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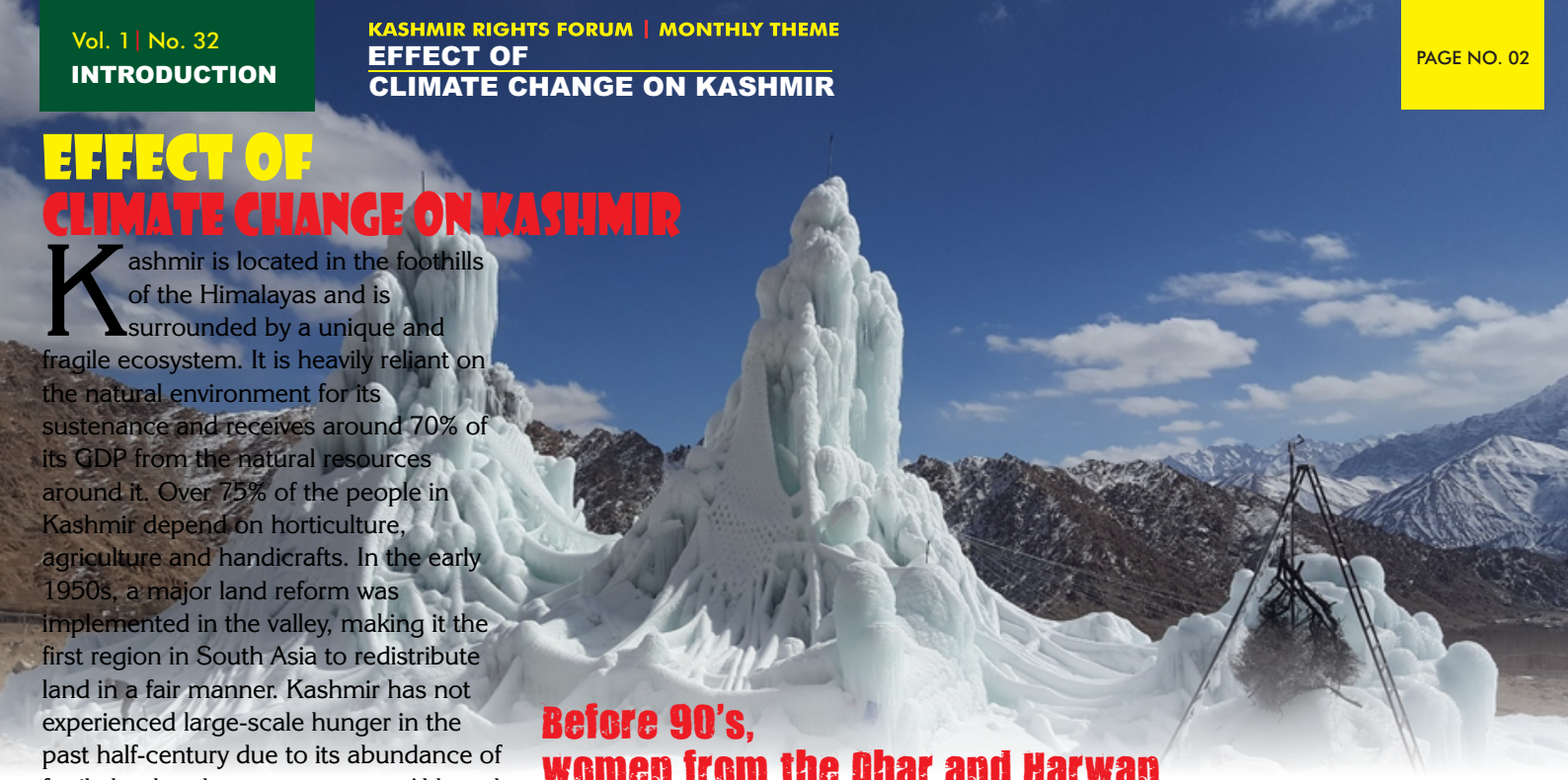
EFFECT OF CLIMATE CHANGE ON KASHMIR



