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ORIGINAL ARTICLE

Impact of Climate change on the abundance of *A. benthamii* in the lower reaches of Phalgam Anantnag Jammu & Kashmir - India

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ABSTRACT
The richness of India's medicinal plant resources is widely known. Medicinal plants at Phalgam are extremely valuable to human livelihood. Because of their use in both traditional medicine and agriculture, research into the possible consequences of climate change on medicinal plants is of paramount importance. At Phalgam, there is evidence that climate change is having a major effect on plant life cycles and distribution. The data on meteorological parameters and tourist data was collected from the offices of respective Departments. Four independent surveys were conducted during the study period to locate the A benthamii. However, no plant was located during our investigation in the study area. There has been appreciable decrease in the rainfall and increase in the temperature over the last two decades in Phalagam. The study indicated that climate change may have caused a great shift of A benthamii to higher reaches.
Keywords: *Threats, Medicinal Plants, Phalgam, Climate Change*

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INTRODUCTION

Medicinal plants are extremely important to human survival, and India is known for having a richness of medicinal plants. Given the economic significance of medicinal plants and their use in traditional medicine, research on the potential impacts of climate change on these plants should be given top priority. Worldwide, around 4000 million people depend on medicinal plants for their healthcare requirements. This includes those living in remote areas of the Himalayas, where access to Western pharmaceuticals is exceedingly difficult (1,2). Many ailments, including as dysentery, diarrhoea, skin conditions, typhoid, epilepsy, leprosy, diabetes, rheumatism, etc., are treated locally with these plants (3,4). Among the *Boraginaceae family, Arnebia benthamii* is a member. Reports have come in from the Indian states of Jammu and Kashmir, Himachal Pradesh, and Uttaranchal. Kahzaban, Gaozaban, Laljari, and Ratanjot are the names it is known by in the area. This herbaceous perennial is 30-90 cm tall, has strong woody roots that become deep red, is monocarpic, and has hermaphrodite blooms; it takes three to four years for the plant to attain reproductive maturity (5). Traditional medicine makes use of several components of A benthamii, including the plant's roots, stems, leaves, flowers, and seeds, to treat heart conditions. People who suffer from cardiac conditions have said that the flowers help them relax. Not only that, but the herb has expectorant, diuretic, tonic, and simulative properties. Jam and syrup produced from flowering branches are useful for treating throat and tongue issues. The bulk of composite drugs used to treat high fevers in the Unani medical system include it. One commercial herbal medicine with antimicrobial, antifungal, anti-inflammatory, and wound-healing characteristics is Gaozaban, which contains abenthamii as one of its main ingredients (6,7). It is believed that the plant also has antioxidant capabilities. Locals in the Himalayan region utilize a unique kind of tea called "Kahwa" that is made from this plant dried and boiled to treat chest infections, particularly in youngsters. The drug's real ingredient, the root, is thought to have anthelmintic, antipyretic, and antiseptic properties. It is also said to be helpful

in treating a variety of conditions, including bronchitis (8,9), abdominal pain, itching, and disorders of the eyes. The UT J&K, particularly Phalagam, is well-known for the wide range of medicinal plants that grow there. These plants have been utilised in aromatherapy, cosmetics, and the treatment of a variety of illnesses. It is suggested that, in addition to a number of other factors, climate change may have been a major factor in the disappearance of therapeutic plants, particularly *Arnebia benthamii* in these particular locations (10,11).

The advantages derived from medicinal plants are anticipated to drastically decrease as a result of climate change, since numerous species are predicted to experience possible habitat loss, extinction, and loss of chemical and therapeutic qualities (11–13). Therefore, research on how climate change is affecting *Arnebia benthamii* is desperately needed

MATERIAL AND METHODS

Study Area

The present study was undertaken at Pahalgam tourist spot in District Anantnag of Jammu & Kashmir, India. It is a hill station 45kms North East from District Headquarter Anantnag. It is located on the banks of Lidder River at an altitude of 8989 feet (2740meters) between $34^0 01'$N and $75^0 11'$E latitudes and $34^0 01'$N and $75^0 19'$E longitude. It has a total population of 5922 (census 2001) comprising of 56% male and 44% female population respectively and with overall literacy rate of 35%.

