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# Analysing Climate Change Manifestations Through People's Perception In Kashmir Valley, India.

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***Abstract***

The Kashmir Himalayas, a fragile mountainous, region, are experiencing the adverse effects of climate change, including rising temperatures, erratic rainfall, and extreme weather events. This study, based on primary data from 384 respondents in the Kashmir Valley, assesses people's perceptions of climate change impacts, particularly on temperature, precipitation, extreme weather events, and agriculture. Results indicate that 57% of respondents observe a decline in rainfall, 75% note a significant reduction in snowfall, and almost 60% perceive a decrease in stream discharge. Additionally, 75% believe that extreme weather events have become more frequent and intense, adversely affecting agricultural productivity. These findings align with empirical studies on climate change in the region and can serve as a basis for mobilizing public participation in government and non-governmental initiatives aimed at adaptation and mitigation.



***Keywords: Climate Change manifestation, Catastrophic, Quantifiable, Perception, Adaptation, Mitigation***

## Introduction:

### 1.1 Climate:

Climate is a fundamental factor in the development of human life. It is a statistical concept denoting the average or typical range of weather conditions in a specific location (Weber, 2010). This encompasses the overall weather pattern, seasons, and extremes like droughts or periods of increased precipitation. According to the IPCC (2007b), climate is defined as the long-term average of weather conditions, encompassing elements such as temperature, humidity, atmospheric pressure, wind, rainfall, and atmospheric particle concentration in a given location over an extended period. The composition of climate is influenced by three key factors: the amount of solar energy released into the atmosphere, its distribution across the system, and the interactions among various components within the system (Trenberth, 1992).

### 1.2 Climate Change:

Climate change is a multifaceted, abstract, quantifiable, and potentially catastrophic environmental challenge stemming from myriad human-induced activities worldwide (cf. IPCC, 2007 and Vainio et al., 2013). As defined by the United Nations Framework Convention on Climate Change (UNFCCC), it is "a change in climate attributed directly or indirectly to human activity that alters the composition of the global atmosphere and natural climate variability observed over comparable time periods" (UNFCCC, 2007 and IPCC, 2007).

This issue intricately intertwines nature, society, and individuals' preferences for material or non-material values, transcending boundaries, as articulated by former UN Secretary General Ban Ki Moon. Climate change is labelled a 'global challenge' requiring international cooperation, deemed by former US Secretary of State John Kerry as "likely the world's most lethal weapon of mass destruction," necessitating urgent action.
An urgent and visible concern of the twenty-first century, climate change is characterized as a textbook example of a "wicked problem" (Conradie, 2020) with nested, intractable, and unforeseen challenges. Regarded as the most serious environmental threat of the century (Stephenson et al., 2010), the global average temperature of land and oceans increased by 0.950 Celsius between 1880 and 2012 (Hansen et al., 2010 and Stocker, 2014). Climate models predict a 1–20 Celsius increase in tropic temperatures by 2050 (Deffenbaugh and Field, 2013), with less certainty regarding rainfall increases (Loarie et al., 2009). India's annual average temperature increased by 0.560 Celsius between 1901 and 2009 (Attri and Tyagi, 2010).
Experts project a 1.4-2.40 Celsius increase in the average global temperature by the end of the century, leading to rising sea levels, altered rainfall patterns, floods, droughts, and a decline in agricultural production, crop yields, and livestock productivity, resulting in food scarcity. Climate change stands as one of the most pressing and divisive global challenges, demanding collaborative, immediate, and sustained global efforts to mitigate its far-reaching impacts.

**1.3 Climate Change Perception:**

While people may not directly witness climate change, they interpret environmental shifts as indicators, influenced by information from the media (Heath and Gifford, 2006; Etkin and Ho, 2007). Perception, a process converting raw facts into meaningful patterns, involves various psychological components like beliefs, attitudes, and concerns about climate change (Whitmarsh and Chapstick, 2018). Individual characteristics, experiences, and cultural environments shape perceptions (van der Linden, 2015; Whitmarsh and Chapstick, 2018). Climate change perceptions are crucial for developing policies, necessitating recognition of its existence, effects, and causes (Zhou and Feng, 2011). Public perceptions are influenced by structural, psychological, social, and cultural elements (Weber, 2010) making assessment challenging.
Various methods exist to measure climate change beliefs, with direct questioning being popular (Akerlof and Maybach, 2011; Leviston and Walker, 2010; Reser et al., 2011). Some studies analyse sequences of statements to infer views on climate change (Whitmarsh, 2011; Poortinga et al., 2011). Human perception is influenced by personality, community, environment, and their interactions (Sarkar et al., 2012). Public attention to scientific facts and media narratives shapes perceptions and behaviours (Weber, 2010).