Kashmir is located in the foothills of the Himalayas and is surrounded by a unique and fragile ecosystem. It is heavily reliant on the natural environment for its sustenance and receives around 70% of its GDP from the natural resources around it. Over 75% of the people in Kashmir depend on horticulture, agriculture and handicrafts. In the early 1950s, a major land reform was implemented in the valley, making it the first region in South Asia to redistribute land in a fair manner. Kashmir has not experienced large-scale hunger in the past half-century due to its abundance of fertile land and water resources. Although agriculture cannot contribute to the overall food security, the income generated by non-agricultural produce for the land-owning segment of the population has been instrumental in preventing hunger. As a result of environmental changes like inconsistent rain, snowfall and fast receding glaciers due to climate change, water is becoming scarce because of which farmers, particularly the poor who have very small holdings, have been forced to shift from farming to rain-fed agriculture. Livestock sector is also facing uncertainty. One of the most visible effects of climate change can be seen in the rapid melting and retreat of glaciers.

Post 90's, new varieties of seeds and plants, agricultural practices, market dynamics and the socio-cultural changes that were introduced, which had badly impacted the valley. The existing land holdings have been severely fragmented due to family expansion and subsequent division, and with less water availability, deforestation has been on the rise. The younger generation is not finding agriculture or afforestation profitable. In June 2007, the Kashmir government admitted that compared to 2000 crore from horticulture, the UT imported 16,000 crores worth of mutton milk and poultry from other states every year. Climate change, amongst other factors, has reduced the ability of local rural economies to produce these basic commodities. The report also conveyed its concern over the increasing imports of essential commodities which include vegetables, milk, poultry and mutton. The locals who are completely dependent on agricultural produces must consider diverse influences and impact of these changes in arid, semi arid, semi temperate and temperate zones of Kashmir on their livelihood.

Before 90's, women from the Dhar and Harwan area of Srinagar used to earn their living by selling ice, locally known as Yakh in cities which was extracted directly from the glacier. They would roam through the city and sing in Kashmiri, 'Wai Yakho! Kamyu Van Volmukh! Ha Yakho, Andrei Golkho Yakho! Which means (O' Ice, I marvel what forest I fetched you from? Don't melt from inside).

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AN OVERVIEW OF CLIMATE IN KASHMIR

Jammu and Kashmir is divided into two distinct climatic zones: the temperate Kashmir valley and the subtropical Jammu region. Due to the rugged topography of the region, the climate of Jammu is very different. The south of the UT is characterized by a monsoon tropical climate, with the maximum temperature reaching over 45°C in the summer and moderate to heavy rainfall in July and August. The winter is cold from November to March, with moderate to heavy snowfall and the summer is mild with very short rains. January is the coldest month, while in July and August, very heavy and erratic rainfall occurs. The climatic conditions vary as the region has topographic variation.

CHANGE IN CLIMATE PATTERN OF VALLEY

Over the years, there has been a mixed trend with fluctuation in the average temperature of Srinagar district on a monthly basis. The January temperature has shown an abrupt increase from – 0.7 degrees in 1987 to 4.7 degrees in 1988 and a decrease from 05 degrees in 1990 to – 2 degrees in 1991. Average March temperature has sharply increased from 8.7 to 13.6 degrees between 2003 to 2004 followed by a sudden decline. [a]

[a] *A Preliminary Study on Climate Change, Researchgate.net.*

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There were decreasing trends in May average temperature. The maximum fluctuations in temperature were found in the months of July and August during the period 1987 to 2015. The December average temperature shows a decreasing trend from 1991 to 1996 followed by sharp positive and negative trends. The annual average temperature of Srinagar from 1987 to 2014 shows a visible warming trend. The spring and winter seasons show a significant warming trend whereas the summer and autumn seasons show insignificant warming trend. [b]

