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Unraveling the Impact of Climate Change on Health Dynamics in District Swat, Pakistan: A Pathway to Sustainable Resilience

Muhammad Qasim Mian[a*], Syeda Azka Ayman[b], Basit Ali[c], Ubaid Ullah[d]

[a]Department of Sociology, University of Malakand Pakistan. [b]Department of Psychology, National University of Modern Languages, Islamabad, Pakistan. [c]Department of Sociology, University of Malakand, Pakistan. [d]Department of Sociology, University of Malakand, Pakistan

[*]**Email:** Miannnn03@gmail.com

***Abstract*:** Climate change is causing significant disruptions worldwide, and Swat, Khyber Pakhtunkhwa (KP), is no exception. This qualitative research delves into the extensive effects of climate change on the health of Swat's residents, particularly those in vulnerable communities. By conducting in-depth interviews with healthcare professionals, local authorities, and affected individuals, alongside employing data collection methods such as audio recordings and meticulous note-taking, a comprehensive understanding of the situation was developed. The study highlights the multifaceted factors contributing to climate change in the region, including deforestation, glacial melting, and unpredictable weather patterns, and explores their cascading effects on public health. The findings reveal that climate change is exacerbating various health issues, including a rise in respiratory problems due to increased air pollution, a surge in waterborne diseases from contaminated water sources, heat-related illnesses stemming from rising temperatures, and a growing prevalence of mental health challenges as communities struggle with climate-induced stress and displacement. To address these impacts, urgent measures are needed, including substantial investment in resilient infrastructure, strengthening local healthcare systems to cope with emerging health threats, improving water management practices to ensure safe drinking water, enhancing early warning systems for extreme weather events, promoting public health education focused on climate adaptation, empowering communities through participatory approaches, and integrating mental health support into climate response strategies. The study emphasizes the importance of coordinated and proactive measures at both local and governmental levels to mitigate the socio-economic and psychological consequences of climate change. By offering valuable insights from respondents, the study concludes by recommending specific actions to alleviate the adverse impacts of climate change on health in Swat, KP, and calls for a comprehensive, multi-sectoral approach to ensure the well-being of the region's inhabitants.

Keywords: Climate change, Health dynamics, vulnerable communities, Extreme weather events, Ecosystems, Climate adaptation, resilient infrastructure, Public health education.

1. Introduction

Climate change is a continuous and occasionally irreversible movement in the prolonged patterns of atmospheric variables in a particular area and in the whole world (Ikram et al., 2016). The majority of climate experts are of the opinion that climate is varying because of anthropogenic influences and will continue changing unless sufficient

mitigation measures are adapted (Anderegg et al., 2010). Climate change is a phenomenon that arises due to emissions of greenhouse gases from fuel combustion, deforestation, urbanization, and industrialization, resulting in variations in solar energy, temperature, and precipitation (Upreti, 1999). Changes in climate forcing affect the quantity and quality of groundwater, the frequency and intensity of droughts and floods, and ultimately, the water resource management practices, especially at local scales (Amell, 2003). It poses a real threat to life, affecting various aspects such as water resources, agriculture, coastal regions, freshwater habitats, vegetation, forests, snow cover, and geological processes such as melting, landslides, desertification, and floods, all of which have long-term effects on food security and human health (Malla, 2008).

On a global scale, decreased precipitation levels and increased surface temperatures result from excessive deforestation, generating a major global threat to biodiversity and natural ecosystems (Ishaq et al., 2015; Pandit et al., 2017). Due to deforestation and the massive use of fuels, an increase in CO2 concentration has been noted from 280 ppm to 380 ppm (Shakoor et al., 2011). Among twelve highly exposed countries to climate change, Pakistan is also at a higher degree of risk of facing the ill impacts of climate change (Ullah et al., 2015). For instance, in Pakistan, the 2010 flood caused approximately 2000 mortalities and destroyed more than 700,000 buildings, houses, and other infrastructures (Salma et al., 2012). Climate change can be better understood with the help of a simple analogy. Consider the amount of salt in food. Salt is essential for flavor, but too much can make food bitter. Similarly, sunlight is crucial for life, but an excess can lead to harmful effects, such as the greenhouse effect. Human activities, such as industrialization and deforestation, have increased the concentration of greenhouse gases in the atmosphere, intensifying the greenhouse effect and leading to various consequences, including melting ice caps and ocean acidification.

The race for economic development has led nations to engage in advanced gaseous emission technologies, resulting in increased emissions of greenhouse gases such as carbon dioxide, methane, nitrous oxides, and fluorinated compounds. This exploitation of nature, through activities like deforestation, increased agriculture, and pollution, has significantly contributed to climate change. The increased proportion of gases in the atmosphere traps more sunlight, intensifying the greenhouse effect and exacerbating climate change. Pakistan is among the countries at the receiving end of climate change impacts. The average temperature of Pakistan is projected to increase in various regions of the country. Factors such as dearth of fresh water, excess of greenhouse gases, deforestation, and substantial mechanization and industrialization have intensified the climate situation. The country has already experienced extreme climatic events such as severe droughts and floods, and such events are forecasted to increase in intensity in the future.