**1.4 Study Area:**

The Valley of Kashmir is nestled in the North-Western folds of Himalayas. The mountain ranges rise to height of about 5550 m in the north-east and dip down to a height of 2770 m in South (Bhat and Rather,2018). The study area is between 330s30'N and 34o40'N in latitude and 73o45'E and 75o35'E in longitude. It is 15,853 km2 in size. The Kashmir valley is one of the three parts of the old state of Jammu and Kashmir that are separated by the Himalayas. People believe that these divisions are like a three-story building, with the semi-closed ecosystem of the Kashmir valley in the middle (Raza, et al., 1978; Dar, 2017; Khan, 2007). The Greater Himalayas to the Northeast and the Lesser Himalayas (Pir Panjal range) to the Southwest make up the borders of the Kashmir valley, which is a mountain basin (Romshoo et al., 2020). The Kashmir valley is 140 km long from north to south and 45 km wide from east to west. It has ten districts (Ganaie et al., 2014). Based on morphology, the valley of Kashmir can be divided up into the valley floor, the Karewas, the foothills or rimlands, and the side valleys (Lone et al., 2022). The alluvium left by the Jhelum River and its tributaries is what makes the valley floor the most interesting part. Because the land is flat and there are a lot of fertile alluvial deposits, there are irrigation facilities available all year. The "rice bowl of Kashmir" is an area of farmland that is mostly made up of paddy fields. The Karewas and the valley floor are both important parts of the geography of the Kashmir valley. The Karewas are flat-topped mounds that come from lakes and have a wavy surface. They are on both sides of the valley floor (Kumar et al., 2020; Bhatt, 1975). Along the length of the valley, they are spread out over a large part of the southern edge. Around mountain ridges, their tops tend to slope, but in the middle of a valley, they are mostly flat (Lone et al., 2022). They are considered perfect for market gardening because of the above qualities. Most of the border mountains and the low mountains in the valley are in the foothills (Easterbrook, 1999; Juanico, 1987). Conifer trees form a dense canopy over these hills from the different Himalayan Mountain ranges down to the valley plain. (Sabha et al. 2020) states that the side valleys are the major sources of water for the Jhelum River. These small-scale changes in landforms and climate give the area yet another unique agricultural and ecological regime.

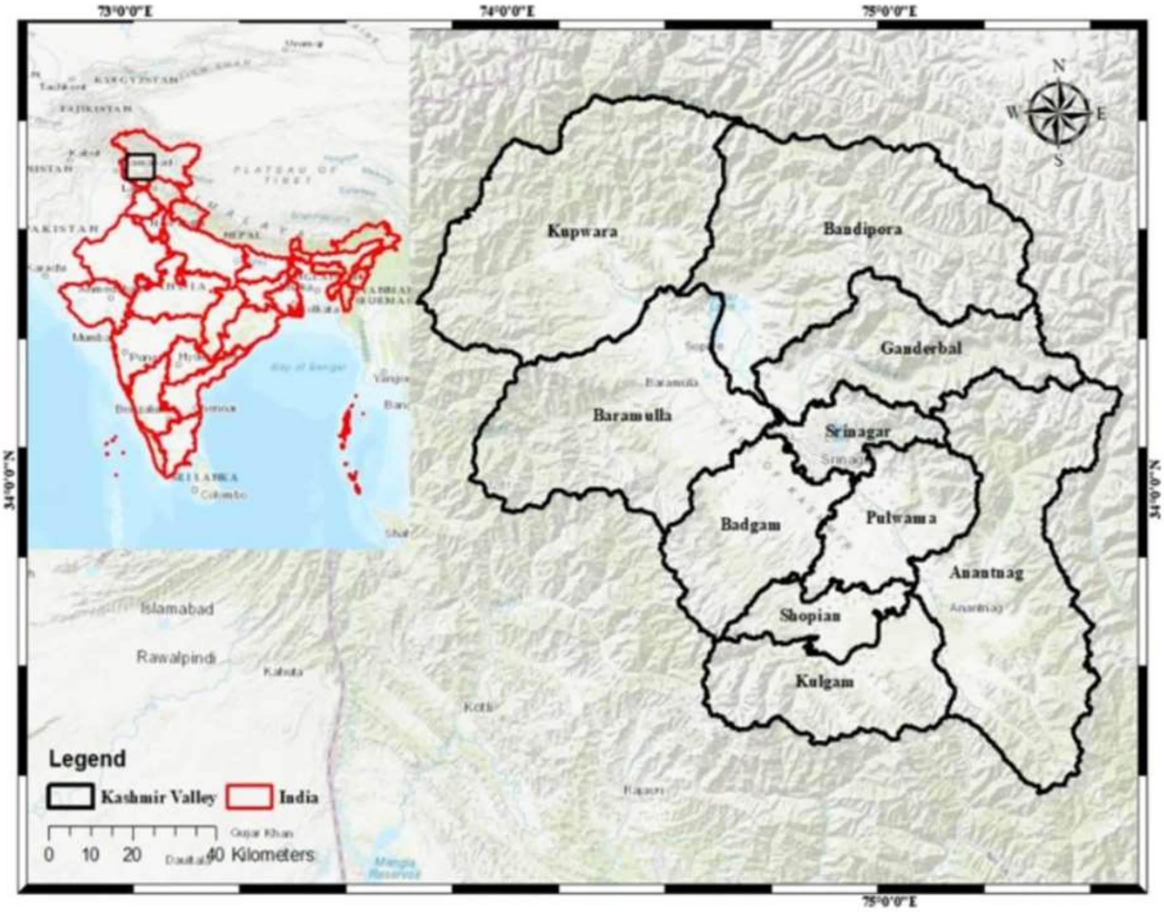


**Fig 1:** Study area map

**Database and Methodology:**

**Data base**

The current research relies on data gathered through a structured questionnaire. Data collection was carried out using a simple random sampling technique.

