Public Perception About Climate Change in Gilgit Baltistan (Pakistan)

Uzma Hanif[1] and Noman Arshed[2]

Abstract

Geospatial positioning of Gilgit-Baltistan exposed the land of the mighty Himalaya-Hindukush-Karakoram region to adverse impacts of climate change. Climate change is a "Global" issue that calls for "Glocal" action. Deficit and impaired public perceptions of climate change and its imposed risks and adverse impacts could herald climate change adaptation, mitigation, and resilience policies as well as practices at the local level. Climate Change can be evident over decades, and it is often challenging to perceive it in the short run by personal experiences. Adequate public perception and beliefs regarding climate change pave the way for efficient climate change actions. The study explored the role of demographic and socio-economic factors, i.e. age, gender, employment status, education level, and access to information and warning systems, in shaping climate change public perception in mountain communities of Gilgit Baltistan (GB). Survey data were collected using random stratified sampling across the GB overall 892 observations were collected. The Logistic regression analysis results reveal that access to warning systems through mobile phones, formal education, employment, adult people, and male respondents tend to have higher levels of climate change perception and beliefs. The study also found that most respondents have experienced an increase in temperature and a change in precipitation patterns, with increased hazardous incidences such as floods, avalanches, and landslides. The research findings recommend developing an integrated policy framework for local climate actions by strengthening education, disseminating warning systems, and promoting employment opportunities for inclusive climate change adaptation and mitigation practices in the GB.

Keywords: Climate Change, Public Perception, Gilgit Baltistan.

Introduction

Climate change is a long-run alteration in global and regional climate patterns. Unlikely daily weather fluctuations that people can directly experience, climate change can be evident over decades, and it is often challenging to perceive it in the short run by personal experience. Climate Change is a "public good". No region of the world stands immune to it. Climate change is a looming challenge to sustainable development worldwide, printing footprints on complex human-environmental systems. Climate change has raised serious concerns for developing countries, and Pakistan is not alone in facing its tremendous social, environmental, and economic impacts. An

[1]*Assistant Professor, Department of Economics, Forman Christian College University, Lahore, Pakistan.*
Email: uzmahanif@fccollege.edu.pk
[2]*Assistant Professor, Department of Economics, University of Education, Lahore, Pakistan.*
Email: noman.arshed@ue.edu.pk

Acknowledgement: The authors are grateful for the support of the International Centre for Integrated Mountain Development (ICIMOD). The underlying study is part of the ICIMOD-Funded Project.

enormous spatiotemporal variability has been found in Pakistan's log-run climate data, impacting all spheres of life.

Its varied topography and ecological landscape ranges from extremes of "0" to "8611" meters above sea level, containing deltas, river plains, mountains, deserts, oceans, and Pothohar Plato, making it vulnerable to climate change. According to the Global Climate Risk Index, Pakistan has been ranked as the fifth most vulnerable country to climate change (UN-Habitat, 2023). According to the Inform Global Risk Index 2019, Pakistan has the highest risk among South Asian countries (Arshed et al., 2023).

Due to its geospatial position, the Gilgit Baltistan (GB) region of Pakistan proved to be more vulnerable to the adverse impacts of climate change. The convergence of three mountain ranges in GB makes it one of the most mountainous regions in the world. The Karakoram Range, in particular, is home to some of the world's tallest peaks, including K2, the second-highest mountain. Conversely, the Himalayas are known for their vast glaciers and high-altitude plateaus, while steep slopes and deep valleys characterize the Hindu Kush range. Intra Gilgit-Baltistan's varied topography poses multifaceted challenges to life there, even without climate change. Climate change has altered the socio-economic development paths of the region.

The Gilgit Baltistan is the land of the union of mighty Himalayan-Hindukush-Karakoram ranges, home of 7,000 glaciers, host of the world's second highest peak, the gateway of Pakistan's water lifeline, home of distinct biodiversity and custodian of diverse sacred culture, is nagged by inescapable climate change. Glaciers' dynamics are the most sensitive indicators of climate change, and the recession rate of glaciers has also amplified in general. However, some high-elevation Karakoram glaciers are either stable or showing surging behavior. Such anomalous response of glaciers in the Karakoram Range to global warming is known as the Karakoram Anomaly. Spatio-temporal changes in rainfall and snowfall patterns have been reported from 1971 to 2018 in the region (Sohail et al., 2022).

Shabbir et al., (2023) identified 1089 central land sliding incidents (rock sliding, mud sliding, mud flows, debris flow) from 2003 through 2019, and 1072 people lost their lives because of land sliding incidents despite a massive loss of property and livestock. Further, permafrost melting ignites rock sliding and avalanches down to the cliffs, adversely affecting adjacent valley floors.

The GB and consequently the entire of Pakistan, is expected to face changes in its river flows due to rapidly receding glaciers (Chaudhry, 2017). Melting glaciers are giving birth to Glacial Lake Outburst Floods (GLOFs), threatening the life, property, biodiversity, and livelihood of marginal communities of the GB. The GB is the hotspot of HKH biodiversity, consisting of diverse species (some endangered species), gene pools, and ecosystems. Climate change is proving a nemesis for this rich biodiversity.

Climate Change is a "Global" issue that calls for "Glocal" actions, deficit, and impaired perception and belief of climate change and its impacts could herald climate change adaptation, mitigation, and resilience policies and practices at the local level (Gupta et al., 2007).

Empiricist philosophers advocate that perception springs from sensory experiences, i.e." seeing, hearing, and touching". This perception thus leads to "action". On the other hand, Rationalist philosophers empathize with the role of reason and innate ideas (knowledge) shaping humans' actions. The action theory reveals that belief systems, desires, and practical reasoning guide humans' activities. Aristotle shared the role of practical wisdom (Phronesis) in making desires and actions virtuous. Existential philosophy dug up the idea of radical freedom and responsibility resulting from freedom. Thus, perception and choices are intimately connected; humans are responsible for the actions that arise from freedom.

