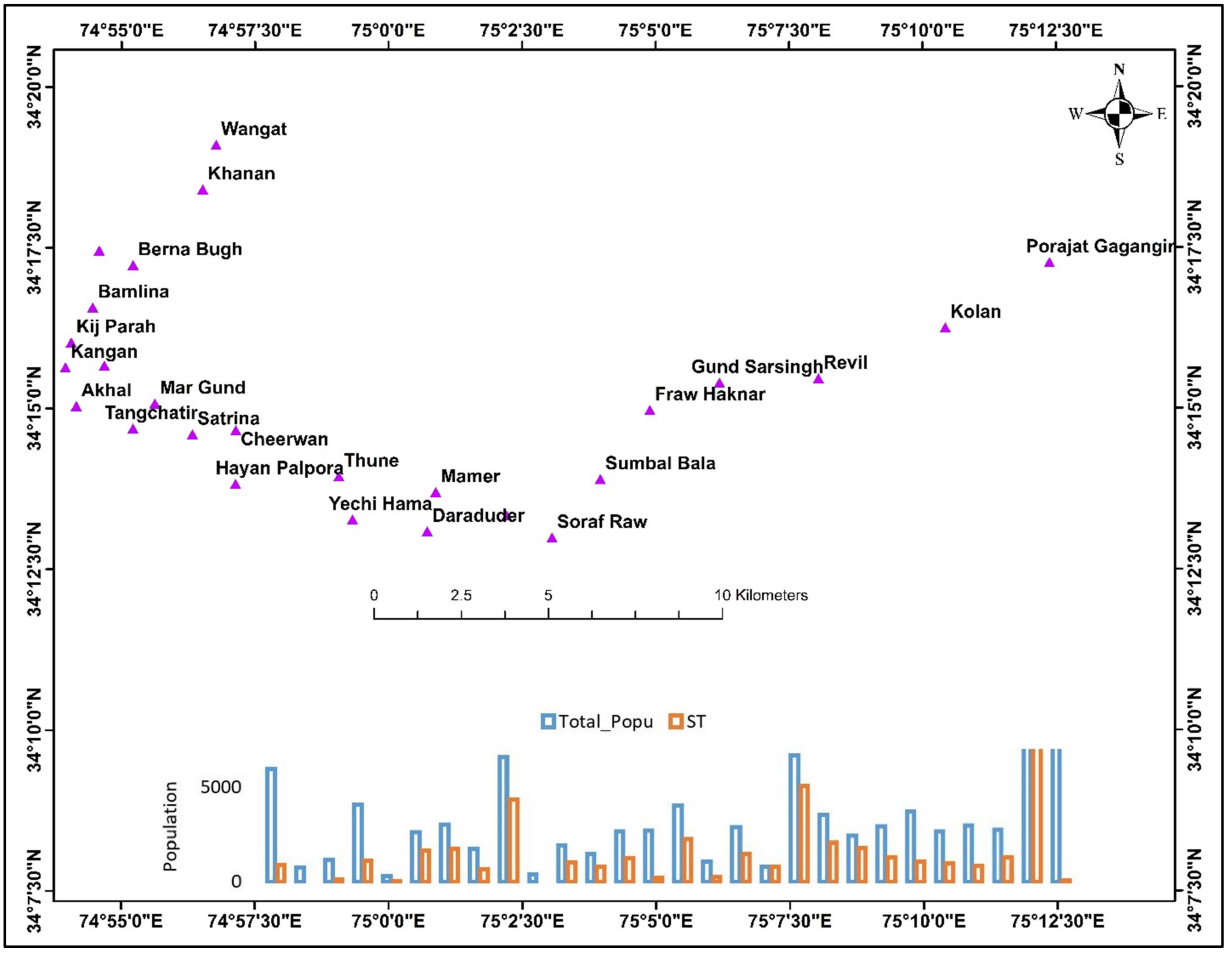

Fig. 6. Geographic location and tribal Population in Ganderbal.

