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Evaluating the Local Perceptions of Climate Change Vulnerability in Hindukush Himalayan region of Pakistan

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ABSTRACT

This study was conducted with an aim to find out the perceptions of the local people about the causes of vulnerability to the climate change and the possible adaptations to reduce the impacts on local people in Hindukush Himalaya mountainous region of Pakistan. Household survey method was used for the collection of data involving total of 1066 households using structured questionnaire in district Swat located in this region. Mostly elderly people were interviewed for the survey. Using random number generation technique, clusters from each zone were selected for sampling. The information was analyzed using SPSS (version 20). The association between the climate change knowledge and demographic variables were explored using Chi-square tests and Cramer's V statistics. The results showed that the majority (88.5%) of the respondents were aware of the climate change in the area. Deforestation (37.2%), natural causes (29.7%) and combustion of fossil fuels (14.7%) were the main reported causes of the climate change. Natural hazards such as floods (16.8%), dry spells (16.2%), vector borne diseases (10.8%), and changes in biodiversity (10.5%), lower agricultural productivity 10.1%) and heat waves (9.9%) were among the major perceived impacts of climate change. A Significant relationship ($p < 0.05$) was found between the demographic variables and the climate knowledge in the study area. The low education and sometimes little awareness about the global climate change were the limitations in this study in addition to the strong religious beliefs. This results in little response to the global climate change vulnerability. The study recommends that reducing the vulnerability to the increasing menace of the climate change requires the participation at the community level (by education and awareness), the Government and other organizations.

Keywords: *Climate change, Public perception, Vulnerability, Swat, Climate knowledge.*

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1. INTRODUCTION

Climate change is the greatest of all the challenges facing the humanity in the 21st Century. The climate change is an especially difficult problem due to its global nature (Mason C. F. et al., 2017). It is becoming a survival issue for the people all around the globe (Yuan X-C., et al., 2017). Although this problem is facing the whole humankind, some people are more vulnerable to this global menace because of different reasons. These reasons include living in the region's most vulnerable part to the climate change, overwhelming poverty in some places and living in hazard prone areas (Ullah W., et al., 2017).

Various studies conducted in the region, point out that the climate of Pakistan is changing (Salma S., et al., 2010; Farooqi A. B., et al., 2005). The temperature of the country has increased over the past years (Chaudhry Q. U. Z., et al., 2009). According to (Salma S., et al., 2010), the climate change is happening in Pakistan with big increase in temperature in the major cities. A warming of 0.47 °C has been reported since 1960, with 1988 and 2002 as the warmest years in the climate history of Pakistan (Chaudhry Q. U. Z., et al., 2009). The temperature increases are estimated for both summer and winter, which are higher in the northern Pakistan as compared to the southern Pakistan (Yu W., et al., 2013).

The Global Vulnerability Index (GVI) puts Pakistan among the leading countries (top 10) vulnerable to the changing climate (Ullah W., et al., 2016). Although it contributes 0.8% of the total GHG emissions which is far below the global average (Abbas Z., 2009) and is ranked 135th among the global greenhouse gas emitters (Khan J. A., 2011). German watch rated Pakistan 8th on the Climate Risk Index (CRI) among the top 10 countries that have been affected by the impacts of weather related events (Kreft S., 2016). Pakistan is vulnerable to a number of natural disasters including floods, drought, cyclones, earthquakes and other extreme weather conditions. It is estimated that about 40% of the people living in Pakistan are highly exposed and vulnerable (predicted to increase in future) to the adverse climatic changes (Ullah W., et al., 2016; Atta-ur-Rehman, et al., 2011).

The difficulty in the understanding of the public perception obstructs the development of the climate change adaptation policies (de Jalón S. G., et al., 2013). The climate perceptions by the individuals, communities and other stakeholders in the society have got importance in the recent time, due to their exposure to the climate vulnerabilities, and the evidences

pertinent to the subject have accumulated extensively in the form of empirical and theoretical data. It is therefore necessary to integrate and study the perceptions of the local communities in the climate change debate and adaptation policies (Lorenzoni I., et al., 2007; Roser D., et al., 2015; Jurt C., et al., 2015).

Countries like Pakistan are in an urgent need to context specific studies on public perception about the climate change for effective decision making towards mitigation and adaptation of the expected climate change, as the climate change will become more evident in near future (Farooqi A. B., et al., 2005). Swat lies in the Hindukush Himalaya region where the impacts of climate change are the most prominent. These impacts include retreating glaciers, changing hydrological processes, extreme floods and snow cover the changes which are currently getting attention (Qing-Long Y., et al., 2017). This study aims at filling this gap by focusing on the district of Swat as a case study by exploring the public perceptions of the climate variability and local adaptation strategies.

