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Understanding the community's perception of climate change and adaptations in the Mid Hills of Pakistan

LAILA SHAHZAD*[1], ARIFA TAHIR[2] & FAIZA SHARIF[3]

[1,2]Environmental Science Department, Lahore College for Women University, Lahore, Pakistan
[1,3]Sustainable Development Study Center, GC University, Lahore, Pakistan

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***Corresponding Author:**

Laila Shahzad
lailashahzad@gcu.edu.pk

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ABSTRACT

Climate change poses a higher risk to the livelihood of vulnerable rural mountainous community due to prevailing poverty and more dependence on the natural resources of the surrounding areas. Aim of the study was to assess the local people's perception of changing climate and to link it with meteorological data in the mid hills of Tehsil Balakot, KPK Pakistan. Using mix method approach of interviews and questionnaire, data was collected from 200 randomly selected households. Temperature data of 30 years 1985 to 2014 showed that there is an overall decrease in mean minimum annual temperature by a factor of 0.0024 for each year whereas there is an overall increase in mean maximum annual temperature by a factor of 0.0412 for each year. The mean annual rainfall of thirty years was recorded as 1471.27 mm with a decreasing trend of 0.9484 annually. Descriptive analysis showed that 83.5% and 40.5% of respondents observed change in temperature and increase in annual rainfall respectively. Local residents of the area were more vulnerable to climate change and natural hazards due to their poor socio-economic conditions and previous disasters history. In order to adapt to change in climatic conditions, mitigatory measures should be taken to improve their living conditions. Deforestation should also be avoided to overcome and reduce their vulnerabilities. Community resilience can help in mitigation and adaptation at local level.

Keywords: Climate change, Natural hazards, Mountainous Communities, Vulnerability

INTRODUCTION

Intergovernmental Panel on Climate change (IPCC, 2014) in its fifth assessment report state that the changing climate is one of the biggest challenges of the 21st century that will bring about unexpected extreme events to the whole world. In particular, South Asia is the home of one fifth of world's population and is considered as most disaster prone region of the world (IPCC, 2007; Aryal *et al*., 2018). With ever increasing population coupled with poverty, natural resource dependence and degradation; this region is highly vulnerable to climate change and resulting natural disasters (Abid *et al*., 2016). Pakistan is among the most vulnerable and having higher economic losses due to natural disasters and climate change in South Asia (Akhtar *et al*., 2008, Shah *et al*., 2018). The additional burden of loses from natural disasters comes from the hazardous geographic location of the country (Ainuddin *et al*., 2013; Ullah *et al*., 2017). According to Risk management index calculated on Global scenario, Pakistan ranks in category 4 (2.0-2.4) which indicates poor disaster risk management and poor adaptive capacity with a high likelihood of having current and future disasters (Ali & Erenstein, 2016). United Nations Framework convention on Climate Change (UNFCCC, 2013) defines climate change as the weather pattern which departs from a decadal time span. The changing climate is even more evident in mountainous regions due to their marginalization, higher dependence on natural resources and extreme poverty (Macchi, 2011; Sarwar *et al*., 2016). Human activities linked with development have increased the concentration of greenhouse gases (GHGs) in the atmosphere thus warming it up (Maitib *et al*., 2017). The emission of GHGs has increased by 70% since the rapid

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economic growth caused by the industrial revolution (Eggleston *et al*., 2006). Climate change is not just rising average global temperatures that concern scientists but also their effects on weather extremes, declining global ice cover and sea level rise. In fact, many of the predictions have made in the past about the impacts of global warming include disappearing glaciers, loss of sea ice, more extreme heat waves, accelerated sea level rise, and stronger hurricanes (Chaudhury *et al*., 2016; Choe *et al*., 2017). Adaptation enhances the capacity of people and governments to reduce climate change impacts (Akhtar *et al*., 2008). The term climate adaptation basically referred to the tendency to maintain as well as to improve the standards of living in such an appropriate manner that one could bear the severity and intensity of adverse climatic patterns (Aalst 2008).

