

RESEARCH ARTICLE

# Climate change and the Western Himalayan community: Exploring the local perspective through food choices

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Received: 18 December 2021 / Revised: 21 April 2022 / Accepted: 7 November 2022 / Published online: 8 December 2022

**Abstract** The local belief systems are crucial for climate change adaptation. Even climate experts are unanimous about the fundamental association between local beliefs and climate change adaptation strategies. However, the local perspective is missing from the significant policy dialog platforms. The local beliefs can potentially serve as both objective and psychological refuge for local societies during climate-related emergencies. Similarly, only limited studies have acknowledged the significance of local food choices, providing a model for global responses to climate change. The objective of the study is (i) to explore the local community's insights and awareness of climate change and (ii) to assess the impact on local food choices affecting their food security in the face of climate change in the Western Himalayan Region, India. The study is based on 210 in-depth household interviews and surveys in 10 villages of Uttarakhand, India. The exploratory factor and thematic analysis results highlight the significance of local perception of climatic variabilities, food choices, and beliefs in climate change adaptation policies. Hence, the current study's outcomes emphasize on the integration and promotion of both scientific methods and local knowledge for inclusive climate change adaptation and food security policies in the Himalayan Region.

**Keywords** Factor analysis · Local food choices · Qualitative approach · Socio-climatological perspective · The Western Himalayan Region

## INTRODUCTION

Climate change is one of the significant challenges the world is facing in the twenty-first century, and the local community of the Himalayan region is among the most

vulnerable communities due to their closer proximity to the natural environment (IPCC 2014, 2018, 2021). Further, the local belief systems are crucial for climate change adaptation. Even climate experts are unanimous about the fundamental association between local beliefs and climate change adaptation strategies. Nevertheless, the local perspective is missing from most of the policy platforms. Therefore, it is crucial to acknowledge the significance of local food choices, providing a model for global responses to climate change (UNDP 2007; FAO 2010; UNEP 2021; UNESCO 2021).

Thus, this study was conducted, and the findings indicate that incorporating local beliefs about climate change can significantly aid in the success of climate change adaptation policy. Therefore, understanding the local perception can assist climate experts in better communication about climate action and alternative adaptation policies.

## Theoretical framework

The Himalayan region assumes great importance to India's communities socially, culturally, and economically. Approximately, 51 million of the population in the mountain region practices sustainable agriculture, which is primarily dependent on favorable natural climatic conditions. Therefore, the rapid pace of climate change has affected their food security. Here, food security is defined as healthy people with access to adequate, affordable, good quality, and nutritious food (Wester et al. 2019). For decades, the Himalayan region has remained carefully balanced, resulting in the region's remarkable biodiversity. Nevertheless, in the recent two decades, the rapid pace of climate change has increased vulnerability (NAPCC 2010). The decrease in rainfall and extreme precipitation during monsoons have led to an increased incidence of floods and

drought. Also, the increased incidence of heat stress affects crop yield in the region (IPCC 2018).

Further, the mountain region exemplifies a unique approach to climate change research. At higher elevations, climate change is occurring rapidly, which results in changes in vegetation and ecological and geographical conditions. Also, due to climate change, the cultural value of local communities is changing, hence, acknowledging the intricacies of environment–society interaction (IPCC 2022). Moreover, the Himalayan region is vulnerable to natural interferences such as landslides and erosion. The outcomes of the interaction of these multifaceted elements of change are difficult to forecast but will have significant consequences not in the mountain region but globally. Thus, exploring and assessing possible dimensions of climate change in the Himalayan region is imperative. Therefore, the urgency of a holistic approach arises to bring all the stakeholders, viz., local community, climate experts, and policymakers, together for the ideal solution for sustainable climate change action (Wester et al. 2019).

Therefore, in 2008, the Department of Science and Technology (DST), India, launched the National Action Plan on Climate Change (NAPCC), which draws a framework of how national agencies can support all stakeholders through local and regional policymakers to aid in climate adaptation. Therefore, National Mission for Sustaining Himalayan Ecosystem (NMSHE) and National Mission on Strategic Knowledge for Climate Change (NMSKCC) are among the eight missions for integrating the geographical and social context (DST 2010). Subsequently, DST recommended certain location-specific adaptation measures to the Government of India measures with various organizational supports.

Thus, integrating local communities' perspectives is crucial for sustainable climate change policy due to their inherited local knowledge about nature from generation to generation (UNFCCC 2020). According to some estimates, local communities take care of approximately 80% of the world's biodiversity; community forests store at least 24% of the above-ground carbon emissions through their local beliefs and practices (IUCN 2020). Hence, recognizing local understanding, traditions, belief systems, and their involvement in environmental governance can significantly improve the sustainable efforts to conserve and mitigate the challenge of climate change (IPBES 2019).