**Methodology**

Initially, the content validity index was utilized to assess the internal consistency among various indicators of climate change. The calculation of the content validity index followed a specific formula:

*CVI= n/N*

Where n= Numbers of evaluators agreed and n= Sum of evaluators.

Additionally, the item content validity index was utilized to evaluate the extent to which individual items were deemed relevant and representative of the construct being measured by a consensus of content experts. In this context, the content experts primarily consisted of individuals who had first-hand experience with the changes in climate manifestations within the study region. The calculation of the Item Content Validity Index (I-CVI) followed a specific methodology.

***No. of experts rating the important items /Total. Number of experts.***

The I-CVI is calculated for each individual item in a scale or questionnaire.

Then A-CVI, which is an aggregate measure that provides an overall assessment of content validity for the entire set of items or constructs was calculated by following method:

***Average-Content Validity Index(A-CVI) = Sum of I-CVI / Total number of items.***

Calculating these indices is aimed at determining whether the items within a measuring tool adequately and accurately represent the content domain they are intended to evaluate. Content experts are enlisted for this process to assess and rank the clarity and relevance of each item. Utilizing the quantitative measures of expert agreement provided by the I-CVI and A-CVI (Table 1), researchers can make informed decisions about which items to retain, modify, or eliminate in order to enhance the content validity of the instrument. To streamline data analysis and communication, an agreement level table or a percentage level table (Table 2) was constructed based on a 4-point Likert scale. This facilitates decision-making processes, quality control, trend identification, risk assessment, and policy formulation within the realms of agriculture and environmental management. Employing pie diagrams (Fig 2) serves to make complex information more accessible and visually appealing. Climate change encompasses numerous interconnected factors, and a pie diagram can effectively simplify and elucidate the relationships between these variables. As pie diagrams are straightforward and easy to comprehend, they serve as a valuable tool for conveying survey data to diverse audiences, including those who may not possess a strong familiarity with statistical concepts.

**Sample size**

The sample size was calculated based on the population size of the chosen region. The sample size for this investigation was calculated using the sample size determination formula. The margin of error is 10% at a 90% level of significance, with a standard deviation of 0.89 and a Z score of 1.65. (S.D- standard deviation).

$$Sample\ size = \frac{(Z\ score)2 * S.D(1 - S.D)}{(Margin\ of\ Error)}$$

| Significant confidence level | Z score value |
|---|---|
| 90% | 1.65 |
| 95% | 1.96 |
| 99% | 2.57 |

Based on the sample size calculation formula, the sample size of the study is 384 respondents.

**Results**

Perceptions of climate change are multidimensional, comprising several psychological components such as information, beliefs, attitudes, and concerns about whether and how the climate is changing (Whitmarsh and Chapstick, 2018). Individual characteristics, experience, information received, and the cultural and geographical environment in which they live all influence and shape perception (van der Linden, 2015; Whitmarsh and Chapstick, 2018). Perceptions of climate change are shaped and impacted by a diverse array of structural, psychological, social, and cultural aspects and processes with various intentions (Weber,2010). Over the year and over several decades, precipitation fluctuates in amount, intensity, frequency, and type (for example, snow vs rain), impacting the environment and society. The variability in the amount of precipitation is determined by the temperature characteristics. This variability affects the quantity of water that flows out through streams around the year, significantly impacting agricultural productivity. The present study was conducted in Kashmir Valley, located in the northwestern folds of the Himalayas. The first internal consistency of surveyed data regarding climate change manifestations was calculated using the content validity index, then summarising the change in climate change manifestations using an agreement level table.

**Table:1 Content Validity Index of Climate Change Manifestations: -**

| Statements | Increase | Decrease | Un-Change | Total | I-CVI | A-CVI |
|---|---|---|---|---|---|---|
| 1.Change in Rainfall. | 23% | 57% | ------ | 80 | 0.8 | ------ |
| 2.Change in Snowfall. | 10% | 75% | ------ | 85 | 0.85 | ------ |
| 3.Change in temperature | 68% | ------ | 18% | 86 | 0.86 | ------ |
| 4. Change in stream discharge | ------ | 60% | 18% | 78 | 0.78 | ------ |
| 5.Change in Ext. Weather Events | 72% | ------ | 16% | 88 | 0.88 | ------ |
| 6.ChangeinAgricultural Production | 18% | 60% | ------ | 78 | 0.78 | ------ |
| Sum | | | | | 4.95 | 0.825 |

**Source:** Almanasreh et.al (2019).

It is clear from Table 1 that the I-CVI of four statements, i.e., Change in Rainfall, Change in Snowfall, Change in Temperature, and Change in Extreme Weather Conditions, was 0.8, 0.85,0.86,0.88, respectively. Similarly, the I-CVI of Change in Stream Discharge and Agricultural Production was 0.78 each. The sum of the I-CVI of all the statements was 4.95, while the A-CVI was 0.825, clearly depicting extremely good internal consistency or score more than the range acceptable for checking Content Validity Index reliability.

The identification of climate change relies on alterations in various climatic indicators. In this investigation, we scrutinized several significant variables including precipitation, snowfall, temperature, streamflow, and occurrences of extreme weather events. These factors directly impact the agricultural productivity of the region.