Climate change is one of the most important global challenges affecting mountain ecosystems (Briner *et al*., 2013). Disasters hit mountainous communities and cause indirect great impacts downstream, affecting millions of people. Mountain climates vary noticeably with different exposures and provide limited resources. Inhabitants of these regions use their indigenous knowledge and developed sophisticated techniques for farming, livestock breeding, forestry and water use on steep slopes and in harsh unpredictable conditions (Wang *et al*., 2013). However, Hindu Kush Himalayan (HKH) is highly vulnerable to climate changes, affecting water volumes which directly affect the livelihood of locals (Elalem & Pal, 2013; Camp 2017).

The region is also at high-risk of avalanches, landslides, volcanic eruptions, earthquakes and glacial lake outburst floods which further threaten lives and livelihoods (Keating *et al*., 2016). As it can wipe out major livelihood resources such as standing crops, stored food, seeds, and fertile land (Veith, & Shaw, 2011), while fragile soils and vegetation cover make these areas more vulnerable to environmental degradation (Peterson & Halofsky 2017). Pakistan is alarmed to face future food insecurity majorly because of effected water availability due to changing climate. The water resources of HKH are life-line to Pakistan. Pakistan as an agricultural country has 47% population dependent upon agriculture with 24% contribution in national GDP (Ullah *et al*., 2015). With lesser contribution in global emission of GHGs, Pakistan suffers a lot from the consequences of climatic changes in terms of droughts, floods, weather alterations etc. (Akhtar *et al*., 2008; Ullah *et al*., 2017). This changing phenomenon is affecting the livelihood of people who have sufficiently less knowledge of adaptation to climate change. Better adaptation directly strengthens the resilience, which reveals the ability of systems or people to return to a former condition after facing stresses (IPCC, 2014). The local people have been using their traditional coping methods to sustain to changing environment but there is very little documentation of their techniques and accomplishments (Herman-Mercer *et al*., 2016).

Though climate change research has evolved from a bottom up approach rather than top-down approach, these people can be better instrumental to study the change analysis (Sonwa *et al*., 2016). Many studies have been carried out to assess farmer's perception of adaptation to climate change throughout the world, there is still little work done in the mountainous regions of Pakistan. Keeping this research gap in consideration, the study therefore investigates perception of local people to assess climatic changes in Tehsil Balakot and how this change has affected the rural community and their livelihood; and what are their practices to mitigate the effects.

MATERIAL AND METHODS

Study area

Balakot (34°33N; 73° 20E) is the biggest Tehsil of District Mansehra, KPK Province-Pakistan. It has an average elevation of 900m and one of the popular tourist stay over in the region (Soomro *et al*., 2010). The area was totally destroyed by the massive earthquake of 2005 and the losses were enormous ranging from death tolls to loss of agricultural land (UNDP, 2007). It is mostly mountainous and rural area with wage labor as major occupation, followed by agriculture and seasonal migration to main District Mansehra and Naran Valley. Majority of rural women were involved in livestock rearing and crop production. After agriculture, forest has become a major source of income in supporting livelihood (Soomro *et al*.,

2012; Basharat *et al*., 2016). Most of the community for their livelihood is totally dependent upon the ecological resources of the area, in the context of changing climate and dependence upon temperature and precipitation the community has become highly vulnerable in such marginalized region. Forest cover has changed over time due to use as fuelwood, the region is extremely cold winter nights and have no fuel available other than forest woods. Soil infertility, wind erosion and no irrigation infrastructure are the already documented reasons for the decrease in production of crops (Qasim *et al*., 2010). This scenario has provided our study a rational to know the perception of rural people and their mitigating strategies if any. The map of study area is shown in Fig. 1.