In the recent two decades, climatic variabilities like forest fires, cloud bursts, floods, and landslides have exponentially increased in Uttarakhand, a part of the Western Himalayan Region, India. Moreover, the production and harvesting of locally significant food crops and fruits are declining and have also affected food choices due to dietary shifts (Bagchi et al. 2004; Wang et al. 2013). Since food choice is associated with local beliefs, changing

food choices also affects the food security of the local community (Saxena et al. 2005; Negi et al. 2017); therefore, the local perspective is crucial for inclusive climate policy. Nevertheless, most of the research has been done on agrobiodiversity (Pandey et al. 2017; Ravera et al. 2019), ethnobiology (Ramakrishnan 2001; Chaudhary and Bawa 2011; Junqueira et al. 2021), and socio-economic perspective (Arnell 2004; Senapati and Gupta 2017), which involves considering the specific target groups such as farmers (Shukla et al. 2019; Baig et al. 2020; Cuaton and Su 2020), and climate experts (Rosenberg et al. 2010; Stoutenborough et al. 2014). Due to this, the local perspective, especially the local communities' perspective, gets little attention. Thus, the present study will fill the research gaps for evidence-based policy formation linked to sustainable consumption patterns and practical future adaptive measures for the mountain community.

Hence, the current study assesses the climate change impacts and local communities' approaches toward climate change. We hypothesize that the apprehension of climate change will aid in climate action. The study aims for a comprehensive understanding of local perspectives in the face of mixed outcomes from existing literature. This study employs exploratory factors and thematic analysis to explore the localized meaning of climate change and propose an evidence-based food security policy. The objective of the study is (i) to explore the local community's insights and awareness of climate change and (ii) to assess the impact on local food choices affecting their food security in the face of climate change in the Western Himalayan Region of India.

## MATERIALS AND METHODS

### Research setting

Uttarakhand has a 'Pahari' culture, i.e., the culture is mainly followed in India's mountain region. The state is located in the Western Himalayan Region of India, with a total population of 10,086,292, where 49.03% are women and 50.93 men, with 69.77% rural population and 30.23% urban population. About 75% of the population practice local subsistence farming through local methods and depend on natural rainfall, ensuring resilience against climatic change (Bisht et al. 2018). Most of the local community follows the norms and values set by social institutions.

### Sampling technique and participants

A cross-sectional household study was conducted in five select districts: Haridwar, Dehradun, Tehri Garhwal,

Nainital, and Almora of Uttarakhand, India (Fig. 1), from March to August 2021. The very reason for selecting the mentioned district is because these districts are on a higher rank on the high vulnerability index due to climate-induced disasters (NIDM 2012; World Bank 2019; GoI 2021). Similarly, in the recent two-decade, the climate has been changing at a rapid pace. Therefore, only those respondents were interviewed and surveyed who were above 18 years old expressed interest and readiness to participate in the interviews and surveys. A total of 210 households aged between 18 and 75 years old were selected (58.1% of men and 41.9% of women). Since mixed-gender participation brings the element of inclusivity, thus, the perception of both males and females was incorporated. The highest number of participants was between 20 and 49 years old, i.e., 59.5% of the total participants (Table 1). Most importantly, the participants' informed consent was obtained before the interview.

### Data collection

The mixed-method technique is used for data collection, which includes both structured surveys, i.e., a 5-point Likert scale, and semi-structured interviews in Hindi and English in natural surroundings allowing the respondents a comfortable space for meaningful responses. The reason for using the mixed-method techniques is that it allows the researchers to develop in-depth insights on the topic (Creswell and Clark 2017). Structured surveys were taken because quantitative surveys assist in determining the degree of conformity and differences among participants owing to specific rationale (Newig and Fritsch 2009). The

