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PAKISTAN IN THE ERA OF CLIMATE CHANGE: IMPACTS AND ADAPTATION PATHWAYS

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Abstract

Purpose:

The paper explores community level awareness, perceived effects, adaptation behavior, obstacles, and desirable approaches to climate change in Pakistan, one of the highly susceptible countries to climate variability.

Design/methodology/approach:

A quantitative research design was adopted with a structured questionnaire being conducted on 380 respondents in seven regions of Pakistan. The survey was used to collect demographic profiles, awareness, and adaptation practices, and perceived challenges. The analysis of the data was conducted using descriptive statistics, such as frequencies, percentages, means, and standard deviations, to help gain the evidence-based picture of the climate change dynamics.

Findings:

Findings show that there is a lot of awareness regarding the issue of climate change, and those who take part are more than aware of the adverse impacts of climate change on agriculture, water, and livelihood. However, adaptation practices remain inconsistent, with water conservation relatively more common compared to disaster preparedness and resilient farming. Among the most crucial challenges are the shortage of financial resources, low level of governmental support, and technical inaccessibility. Public awareness campaigns, government investment in infrastructure, and nature-based solutions were all of high preference by the respondents as priority adaptation strategies.

Originality/value:

The research provides one of the best community-level evaluation of Pakistani climate change adaptation. Connecting awareness, practices, barriers, and strategies, the findings offer action-able information to policymakers, development organizations, and researchers in the area of climate resilience and sustainable development.

INTRODUCTION

Since climate change is one of the biggest issues of the twenty-first century, it is affecting the environmental, social, and economic environments of countries worldwide. Its extensive effects cross borders of all geographical locations, impacting both the developed and developing nations, the extent of which varies considerably, as well as the ability to react to it (Hussain et al., 2022). The phenomenon poses especially threatening conditions to developing countries such as Pakistan due to the geographical weaknesses of the country, socio-economic status and the low adaptive capacities (Khan et al., 2016). Being a country with a wide variety of biological environments, such as both glaciers in the north and arid deserts in the south, Pakistan is at the forefront of climate change (Mustafa et al., 2021). Environmental frailty and large reliance on climate-related industries like agriculture and water resources make it particularly vulnerable to the shifting climate (Baloch et al., 2025). The effects of climate change on Pakistan and adaptation avenues have thus emerged as not only a scientific need, but also a national survival and development issue.

Pakistan is one of the nations that are highly vulnerable to climate change, even though it has produced dropper contributions towards global greenhouse gas emissions. It has emissions less than one per cent of the world output but the consequences of such emissions on the population are immense (Iqbal, 2020). The increase in the average temperatures, change in the rainfall distribution, high speed of melting glaciers, frequent floods, recurrent droughts, and rising heat waves are transforming the lives and livelihoods of millions of people. Recent disastrous floods have brought to light the susceptibility of people, infrastructure and economies to disasters caused by climate (Yasin et al., 2021). Concurrently, the changes in the seasonal weather patterns are posing threats to agriculture, the back bone of Pakistan economy, which absorbs a good percentage of the population and is highly reliant on standard conditions of weather (Syed et al., 2022). Even in the country in which ensuring food security has already become a problem, climate change can only increase vulnerabilities and expand the already existing inequalities.

Another dimension of climate change that is critical to Pakistan is water scarcity. The rivers and irrigation systems in the country are becoming more unstable in the changing climatic conditions and they rely on the melting of the glaciers as well as monsoon rains (Museera & Khan, 2023). The glaciers in the north commonly known as the water towers of South Asia are melting at an alarmed rate posing a two-fold danger of sudden deadly glacial lake outburst flooding in the near-term and water shortage in the long-term (Abid et al., 2016). Concurrently, the rain is becoming unpredictable and therefore we experience both floods and droughts in short durations of time (Rehman et al., 2018). Such variations cause major problems with the management of water resources, which is already exposed to stress related to population growth, urbanization, and mismanagement (Batool & Saaed, 2017). As agricultural productivity in Pakistan depends greatly on water, the consequences of the food production, rural livelihoods and stability of the nation are critical.

The climate change in Pakistan has social and health consequences in addition to environmental and economic consequences. Internal migration pressures stemming out of communal displacement due to floods and droughts leads to unplanned urbanization and inadequate infrastructure in the urban regions in most instances (Adnan et al., 2024). The heat waves are directly hazardous to human health and especially in urban areas where limited space is with dense population and increasing

temperatures impact the human health situation. Diseases that are climate sensitive like malaria, dengue are also on the increase as the weather changes (Dars et al., 2021). The disadvantaged groups, such as women, children, and the poor, have disproportionate risks because they have weak access to the resources and decision-making forums (Qureshi et al., 2024). Consequently, climate change does not only pose a threat to the physical environments but also increases social inequalities which makes it an environmental and human rights problem.

Pakistan has realized that adaptation and resilience-building are critical measures in addressing the issue of climate change. Various adaptations measures have been launched by national and provincial governments, civil society organizations and international associates (Usman et al., 2023). Among these efforts are efforts to be made to enhance the management of water, climate-resilient agriculture, enhanced disaster preparedness, and safeguarded vulnerable ecosystems. The planting of billions of trees, the use of improved early warning systems and integration of climate-related problems into the development policies are some of such adaptation initiatives (Din and Bibi, 2025). The scale of the challenges, though, is often much greater compared to the available resources and institutional ability. Most of these initiatives fail because of financial limitations and lack of governance and technological limitations that expose a community to recurring catastrophes (Amin & Kazmi, 2024).