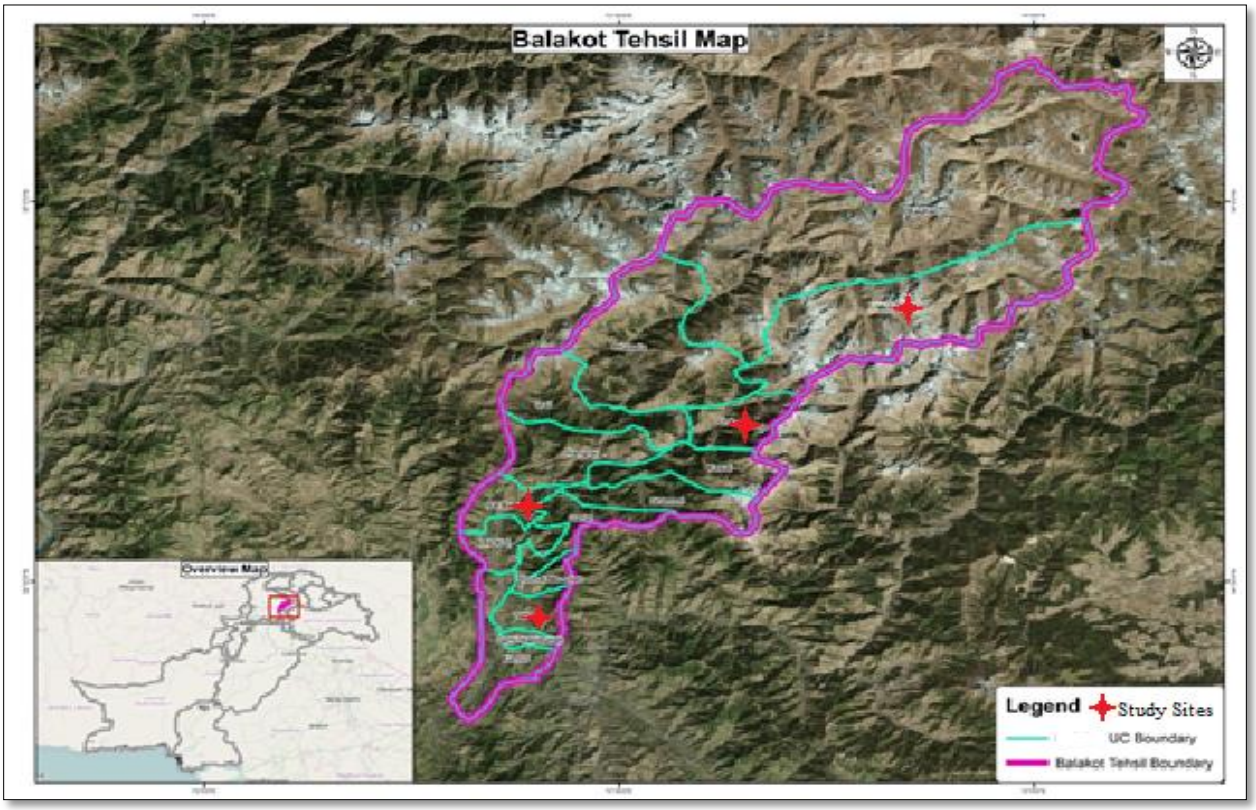

Fig. 1: Map of Tehsil Balakot indicating study sites

Sampling procedure and study population

Primary data for the study was collected from the field survey whereas secondary data was taken from many governmental departments including agricultural, irrigation and forest dept. Govt. of Pakistan. Tehsil Balakot has fifteen union councils (UCs), but population is unevenly distributed. Four villages from four UCs (Kawai, Mohandri, Balakot and Gari Habibullah) were chosen; the household survey of two hundreds houses was carried out chosen randomly to be the study population. Interviews were conducted using standard questionnaire applying qualitative and quantitative approach for data collection. In addition, Climatic data of temperature and precipitation was taken from the Balakot Station for a period of thirty years (1985 to 2014). Using mix method approach of data collection, interviews and house hold data was compared with climatic records of study area (Furberg *et al*., 2018).

Field survey tool

For primary data collection, a questionnaire was designed based on 34 items by thorough study of literatures which has helped in gathering information about demographic characteristics, social and economic conditions, and their perception regarding the climate change. A hazard mapping was carried out during a focus group discussion session after obtaining household data (Gentle and Maraseni 2012; Gentle *et al*., 2014).

Section 1: Socio-demographics of the locals

The first section inquired information about the respondents' demography. The information gathered was about their gender, age, and number of people living in their house. It also inquired about their education attainment, income of household, source of income, literacy rate, unemployment status and access to basic facilities like health facilities.

Section 2: Observation on climate change and adaptation

The section inquired about the perception impacts of climate change. Questions were asked to analyze the opinion of people about climate change and its impacts on their lives. This section was helpful in assessing the vulnerability of community to climate change and its relation with natural disasters. People's perception about temperature change and its impacts on their income, variation in flowering and fruiting pattern, change in food production, change in food diversity, change in harvesting season, change in annual rainfall and its impact on productivity, change in glacier melting, snow pattern, biodiversity loss and availability of natural resources was inquired. This data helped us in developing a viewpoint of climatic changes in the region and how was the community adapting (Joshi *et al*., 2017).