4.3. Literacy:

The literacy rate of the region is approximately 55% which stands at 21% lower than the average literacy of Jammu and Kashmir. The Kangan town, which is the west extension of the cross-section (Fig. 7) and nearest to the urban class has a literacy rate of 79.7%, and 14% of the tribal population. The Gagangir village at the east extension of the cross-section has a literacy rate of 42% and 47% of the tribal population. This also shows that the literacy rate is decreasing nearly half with the increase of the tribal population and vice versa. The Gagangir village is approximately 30km distant from Kangan town and the graph (Fig. 7) shows a gradually decreasing trend in the literacy rate and therefore signifies the remoteness also as a fall-off factor.

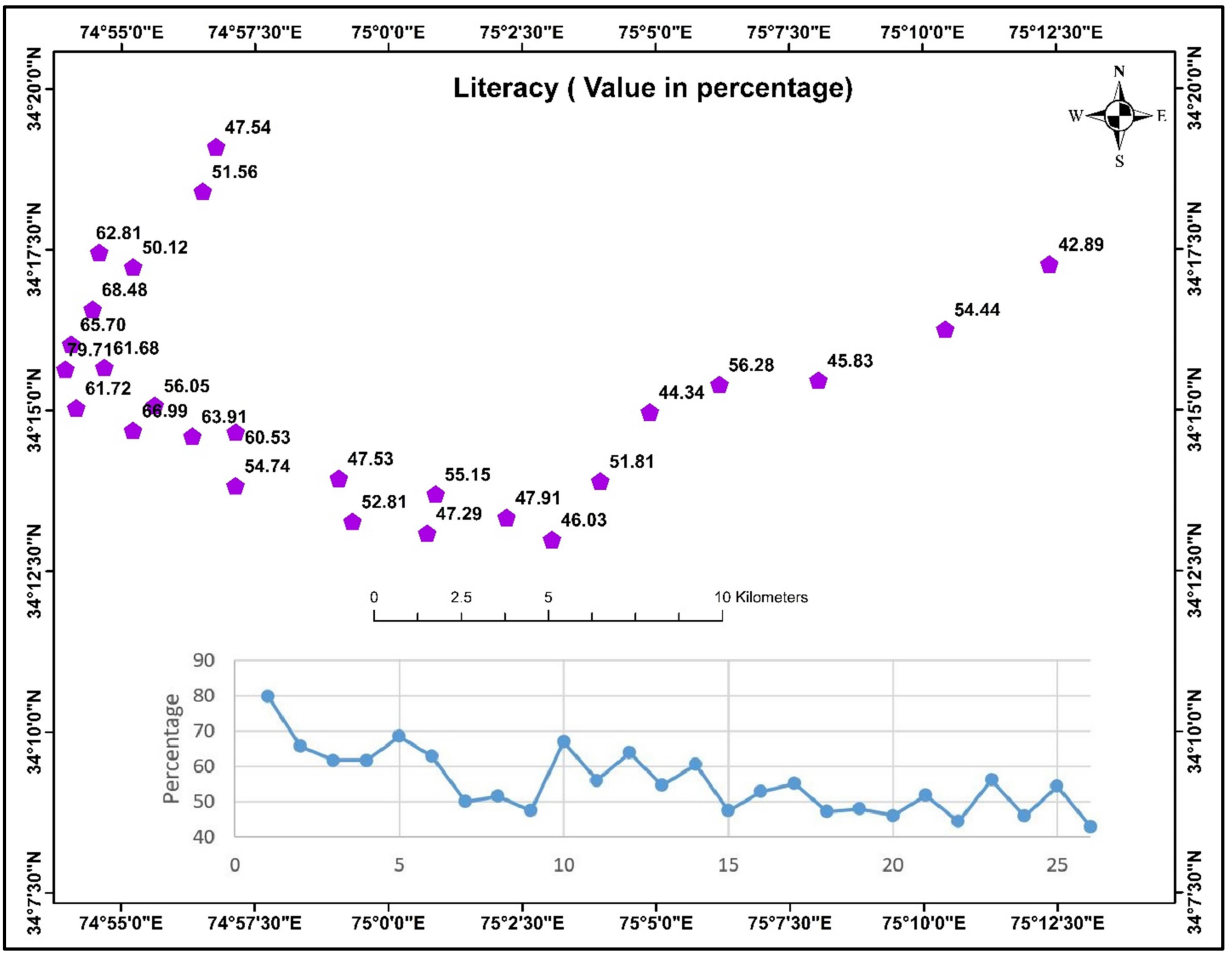

Fig. 7. Literacy rate of the tribal region of Ganderbal.

