

Spatiotemporal Change Study for High Altitudes of Pithoragarh District Uttarakhand as an Indicator of Climate Change?

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Abstract

The spatiotemporal remotely sensed data are extremely valuable for detecting changes in vegetation cover, land use/cover classes, snow, water bodies and other terrestrial features. Mapping of tree line, vegetation line, Snow line and its shift analyses can help in better knowing the trend of climate change scenarios.

The present paper deals with a change analysis pattern in tree line, alpine pastures and snow line for a period of 1972 to 2016. The study was carried out in two block i.e., Munsiyari and Dharchula of Pithoragarh district of Uttarakhand Himalaya using Landsat data of the listed years. The study showed that the from 1972 to 2016 there is mean increase in tree, grassland/pastures and snow line. The mean upward shift of the tree line was highest in Munsiyari block (4504 m) and Dharchula block lowest (2856 m). Magnitude of upward shift in terms of elevation range showed that at many places in the Munsiyari Block, the upward shift of the tree line crossed 419 m, during 44 years interval. Grassland are found at an elevation of 1400-5754 m interval during 1972, 1523-5780 m interval during 1998 and 1742-6090 m interval during 2016. This included great expanses of pure meadows (grasslands), flowering herbs and scattered miscellaneous vegetation. The vegetation near the snow line and in the proximity of the glaciers was rather thin, scattered, apart from the mosses and lichens. The snowline during 1972 is an elevation of 2939 m, 2991 m for 1998 and 3132 m for 2016.

Keywords: Spatiotemporal; Climate change; Munisayri; Dharchula; Tree line

Introduction

Alpine pasture/grassland, meadows or Bugyals, in higher elevation range between 3,300 m (10,800 ft) and 4,000 m (13,000 ft) of the Himalayas in the Indian state of Uttarakhand, where they are called "nature's own gardens". The topography of the terrain is either flat or sloped. The surface of these Bugyals is covered with natural green grass and seasonal flowers. They are used by tribal herdsman to graze their cattle. During the winter season the alpine meadows remain snow-covered. During summer months, the Bugyals present a riot of beautiful flowers and grass. As Bugyals constitute very fragile ecosystems, particular attention needs to be given for their conservation.

The mountain ranges are karstic, exhibiting fast drainage. Considerations of plant cover and soils are therefore, crucial for water protection [1]. Apart from the potential of climate changes for direct impact on the hydrological cycle [2], they will very probably also change vegetation properties. Nevertheless, in which way and to what extent such changes will occur remains unclear as yet. An assessment of impacts of climate and land use changes on the vegetation was therefore of high priority as a prerequisite for future strategies of water management. From a management perspective it is particularly important to evaluate changes which might occur at the local scale. In addition to climatic influences, other potential contributing factors

also have to be taken into account of which land use may be most important.

Most of the research on alpine tree line shift has primarily been based on field data with a limited geographical extent. Due to its synoptic view and historical records for a wide area, remote sensing is an important tool to study alpine tree line and changes in the recent past. This study confirms that there is an upward shift of vegetation in the alpine zone of the Himalayas. In the Himalayas land above the tree limits is used as alpine pasture for arising cattle during December month.

Temporal remotely sensed data are extremely valuable for detecting changes in vegetation cover, land use/cover classes, snow, water bodies and other terrestrial features. However, the process of change detection involves a number of methodological considerations such as proper ortho-rectification of remotely sensed data, minimizing errors on account of varying phenophases which influence reflectance/radiometry, and availability of snow/cloud free image [3].

Remote sensing is an important tool to study alpine treeline and changes in the recent past. This study confirms that there is an upward shift of vegetation in the alpine zone of the Himalayas. In remote sensing studies of vegetation, spectral vegetation indices are normally used. Among all vegetation index (NDVI) is widely used in detecting vegetation change, vegetation greenness and vegetation status, as it has good correlation with canopy cover and leaf area index.