The main objectives covering the study are i) to explore the public perceptions about the climate variability and ii) to understand the climate change vulnerabilities and local adaptation strategies in the study area. Research questions for the study include i) How do the local communities recognize the climate variability? ii) What are the causes, impacts and public observations of the climate change in the study area?

The climate change is the most noticeable in the mountainous communities, and has a direct effect on the livelihoods of the people living there. Increased climate variability and change can cause frequent and high intensity climate induced hazards, by pushing the communities to adapt to these changes or forcing them to migrate from their areas. The mountainous communities are predominantly vulnerable due to their livelihood dependency on natural resources such as forests, agriculture and tourism, etc. The affected communities may not cope on their own and may need external support for better understanding of the climate change phenomena. Public perception about the changing climate in these areas is still not scientifically developed, but they cope with the changing climate using the local knowledge and strategies. The local knowledge can help the policy makers and decision makers to utilize adaptation policy framework for the climate change. It is therefore required to explore the sources of the livelihood in the mountainous areas, vulnerability of the climate change to these sources, and the role of indigenous knowledge in the current and future adaptation strategies.

2. STUDY AREA

District Swat is a mountainous area situated in the Hindukush range of Khyber Pakhtunkhwa region of Pakistan. It is located at 34°46′58″N and 72°21′43″E latitude/longitude. It borders district Chitral in the North, district Dir in the West and Gilgit-Baltistan province in the North-east. The area comprises of varied elevations that stretches from 600 to above 6000 meters. Swat district covers an area of 5337 Km2 with a population of 1.26 million (Government of Pakistan, 1999; Bangash S., 2012). River Swat is the main river that drains the entire watershed of Swat region (Ahmad H., et al., 2015).

The study area lies in the temperate zone where various factors including altitude, latitude, Indian Ocean monsoons and western cyclonic currents control the climate. June is the hottest month of the area with 33 °C as maximum temperature while January is the coldest month with a minimum temperature of -2 °C. An average rainfall of 1000mm to 1200mm annually prevails in the study area (Dahri Z. H., et al., 2011; Bazinni F. 2013).

The population of Swat is dependent on agriculture, horticulture, livestock, fisheries, tourism and forest resources of the area (Sabir M. A., 2001; Khan S. R., et al., 2009). Apart from dependency on the natural resources, the people also find their jobs in several industries and are employed in multiple public and private sector organizations (Sabir M. A., 2001). Moreover, some of the households are dependent on local and foreign remittances (Khan S. R., et al., 2009).

3. MATERIAL AND METHODS

Research Design

The case study approach (Yin R. K., 1984; Eisenhardt K. M., 1989; Crowe S., et al., 2011) was adopted to explore the dynamics of the climate change perceptions in district Swat using quantitative research tools. The study area is selected because the impacts of the climate change are more evident in the mountainous areas compared to the plain areas. The study area fits to this description as the climate of the area is already changing (Shah M., et al., 2012; Ali K., Rahman I. U., et al., 2014; Ali K. A., 2015) and might get worse in the future.

Sample size

The questionnaire survey was conducted in the whole district Swat using stratified sampling technique. District Swat was divided into clusters (union councils) based on population. Using random number generation technique, clusters from each zone were selected for sampling. To get a greater accuracy in our results, sample size was selected using 95% confidence level and 3% confidence interval. The total sample size against the total population of 882456 people (Government of Pakistan, 1999) was calculated (using sample size calculator) as 1066 which was then proportionally allocated to tehsils and union councils using proportional allocation sampling method (Sekaran U., 2003; Bowley A. L., 1925). The extent of the study area is depicted in figure 1.

Data collection

The survey was conducted in 9 months from September 2015 to May 2016. The questionnaire was pre-tested on a small number of respondents in the study area. The questionnaires consisted both of the quantitative and qualitative questions, based on a mixture of closed and open-ended questions. Due to the low literacy rate of the study area, the questionnaires were filled using face to face interviews with the respondents for a proper data collection. The key terms related to climate change were explained to the respondents in the native language (Pashto) for the ease of data collection.

Data Analysis

The qualitative and qualitative responses were put in SPSS version 20. A great care was taken in the data input using encoding of the variables. The questionnaire survey results were analyzed using descriptive statistical tools such as percentages, mean and standard deviation. The demographic variables such as age, education, income were compared with the explanatory variables using chi-square analysis and Cramer's V statistics. The results with chi-square statistics were analyzed with varying levels of significance (i.e. 0.05, 0.01 and 0.001).