Climate:

The Climate of Phalgam wildlife sanctuary is temperate to arctic. The climate of the area is of peculiar type owing to its rugged topography. The year is divided into four seasons i.e., spring (Mrh-May), summer (June-Aug.), autumn (Sept.-Nov.), and winter (Dec.-Feb.). Winter months are very cold of short day duration with temperatures around -10^0C to 15^0C, sky very cloudy with moderate to heavy snowfall and rain as a result of strong winds from the Mediterranean depressions. Summer months are hot with temperature ranges between 20^0C to 30^0C with average rainfall.

CLIMATOLOGICAL PARAMETERS:

The Meteorological data pertaining to rainfall, temperature, humidity has been collected from the Meteorological Department Situated in Srinagar.

TOURIST FLOW:

The Data of tourist flow in the study area was obtained from Department of Tourism Srinagar, Kashmir.

SURVEY AND OBSERVATION METHOD:

An extensive survey was conducted to locate and identify the Arnebiabenthamii in the forests of Phalagam from April 2022 to June 2023 in all the four seasons of the year. Various field trips were conducted with the help of tribal people commonly known as Gujjar's and Bakarwals who have deep understanding and knowledge of the medicinal plants of the area.

RESULTS:

Table 1: Comparative account of population status (density/m^2) of *Arnebiabenthamii* in different Kashmir Himalayan regions

Survey No	Site I	Site II	Site III	Site IV
I	-	-	-	-
II	-	-	-	-
III	1	-	-	-

Source: Survey during 2022-23

Table 2: Foreign Tourists Visits (FTVs) and Domestic Tourists Visits (DTVs) in the Union Territory of Jammu & Kashmir during 2019 to 2022

Year	FTVs	DTVs
2019	57920	16163330
2020	5317	2519524
2021	1650	11314920
2022	19987	18617740

Source: Tourist Department Srinagar

Table 2: Average temperature at the study area

Month	Day	Night	Rainy Days
January	4°c	-5°c	10
February	7°c	-2°c	10
March	12°c	2°c	9
April	17°c	6°c	10
May	22°c	10°c	9
June	25°c	14°c	7
July	27°c	17°c	14
August	26°c	16°c	14
September	25°c	13°c	6
October	20°c	7°c	3
November	13°c	2°c	5
December	8°c	-2°c	6