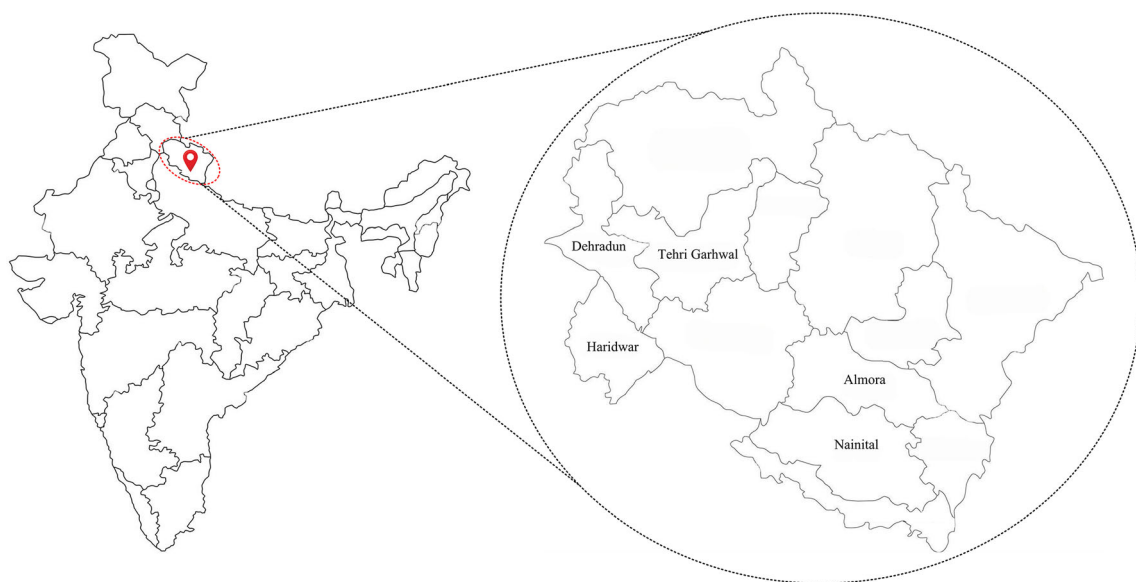
statements were designed to capture the degree of variabilities toward the specific statement. For example, “Do you think rainfall patterns have changed in recent two decades?” Accordingly, five options were given, i.e., from strongly disagree, disagree, neutral, agree, to strongly agree. Also, the value was assigned to each option from 1 to 5, respectively. The semi-structured interviews were based on the fundamental themes, namely, local awareness and perception of climate change, the impact of infrequent rainfall, unstable temperature, unpredictable seasonal variations, and forest fires on local food.

Further, reliable research principles are followed to establish the study's research quality (Athens 2010). Primarily, the triangulation approach was incorporated for interviews, response forms, diary notes, and some audio-tapes of the conversations during the field study. Further, participants were allowed to cross-check their respective responses, contributing to the research work's credibility and accuracy of the collected data. Moreover, the descriptive records of the 210 responses were explored and analyzed to ensure the transferability of the field research's outcome.

### Analytical tools and techniques

#### Factor analysis

The Principal Components Analysis (PCA) is used to explore the interrelationships between the items on Statistical Package for the Social Sciences (SPSS 23). Since the acceptable value of Cronbach's Alpha is greater than the .7 value. Thus, the reliability of each factor has been checked



**Fig. 1** Map of the surveyed region, Uttarakhand, India

**Table 1** Demographic and lifestyle profile of the participants

Attributes	Categories	% total respondents
Family type	Nuclear family	49.5
	Joint family	50.5
Gender	Male	58.1
	Female	41.9
Age	20–29	8.60
	30–39	19.0
	40–49	31.9
	50–59	18.1
	Above 60 years	22.4
Social category	General	54.8
	Other Backward Classes	33.3
	Schedule caste	11.0
	Schedule tribe	1.0
Marital status	Unmarried	10.5
	Married	89.5
Education	Illiterate	8.6
	Primary	11.9
	Middle	13.8
	High	21.9
	Senior Secondary	20.5
	Graduation	18.6
	Post-graduation and above	4.8
Profession	Service	24.8
	Agriculture	42.9
	Business	19.0
	Others	13.3

through Cronbach's Alpha values, which are .864, .808, and .743, respectively, for F1, F2, and F3. Additionally, Cronbach's Alpha (0.846) test was run to verify the reliability of the questionnaires used for response collections. Also, only those statements with loading factors of at least 0.35 were kept; accordingly, 12 items were analyzed, which explained 72.54%. Moreover, the suggested minimum sample size for exploratory factor analysis is 3 to 20 times the number of variables. Thus, the sample size was 210 households (Mundfrom et al. 2005). Further KMO value is .73, which shows the sample size adequacy, and Bartlett's test value is .000, which shows a substantial degree of correlation in the data (Table 2).

Climate change means the change of climate, which is directly or indirectly influenced by human actions besides the natural activities that change the atmosphere's composition. Further, the impact of climate change has been observed over a while (UNFCCC 2020). Local food is defined as food that belongs to a specific region, has region-specific unique ingredients passed from generation to generation, and is commercially available for at least

50 years (Ostrom 2006). Therefore, fourteen variables were initially used, which could explain climate change's meaning and impact on local food and associated local belief. Hence, after PCA, only twelve variables were incorporated based on the acceptable loading factors criteria for the study. Additionally, analysis of the scree plot depicted the inflexion point, which is the further justification for retaining three factors (Field 2009).