Aristotle's idea of "Teleology" and Plato's theory of "Forms" say that human beliefs about the "nature of reality" and "the purpose of things" influence their actions. According to Aristotle, virtues are closely related to belief systems. Existentialism defines human choices and activities originating from beliefs about existence, freedom, and authenticity. Rationalists believed in innate ideas, while empiricists argued that all knowledge stems from sensory experience. Therefore, thoughts are derived from reason or experience and influence how humans perceive and act.

Karl Marx's ideology suggests that social and economic conditions shape beliefs. Belief systems can function to maintain existing power structures and influence how humans perceive and act within a society. However, knowledge is different from perception. Socrates argued to Theaetetus that knowledge must be incorrigible and real (Grene, 1974).

The study is based on survey data collected from 892 GB citizens to evaluate their perceptions and beliefs about climate change. Therefore, the relevance of their personal experience with climate extremes and their perception has been captured and quantified. Additionally, the impact of demographic and socio-economic factors, e.g. age, gender, employment, and access to information and warning systems, have been examined to identify the climate change perception of climate-vulnerable mountain communities. The study would pave the path for policymakers to understand the factors that shape the actions of local communities to counter regional climate change impacts and devise policies to strengthen these factors for regional climate change policies.

Research Questions

The study addresses the questions: How do demographic and socio-economic factors, i.e. age, gender, employment status, education level, and access to information and warning systems, play their role in shaping climate change perceptions and beliefs in mountain communities of Gilgit Baltistan?

Research Objectives

The study is developed to unfold the complex system of climate change perceptions and beliefs of climate change vulnerable communities of Gilgit Baltistan to devise regional climate change policies to strengthen local climate change actions.

Literature Review

Most US and European households believe climate change is a natural phenomenon; it is happening, and the global community will have to bear its impacts in the coming years (Lorenzoni & Pidgeon, 2006; Nisbet & Myers, 2007).

Media depiction of climate change with explanations for climate change extreme events by disseminating scientific knowledge of the relevant circumstances with shreds of evidence (Asplund et al., 2013; Ranney et al., 2012). Influence humans' perceptions and beliefs towards climate change. People, worldwide, do not learn climate change dynamics from scientific research journals' lexicons but form different means of mass media (Allan et al., 2000). Pasquaré and Oppizzi (2012) pointed out that Italian people's climate change perception and beliefs are being affected by media coverage and the way hydrogeological hazards and extreme climate events from 2007-2010 are presented.

Emileva et al. (2023) probed the positive and significant influence of "smart-phone-based weather information acquisition" and farmers' perception of droughts by collecting farm farm-level cross-section data set of 2830 farmers from Kyrgyzstan, Mongolia, and Uzbekistan for 2021. Pondorfer (2019) investigated and compared the factors that affect public perception of climate change in the

small island societies of Bougainville and Palawan. Analysis of survey data shows that, among others, access to climate change information via mobile phones has remarkably increased the public perception of climate change in these small island coastal societies. Lee et al. (2015) found evidence from intensive survey data from 119 countries worldwide that perception is more significant for those with better access to information.

Discussing the PEW Centre research survey, Zainulbhai (2015) stated that in the U.S, Canada, Australia, the UK, South Korea, Germany, and Spain, women, in general, were found to have a higher perception of climate change extreme events than men, they consider climate change a serious challenge that needed to be tackled on a priority basis.

Sun and Han (2018) found that adult women in Taiwan have more propensity for climate change-imposed risk perception than adult men. The researchers used "The Taiwan Social Change Survey" data of 2013; by employing "Logistic Regression Analysis", they found correlations for individual factors, including gender, for measuring different dimensions of climate change perception. By having a higher level of climate change perception, women develop and carry out more climate change hazard preparedness measures relative to menfolk in the Philippines and Thailand's climate change hazard and disaster-prone regions (Hoffmann & Muttarak, 2017). Whereas, in the "Pra River basin of Ghana", male farmers are found to have more perception of agro-climate change vulnerabilities and hazards than female farmers, hence, practice climate change resilient strategies more efficiently (Bessah et al., 2021). Interestingly, survey data analysis of three different provinces of the Mekong Delta, Vietnam, revealed that climate change's perceived impacts on the agricultural sector are almost the same for males and females. The results also show that climate change stresses are governing on the "household level" instead of the "individual level" (McKinley et al., 2016).

Education enhances the capabilities of individuals and households to understand the scientific explanations of the risks imposed by climate change. Therefore, people with higher education levels tend to have a higher level of perception regarding climate change. The role of formal education in forming individuals' and households' perceptions and preparedness for climate change-induced hazards and disasters is channeled through direct as well as multiple mediation channels. Cvetković and Grbić (2021) found that education level was the most effective predictor of public perception of climate change-induced disasters among five demographic and socio-economic variables. Interview data were collected in 2020 from selected cities of "Serbia, Belgrade, and Sremska Mitrovica", applied Multivariate Regression analysis, and suggested strategies to improve knowledge and awareness of people for climate change policies focusing on behavioral aspects. Hoffmann and Muttarak (2017) came up with a detailed investigation of the role of education in determining paths and levels of climate change perception and disaster preparedness in the Philippines and Thailand. Overall, education improved the climate change-imposed risk perception and paved the way toward enhancing social capital and climate change disaster preparedness. The education also replaced climate change experience and disaster risk anticipation. Educated females tend to have higher perceptions, thus preparing more for climate change disasters.

Cerani et al. (2023) explored a significant relationship between education level and climate change perception as well as a small quantity of connection between education and sustainable behavior of the Montenegro citizens by analyzing the 2021 data of "The European Social Survey (ESS)". The level of formal education is positively and significantly associated with climate change perception for the western coastal zone of Malaysia, a highly vulnerable region to climate change (Ehsan et al., 2022). The survey data were collected using well-structured questionnaires. The

binomial and ordinal regression results show that education level is positively associated with a high level of public perception. Thus, high-risk perception led to significant planned adaptation measures by households.