Khyber Pakhtunkhwa (KP) is characterized by diverse ecosystems, including mountains, plains, and river valleys, which are highly sensitive to climate variability and change. The region's economy, largely dependent on agriculture, faces significant risks due to climate change-induced shifts in temperature, precipitation patterns, and extreme weather events. The province has already experienced more frequent and severe floods, droughts, and heat waves, which are threatening its economy, environment, and health. Swat, located in KP, is surrounded by hills. Conducting research on the impact of climate change on the health of the people of Swat KP is crucial to comprehensively assess the challenges posed by changing climatic conditions. Utilizing qualitative research methods can provide a holistic understanding of the complex interactions between climate change and human well-being in KP. This research serves as a foundation for effective policy interventions and sustainable development strategies to build resilience and ensure the well-being of the population in the face of climate change.

1.1 Statement of the Problem

Swat, a small valley in Khyber Pakhtunkhwa (KP), a province located in northwestern Pakistan, is experiencing significant consequences for health as a result of climate change. The region is characterized by its diverse geography, including mountains, valleys, and plains, and is home to a large population that heavily relies on agriculture, forestry, and natural resources. The effects of climate change, such as rising temperatures, changing rainfall patterns, and extreme weather events, pose considerable challenges to the health of the people of Swat, KP. Ultimately, these changes in climate will impact the public health of Swat residents. Therefore, understanding the impact of climate change on the health of the population of Swat, KP, is crucial for identifying effective mitigation and adaptation strategies to safeguard livelihoods.

1.2 Objectives of the Study

a) To describe the socio-demographic characteristics of the respondents.

b) To identify climate change impacts on the health of the respondents.
c) To develop health-centric mitigation and adoption measures.

1.3 Significance of the Study

This study explores the profound impact of climate change on health in Swat, KP, Pakistan, a region facing increasing temperatures, more frequent heat waves, and intensified floods and droughts. Rising temperatures exacerbate heat-related illnesses such as dehydration and heatstroke, and worsen cardiovascular and respiratory conditions, particularly affecting the elderly and those with pre-existing health issues. Climate-induced disruptions in clean water availability lead to a surge in waterborne diseases, including Typhoid and Malaria, with severe consequences for children, who are already vulnerable to malnutrition and stunted growth due to climate-related food insecurity.

The study emphasizes the urgent need for comprehensive strategies to address these health risks. It advocates for substantial improvements in healthcare infrastructure, enhanced access to clean water and sanitation, and the implementation of effective early warning systems for extreme weather events. By focusing on these critical areas, the research aims to protect public health and build resilience against climate change.

In addition to that, the study also highlights the connection between environmental conservation and health. The degradation of ecosystems, such as forests and wetlands, not only exacerbates health risks but also undermines essential ecosystem services like air and water purification and disease regulation. Addressing climate change requires a holistic approach that integrates both public health promotion and environmental conservation.

2. Literature Review

Climate change is a pressing global issue that significantly impacts human health. Rising global temperatures, driven by increased greenhouse gas emissions from activities such as burning fossil fuels and deforestation, contribute to more frequent and severe weather events, including heatwaves, floods, and hurricanes (IPCC, 2021). These changes have multifaceted effects on health: elevated temperatures can lead to heat-related illnesses and exacerbate chronic conditions, while extreme weather events can result in physical injuries, fatalities, and disruptions to healthcare access (WHO, 2022).

2.1 Effects of Climate Change on Health

2.1.1 Health Impacts of Increasing CO2 Levels and Rising Temperatures

Increasing levels of CO2 and rising global temperatures due to climate change are significantly impacting human health. Elevated CO2 concentrations, projected to reach 1,000 ppm in various environments by the end of the century, can cause a range of health issues including inflammation, respiratory acidosis, kidney calcification, and bone demineralization. Additionally, higher CO2 levels negatively affect plant carotenoid concentrations—important antioxidants for human health—while promoting increased pollen and mold spore production. This exacerbates respiratory conditions such as asthma and allergies (Smith et al., 2021).

Simultaneously, rising temperatures are linked to severe heat-related health outcomes. The number of heatwave exposure events globally increased by 220 million in 2018 compared to the average from 1986–2005. In France, the economic impact of heatwaves from 2015 to 2019 was €25.5 billion, primarily due to mortality costs (€23.2 billion). Increased body temperatures from heatwaves cause vasodilation, higher heart and respiratory rates, and oxidative stress, which are associated with adverse birth outcomes such as pre-term birth and low birth weight (Liu et al., 2020).

2.1.2 Health Impacts of Increasing Air Pollutants and Flooding

Increasing levels of air pollutants, worsened by climate change, represent a major environmental health risk. Air pollution, responsible for approximately 7 million deaths annually, includes key pollutants such as particulate matter (PM), ozone, nitrogen dioxide, and sulfur dioxide. Fine particulate matter (PM2.5), in particular, is harmful as it penetrates deep into the lungs and bloodstream, leading to inflammation and severe health effects. Long-term exposure to PM2.5 has been associated with higher hospitalization rates for COVID-19 and increased risks of acute asthma exacerbations (World Health Organization, 2021).