Further, considering the public communications and ground truthing, the study suggests that the lack of educational awareness, guidance and counseling, and motivation plays a significant role in the literacy dip.

The female literacy of the region stands at 43% which is 24% lower than male literacy and 33% lower than the average literacy of Jammu and Kashmir. The study suggests that the lower proportion of female literacy is a significant worry among all the highly populated tribal villages in the region. Some of the villages show a literacy rate of around 35% and even lower as represented in Fig. 8. The remoteness and awareness discrepancy is considered as the major implications for literacy decrease in females.

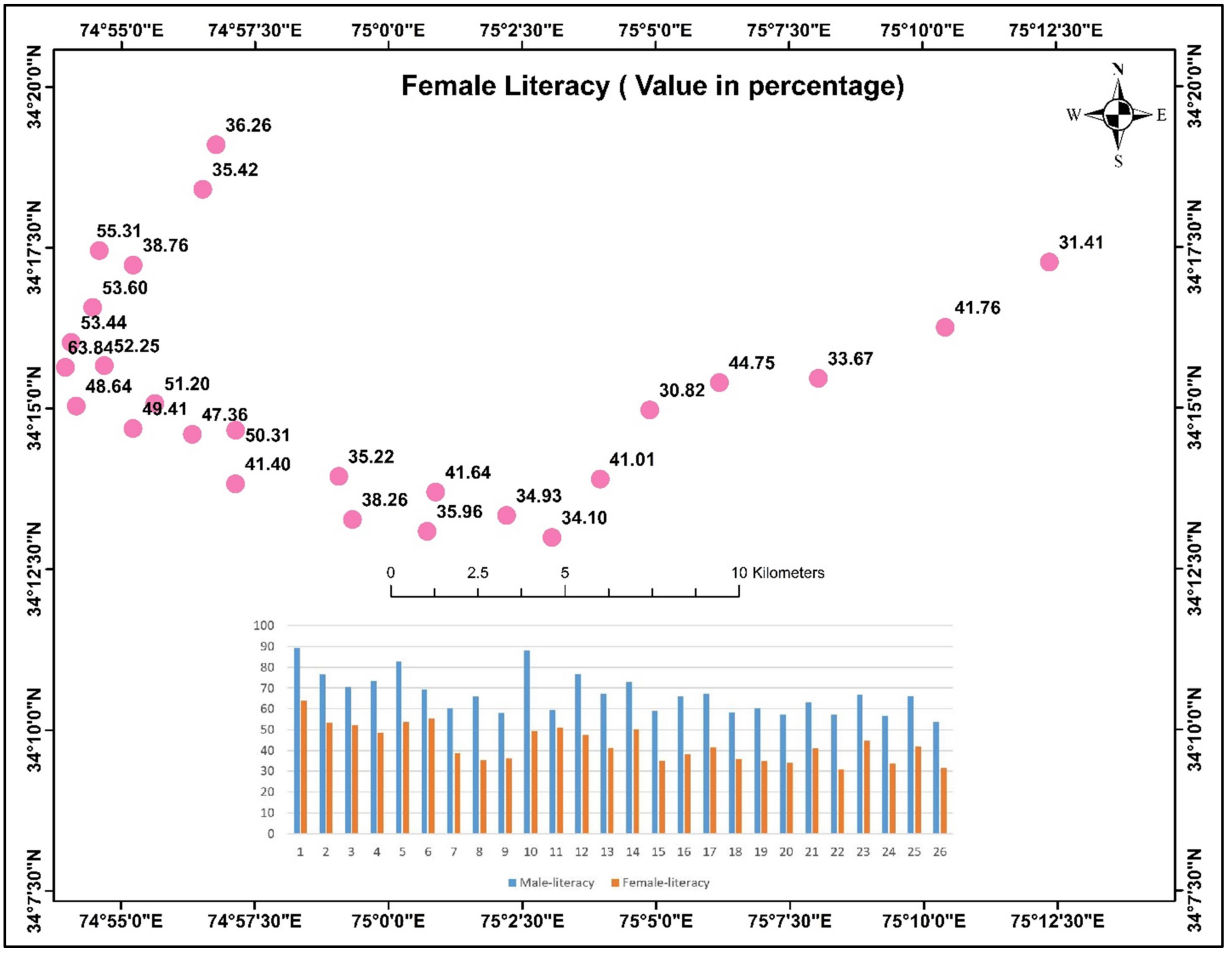

Fig. 8. Status of Female Literacy in the tribal region of Ganderbal district.