Pilot study

The main purpose of conducting pilot study was to check the response of respondents towards the questionnaire and to check either the questions designed were understandable for posing correct idea. Twenty households were visited and information was collected as a part of pilot work. This helped in modification and improvement of study tool.

Main survey

Using the updated questionnaire, data was collected during a field survey interviewing two hundred head of the households; it was preferred that the head of household should be above 35 years of age and living in the area from last twenty years.

This was done to get a picture of changes observed in some time period (Shah *et al*., 2018).

Data analysis

The data collected was analyzed using SPSS version 21 to determine the frequency and percentage response, also regression trend analysis was done to assess change in climatic data. The regression analysis provided an

RESULTS AND DISCUSSION

Climatic trends of tehsil Balakot

The temperature records of over 30 years (1985-2014) collected from the Balakot meteorological station were mapped as mean annual minimum temperature and mean annual maximum temperature as shown in Fig., 2 and Fig., 3. Regression trend analysis showed that there was an overall decrease in mean minimum annual temperature by a factor of 0.0024 for each year whereas increase in mean maximum annual temperature was recorded by a factor of 0.0412 for each year.

An average analysis of temperature showed erratic trend of increasing and decreasing temperature throughout thirty years. But in case of minimum temperature an overall range of 11.2 °C to 14.1 °C was observed, minimum 11.2 was in year 2005 whereas 14.1 the highest among minimum temperatures was in year 2000. In terms of mean maximum temperatures a range of 22.6 °C was lowest in year 1997 with a highest value of 26.6 °C in year 2010 as shown in Fig., 3. This statistical trend of temperature was then compared with opinions of people during field survey. Most of them informed of their agriculture loss in year 2010 due to severe weather and resulting floods and landslides. The reported impacts were also linked with decreasing drinking water in springs and wells and loss in irrigation water. Similarly loss in forest cover, reduced availability of NTFP, and less grazing land was also reported by the locals.