Remote sensing is now recognized as an essential tool for viewing, analyzing and characterizing the alpine treeline ecotone. Mapping of

tree line, vegetation line and analysing shift in these using remote sensing data have been reported for a site in NDBR based on the above observation, a study was taken up at the space application center, Ahmedabad, to analyse the change in tree line and alpine vegetation line in the Indian Himalayan region. Here we highlight the results of remote sensing-based observation on tree line changes in Uttarakhand, India.

The present work determiners the extent of such alpine pastures in the eastern and western Himalayas using Landsat-1MSS, Landsat-5TM and Landsat-8 OLI (TIRS) for the period 1972, 1998, 2016. The result of the was changing the tree line snow line and grassland.

Study Area

The present study proposes the spatiotemporal study of alpine meadows of Pithoragarh district which is one of the district of Uttarakhand state. In this present study two block i.e., Munsiyari and Dharchula were selected. Total area as per availability of remote sensing data scene availability of Munsiyari and Dharchula has 5597.42 km.sq. for this study cover only 4378.528 km.sq. area for 1972, 5182.42 km.sq. 1998 and 5297.30 for 2016. And the remaining area are 1218.892 km.sq. 414.443 km.sq. and 300.12 km.sq. for 1972, 1998 and 2016 respectively (Figure 1).

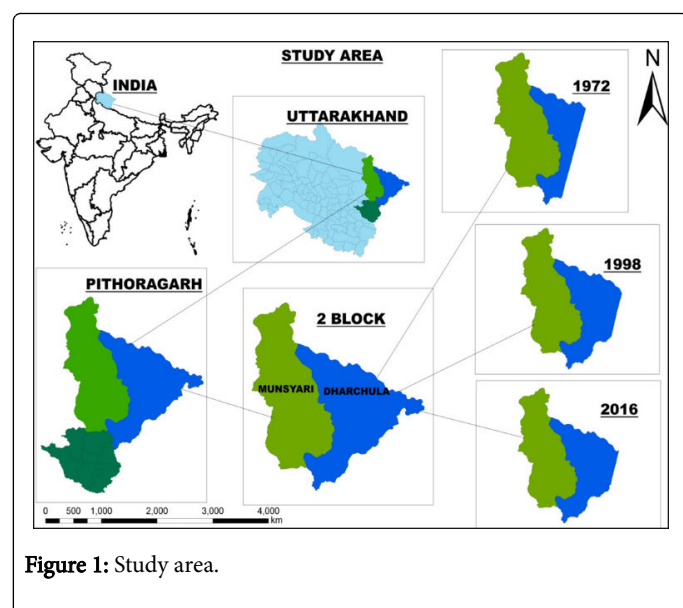


Figure 1: Study area.

Climate and Rainfall

Pithoragarh town, being in a valley, is relatively warm during summer and cool during winter. During the coldest months of December and January, the tropical and temperate mountain ridges and high locations receive snowfall and have an average temperature of 5.5-8.0°C (41.9-46.4°F). The temperature rises from mid-March through mid-June. The areas above 3,500 m (11,500 ft) remain in a permanent snow cover. Regions lying at 3,000-3,500 m (9,800-11,500 ft) become snow bound for four to six months. Winter is a time for transhumance—the seasonal migration of the Bhotiya tribe with their herds of livestock to lower, warmer areas.

Materials and Methods

In present Study the Various Landsat series was used for spatiotemporal monitoring like, Landsat 1 MSS data (1972), Landsat 5 TM data (1998), Landsat 8 OLI data (2016) and Cartosat-1 (DEM) data. The methodology involves the Image pre Processing, Digital classification, Unsupervised Classification, Visualization classification, Indices Classification, In present study the use of NDVI, NDSI, NDWI, SAVI based on threshold value for classification for getting better result, then others (Figure 2).