4.4. Employment Status:

The study area has a total population of approximately 70 thousand among which 19 thousand are workers according to the survey of India, Census 2011 (Fig.9). However, the proportion of female workers stands at 17% and is even lower than 10% in 9 out of 26 villages. The proportion of female workers is very less compared to the male workers in the region (Fig.10). Further, the volume of workers also lessens with the increase in the remoteness of the villages from the Kangan town. Considering the public communications and ground truthing, the study suggests that the region perceives the financial uncertainties and therefore necessitates employment generation.

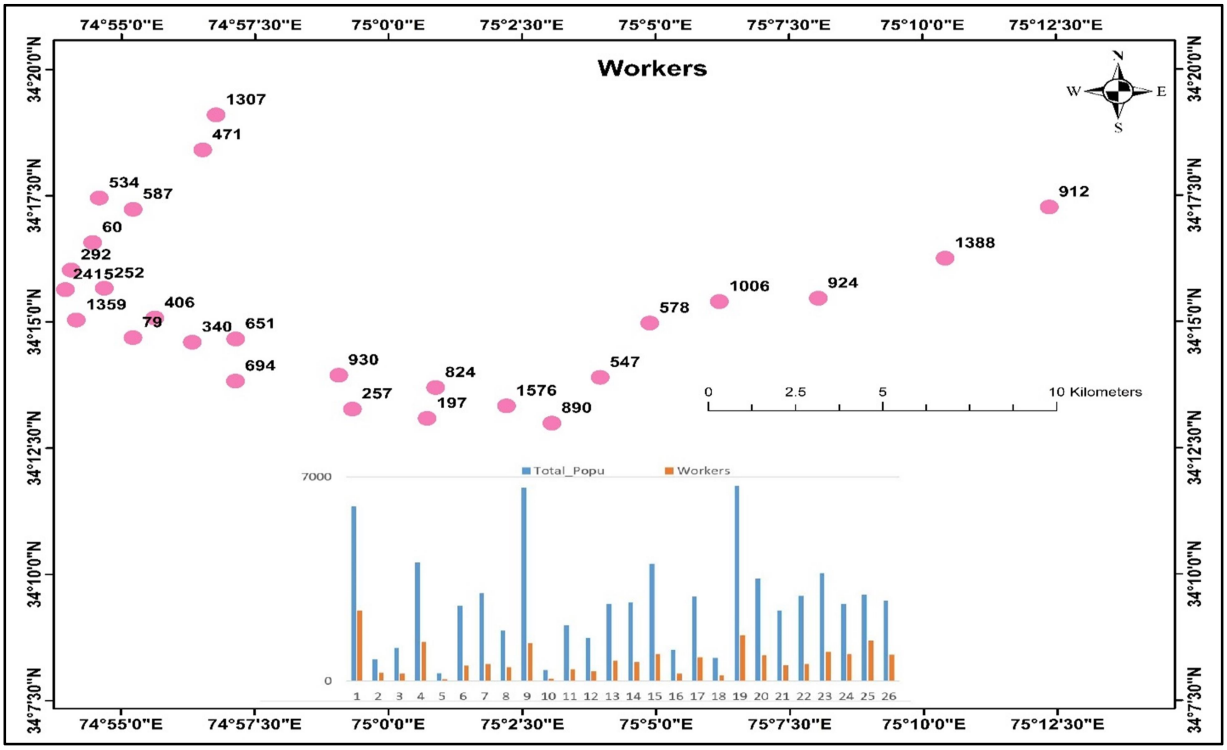

Fig. 9. Employment status in the tribal region of Ganderbal district.