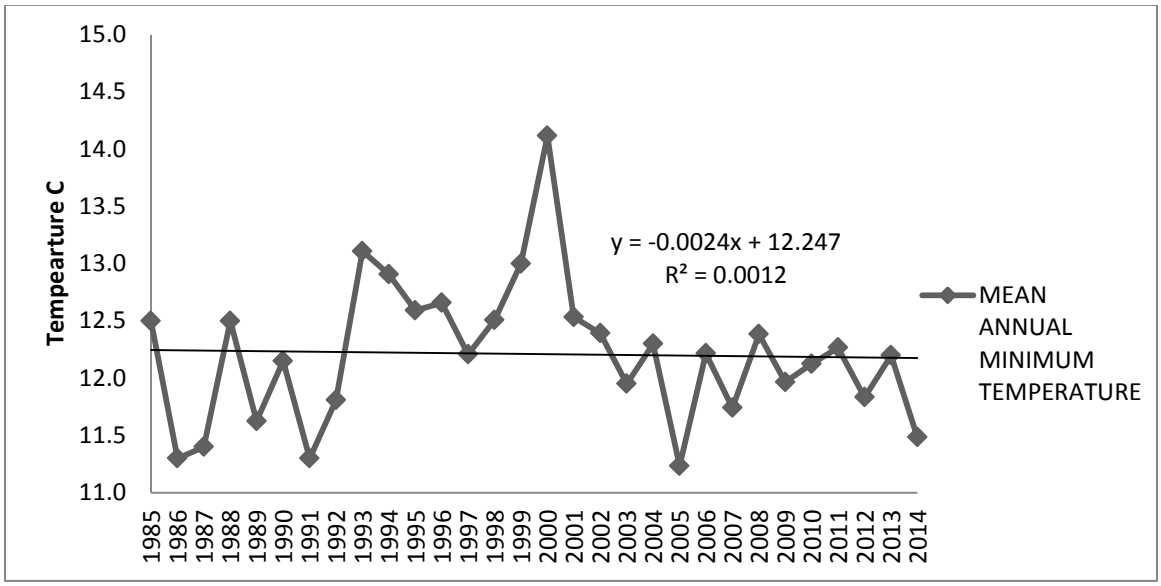

Fig. 2: Mean Min. Temperature (Annual) from 1985 to 2014

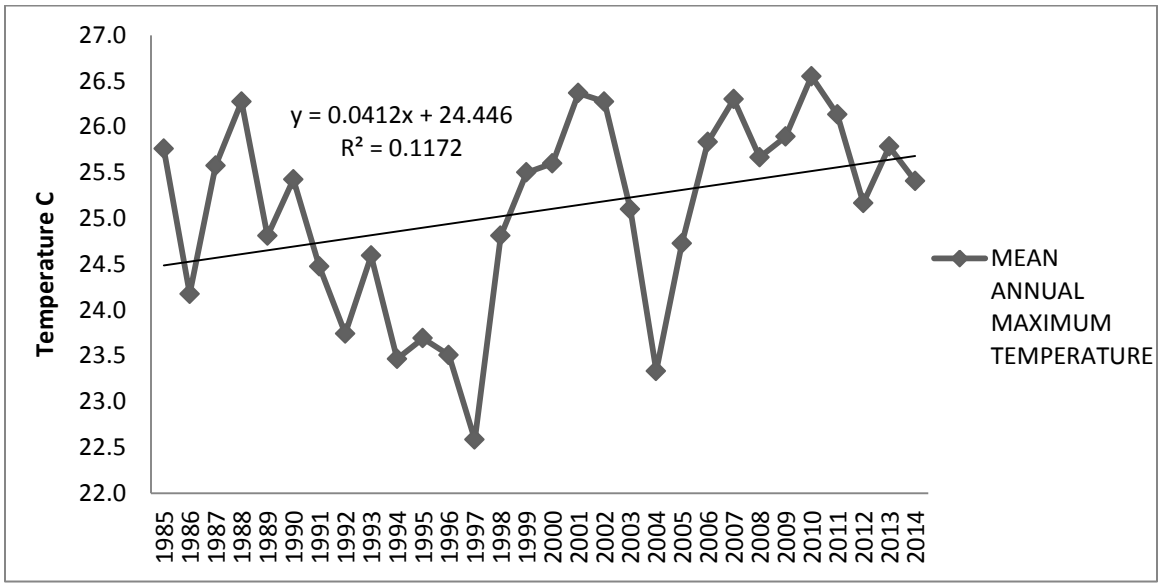

Fig. 3: Mean Max. Temperature (Annual) from 1985 to 2014

Like temperature, there was unpredictable pattern of rainfall data which was taken from the Balakot Meteorological station as shown in Table- I. Overall the mean annual rainfall of thirty years was 1471.27 mm during 1985 to 2014. A drift in rainfall was calculated for a decadal period i.e. 1985-1994, 1995-2004 and 2005-2014 to observe changes over a time of period. From the data, a general trend was developed for the winter and summer rainfall which was similar according to the local people as well. The monsoon period was considered as pre, post and mean monsoon months taking into account cropping seasons too. An increasing trend of mean winter rainfall was observed during 2005 to 2014; which was much higher than 1985-1994 and 1995-2004. This higher pattern of winter rainfall has influenced the wheat productivity as described by women during FGDs. Unpredicted rainfall was one of the identified hazard which impact community livelihood and ranked higher in hazard ranking as

shown in Fig., 3. The average rainfall in month of October and November was 46.8 and 36 mm respectively which was “minimum” recorded during thirty years span. A decreasing trend of rainfall was observed in months of March to May during 1995-2004 and 2005- 2014. This was time when usually in past there was plenty of rainfall. There was a clear change in rainfall pattern for pre-monsoon period. It was also reported by the community and validated by the statistical data. Although the mean monsoon period was same for all three decades. Similar results of winter temperature and rainfall were produced by the work of Shah *et al*., 2010.