Finally, three broad factors evolved. The first factor (food choices and local beliefs) used the six variables, which explored the impact on local food choice, overall food choice, community's food choices, the impact of deforestation in the region, the importance of local knowledge, and harm to nature. Thus, these variables assisted in defining the significance of local knowledge and food choices, which can form the basis for developing the natural ecosystem and resources management strategies for climate change (IPCC 2007). The second factor (the local context of climate change) employed the four variables (i.e., change in rainfall pattern, temperature pattern, seasonal variation, and impact of snowfall (on the harvesting of locally grown crops) to describe the localized meaning of climate change. In the third factor (importance of customary beliefs), two variables (importance of customary norms beliefs and religious beliefs) were used to explain the importance of local beliefs and practices of local societies. Since the twelve variables were able to explore and assess the association between climate change and local knowledge through local food choices, the same were incorporated for the current study (Table 2).

### Thematic analysis

Thematic analysis is a qualitative approach used to discover new themes, 'some level of patterned response or meaning' (Braun and Clarke 2006). Thus, qualitative research often involves exploring an in-depth understanding of specific phenomena. Thus, the sample size is usually smaller. The existing literature suggests that a sample size of around 5 to 50 respondents is enough (Dworkin 2012; Fugard and Potts 2015; Malterud et al. 2016). Hence, 42 household surveys from every five districts were selected for this research. Therefore, in total, 210 household surveys were conducted. Hence, the deductive approach is used to analyze the qualitative data to substantiate the factors further.

Qualitative data analysis software (NVivo 12) was also used to conduct thematic analysis interviews based on the factors generated through PCA to describe the results further. NVivo 12 permits the creation of files called 'nodes' and aids in categorizing and conceptualizing the qualitative responses (Elo et al. 2014). Therefore, the descriptive qualitative data were extracted using the codes to

substantiate further the three factors that evolved through PCA. The codes were assigned manually to the relevant statements, potentially explaining broader perspectives in sync with the defined themes (Table 3).

Further, comprehensive knowledge of the local meaning of climate change can be valuable for successful strategies during climatic variabilities. Inclusion and recognition of local approaches during climate action at the local community's level aid in greater adaptation and resilience to the disastrous impact of climate change. Moreover, for inclusive food security, the policies must be in sync with the local beliefs of the communities. For example, locally produced food has the potential to lower the cost of transportation, reduce wastage, and help in the revival of local economies (Terry 2009; IPCC 2014; UNFCCC 2020). Therefore, the second factor (F2) has been used to explore the theme associated with the localized meaning of climate change. The PCA's first (F1) and third factors (F3) were clubbed to explore the food security and climate change adaptation dynamics.

## RESULTS

### The localized meaning of climate change

The degree of awareness for climatic variabilities is time and space context-specific, which varies according to local

communities' own experiences with their ecosystem. The preliminary knowledge of climate change comes from the direct observation of the environment and its physical consequences. A comprehensive understanding of change is a significant factor in the local knowledge base of the communities.

The evidence suggests that communities' opinion about changing climate is significantly affected by the region's fluctuating temperature, i.e., cool and warm years of the region (Donner and McDaniels 2013; Bauerfeind and Fischer 2014). For example, the precipitation in the lowland district has decreased; the respondents in the Haridwar district defined climate change in terms of temperature and rainfall patterns in recent decades.

The rainfall pattern is no more the same as it used to be in the early 2000s. In the early decades in the plane region, it used to rain heavily, but now a decline in rainfall has been observed. It is erratic and scanty nowadays. Similarly, now it is too hot to go outside during summer. Summer is not suitable for health due to harmful rays. (a 46-years old female)

Similarly, the snowfall pattern's spatial dependence structure significantly influences the perception of climate change (Nicolet et al. 2016). The variability in snowfall and rainfall has increased with time and is not constant now. Similarly, the villagers in Tehri Garhwal districts associated the concept of climate change with decreased