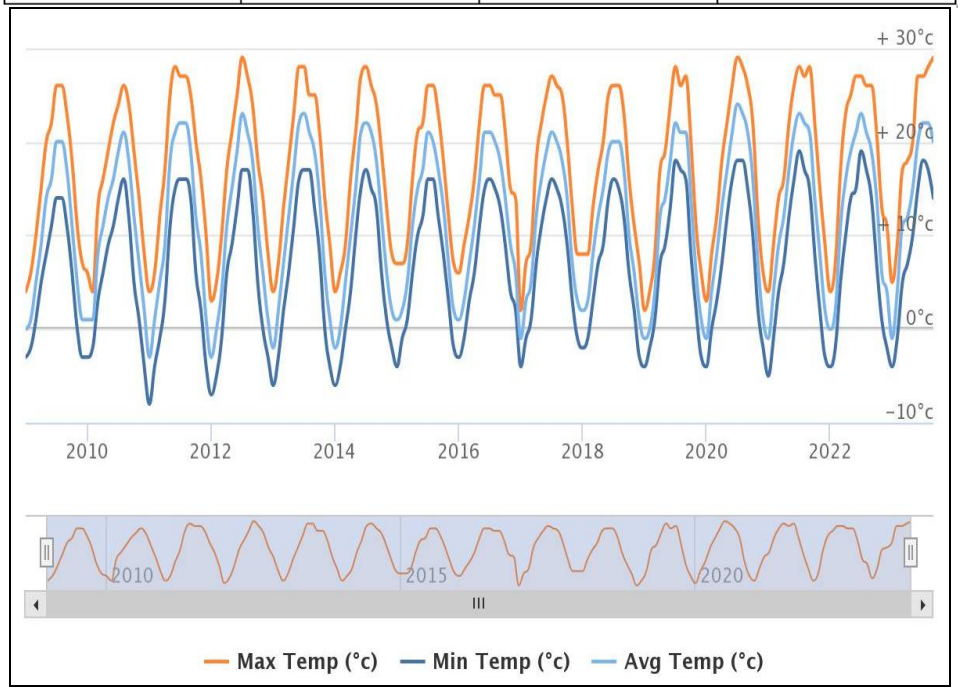

Fig 1: Max, Min and Average Temperature at study area

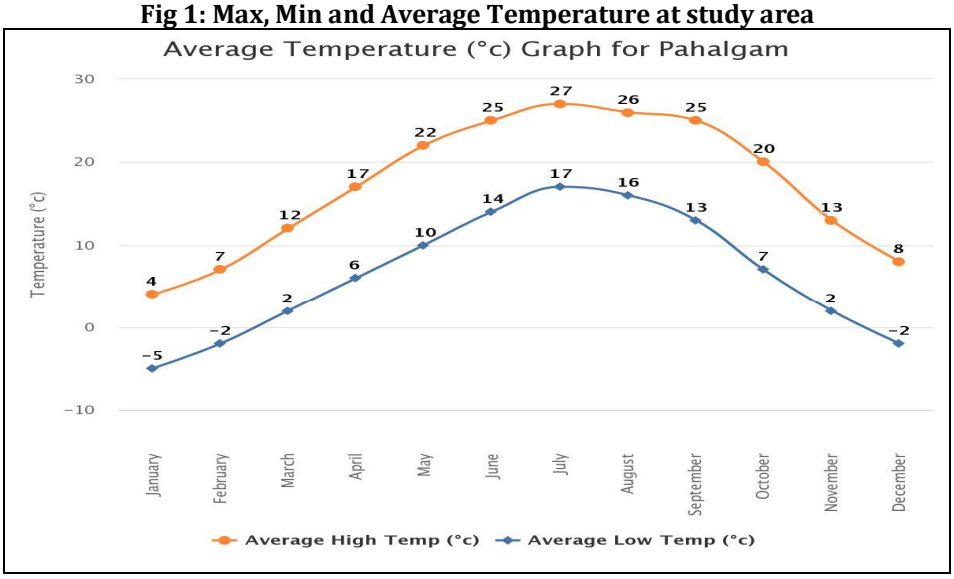

Fig 2: Average rainfall at study area

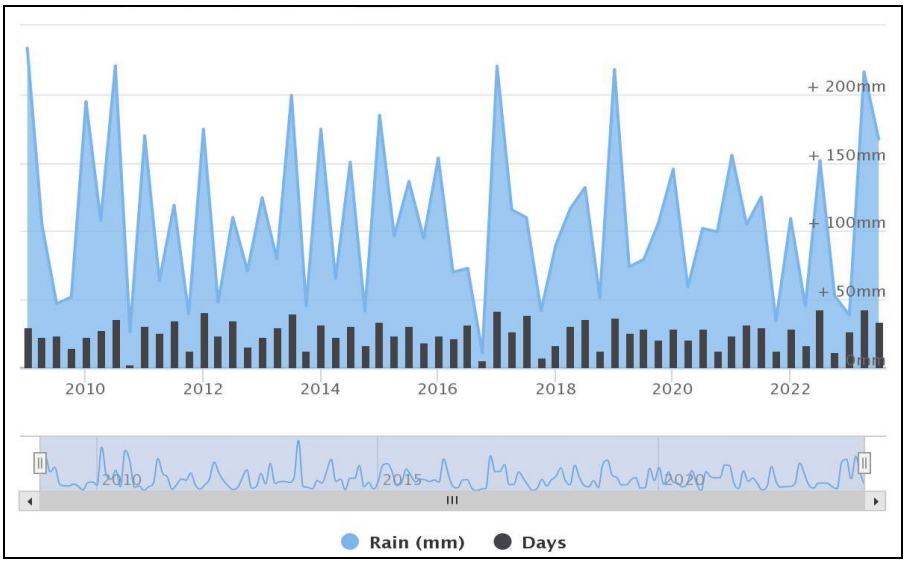

Fig 3: Average Rain fall in the study area

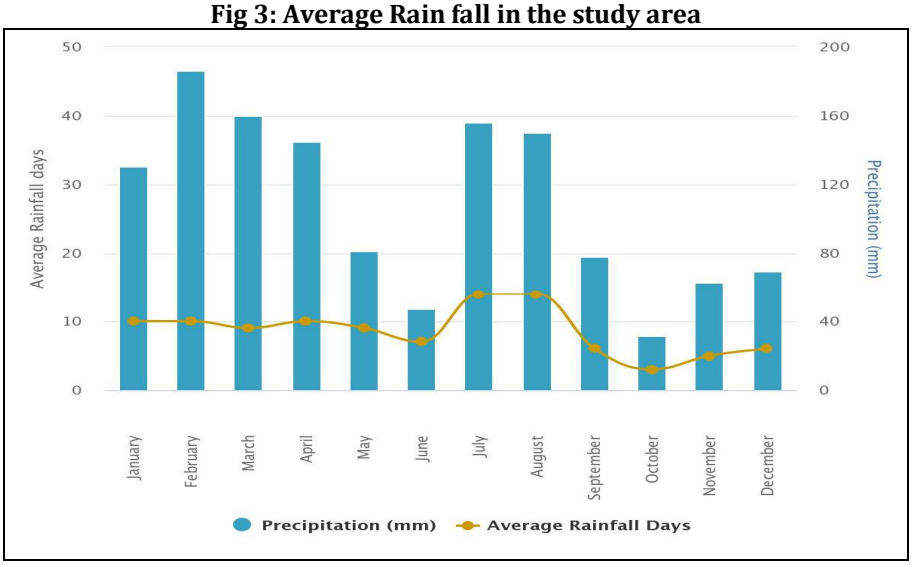

Fig 4: Average precipitation at the study area

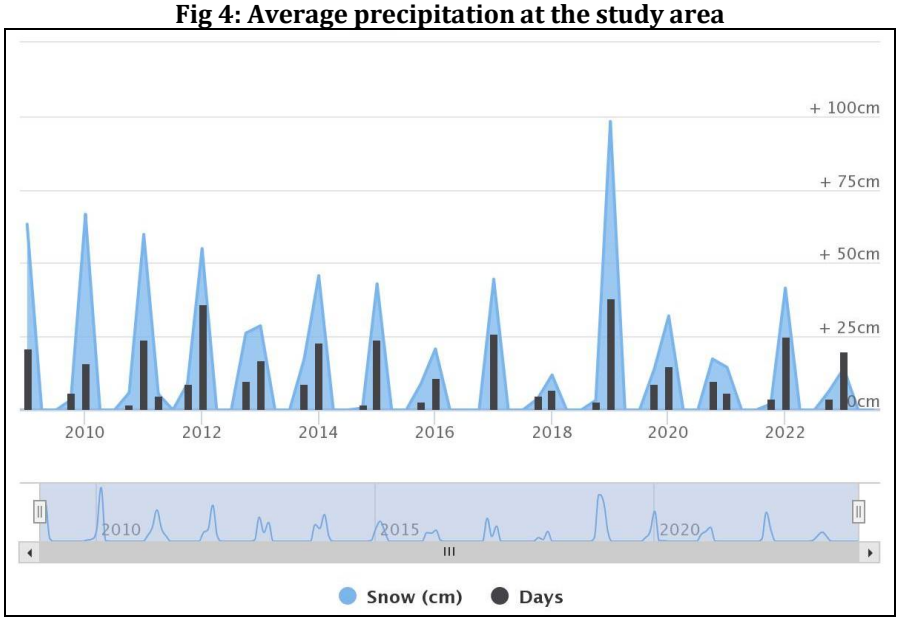

Fig 5: Average snowfall at the study area

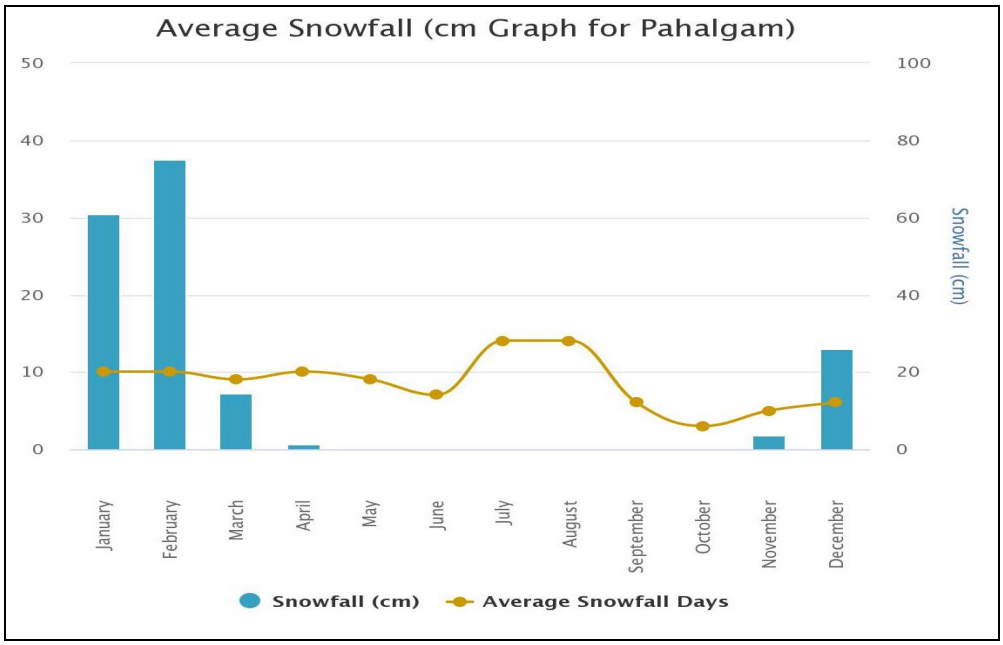

Fig 6: Average snowfall recorded at the study area

DISCUSSION

Climate change is having an impact on ecosystems worldwide, including populations of aromatic and medicinal plants. Medicinal plants in the study region, along with native species and plants that have experienced genetic diversity loss, face challenges due to climate change (14). If the frequency and severity of severe weather continue to rise, it will have a negative influence on the harvests of medicinal plants, which currently threatens their availability and supply on global markets. Because of this, efforts are underway to find ways to mitigate the impact of climate change on aromatic and medicinal plants. Because of characteristics such a smaller population structure, more anthropogenic intimidation (15), increased habitat specialisation, and a narrower distribution area, endemic species may be more susceptible in the near future to changes in their range of distribution as well as to habitat degradation or loss. *Because it is considered a vulnerable, non-endemic plant species of Kashmir, A. benthamii* is also one of 59 medicinal plants that have been chosen