The Kashmir Valley receives most of its precipitation in the form of snow during winter months. From the past few years various researchers have reported decreasing snowfall during winter months due to variations in Western Disturbances. [c] Such decreasing snowfall results in less snow cover in these regions which melts within a short period of time during winter season and leaves scope for early spring season which results in early increase in temperature and direct heating of the earth's surface that has also been established due to early flowering of plants in this region. [d]

IMPLICATIONS OF CLIMATE CHANGE ON KASHMIR

The implications of climate change on Kashmir valley are worse. Some of the consequences of the climate change are discussed below:

(a) Food Deficit: The deficit in food production in Kashmir region has reached 40 per cent, while the deficit is 30 % in vegetable production and 69 per cent in oilseed production putting food security at a greater risk. During the 80's, valley had a food deficit of only 23 %. At present more and more paddy land is changed into rain-fed orchards resulting in food deficit by 40 %. The deficit may go par 60 % in the coming decade in case the current rate of change is not taken into account. Surveys reveal that 330,956 Kanals of paddy land have been converted into rain-fed dry land in Kashmir till 2021. [e] As against a revenue of 10,000 crore from the horticulture sector, the imports of mutton, milk and poultry have risen to a gigantic 58,050 crore in year 2017 and 28,228 crore imports in 2011-12 from the neighbouring states. It is clear from the above figures that among other factors, the impact of climate change has contributed its bit in reducing the capacity of the local rural economy to produce these essential commodities. The large-scale transition from paddy cultivation to rain-fed crops poses risk to food security.

(b) Melting of Glaciers: The actual time of snowfall has also changed, with December and January seeing little or no snowfall, while February and March witness heavy snowfall. The quantity of snow in Kashmir has clearly decreased over the past few decades. While there are occasional heavy snowfalls, the snow cannot freeze and turn into hard and long-lasting crystals due to higher temperatures, leading to faster melting. [f] The average area of glacial range has also decreased from 1,000 sq km to 0.32 sq km. Many areas have completely lost their small glaciers, including some parts of east Srinagar and Pulwama. In other areas, such as Budgam, small glaciers have depreciated more than one-fifth of their original volume. In the upper reaches of Ganderbal, the Najwan Akal which was thought to be a major glacier has completely disappeared. Similarly, the Thajwas, Zojila and Naranag glaciers were large enough to last up till October, however they have considerably been retreated. The winter and spring water run-off has increased due to early meltdown of glaciers, resulting in frequent floods, resulting in significant decrease in water availability in streams during summers. [f] In Karnah, which falls between the temperate parts of Kashmir and semi temperate regions of PoK, the risk of flash floods has increased. It has been observed that the amount of rainfall during winters has also increased in comparison to the past.

[b] Evaluating the Impact of Climate Change on Extreme Temperatures and Precipitation, 03 October 2021, Springer Link.
[c] Brown and Robinson, 2011; IPCC, 2007
[d] Dunne et al, 2003; Zaz and Romshoo, 2013.
[e] Inter-Governmental Panel on Climate Change, IPCC
[f] On the brink? A Report on Climate Change and its Impact in Kashmir, Shaheen Hussain Talib.
[g] May 2007 Tropical Cyclone Report, national Centers for Environmental Information

© Disproportionate Rainfall and Floods: There is a great deal of unpredictability in the western disturbances that pass over Kashmir, which may be due to factors such as unusual distribution of rainfall over space and time, shifting patterns of precipitation and sustained deficiency of snowfall. Due to fast receding of glaciers, the valley is heading towards flash floods and storms. In May 2007, Kashmir witnessed three days of unusual late morning fogs in Srinagar, marking it a highly unusual occurrence for the locals. [g] The untimely and unprecedented windstorms in May 2007 wiped out almond crops by 60% and caused significant damage to flora and property. The 2007 spring floods have largely been a consequence of fast meltdown of snow in the mountains, coupled with the spring rains. In future, any major snowfall in spring, like the one which occurred in March 2007, followed by rainfall stretched over 48 hrs could wreak havoc in Kashmir.