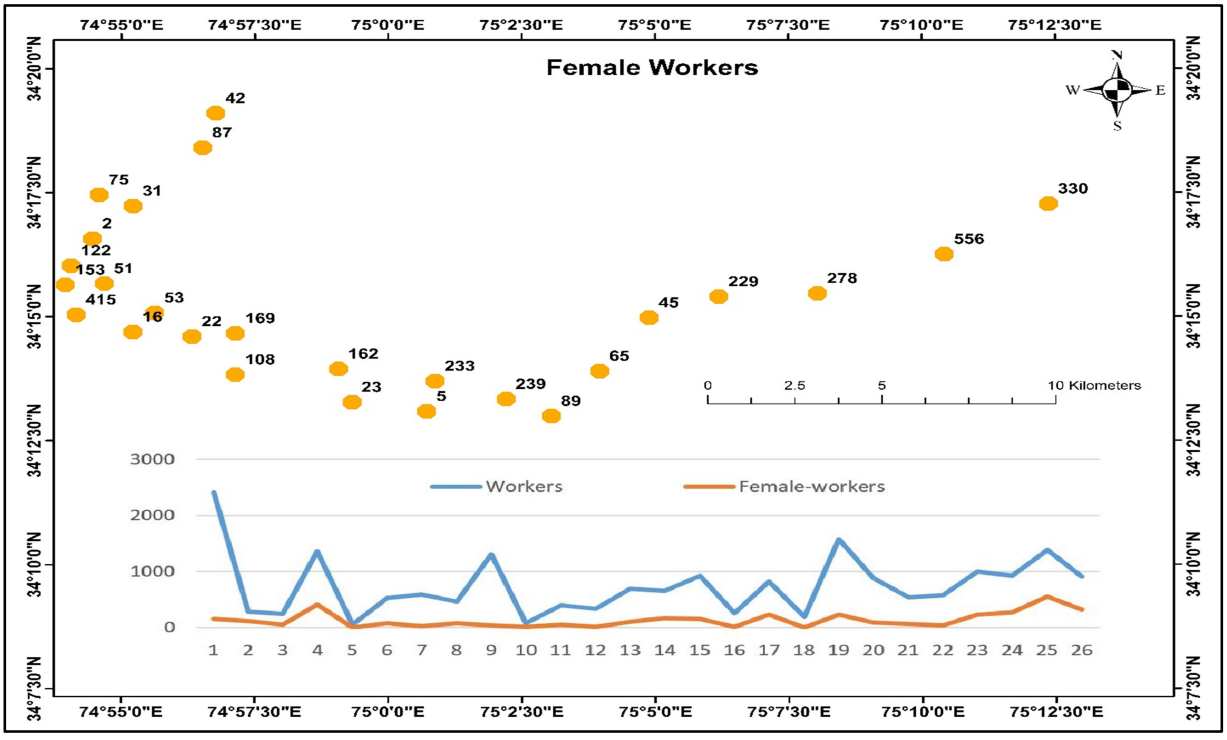

Fig. 10. Women employment status in the tribal region of Ganderbal district.

4.5. Land Classifications:

The study area is surrounded by the lush green forests and is spread to a larger extent. The major land classes in and around the study region include Forest, Agriculture, Horticulture, Water, Settlement, Grass and Scrub, Exposed rock mass, and Non-perennial snow. The black dots in (Fig. 11) represent the location of villages on the land use land cover map. The study shows the sizable land features of agriculture as well as the ample traces of horticulture. However, these classes decrease in the area with respect to the distance from Kangan town along with the decrease in the settlement. Being a mountainous topography, the study region features a diverse landscape ranging from mountain peaks to ridges. The study area is also featured by glaciers and therefore gives shape to the well-structured type of drainage system. Further, the adjacent landscape also features grasslands which act as the most suitable periphery for the animal ecosystem.