Adaptation is not just a matter of responding to consequences of climate change, but also of adjustment of systems and practice to achieve future resiliency. This requires a holistic approach that includes science, local practices and involvement of communities in Pakistan. One such area is that farmers must be able to access information about evolving weather conditions, and help in adapting climate-smart technologies (Fauz et al., 2025). The cities must have climate sensitive planning that includes not only the investment in the sustainable infrastructures but also the improved civic amenities (Mian et al., 2024). The resilience enhancement solutions may be economical, and they are ecosystem-based, such as wetland restoration or forest protection. Notably, the strategies in adaptation should be inclusive and the marginal groups should not be left out in the decisions and the gain of climate policies (Ahmad et al., 2023).

The resilience of the climate in Pakistan is also related to international cooperation. The situation in Pakistan highlights the importance of climate justice across the globe since the country is a low-emission high-vulnerability nation (Afshar & Shah, 2025). The country needs access to climate finance, transfer of technologies, and capacity building in order to be able to take effective adaptation measures. International bodies like the Paris Agreement give Pakistan a chance to present its needs and cooperate with other countries that also struggle with the same issues (Muzamil et al., 2024). Nevertheless, the international commitments made tangible on the ground is still a continuous challenge and this shows the difference between the promises and the realities in global climate regime.

There is no use overemphasizing the urgency of dealing with climate change in Pakistan. The future development of the country, its security, and stability are inextricably linked with the capacity to respond to the changes in the environmental conditions (Jamali et al., 2024). Unless it is acted upon, the effects of climate change have the potential to reverse the achieved achievements in poverty alleviation, education, health, and economic development. Simultaneously, climate change is also an opportunity to become innovative, work together, and change (Masood et al., 2023).

Pakistan can take the way to more resilient and sustainable future by investing in renewable energy, sustainable agriculture, and green infrastructure. The possibility of developing green jobs, enhancing resource management, and community resiliency gives an opportunity to believe that the problem of climate may be transformed into sustainable development opportunities (Babur et al., 2016).

This research work will examine the impacts of climate change in Pakistan and the possible methods of adapting that would enable it to address its weaknesses. With the insights of the communities, the role of the institutions and the barriers to the adapting process, this study seeks to shedding light on the challenge of the scale of the challenges and the strength of person and system to cope with the challenges. Evidence-based policy, resource mobilization, and development of cooperation between local, national, and international levels depends on the knowledge of these dynamics. With the age of climate change, the choice that Pakistan makes today will determine how far it can go with its immunization of it's surrounding, keeping its economy alive and seeing the health of the generation to come.

Literature Review

Global Perspectives on Climate Change

Climate change is a global problem that has gained a subject of wide interest in the past few decades due to the widespread impacts it has on the ecosystems, economies, and societies (Shaw et al., 2013). It is mostly caused by human activities that emit greenhouse gases, deforestation, industrialization, and unfriendly energy use (Pachauri & Chand, 2008). The Intergovernmental Panel on Climate Change has repeatedly emphasized the fact that the climate system on Earth is heating at a rate never experienced before and that the effects of the same are observable all over the continents (Malik et al., 2020). Increased temperatures, sea level, irregular rainfall, melting glaciers, and the growing occurrence of extreme weather have become a great threat to sustainable development (Lehner & Stocker, 2015). Scholars also highlight the fact that even though climate change is a global phenomenon, it does not affect all countries equally but rather skewed such that developing countries are disproportionality affected, having few adaptive capacities.

Climate Change in South Asia

South Asia is one of the most susceptible regions in the effects of climate change because of the geography, population density, and the reliance of climate-sensitive regions. There are common vulnerabilities that characterize countries such as India, Bangladesh, Nepal and Pakistan such as heavy dependence on monsoon precipitation as the main source of agriculture, exposure to cyclones and floods, and poverty (Sivakumar & Stefanski, 2010). Melting of the Himalayan glaciers, which are the major sources of water in the area, is an issue of concern. South Asia has been hit by frequent floods, droughts and heat waves that interfere with livelihood, food security and health of the people (Mirza, 2011). According to academic literature, adaptation activities in the area should be coordinated at the regional level because water resources, ecosystems, and migration patterns cut across the national borders (Afzal & Nishtar, 2023).

Climate Change and Pakistan's Vulnerability

Pakistan has been rated as one of the most vulnerable countries on climate in the world. Geographic diversity of the country, which varies between the glaciated mountains in the north and the dry deserts in the south, presents the country to various climate hazards. The literature indicates that Pakistan is under threat of high temperature, melting glaciers, floods, drought and rise in sea level along the Arabian Sea (Fahad & Wang, 2020). The dependency of agriculture on the forecastable weather conditions causes food security to be a matter of

concern. The Indus River system that supplies most of the water resources and is fed by glaciers and monsoon rains is experiencing considerable threat due to unpredictable water supplies (Malik et al., 2012). The impacts are not only environmental but also social, economic, and political and therefore the problem of climate change is multifaceted to Pakistan.

Socio-Economic Impacts of Climate Change in Pakistan

The socio-economic effects of climate change in Pakistan are at the extensive scale. Agriculture is oriented at occupying a huge portion of the population and the large share of GDP and it is extremely sensitive to changes in temperature and precipitation (Gul et al., 2019). The fluctuation of climatic conditions has also been linked to a decrease in crop production, soil erosion and pest attacks. Water shortage is a significant cause of rural poverty and threat to food security. Even urban centers do not escape as heat-waves, floods, and air pollution deepen in fast developing cities (Hasan et al., 2025). Mobility and migration due to climate have been reported and this frequently puts strain on urban infrastructure and services. It is also reported in the literature that women, children, and low-income households are the most disadvantaged groups because they lack the means to adjust to the impact of climate-related challenges (Dars et al., 2021).