It is widely believed that younger population groups have a high level of climate change impacts and risks perceptions, stronger beliefs about climate change, and are more concerned and engaged with climate change-related activities than older population groups. Due to the inconsistent application of outcome variables, there is mixed research evidence in the context of environment change-related perceptions, concerns, and beliefs for the "age" factor. Climate change-related experience increases with age; at the same time, another critical determinant, i.e. "education", replaces experience-based perception of climate change. The younger population was more concerned about climate change and its varied impacts, while older people were more "skeptical and suspicious" (Poortinga et al., 2011). Li et al. (2011) found that older people have a higher level of perception and stronger beliefs than younger people in the US and Australia.

Casey and Scott (2006) explored the idea that an increase in age is associated with high "ecocentrism" in Australia. Poortinga et al. (2023) used the data from three national-level surveys in the UK in 2020, 2021, and 2022 to explore the role of age in climate change perception, concerns, and beliefs. Their study revealed the existence of an overall pattern of higher levels of climate-related beliefs, risk perception, and emotions among younger generation groups.

Climate change impacts and risk perception are highly influenced by employment status; employed individuals have more propensity for climate change-related perception and preparedness than unemployed and retired individuals (Bodine, 2022). Employment status and education level were strongly associated with climate change vulnerability perception in selected cities of Serbia, Belgrade, and Sremska Mitrovica in 2020 (Cvetkovic & Grbic, 2021).

Brown (2015) analyzed the perceptions of climate change-related risks and attitudes of "Southeastern Louisiana" citizens, as the region is highly prone to impacts of climate change, by taking critical socio-economic and demographic attributes. In this context, the level of employment status and climate change perception revealed exciting results for the region. The employment variable of the study measured that 40.1% of respondents were full-time employed, 11% were employed part-time, and the remaining 48.8% were unemployed and retired. It is deduced from the analysis that full-time employed persons have a 51.5% chance of having concerns and perceptions about climate-related risks as compared to people who are partially unemployed and retired, with a 59.8% chance of having concerns and perceptions about climate change. Thus, unemployed and retired individuals perceive climate change-related risks more than employed individuals.

Data Collection and Methodology

Sample and Data Collection

Overall, 892 respondents from the adult population (above 18) have been accessed by applying stratified random sampling methodology from four districts of Gilgit Baltistan to ensure optimum presentation of each group of people based upon age, education, employment, gender, and access to mobile phones. The data on demographic and socio-economic factors, i.e. age, gender, access to warning systems via mobile phones, education level, and employment level, have been collected with a structured questionnaire. The data were collected in 2018, 2019, and then in 2023.

Data Construction

Table 1- shows the variables as; CH is the dependent variable to assess the respondents' perception of climate change, i.e. perceive and believe that climate change is happening. At the same time, other variables are used as independent variables.

Table 1 Variables and Definitions

Variable name (symbol)	Construction
Climate Change is Happening (CH) [Dependent Variable]	1 – Respondent has a perception about (perceive that climate change is happening) 0 – Respondent doesn't have the perception of climate change (perceive that climate change is not happening
Age (AGE)	Ordinal categories 1 if age below 18 2 if age between 18 and 30 3 if age between 30 and 40 4 if ages between 40 and 50 5 if the age is between 50 and 60 6 if the age is between 60 and 70 7 if the age is between 70 and 80 8 if the age is between 80 and 90 9 if the age is between 90 and 100
Gender (GEN)	1 - The respondent is male 0 – The respondent is female
Access to Warning System through Mobile Phones (EWM)	1 – The respondent has a mobile phone and has access to climate change warning systems 0 – The respondent does not have a mobile phone and, hence does not have access to climate change warning systems
Education (EDUC)	Number of years of schooling
Employment (EMP)	1 – Respondent is employed 0 – Respondent is unemployed
Perceived increase in floods (PEFLOOD)	1 – Respondent perceives that there has been an increase in floods in the last five or more years 0 – Respondent perceives that there has been no increase in floods in the last five or more years
Perceived change in rainfall patterns (PRRAIN)	1 – Respondent perceives that there has been a change in rainfall in the last five or more years 0 – Respondent perceives that there has been no change in rainfall in the last five or more years
Perceived change in snowfall patterns (PESNOW)	1 – Respondent perceives that there has been a change in snowfall in the last five or more years 0 – Respondent perceives that there has been no change in snowfall in the last five or more years
Perceived increase in rock falling (PEROCK)	1 – Respondent perceives that there has been an increase in rock falling in the last five or more years 0 – Respondent perceive that there has been no increase in rock falling in the last five or more years
Regional Dummies	5 Districts are covered (Ghanche, Hunza, Nagar, Shigar, and Skardu) since they all are interactive dummies, there is no need to make one as base.

Methodology

Following equation 1 is the parametrized version of the estimation model.

$$\begin{aligned}\llbracket CH \rrbracket\_i = \alpha\_0 + \alpha\_1\ \llbracket GEN \rrbracket\_i + \alpha\_2\ \llbracket EMP \rrbracket\_i + \alpha\_3\ \llbracket EWM \rrbracket\_i + \alpha\_4\ \llbracket EDUC \rrbracket\_i \\ + \alpha\_5\ \llbracket AGE \rrbracket\_i + \alpha\_6\ \llbracket PERAIN * Regional\ dummy \rrbracket\_i + \alpha\_7\ PEFLOOD \\ * Region\ Dummy\ + \alpha\_8\ PESNOW * Region\ Dummy\ + \alpha\_9\ PEFROCK \\ * Region\ Dummy + e\_i \ldots\ldots\ldots\ldots\ldots\ldots (1)\end{aligned}$$

Logistic regression is used in this study to predict the event which has only two categories. This model is used to predict the categorical dependent variable (CH in this study) and solves the binary classification problem. This model uses the log of odds of the event using the linear combination of the independent variables (Archer & Lemeshow, 2006; Hosmer Jr et al., 2013).