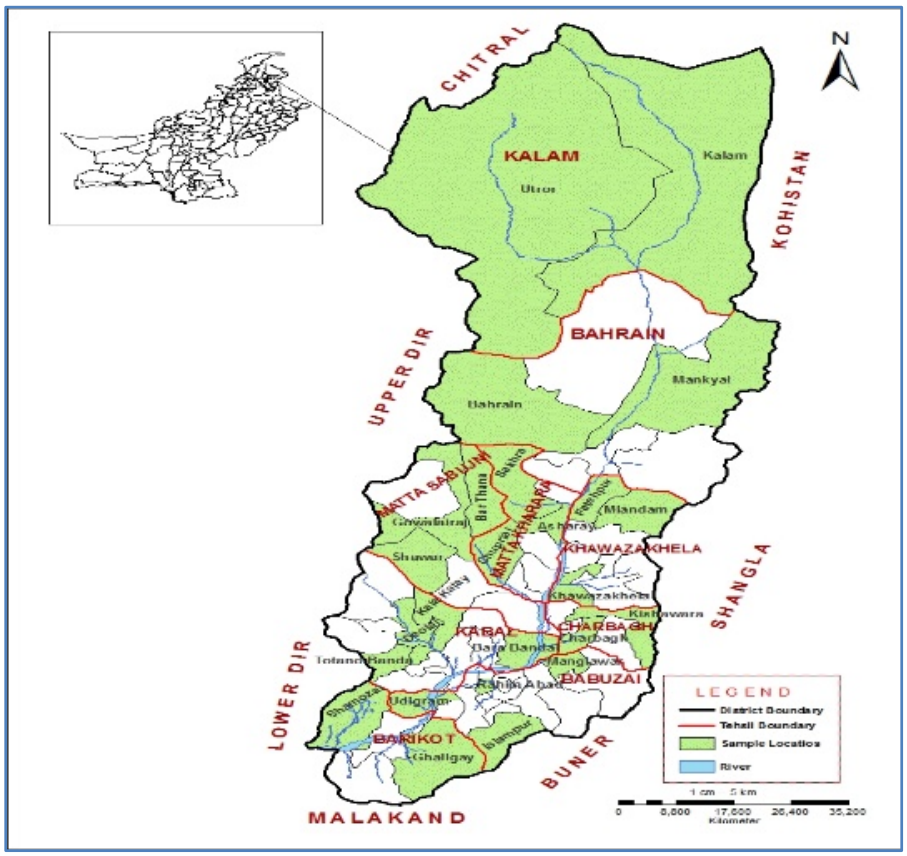

Figure 1. Map of the study area

4. RESULTS AND DISCUSSION

Socio-demographics

The majority of the surveyed respondents (35.5%) were within the range of 31 to 40 years of age while the total respondents above 30 years of age comprised more than two thirds of the sample size. With respect to the education, only 45.2% were having formal education, while 50.1% of them had primary/middle education showing a low level of education. The results are in alignment with the education statistics in the study area. According to the population census 1998, the literacy ratio (10 years and above) in the district is 28.75% (Male 43.16%, Female 13.45%). Thereby, it shows a striking resemblance with the results from our study (Government of Pakistan, 1999).

Nearly half (48.9%) of the respondents have 20,000 rupees or less as monthly household income, whereas a mere (12.42%) have monthly income more than 40000 rupees. This is showing a low economic profile of the respondents within the study area (Table 1).

Climate change knowledge

The survey respondents were asked whether they knew about the climate change. Majority (88.5%) of the respondents were affirmative about the climate change in variable perceptions while a minor (11.5%) number of the respondents didn't know the climate change (Figure 2). The study revealed that almost all the respondents have observed the climate change one way or the other, but they could not name it properly or scientifically. The results of the similar nature have been produced by other studies (Yu H., et al., 2013; Liu Z., et al., 2014; Kabir M. I., et al., 2016).

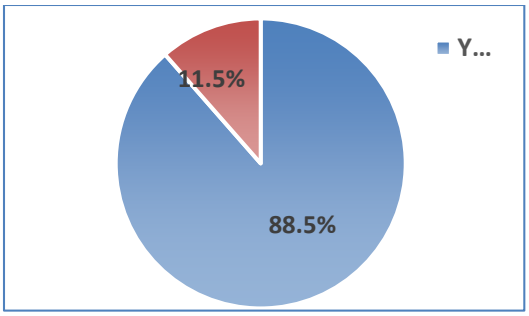

Figure 2. Public understanding of Climate change/Global Warming

The increase in temperature (32.1%), changes in rainfall pattern (24%), extreme weather conditions (22.4%), changes in bio-diversity (15%) and melting of ice caps (6.1%) were the major factors in recognizing climate change. Age, education and income had a modest effect on individual climate change knowledge. Respondents with high age (51 and above) tended to have the greater knowledge of the temperature increase (78.7 %, $p < 0.01$) and the extreme weather events (56.8%, $p <$