for conservation (16). The export of plant species taken from natural regions in India is prohibited by the Convention on International Trade in Endangered Species of natural Flora and Fauna, which includes it on its list of threatened species (17). The medicinal herb A. benthamii is an important component of the over-the-counter medicine "Gaozaban," which has antifungal, antibacterial, wound-healing, and anti-inflammatory effects (1). The plant's roots contain an abundance of the dye shikonin, a red pigment with a number of ethno-pharmacological uses (18). According to the tables, the weather data for Pahalgam station from 2010 to 2022 showed an increasing trend in the maximum temperature, which rose sharply from 16.70 °C to 19 °C, an increase of approximately 2.30 °C in the last 12 years. Precipitation as seen in the above figures in the area has significantly decreased over this decade that has caused drastic changes in the flora and fauna of the region. The possibility that certain plant species would relocate to and dwell in higher altitudes under future climate forecasts may indicate a shift in the species' niche brought on by the anticipated rise in earth's temperature (19,20).

As was seen throughout the investigation, the advantages of this medicinal plant are projected to significantly decrease due to climate change. This was also supported by the data we gathered from the survey questionnaire and collaborative meetings. There is a plethora of practical knowledge, distribution, and traditional applications held by the indigenous people of this region, such as the Gujjars and Bakerwals.The Group discussions with them revealed that these areas were having abundant with *A. benthamii* previously, further strengthen our argument that these plants are not now found in the selected areas. This plant species may have moved to higher altitudes in the area that need to be further investigated.

Climate change has a profound effect on *A. benthamii*, both in cultivation and in the wild. A targeted study approach is urgently needed, Compared to other medicinal plants, research on *A. benthamii* and climate change is quite sparse and negligible. Given its potential as sources of medicinal importance, it is imperative that this plant needs to be preserved.

CONCLUSION

This changing pattern of temperature and precipitation has caused devastating impact on the extinction of *A. benthamii* in the area, apart from other factors. It is very important to understand the changes in the global climate patterns and their impact on the endemic plant species for their conservation. More work needs to go into undertaking a comprehensive ethnobotanical survey of the entire Pahalgam valley, paying special attention to studying the conservation status of the important and rear medicinal herbs, so that we can accurately portray the range of ethnomedical uses of the different species found at higher elevations. It is necessary to determine which regions of Phalgam's A. benthamii range have had the most loss of species and which have seen the greatest increase in order to determine whether or not this plant is best suited for ex situ or in situ conservation efforts.

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