The estimation method is a logit model.

$$log\frac{P(y)}{1-P(y)} = \sum_{i=0}^{j} b_i x_i$$

Applying exponent on both sides

$$\frac{P(y)}{1-P(y)} = \exp(\sum_{i=0}^{j} b_i x_i)$$

$$\frac{P(y)}{1-P(y)} = \prod_{i=0}^{j} \exp(b_i x_i)$$

After inverting the equation, we get

$$P(y) = \frac{\exp z}{1+\exp z}$$

Where z is,

$$z = \sum_{i=0}^{j} b_j x_j$$

Here y is CH: perception and belief that climate change is happening, is the binomial dependent variable, and x matrix is a set of independent variables in equation 1 to form logistic regression to estimate the binomial dependent variable. Equation 1 will be used in the logistic regression to estimate the slope coefficients in the case of the binomial dependent variable. The estimates are validated using several post-regression diagnostics. A study by Arshed et al. (2017) used this model to estimate binomial dependent variables, the post-regression diagnostics are discussed by (Arshed, 2023).

Results and Analysis

Table 2 provides the descriptive statistics of the variables across the regions. Here, we can see that for all regions, a major proportion of respondents have climate change perception: believing that climate change is happening, and are marked in the 'CH' variable mean value. The lowest incidence is in Shigar where 81.7% of the respondents have considered that climate change is happening with the highest standard deviation, while the highest incidence is in the Skardu. 'EWM' shows access of households to warning systems via mobile phones, Ghanche district has the lowest incidence of access while it also has the highest dispersion in incidence of access to warning systems. 'EDUC' represents the number of years of formal education, Hunza has the highest incidence of education, while Skardu has the highest dispersion.

'EMP shows the employment level. Skardu has shown the lowest level of employment across districts, while Nagar has the highest dispersion. The perception of rainfall, floods, snowfall, and rock falling has been included in the study as perceived indicators of climate change. For the case of rain spatiotemporal variation perception in the last five years; 'PERAIN' in Skardu has the highest incidence. For the case of flood spatiotemporal variation perception in the last five years, 'PEFLOOD' in Hunza has the highest incidence. The case of snowfall, spatiotemporal variation perception in the last five years or more, 'PESNOW' in Hunza has the highest incidence. For the case of land/rock sliding spatiotemporal variation perception in the last five or more years, the case of 'PEROCK' in Hunza has the highest incidence.

Table 2 – Descriptive Statistics Region: Ghanche

	N	Mean	SD	Min	Max
CH	124	0.863	0.345	0	1
AGE	124	1.589	1.403	0	6
GEN	124	0.742	0.439	0	1
EWM	124	0.637	0.483	0	1
EDUC	124	10.347	5.972	0	18
EMP	122	0.623	0.487	0	1
PERAIN	124	0.935	0.247	0	1
PEFLOOD	124	0.734	0.444	0	1
PESNOW	124	0.734	0.444	0	1
PEROCK	124	0.694	0.463	0	1
Hunza					
CH	185	0.886	0.318	0	1
AGE	184	1.212	1.505	0	7
GEN	185	0.697	0.461	0	1
EWM	185	0.881	0.325	0	1
EDUC	184	11.799	4.198	0	18
EMP	182	0.637	0.482	0	1
PERAIN	185	0.946	0.227	0	1
PEFLOOD	183	0.847	0.361	0	1
PESNOW	185	0.946	0.227	0	1
PEROCK	185	0.778	0.416	0	1
Nagar					
CH	119	0.866	0.343	0	1
AGE	119	1.05	1.431	0	5
GEN	119	0.714	0.454	0	1
EWM	119	0.866	0.343	0	1
EDUC	119	9.723	5.513	0	16
EMP	119	0.496	0.502	0	1
PERAIN	119	0.916	0.279	0	1
PEFLOOD	119	0.706	0.458	0	1
PESNOW	119	0.941	0.236	0	1
PEROCK	119	0.672	0.471	0	1

Shigar					
CH	278	0.817	0.388	0	1
AGE	273	1.758	1.512	0	7
GEN	277	0.83	0.376	0	1
EWM	278	0.802	0.399	0	1
EDUC	278	6.126	5.662	0	18
EMP	278	0.529	0.500	0	1
PERAIN	278	0.939	0.240	0	1
PEFLOOD	278	0.683	0.466	0	1
PESNOW	278	0.849	0.359	0	1
PEROCK	278	0.597	0.491	0	1
Skardu					
CH	186	0.898	0.304	0	1
AGE	186	1.925	1.523	0	6
GEN	186	0.704	0.458	0	1
EWM	185	0.692	0.463	0	1
EDUC	186	6.177	6.077	0	18
EMP	186	0.425	0.496	0	1
PERAIN	186	0.962	0.191	0	1
PEFLOOD	186	0.747	0.436	0	1
PESNOW	186	0.882	0.324	0	1
PEROCK	186	0.677	0.469	0	1

Table 3 provides the association of nominal variable with different types of independent variables using Pearson chi^2. Here other than age all variables have shown significant association with the dependent variable.

Table 3 Associations of Independent variables with CH

Variable	Pearson Chi^2	Prob.
AGE	8.6638	0.278
GEN	31.0746	0.000***
EMP	29.5199	0.000***
EWM	17.1729	0.000***
EDUC	39.9288	0.001***
REGION	27.6144	0.000***
PEFLOOD	10.8307	0.001***
PESNOW	9.0557	0.003***
PEROCK	5.4112	0.020**

*** Significant at 1%, and ** 5%

Table 4 provides the logistic regression estimates for equation 1 with odd ratios as slope coefficients. The estimates are based on 892 observations. With a significant Likelihood Ratio (LR) test, the overall model is fit. The model has enabled us to explain 16.9%, 23%, and 38.3% variation in odds of climate change perception according to Pseudo R^2, (Cragg & Uhler, 1970) R^2

and (McKelvey & Zavoina, 1975) R^2 respectively. The model can also predict the dependent variable by 87% correctly.