0.004) while more respondents (20 %, p < 0.001) aged 41 to 50 selected melting of the glaciers (Table 2).
With respect to education, more respondents with no formal education (59.4 %, p < 0.01) had selected the change in rainfall pattern while greater number of the respondents with Masters/PG (72.2 %, p < 0.001) education had selected changes in biodiversity and melting of the ice-caps or glaciers (50 %, p < 0.001). The greater number of respondents from the Very high-income group (43.8 %, p < 0.05) had selected changes in biodiversity while Very low income group (20.9 %, p < 0.001) have selected melting of ice-caps or glaciers (Table 3). The melting of the glaciers had been reported in the upper parts of district Swat, because most of the glaciers of the district are in the upper reaches of the study area**.**

Table1. Descriptive statistics of the public understanding about climate change in the study area

Climate change characteristics	Responses (N)a	Responses (%)
Do you know Climate change/Global warming?		
Yes	934	88.5
No	121	11.5
Total	1055	100
How do you recognize climate change?		
Increase in Temperature	763	32.1
Change in Rainfall pattern	572	24
Extreme Weather Events	532	22.4
Changes in Bio-diversity	356	15
Melting of Ice-caps/ Glaciers	146	6.1
Rise in Sea Level	8	0.3
Other	3	0.1
Total	2380	100
Main Causes of Climate Change?		
Deforestation	668	37.2
Natural Causes	532	29.7
Combustion of fossil fuels	264	14.7
Act of God or Nature	170	9.5
Greenhouse Gases	147	8.2
Other	13	0.7
Total	1794	100
What are the Impacts of climate change?		
Flooding	743	16.8
Droughts or dry spells	716	16.2
Vector borne diseases	478	10.8
Changes in flora & fauna	462	10.5
Lower agricultural productivity	446	10.1
Hot temperature/heat waves	437	9.9
Decrease in cold days	427	9.7
Increase in extreme events	256	5.8
Low rainfall	125	2.8
Increase in hot days	103	2.3
Landslide	90	2.0
Road Erosion	71	1.6
Miscellaneous	62	1.4
Total	4416	100

[a.] Total number of responses exceed the sample size because more than one answers were permissible.

Perceived Causes of Climate change

The respondents perceived various reasons causing climate change in the study area which included deforestation (37.2%), natural causes (29.7%), combustion of fossil fuels (14.7%), act of God (9.5%) and greenhouse gases (8.2%) among the major perceived causes (Table 1).
The survey results showed that the deforestation is the major perceived cause of the climate change. This depicts the worsened situation of deforestation in the study area (Khan M. S., et al., 2015; Khan N., et al., 2015; Qasim S., et al., 2015; Pellegrini L. 2011). Mostly the aged respondents being 31 to 40 were (70.1 %, p < 0.001), and predominantly the educated respondents with education of Masters/PG level were (83.3 %, p < 0.001). In addition, the respondents with FSc/A-Level were (79.2 %, p < 0.001) associated the deforestation with the climate change.
The low level of literacy rate tends to shape perceptions about causes of the climate change in the study area. This is evident from the results that the higher number of respondents having no formal education had selected natural causes (54.9 %, p < 0.001) and (19.6 %, p < 0.001) as reasons for the climate change. This implies that educated respondents negate the act of God or nature as the main cause of the climate change. They inclined to select GHGs, combustion of fossil fuels, deforestation as causal reasons for the climate change. The belief system in the study area is more dominant towards God or religion, a hefty number of respondents pointed out that climate change is the will of God, and we can't do anything about it. Similar results have been reported by other studies (Haq S. M. A., et al., 2016).
Combustion of the fossil fuels and greenhouse gases collectively made less than one fourth of the results, that shows the low level of awareness among the respondents about greenhouse gases as casual agents of the climate change. Conversely, the greater number of the highly educated (Masters/PG) respondents selected combustion of fossil fuels (50 %, p < 0.001) and GHGs (83.3%, p < 0.001). Similarly, the Very High-income group perceived combustion of fossil fuels (33.8 %, p < 0.01) and GHGs (31.5 %, p < 0.001) causing the climate change (Table 2).
Collectively close to two third (60.1%) of the respondents perceive anthropogenic sources as responsible for causing climate change which is consistent with other similar studies (Whitmarsh L., 2008; Yu H., et al., 2013; Kabir M. I., et al., 2016).