**Table:2 Agreement Level Table Showing Responses of the Respondents in percentages with Respect to following Statements.**

| Statements | AGREEMENT % | Increase | Decrease | Un-change | Can't Say |
|---|---|---|---|---|---|
| 1.Change in Rainfall. | | 23% | 57% | 12% | 8% |
| 2.Change in Snowfall. | | 10% | 75% | 7% | 8% |
| 3.Change in Temperature. | | 68% | 5% | 18% | 9% |
| 4.Change in Stream Discharge. | | 8% | 60% | 18% | 9% |
| 5.Change in Ext. Weather Events. | | 72% | 4% | 16% | 8% |
| 6.Change in Agricultural Production | | 18% | 60% | 13% | 9% |

**Source:** Field Survey-2022

**1.Change in Rainfall and Snowfall: -**

***a) Rainfall Change***

In the Kashmir Valley, a critical concern has emerged regarding the changing precipitation patterns, particularly in terms of both rainfall and snowfall. The data from the table indicates that 23% of the respondents perceive a rise in rainfall. In comparison, a substantial majority of 57% of the participants believe there has been a decline in rainfall. Our study is in conformity with the study of (Shafiq et al (2019), which confirms that the precipitation patterns in various topographic zones is witnessing a steady decline over the past 37 years. The significant variability in perceptions suggests that most of the population believes that there has been a decrease in rainfall in the Kashmir Valley. Individual experiences with changing climate conditions, personal observations of weather patterns, and community conversations that draw attention to the shifting precipitation patterns in the area likely influence the response. It is crucial to acknowledge that individuals' comprehension of climate change often originates from their immediate environment and interactions, thus making these perceptions a valuable manifestation of the local community's collective consciousness and involvement with the environmental changes in the Kashmir Valley. The importance of these views depends on their capacity to shape individual and community choices and stimulate discussions and initiatives about climate resilience and adaptation in the region.

***b) Snowfall Change***

The study reveals an interesting perspective among respondents regarding the snowfall patterns in the Kashmir Valley. Specifically, 10% of the participants acknowledge an increase in snowfall, but a substantial majority of 75% believe there has been a substantial decrease. The findings of the study corroborate with previous studies carried out by IPCC (2001), Kaur et al. (2009) and Kripalani et al. (2003), which indicate a decline in snowfall and an increase in temperature in the Kashmir valley. This general mindset aligns with growing worries about how climate change may affect local traditional weather patterns. The notable percentage of respondents who observed a decrease in snowfall is particularly remarkable, considering that snowfall plays a crucial role in maintaining the region's ecological balance and supporting multiple sectors. Snowfall, especially during the chillai kalaan (the 40-day harsh winter), has decreased, with more wet snow and less powder snow, especially in Srinagar over the last 30 years. Gulmarg and Pahalgam, two famous tourist destinations in Kashmir, show seasonal decreasing trends of snowfall of about 15 mm and 1.8 mm per decade.

The reduced snowfall in the Kashmir Valley has varied implications for water availability, agricultural practices, and overall ecological health. The decrease in snowfall can harm water reservoirs, impacting water supply. The snow in the Himalayan region serves as a natural reservoir, holding water that gradually melts and feeds streams and rivers throughout the summer. A reduction in snowfall can result in decreased water flow, impacting agricultural irrigation and hydroelectric power generation, vital local economy components. The implications for agriculture are substantial because irrigation in the Kashmir Valley relies primarily on the yearly snowmelt. Reduced snowfall could lead to water scarcity during crucial seasons of crop cultivation, potentially affecting crop yields and overall production of paddy, which is a water-intensive crop. Farmers may need to adapt by exploring alternative water sources or implementing more water-efficient agricultural practices. In addition, the region's ecological health is intimately linked to the varying snow cover during different seasons. The flora and fauna of the Kashmir Valley have adapted to the particular temperature conditions, and significant changes in snowfall patterns might disrupt these ecosystems. Changes in snowfall can also cause variations in temperature and weather patterns, exerting extra pressure on biodiversity and habitats. The study concludes that the decrease in snowfall, according to the survey data, raises serious concerns for the long-term viability of the ecological and socio-economic conditions in the Kashmir Valley. The area's residents appear to be cognizant of the potential consequences of these alterations, aligning with broader global discussions over the impacts of climate change on mountainous ecosystems and the communities that depend on them. A thorough strategy that considers adaptable strategies for various local economic sectors and environmental conservation measures is required to address these issues.