Environmental and Health Dimensions

There are also wide-ranging environmental and health impacts of climate change. The line-melting of glaciers in the north has created glaciers lakes, which has enhanced the chances of glacial lakes outbursting floods (Tong et al., 2000). Rise in sea levels and saltwater intrusion are seen to be a threat to coastal ecosystems, especially in Sindh, compromising agricultural output and the freshwater supply (Day, 2008). Climate-sensitive diseases like malaria, dengue, heat-related illnesses are on the increase on the health front. Respiratory and cardiovascular diseases are also aggravated by air pollution, which is accompanied by an increase in temperature (Iqbal, 2020). According to the literature, climate change is not only an environmental crisis but a national health emergency to Pakistan.

Adaptation and Resilience Pathways

One of the major themes in the literature on climate resilience in Pakistan concerns the process of adaptation to the changing climate. The scholars underline the necessity of multi-level adaptation measures which include community-based programs, institutional changes and technological developments (Zorita et al., 2025). Some of the measures that have been put in place in agriculture to cope up with the changes in climate are the introduction of crop varieties that withstand the climate, better irrigation methods and livelihood diversification. The rain water harvesting, efficient irrigation and integrated water governance has been noted as the main responses to water resource management (Afshar & Shah, 2025). Potential ways to enhance resilience have proven to be disaster preparedness, community-based adjustment, including early warning systems, and ecosystem-based methods (Kareem et al., 2020). Literature recommends that the adaptation activities must be inclusive enough to ensure the involvement of the vulnerable population and that local knowledge systems are considered.

Barriers to Effective Adaptation

Although it is not denied that the need to adapt is among the key factors, numerous barriers are on the path to proper responses in Pakistan. Financial limits restrict the availability of funds in climate-resilient infrastructure and technologies (Mees et al., 2018). The governance concerns include institutional fragmentation, lack of coordination, and ineffective implementation of policies, among others, and paralyze adaptation. Poor access to

climate related information and technology also denies communities who make good decisions (Mallen et al., 2022). Social and cultural barriers to adaptation include resistance to new practices, and asymmetry in accessing resources. The answer to surmounting such obstacles, as the scholarly literature emphasizes, is the increase in institutional capacity, mobilisation of climate financing, and the greater involvement of government and civil society and communities.

The Role of International Cooperation

The second area, which underscores the value of international cooperation in supporting climate resilience in Pakistan is also presented in literature. Given that, although Pakistan is a very low contributor to the global greenhouse gas emission, the country is disproportionately harmed by the influence of the gases, the idea of climate justice is most often referred to (Victor, 2006). Climate finance availability, transfer of technology and capacity building are key in ensuring that Pakistan can adjust. The opportunities to mobilize resources and take accountability can be achieved via international mechanisms like the Paris Agreement (Akhtar, 2024). Joint studies, local programs and international cooperation are also mentioned as the ways to enhance the Pakistani adaptation capacity. Nevertheless, there are still loopholes between the international commitments and the actual provision of the financial and technical services so that Pakistan is left to fight with the constrained resources (Chan et al., 2018).

Opportunities for Sustainable Development

Although climate change is extremely dangerous, the literature also highlights possible opportunities that Pakistan would need to avail of the avenues in sustainable development. The renewable energy, such as solar and wind, offers both the chance to not only reduce the dependence on fossil fuel but also create green employment (Khan et al., 2016). The restoration of ecosystems, afforestation and sustainable land management are potentially effective both in ecological and economic ways. Urban resilience planning, sustainable infrastructure planning and circular economy make it possible to transform the vulnerabilities into the growth opportunities (Hussain et al., 2022). According to researchers, the climate change threat also opens the opportunity to reconsider the development models and promote the long-term sustainability.

Research Gaps and Emerging Directions

The literature has identified several gaps in the knowledge and the response on climate change in Pakistan. There is research in localized effects and the community level standard of adaptation, but there are enormous differences between the areas. The gender factor of climate change, particularly the roles of women and marginalized bodies and how they can be utilized to be more resilient needs further investigation. The efficiency of policy interventions and adaptation projects is also to be evaluated further. New fields of interest are artificial intelligence use, remote sensing, and digital platforms to monitor the climate and adaptation planning. Another emerging area of investigation is the intersection of climate change and topics of national security, immigration, and economic growth.

Major Objectives of the Study

- To examine the perceived impacts of climate change on Pakistan's environment, economy, and society.
- To assess the level of awareness and adaptation practices adopted by communities to cope with climate challenges.
- To identify the key barriers that hinder effective adaptation and resilience-building in Pakistan.
- To explore potential adaptation pathways and strategies that can strengthen Pakistan's capacity to address climate change.

Problem Statement

Pakistan is one of the most climate-sensitive nations, even though it is a country that produces the least global emissions. The increase in temperature, unpredictable rainfall, melting glaciers, floods and drought continue to pose a threat to its agriculture, water supplies, health, and livelihoods. Societies are increasingly struggling to cope with these risks, but financial, technological and institutional constraints inhibit good responses. There is also limited awareness, and poor policy implementation, which increases vulnerabilities. The essential necessity is to explore the effects of climate change and find the way to adapt sustainably to protect the environment, economy, and population of Pakistan.