Table 2. Chi-Square statistics of the public perception of climate change in the study area

Public observations about CC	Age		Education		Income	
	Sig.	Cramer's V	Sig.	Cramer's V	Sig.	Cramer's V
Recognition of CC						
Increase in Temperature	.003	.114	.609	.058	.609	.058
Change in Rainfall pattern	.968	.016	.004	.128	.004	.128

Extreme Weather Events	.004	.113	.071	.098	.071	.098
Changes in Bio-diversity	.461	.049	.001	.142	.001	.142
Melting of Ice-caps/ Glaciers	.001	.125	.000	.181	.000	.181
Causes of CC						
Greenhouse Gases	.213	.065	.000	.416	.000	.206
Fossil Fuels Burning	.181	.068	.000	.202	.007	.116
Deforestation	.001	.127	.000	.189	.366	.064
Natural Causes	.048	.087	.000	.148	.000	.144
Act of God or Nature	.682	.038	.000	.148	.310	.068
Impacts of Climate Change						
Flooding	.060	.084	.002	.134	.090	.088
Droughts or dry spells	.000	.166	.000	.194	.000	.179
Vector borne diseases	.607	.042	.347	.073	.000	.151
Changes in flora and fauna	.761	.033	.801	.047	.448	.060
Lower agricultural productivity	.101	.077	.019	.113	.000	.171
Change in temperature	.918	.022	.078	.097	.217	.074
Decrease in winter days	.437	.051	.223	.081	.000	.172
Increase in extreme events	.056	.085	.110	.092	.141	.081
Low/no rainfall	.571	.044	.824	.045	.000	.209
Extended summer days	.520	.046	.328	.074	.008	.115
Landslide	.001	.127	.013	.117	.018	.107
Road Erosion	.017	.099	.104	.093	.000	.188

Perceived Impacts of climate change

The major perceived impacts (Table 1) were flooding (70.6%), drought or dry Spells (68.1%), vector borne diseases (45.4%), changes in flora and fauna (43.9%), low agricultural productivity (42.4%), hot temperatures/heat waves (41.5%), the decreases in cold days (40.6%), the increases in extreme weather events (24.3%), low/no rainfall (11.9%), the increases in the number of the hot days (9.8%), landslides (8.6%), road erosions (6.7%) and storms (1.5%).

Climate change is known to exert various ranges of impacts on the environment and human ecosystem. The study area has experienced many high intensity floods recently (Atta-ur-Rehman., et al., 2011), therefore it is expected as the common response to the impacts of the climate change. Chi-square test results indicated that significantly higher number of respondents who obtained higher studies (Masters/PG, 89 %, $p < 0.01$) and FSc/A-Level (85 %, $p < 0.01$) had perceived flooding.

With regards to droughts or dry spells, results indicated that mostly the respondents aged from 21-30 (77.2 %, $p < 0.001$), greater number of FSc/A-level (86.8 %, $p < 0.001$) educated respondents and Very Low-Income group (75.9 %, $p < 0.001$) had perceived dry spells as a perceived cause. It could be attributed to the high dependency of the low-income groups on the environmental and agricultural practices; therefore, they tend to have more observation related to the droughts compared to the other income groups.

Various studies indicated the prevalence of vector borne diseases caused by the climate change which might increase in the future (Githeko A. K., et al., 2000; Martens W. J. M., et al., 1995) A great number of the respondents chose 'the vector-borne diseases' while mostly (48.1%) middle aged (31 to 40 years) respondents perceived the impact of the climate change. Significantly greater number of respondents in High Income group (60.6 %, $p < 0.001$) have selected vector-borne diseases compared to the other income groups.

Climate change is going to affect the agricultural productivity in some parts of the world (Hussain S. S., et al., 2007; Bryan E., et al., 2013) The current study shows that a considerable number of respondents selected 'lower productivity' as an impact of the climate change. Chi-Square analysis indicates that significantly large number of the respondents with education of FSc/A-Level (41.5 %, $p < 0.05$) have selected lower agricultural productivity. With respect to the income groups, significantly higher number of the respondents related to High Income group (56.4 %, $p < 0.001$) have selected lower agricultural productivity.

Many respondents chose the 'Decrease in winter days' (40.6%) and relatively small proportion of the respondents selected 'Increase in warm days or Extended summers' (9.8%) as the impacts of the climate change. Because of the temperature rise, the number of summer days are increasing while the number of the winter days are decreasing. Results indicated that significantly greater number of the respondents from the high-income group (53.7 %, $p < 0.001$) have selected the "Decrease in winter days" while significantly more number of respondents of Very High-income group (15.4 %, $p < 0.01$) have selected the "Extended summers" as the impacts of the climate change.

The results showed that a slightly less number of respondents have chosen the 'landslides' (8.6%) and 'road erosion' (6.7%) as the impacts of the climate change compared to the other listed impacts. Chi-Square analysis indicates that significantly high number of respondents aged 31 to 40 (12 %, $p < 0.001$) have selected landslides while significantly more respondents aged 21 to 30 have selected road erosion as the impacts of the climate change. While significantly higher number of respondents with education of Masters/ PG (22.2 %, $p < 0.05$) have selected the landslides. In the income groups, significantly more respondents related to Low Income group (11.6 %, $p < 0.05$) have selected landslides, while significantly greater number of respondents related to Very Low-Income group (16.2 %, $p < 0.001$) have selected road erosion as the impacts of the climate change (Table 2).