The estimates of access to warning systems via mobile phones show that if there is access, the odds of perceiving climate change are increasing by 0.579 times. As discussed, it shows its potential benefit in the climate change vulnerable regions (Kelman & Glantz, 2014). Almost 92% of the residents of Gilgit Baltistan have at least one cell phone in their household (Pamir Times, 2017). The National and Gilgit Baltistan Disaster Management Authorities disseminate warnings for climate change risks through mobile phone messages. Possession of cell phones strengthens access to climate change warning systems, hence improving public perception of climate change.

From the estimates of education, it can be seen that if there is a one-year increase in formal education, the odds of perceiving that climate change are happening increase by 0.052 times. The literacy rate is remarkably high across Gilgit Baltistan, Hunza in particular (Hisam, 2020). The results are similar to (Blankespoor et al., 2010; Feinstein & Mach, 2020; Wamsler et al., 2012).

From the estimates of employment, it can be seen that being employed increases the odds of perceiving that climate change is happening increases by 0.929 times. The findings are compatible with the findings of (Brown, 2015; Cvetkovic & Grbic, 2021).

For the case of age, one category shift in the age of the respondent increases the odds of perceiving that climate change is happening increases by 0.472 times. Age increases climate change understanding and perception through direct and indirect experience. The outcome of the age and public perception of the current study is accordant with Zaval (2011) and Casey and Scott (2006).

For the case of gender, male respondents have odds of perceiving that climate change is happening 3.075 times higher than female respondents. Gender and public perception have mixed results, however, the outcome of the study that male respondents tend to have a higher perception than females are compatible with the findings of (Bessah et al., 2021).

The cross-product of age and gender is negative and significant, showing that the odds of perceiving that climate change is happening are lower for elderly males than elderly females.

While comparing the perceived changes in different climate change events in different districts of Gilgit Baltistan. It is noted that for the case of PEFLOOD, its higher perception has increased the odds of perceiving climate change happening in Nager as compared to other districts. For the case of PESNOW, its higher perception has increased the odds of perceiving that climate change is happening in the case of Nagar as compared to other districts. For the case of PERAIN, its higher perception has increased the odds of perceiving that climate change is happening in the case of Ghanche, Hunza, Shughar, and Skardu as compared to Nagar. For the case of PEROCK, its higher perception has increased the odds of perceiving that climate change is happening in the case of Ghanche, Hunza, and Skardu as compared to Nagar and Shigar.

Table 4 - Logistic regression

CH (Dep. Var.)	Odd ratio	St. Err.	t-value	p-value	[95% Conf	Interval]	Sig
AGE	1.4726	0.0789	7.22	0.000	1.325	1.635	***
GEN	4.0755	1.2631	4.53	0.000	2.220	7.482	***
AGE*GEN	0.7354	0.0708	-3.19	0.001	0.629	0.888	***
EMP	1.9298	0.3841	3.30	0.001	1.306	2.850	***
EDUC	1.0520	0.0311	1.71	0.087	0.992	1.115	*
EWM	1.5795	0.2903	2.49	0.013	1.106	2.264	**
PEFLOOD* Ghanche	0.0798	0.0410	-4.91	0.000	0.029	0.218	***

PEFLOOD * Hunza	0.2222	0.0858	-3.89	0.000	0.104	0.473	***
PEFLOOD * Nagar	1.334	0.0993	3.87	0.000	1.153	1.544	***
PEFLOOD * Shigar	0.6097	0.0793	-3.80	0.000	0.472	0.787	***
PEFLOOD * Skardu	0.0325	0.0155	-7.19	0.000	0.012	0.082	***
PESNOW * Ghanche	0.2856	0.0821	-4.36	0.00	0.162	0.501	***
PESNOW * Hunza	0.1454	0.1242	-2.26	0.024	0.027	0.775	**
PESNOW * Nagar	1.7558	0.4712	2.10	0.036	1.037	2.971	**
PESNOW * Shigar	0.3037	0.1445	-2.52	0.012	0.132	0.776	**
PESNOW * Skardu	0.2346	0.1376	-2.47	0.013	0.074	0.740	**
PERAIN * Ghanche	2.6778	1.5558	1.80	0.090	0.857	8.362	*
PERAIN * Hunza	4.2557	0.7996	7.71	0.000	2.944	6.151	***
PERAIN * Nagar	0.1185	0.1155	-2.19	0.028	0.017	0.801	**
PERAIN * Shigar	1.0216	0.7178	0.03	0.976	0.257	4.049	
PERAIN * Skardu	35.2624	9.3543	13.43	0.000	20.965	59.308	***
PEROCK * Ghanche	1.7419	0.1393	6.94	0.000	1.489	2.037	***
PEROCK * Hunza	1.2324	0.0958	2.69	0.007	1.058	1.435	***
PEROCK * Nagar	0.6491	0.0513	-5.46	0.000	0.555	0.758	***
PEROCK * Shigar	0.3694	0.0509	-7.20	0.000	0.281	0.484	***
PEROCK * Skardu	1.1701	0.1011	1.82	0.069	0.987	1.386	*
Constant	3.7479	5.3858	0.92	0.359	0.224	62.660	

Pseudo r-squared	0.169	Several obs.	892
McKelvey & Zavoina's R2	0.383	Cragg & Uhler's R2	0.230
Chi-square	598.19	Prob > chi2	0.8912
LR	120.53	Prob > LR	0.000
Akaike crit. (AIC)	0.732	Bayesian crit. (BIC)	-5357.79

*** $p<.01$, ** $p<.05$, * $p<.1$

The link test showed that the squared estimated dependent variable is insignificant, confirming no misspecification in the model. The Variance Inflation Factor (VIF) statistics confirmed that there is no collinearity among the variables.