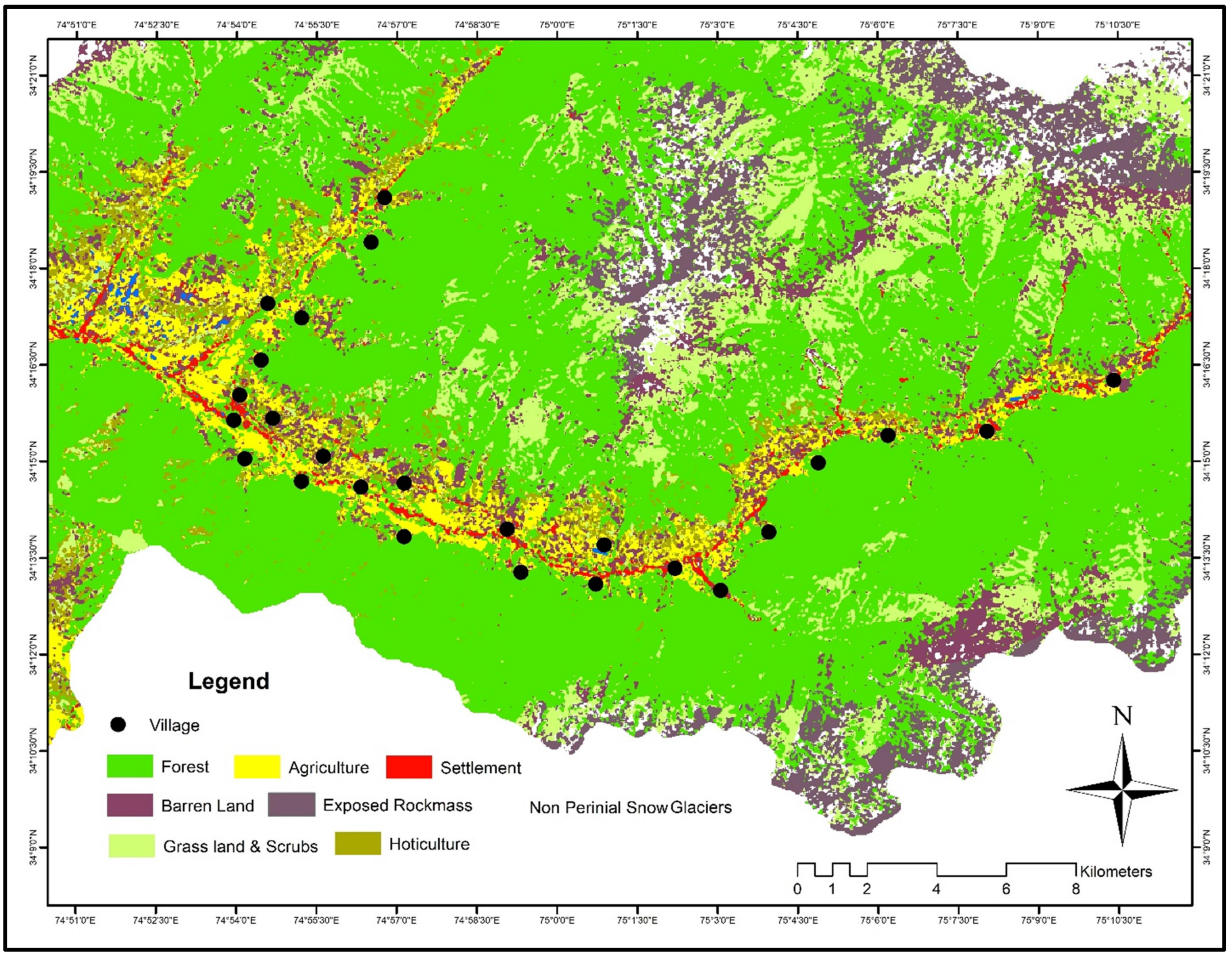

Fig. 11. Land use in the tribal region of Ganderbal district.

4.6. Land use changes in the Tribal region of Ganderbal district:

The land use classifications and the change detection for the period of 35 years starting from 1985 to 2020 were estimated as represented in Figure 12. The major land classes were considered for the change detection which include Cropland, Built-up, Scrubland/Rock mass, Water, Grassland, Forest, and Perennial Snow. The cropland has shown an increase of 56.30% and was seen as 30.53 km^2 in the year 1985 and 47.72 km^2 in the year 2020. The Built-up has shown an increase of 44.97% and was recorded as 6.04 km^2 in the year 1985 and 8.75 km^2 in the year 2020. The Scrubland/ Rock mass has shown an increase of 38.95% and was recorded as 2.67 km^2 in the year 1985 and 3.71 km^2 in the year 2020. The Grassland has shown an increase of 33.74% and was recorded as 137.02 km^2 in the year 1985 and 183.25 km^2 in the year 2020. However, there is a considerable decrease in the imperative resources including Water, Forest, and Perennial Snow. The water bodies show a decrease of 28.28% whereas the Perennial Snow shows a decrease of 31.71% during the period of 35 years. Further, the forest area is showing a decrease of 30.55% and was recorded as 726.32 km^2 in the year 1985 and 504.39 km^2 in the year 2020. A detailed description of the land use changes in the region is given in Table 2.

