RESEARCH ARTICLE

OBSERVATIONS ON TEMPERATURE VARIATION IN ALPINE ZONE OF UTTARAKHAND: A CASE STUDY OF TUNGNATH

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Abstract: The metrological data for maximum, minimum and soil temperature was recorded at 3600 mt. altitude during 2015-16 for Ph.D. programme under the topic "Phenological response of four Rhododendron species with reference to climate change" and compared with the data recorded for same parameters at the same altitude and place collected during June to September, 1979 by High Altitude Plant Physiology Research Centre Srinagar. In weekly temperature recording it is observed that the maximum air temperature has increased from 2 to 4 ºC as well as the minimum temperature has also decreased up to 2 to 3ºC within a span of 35 years. However, soil temperature has shown the increase of about 2 to 3 ºC. It indicates that though the variation in mean temperature does not increase significantly but the difference between maximum and minimum temperature has increased drastically. This clearly indicates that the variation in temperature which is responsible for all the metabolic processes in plants and plays a significant role in plant adaptation has significantly increased in both sides. Which means that plants has to face both extreme low as well as high temperatures, which may cause loss of those species which has low adaptation potential to these temperature extremes.

Keywords: Alpine Zone, Metrological data, Temperature, Uttarakhand

INTRODUCTION

In today's scenario the subject of climate change continues to be a topic of hot debate at global conventions, world summits & International Conferences. Change in climate is not an endemic phenomenon which restricted to a particular region instead of that its spreading globally which is a big alarm to the mankind and needs a continuous vigilant.

Many evidences have been gathered to depict that climate change is taking place. The main reason behind this is the continuous emission of green house gases into the atmosphere through anthropogenic activities. Over the past 100years the global average temperature has increased by approximately 0.6ºC and is projected to rise at a rapid rate. The third assessment report from the IPCC projects that the earth's average surface temperature will increase by 1.4 to 5.8 ºC between 1990 and 2100, if no major efforts are undertaken to reduce the emission of green house gases.

Climatic conditions determine where individual species of plants can survive and reproduce. The species in an ecosystem are in general strong adapted to the long prevailing climatic pattern but many of them are vulnerable to modest changes due to low adaptation potential.

In the present study site Tungnath where the five species of Rhododendron are exist as a dominant vegetation of this region showed many indications of the change in the phenology like bud break, flowering and reproduction may be because of the change in climatic condition. To find out the changes in temperature both air and soil, rainfall/snowfall and light intensity, the metrological data of these parameters was recorded round the year at weekly interval during 2009 -10 and presented in this paper. Since, the temperature data of 1979 from June to September was available; this was considered to find out the temperature variation within the interval of 30 years at the same place and altitude.

MATERIALS AND METHOD

The present study was carried out at 3600 mt. altitude above mean sea level at Chandrashilla, Tungnath area of District Rudraprayag, Uttarakhand. The metrological data was collected 2015 – 16 at weekly interval and compared with the metrological data record available for the same place from June to September 1979 collected by High Altitude Plant Physiology Research Centre Srinagar Garhwal. The maximum - minimum air temperature and soil temperature were recorded by using maximum - minimum thermometer and soil thermometer for soil temperature. The observations of air and soil temperature during 2015-16 are given in Fig. 1 (a, b, c) however; the comparison of this data available from June to September is given in Fig. 2(a, b, c).

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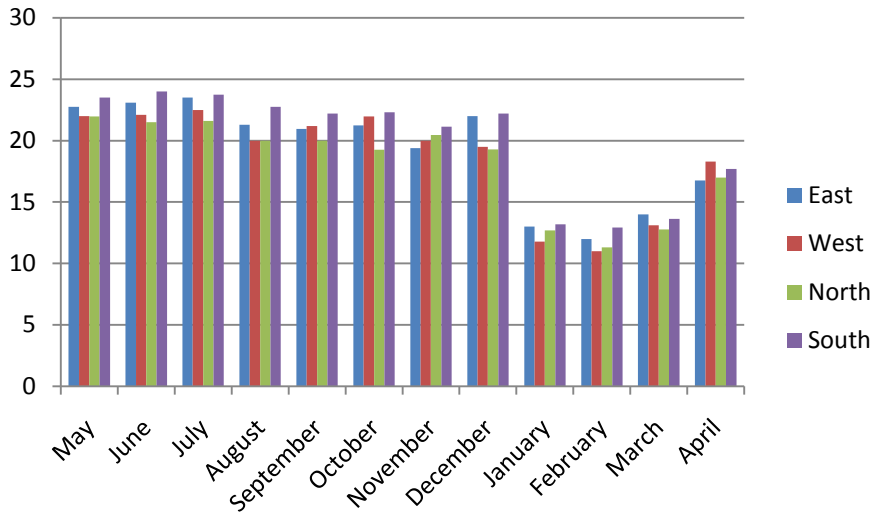