Methodology

This study employed a quantitative research design to assess the impacts of climate change, adaptation practices, perceived barriers, and preferred strategies among communities in Pakistan. A structured questionnaire was developed, comprising both demographic questions and Likert-scale items ranging from 1 (strongly disagree) to 5 (strongly agree). The instrument was designed to capture perceptions regarding climate change awareness, its socio-economic and environmental impacts, current adaptation measures, constraints, and policy preferences.

The survey was administered to a sample of 400 respondents drawn from diverse provinces and regions of Pakistan, including Punjab, Sindh, Khyber Pakhtunkhwa, Balochistan, Islamabad, Gilgit-Baltistan, and Azad Jammu & Kashmir. A purposive sampling approach was adopted to ensure representation from different occupational, educational, and socio-economic groups, reflecting both rural and urban perspectives. Out of the distributed questionnaires, 380 valid responses were collected, yielding a high response rate.

Data analysis was conducted using descriptive and inferential statistical techniques. Frequencies and percentages were calculated to summarize demographic variables such as gender, age, education, occupation, and region. Mean scores and standard deviations were computed for each Likert-scale item to identify the central tendencies and variability in responses. These measures enabled the identification of strongly supported perceptions, commonly practiced adaptation strategies, and widely recognized barriers. Results were presented in the form of tables and figures for clarity, followed by detailed interpretation.

The methodological rigor was ensured through pre-testing of the questionnaire to refine clarity and reliability. Ethical considerations were observed by maintaining anonymity of respondents and obtaining informed consent prior to data collection. This methodological approach provided robust evidence on community-level perceptions and responses to climate change in Pakistan, thereby contributing to policy-relevant insights on resilience and adaptation.

Results and Discussions

Demographic Information

Figure No. 1 Gender wise distribution of the respondents

The gender distribution of the sample indicates a relatively balanced representation between male and female participants. Out of the total respondents, 220 were male, accounting for 55.0% of the sample, while 180 were female, representing 45.0%. Although males constitute a slightly higher proportion, the difference of 10 percentage points suggests that both genders are well represented. This near-equitable distribution enhances the reliability of the findings by reducing potential gender bias and ensuring that perspectives from both groups are adequately reflected in the study.

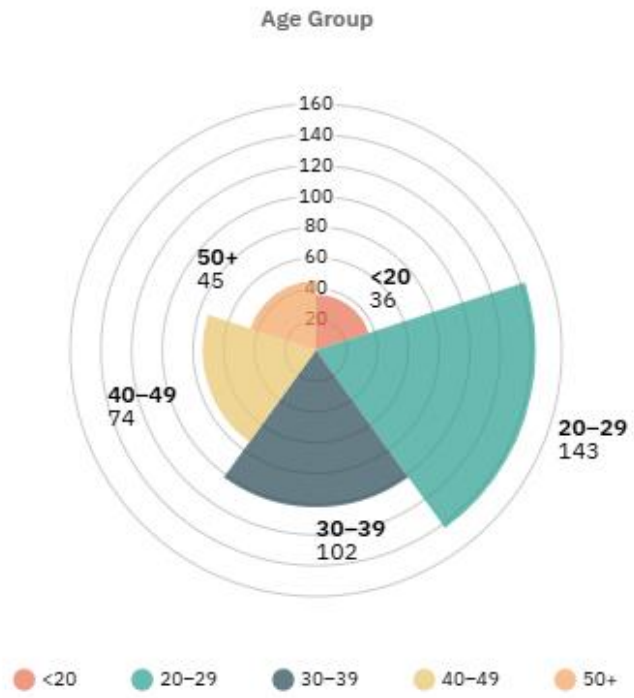

Figure No. 2 Age wise distribution of the respondents

The age distribution of respondents reflects a diverse representation across different groups, with a noticeable concentration among younger participants. The largest proportion falls within the 20–29 age group, comprising 143 individuals or 35.8% of the sample, followed by the 30–39 age group with 102 respondents (25.5%). Participants aged 40–49 account for 74 individuals (18.5%), while those aged 50 and above make up 45 respondents (11.2%). The smallest segment is individuals under 20 years old, representing 36 participants (9.0%). This distribution highlights a strong presence of younger to mid-career respondents, suggesting that the study primarily captures perspectives from early and middle stages of professional and personal development.

Figure No. 3 Education Level of the respondents

The education level distribution demonstrates a wide range of academic backgrounds among respondents. The largest groups are those with a bachelor's degree (117 respondents, 29.2%) and secondary education (114 respondents, 28.5%), indicating that nearly three-fifths of the sample possess mid- to higher-level qualifications. Individuals holding a master's degree or higher constitute 87 participants (21.8%), reflecting a considerable representation of advanced academic attainment. Meanwhile, 59 respondents (14.8%) reported having only primary education, and a smaller portion of 23 participants (5.8%) indicated no formal education. This spread suggests that while the majority of respondents have attained secondary or higher education, the sample still captures perspectives from varying educational backgrounds, ensuring inclusivity and broader representativeness.