Additionally, climate change is driving an increase in the frequency and intensity of extreme precipitation events, leading to more frequent flash floods and coastal flooding. These extreme weather events pose serious health risks, including drowning, trauma, and exposure to carbon monoxide from unventilated generators. Floods also disrupt

access to healthcare services, exacerbating health outcomes and complicating recovery efforts (Munich RE, 2020).

2.1.3 Health Impacts of Land Degradation, Desertification, and Declines in Biodiversity

Land degradation, exacerbated by climate change, affects 20% of the Earth's vegetated surface and over 1.3 billion people. This degradation, along with drought and desertification, has significant health impacts, including food and water scarcity, malnutrition, and respiratory issues from dust storms (UNCCD, 2018).

The decline in environmental greenness and biodiversity further compounds these issues. A decrease in biodiversity disrupts the human microbiome and immune system, increasing the risk of allergies and inflammatory disorders. The dilution effect, where diverse ecosystems help lower disease transmission, underscores the importance of preserving biodiversity to prevent outbreaks of infectious diseases (Rook, 2013).

2.2 Climate Change and Health in Pakistan

Climate change, driven by human activities such as fossil fuel consumption and deforestation, poses severe environmental and public health challenges globally, with Pakistan being particularly vulnerable. In 2022, extreme heat reached over 50°C in parts of Pakistan, intensifying the monsoon season and causing catastrophic floods that submerged two-thirds of the country. These floods resulted in over 1,300 deaths, destruction of 1.2 million homes, and significant damage to infrastructure, leading to a public health crisis marked by waterborne diseases, respiratory issues, and increased vulnerability among displaced populations (IPCC, 2022; WHO, 2023).

Pakistan's susceptibility to climate change is exacerbated by rapid glacial melt, deforestation, and soil erosion. The Global Climate Risk Index consistently ranks Pakistan among the most climate-vulnerable nations due to its geographical location and socio-economic conditions. Glacial melt in the northern regions and heavy rainfall from low-pressure systems in the Arabian Sea contribute to severe flooding. Additionally, air pollution from industrial emissions and vehicle exhaust worsens respiratory and cardiovascular diseases, while inadequate sewage systems and limited freshwater resources increase the risk of waterborne diseases like cholera and dengue (Smith et al., 2014; McMichael et al., 2006).

The floods have displaced millions, causing a sharp rise in malnutrition, particularly among children, and severe health risks for approximately 73,000 pregnant women due to the destruction of health facilities. Emergency relief efforts by WHO, UNICEF, and other organizations have provided temporary shelters, clean drinking water, and basic healthcare services. However, these measures are insufficient for long-term resilience. Pakistan urgently needs investments in climate-resilient infrastructure, improved healthcare delivery systems, and enhanced public health preparedness. The international community, especially wealthier nations responsible for significant greenhouse gas emissions, must support sustainable solutions to mitigate these health impacts (Haines et al., 2017; IPCC, 2021).

Global warming, with a 1.1°C increase in temperatures since the pre-industrial era, has led to more frequent and severe weather events, including heatwaves, floods, and droughts. In Pakistan, this warming not only contributes to heat-related illnesses but also alters ecosystems, facilitating the spread of vector-borne diseases such as malaria and dengue. The ongoing changes in climate are amplifying existing health risks and creating new challenges for public health in the region (IPCC, 2022; WHO, 2023).

2.3 Climate Change Mitigation and Adaptation Measures in Pakistan

2.3.1 National Efforts and Education in Addressing Climate Health Impacts

Pakistan is actively tackling the health impacts of climate change through initiatives supported by the World Health Organization (WHO) and is developing a comprehensive national strategy. However, progress is hindered by challenges such as an agriculture-based economy, limited technological and financial resources, and insufficient commitment from the public and policymakers. The National Climate Change Policy (NCCP) of 2012 estimates that adaptation needs could range from $7 billion to $14 billion annually. Additionally, climate change threatens health systems by disrupting supply chains, causing workforce shortages, and damaging facilities, highlighting the need for climate-resilient adaptations to improve health outcomes and system responses (UNCCD, 2018).

Education is crucial in advancing climate action and mitigating health impacts. The Intergovernmental Panel on Climate Change (IPCC) underscores the importance of disseminating findings from its Sixth Assessment Report, released in August 2021. Educating both children and adults about how climate change affects personal health can drive solutions at individual and community levels. Online dissemination of health information enhances health literacy, empowering individuals to make informed, data-driven decisions (IPCC, 2021).

2.3.2 Individual Climate Actions and Technological Monitoring

Individual actions are crucial in combating climate change, with the "reduce, reuse, recycle" philosophy offering a practical framework for mitigation. Individuals can contribute through various strategies across transportation (e.g., living car-free, reducing air travel), energy (e.g., conserving home energy, choosing decarbonized electricity), food (e.g., adopting a meatless diet, minimizing food waste), and consumer behavior (e.g., mindful purchasing of furniture, clothing). Collectively, these actions can significantly mitigate the broader impacts of climate change (IPCC, 2022; UNEP, 2020).