Table I: Pattern of Rainfall (mm) in Tehsil Balakot

Year	Total Annual (Jan-Dec)	Mean Winter (Dec-Feb)	Mean Summer		
			Pre-Monsoon (March- May)	Mean-Monsoon (June-Sept)	Post-Monsoon (Oct- Nov)
1985-1994	1649.52	87.99	133.84	198.18	50.65
1995-2004	1348.48	67.93	99.14	191.01	41.64
2005-2014	1415.81	109.77	95.59	187.70	35.14
Source: Pakistan Meteorological Dept. (PMD) Govt. of Pakistan (2017)					

Socio-demographic characteristic of surveyed population

An overall demographic picture of community was quantified and results are described in Table- II. In the first part gender of respondents were determined as male were 52% and female 48%respectively. Age of the respondents were asked, 69% of the respondents were between21-30 years age group. The number of people living in a house was also determined to assess level of crowding. About 41.5% of people have spent 1-10 years. It was found that 68 % population had never visited the school or spent only primary levels at school. The number of people earning was also determined. Households containing 1-3 earning members were 75.5%. The source of income of the household was also determined. Almost all of respondents have opted agriculture as prime source, doing either as wage labor or cultivating for personal use. Livelihood diversification is considered as an adaptation strategy, it was seen that 78% of respondents either don’t know this or they had never thought of it which shows their poor adaptive capacity. Almost 76% people had affected land from previous disasters. In terms of energy, 61%households were relying on forest wood as a prime source for lightening, cooking, heating and other uses.

Table II: Characteristics of study population

Variable	Description	N (%)	Variable	Description	N (%)
Gender	Male	104 (52)	**Literacy level**	Uneducated	136 (68)
	Female	96 (48)		Educated	64(32)
Age (years)	Less than 20 years	17 (8.5)	**How many members in your**	1-3 people	151 (75.5)

	21-30 years	138 (69)	**house are earning?**	4-6 people	48 (25)
	31-40 years	19 (9.5)		More than 6 people	1 (0.5)
	41-50 years	18 (9)	**Source of income**	Agriculture	200 (100)
	Above 50 years	8 (4)		tourism	72(36)
No. of people living in house	2-4 people	35 (17.5)		livestock rearing	57(28.5)
	5-8 people	116 (58)		any other	-
	9-12 people	40 (20)	**Have you ever thought of livelihood diversification?**	Yes	43(21.5)
	More than 12 people	9 (4.5)		No/Don't know	157(78.5)
How much time you have spent in the area	Less than 1 year	20 (10)			
	1-10 year	83 (41.5)	**Do you or your land previously affected by any natural hazards?**	Yes	152 (76)
	11-20 years	28 (14)		No	48 (24)
	21-30 years	36 (18)	**What is major energy's source of household?**	wood	122 (61)
	More than 30 years	33 (16.5)		leaf litter	67 (33.5)
				gas/electricity	11 (5)

Perceptions on climate change and adaptations in mountainous region

An in-depth analysis was done to assess the observations of community for climate change and its adaptation. Percentage and frequency of questions inquired is presented in Table- III. Respondents were asked about their views about climate change and most of the respondents were familiar to term climate change whereas only 3.5% of the respondents were not familiar to term climate change. Reasons of climate change were also determined and 60.5% of the respondents indicated deforestation as a major reason of changing climatic conditions, whereas 6.5% of the respondents indicated pollution and energy exhaust, industrialization and global warming as reasons of climate change. Observation on the land use planning was resulted as 64.5% of the respondents said that there was no proper land use planning. In case of increase in disasters frequency and intensity, 59.5% of the respondents agreed a multitude. The change in temperature was also assessed. 83.5% of the respondents observed a change in temperature where 59.5% of the respondents said it has no effect on income.

Respondents were asked about the change in irrigation system and 34% of the respondents agreed of alteration. In terms of loss in biodiversity, 62.0% of the respondents related it with climate change. Change in flowering and fruiting pattern of crops was observed by 52% respondents, 41.5%

observed less food diversity and40% observed change in harvesting season of crops. Change in annual rainfall was felt by 40% of the respondents whereas 43% also observed increase in glacier melting. Change in snow pattern of the area was also observed by 57.5% of the respondents however 71% of the respondents described loss in natural resources of their region after the earthquake of 2005 and floods of 2010 and 2013.