**2.Change in Temperature and Stream Discharge: -**

***c) Temperature Change***

Over time, a noticeable change in climate patterns has become apparent in the picturesque Kashmir Valley, characterized by a steady rise in temperature. The study indicates that many respondents (68%) believed temperatures have risen in the Kashmir Himalayas. The study agrees with the results of (Shafiq et al. (2019) for the period 1980–2014, which demonstrated a notable and statistically significant rise in the average annual temperature of the Kashmir valley. This perspective represents a regional consciousness and corresponds to worldwide patterns linked to the wider problem of climate change, where increasing temperatures are a significant manifestation of environmental changes. An immediate consequence is expected to be experienced in the region's ecosystems since temperature alterations can disturb the fragile equilibrium of plant and animal life that have adapted to particular climate conditions. These changes can potentially impact the movement of organisms, the timing of reproductive cycles, and the overall diversity of life in the area. The average annual mean maximum temperature over the Kashmir valley increased by 20C between 1980 to 2020 (0.50 per decade), according to a July 2021 study published in Science Direct, mirroring and outstripping a 0.20C rise per decade recorded by a 2016 study of mean, maximum and minimum temperatures over the subcontinent between 1981 and 2010. Temperature fluctuations significantly impact water supplies, which are crucial for human consumption and agriculture. Elevated temperatures can expedite the melting of snow and glaciers, influencing the timing and volume of water discharge into rivers and streams. This might result in difficulties associated with water scarcity, impacting not just agricultural activities but also the provision of domestic water and other vital services. The agriculture sector, which constitutes a substantial portion of the local economy, is especially responsive to fluctuations in temperature. Elevated temperatures also have the potential to modify the duration of growing seasons, impact the productivity of crops, and contribute to the proliferation of pests and diseases. Farmers may need to modify conventional methods by introducing heat-resistant crop types and modifying planting schedules to coincide with the shifting climate. Furthermore, the perceived rise in temperature highlights the pressing need for communities to implement adaptive measures and participate in sustainable practices from a wider social perspective. This encompasses efforts to improve water management, advocate for energy conservation, and increase public knowledge of the consequences of climate change. The local population seems highly sensitive to alterations in their immediate surroundings, expressing a desire to engage in community-driven initiatives to tackle the difficulties presented by escalating temperatures. The study confirms the variability of climate patterns and indicates an increased awareness of the possible consequences for ecosystems, water supplies, and agriculture.

***d) Stream Discharge Change***

Approximately 60% of the respondents had observed a decline in the flow of stream discharge. This indicates a shared concern about the decreasing availability of water and the potential consequences for local ecosystems. These views, as seen from the people's point of view, have important ramifications for many areas vital to their everyday life. The respondents are particularly concerned about water supply due to their perception of a decrease in stream discharge. In the agrarian region of the Kashmir Valley, where agriculture is the main source of income, stream water plays a crucial role in providing irrigation. On 14 September 2023, the water level at Sangam, the main measuring point for the Jhelum River in Srinagar, reached a historic low of 0.01 ft, which in 2022 was 0.50 ft. This decline marks the lowest September measurement in the past 70 years. The observed decrease in stream discharge may result in water scarcity for crops, impacting yields and overall agricultural production, due to which farmers might have to change their methods to deal with a decreasing water supply. These concerns go beyond agriculture to include the ecosystem as a whole. With less water flowing through the streams, local ecosystems—including the plants and animals that depend on them for survival—may find it difficult to maintain their habitats. The observed decrease in stream discharge has the potential to disturb the intricate equilibrium of aquatic ecosystems, resulting in a negative impact on biodiversity and potentially leading to the extinction of crucial species. Moreover, alterations in stream discharge have consequences for hydropower generation, a substantial energy source in the area. The results of the study are in conformity with the research carried out by (Bolch et al., 2012; Kulkarni and Karyakarte, 2013) regarding the rapid depletion of glaciers in the Himalayas and its projected consequences on stream flows have garnered significant interest from researchers in recent decades, raising concerns within the scientific and political arenas. The observed decline may give rise to apprehensions over the long-term viability of hydropower initiatives, impacting both energy generation and the dependability of electricity provision for local residents. From the perspective of water security, the apparent decrease in water flow in streams contributes to the general concern regarding the supply of clean and easily available water for drinking and household purposes. To solve these challenges, communities may need to consider other water sources or allocate resources toward water conservation initiatives. Overall, the observed decline in stream discharge, as reported by most participants, signifies the community's concern regarding the actual effects on water supply, local ecosystems, farming, and energy generation. These issues are not just theoretical; they impact the livelihoods and general well-being of the people living in the Kashmir Himalayas.

**3.Change in Extreme Weather Events and Agricultural Production: -**

***e) Extreme Weather Events Change***

The study highlights a significant apprehension among respondents in the Kashmir Valley regarding the escalating occurrence and severity of extreme weather events over a period of time. A significant majority of 72% of respondents indicate that natural occurrences such as extreme precipitation, cloudbursts, windstorms, hailstorms, frequent droughts, flash floods, and similar events have increased frequency and intensity within the region. Of all these occurrences, hailstorms are becoming more common, especially in cold and high-altitude areas (Bedka et al., 2018; Mahoney et al., 2012; Allen and Allen 2016; Schlie et al., 2019; Akbar et al., 2023, Shafi et al., 2023). The current study closely resembles the work of Roy et al. (2004), who noted a noticeable increase in extreme precipitation events in nearby regions from the NWH in Kashmir to the Deccan plateau in India between 1910 and 2000. Increased extreme precipitation events in the Kashmir Valley can have profound and multifaceted consequences. It heightens the risk of flooding, as heavy rainfall can overwhelm rivers and water bodies, leading to flash floods and inundation of low-lying areas. This poses a threat to homes, infrastructure, and agricultural lands. The region's topography, characterized by steep slopes, makes it susceptible to landslides during intense precipitation, resulting in further damage to property and posing risks to lives. Infrastructure, including roads and bridges, is vulnerable to the erosive forces of increased rainfall, leading to disruptions in transportation and communication networks. The diverse range of extreme weather events mentioned, from cloudbursts to droughts and flash floods, highlights the complexity of the challenges faced by the Kashmir Valley, e.g., the occurrence of hailstorms has been significantly damaging crops and infrastructure resulting in huge losses (Shafi et al., 2023). Once considered rare, these events are now perceived as more frequent and intense, pointing towards a shift in the region's climate dynamics.