Fig.1 (a) Maximum Temperature

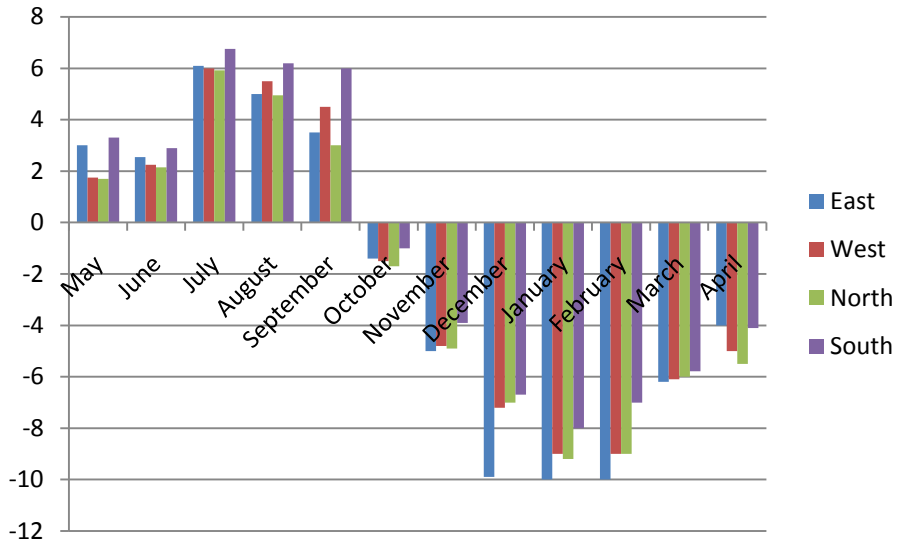

Fig.1 (b) Minimum Temperature

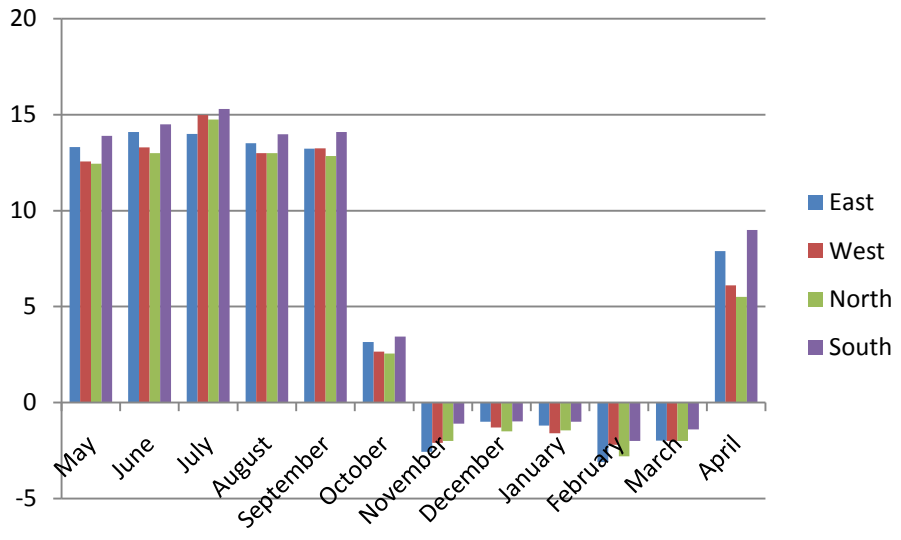

Fig.1 (c) Soil Temperature

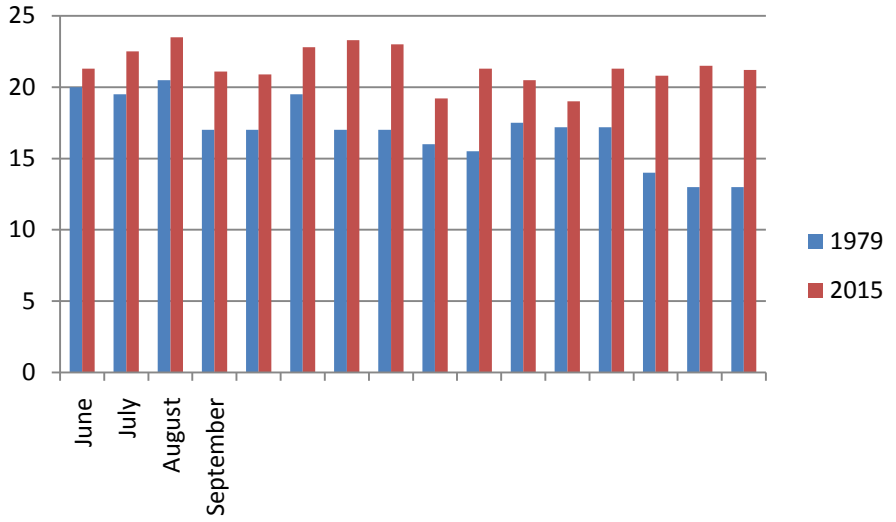

Fig.2 (a) Maximum Temperature

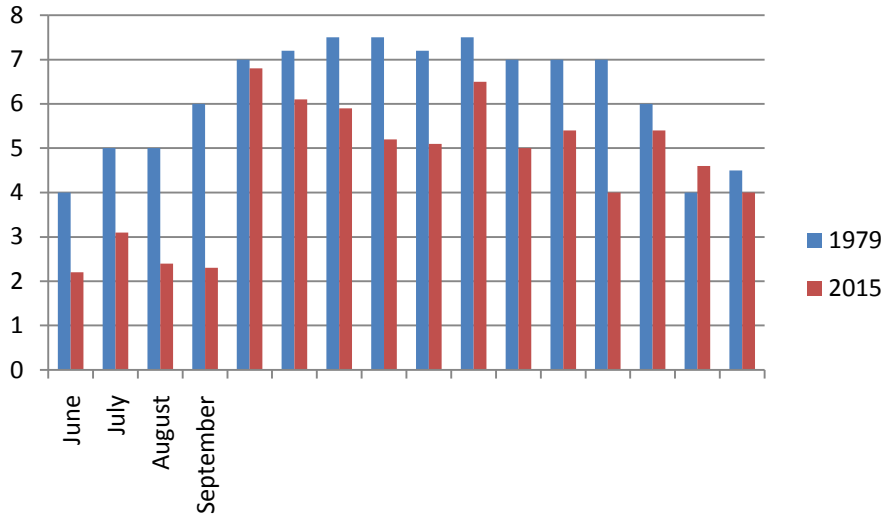

Fig.2 (b) Minimum Temperature

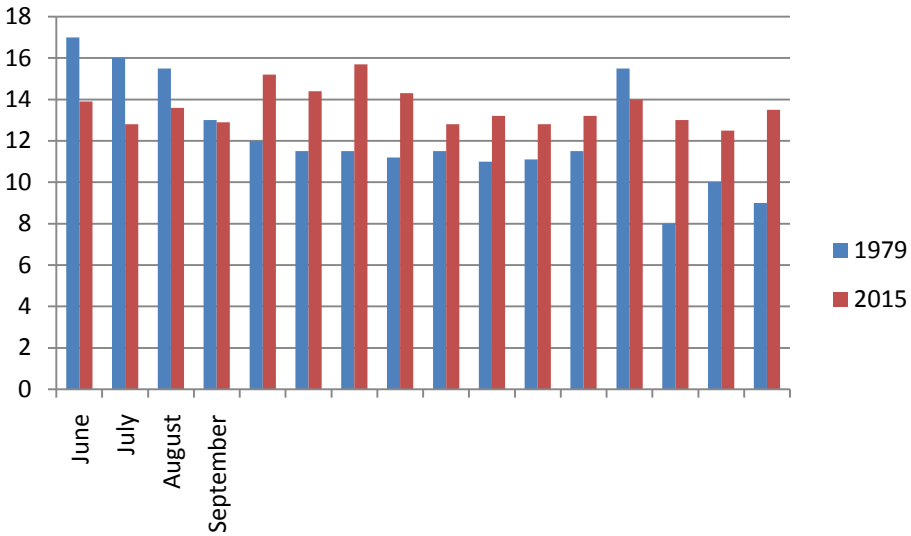

Fig.2 (c) Soil Temperature

RESULTS AND DISCUSSION

The data collected from June 2015 to September 2015 was compared with data recorded by S. Nautiyal in 1979. During 2015 the highest temperature was recorded in the third week of June (23.5 ºC) followed by third week of July (23.3 ºC), were as the lowest, maximum temperature was recorded in the fourth week of August (19 ºC) and the third week of September (19 ºC) followed by first week of August (19.2 ºC). However during 1979 the highest maximum temperature was recorded in the third week of June (20.5 ºC) followed by the first week of June (20 ºC). However on the monthly basis the maximum temperature was found in 2015 in the month of July (22.5 ºC) followed by the June (22.1 ºC), and in 1979 maximum temperature was recorded in the month of