(d) Damage to Crop Production: There is greater unpredictability of rainfall over space and time in comparison to the set pattern of the district seasons in Kashmir. There is also a drastic decrease in snowfall as compared to past. Early blooming of fruit blossoms and flowers due to warmer temperatures during February and March in Kashmir has been damaging fruit produce as sudden late snows in February and March devastate blossoms. This situation is likely to result in greater livelihood vulnerabilities for the poor farming communities. One of the most critical is the influence on farm practices. In the Karewas areas, there is a general pattern of farmers switching from paddy cultivation to rain fed horticulture and low irrigation crops such as maize, oats, grazing grass and vegetables. Inadequate natural irrigation from glacier-fed streams coupled with low returns on rice crops are influencing people to risk turning to markets to buy their rice while investing their land and hopes on financial returns from rain-fed crops.

(e) Scarcity of Drinking Water: Heat waves and untimely rain have caused rapid melting of the glaciers and snow cover, leading to acute water shortage in Kashmir. Due to fast melting of glaciers, fresh water shortage is likely going to increase in coming days. The official hydrological data of all main rivers of Kashmir Himalayas and their major tributaries show that today the discharge of these rivers and tributaries has almost halved as compared to only 50 years back be it in Jehlum, Chenab or any other river or in major tributaries like Liddar, Sandren, Vishow, Rambiara and others. Today the discharge of Chenab is less than half of

what was 60 years ago and the discharge is diminishing year after year. Fifty years ago Chenab basin used to have about 8000 sq km area under glaciers, permanent and ephemeral snow cover which would contribute huge quantities of water during summer to this river through numerous perennial tributaries as compared to the present 4100 sq km snow cover area.[18]

(f) Impact on Agriculture and Horticulture: According to surveys conducted in different parts of the Karewas, the increase in average temperatures and the early and rapid melting of glaciers in the mountain range of Pirpanjal have significantly reduced the availability of water in the Karewas in the last 25 years. This has had a negative impact on the agricultural production of the area. Some crops have completely failed or are replaced by low water fodder. Surveys conducted in the Karewas area of Budgam district during this study showed that saffron yields have fallen to almost half in the last decade. In the Ganderbal district where one of the major tributaries of Jhelum flows, the Sindh nallah, people have talked about the collapse of plant

(g) Impact on Tourism Potential: Gulmarg, which is a key winter tourism hotspot in Kashmir is witnessing a sharp decline in tourist visits this season due to insufficient snow. Despite substantial tourist numbers in 2023, officials project at least 60% reduction in footfall. The scarcity of snow is adversely affecting ski resorts and related businesses, impacting the local economy.

REASONS BEHIND CLIMATE CHANGE IN KASHMIR

There are multiple reasons behind climate change in Jammu and Kashmir as discussed below.

(a) Temperature Rise: The Inter-governmental panel on climate change (IPCC) has predicted that due to increase in global temperatures, sea level will rise by one meter till the end of year 2100. [h] In such a scenario, the plains in Kashmir would not receive snow and the snowfall in the upper reaches would hardly last long enough to support the rivers in the region all year round, which would impact the livelihoods. On an average, the temperature in the Kashmir region has increased by 1,450 degrees Celsius while in the Jammu region it has increased by 2,320 degrees Celsius. According to the Indian Meteorological department's (IMD) monitoring,

Saffron cultivation as a commercial farming enterprise in J&K is facing a grave threat of extinction as the area declined from 5707ha (1996-97) to 3280 ha (2008-09) thereby decreasing the production from 16 M.T to 7.70 M.T.