***f) Agricultural Production Change***

The data from the table reveals a mixed perception among respondents in the Kashmir Himalayas regarding alterations in agricultural productivity. Although 18% of individuals see a rise, a significant majority of 60% perceive that there has been a decline. The results of the study are in conformity with the works of Parry et al (2004), who analysed that the decrease in agricultural production of a region is linked with the increase or change in extreme weather events from time to time. This contrasting view reflects the community's different understanding of how environmental changes affect agriculture. Personal experiences, perceptions, and interpretations of the changing situations in the region likely influence the differing viewpoints of individuals. The 18% who observe a rise in agricultural output may attribute this to favourable weather conditions, enhanced farming techniques, or the implementation of resilient crop types. These individuals might have observed prosperous harvests, enhanced yields, or improvements in agricultural methods in their areas. Their perception of a favourable agricultural production trend can promote hope and adaptability in response to environmental fluctuations. Conversely, the majority (60%) observing a decline in agricultural output indicates worries and difficulties the farming community faces. From their perspective, temperature fluctuations, precipitation patterns, or other environmental conditions may adversely affect agricultural productivity. Economic hardship and a sense of vulnerability might result from experiences with crop failure, lower yields, or difficulties adjusting to changing conditions. The diverse view highlights the complex correlation between environmental changes and agricultural productivity. Community experiences and local climate conditions influence the different perspectives. It is crucial to acknowledge that such perceptions can also be impacted by additional factors, such as socio-economic circumstances, the availability of resources, and the human ability to cope with challenges. From a community perspective, the varied perception demands implementing adaptive measures that consider the potential advantages and difficulties linked to altering environmental conditions.