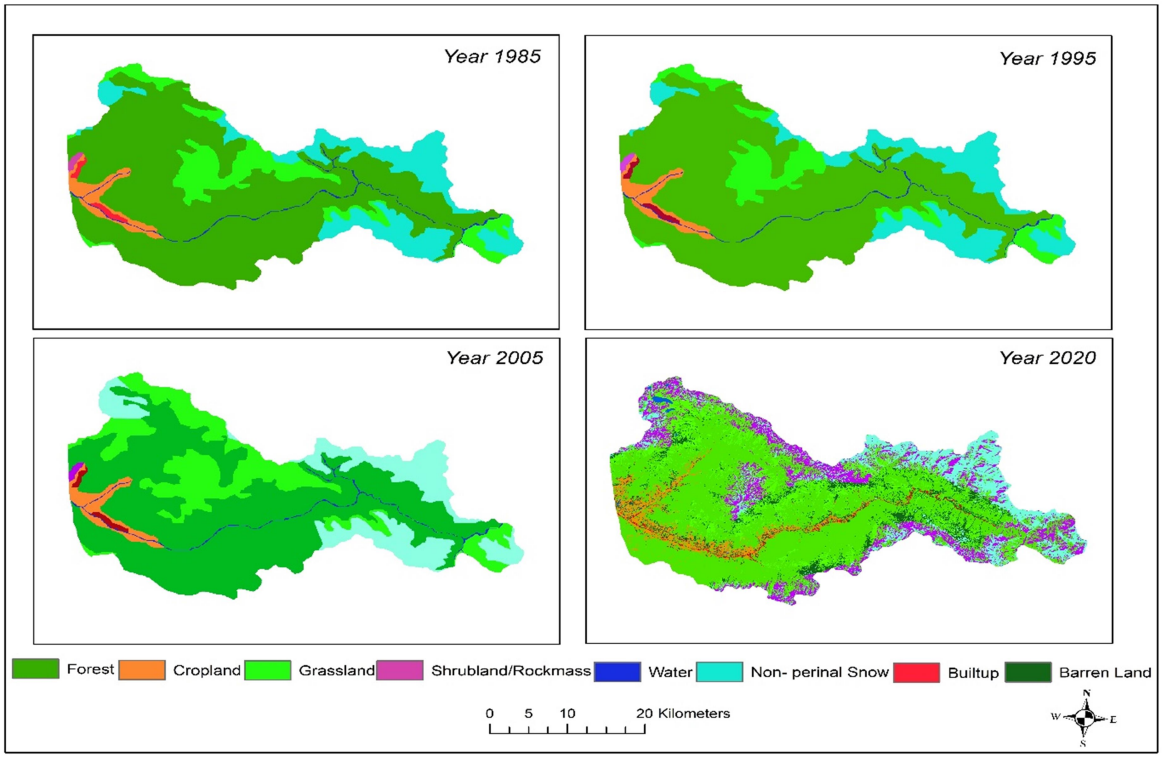

Fig.12 Land use changes in the populated tribal region of Ganderbal from 1985 to 2020

Table 2. Statistical description of the land use changes in the tribal region of Ganderbal

Land Feature	Year-1985 (sq.km)	Year-1995 (sq.km)	Year-2005 (sq.km)	Year-2020 (sq.km)	Change in 35yrs in %
Cropland	30.53	30.53	35.71	47.72	↑ 56.30
Built-up	6.04	6.04	6.88	8.7562	↑ 44.97
Scrubland	2.67	2.67	2.62	3.71	↑ 38.95
Water	10.28	10.28	10.31	7.3724	↓ -28.28
Grassland	137.02	118.82	150.54	183.2573	↑ 33.74
Forest	726.32	743.73	648.21	504.3915	↓ -30.55
Perennial Snow	179.17	179.96	160.76	122.3406	↓ -31.71