temperatures are rising in both the Kashmir valley and Jammu region, with a significant increase in the maximum temperature year-on-year of 0.050 degrees Celsius. [i] Although occasionally it does have spells of late snowfall, however, the inability of snow to freeze and develop into hard and longer lasting crystals owing to higher temperatures right from the plains to higher altitudes has resulted in faster meltdown. At higher altitudes the inability of snowflakes to turn into hard crystals due to higher temperatures has severely impacted glacier formation. In some areas, the amount of snowfall has reduced by over half to one-fourth as compared to amount of snowfall past four decades. The amount of rainfall during winters has also increased which is attributed to higher temperature prevalent closer to the earth's surface in the plains and the Karewas areas, thereby constraining snowfall in the Kashmir.

For instance, during November 2006, Forest Protection Force seized large quantity of fresh wood from a Saw Mill in Baramula and Kupwara. The large scale deforestation has shown bad impact on the climate of valley.

(b) Deforestation: Forests have greatly suffered from considerable damage during the last few decades. According to some reports, nearly 20% to 30% of the forest cover has declined due to illegal cutting of the trees. For instance, during November 2006, Forest Protection Force seized large quantity of fresh wood from a Saw Mill in Baramula and Kupwara. The large scale deforestation has shown bad impact on the climate of valley. Additionally, due to large scale cutting down of trees in view of developmental projects, the climate has got severely impacted.

[h] *Over 6 lakh Kanal Paddy Land Lost in a Decade, Jeopardising Food Self-Sufficiency, Mukeet Akmali, Oct 05, 2023, Greater Kashmir.*
[i] *Indian Meteorological Department (IMD).*

© **Emission of Green House Gases:** As per Climate Resilient City Action Plan (CRCAP) for mere Srinagar City have increased by 0.96% between 2005 and 2022. The GHG emissions from the energy sector have increased by 479.51 Kt CO2 E in 2005 and 538.14 Kt CO E in 2022. The emissions from waste sector have increased by 676.09 Kt CO E from 2005 to 2022. The estimated CAGR for Srinagar city's GHG emissions is 0.96%. According to the projections, the energy sector accounts for 78% of Srinagar City's total GHG emissions by 2030. [j]

Jammu and Kashmir is adding 1.45 million tonnes of Green House Gases (GHG) annually to atmosphere as its dwindling forests are able to absorb only 10.21 million tonnes of such gases out of the total emissions of 11.66 million tonnes, a government report on CO_2 emissions has revealed.

CRISIS IN SAFFRON BELT: PAMPORE-KHREW CASE STUDY

Pampore is well-known for producing quality Saffron in the UT. However, for the past 20 years, it has been experiencing the lowest snowfall in the whole of Kashmir. This is strange because even when the areas near it on the same altitude (about 15–20 km from Srinagar or Pulwama) get snowfall of two feet. This geographical area gets either rain or snow of one to two inches only.

One of the main reasons cited by locals is the number of industrial units that have been established in the region since 1982. The resulting smoke and dust particles from these factories remain trapped in the atmosphere for an extended period of time due to the fact that the area is encircled by high mountains on two sides in the eastern and northern direction. Due to the normal wind blowing in Kashmir Valley from the west to the east, the investigation in the area has revealed that the smoke is trapped for a prolonged period of time, resulting in an increase in the temperature in the lower atmosphere due to the presence of larger quantities of warmer gases in the atmosphere. The lack of tree cover over the mountains further exacerbates the problem. The presence of trees could have counteracted the excess carbon in the air. Although normally in hotter regions aerosols are believed to have a cooling effect on the lower environment, in the case of a cold region like Kashmir, investigations have shown, extreme cold temperatures and cloud cover during winter do not make aerosols which create a cooling effect on the sunlight falling on the earth's surface. The kind of coal used in the cement factories in the area has high sulphur and carbon content and the percentage of ash is also high. As a result carbon and heat get trapped in the lower atmosphere. [21] People in these areas have largely shifted from paddy to maize. In case there is some rain; people grow fodder for their cattle. The net sown area has receded due to scarcity of water. There is also a change in the lifestyle of people because they now buy food grains largely from open markets. In this area, like in many other areas of Kashmir, blooming of almond and other fruits happens now in February in comparison to March or April in the past.