Figure 1 Logistic Regression Diagnostics

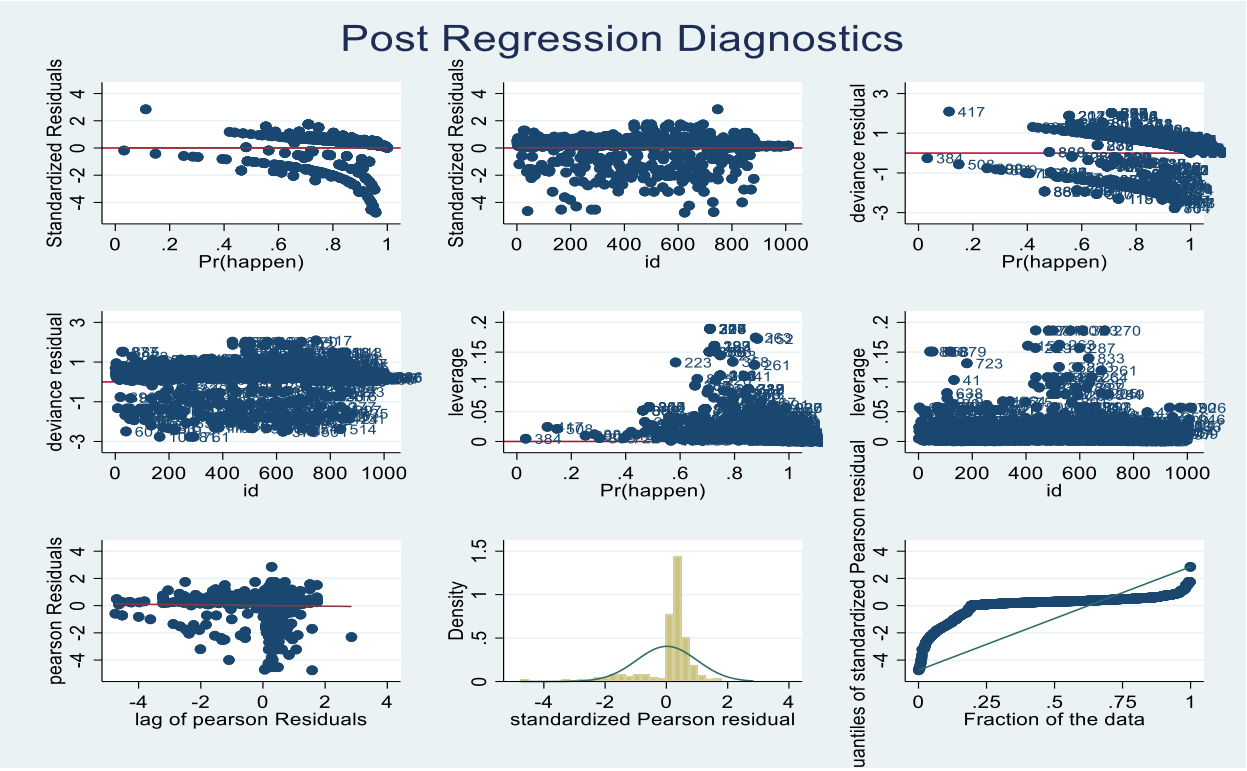

Figure 1 provides seven plots generated from residuals and estimated dependent variables to assess the model's validity. The first four plots compare two types of residuals with the estimated dependent variable and the number of observations. Since we do not observe patterns in it, it can be concluded that there is no heteroskedasticity in the data. Plots 5 and 6 plot the leverage value; since the highest value is near 0.3, this denotes less likelihood of outliers disturbing the model coefficients. Plot 7 compares residuals with observation-lagged residuals; since there are no apparent associations, it rules out the chances of autocorrelation. The last two plots present the histogram of residuals. It denotes slightly negatively skewed data. Since the sample size is above 30, it can be assumed that the data is asymptotically normally distributed.

Conclusion and Policy Implications

The perception and beliefs of Gilgit-Baltistan citizens regarding climate change pave practical actions. Climate change is a long-term phenomenon; it is challenging for individuals to perceive it quickly, hence taking climate change actions. Certain factors constitute and may affect people's perceptions and beliefs of climate change in vulnerable areas. It is an acclaimed fact that if people perceive climate change. They will adopt policies to alter their living and livelihood practices to adapt to climate change accordingly. The study explored the factors that determine the paths of climate change public perceptions and beliefs in Pakistan's climate change-prone region, i.e., Gilgit-Baltistan. This region is also important in terms of the high scale of downstream water dependency, about nine countries have acknowledged the glaciers' flows from this region as their major water source (Arshed et al., 2023).

Logistic regression analysis on the likelihood of public perception reveals that access to information via mobile phones increased the public perception and belief of climate change. The results from the sample of 892 respondents of the GB showed that education, employment, and access to mobile phones are significant indicators explaining the perceptions about climate change. The perceptually acknowledging climate change is 0.579 times compared to not having access to mobile phones. A vast majority of the GB population possess smart cell phones. The National and Gilgit-Baltistan Disaster Management Authorities disseminate climate change-related warnings through cellular phone companies. Therefore, it has found as an effective way to climate change warnings. Thus, public perception through climate change communication.

Education is considered a key to positive "change" and holds for improving climate change public perception and belief; even education can replace the experience-based perception of climate change. The attainment of formal education increases the perception of climate change by 0.052 times. Formal education has been measured on a scale of 5 to 16 years or more. The literacy rate is remarkably high in Gilgit Baltistan, thus leading the way for climate change public perception. Age increases the understanding and experience of climate change-related information and the occurrence of climate extremes, which is relatively high in GB. Age increases the perception of climate change in GB by 0.472 times. Older people tend to have more experience with local climate change dynamics. Employment status has the highest impact on the perception of climate change; employed persons have a higher level of, i.e. 0.929 times more than unemployed people of GB. In the case of gender, male respondents are found to be more cautious about climate change than female folks. Men have 3.075 times higher than females in this area.