Public observation of the Climate system

Based on six climatic change indicators, the respondents were asked to record their observations over the past 20 years (1996-2015), firstly in terms of the increase or decrease in these indicators, and secondly the observing time span. The results are summed up in the following text (Table 3 and 4).

- **Change in Temperature**

With respect to observing change in the temperature, a larger portion (76.3%) of the respondents reported the increase in temperature while only 25.4% reported the decrease in temperature. Chi-Square statistics showed moderate significance between the age (Cramer's V = 0.160), education

(Cramer's V = 0.131) and income groups (Cramer's V = 0.164). More respondents being at age 51 years or above (85.0 %, p < 0.001) have observed the increase in temperature. The increase in temperature decreases within the age group from higher to lower age which validates that the age plays an important role in understanding the changes in the climate system. Conversely more respondents aged 21-30 (32.3 %, p < 0.001) have observed decline in temperature which implies that the low age is attributed to less experience and understanding of the climate system.

Significant number of highly educated respondents with education level Masters/PG and Bachelors have experienced the increase in temperature (77.8%, p < 0.01 and 76.9%, p < 0.01 respectively), while more respondents with education equivalent to FSc/A-Level (41.5 %, p < 0.01) have observed the decrease in temperature with respect to the other education groups. Comparably, more High Income and Very High-Income groups (86.2%, p < 0.001 and 84.6%, p < 0.001 respectively) have experienced changes in temperature than the Low Income and Very Low-Income groups (73.2%, p < 0.001 and 65.7%, p < 0.001 respectively).

The observing time span shows that majority (64.9%) of the respondents had observed changes in the temperature since 6 to 10 years within a strong association within the age groups (Cramer's V = 0.308) and moderate association within education (Cramer's V = 0.140) and income groups (Cramer's V = 0.180).

- **Change in rainfall pattern**

The results showed that 74.6% of the respondents reported the decreased rainfall, while an increase in rainfall was reported 25.4%. A moderately significant relationship between the demographic variables and the change in rainfall pattern is observed. Most observed the decrease in rainfall lies in the age group 51or above (83.33 %, p < 0.01) while the least in aged 21 to 30 (66.34 %, p < 0.01). Conversely, significantly larger numbers of the respondents of the group aged 21 to 30 have experienced the increase in rainfall (33.66%, p < 0.01) than any other groups. Mostly the Non-Educated, Masters/PG and Primary Educated respondents have observed decline in overall rainfall (78.4%, p < 0.01, 77.8%, p < 0.01 and 74.2%, p < 0.01 respectively) whereas more FSc/A-Level educated respondents observed the increase (45.3 %, p < 0.01) with a weak association (Cramer's V = 0.131) within the education group. With respect to the income of the respondents, significantly the higher number of the Very High Income and High-Income groups have observed decline in rainfall (84.6%, p < 0.001 and 84.5%, p < 0.001 respectively).

With respect to the observing time span, 65% of the respondents had observed the change in rainfall pattern since 6 to 10 years ago while 13.4% observed the change since 1 to 5 years ago. Chi-square statistics shows the strong correlation between the age groups (Cramer's V, 0.313), education (Cramer's V, 0.146) and income groups (Cramer's V, 0.182).

- **Change in Snowfall pattern**

Snowfall in the study area is responsible for the smooth flow of the River Swat, which originates from the upper reaches of District Swat (Ahmad H., et al., 2015). The River Swat is responsible for some of the major livelihood sources of this mountainous community or in other terms, variation in Snowfall patterns bears the gruesome consequences for the community. The results show that the majority of the respondents are of the view that there is quite a significant change in the snowfall pattern in this area. About 92.8% of the respondents have observed a decline in the snowfall throughout the study area.

Results of Chi-Square test indicated that significantly large number of respondents aged 41 to 50 (96.5 %, p < 0.05) and 51 or above (94.3 %, p < 0.05) have observed decline in the Snowfall in District Swat. On the contrary, more respondents from the age groups 31 to 40 and 21 to 30 reported the increase in the Snowfall (9.6 %, p < 0.05 and 9.4 %, p < 0.05 respectively) compared to the old age groups. There is no significant relationship found between the education (Cramer's V = 0.067, p > 0.05) and income groups (Cramer's V = 0.081, p >0.05) for the changes in snowfall pattern in the area.

The demographic variables show a moderate to strong Cramer's V association within age (V = 0.312), education (V = 0.136) and income groups (V = 0.180) with respect to the climate observance time span of the respondents.

