



**RESEARCH PAPER**

**Climate Change and its Effects on Pakistan**

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**ABSTRACT**

To comprehend the challenges and impacts posed by climate change in Pakistan, this paper tries to investigate socioeconomic, environmental, and ecological factors. The paper also aims to address the concerns based on urgency by exploring numerous impacts caused by the growing changes in climate. The repercussions of global warming are severe that affect everyone including Pakistan. For an effective adaptation and mitigation mechanism, understanding the ramifications of climate change on Pakistan is essential. To investigate and collect relevant data on climate change in Pakistan, this research paper looks at the existing academic literature, government policies, international reports, and scientific statistics. The paper's findings and results have identified Pakistan as an extremely vulnerable country in terms of climate change. The rising temperature, changing patterns of precipitation, rapid melting of glaciers, rising level of the sea, heat waves, devastating floods and their impacts on agriculture, rapid contamination and scarcity of water, and growing health issues are some glimpses of climate change in Pakistan. The report emphasizes the necessity of a sustainable mechanism in Pakistan that should include adaptation and mitigation initiatives on an urgent basis.

**KEYWORDS** Adaptation and Mitigation, Climate Change, Pakistan

**Introduction**

Climate change is a challenge to the world environment that has wreaked havoc around the world. The maximum consumption of fossil fuels and non-renewable energy sources by industrial nations has resulted in the rise of temperature coupled with urban, wildfire, and bush fires, rapid melting of glaciers, and occurrence of severe rainfalls and floods. The radical changes in climate during the century have jolted the world's peace and security. In this case, Pakistan is no exception. As the earth's climate system undergoes some unprecedented changes, countries like Pakistan have become vulnerable. It is reported that the country contributes less than 1 percent in global emissions but it faces grave impacts and repercussions of climate change. The rising temperature, glacier melting at high space, heatwaves, floods of 2010, and 2022 including heavy rainfalls in 2022 and 2023 respectively have witnessed the havoc posed by climate change in Pakistan. Since the country's mode of production relies on agriculture, the effects of climate change such as floods, heatwaves, and heavy rainfalls have destroyed the cropping system and fertilization of land.

The concept of climate change is defined by the Intergovernmental Panel on Climate Change (IPCC) as a long-term shift in the patterns of weather, including changes in temperature, rainfall, and extreme events caused by anthropogenic as well as natural induced factors (IPCC, 2021). The core concern of climate change is the growing concentration of greenhouse gases (GHGs) in the atmosphere – particularly the emission of carbon dioxide (CO<sub>2</sub>) from the burning of fossil fuels and the use of pesticides and chemicals. With different parts of the world, Pakistan has also been exposed to a broad range of climate hazards such as an unbearable rise in temperature, scorching heatwaves, rapid glacier melting, floods, droughts, and rising sea level. The country's diverse topography, from the

soaring peaks of the Himalayas to the coastal areas along the Arabian Sea, further amplifies its vulnerability to climate impacts.

The ongoing repercussions of climate change in Pakistan are witnessed as severe and will deteriorate further in the coming decades. The temperature rise has been witnessed throughout the country resulting in extreme heatwaves and heatstroke for a prolonged period in urban as well as rural areas (Khan et al., 2020). The weather changes also alter the monsoon season. It can be witnessed by the increased frequency of heavy rainfalls and severe floods (Muhammad Tahir et al., 2015). The rapid melting of glaciers in the mountain ranges such as the Karakoram range and the Hindu Kush has threatened the country's water resources. Though glaciers provide natural reservoirs, and supply fresh water through rivers used for agriculture and hydropower generation (Rehman et al., 2021). However, the retreat of glaciers has reduced the availability of water and increased the chances of glacial lake outburst floods. Further, the coastal regions of the country are also threatened due to the rising sea level. The rising sea level is expected to lead to saltwater incursion and erosion resulting in the vulnerability of the coastal communities (Memon, 2016). These coastal areas are home to millions of people and contribute significantly to the country's economy through fishing, tourism, and port activities.