Technological advancements are enhancing global exposure monitoring, which is vital for tracking climate change and its health impacts. Public databases, private company data, and technologies such as remote patient monitoring, wearables, and Bluetooth devices facilitate real-time and longitudinal health outcome tracking in response to climate events. These innovations enable objective measurement of health outcomes linked to climate change, improving our understanding and response to these challenges (WHO, 2021; NASA, 2020).

2.3.3 Enhancing Health Infrastructure and Services for Climate Resilience

Strengthening health infrastructure is critical for mitigating the health impacts of climate change. This includes designing and constructing health facilities to withstand extreme weather events such as heatwaves, floods, and storms. Facilities should be equipped with systems that ensure continuous healthcare delivery even during climate-related emergencies. Key strategies include improving building designs for resilience, upgrading emergency response plans, and integrating climate risk assessments into health facility planning to ensure long-term sustainability (Sarr et al., 2021; Nair et al., 2020).

Expanding access to climate-smart health services is also essential. This involves developing and implementing health services that are resilient to climate-induced stressors. Features such as energy-efficient infrastructure, flood-resistant facilities, and flexible service delivery models are crucial for adapting to changing climate conditions. These adaptations help maintain service continuity and effectiveness in the face of climate-related challenges (Sarr et al., 2021; Nair et al., 2020).

Advancing research on the linkages between climate change and health is vital for effective mitigation and adaptation. Research should focus on the direct and indirect effects of climate change on health outcomes, such as heat-related illnesses and vector-borne diseases. This research provides the evidence needed to develop informed policies and strategies that address the health impacts of climate change and promote resilience (Myers et al., 2017; Haines et al., 2006).

3. Material and Methods

In the present study, Swat Valley, Khyber Pakhtunkhwa was selected as a universe. The data from total 18 respondents who belong to Swat, Khyber Pakhtunkhwa and have been the victims of the climate change. The sample consists of people with predominantly rural background. They belong to all kind of socio-economic background. Moreover, purposive sampling of 50 different people. When we collected data from these fifty students, we reached to the saturation point and we choose this as our sample size for study. As the information was being repeated over and over again, we limited our study to this point.The nature of our study was qualitative and in-depth interviews were used for data collection. However, before conducting the interviews, a data collection tool in the form of interview guide was developed. The purpose behind the development of this tool was to collect accurate data keeping in view the study objectives. However, new questions were also asked when necessary during the interview process. Each interview lasted up to 40-50 minutes. Before conducting the interviews, the respondents were informed about the purpose and objectives of the study and their confidentiality was ensured.The data was collected through a well-designed interview guide. We conducted interviews, also recorded the voice of our respondents whenever it was needed and we had also taken notes during our interviews with the respondents. After this, the data was transcribed and made case studies from those.

4. Result and Discussion

Data analysis was the most essential task in our field study. We collected data from the selected respondents through interview as a tool of data collection, then we analyzed these data in the case of case studies. This chapter analyzes the different dimensions of the problem. The impact of the climate change on the health of the people of Swat Valley was studied in detail. The problem has also been analyzed from second sources as well as from field

data obtained through a pre-determined methodology. The data was presented in the form of case studies and conclusion was derived from it.

4.1 Case Study No 1

Muhammad Ibrahim Shah, a 24-year-old student from Tehsil, Swat, has observed significant climate changes in Swat Valley over the past decade, including erratic rainfall and prolonged droughts. These changes have impacted agriculture, water availability, and public health. Increased air pollution from wildfires and industrial activities has led to a rise in respiratory issues like asthma. Additionally, climate change has expanded mosquito habitats, increasing the risk of diseases such as malaria and dengue fever.While Ibrahim and his acquaintances have not experienced illnesses from extreme weather events, worsening water quality and reduced crop yields have caused food shortages and malnutrition. He has noted a rise in heat-related illnesses and stress in communities due to uncertain weather patterns. Ibrahim emphasizes the need for enhanced education and resources to help communities adapt to climate change. This includes improving healthcare infrastructure, ensuring clean water access, training healthcare workers, and developing early warning systems. He advocates for combining traditional knowledge with modern practices and adopting eco-friendly habits to better manage climate-related health risks.

4.2 Case Study No 2

Atif Ahmad, a 24-year-old student from Bahrain, Swat, has observed significant changes in local weather patterns over the past decade, including more frequent and intense rainfall leading to flash floods and landslides. These changes have contributed to an increase in waterborne diseases like cholera and typhoid due to contaminated water sources. Although Atif has not been personally affected by extreme weather events, he has seen a rise in respiratory issues in his community linked to heightened air pollution. The expansion of mosquito breeding seasons has led to more cases of dengue fever and Zika virus, while declining crop yields have caused food insecurity and malnutrition. Additionally, the uncertainty of extreme weather events has induced psychological stress within the community. Atif emphasizes the need for comprehensive public health education and awareness campaigns to address climate-related health risks. He advocates for improved healthcare infrastructure, training for healthcare workers, and the development of early warning systems to enhance community resilience and adapt to climate change.