June (19.25ºC) followed by July (17.62 ºC) lowest maximum temperature was recorded in the month of August (20ºC) followed by September (21.2 ºC) , in 1979 lowest maximum temperature was recorded in the month of September (13.3 ºC) followed by August (16.55 ºC). Highest difference in maximum temperature during 1979 to 2015 was found (7.9 ºC) in the month of September followed by July (4.87ºC). However, the highest values of minimum temperature was recorded in 2015 in the first week of July (6.8 ºC) followed by the second week of August (6.5ºC) lowest minimum temperature was recorded in first week of June (2.2 ºC) followed by the last week of June (2.3ºC), however in 1979 the highest minimum temperature was recorded in third week of July (7.5 ºC) followed by first week of August (7.2 ºC). However lowest minimum temperature was recorded in 1979 in the first week of June (4 ºC) followed by the last week of September (4.5 ºC). Whereas on the monthly basis in 2015 highest minimum temperature was recorded in the month of July (6 ºC) followed by August (5.5ºC), and the lowest temperature was recorded in the month of June (2.5 ºC) followed by September (4.5 ºC) and in 1979 highest minimum temperature was recorded in the month of July (7.3 ºC) followed by August (7.17 ºC), and the lowest minimum temperature was recorded in the month of September (5.37 ºC) followed by the June (5 ºC).In 2015 the highest soil temperature was recorded in the third week of July (15.7 ºC) and the minimum soil temperature was recorded third week of September (12.5 ºC) followed by the fourth week of June (12.8 ºC).However during in 1979 maximum soil temperature was recorded in the first week of June (17 ºC) followed by the second week of June (16 ºC) and the minimum soil temperature was recorded in the second week of September (8 ºC) followed by last week of September (9 ºC) .On monthly basis in 2015 the maximum temperature was recorded in the month of July (14.9 ºC) followed by the June (13.3ºC) and in 1979 the maximum temperature is recorded in the month of June (15.37 ºC) and minimum temperature was recorded in the month of September(10.62 ºC) followed by August (11.27 ºC) and the highest difference during 1979-2015 in soil temperature was recorded in the month of July (3.87 ºC) followed by September (3.57 ºC).