People in these areas have largely shifted from paddy to maize. In case there is some rain; people grow fodder for their cattle. The net sown area has receded due to scarcity of water.

[j] *Signs of Climate Change in Kashmir, Arif Shafi Wani, 17 Sep, 2023, Greater Kashmir.*

RECOMMENDATIONS

a) While some of the causes of global warming, such as climate change are global in origin, there are local steps that need to be taken in order to reduce the emissions of greenhouse gases in Kashmir. Most of the heat trapping gases are trapped in the Kashmir because of the presence of high mountains on every side.

b) Kashmir needs to urgently revamp its environmental and social assessment system for large-scale projects. The current system for assessing the social and environmental impact of large-scale projects at the governmental level does not address all the concerns about the negative environmental impact of such projects.

c) The Kashmir valley is vulnerable to trapped gases. The government should review the policies of trading its carbon credits in the international markets and address the increasing concerns about the underestimation of greenhouse gas emissions in Kashmir.

d) Stringent laws should be implemented not only for controlling emissions from private cars and industrial units but also for large emissions from government/military establishments, such as charcoal based heating systems, in winters. Hundreds of heavy vehicles and paramilitary and governmental vehicles move through Kashmir daily, producing a high amount of greenhouse gases, which are outside the control of the law enforcement agencies. The Government should create a mechanism to make non-civilian inquiries under State law in order to prevent this pollution, as the military vehicles are moving through the most eco-sensitive areas of Kashmir.

e) The government and non-government organizations must investigate how WTO and trade liberalization policies could affect the availability of Kashmiri fruits in the market. If there is a significant shift in market demand or the pattern of demand, thousands of farmers in Kashmir will not be able to earn their living. This could lead to the loss of food security for over four million people in vulnerable areas of the state, such as Karewa, Gurez and Karnah, as well as in the areas surrounding the state of Ladakh, Uri and Doda.

f) A food security monitoring system should be put in place at both the governmental and non-governmental levels to assess current and future vulnerability.

g) Even though the state is not allowed to build large dams or reservoirs on large rivers under the Indus water treaty, special attention should be given to innovative rain water harvesting methods, small check dams, and other water conservation measures to make sure water is available during dry summer months.

h) Although tourism promotion is one of the top priorities for the government, a shift from infrastructure-driven tourism to eco-driven tourism is urgently needed. The horizontal economic benefits of eco-tourism for poor communities would be much better than the vertical economic benefits for a few companies. It would also help in the economic benefit of poor and marginalised communities in areas like Kupwara (Bungus), Gurez Valley (Bhaderwah), Lolab Valley, Naagberan (Tral), Rajouri Poonch, Doda and so on.

I) The promotion of large-scale tourist activities in ecologically fragile ecosystems result in huge pollution of water bodies and generates large amount of carbon-dioxide which remains a matter of serious concern. Urgent action is needed to address the environmental concerns expressed by the SPCB on the large-scale tourist activity in the State.

j) Government needs to seriously pursue reopening of traditional road links of the Kashmir valley with the outside world to help reduce people's vulnerabilities to climate change and natural disasters. Kashmir valley happens to fall under the highly vulnerable Zone V of the seismic zone. Any eventuality of another major earthquake and subsequent breakdown of road communications and collapse of bridges due to landslides could result in a major humanitarian catastrophe, especially for many land-locked and isolated areas. Growing food insecurity as a result of shift to horticulture could pose additional risks in such a situation, especially for the poor.