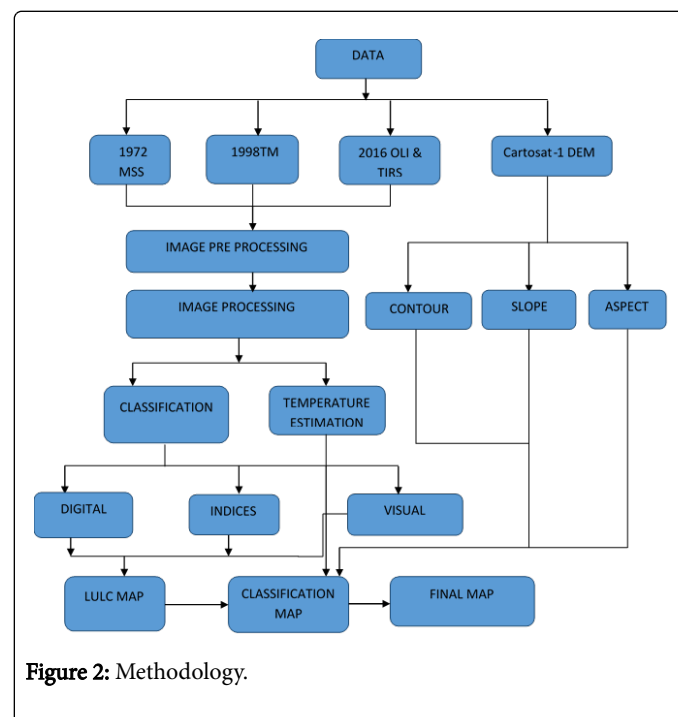


Figure 2: Methodology.

Results

The tree line during 1972 is an average elevation of 3300 m, 3386.5 m for 1998 and 3749 m for 2016. Thus, there is a mean upward shift of the tree line. The difference in the surface distance from the past to the current period is mainly due to the zigzag nature of the ingression along suitable elevational gradients. The mean upward shift of the tree line was highest in Munsiyari block (4504 m) and Dharchula block lowest (2856 m). Magnitude of upward shift in terms of elevation range showed that at many places in the Munsiyari Block, the upward shift of the tree line crossed 419 m, during 44 years interval.

Grassland are found at an elevation of 1400-5754 m interval during 1972, 1523-5780 m interval during 1998 and 1742-6090 m interval during 2016. This included great expanses of pure meadows (grasslands), flowering herbs and scattered miscellaneous vegetation. The vegetation near the snow line and in the proximity of the glaciers was rather thin, scattered, apart from the mosses and lichens. The snowline during 1972 is an elevation of 2939 m 2991 m for 1998 and 3132 m for 2016 (Table 1).

Class	1972		1998		2016	
	High	Low	High	Low	High	Low
Tree line	4252	2348	4346	2427	4671	2827

Grassland	5754	1400	5780	1523	6090	1742
Snow	6548	2939	6548	2991	6548	3132

Table 1: Spatiotemporal Changes.

Discussion

Previous studies from the tree line zones in the Himalayas had shown that the vegetation has fluctuated in the past in response to long-term climatic changes. In this study had change on the temperature in 1998 was 17.81°C and recent temperature is 18.96°C, was change in 1.15°C. Studies on the impact of ongoing warming under the background influence of greenhouse gases world over have shown that during the past few decades alpine plant species have shifted to higher elevation, though the shifting rate varies with species and their sensitivity to climate. This study confirms that there is an upward shift of vegetation in the alpine zone of the Himalayas. Though there may be some error in the exact elevation gradient in general,

there is no doubt that the change is significant. However, any meaningful research to model the vegetation dynamics response to warming requires an effective, long-term ground-observation strategy.

Satellite remote sensing data are the best option in view of the rugged, inaccessible and vast stretch of the Himalayan alpine area. This study has shown the potential of remote sensing data to create and update a database of alpine tree line and vegetation lines.

References

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