The highest increase in winter mean maximum temperature (across India) was obtained for Himachal Pradesh (plus 0.06 degree Celsius per year) it said. Uttarakhand, too, showed a significant increase (plus 0.02 degree Celsius per year) in winter mean maximum temperature. This clearly indicates that the variation in temperature which is responsible for all the metabolic processes in plants and plays a significant role in plant adaptation has significantly increased in both sides. Which means that plants has to face both extreme low as well as high temperatures, which may cause loss of those species which has low adaptation potential to these temperature extremes. Significant upward shift of plant species have already been reported from many parts of the globe due to warming (Cannone *et al*., 2007; Kelly *and* Goulden, 2008). Most importantly, it is predicted that impacts of global climate change will be more pronounced in higher altitude (Beniston, 2003). However in the present study site due to the warming *Rhododendron campanulatum* proceeding upward from subalpine (3200 mt masl.) to alpine (3800 mt.masl) zone. Signatures of Climate Change have already begun to appear in the Kumaun Himalayan region in the form of early flowering/fruiting of native trees such as *Rhododendron arboreum* (Gaira *et al*., 2014), here in our study in the Garhwal himalaya same pattern was observed i.e in all four species of Rhododendron Floral buds break was first noticed on set of Spring as soon as the snow melt above (9,000 ft) and observed early flowering/fruiting, seed setting, seed dispersal. Various studies suggest that warming in the Himalayas has been much greater than the global average of 0.74°C over the last 100 years (IPCC 2007). Same trend was observed in our study that temperate, sub-alpine and alpine temperature rose up to 2-3 ºC within 35 years. The All-India rainfall data do not show any significant trend in monsoon rains, however, there are some regional variations. A trend of about 10 to 12% (of the normal) increase in monsoon rains were reported along the west coast, northern Andhra Pradesh and north-western India during the last century. A decreasing trend of about 6 to 8% is observed over the last 100 years over eastern Madhya Pradesh, North-Eastern India and some parts of Gujarat and Kerala (NAPCC, 2008). While in alpine zone at our study site it was also higher (105 cm) during monsoon and minimum (5-6 cm) during winter or after monsoon.The report in Research Communications journal that they analyzed the long-term temperature data of the region for the previous 40 years (1971-2011) and found a comparatively small but significant increase in mean maximum temperature of 0.5 ºC over the period.in

Johannesburg, South Africa, where it is summer, the air temperature can reach 35°C (95° F), and in Fairbanks, Alaska at that same time of year, it is the middle of winter and air temperatures might be -35°C (-31° F) however in alpine region of Garhwal Himalaya it is in summer can reach (26.32°C) and during December-February minimum temperature (-10.8 °C).

It is interesting to note that during last 35 years the maximum temperature in Alpine zone has increased but at the same time the minimum temperature has decreased. Therefore, though the mean temperature of maximum and minimum does not change much but the gap between maximum and minimum values has increased. It means that the plants have to face both maximum and minimum extremes temperature. Those species having low adaptation to these temperature extremes may be lost in future. The soil temperature in general has shown increasing trend by 2 to 3 ºC in last 30 years. Increasing soil temperature to some extend may help root growth and ultimately shoot growth also and also provide opportunity to soil microbes to multiply and work vigorously for their diverse functions. Abrupt temperature variation though may not be much destructive to Alpine vegetation keeping in view of their perennial nature but certainly it can affect the phenology of most of the species as most of the metabolic processes are temperature governed. The bud break (both flower and vegetative bud), flowering, new shoots and leaf initiation, pollination, fruit and seed development, seed dispersal, seed germination and survival of these regular activities may be effected which may lead to loss of some species, introduction of new species and gradual shift of vegetation.

Maximum Temperature

Month	Week	1979	2015	Difference
June	1	20 ºC	21.3 ºC	1.3 ºC
	2	19.5 ºC	22.5 ºC	3 ºC
	3	20.5 ºC	23.5 ºC	3 ºC
	4	17 ºC	21.1 ºC	4.1 ºC
Average		19.25 ºC	22.1 ºC	2.85 ºC
July	1	17 ºC	20.9 ºC	3.9 ºC
	2	19.5 ºC	22.8 ºC	3.3 ºC
	3	17 ºC	23.3 ºC	6.3 ºC
	4	17 ºC	23 ºC	6 ºC
Average		17.62 ºC	22.5 ºC	4.87 ºC
August	1	16 ºC	19.2 ºC	3.2 ºC
	2	15.5 ºC	21.3 ºC	5.8 ºC
	3	17.5 ºC	20.5 ºC	3 ºC
	4	17.2 ºC	19 ºC	1.8 ºC
Average		16.55 ºC	20 ºC	3.45 ºC
September	1	17.2 ºC	21.3 ºC	4.1 ºC
	2	14 ºC	20.5 ºC	6.8 ºC
	3	9 ºC	19 ºC	12.5 ºC
	4	13 ºC º	21.2 ºC	8.2 ºC
Average		13.3 ºC	21.2 ºC	7.9 ºC

Minimum Temperature

Month	Week	1979	2015	Difference
June	1	4.00 ºC	2.2 ºC	1.8 ºC
	2	5.00 ºC	3.1 ºC	1.9 ºC