4.3 Case Study No 3

Mazhar Ali Shah, a 20-year-old student from Miandam, Swat, has observed notable changes in weather patterns over the past decade, including increased rainfall, flooding, and landslides. These changes have heightened the prevalence of waterborne diseases like gastroenteritis, due to contaminated water sources. Although Mazhar and his acquaintances have not suffered from illnesses linked to extreme weather events, climate change has extended mosquito breeding seasons, leading to higher incidences of malaria and dengue fever.The impact on agriculture has been significant, with decreased crop yields contributing to food insecurity and malnutrition. Additionally, pollution from agricultural runoff has worsened water quality, posing further health risks. Mazhar has also noticed a rise in heat-related illnesses and increased stress due to uncertainty about extreme weather events. He underscores the importance of public health education, training for healthcare workers, and the development of early warning systems to address these challenges. Proactive measures, including ensuring access to clean water and good hygiene practices, are crucial for community resilience and health in the face of climate change impacts.

4.4 Case Study No 4

Latif Ahmad, a 21-year-old student from Kalam, Swat, has witnessed significant weather changes over the past decade, including hotter summers, colder winters, and more intense rainfall leading to flash floods. These climate shifts have increased incidents of heatstroke and dehydration and exacerbated respiratory issues due to dust storms. The rise in waterborne diseases, such as cholera and typhoid, highlights the vulnerability of communities during floods when access to clean water is compromised. Heatwaves have particularly affected the elderly, like Latif's grandfather, and increased mosquito-borne illnesses, such as dengue fever, due to stagnant water left by floods. Additionally, climate change has disrupted agriculture, reducing crop yields and contributing to food insecurity and malnutrition. Latif also notes the mental health impact, with increased stress and anxiety in response to unpredictable weather patterns and their effects on livelihoods. Latif advocates for improved public health

education, early warning systems, and better access to clean water and sanitation. He stresses the need for proactive measures, including healthcare training, community resilience-building, and sustainable practices. By combining education, early warnings, and traditional knowledge, Latif aims to enhance community preparedness and health in the face of climate change.

4.5 Case Study No 5

Yasir Ahmad, a 24-year-old resident of Kanju, Swat, has observed significant shifts in local weather patterns, including prolonged, drier summers and more intense monsoons. These changes complicate weather forecasting and have led to concerns about health impacts in his community. Yasir has noted a rise in skin issues, like rashes and allergies, potentially linked to worsened air quality due to increased dust. While he has not personally suffered from extreme weather-related health problems, he is aware of waterborne illnesses in nearby villages following floods, highlighting the critical need for clean water access during crises. Water scarcity is a growing concern for Yasir, with springs depleting faster during summers, affecting daily life and sanitation. He is also worried about agricultural challenges, including decreased availability of locally grown produce, which impacts nutrition and affordability. Although he hasn't observed a significant rise in heat-related illnesses, Yasir stresses the importance of awareness and preparedness for such issues, particularly for those working outdoors. To address these challenges, Yasir advocates for several proactive measures, including research into drought-resistant crops, investment in agricultural research, and establishing mobile clinics for remote areas during emergencies. He also supports tree planting to provide shade and conserve water, promoting water conservation practices, and raising awareness among healthcare professionals about climate-related health risks.

4.6 Case Study No 6

Hafsa Bibi, a 21-year-old student from Madyan, Swat, has observed significant changes in local weather patterns, including milder winters, hotter summers, and unpredictable rainfall resulting in floods and droughts. While Hafsa herself has not faced major health issues, she has noticed increased illness among younger children in her village, which she attributes to greater outdoor exposure and changing environmental conditions. Water scarcity is affecting daily hygiene and potentially leading to skin problems. The erratic weather is also impacting agriculture, leading to food shortages and health concerns due to reduced dietary diversity. To address these challenges, Hafsa advocates for education programs focused on disaster preparedness and health management, particularly for women. She suggests establishing regular medical clinics in villages during peak summer months and promotes water conservation and drought-resistant crop cultivation to address water scarcity and improve agricultural sustainability. Hafsa emphasizes the importance of training healthcare professionals on climate-related health risks and integrating traditional knowledge with modern practices. She also calls for government investment in sustainable agriculture and accessible healthcare to enhance community resilience against climate-related health issues.

4.7 Case Study No 7

Fatima Ali Shah, a 25-year-old student from Matta, Swat, has observed significant changes in local weather patterns, including shorter and milder winters, longer and hotter summers, and reduced rainfall. These unpredictable changes have led to an increase in allergies and respiratory issues, particularly during spring dust storms. While Fatima's family has not been directly affected, she is concerned about the impacts on neighboring villages, where people have suffered from injuries and illnesses due to floods. The rise in mosquito populations, particularly after heavy rainfall, raises concerns about diseases like dengue fever. Water security is also a major issue, with erratic fluctuations in the Swat River complicating access to clean drinking water. Additionally, unpredictable rainfall disrupts crop cycles, leading to food shortages and higher prices, which affect community health.To address these challenges, Fatima advocates for proactive measures such as investing in rainwater harvesting systems and conducting educational workshops on climate-related health risks. She emphasizes the importance of collaborative efforts between local leaders and environmental groups to promote sustainable practices and resilience-building initiatives. Fatima calls for government prioritization of environmental protection and the integration of traditional knowledge to help the community adapt and thrive amid changing climate dynamics.