Social implications of the study include that local knowledge-based perceptions on climate change and its impacts on social, ecological, and economic sectors could help scientists, practitioners, and policymakers to understand local ground realities and respond accordingly through effective planning and implementing adaptive measures, including policy formulation. The research findings recommend developing an integrated policy framework for practical local climate actions by strengthening education, disseminating warning systems, and creating employment opportunities in Gilgit Baltistan to minimize climate change risks and vulnerabilities.

References

- Allan, S., Adam, B., & Carter, C. (2000). *Environmental Risks and the Media*. Psychology Press.
- Archer, K. J., & Lemeshow, S. (2006). Goodness-of-fit Test for a Logistic Regression Model Fitted using Survey Sample Data. *The Stata Journal: Promoting Communications on Statistics and Stata*, *6*(1). https://journals.sagepub.com/doi/abs/10.1177/1536867X0600600106
- Arshed, N. (Director). (2023, October 25). *Estimate Logistic Regression Model | Performing Post Regression Diagnostics*. https://www.youtube.com/watch?v=XGsLvJ0b29g
- Arshed, N., Alamgir, S., & Aziz, O. (2017). Structural Determinants of Poverty in Pakistan. *International Journal of Economics and Financial Research*, *3*(1), 1–7.
- Arshed, N., Saeed, M. I., Salem, S., Hanif, U., & Abbas, M. (2023). National strategy for climate change adaptability: A case study of extreme climate-vulnerable countries. *Environment, Development and Sustainability*. https://doi.org/10.1007/s10668-023-04122-y
- Asplund, T., Hjerpe, M., & Wibeck, V. (2013). Framings and coverage of climate change in Swedish specialized farming magazines. *Climatic Change*, *117*(1), 197–209. https://doi.org/10.1007/s10584-012-0535-0

- Bessah, E., Raji, A. O., Taiwo, O. J., Agodzo, S. K., Ololade, O. O., Strapasson, A., & Donkor, E. (2021). Gender-based variations in the perception of climate change impact, vulnerability and adaptation strategies in the Pra River Basin of Ghana. *International Journal of Climate Change Strategies and Management*, *13*(4/5), 435–462. https://doi.org/10.1108/IJCCSM-02-2020-0018
- Blankespoor, B., Dasgupta, S., Laplante, B., & Wheeler, D. (2010). The Economics of Adaptation to Extreme Weather Events in Developing Countries. *Center for Global Development Working Paper*. https://doi.org/10.2139/ssrn.1542720
- Bodine, F. (2022). GeoPoll Report Supplement: The Impact of Education and Employment on Climate Change Perceptions in the Caribbean. *GeoPoll*. https://www.geopoll.com/blog/education-employment-climate-change/
- Brown, H. (2015). *An Analysis of Risk Perceptions and Attitudes towards Climate Change among Residents of Southeastern Louisiana* [Master of Science, Louisiana State University and Agricultural and Mechanical College]. https://doi.org/10.31390/gradschool_theses.2962
- Casey, P. J., & Scott, K. (2006). Environmental concern and behaviour in an Australian sample within an ecocentric – anthropocentric framework. *Australian Journal of Psychology*, *58*(2), 57–67. https://doi.org/10.1080/00049530600730419
- Ćeranić, G., Krivokapić, N., Šarović, R., & Živković, P. (2023). Perception of Climate Change and Assessment of the Importance of Sustainable Behavior for Their Mitigation: The Example of Montenegro. *Sustainability*, *15*(13), Article 13. https://doi.org/10.3390/su151310165
- Chaudhry, Q. U. Z. (2017). *Climate Change Profile of Pakistan* (Pakistan). Asian Development Bank. https://www.adb.org/publications/climate-change-profile-pakistan
- Cragg, J. G., & Uhler, R. S. (1970). The Demand for Automobiles. *The Canadian Journal of Economics / Revue Canadienne d'Economique*, *3*(3), 386–406. https://doi.org/10.2307/133656
- Cvetkovic, V., & Grbic, L. (2021). Public perception of climate change and its impact on natural disasters. *Journal of the Geographical Institute Jovan Cvijic, SASA*, *71*(1), 43–58. https://doi.org/10.2298/IJGI2101043C
- Ehsan, S., Begum, R. A., Abdul Maulud, K. N., & Mia, M. S. (2022). Assessing household perception, autonomous adaptation and economic value of adaptation benefits: Evidence from West Coast of Peninsular Malaysia. *Advances in Climate Change Research*, *13*(5), 738–758. https://doi.org/10.1016/j.accre.2022.06.002
- Emileva, B., Kuhn, L., Bobojonov, I., & Glauben, T. (2023). The role of smartphone-based weather information acquisition on climate change perception accuracy: Cross-country evidence from Kyrgyzstan, Mongolia and Uzbekistan. *Climate Risk Management*, *41*, 100537. https://doi.org/10.1016/j.crm.2023.100537
- Feinstein, N. W., & Mach, K. J. (2020). Three roles for education in climate change adaptation. *Climate Policy*, *20*(3), 317–322. https://doi.org/10.1080/14693062.2019.1701975
- Grene, M. (1974). Three Aspects of Perception. In M. Grene (Ed.), *The Understanding of Nature: Essays in the Philosophy of Biology* (pp. 13–34). Springer Netherlands. https://doi.org/10.1007/978-94-010-2224-8_2
- Gupta, J., Van Der Leeuw, K., & De Moel, H. (2007). Climate change: A 'glocal' problem requiring 'glocal' action. *Environmental Sciences*, *4*(3), 139–148. https://doi.org/10.1080/15693430701742677
- Hisam, Z. (2020, November 9). *Two sides of Hunza Valley*. DAWN.COM. https://www.dawn.com/news/1589391