**Table 2** PCA and descriptive statistics

Items	F1	F2	F3	Mean	Std. D
Food choice and local beliefs					
Local food practices	<b>.418</b>			4.18	.702
Overall food choices	<b>.848</b>			4.23	.704
Community's food choices	<b>.867</b>			3.92	.963
Deforestation	<b>.927</b>			4.30	.706
Local knowledge	<b>.928</b>			4.29	.703
Harmony with nature	<b>.928</b>			4.29	.703
The local context of climate change					
Rainfall pattern		<b>.890</b>		4.05	.826
Temperature pattern		<b>.827</b>		4.10	.858
Seasonal changes		<b>.848</b>		4.17	.818
Snowfall		<b>.506</b>		4.29	.659
Importance of local beliefs					
Customary norms			<b>.894</b>	3.82	.981
Religious beliefs			<b>.870</b>	3.81	.922
<b>% Variance explained (72.54)</b>	<b>36.68</b>	<b>22.07</b>	<b>13.79</b>		
Cronbach's alpha (.846)	<b>0.864</b>	<b>0.808</b>	<b>0.743</b>		
Bartlett test of sphericity (p-value)			<b>.000</b>		
Kaiser–Meyer–Olkin			<b>0.73</b>		



**Table 3** Coding and major themes

Codes	Perspectives	Themes
Climatic factors, unpredictable rainfall, Extreme temperature	Suitable climatic conditions are missing to grow local food crops; heavy rainfall damages the local crops; extreme temperature causes loss of productivity; Landslide and cloud burst is very common	Phenomena of climate change
Local food, Conventional farming, Local communities, Lifestyle change, Migration	Local foods are less grown; Local food is ignored; Local ways of cooking and food choices are forgotten; Unfavorable environmental change has created havoc among the local communities; People like the sedentary lifestyle; Emotions and feelings have severely been affected due to delayed seasonal change	Food choices and local lifestyle

snowfall, increased rainfall, and loss of local plant varieties.

Earlier, there used to be heavy snowfall in my region, but the incidence of snowfall has decreased with the passage of time. Besides, sometimes the rainfall is heavy, and sometimes it is low. For me, this is the definition of climate change. (a 49-year old male)

The degree of unstable change in rainfall patterns both within and between seasons (Mondal et al. 2016) affects the regional vegetation. Hence, the notion of climate change is being shaped by the availability of region-specific plant species. For example, the villagers in the Dehradun district explained climatic variabilities in terms of loss of vegetation besides other factors like high temperature and lesser rainfall. The region used to be heavily covered with green vegetation and trees. Similarly, the respondents of the Almora district defined climate change with the notion of dietary shifts.

We used to have Jhangora (Indian barnyard millet), Koda (finger millet), and Koni (foxtail millet), which are no longer found or grown in the mountains due to unfavorable climatic conditions. Similarly, this time it rained heavily and affected the pollination of Kafal (a fruit), mainly found in the mountainous regions. (a 57-years old female)

The concept of climate change has now been associated with risk caused by natural disasters and has become part of the general awareness among the local communities (Andersson-Sköld et al. 2013). When asked the same question from the villagers about climate change, they correlated the change in climate with natural disasters like frequent cloudbursts, landslides, and forest fires.

We used to consume the juice of the local flower for our daily needs. But, the increased incidence of forest fires has drastically affected production. (61-year old female)

The changing patterns of rainfall, snowfall, and irregular precipitation patterns, i.e., fluctuating temperature, are the

modes of direct observations in the climate and have been incorporated into the standard definition of climate change. Nevertheless, there is a contextual meaning of climate change as acknowledged by local respondents, which acts as proof of climate change, for example, atmospheric, ecological, and biological indicators (Table 4). The atmospheric indicators can be observed in the change in the sky and clouds' colors, which also helps predict wind direction; ultimately, the fluctuation is observed as a long-term trend. Similarly, the ecological indicators can be the direction of river streams, landslides, and forest fires, which affects the local ecosystem and eventually results in the retreat of glaciers' rise in sea level as an indication of climate change.

Moreover, the changing dynamics of natural resources and local vegetation varieties act as biological indicators, influencing the productivity level and change in the harvesting time of local crops. Thus, the knowledge of climate change warns of forthcoming extreme weather conditions and aids in identifying inconsistent climate-related trends in the region. Thus, the inclusive insight of weather forecasting is imperative, especially in the regions such as the Western Himalayan Region, which is among the most vulnerable and has limited resources to tackle the natural disasters induced due to climate change.

Moreover, 89.5% of respondents agreed on climate change, and 7.6% disagreed that climate change is the reality of modern times. Additionally, when the questions related to indicators of climate change were asked, 85.2% agreed, 6.2% disagreed with unpredictable rainfall patterns, 80.0% agreed, 3.8% disagreed with unstable temperature change, 90.5% agreed, and 6.2% disagreed with delayed seasonal change. Further, regarding the impact of climatic variabilities, namely, change in land-use pattern, 93.4% agreed, and 2.4% disagreed; shifting cropping pattern, 59.5% agreed, and 13.3% disagreed. Similarly, on the negative impact on biodiversity, 75.7% agreed, 7.1% disagreed, impact on local food choices, 73.4% agreed, and 11.9% disagreed.