4.8 Case Study No 8

Husna Gul, a 24-year-old resident of Mingora, Swat, has observed increasingly erratic weather patterns, with

milder winters and scorching summers, and unpredictable rainfall. These changes have made it challenging for the community to adapt. Although Husna herself has not faced significant health issues, she notes widespread complaints of headaches and dizziness during intense heatwaves, possibly due to dehydration. Concerns about waterborne illnesses following floods highlight the critical need for clean water access. The rise in mosquito populations after heavy rains raises fears about diseases like dengue fever and chikungunya, straining healthcare resources. Scarcity of clean water, especially during hot summers, compromises hygiene and exacerbates health disparities. Changing weather patterns affect local agriculture, causing price fluctuations and affecting food availability. Heatstroke, particularly among outdoor workers, and the psychological toll of climate change also pose significant challenges. Husna advocates for government support through subsidies for rainwater harvesting and heat-resistant crops, as well as community-driven efforts like awareness campaigns and traditional knowledge preservation. She emphasizes the importance of proactive measures and community engagement to build resilience and improve overall health in the face of climate change.

4.9 Case Study No 9

Rida Khan, a 24-year-old student from Kalakot, Madyan, has observed increasingly unpredictable weather patterns, including shorter winters, longer and hotter summers, and erratic rainfall. These changes disrupt traditional seasonal rhythms and pose significant challenges. Although Rida has not experienced major health issues, she notes that younger children show signs of fatigue, possibly due to intense heat or airborne pollutants. Reports from neighboring villages indicate outbreaks of waterborne illnesses following floods, underscoring the critical need for safe drinking water. Rida is also concerned about rising mosquito populations after heavy rains, which increases the risk of malaria and strains limited healthcare resources. Water scarcity, exacerbated by unreliable springs, leads to hygiene challenges and potential skin infections, particularly for vulnerable groups. The changing weather adversely affects local agriculture, leading to uncertain crop yields and food insecurity. The threat of heatstroke, particularly among the elderly, and the psychological impact of climate change add to the community's challenges. Rida advocates for comprehensive climate education, mobile medical clinics during crises, and workshops promoting sustainable practices and traditional knowledge. She urges the government to prioritize environmental protection and develop climate-resilient healthcare infrastructure. By raising awareness and fostering community resilience, Rida hopes her community can better adapt to the impacts of climate change.

4.10 Case Study No 10

Ahmmad Khan, a 28-year-old resident of Kalam in Swat Valley, has observed significant changes in local weather patterns over the past decade. The region now experiences scorching summers, milder winters, and erratic rainfall, leading to severe floods. These climatic shifts have resulted in a rise in respiratory ailments such as asthma and allergies, linked to increased air pollution from deforestation and industrial emissions. Heat-related illnesses, including heat strokes and dehydration, have also surged, while floods bring the risk of waterborne diseases like cholera and dysentery. Despite avoiding serious health issues himself, Ahmmad reports frequent complaints of headaches and dizziness among neighbors during extreme heatwaves. The community faces an elevated risk of mosquito-borne diseases like malaria and dengue fever following heavy rains. Ahmmad advocates for improved early warning systems, better healthcare infrastructure, and public awareness campaigns to enhance community resilience against climate-related health challenges.

4.11 Case Study No 11

SanaUllah Khan, a 25-year-old resident of Bahrain in Swat Valley, provides a comprehensive analysis of the health impacts of climate change on his community, particularly affecting the lower middle class. Over the past decade, he has observed a shift to sweltering heatwaves and unpredictable rainfall, leading to severe floods that disrupt daily life. These changes have exacerbated respiratory issues like asthma and allergies due to poor air quality from industrial emissions and deforestation. The rise in extreme weather events has also increased heat-related illnesses such as heat strokes and dehydration, along with waterborne diseases like cholera and diarrhea from contaminated water sources. SanaUllah highlights the growing prevalence of mosquito-borne illnesses, including malaria and dengue fever, which spread rapidly amidst the conducive climatic conditions. Additionally, erratic weather disrupts agriculture, leading to crop failures and food shortages that worsen malnutrition and health disparities within the community. The psychological toll of climate change, including heightened stress and anxiety, further impacts well-being. In response, SanaUllah advocates for a holistic approach to addressing these challenges. He calls for robust

early warning systems, investments in healthcare infrastructure, and targeted public awareness campaigns to empower individuals and mitigate health risks.