Table 3: Percentages of respondents by public observation of climate change and chi-square results by demographic variables

Public observation of CC	Change	N	Percent	Age Groups		Education		Income	
				Sig.	**Cramer's V**	**Sig.**	**Cramer's V**	**Sig.**	**Cramer's V**
Rainfall	Increased	260	25.4	.001	.131	.002	.136	.000	.176
	Decreased	763	74.6						
	Total	**1023**	**100.0**						
Temperature	Increased	780	76.3	.000	.160	.003	.131	.000	.164
	Decreased	242	23.7						
	Total	**1022**	**100.0**						
Snowfall	Increased	74	7.2	.012	.104	.467	.067	.153	.081
	Decreased	951	92.8						
	Total	**1025**	**100.0**						
Size of Glaciers	Increased	70	26.3	.000	.468	.032	.214	.008	.228
	Decreased	196	73.7						
	Total	**266**	**100.0**						
Summer Days	Increased	818	83.9	.000	.180	.005	.130	.031	.105
	Decreased	157	16.1						
	Total	**975**	**100.0**						
nter Da	Increased	120	12.1	.004	.116	.956	.033	.000	.144

	Decreased	869	87.9						
	Total	**989**	**100.0**						

* The number of respondents varies due to missing values

- **Change in the Size of Glaciers**

A major portion (73.7%) of the respondents hold to this belief that the glaciers in their areas are retreating. The results show that significantly more respondents aged 41-50 (85.1 %, $p < 0.001$) have observed decline in the size of the glaciers while less respondents aged 21-30 (33.9 %, $p < 0.001$) have experienced the retreat in glaciers. On the other hand, significantly more respondents of the same age group 21-30 (66.1 %, $p < 0.001$) have observed the increase in the size of glaciers compared to elderly group 41-50 (14.9 %, $p < 0.001$). Significantly more respondents with No Education (77.5 %, $p < 0.05$) and FSc/A-Level (75 %, $p < 0.05$) have observed the decrease in the size of Glaciers. With respect to income groups, significantly more of the Low Income (78.2 %, $p < 0.01$) and Very Low Income (75.7 %, $p < 0.01$) groups have observed retreating in glaciers or the decrease in the size of the glacier while significantly more respondents from the High-Income group (64.3%, $p < 0.01$) have observed the increase in the size of glaciers.

More respondents from the upper reaches of the district Swat have observed the decrease in the size of Glaciers. These include Kalam (14.8%), Utror (7.7%), Bahrain (17.3%), Mankyal (9.2%) and Miandam (8.2%) among the total responses for the decrease in the size of glaciers. The results illustrated that the change in Glaciers' size is more obvious to the respondents belonging to the upper reach of the district. The upper reaches of the study area consisted of Glaciers or snow-covered mountains.

Around 72.7% of the respondents reported that they have observed changes in the size of glaciers since 6 to 10 years ago, while 23% of the respondents reported the change in the same indicator since 1 to 5 years ago which implicates that 96% of the respondents are observing the change in glaciers within 10 years' time frame, which is alarming than any other climate change indicators in the study area. Results of Chi-square test shows a strong correlation (Cramer's V = 0.315) among the age groups for the observed changes.

Table 4: Descriptive and Chi-Square statistics of the time interval of the changes in CC indicators observed by the respondents in the study area

Public observation of CC	Change	N[a]	Percent	Age Groups		Education		Income	
				Sig.	**Cramer's V**	**Sig.**	**Cramer's V**	**Sig.**	**Cramer's V**
Rainfall	1-5	137	13.5	.000	.313	.000	.146	.000	.182
	6-10	664	65.4						
	11-20	214	21.1						
	Total	**1015**	**100.0**						
Temperature	1-5	138	13.6	.000	.308	.000	.140	.000	.180
	6-10	658	64.9						
	11-20	218	21.5						
	Total	**1014**	**100.0**						
Snowfall	1-5	138	13.6	.000	.312	.000	.136	.000	.180
	6-10	653	64.5						
	11-20	221	21.8						
	Total	**1012**	**100.0**						
Size of Glaciers	1-5	47	23.0	.000	.315	.204	.181	.248	.159
	6-10	149	73.0						
	11-20	8	3.9						
	Total	**204**	**100.0**						
Summer Days	1-5	164	16.2	.000	.279	.000	.128	.000	.190
	6-10	621	61.5						
	11-20	225	22.3						
	Total	**1010**	**100.0**						
Winter Days	1-5	168	16.7	.000	.282	.000	.128	.000	.176
	6-10	614	60.9						
	11-20	226	22.4						
	Total	**1008**	**100.0**						

[a] The number of respondents vary due to missing values

- **Change in the number of Summer/warm Days**

The results indicated that a large portion (83.9%) of the respondents observed an overall increase in the length of the summer season. This implies that hotter days have increased than before.