**Table 4** Local concept of climate change

Categories	Local understanding of		
	Climatic events	Seasonal projections	Long-term trends
Atmospheric indicators	Changing colors of clouds and incidents of cloudburst	The direction of the wind can be predicted	Fluctuations in temperature, rainfall, snowfall pattern
Ecological indicators	Change in the direction of waves in the river streams	Shifting in the water level of a local source affects the farming and household consumption pattern	The rise in sea level
	Incidents of landslides		Retreat of glaciers
	Drying of rivers		Land-use change
	Declining water level		Shifts in ecology
	Forest fires		
Biological indicators	Change in flowing times of fruits and local plants	Early budding of the flowers negatively affects the level of productivity	Decrease in <i>Madua</i> and <i>Kala Bhat</i> production
	Shifts and extinction of local plant varieties		The observed change in the timing of local crops harvesting

### Food security and adaptation

The local subsistence method of farming and local food choices have been a significant part of the mountain regions of Uttarakhand, which further ensure the diversity of food choices, hence increasing the chance of more remarkable adaptation against climate change (Bisht et al. 2018). The local communities of the Western Himalayan mountains are well known for their distinctive ethnic food culture and local knowledge. The plant species are significant in their local food practice (Abdullah et al. 2021). Nonetheless, the local food system has experienced a significant transition in recent decades due to seasonal shortfalls (Dame and Nüsser 2011; Hussain and Qamar 2020).

The food consumption pattern and the local agricultural techniques in the Western Himalayan Region have shifted in recent decades (Shukla et al. 2018). The food choices of local communities are characterized by a substantial portion of culturally significant local foods. Consumption of local produce is essential for nutritional needs and other necessary elements essential for local people in critical climatic conditions. Nevertheless, due to climatic instabilities, local food consumption has been disrupted (Andronov et al. 2020).

We used to consume Bajra (maize), Makki ki roti (maize flour), and Jhangora ki kheer (barnyard millet), but it is no more found here. Also, Loki (bottle gourd) and Tori (ridged gourd) used to be the staple food, but now, the production has been affected due to climate change. (57-year old female)

The experience of susceptibility to local food practices to natural hazards frequently results in food insecurity. Hence, understanding the multifaceted dimensions of local food is imperative in the face of the ever-increasing risk of

climate disasters. Moreover, the local values and beliefs associated with the communities' food are not accounted for during disaster preparedness (Wentworth 2020). Sometimes due to landslides, the mode of transportation gets badly affected, which results in various issues ranging from scarcity of water and food to vegetables for human consumption. So, at that time, they have to manage with available options for months.

Climate change has undoubtedly affected the local food crops in the mountain regions such as Bajra, Kodu, etc.; the production has severely been affected. We have to be reliable on local food like Pahari Aloo (potatoes grown in the mountainous regions) (a 52-year old male)

Drastically climatic variations at higher latitudes and altitudes have a significant impact on the biodiversity of the region affecting the growth pattern and nutrient quality of the native species. Hence compels the community to shift their food choices to get the required nutrition for their daily needs (Srivastava and Kumar 2021). The local communities of the Himalayan region practice local agriculture strategies to produce culturally accepted food crops. Still, due to climatic vagaries, the communities have shifted to new cash crop-based farming (for example, a shift from wheat to sunflower oil) and local hunting choices.

The local food choices were organic. A few decades back, the climatic conditions were stable and favorable for local food varieties, and people were also hard working. However, global environmental change has completely changed the scenario. Besides that, the high nutrition profile of local food choices. The local eating practice has changed; for example, people used to sow rice and Madua on a larger scale for personal consumption at the local level. Also, sunflower seeds were used for oil, but now these things have changed. Now people are more focused on cash crops like beans

because of the change in the tradition of consuming home-grown or customary foods, as told by a 46-year-old female.

Now, I have observed the drastic shift in the food choices of my community. They are neither practicing the local ways and means of cooking nor eating locally grown food.

Furthermore, the inclusion of the socio-ecological dimension is a fundamental adaptation strategy at the policy formation stage. Thus, the long-term sustainable solution to climatic variabilities, the role of local biodiversity conservation, and the local lifestyle become vital. Local food crops should be promoted due to their availability, accessibility, and greater acceptance among local communities. Hence, explicit modeling of local biodiversity in response to environmental change is significant (Kumar 2012). When the question of adaptation strategies was asked, respondents agreed on the significance of the local food practice, which helps to adapt better during natural calamities. For example, the phenomenon of ‘Kitchen Gardening’ was prevalent that used to help the local communities to adapt during unstable climatic conditions. But now, due to a lesser focus on local adaptation strategies, the pattern has also changed.

