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Climatic parameters (temperature and precipitation) and their relationship with Timberline altitude in Indian Himalayan Region: Case study of Sikkim State

Avantika Latwal*, Dr. Rehana Shaik*, Dr. Subrat Sharma**

****International Institute of Information Technology, Gachibowli 500032, Hyderabad* ***G. B. Pant National Institute of Himalayan Environment, Ladakh Regional Centre, Leh, 194101, Ladakh (UT)*

INTRODUCTION

The impact of global warming is being felt all over the world by way of rising air temperature, changes in precipitation and melting of the glaciers. In recent decades the mountain ecosystem in Himalaya has warmed more rapidly than many other areas of the globe. Therefore, an increasing number of studies have focused on the Himalayan timberline because it is very sensitive to climate change and could provide the biological proof of global warming. Hence, it provides a unique opportunity to study the different climatic parameters (temperature, precipitation) response on vegetation in high altitude environment.

OBJECTIVE

The main objective of the study is to analyze influence of changing climate (variations in the air temperature and precipitation at timberline altitude) on timberline altitude (ITL – Island Type Timberline, CTL – Continuous Type Timberline) between the year 1977 and 2015.

STUDY AREA & METHODOLOGY

The present study is carried out in the Sikkim state. It is a small state in the north-eastern part of Indian Himalayan Region (IHR) which lies between 27º04'46" to 28º07'48"N latitudes and 88º00'58" to 88º55'25"E longitudes and covering an area of 7096 km2 (Fig.1). To find the relationship and dependency of timberline altitude with temperature and precipitation and changes in climatic data parameters (temperature and precipitation) along timberline in past and present year (1977 and 2015), air temperature (daily mean) and daily precipitation (rainfall) were extracted from gridded data (resolution of 0.25º) of APHRODITE for different years (1977 & 2015) using MATLAB R2019a. Annual mean temperature and total annual rainfall were derived from the daily data set. To extract annual mean temperature and annual precipitation at timberline altitude (various points) interpolation technique was used to harmonize the different resolutions of two data sets. We used bilinear interpolation to extract temperature and rainfall for each timberline point which uses four near neighbor grids and estimates the distance average with closer the grid being given higher weights. Bilinear interpolation algorithm is popular due to its computational efficiency and quality. It is particularly useful for downscaling meteorological input data which are already gridded. Temperature and precipitation (rainfall) were recorded for both the years (1977 and 2015). After extraction of temperature and precipitation values along timberline, the timberline elevation is categorize into altitudinal range and average values of temperature and precipitation were taken for further analysis.

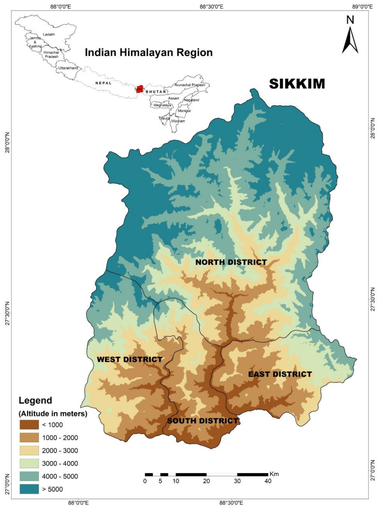

Fig.1. Study Area - Sikkim State

RESULTS

- Temperature difference (past & present) in different elevation zones of timberline was more in higher altitudes than the lower ones.
- The rate of increase of temperature was 0.21 ºC decade-1 for ITL altitudes while at CTL altitudes the rate was slightly higher 0.23 ºC decade-1 (Fig.2).

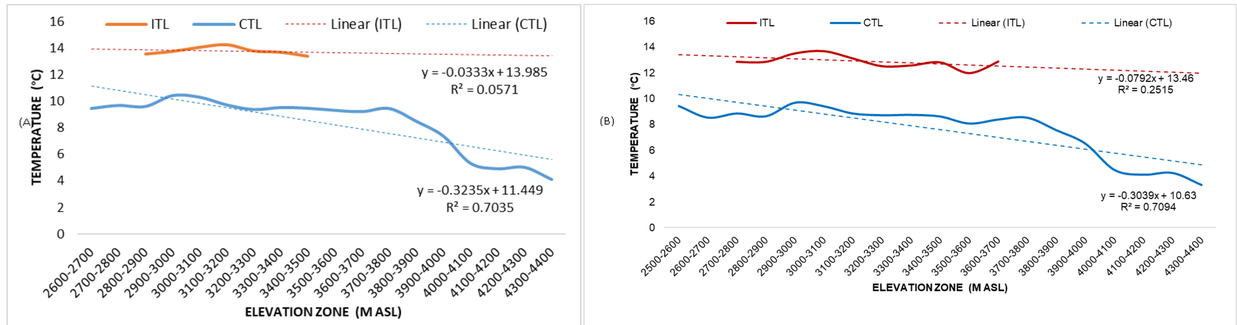

Fig. 2. Elevational trends for Annual mean temperature (A) in 2015 (B) in 1977 along timberline altitude in Sikkim State (values averaged for each 100m elevation band)

- Similar to temperature, the rate of increase in rainfall from 1977 was more in outer Himalayan timberline altitudes (ITL, 187mm decade-1) than the inner Himalayan timberline altitudes (CTL, 93mm decade-1), Fig.3.

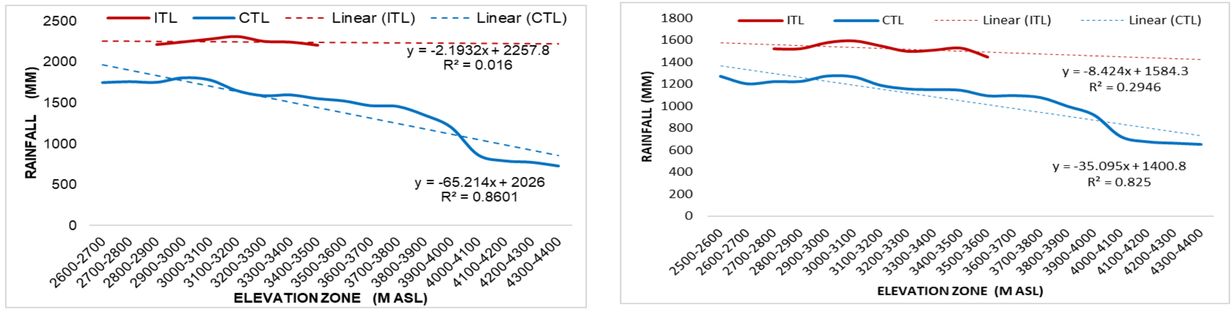

Fig. 3. Elevational trends for Annual rainfall (A) in 2015 (B) in 1977 along timberline altitude in Sikkim State (values averaged for each 100m elevation band)

CONCLUSION

- The study observed that that the outer Himalayan ranges became warmer and wet than the inner Himalayan timberline altitudes in the studied time period (37 years).
- The findings suggested that the timberline ecotone dynamics could refer to as the sensitive area under climate change, and climatic parameters (temperature and precipitation) are natural drivers for changes in the timberline altitude triggered by climate change.