5. Discussion:

The Ganderbal district can be seen as an attractive land surface which is containing almost every land feature and can be therefore perceived as an ample opportunity for ecological empowerment as well as wealth incitement for its people. Further, the biological diversity and its exploration in the upper reaches of district Ganderbal can be a big boost to the tribal people who are mostly residing in these areas. Further, the detailed investigations of the plant dynamics using advanced scientific tools will bring greater insights into unexplored land surfaces of mountainous regions of the district Ganderbal. The tribal population of the Ganderbal district are residing in the upper regions, nearing the mountainous areas. The people are highly affiliated with the greater land slopes and unexplored plant genomics. Further, these areas have the least agricultural and horticultural diversity and are highly occupied by barren lands and non-perineal snows. Keeping this in view, detailed land scientific studies can be thought of utmost importance where integrated geospatial techniques in association with biological studies can play a greater role.

Based on the geospatial analysis, the study suggests that the region has gone through recent land use changes. The difference is seen due to insufficient irrigation which is undoubtedly linked to climate change and the recession of glaciers. The land use change has certainly played the role in the recession of agriculture. The Study consists of 26 villages, all included in tehsil Kangan of district Ganderbal and geographically situated in the mountainous landscape of greater Himalaya. The Gujjar and Bakerwal is the dominant tribe in the region and comprises about 46% of the total population. The literacy rate of the region is low compared to the neighboring non-tribal region which stands at approximately 21% lower. The fall in the literacy rate is due to many reasons among which include remoteness, unavailability of education awareness, and insignificant motivation. The proper management of education infrastructure, visualizing and making connections at the ground level, creating education awareness teams,

motivational speeches at the school level, discussing opportunities with students, etc., can play a significant role in enhancing literacy in the region. Also, female literacy, which is comparatively low, needs a convenient methodology to nurture the literacy of women which will, in turn, play a substantial role in the social development of the region. The study has found moderate to low economic settings in the region and the number of workers stands at 26% of the total population. The insufficient revenue, according to the residents plays a significant role in limited education apart from lack of awareness and motivation. However, the study suggests ample opportunities for economic growth considering the topography, climate, and land classification of the region. The area is neighboring the Great Himalaya Lakes, an adventurous trek, spectacular mountain valleys and meadows, glaciers, and radiant streams, and is therefore well suitable for economic tourism. The study suggests that a convenient tourism policy, training of local guides, providing relevant skill education, creating a homestay environment, and sustainable land management will play a very significant role in economic tourism and therefore the development of the region. However, the study has found considerable land degradation which may prove taxing in the region, and the immediate mitigation policies like afforestation and surface water management may undeniably bring positive impacts. The decadal land cover changes are substantially evident and therefore the appropriate mitigation policies and convenient methodologies are of utmost use.

6. Conclusion:

The tribal population of Jammu and Kashmir is usually living in remote and rigid topographies. The infrastructure is mostly located away from the cities and dense settlements with their own culture and living standards. They are closely linked to hillsides, green environments, and fast-flowing waters and are living their life in distant landscapes. The study found a considerable change in the land ecosystem where some of the land features have increased in size while some have decreased. The considerable decrease of forest land, water bodies, and Perennial snow/Glaciers remain worrisome and can have certainly a negative impact on the tribal regions as a whole. These negative impacts will certainly play a greater role in the climate crisis and therefore the direct effect on the agriculture and horticulture sectors of the region. The afforestation and hydrological management appear to be convenient methods that can be used to procure ecological balance in the region. Investment in Reforestation, invasive Species Management, estimating and restoring groundwater levels, and surface hydrological modeling is highly needed for the long-term development of the region. The study suggests that the Geospatial technological approaches can be thought of as a major approach for the long-term assessment and the conduit for the firm development of the tribal population. Further, the study suggests that Geospatial technology should be considered an essential component of the environmental impact assessment. The spatial tools like GIS and Remote sensing can enhance the substantial viewing of ecological implications and effective analysis of the natural resources for planning and policy-making.

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