To adapt to the climatic conditions, we prepare ourselves and stock food and other essential items in advance. In the earlier days, we used to grow food in our backyard for personal consumption. For example, Kala Bhat (black soybean, vegetables like Kandali (nettle plant) and Linguda (fiddleheads greens) are used to grow in mountainous regions, which are no more or rarely found in my district (a 62-year old female)

In addition, on the questions related to the impact of climate-induced changes on the native community’s cultural norms associated with food choices, viz., food choices are based on cultural beliefs, 63.3% agreed, and 22.9% disagreed, community’s beliefs are significant 75.2 agreed, and 22.4% disagreed, with religious beliefs are essential 69.0% agreed and 14.8 disagreed, impact on local food practices 76.7% agreed, and 9.0 disagreed.

## DISCUSSION

The thematic analysis of the local community’s perception is consistent with the Indian Meteorological Department’s (IMD) observation, which observed the fluctuation in the mean annual rainfall pattern. The recent forecast of 868.6 mm based on 1971–2020 data is less than the 1961–2010 data, which forecasted 880.6 mm of rainfall (IMD 2020). India falls under the tropical zone; thus, annual rainfall depends heavily on the monsoon. Nevertheless, the analysis of 30 years of data (1989–2018) uncovers the region’s high spatial and temporal

variability of rainfall. Climate change has adversely affected the frequency and intensity of rainfall patterns in the region. For example, the Garhwal region has received lesser annual rainfall. In contrast, the Kumaon region (mountainous areas) has shown increased annual rainfall if the comparison is made to the mean annual rainfall pattern of the Garhwal region (Guhathkurta 2021). But, in the overall region, the rainfall has decreased.

Further, the local understanding of temperature is consistent with various scientific reports, showing a significant temperature rise in the Western Himalayan Region (Friedlingstein et al. 2021; IPCC 2022). India’s average temperature has risen by around 0.7 °C from 1901 to 2018 (Krishnan et al. 2020). The difference in the perception attached to temperature among the plane and mountainous regions is due to latitude variations. Also, at higher altitudes, the rise in temperature is significant compared to low altitudes affecting the local food choices due to uncertainty in productivity (Das 2021). Likewise, multiple studies have found that due to climate change, the phenomena of early flowering frequently affect the crop productivity of local communities. The current study’s finding is in synch with the earlier research and reports. The anticipated effect will also be disastrous for agriculture and food security (Gupta and Pathak 2016; Vernooij et al. 2017; Pandey et al. 2018).

The majority of Uttarakhand’s population is dependent on subsistence farming; therefore, a large section of local people subsist on local agriculture and allied activities for their socio-economic and nutritional requirements. Moreover, local diversified crops in the Western Himalayan Region are vital for a sustainable ecosystem and for conserving local knowledge of ethnic food. Locally grown food has evolved, acting as a nutritional need and food security source. But, due to seasonal instabilities, biodiversity is also shifting and changing; hence, the conservation of local food choices and crop systems requires policymakers’ urgent attention (Negi et al. 2009). Thus, the in-depth analysis of local community attitudes about climate change and its impact on food choices can significantly aid in climate change adaptation strategies in the mountain region, which also have global significance (Chaudhary and Bawa 2011).

The natural ecosystem is the primary source of ecosystem services, including provisioning, cultural, and other supportive services (UNESCO 2021). Hence, the facilities delivered by the mountain ecosystem aid in the sustenance of more than half of the global population and are critical in the maintenance of the integrity of the Earth system through various ecological functions (IPCC 2021). For example, conventionally, two crop cycles are followed in the Western Himalayan Region, i.e., Rabi and Kharif, but delayed seasonal rainfall has affected the productivity of locally grown crops and hence, affected the food choices.



Furthermore, food choices are not only the source of satisfying human's nutritional needs; it also illustrates the social and cultural identity of the local community (Clark et al. 2020; Adaawen 2021). It is imperative to document and analyze the local food choices, which will assist in a comprehensive understanding of the ecologically and culturally significant local foods for the inclusive approach to tackling the issue of food security in times of climate change (NAPsC 2010).