Table III: Observations of locals on climate change and adaptation

Variable	Description	N (%)	**Variable**	Description	N (%)
Do you know the term climate change?	Yes	193 (95.5)	**Have you observed any change in temperature?**	Yes	167 (83.5)
	No	7 (3.5)		No	14 (7)
	No idea	0		No idea	19 (9.5)
What do you think are the reasons of climate change?	Deforestation	121 (60.5)	**If yes, what is that change?**	Increase in temp.	129 (64.5)
	Land use change	66 (33)		Decrease in temp.	27 (13.5)
	Any other	13 (6.5)		Both	13 (6.5)
Do you think there is proper land use planning in your region?	Yes	37 (18.5)	**How these changes in temperature affect your income?**	Increase in income	17 (8.5)
	No	129 (64.5)		Decrease in income	64 (32)
	No idea	34 (17)		No effect	119 (59.5)
Do you agree that earthquakes are regular feature of your area?	Yes	118 (59)	**Is this change in climatic conditions affecting your health?**	Yes	143 (71.5)
	No	82 (41)		No	46 (23)
Does the disaster increased here?	Yes	119 (59.5)		No idea	11 (5.5)
	No	81 (40.5)	**Have you observed any change in flowering and fruiting pattern of crops?**	Yes	104 (52)
Have you felt any change in snow pattern?	Yes	115 (57.5)		No	53 (26.5)
	No	56 (28)		No idea	43 (21.5)

	No idea	29 (14.5)		Less diversity	83 (41.5)
Do you understand term resistance to be applied in your cropping system?	Yes	39 (19.5)	**Is there any change in food diversity over past ten years?**	More diversity	52 (26)
	No	97 (48.5)		No change	22 (11)
	No idea	64 (32)		no idea	43 (21.5)
Which crop is abundant here?	Maize	34 (17)	**Do you observed any change in harvesting season of crops?**	Yes	80 (40)
	Wheat	65 (32.5)		No	58 (29)
	Rice	20 (10)		No idea	62 (31)
	Corn	21 (10.5)			
Are the natural resources depleted after the disaster?	Yes	142 (71)	**Have you observed any change in annual rainfall?**	Less	74 (37)
	No	31 (15.5)		More	81 (40.5)
	No idea	27 (13.5)		No change	26 (13)
Do the people living here are suffering from more health problems?	Yes	166 (83)		No idea	19 (9.5)
	No	28 (14)	**Have you felt any change in glacier melting?**	Yes	86 (43)
	No idea	6 (3)		No	62 (31)
Is the climate change leading to biodiversity loss?	Yes	102 (51)		No idea	52 (26)
	No	84 (42)	**If yes, did it result in formation of artificial lake?**	Yes	48 9 (24)
	No idea	14 (7)		No	67 (33.5)
Do you think the organizations are considering climate change an issue?	Yes	124 (62)		No idea	85 (42.5)
	No	25 (12.5)	**Is there any reservoir to store flood water?**	Yes	32 (16)

	No idea	51 (25.5)		No	124 (62)
Is the Government working on making people resilient to changing climatic conditions?	Yes	73 (36.5)		No idea	44 (22)
	No	79 (39.5)	**Have you observed any change in irrigation system?**	Yes	68 (34)
	No idea	48 (24)		No	67 (33.5)
				No idea	65 (32.5)

Lastly people were asked to describe the hazards/disasters to which they had higher exposure in the period of last ten years and their response was mapped through the hazard ranking system of 0 to 5. Here 0 indicates least and 5 as highest level of exposure. It showed that community felt higher hazard of earthquake with a rank of 5; landslides, floods and rainfall were at 4th rank. The reason was the deadliest earthquake of 2005 from which they still couldn't recover loses. In addition to this, landslides were common phenomenon, and change in rainfall pattern had adversely affected their livelihood.