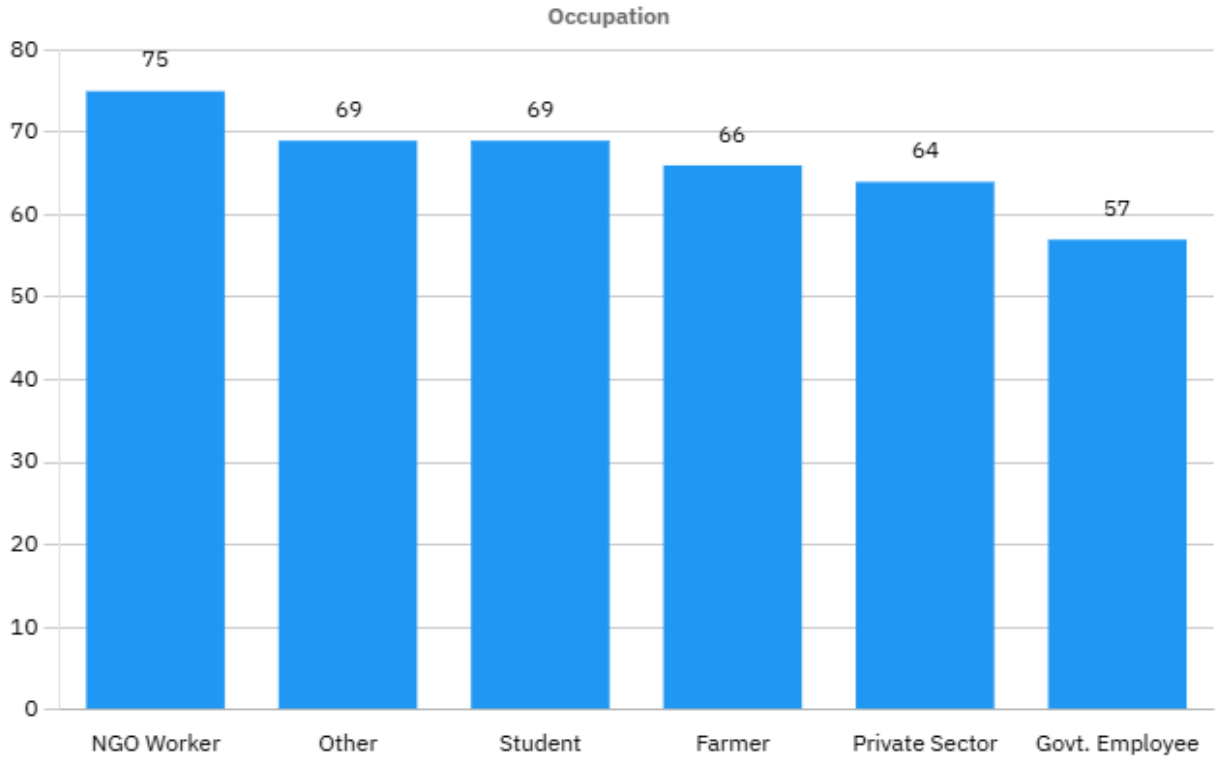

Figure No. 4 Occupation of the respondents

The occupational distribution reveals a fairly balanced spread across different professional categories, with no single group dominating the sample. NGO workers form the largest segment, comprising 75 respondents (18.8%). Students and individuals categorized under "Other" each account for 69 participants (17.2%), followed closely by farmers with 66 respondents (16.5%) and private sector employees with 64 respondents (16.0%). With 57 participants (14.2%), Government employees represent the smallest group. This distribution indicates that the study incorporates perspectives from diverse occupational backgrounds, enhancing the comprehensiveness of the findings and reducing bias toward any particular professional group.