Moreover, the country's economy and society are agrarian. The livelihood of a major chunk of the population relies on agriculture. There is also a momentous contribution of agriculture to the country's GDP. Therefore, changes in agriculture caused by the changes in rainfall, and temperature affects the productivity and patterns of crop yield leading to food insecurities and economic losses (Nawaz et al., 2019). To sum up, Pakistan has been exposed to multiple changes of climate change such as extreme weather conditions and temperature, heatwaves, rapid glacier melting, heavy rainfalls, severe floods, and rising sea level. These climate changes have far-reaching impacts on the health and livelihood of humans, and various sectors, such as water resources, the agriculture sector, and the economy as a whole. Therefore, this research venture aims to address the far-reaching implications posed by climate change in Pakistan. This study also aims to explore sustainable ways and strategies for adaptation and mitigation to build resilience and safeguard the well-being of

Climate change has posed significant challenges to Pakistan. The changing nature of climate has threatened the capacity and growth of different economic, social, political, and environmental sectors. This study seeks to understand and address the effects and vulnerabilities posed by climate change in different sectors of Pakistan particularly to the environment, economy, and society. The adverse impacts of climate change in Pakistan are of various kinds including rise in temperature, changing patterns of precipitation, glacial melting, rising sea-level, extreme weather events, and scorching heatwaves. These impacts have far-reaching consequences on the agriculture sector, human health, water resources, and livelihood. Therefore, this paper aims to explore the intensity and implications of climate change in Pakistan and suggests an insight into the policy-making and decision-making, to develop a comprehensive strategy for an effective adaptation and mitigation policy.

## **Literature Review**

This research study explores the existing academic literature on the impacts posed by the changing nature of the climate in Pakistan. The study aims to provide a comprehensive review of existing literature including research journals, government and intergovernmental reports, books, documentaries, and academic sources of data to address the effects of climate change on social, economic, and environmental sectors in Pakistan.

## **Climate Change-Induced Vulnerabilities in Pakistan**

Due to its topography, socio-economic features, and geographical location, Pakistan is vulnerable to climate change. The intergovernmental reports and academic research have addressed the growing increase in temperature, heatwaves, melting of glaciers, changing patterns of precipitation, heavy rainfalls, rising glacial melting, floods, and sea-level rise in different parts of Pakistan (IPCC, 2021).

### **Changes in Temperature**

Academic research and international reports have witnessed an increased average temperature across Pakistan. The occurrence of heatwaves and lengthy periods of life-threatening heat have become more frequent throughout the country (Khan et al., 2020). The temperature change has grave implications for agriculture, human health, drinking water, and the ecosystem.

### **Changing Patterns of Precipitation**

For the last several decades, different studies have witnessed a rapid change in the patterns of monsoon season and precipitation – particularly in timing, distribution, and intensity of rainfall leading to flash floods and related devastations (Kundzewicz et al., 2014). Resultantly, the agriculture sector and water resources are badly affected.

### **Water Resources and Glacier Melting**

The mountainous areas of Pakistan including the Karakoram ranges and Hindu Kush Himalayas host glaciers as natural reservoirs. However, the increase in temperature has been rapidly melting the glaciers that threaten the availability of freshwater resources for the long term (Rehman et al., 2021). The glacial melting, therefore poses grave implications for agriculture, hydropower generation, and water management.

### **Sea-Level Rise and Coastal Vulnerability**

The coastline region in Pakistan is home to millions of people. The coastal region of Sindh, Punjab, and Balochistan is significant in terms of livelihood, fishing, and economy of the country. However, the increase in temperature melts glacial belts leading to the sea-level rise. The sea-level rise has made life vulnerable in coastal regions. The seawater invasion, erosion, and coastal flooding have posed severe risks to settlements, livelihood, and infrastructure of fisherfolk communities (Ali et al., 2018). The coastal regions are also subject to extreme weather events, surges of storms, and floods.

### **Impacts on Agriculture**

Since the country has been accounted as an agrarian nation, its agriculture sector has been a source of economy, employment, food security, and livelihood. However, climate change has negatively impacted and transformed the agriculture system in the country. The agricultural stability and productivity were reduced resulting in a decline in cropping and an increase in food insecurities. The changes in seasons, rainfall, precipitations, water stress, and excessive use of pesticides, and chemicals have reduced the productivity of the agriculture sector in Pakistan (Nawaz et al., 2019). Resultantly, economic growth and prosperity, livelihood, and food security are being adversely affected.

### **Theoretical Framework**

To address the impacts and repercussions of climate change in Pakistan, several theoretical approaches are employed. These approaches provide a comprehensive insight

into the various effects posed by climate change in Pakistan. The approaches also offer various aspects of climate change such as its impacts, adaptation, and mitigation within the context of Pakistan.

### **System Theory**

This theoretical approach provides a foundational framework to investigate the interconnections, and multifaceted interactions between corporeal apparatuses including the atmosphere, biosphere, and hydrosphere, coupled with socio-economic and anthropogenic activities in shaping the effects of climate change in Pakistan (Bertalanffy, 1968).