4.12 Case Study No 12

Gul Bacha, a 30-year-old resident of Kabal in Swat Valley, offers a detailed analysis of the impact of climate change on his community, particularly affecting the lower middle class. Over the past decade, he has observed increasingly scorching summers and erratic rainfall, leading to frequent and severe floods that disrupt daily life. These changes have exacerbated health issues, including respiratory ailments from poor air quality caused by industrial emissions and deforestation, as well as a rise in heat-related illnesses such as heat strokes and dehydration. Gul highlights the severe threat of waterborne diseases like cholera and dysentery, which become prevalent after floods due to contaminated water sources. The increased incidence of mosquito-borne diseases such as malaria and dengue fever, fueled by the proliferation of mosquitoes, further strains local healthcare resources. Additionally, erratic weather patterns disrupt agriculture, causing crop failures and food shortages that worsen malnutrition and health disparities within the community. The psychological impact of climate change is also significant, with rising stress and anxiety affecting community well-being. Gul emphasizes the urgent need for a comprehensive approach to address these challenges, advocating for robust early warning systems, improved healthcare infrastructure, and public awareness campaigns. He calls for collaboration among local leaders, healthcare professionals, and community members to build resilience and ensure a healthier, more sustainable future for Swat Valley.

4.13 Case Study No 13

Raham Gul, a 27-year-old resident of Kanju in Swat Valley, provides a detailed perspective on the intersection of climate change and health in his middle-class community. Over the past decade, Raham has observed increasingly unpredictable weather patterns, characterized by scorching summers and intense rainfall leading to destructive floods. These climatic changes have exacerbated a range of health challenges. The rise in mosquito-borne diseases like malaria and dengue fever is also notable, as these diseases spread rapidly in the altered climate, straining local healthcare resources. Raham also highlights the impact on food security, with erratic weather disrupting agricultural cycles, leading to crop failures, food shortages, and increased malnutrition. The psychological effects, including stress and anxiety about the unpredictable climate, further affect community well-being. To address these issues, Raham advocates for a holistic approach that includes robust early warning systems, investments in healthcare infrastructure, and public awareness campaigns. He emphasizes the need for collaboration among local leaders, healthcare professionals, and community members to build resilience and ensure a healthier, more sustainable future for Swat Valley.

4.14 Case Study No 14

Abdul Aziz Mian, a 24-year-old resident of Madyan in Swat Valley, explores the effects of climate change on health within his middle-class community. Over the past decade, he has observed significant changes in weather patterns, including rising temperatures, erratic rainfall, and increased flooding. These climatic shifts have exacerbated several health issues. Abdul Aziz also notes the growing prevalence of vector-borne diseases. Warmer temperatures and stagnant water from floods have created favorable conditions for mosquito breeding, leading to higher incidences of malaria and dengue fever. These diseases place an additional burden on local healthcare systems. The impact of climate change extends to water quality and availability, with contamination during floods and scarcity during dry spells worsening hygiene conditions. Fluctuations in water quality contribute to skin infections and other health issues. To address these challenges, Abdul Aziz advocates for early warning systems, improved healthcare infrastructure, and public awareness campaigns. He stresses the importance of training healthcare professionals to handle climate-related health issues and calls for community engagement and collaboration to build resilience. By implementing these measures, Abdul Aziz hopes to ensure a healthier and more sustainable future for his community amidst the changing climate.

4.15 Case Study No 15

Faisal Iqbal Mian, a 23-year-old resident of Madyan in Swat Valley, provides an overview of how climate change intersects with health dynamics in his upper-class community. Over the past decade, Faisal has observed significant shifts in weather patterns, including hotter summers and increased rainfall leading to frequent and

destructive floods. These changes have had several noticeable health impacts. Faisal notes the exacerbation of vector-borne diseases such as malaria and dengue fever, driven by extended mosquito breeding seasons linked to warmer temperatures and stagnant water. These diseases add to the strain on local healthcare systems. Water quality and availability are pressing concerns, with floods leading to contamination and dry spells causing water scarcity. Both issues heighten health risks and complicate access to clean water. Additionally, climate change has negatively impacted agriculture, leading to crop damage, food shortages, and malnutrition within the community. Faisal highlights the psychological toll of climate change, including increased stress and anxiety caused by the unpredictability of extreme weather events and their effects on homes and livelihoods. He advocates for a comprehensive approach to address these challenges, emphasizing the need for enhanced early warning systems, improved healthcare infrastructure, and robust public awareness campaigns. To mitigate and adapt to climate-related health risks, Faisal supports community education on proactive health practices and the integration of traditional knowledge with modern healthcare approaches. He also emphasizes the importance of collaboration between local leaders and healthcare professionals to build resilience and promote sustainable practices, such as energy conservation and water management, which benefit both personal health and environmental sustainability.

4.16 Case Study No 16

Hamdan Ahmad, a 31-year-old resident of Kalakot, provides a nuanced perspective on the impact of climate change on his middle-class community. Over the past decade, he has observed increasingly hotter summers and erratic rainfall patterns, leading to more frequent and severe flooding. These climatic shifts have resulted in a surge in health issues, including respiratory ailments like asthma and allergies, likely worsened by deteriorating air quality. Additionally, there has been a notable rise in heat-related illnesses such as heat strokes and dehydration, especially during prolonged heatwaves. The proliferation of mosquitoes, fueled by warmer temperatures and stagnant water post-floods, has increased the incidence of vector-borne diseases like malaria and dengue fever, further straining local healthcare resources. Climate change also disrupts agricultural cycles, causing crop failures and food shortages that exacerbate malnutrition and food insecurity. The psychological toll of climate change, manifesting as heightened stress and anxiety, underscores the need for comprehensive interventions. Hamdan advocates for robust early warning systems, enhanced healthcare infrastructure, and targeted public awareness campaigns to mitigate these health risks. He emphasizes the importance of community collaboration between local leaders, healthcare professionals, and residents to build resilience and ensure a healthier, more sustainable future for Kalakot.