Chi-square statistics shows a moderate to high significant relationship between the demographic variables and the change in the number of the warm days. More respondents aged 51 or above (94.8 %, $p < 0.001$) have observed the increase, while significantly less respondents aged 21 to 30 have observed the increase in the length of the summer season. The relationship between the age and the increase in summer days declines with the decrease in age groups. Significantly greater number of the respondents with Masters/Postgraduate (88.2 %, $p < 0.05$) education had observed the increase in the length of the summer followed by the respondents with No-Education (86.8%, $p < 0.05$) which implies that education has

low importance in observing the length of the summer. Significantly more respondents from the Middle-Income class (88.7 %, $p < 0.05$) and High-Income class (85.1 %, $p < 0.05$) have observed the increase in the number of the summer days.

The time span of observing the changes in climate system shows that the majority (61.5%) of the respondents are observing these changes since 6 to 10 years ago, with a strong Cramer's V association between the age (V = 0.279), education (V = 0.128) and income groups (V = 0.190).

- **Change in the number of winter/cold days**

The major portion (87.9%) of the respondents observed the decrease in the length of the winter. Chi-Square test indicates that significantly (Cramer's V = 0.282) greater number of the respondents from the higher aged groups have experienced changes in the winter days than the low aged groups. Comparatively more respondents aged 51 or above (94.3 %, $p < 0.01$) have observed the decline in the winter than the respondents aged 21 to 30 (87.0 %, $p < 0.01$). There is no significant (Cramer's V = 0.033; $p > 0.05$) relationship between the education groups. Significantly more respondents from High Income (95.1 %, $p < 0.001$) and Very High Income (92.5 %, $p < 0.001$) groups have observed the decrease in the winter days. The demographic variables show a moderate to strong Cramer's V association between the age (V = 0.282), education (V = 0.128) and income groups (V = 0.176) with respect to the time span of observing the changes in winter days.

The changes in the climate system are visible and almost all the respondents had a clear vision about these seasonal changes. Similar climate indicators have been reported by other studies (Akerlof K., et al., 2013; Howe P. D., et al., 2013) The above results depict that the perceptions and observations of the climate change is affected by the demographic variables such as age, education and income level of the respondents (Yu H., et al., 2013; Liu Z., et al., 2014; Haq S. M. A., et al., 2016). Older respondents are more concerned and more knowledgeable about the climate change than the younger people (Kabir M. I., et al., 2016) With respect to the education, either no or a little significant association was found between the climate indicators and the education levels which implies that education does not play a major role in observing the climate change. Varied responses in the income groups for the climate observations were found, but for most of the climate indicators, significantly large portion of the high income groups have observed changes compared to the other groups.

5. CONCLUSION AND RECOMMENDATIONS

Pakistan is one of the most vulnerable countries to the climate change in the world. It is experiencing the impacts of climate change in the form of climatic hazards. It is predicated that the frequency and intensity of these events will increase in the event of the climate change. The current study, being the first quantitative attempt in the region, intended to assess the public perceptions and knowledge of the causes, impacts and observation of changing climate in the district Swat. Although a unanimous agreement about the climate change was found in the study area, differing views about the causes and impacts of the climate change among the study were documented. The findings presented ample evidences to materialize this prerogative. It is concluded that the weather patterns and climate have changed during the last decades. The Increase in temperature, changes in the rainfall patterns, extreme weather events, changes in biodiversity and melting of ice caps are the main ways to recognize the changes in the climate. Deforestation and natural reasons are the major perceived causes of the climate change while a limited perception about greenhouse gases as the climate change agent was reported. The public observations of the climate parameters (increase in temperature, changes in the rainfall pattern, change in the number of summer/winter days etc.) are in empirical evidence with the climate change in the area.

Perceptions and understandings of the climate change are highly affected by the age, education and the income level of the respondents. Elderly people are more knowledgeable about the causes and the impacts of the climate change as they have been observing the climate system since a long time ago, while educated people tend to blame anthropogenic causes for the climate change compared to the others who opt for the natural causes. The demography of a study area is a major contributing factor to the understanding of the climate change beliefs of a community.

The understanding of the public perceptions about climate variability, and their attitude and beliefs towards the climate vulnerabilities can provide directions to the government for the formulation of the policies, regulation, guidelines and adaptation strategies. Education and capacity building are the most influential factor that could lead to the better understanding of CC and its impacts on the communities. The local adaptation strategies are much needed for tackling this big challenge of the climate change.

In addition to this community organization, support from the government organizations and research institutions are required to better cope with this issue. Further studies are required for the assessment of the local adaptation strategies, the capacity building and the support of the most vulnerable cases including women and the disabled people should be the priority.

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