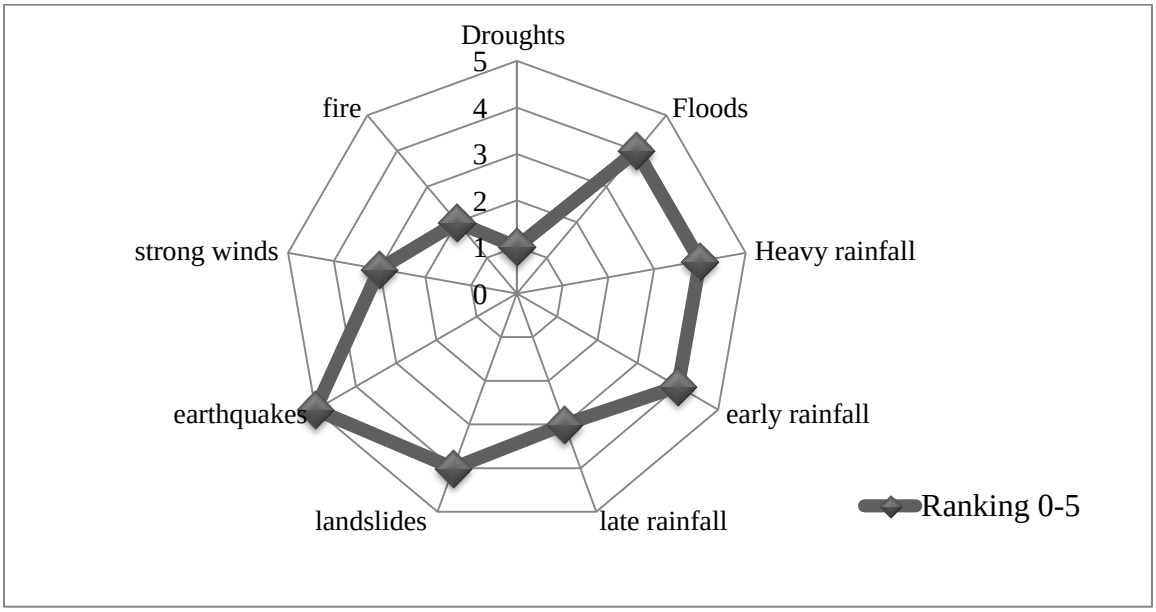

Fig. 3: Spider Diagram of Hazard Mapping in Tehsil Balakot

Overall, perception of the local people about the climate change determined that they were aware of the climate change in their region. Increase in temperature, effect of temperature increase on their health, change in annual rainfall, change in snow pattern and glacier melting were the common perception of the local community about climate change. A case study by Tse-ring *et al*., (2010) revealed that change in temperature in a region affects the precipitation rate directly but indirectly it affects the health of the local people. The data collected from Tehsil Balakot concluded that the change in temperature in the area over past

15 to 20 years was affecting the health of local residents at high pace. People were facing high temperature, and infected by the viral diseases on regular basis. Similarly, relation between harvesting season and the crop abundance revealed that due to variation in climatic conditions, harvesting season was shifted which was affecting the yield and the abundance of crop in the area. Our results were similar to the findings of Chaturvedi *et al*., 2011.

A case study conducted by Chaudhary and Bawa (2011) revealed that over all temperature is increasing with less annual snowfall, glacier retreat, and drying up of water resources. These results were alike to the outcomes of our study. It was assessed that no disaster resistant crops were introduced in the area as an adaptive measure taken to reduce the vulnerability to climate variability; the findings are similar to the study of Alam *et al*., 2017. Local residents observed change in annual rainfall over the past 15-20 years. People were of the opinion that they received heavy rainfall as compared to past years and the heavy rainfall has direct impact on their agriculture activities. Our results were similar to that of study conducted in KPK by Abid *et al*., 2016.

Overall it was identified the people with better income and education were in better position to mitigate the changing climate by having livelihood preferences (Shah *et al*., 2018). Most of households reported change in their agriculture productivity and problems regarding cropping due to water availability and changing temperature. All of them mentioned about reduced forest cover *(Qasim et al. 2010)* and difficulty in getting fuel wood as it was recently banned by the local government. The poor households had difficulties with their day-to-day livelihood activities; similar results were presented by *Gentle and Maraseni (2012)* in their work in Jumla District of Nepal which is also a mountainous region. Most of the community responses' were significant with records of temperature and precipitation.

CONCLUSION

Using a participatory data technique in Tehsil Balakot, experiences of local people were noted which were supported by the meteorological data that climate change is happening in the area and influencing their livelihood negatively. The local people were key factors in mapping and identifying community hazards. Climatic data was taken to validate the perceptions of people, which proved to be an effective tool as viewpoint highlighted during interviewing was matching with the records of temperature and precipitation. In the study area ecological resources were degraded due to increasing population pressure and change in livelihood patterns. The daily life of locals was altered because of change in rainfall and temperature which further impacted their agricultural productivity, change in seasons, reduced water volumes etc. People were not prepared for the long term changes in their weather patterns which will change their day to day livelihood. The study has concluded that such prone areas need special attention from the policy makers to help the local community from natural hazards and adaptation.

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