There are certain limitations associated with both local knowledge and scientific knowledge. For example, knowledge about the future climate is uncertain, location-specific understanding is inadequate to tackle the high-intensity climatic variabilities, and local knowledge is suitable at the local level. While scientific studies on climate change are essential for suitable resilience-building solutions, local knowledge helps reinforce adaptive capacity as a strategy for building resilience (IPCC 2007; Karki et al. 2017). Therefore, Knowledge integration is crucial for climate action because much of the scientific research on the impact of climatic variabilities offers a generalized view. At the same time, engagement with the local community requires a comprehensive understanding of their social, ecological, and lifestyle attributes. Local knowledge comprises various elements of understanding and practices, and hence, policy approaches should be tailored and developed to the local context (Wheeler and Root-Bernstein 2020).

Thus, insights on local issues and resources are sufficiently specialized, which requires the adequate participation of all stakeholders, i.e., community members, and the support of policymakers (Grêt-Regamey et al. 2013). Efforts to integrate local and scientific knowledge, such as “bottom-up/top-down” approaches, are increasingly recognized as valuable in risk assessment and climate change adaptation policy. Also, the integration of local knowledge provides prospects to generate inclusive understanding for both scientists and policymakers in decision-making and faster implementation since it aids in connecting climate change and to impact and consequences on their community (Failing et al. 2007; Kettle et al. 2014).

The current study's findings emphasize and suggest a way forwards with a series of steps that can help in socio-economic and socio-cultural policy measures from local communities' perspective to minimize the effect of climatic change and safeguard the local community's food security in the Western Himalayan Region of India.

Socio-economic policy: the local communities with low and medium Human Development Index (HDI) are severely affected by climate change. For example, in 2020, due to extreme temperature, approximately half of 295 billion potential work hours were lost because of extreme heat (Romanello et al. 2021). Climate change has generated various opportunities and challenges for the local societies of the Himalayan region. Therefore, policy planners should also

integrate the regional concerns of vulnerable communities, and accordingly, schemes and policies should be formulated. For example, *Kafal* and *Buransh* could be integrated into the national livelihood mission. Accordingly, the provision of insurance could promote local foods.

Socio-cultural policy: the local edible plants are socially and culturally acceptable to the local people. Thus, stress should be given to the inclusion of local species (e.g., Madua and Kala Bhat) in the national food security mission to improve the nutritional status and conservation of local foods of the vulnerable mountainous communities.

The native communities of the Himalayan region use locally grown food crops and various plant species for food, medicinal, and socio-cultural purposes. But, due to climate change, the importance of local knowledge of collecting and consuming locally grown foods is eroding. Therefore, assimilating socially and culturally synchronized foods is inevitable for ensuring food security and enhanced climate change adaptation strategies (Clark et al. 2020).

## CONCLUSION

This study was conducted to explore the local community's understanding of climate change for an integrated response of the communities against climatic instabilities. The local context significantly influences the action and attitudes associated with risks because they are inherited through everyday experience. Further, the socio-ecological beliefs of the local communities act as both objective and psychological refuge for climate-related emergencies (IPCC 2021, 2022; UNESCO 2021). Moreover, it is the perception of danger that dominate people's action. Hence, perceptual knowledge of the local communities is imperative for effective communication and adaptation strategies (Becken et al. 2013; Schowalter et al. 2018; Wahab and Popoola 2019). Therefore, this study emphasizes integrating and promoting scientific methods and local knowledge for a holistic approach to climate change adaptation in the Western Himalayan Region of India.

Data collected for the current research may not be a true representative of the plain region due to socio-climatic and geographical variation. Further, the district was purposively selected based on the IMD's high vulnerability index. Also, the small sample size would not have captured the perception of the whole population. In addition, the economic and wealth profile was not incorporated in this study. However, the in-depth interviews unfolded the local meaning of climate change, which corresponded with the finding of scientific reports. Thus, the present study may be a starting point for future studies. Since climate change is a worldwide phenomenon, a parallel and comparative study might be conducted to confront the present study's findings

with a larger population size. Likewise, the longitudinal study is desirable to assess if the climatic conditions remain constant after a few years to integrate other significant elements, such as the wealth component and socio-economic factors that the current study has not investigated. Also, the dynamics of COVID-19 and climate change might be corroborated in future research.

**Acknowledgements** The authors would like to thank the Department of Humanities and Social Sciences, Indian Institute of Technology (IIT) Roorkee community, for providing access to all necessary resources and Ms. Priya (Senior Research Fellow at IIT Roorkee) for her valuable feedback. We would also like to thank the respected editor and anonymous reviewers for their valuable suggestions in further improving the quality of the manuscript.

**Author contributions** Mr. SD developed the idea for the current research paper, reviewed the relevant literature, analyzed and wrote the manuscript. Dr. AJM helped in every step from the formatting, proofreading to the finalization of the draft.

**Funding** This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

## Declarations

**Conflict of interest** The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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