### **Vulnerability and Resilience:**

This theoretical approach examines the sensitivity, exposure, and capacity adaptive in various parts of impacts posed by climate change. This theoretical approach helps to recognize the social, environmental, and economic contours associated with the impacts of climate change in Pakistan (Adger et al., 2007). In the case of resilience, the approach helps in examining the capacity to recover, adapt, and absorb the impacts of climate change (Folke et al., 2010).

### **Political Ecosystem**

The dynamics of power, governance based on the environment, and access to resources are also associated with this approach. This helps to investigate to examine the role of stakeholders and the challenges posed by climate change (Robbins, 2012). The approach also addresses the cost-benefit analysis and duties based on the repercussions, adaptation, and mitigation process of climate change in Pakistan.

### **Development and Sustainable**

The sustainable development approach indicates a proactive strategy for dealing with the challenges and impacts posed by climate change in Pakistan. The theoretical approach involves the integration of environmental and socio-economic factors for the fulfillment of long-term goals such as well-being and resilience. The approach also examines the interdependency of dimensions such as ecological integration, economic growth, and social equality as the guiding principles during policy-making and execution in Pakistan (United Nations, 2015).

### **Governance and Policy-Making**

To address the impacts of climate change in Pakistan, and formulate a sustainable policy framework, this framework is beneficial in terms of institutional efforts and mechanisms. The approach addresses the role of international society, the government of Pakistan, and intergovernmental organizations as a crucial part of dealing with the repercussions of climate change in Pakistan (Betsiil & Bulkeley, 2007). Additionally, the theory also presents information regarding the risks and hindrances to the governance mechanism during policy-making and execution for the impacts of climate change in Pakistan.

### **Material and Methods**

The research paper has incorporated qualitative and quantitative approaches to research. The qualitative method has been used to interpret and analyze the descriptive data such as interviews and surveys. A thematic approach is used to extract themes and prepare a coding scheme from descriptive data based on the impacts of climate change in

Pakistan. The qualitative analysis aims to capture community-based and individual experiences, perceptions, and strategies concerning the effects of climate change in Pakistan. However, the quantitative approach is employed to use numerical data for the analysis of mathematical data through surveys, databases, and scientific studies. The approach includes learning investigation, statistical modeling, and spatial mapping methods to examine the changing trends, repercussions, and vulnerabilities associated with climate change at different temporal and spatial scales. The study has also incorporated a comparative approach of analysis to compare various demographic groups, regions, and sectors in Pakistan. The comparative analysis seeks to comprehend the variations occurring in climate change, its impacts, adaptation, and mitigation process. Therefore, this analysis facilitates the identification of regional disparities, sectoral vulnerabilities, and capacities in responding to challenges posed by climate change.

### **Data Collection**

To address the effects and ramifications of climate change on Pakistan, the paper has employed primary and secondary data sources. For primary data collection, interviews, field surveys, and observations are used to collect the data. The primary data collection involved ethnographic research carried out by interacting with the most affected communities, policymakers, academicians, experts, and stakeholders on impacts, adaptation, and mitigation measures in Pakistan. However, for secondary data collection, existing scholarly, academic work, journal articles, official reports, and books are reviewed and employed in the research. Both the sources of data collection have provided ample information on the effects, trends, repercussions, and projections of climate change in Pakistan.

### **Results and Discussion**

The analysis includes important findings based on the rise in temperature, changing patterns of precipitation, melting of glaciers, and extreme weather events in Pakistan. It also addresses the repercussions of the impacts on different sectors including the environment, economy, and society.

#### **Rising Temperature**

The analysis and findings of the paper reveal a perpetual increase in temperature across the country. The prolonged heat and heatwaves have become common and frequent particularly in urban part of Pakistan (Khan et al., 2020). The rising temperature poses severe implications for the agriculture sector, human health, the environment, and the economy. Other repercussions include a reduction in productivity, heat-related illness, and deaths among the urban population.

#### **Changing Precipitation Patterns**

The findings address a major shift in precipitation patterns in Pakistan as a result of the intensity of heavy rainfall events during monsoon seasons. The heavy rainfall events are resulting in flash floods and associated destructions (Muhammad Tahir et al., 2015) Other related repercussions include damage to cropping and low productivity, water stress, disruption in cultivation, damage to infrastructure, and other long-term socio-economic ramifications.

#### **Glacial Melting and Water Resources**

The analysis and findings also highlight the grave impacts associated with glacial melting on the water resources of Pakistan. Since Pakistan is already a water-stressed country, the scorching heat melts glaciers leading to the scarcity of water resources in the

future. The retreating nature of the Hindu Kush Himalaya and Karakoram ranges is further affecting the natural water reservoirs (Rehman et al., 2021). This glacial melting reduces water availability and increases the risk of glacial lake outburst floods. The implications are far-reaching, impacting agriculture, hydropower generation, and overall water resource management, which are crucial for sustainable development.