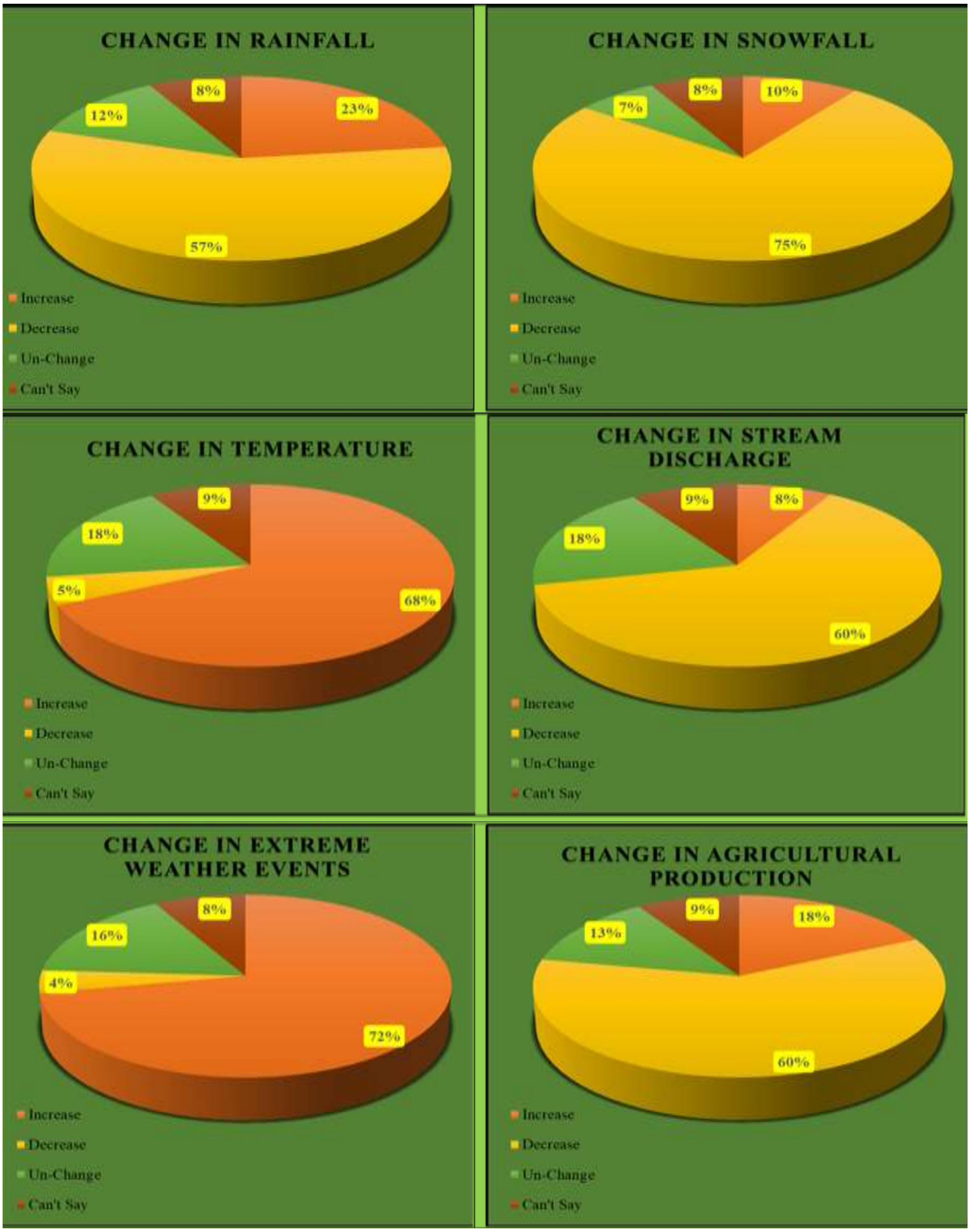


**Fig.2:** Pie diagrams showing climate change manifestations.

## Discussion

Over the course of time, the people of Kashmir Valley have perceived a noticeable decrease in rainfall. This decline in rainfall has far-reaching implications for the region, given that Kashmir heavily relies on precipitation for various aspects of its ecosystem, including agriculture, water resources, and overall environmental balance. People believe that reduced rainfall can lead to water scarcity, affecting crops and potentially impacting the local population's livelihoods. This reduction in precipitation is particularly evident during the winter season having far-reaching implications for various sectors of the economy. The once-predictable rainfall pattern has become more erratic, with significant variations observed in the seasonal distribution of precipitation. The consequences of this changing climate dynamic are tangible, especially in the agricultural sector (Manuel, L et al (2021). Moreover, the variability in rainfall has led to a decline in the number of people engaged in paddy cultivation, further impacting the region's agricultural landscape. The overall agriculture sector has been severely affected by unseasonal rainfall, posing challenges to crop yields and livelihoods. These shifts in rainfall patterns underscore the vulnerability of the Kashmir Valley to changing climatic conditions, emphasizing the need for adaptive strategies and sustainable agricultural practices to mitigate the impacts on both the economy and the livelihoods in the region.

The Kashmir Valley is renowned for its winter landscapes. It heavily depends on snowfall for its water supply, especially during the dry summer when melting snow contributes to river flows. The significance of the meltwater derived from snow and glacier cover can't be underestimated in terms of its impact on local, regional, and sub-continental water resources. It is estimated that this meltwater contributes to around 60–70% of the total annual flow of rivers (Bhandari N. and Nijampurkar V.N., 1981). One significant benefit of glacial runoff is its ability to regulate water supply during drought. Glaciers release huge quantities of water during drought and smaller amounts during flood years, ensuring a consistent water supply even during lean years. Additionally, it is important to note that a warmer climate can expedite the hydrologic cycle, leading to changes in rainfall patterns and the magnitude and timing of run-off (Ul, I. Z., et al., (2015). The diminishing snowfall raises concerns not only for the region's water resources but also for its tourism industry, as the picturesque snow-clad landscapes attract visitors worldwide. (Romshoo et al. (2015) observed changes in snow precipitation and snowmelt runoff in the Kashmir valley and attributed the observed depletion of stream flow to the changing climate in the region. The changing snowfall patterns in the Kashmir Valley underscore the region's vulnerability to climate-induced shifts, necessitating adaptive measures and comprehensive strategies to mitigate the impacts on agriculture and water resources. The untimely snowfall disrupts the natural agricultural cycle and challenges the growth and development of crops. Conversely, late snowfall negatively impacts agricultural output, affecting the timing of planting and potentially impacting yields. Numerous studies (Shafiq et al. (2019) and Romshoo et al., (2015) and the perceptions of the local population indicate a steady rise in the temperature across Kashmir valley, having far-reaching ecological, environmental, and economic implications. As the Kashmir valley has a rich repository of glaciers with its annual share of precipitation, slight changes in the temperature and precipitation regime has far-reaching environmental and economic consequences. The Kashmir Himalayas exhibit significant and pronounced signs of global warming, including rising temperatures, accelerated melting of snow and glaciers, reduced snowfall, and declining stream flows (Dar and Romshoo, 2012). Recent research findings indicate a decline in snowfall in the Lidder basin due to rising temperatures (Mishra and Rafiq, 2016; Romshoo et al., 2015). Consequently, this reduction in snow accumulation on the glaciers has resulted in a negative glacier mass balance (Murtaza and Romshoo, 2017). The nexus between rising temperatures and decreasing stream discharge is a complex interplay that demands careful consideration. The increasing average annual temperature in the Kashmir Valley is a considerable concern. This temperature rise can have multifaceted impacts on the local environment, agriculture, and overall ecosystem. On 1 September 2023, Srinagar experienced its second-hottest September day ever recorded, with temperatures reaching 34.20C, 60C above the normal for this time of year. Warmer temperatures may contribute to changes in precipitation patterns, affecting the water cycle and exacerbating issues related to water scarcity. Changes in temperature can influence flora and fauna, impacting biodiversity and potentially leading to shifts in vegetation patterns. For a region heavily reliant on agriculture, such alterations can pose challenges to crop yields and agricultural practices, affecting the livelihoods of the local population.

Moreover, people’s perception overwhelmingly indicates that the region is witnessing a significant reduction in stream discharge due to the changing climate. The perception of a decline in stream discharge indicates potential challenges in water availability and management. Reduced stream discharge can affect irrigation, drinking water supply, and other water-dependent sectors. This decline might be linked to precipitation patterns, melting snow cover, or alterations in the overall hydrological cycle. Farmers have been compelled to adapt to these evolving conditions, necessitating adjustments in the types of crops cultivated and their planting schedules. Beyond the agricultural sector, the diminished flow and levels of water bodies have had detrimental effects on aquatic life, impacting habitats and biodiversity.