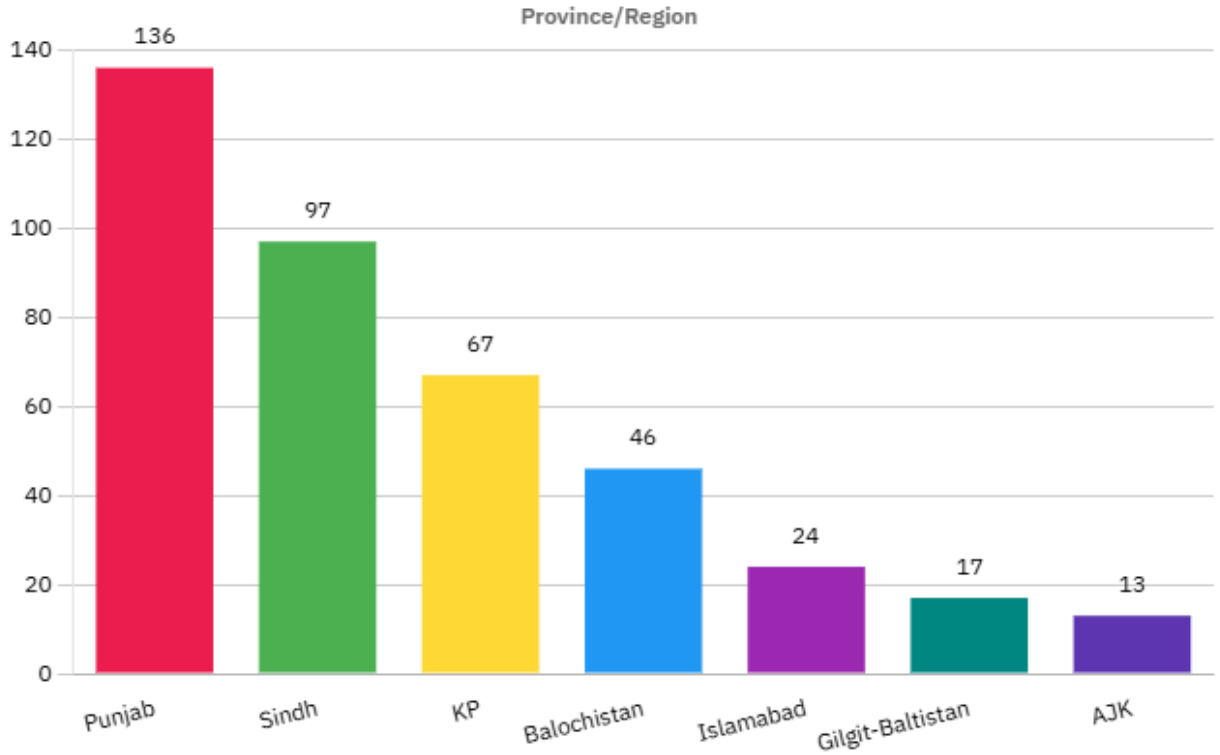

Figure No. 5 Province/Region of the respondents

The regional distribution of respondents shows a broad representation across provinces, with Punjab contributing the largest share at 136 participants (34.0%). Sindh follows with 97 respondents (24.2%), while Khyber Pakhtunkhwa (KP) accounts for 67 participants (16.8%). Smaller proportions are observed in Balochistan with 46 respondents (11.5%) and Islamabad with 24 participants (6.0%). The least represented regions are Gilgit-Baltistan (17 respondents, 4.2%) and Azad Jammu & Kashmir (13 respondents, 3.2%). Overall, the data reflects strong participation from Punjab and Sindh, which together constitute over half of the sample, while also ensuring inclusion of perspectives from less populous regions, thereby contributing to the geographical diversity of the study.

Table 1: Awareness and Perceptions of Climate Change (Strongly Disagree to Strongly Agree: 1-5)

Statement	1	2	3	4	5	Mean	Std. Deviation
Climate change is a serious issue for Pakistan.	1% (4)	2% (8)	5% (20)	38% (152)	54% (216)	4.42	0.76
I have noticed changes in temperature patterns.	2% (8)	3% (12)	10% (40)	45% (180)	40% (160)	4.18	0.91
Rainfall has become more irregular.	1% (4)	4% (16)	12% (48)	48% (192)	35% (140)	4.12	0.85
Floods/droughts are more frequent.	2% (8)	5% (20)	15% (60)	43% (172)	35% (140)	4.04	0.93

Poses risks to human health.	3% (12)	7% (28)	20% (80)	42% (168)	28% (112)	3.85	1.01

The findings in Table 1 highlight a strong level of awareness and concern regarding climate change among respondents. A vast majority (92%, combining "agree" and "strongly agree") acknowledged that climate change is a serious issue for Pakistan, supported by a high mean score of 4.42 (SD = 0.76), indicating strong consensus. Similarly, 85% of respondents reported noticing changes in temperature patterns, with a mean of 4.18, suggesting widespread recognition of climatic shifts.

Perceptions of rainfall irregularity also reflect concern, as 83% agreed or strongly agreed, yielding a mean of 4.12 (SD = 0.85). Furthermore, 78% of participants affirmed that floods and droughts are occurring more frequently, with a mean of 4.04, though slightly more variation is observed (SD = 0.93). Regarding health implications, 70% perceived climate change as posing risks to human health, while 20% remained neutral and 10% disagreed. This item received the lowest mean (3.85) and highest standard deviation (1.01), suggesting relatively more divided opinions compared to other statements.

Overall, the data indicate that respondents demonstrate a high degree of awareness of climate change's environmental impacts, particularly on temperature, rainfall, and extreme events, while slightly less consensus is observed concerning its direct effects on human health.

Table 2: Perceived Impacts of Climate Change (Strongly Disagree to Strongly Agree: 1-5)

Statement	1	2	3	4	5	Mean	Std. Deviation
Negatively affects agriculture.	1% (4)	3% (12)	8% (32)	45% (180)	43% (172)	4.26	0.80
Water availability has decreased.	2% (8)	4% (16)	11% (44)	48% (192)	35% (140)	4.10	0.88
Extreme weather disrupts daily life.	3% (12)	6% (24)	14% (56)	47% (188)	30% (120)	3.95	0.96
Caused economic losses.	4% (16)	8% (32)	18% (72)	46% (184)	24% (96)	3.78	1.02
Migration is increasing.	5% (20)	10% (40)	25% (100)	40% (160)	20% (80)	3.60	1.08

The results in Table 2 emphasize respondents' recognition of the significant socioeconomic and environmental impacts of climate change. The strongest consensus was observed regarding its negative effects on agriculture, with 88% of participants agreeing or strongly agreeing, reflected in the highest mean score of 4.26 (SD = 0.80). Similarly, reduced water availability was acknowledged by 83% of respondents, with a mean of 4.10, indicating a widespread perception of growing water stress.

Extreme weather events were also reported as disruptive to daily life, with 77% agreeing or strongly agreeing. The mean score of 3.95 (SD = 0.96) suggests strong agreement, though with some variability in responses. Economic consequences of climate change were slightly less strongly endorsed: 70% agreed or strongly agreed that it causes economic losses, while

18% remained neutral and 12% disagreed, resulting in a mean of 3.78 (SD = 1.02).

Perceptions about migration showed the greatest divergence, with 60% agreeing or strongly agreeing, 25% neutral, and 15% disagreeing. This item recorded the lowest mean (3.60) and highest standard deviation (1.08), highlighting uncertainty or varied experiences regarding migration patterns linked to climate change.

Overall, the data illustrate that respondents view climate change as posing critical risks, particularly to agriculture, water availability, and daily life, while its impacts on economic losses and migration are perceived as more context-dependent and less universally recognized.