### **Sea-Level Rise and Coastal Vulnerability**

The analysis highlights the sea-level rise as a major threat to the coastal regions in the country. The erosion, saltwater intrusion, and coastal flooding are observed consequences, affecting coastal communities, infrastructure, and livelihoods (Muhammad Tahir et al., 2015). Therefore, the increasing vulnerability of coastal regions in Pakistan due to extreme weather events is placing significant economic challenges and social burdens that would affect the community in the long run.

### **Implications for Sectors**

The increasing severity and impacts of climate change have far-reaching repercussions for sectors such as socio-economic, agricultural, industrial, and economy as a whole. The changes in climate impact crop yields resulting in food insecurity and economic losses in the country (Nawaz et al., 2019). The increased pest and disease incidents and the growing changes in seasons are further adding more troubles for the agriculture sector. The increasing stress on the availability of water resources, risk of flash floods, and groundwater depletion are taking place owing to rapid glacial melting. The impacts on human health due to heat-related diseases and illness, vector-borne diseases, food, and water-borne disease are also witnessed in different parts of the country.

### **Discussion**

The findings and analysis of the study have highlighted the multifaceted and interconnected nature of impacts associated with climate change in Pakistan including the rise in temperatures, changing precipitation patterns, melting of glaciers, sea-level rise, and extreme weather events, that have grave repercussions for various sectors. The adverse effects on agriculture, water resources, human health, and livelihoods require immediate attention and adaptation measures. To address these challenges, an integrated and comprehensive approach like climate-resilient agriculture practices, improved water resource management, and enhanced public health measures are the need of the hour. Additionally, the findings underscore the importance of national policies, international cooperation, and adequate funding to support adaptation and mitigation efforts in Pakistan.

### **Conclusion**

The study has acknowledged climate change as a grave challenge to the socio-economic environment of Pakistan. The adverse impacts of climate change in Pakistan due to the temperature rise, changing patterns of precipitation, glacial melting, sea-level rise, and extreme events of heatwaves, are the key concerns. These impacts have posed severe threats to various sectors including water resources, human health, agriculture, livelihood, and the economy of the country.

Agriculture is the most significant component of Pakistan's economy which is also at the risk of climate change. The sector has become vulnerable due to the temperature rise, changing patterns of precipitation, and scorching heat waves. This has resulted in a decrease in crop yielding, a shift in seasonal cropping, and expanding cases of pests and diseases leading to food insecurities, dangers to livelihood, and the economy.

Water resources in the country are also subject to challenges posed by climate change. The challenges include rapid glacial melting, flash floods, and depletion of groundwater. The retreating of glaciers in mountainous regions has been reducing the availability of fresh water and adding more risks to the outburst of glacial lake floods. Therefore, sustainable water resource management and adaptation measures are necessary to ensure water stress and meet the expanding demands of water supply.

The study has also found impacts of climate change on human health due to rises in temperature, heatwaves, changing patterns of precipitation, and flash floods leading to the spread of water-borne and vector-borne diseases and illnesses among the people. To protect public health and mitigate risks, the implementation of appropriate steps and a comprehensive strategy is crucial.

The sea-level rise has also presented vulnerabilities to the coastal regions of the country. The hazards like erosion and saltwater intrusion poses significant challenges to the coastal belt. The infrastructure and livelihood of the coastal community are at risk which requires proactive management and strategy to promote and enhance resilience and reduce the vulnerability of the coastal population. Therefore, to mitigate the long-term and severe effects of climate change in Pakistan, a multi-faceted comprehensive, and sustainable strategy with adaptation and mitigation measures, must be framed in letter and spirit. Additionally, operative climate change mechanism at the national and international levels is the need of the hour particularly in raising support for Pakistan in its efforts to mitigate and adapt to climate change. The joint effort between Pakistan's international agencies can be a fruitful step in terms of mobilizing and allocating financial resources and information sharing. By taking urgent action, Pakistan can build resilience, protect vulnerable communities, and foster sustainable development in the face of a changing climate.

### **Recommendations**

Climate change has affected the world particularly Pakistan, world should think about it to reduce global warming and future destruction. Some steps can be taken and Pakistan can be protected from future destruction. There is a need for public awareness and the higher education commission Pakistan should encourage research on this side degree programs may be introduced and media is also an important pillar to aware the people. Renewable energy may be encouraged and government should discourage traditional sources of energy. Forest departments may take steps to improve forests and protect them mangroves protection agency may be created. These steps are needed on an emergency basis to discourage environmental issues.

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