People’s perception in Kashmir Valley indicates a significant rise in the frequency of severe weather phenomena, such as flash floods, droughts, cloudbursts, windstorms, and hailstorms. The valley of Kashmir has its own unique microclimate, and the signs of shifting weather patterns within this area are easily recognizable (Romshoo et al., 2017). This perception of a changing climate has tangible impacts on the daily lives and livelihoods of the local population. The change in climatic patterns has forced individuals to modify their adaptation strategies in response to increased frequency and intensification of these events. In recent years, there has been an observed increase in the intensity and frequency of flash floods, which can be attributed to the occurrence of unpredictable and irregular events of heavy rainfall. The increased severity and frequency of droughts emphasize the climate-related difficulties experienced in the region, affecting both water resources and agricultural practices. Furthermore, the Kashmir Valley has witnessed an escalation in the magnitude and recurrence of hailstorms (Shafi et al.,2023) and windstorms, which present risks to agricultural produce, infrastructure, and the general welfare of the indigenous populations. The increasing frequency of cloudbursts, characterized by abrupt and heavy precipitation, brings another level of vulnerability to the area. The aforementioned shifts in extreme weather occurrences highlight the pressing necessity for comprehensive climate resilience strategies and adaptive measures to mitigate the effects on the ecosystem and the well-being of the Kashmiri population. The data highlights a notable apprehension among respondents in the Kashmir Valley regarding the escalating occurrence and severity of extreme weather phenomena over a period of time. The agricultural landscape of the Kashmir Valley is experiencing considerable challenges due to the adverse effects of changing weather patterns. The early flowering in fruit trees, crucial for successful productivity, is increasingly susceptible to the erratic weather conditions in the early spring, particularly in March. This climatic unpredictability has led to a decline in overall production, as recurrent droughts have further compounded farmers' challenges. The negative impact of unseasonal and erratic rainfall on agricultural output is evident, disrupting the normal cropping calendar and contributing to decreased production. Climate-induced shifts in the cropping calendar have resulted in altered planting and harvesting schedules, exacerbating the decrease in overall production. Insufficient precipitation and poor irrigation practices have also reduced paddy cultivation, affecting a key component of the region's agricultural output. The untimely occurrence of rainfall during the harvest season has added to the complexities, negatively influencing the overall production of crops. Furthermore, snowfall in early October has emerged as an unexpected challenge, significantly impacting agricultural productivity and highlighting the vulnerability of the Kashmir Valley's agriculture to changing climate conditions. These multifaceted challenges underscore the urgent need for adaptive strategies and sustainable agricultural practices to safeguard the livelihoods of the farming community in the region.


**Fig.3:** Climate Change Manifestations

In the above Fig. 3, pic. (a) depicts the change in rainfall as there are no signs of rainfall even in the month of December 2023 & pic. (b) illustrates the contrast in snowfall, showing a barren Gulmarg in December (left) compared to the valley covered in snow. Similarly, pic. (c) exhibits change in temperature which is clear from the fact that the saffron industry in Kashmir has been affected by the dual impact of increasing temperatures (2022) & pic. (d) indicates a decrease in stream discharge as water levels on the Jhelum River have dropped to a 70-year low, leaving a houseboat stranded for the first time in over a century (2022). Finally, pic. (e) shows that extreme weather events, such as hailstorms, are causing evident damage to agriculture and horticulture in Baramullah (2023) & the paddy fields in South Kashmir dried up entirely as a result of changes in different manifestations of climate change, as seen in pic. (f), which displays the entire impact on agriculture (2022).

**Conclusion**

Climate change poses global challenges with profound economic, ecological, and hydrological impacts. The fragile Kashmir Himalayas are significantly affected, experiencing elevated temperatures, erratic rainfall, and intensified extreme weather events. Local perceptions are crucial in shaping responses and determining the success of adaptation strategies. Over three decades, the Kashmir Valley has witnessed a perceived decline in rainfall and snowfall, impacting agriculture and water resources, raising concerns about water scarcity and jeopardizing livelihoods. Variability in rainfall has reduced paddy cultivation, altering the agricultural landscape. Diminished snowfall further affects water availability, contributing to a decline in stream water.
Changing snowfall patterns highlight the region's vulnerability, necessitating adaptive measures. The Kashmir Valley experiences noticeable climate shifts, with a steady temperature rise influencing fruit colouring and disrupting the delicate balance of flora. Agriculture faces disruptions in planting schedules due to increasing temperatures. Hydrological changes, including declining stream flow in late summer and autumn and increased flow in spring, raise concerns about water resources, affecting irrigation and water-dependent sectors. The region sees an increase in the frequency and intensity of extreme weather events, posing threats to infrastructure, agriculture, and the population's welfare. Changing climate conditions challenge the agricultural landscape, affecting early flowering in fruit trees, disrupting cropping calendars, and decreasing production. The Kashmir Valley faces complex challenges due to changing weather patterns induced by climate change. Local perceptions, influenced by direct experiences, offer valuable insights for effective climate resilience and adaptation strategies, crucial for formulating policies that resonate with the region's unique vulnerabilities and experiences.

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