Table 3: Current Adaptation Practices (Strongly Disagree to Strongly Agree: 1-5)

Statement	1	2	3	4	5	Mean	Std. Deviation
Local institutions support adaptation.	8% (32)	15% (60)	30% (120)	35% (140)	12% (48)	3.28	1.10
Communities use water conservation.	5% (20)	12% (48)	33% (132)	38% (152)	12% (48)	3.40	1.02
Farmers adopt resilient crops.	7% (28)	15% (60)	35% (140)	35% (140)	8% (32)	3.22	1.03
People follow early warning systems.	10% (40)	18% (72)	25% (100)	37% (148)	10% (40)	3.19	1.12
Disaster preparedness is common.	12% (48)	20% (80)	28% (112)	32% (128)	8% (32)	3.04	1.14

The findings in Table 3 indicate moderate adoption of climate change adaptation practices, with noticeable variability in perceptions. The highest-rated practice was community-level water conservation, with 50% of respondents agreeing or strongly agreeing, while 33% remained neutral and 17% disagreed. This yielded a mean of 3.40 (SD = 1.02), suggesting some progress but also room for improvement in widespread implementation.

Institutional support for adaptation received mixed views, with only 47% agreeing or strongly agreeing, 30% neutral, and 23% disagreeing, resulting in a mean of 3.28. Similarly, the adoption of resilient crop varieties by farmers showed a near-even split: 43% agreed or strongly agreed, 35% were neutral, and 22% disagreed, reflected in a mean of 3.22 (SD = 1.03).

Early warning systems were acknowledged by 47% of respondents, yet 28% disagreed and 25% remained neutral. The mean of 3.19 (SD = 1.12) indicates that while early warning mechanisms are in place, their utilization remains inconsistent. Disaster preparedness was perceived as the least prevalent adaptation practice, with only 40% agreeing or strongly agreeing, compared to 32% neutral and as many as 32% disagreeing. This produced the lowest mean (3.04, SD = 1.14), showing limited preparedness at the community level.

Overall, the results reveal that adaptation practices are present but not fully institutionalized or uniformly adopted. While water conservation appears relatively more common, other critical strategies such as disaster preparedness, resilient farming, and reliance on early warning systems require

stronger promotion, institutional support, and capacity-building to enhance climate resilience.

Table 4: Perceived Barriers to Adaptation (Strongly Disagree to Strongly Agree: 1-5)

Statement	1	2	3	4	5	Mean	Std. Deviation
Lack of financial resources.	1% (4)	2% (8)	5% (20)	38% (152)	54% (216)	4.42	0.74
Government support is insufficient.	2% (8)	3% (12)	7% (28)	40% (160)	48% (192)	4.29	0.82
Limited access to technology.	2% (8)	4% (16)	10% (40)	48% (192)	36% (144)	4.12	0.86
Lack of climate-related information.	3% (12)	5% (20)	15% (60)	47% (188)	30% (120)	3.96	0.94
Cultural/social factors are a barrier.	5% (20)	10% (40)	28% (112)	40% (160)	17% (68)	3.54	1.06

The results in Table 4 highlight several critical barriers hindering effective climate change adaptation. The most widely acknowledged challenge is the lack of financial resources, with 92% of respondents agreeing or strongly agreeing, reflected in the highest mean score of 4.42 (SD = 0.74). Similarly, insufficient government support was strongly emphasized, with 88% agreement and a mean of 4.29, underscoring institutional shortcomings as a major constraint.

Limited access to technology was also recognized as a significant obstacle, as 84% of participants agreed or strongly agreed, yielding a mean of 4.12 (SD = 0.86). Access to climate-related information received slightly lower consensus: 77% agreement, 15% neutral, and 8% disagreement, resulting in a mean of 3.96 (SD = 0.94). This indicates information gaps remain a challenge, though less pronounced than financial or institutional constraints.

Cultural and social factors were perceived as barriers to a lesser extent, with 57% agreement, 28% neutrality, and 15% disagreement, producing the lowest mean of 3.54 (SD = 1.06). This suggests that while socio-cultural barriers exist, they are viewed as less influential compared to structural and resource-related challenges.

Overall, the data reveal that financial limitations, inadequate government support, and restricted access to technology are the dominant barriers to adaptation, while information deficits and socio-cultural constraints also play a role, though to a comparatively lesser degree.

Table 5: Preferred Adaptation Strategies (Strongly Disagree to Strongly Agree: 1-5)

Statement	1	2	3	4	5	Mean	Std. Deviation
Public awareness campaigns are essential.	1% (4)	1% (4)	4% (16)	35% (140)	59% (236)	4.51	0.68
Gov. investment in infrastructure is necessary.	1% (4)	2% (8)	5% (20)	40% (160)	52% (208)	4.40	0.73

Nature-based solutions are effective.	1% (4)	3% (12)	8% (32)	45% (180)	43% (172)	4.26	0.78
Promote climate-smart technologies.	2% (8)	3% (12)	10% (40)	48% (192)	37% (148)	4.15	0.83
Community-based adaptation is more effective.	3% (12)	5% (20)	12% (48)	44% (176)	36% (144)	4.05	0.93

The results in Table 5 highlight strong support for a range of adaptation strategies, with particularly high consensus on public awareness and government-led initiatives. Public awareness campaigns emerged as the most preferred strategy, with 94% of respondents agreeing or strongly agreeing and a mean of 4.51 (SD = 0.68), indicating a strong belief in the role of education and outreach in fostering climate resilience. Similarly, government investment in infrastructure was highly endorsed, with 92% agreement and a mean of 4.40, emphasizing the importance of institutional responsibility in building adaptive capacity.