k) The Agriculture Universities especially the Sheri-Kashmir University of SKUAST needs to carry out thorough research on locally appropriate climate resistant crops and take that research to the farming communities. Although currently SKUAST, Agriculture and Horticulture Departments do undertake such activities. However community based organisations and NGOs are required to be involved to connect with village level bodies for popularising climate resistant crops and livelihood avenues.

l) In view of the limited land available in Kashmir valley and the increasing fragmentation of land holdings due to excessive family growth, it is likely that 80% of the current land holdings in Kashmir would not be able to provide food security for a family of 6-10 people for more than 6 months per year in the coming decade. Policy makers must take this slow onset change into account in order to make the necessary changes in their future planning.

m) Despite unpredictable rains and snowfall, the water table in the plains of Kashmir remain high and there is immense potential for groundwater exploitation in the state. Developing a policy on groundwater extraction and exploitation would help overcome water shortage during the dry season. It would also help in capturing the lost runoff during the winter months to make most of the water available for agriculture.

n) In order to avoid flooding in the valley, it is essential to desilter all the major rivers of the valley. The opening of flood channels for desilting process and granting of licenses to the soil mining companies is imperative for reducing flood vulnerability and the present mining of abundant Karewas.

o) It is a matter of serious concern that more and more communities living on the periphery of forests are resorting to illegal forest produce trade in the face of declining returns from traditional farming. JFM needs to be adapted to the socio-economic situation and geo-political situation of the valley in order to make it more resourceful and meaningful.

p) The State Pollution Control Board (SPCB) requires to be equipped with greater authorities to make sure across-the-board environmental compliances in both civilian and non-civilian domains.

q) Reforestation is the most effective option. It takes a long time to restore the forest to its original condition. Therefore, we need to be vigilant about those who are trying to destroy the forest through the local authorities. Civil administration needs to carry out public awareness programmes on a regular basis and deploy adequate personnels during the night hours, until our society becomes conscious and educated enough about the importance of forest and its valuable uses.

CONCLUSION

The effect of climate change on mountainous ecosystem is going to be severe in coming years. Rainfall has decreased in majority places, with some increase at the Gulmarg station in comparison to baseline precipitation over the period 1980–2010. The projected variations of extreme climate showed that due to increase in Green House Gases concentration in the atmosphere will continue to increase in near future. In line with global trends the Himalayas have seen an increasing trend in warm temperature based indices and a decrease in the cold extreme over the last twenty-five years. The climatic changes will have severe impacts on the agriculture sector, water resources and human health, with a reduction in frost days, an extension of growing season length, and an increase in precipitation but an increase in temperatures and an increase in demands for water for irrigation.

Water resources and water dependent systems will be affected directly under the changing temperature and precipitation scenarios. Dry spells are a new trend in Kashmir's climate and recent years have marked abnormally long dry periods, creating acute water shortages. Prolonged dry spells indicated by consecutive dry days impact the surface water availability during the summer and autumn seasons. Increase in the number of hot days and nights will affect human health by increasing the thermal stresses. The result of the study can be valuable for formulating the sector-specific mitigation of climate change, however, more studies are required for the analysis of climate extremes using multi-model ensembles to further refine the quantification of the changes and uncertainty associated with GCM outputs. Furthermore, increasing the density of meteorological observatories would further help in understanding the microclimatic variation and climate change signals more lucidly.

Government needs to take 'Climate Change' into account in their policy and planning in future so that the uncertainty which climate change brings for livelihoods of millions of people across the region, especially the poor and those affected by geographical and political division can be avoided. To this end, a forward-looking approach is needed that takes into account current trends in climate change as well as the depletion of natural resources such as glaciers and other water resources. It is equally important that scientific research is conducted on the changed conditions in agriculture and horticultural fields. This knowledge is required to be disseminated to the last man at grass-root level by both governmental and independent non-governmental agencies to ensure that food security of Kashmir and the rising unemployment in rural areas do not lead to further socio-economic difficulties and deprivation.


KASHMIR