	3	5.00 ºC	2.4 ºC	2.6 ºC
	4	6.00 ºC	2.3 ºC	3.7 ºC
Average		5.00 ºC	2.5 ºC	2.5 ºC
July	1	7.00 ºC	6.8 ºC	0.2 ºC
	2	7.2 ºC	6.1 ºC	1.1 ºC
	3	7.5 ºC	5.9 ºC	1.6 ºC
	4	7.5 ºC	5.2 ºC	2.3 ºC
Average		7.3 ºC	6 ºC	1.3 ºC
August	1	7.2 ºC	5.1 ºC	2.1 ºC
	2	7.5 ºC	6.5 ºC	1 ºC
	3	7.0 ºC	5 ºC	2 ºC
	4	7.00 ºC	5.4 ºC	1.6 ºC
Average		7.17 ºC	5.5 ºC	1.67 ºC
September	1	7.00 ºC	4 ºC	3 ºC
	2	6.00 ºC	5.4 ºC	0.6 ºC
	3	4.00 ºC	4.6 ºC	0.6 ºC
	4	4.5 ºC	4 ºC	0.5 ºC
Average		5.37 ºC	4.5 ºC	1.17 ºC

Soil Temperature

Month	**Week**	**1979**	**2015**	**Difference**
June	1	17.00 ºC	13.9 ºC	3.1 ºC
	2	16.00 ºC	12.8 ºC	3.2 ºC
	3	15.5 ºC	13.6 ºC	1.9 ºC
	4	13 ºC	12.9 ºC	0.1 ºC
Average		15.37 ºC	13.3 ºC	2.07 ºC
July	1	12.00 ºC	15.2 ºC	3.2 ºC
	2	11.5 ºC	14.4 ºC	2.9 ºC
	3	11.5 ºC	15.7 ºC	4.2 ºC
	4	11.2 ºC	14.3 ºC	3.1 ºC
Average		11.55 ºC	14.9 ºC	3.35 ºC
August	1	11.5 ºC	12.8 ºC	1.3 ºC
	2	11.00ºC	13.2 ºC	2.2 ºC
	3	11.1 ºC	12.8 ºC	1.7 ºC
	4	11.5 ºC	13.2 ºC	1.7 ºC
Average		11.27 ºC	13 ºC	1.72 ºC

September	1	15.5 ºC	14 ºC	1.5 ºC
	2	8.00 ºC	13 ºC	5 ºC
	3	10.00 ºC	12.5 ºC	2.5 ºC
	4	9.00 ºC	13.5 ºC	4.5 ºC
Average		10.62 ºC	13.25 ºC	3.37 ºC

REFERENCES

Beniston, M. (2003). Climate change in mountain regions: Climatic change 59: 5-31.

Cannone, N., Sgorbati. S. and Guglielmin, M. (2007). Unexpected impacts of climate change on alpine vegetation. *Frontiers in Ecology and the Environment* **5**:360-364.

Dhār, U. (2002). Conservation implication of plant endemic in high-altitude Himalaya. *Current Science* 82: 141-148.

Gaira, K.S., Rawal, R.S., Rawat, B. and Bhatt, I.D. (2014). Impact of climate change on the flowering of rhododendron arboreum in central himalaya, India. *Current Science* **106**: 1735-1738.

IPCC. (2007a). Climate change 2007: The physical science bases. Contribution of working group I to the fourth Assessment report of the Intergovernmental Panel on Climate Change{Solomon, S; Qin, D. ; Manning, M.; Chen, Z.;Marquis, M.; Averyt, K.B.; Tinnor, M.; Miller, H.L.; (eds)}. Cambridge and New York: Cambridge University Press.

IPCC. (2007b). Climate change 2007: Impacts, Adaptation and Vulnerability. Contribution of working group II to the fourth Assessment report of the Intergovernmental Panel on Climate Change {Parry, M.L.; Canziani, O.F.; Palutikof, J.P.; Vander Linden, P.J.; Hanson, C.E. (eds)}. Cambridge: Cambridge University Press.

Kelly, A.E. and Goulden, M.L. (2008). Rapid shifts in plant distribution with recent climate change. *Proceedings of the National Academy of Sciences* **105**:11823-11826.