Nature-based solutions also received substantial support, with 88% of respondents agreeing or strongly agreeing (mean = 4.26, SD = 0.78), reflecting recognition of the effectiveness of ecological approaches in addressing climate risks. Promoting climate-smart technologies was supported by 85% of participants, yielding a mean of 4.15, though with slightly more variation in responses (SD = 0.83).

Community-based adaptation strategies were endorsed by 80% of respondents, with a mean of 4.05 (SD = 0.93), though this item recorded the lowest score among the strategies, suggesting comparatively less consensus on localized approaches.

Overall, the findings underscore a strong preference for multi-level strategies that combine public awareness, institutional investment, technological innovation, and ecological practices. While community-based adaptation is valued, large-scale awareness campaigns and infrastructure investment are perceived as the most critical and impactful measures for effective climate change adaptation.

Discussion

The findings of the current research imply the complex and multi-faceted nature of climate change in Pakistan, not only in the context of the growing awareness of society but also in the context of the significant obstacles to adaptation. According to the qualitative analysis, the respondents were diverse in terms of age, education, occupation, and location that ensured the different perspectives of the respondents around the climate change. This inclusivity increases the reliability of the results and restates the fact that climate change is a topic of concern among a range of demographic and geographic boundaries (Khan et al., 2016).

It was established that the level of awareness was generally high with most of the respondents acknowledging that climate change was a major issue to Pakistan. This coincides with the increasing reveal of climate catastrophes such as floods, drought and heat waves that have directly and physically affected communities (Hussain et al., 2022). The existence of the powerful awareness base is a positive finding, since it is a sign that the campaign to disseminate the urgency of climate change is gaining a reflection on the population. However, the awareness is not sufficient: the translation of this knowledge into the practical adaptation practices also can be regarded as a challenge (Akhtar, 2024).

The impacts analysis revealed that the perception of the adverse effects of climatic change was wide-ranged particularly when

compared to agriculture, water, and economic stability. The respondents noted that the climate impacts have been disrupting livelihoods and leading to other social ills, including migration (Kareem et al., 2020). This demonstrates that climate change is not a matter of environment as it is a matter that traverses the economical development, food security and social stability. These findings reinforce the notion of the necessity of coherent policy interventions, which must be established into the interactions of climate change and the other developmental concerns (Mirza, 2011).

Adaptation practices were identified but at different levels of improvement. Even though some of the respondents mentioned such activities as climate-resistant agriculture and water conservation, the unequal representation of the latter suggests that there are still many gaps (Malik et al., 2012). The presence of obstacles like financial constraints, inaccessibility to technologies and government resources indicates that the systemic issues still persist and become obstacles to the overall implementation. These results point to the urgent necessity to invest in climate finance, institutionalization, and specific interventions to assist vulnerable populations (Gul et al., 2019).

On a positive note, the respondents indicated that they fully support several measures that can be adapted such as nature-based solutions, climate-smart technology, and community-based programs (Fahad & Wang, 2020). The public awareness as a priority implies that the communities consider education and participation as critical elements of resilience-building. Together, these lessons indicate the need to have multi-level partnership between government institutions, the civil society, and local communities. These results highlight the point that although the climate challenges that Pakistan must deal with are considerable, there exist some evident avenues of enhancing resilience should the resources, policies, and efforts be properly coordinated.

Conclusion and Recommendations

The paper has explicitly defined that Pakistan is being put on the brink of the impacts of climate change as its agriculture, water resources, economy and livelihoods have become more and more endangered. The findings demonstrate that despite a relatively similar level of awareness of the climate change among the population, practical adaptation undertakings have been unbalanced and in most instances hampered by structural, financial and institutional challenges. Societies are now more sensitive to the changing weather conditions and environmental risks but they can do little to change it. It reveals that knowledge and action are currently at a dire lack of connection that must be filled in using a comprehensive policy, technological progress and involvement.

The results seem to emphasize climate change as a socio-economic or developmental problem and not only an environmental one. Its effects extend to food security, health, employment, and even migration and are reflective of the need of integrated action, which cuts across numerous sectors. As much as some adaptation practices are emerging such as resistant farming practices and water conservation, these are not sufficient given the coverage and scope of the practice. In the absence of significant support, the vulnerable groups will remain vulnerable and the resilience of the nation will remain low to deal with the rising climate pressures.

The study would recommend a number of solutions to address these challenges. First, the government institutions should be more actively involved in the rollout of policies by transforming climate plans into practical programs in the national and local levels. There is a need to invest more on climate resilient infrastructures, disaster preparedness and renewable energy initiatives. Second, the

financial instruments such as climate funds, subsidies and microcredit programs will be expanded to enable poor communities and small-scale farmers who lack resources to take adaptive measures. Third, the transfer of technology and innovation ought to be placed on the agenda, and communities must be made available with access to climate sensitive agriculture, early warning and effective water management solutions. Fourth, the awareness-focused campaigns and education should be strengthened in such a way that they seal the knowledge-behavior gap, and engage the masses in the adaptation. Finally, the involvement of the government agencies, civil society, academia and local communities in the common activities to develop inclusive adaptation pathways should be considered.

Lastly, the ability of Pakistan to respond to the problem of climate change will be anchored on proactive governance, mobilization of resources and concerted efforts. By surmounting challenges and multiplication of adaptation responses, the country would be in a position to produce a more robust and climate-adaptive future of the citizens.

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