4.17 Case Study No 17

Hameed Ullah, a 27-year-old resident of Barikot in the Swat Valley, provides a nuanced perspective on the impact of climate change on his lower-class community. Over the past decade, Hameed has observed rising temperatures and erratic precipitation patterns that often lead to devastating floods, severely affecting livelihoods and health. He highlights a range of health challenges exacerbated by climate change, including respiratory issues like asthma and allergies, waterborne diseases such as cholera and dysentery, and heat-related illnesses like heat strokes and dehydration. These health threats are particularly acute during extreme weather events, with vulnerable community members experiencing severe impacts. Hameed recounts instances of illness among his family and neighbors due to contaminated water or prolonged heat exposure, illustrating the harsh realities of climate-induced health risks. He also addresses the rise in vector-borne diseases, noting the increased prevalence of malaria and dengue fever due to mosquito proliferation. Beyond these physical health impacts, Hameed discusses the psychological distress caused by the uncertainty and loss of traditional coping mechanisms in the face of unpredictable weather. To address these challenges, he advocates for a holistic approach that includes investments in healthcare infrastructure, robust early warning systems, and targeted public awareness campaigns tailored to the socio-economic and cultural contexts of Swat Valley. Hameed emphasizes the need for community resilience through collaborative efforts among local leaders, healthcare providers, and residents, aiming for a healthier, more sustainable, and equitable future for all in the Swat Valley.

4.18 Case Study No 18

Jawad Ali Mian, a 23-year-old resident of Bar Kalai in the scenic Swat Valley, provides comprehensive insights into the complex relationship between climate change and health dynamics within his upper-middle-class community. Over the past decade, Jawad has observed noticeable shifts in weather patterns, including subtle

temperature changes, increased erratic rainfall, and a rise in extreme weather events like floods. He identifies a range of health challenges exacerbated by these climatic changes, including respiratory ailments, heat-related illnesses, and a heightened prevalence of waterborne diseases such as cholera and dysentery. Drawing from personal experiences and community observations, Jawad recounts incidents of illness during floods and heatwaves, highlighting the community's vulnerability to climate-induced health risks. He also addresses the rise in vector-borne diseases, noting the proliferation of mosquitoes as a significant public health threat. Beyond physical health impacts, Jawad articulates the psychological stress and anxiety associated with the uncertainty of extreme weather events. He advocates for a holistic approach to health, emphasizing the need for enhanced early warning systems, improved healthcare infrastructure, and targeted public awareness campaigns tailored to Swat Valley's socio-economic context. Jawad stresses the importance of collaboration among local leaders, healthcare providers, and community members to build resilience and adaptive capacity. He also highlights the role of sustainable urban planning and green infrastructure in mitigating heat-related illnesses and integrating climate adaptation measures into agricultural policies to enhance food security. Through his detailed understanding of climate change's impact on health, Jawad emerges as a dedicated advocate for community-driven solutions, aiming for a healthier, more sustainable, and resilient future for all residents.

5. Conclusion

The research conducted in Swat Valley, Pakistan, highlights the significant impact of climate change on health in the region. Shifting weather patterns, including shorter, milder winters, longer, hotter summers, and unpredictable rainfall, disrupt traditional seasonal cycles and have profound effects on public health. Climate change exacerbates health issues such as respiratory diseases, waterborne illnesses, heat-related ailments, and vector-borne diseases, with vulnerable populations being disproportionately affected. Increased frequency of droughts and floods places additional strain on water availability and quality, leading to heightened risks of waterborne epidemics and hygiene concerns. Erratic weather patterns further disrupt agriculture, resulting in reduced crop yields, food shortages, and economic instability, all of which contribute to health challenges. Adapting agricultural practices is essential to ensure sustainable food production and enhance community resilience. To address these challenges, strengthening early warning systems and healthcare infrastructure is crucial. Public awareness campaigns, integrating traditional knowledge with modern healthcare practices, and fostering community-driven solutions are vital for managing climate-related health risks. Government support is needed to implement effective climate adaptation and mitigation strategies, including investments in healthcare, disaster preparedness, and mental health support. In conclusion, a multi-sectoral approach that emphasizes community participation, sustainable land management, and diversified, climate-resilient livelihoods is necessary. This approach should address both immediate health impacts and long-term resilience to climate change, ensuring that the health of the Swat Valley's population is safeguarded against the evolving and catastrophic climate challenges that we face.

5.1 Suggestions

To address climate change health impacts in Swat, invest in sustainable infrastructure and strengthen healthcare systems. Promote sustainable agriculture and improve water management to enhance food security. Implement early warning systems and public health education to mitigate risks from extreme weather. Address mental health impacts with support services. Integrate climate considerations into public health policies and support climate literacy for long-term resilience. Foster community engagement and capacity building to enhance adaptive responses to climate-related health challenges.

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