- Hoffmann, R., & Muttarak, R. (2017). Learn from the Past, Prepare for the Future: Impacts of Education and Experience on Disaster Preparedness in the Philippines and Thailand. *World Development*, *96*, 32–51. https://doi.org/10.1016/j.worlddev.2017.02.016
- Hosmer Jr, D. W., Lemeshow, S., & Sturdivant, R. X. (2013). *Applied Logistic Regression*. John Wiley & Sons.
- Kelman, I., & Glantz, M. H. (2014). Early Warning Systems Defined. In A. Singh & Z. Zommers (Eds.), *Reducing Disaster: Early Warning Systems For Climate Change* (pp. 89–108). Springer Netherlands. https://doi.org/10.1007/978-94-017-8598-3_5
- Lee, T. M., Markowitz, E. M., Howe, P. D., Ko, C.-Y., & Leiserowitz, A. A. (2015). Predictors of public climate change awareness and risk perception around the world. *Nature Climate Change*, *5*(11), 1014–1020. https://doi.org/10.1038/nclimate2728
- Li, Y., Johnson, E. J., & Zaval, L. (2011). Local warming: Daily temperature change influences belief in global warming. *Psychological Science*, *22*(4), 454–459. https://doi.org/10.1177/0956797611400913
- Lorenzoni, I., & Pidgeon, N. F. (2006). Public Views on Climate Change: European and USA Perspectives. *Climatic Change*, *77*(1), 73–95. https://doi.org/10.1007/s10584-006-9072-z
- McKelvey, R. D., & Zavoina, W. (1975). A statistical model for the analysis of ordinal level dependent variables. *The Journal of Mathematical Sociology*, *4*(1), 103–120. https://doi.org/10.1080/0022250X.1975.9989847
- McKinley, J., Adaro, C., Pede, V., Setiyono, T., Thang, T. C., Huong, D. L., Kien, N. T., Quicho, E., Sheinkman, M., & Wassmann, R. (2016). *Gender differences in climate change perception and adaptation strategies: A case study on three provinces in Veitnam's Mekong River Delta* (CCAFS Info note). Climate Change, Agriculture and Food Security. https://cgspace.cgiar.org/bitstream/handle/10568/76928/CCAFS%20Info%20Note_PIRCCA.pdf
- Nisbet, M. C., & Myers, T. (2007). The Polls—Trends: Twenty Years of Public Opinion about Global Warming. *Public Opinion Quarterly*, *71*(3), 444–470. https://doi.org/10.1093/poq/nfm031
- Pamir Times. (2017, July 28). Survey: 92% respondents in Gilgit-Baltistan report presence of at least one cellphone in their house. *Pamir Times*. https://pamirtimes.net/2017/07/28/survey-92-respondents-in-gilgit-baltistan-report-presence-of-at-least-one-cellphone-in-their-house/
- Pasquaré, F. A., & Oppizzi, P. (2012). How do the media affect public perception of climate change and geohazards? An Italian case studies. *Global and Planetary Change*, *90–91*, 152–157. https://doi.org/10.1016/j.gloplacha.2011.05.010
- Pondorfer, A. (2019). The perception of climate change: Comparative evidence from the small-island societies of Bougainville and Palawan. *Environmental Development*, *30*, 21–34. https://doi.org/10.1016/j.envdev.2019.04.002
- Poortinga, W., Demski, C., & Steentjes, K. (2023). Generational differences in climate-related beliefs, risk perceptions and emotions in the UK. *Communications Earth & Environment*, *4*(1), Article 1. https://doi.org/10.1038/s43247-023-00870-x
- Poortinga, W., Spence, A., Whitmarsh, L., Capstick, S., & Pidgeon, N. F. (2011). Uncertain climate: An investigation into public skepticism about anthropogenic climate change. *Global Environmental Change*, *21*(3), 1015–1024. https://doi.org/10.1016/j.gloenvcha.2011.03.001
- Ranney, M. A., Clark, D., Reinholz, D. L., & Cohen, S. (2012). *Changing Global Warming Beliefs with Scientific Information: Knowledge, Attitudes, and RTMD (Reinforced Theistic Manifest Destiny Theory)*. *34*, 2228–2233.

- Shabbir, W., Omer, T., & Pilz, J. (2023). The impact of environmental change on landslides, fatal landslides, and their triggers in Pakistan (2003–2019). *Environmental Science and Pollution Research*, *30*(12), 33819–33832. https://doi.org/10.1007/s11356-022-24291-z
- Sohail, M. T., Mustafa, S., Ali, M. M., & Riaz, S. (2022). Agricultural Communities' Risk Assessment and the Effects of Climate Change: A Pathway Toward Green Productivity and Sustainable Development. *Frontiers in Environmental Science*, *10*. https://doi.org/10.3389/fenvs.2022.948016
- Sun, Y., & Han, Z. (2018). Climate Change Risk Perception in Taiwan: Correlation with Individual and Societal Factors. *International Journal of Environmental Research and Public Health*, *15*(1), Article 1. https://doi.org/10.3390/ijerph15010091
- *UN-Habitat Pakistan Country Report 2023*, (2023). UN-Habitat. United Nations Human Settlements Program. https://unhabitat.org/sites/default/files/2023/06/4._pakistan_country_report_2023_b5_final_compressed.pdf
- Wamsler, C., Brink, E., & Rentala, O. (2012). Climate Change, Adaptation, and Formal Education: The Role of Schooling for Increasing Societies' Adaptive Capacities in El Salvador and Brazil. *Ecology and Society*, *17*(2). https://www.jstor.org/stable/26269029
- Zainulbhai, H. (2015, December 2). *Women, more than men, say climate change will harm them personally*. Pew Research Center. https://www.pewresearch.org/short-reads/2015/12/02/women-more-than-men-say-climate-change-will-harm-them-personally/