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Impact of Climate Change on Pakistan and Proposed Solutions: Evidence from Literature

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Abstract

The current research examines the impact of climate change on Pakistan (social, economic & environmental) and proposed solutions from existing literature. For this purpose, the qualitative research design was adopted, and literature has been taken from the last ten years' papers, articles, reports, and books. However, for the analysis of impacts, the most recent year-2023 literature has been taken from international journals. The result was divided into a total of four themes: a) social, b) economic, c) environmental impacts, and d) mitigation strategies for climate change in Pakistan. Results and findings showed that climate change has negatively affected the social, economic, and environmental well-being of the people of Pakistan, especially, people who are associated with agriculture and livestock. Frequent droughts, urban flooding, land-sliding, cyclones, earth-quick, etc., not only disturb social life but also have several negative economic implications such as decreases the per capita income, loss of Gross Domestic Products (GDP) and food security and safety. Though, Pakistan, being a developing country, has signed many agreements with international organizations like United Nations (UN), World Bank (WB), etc to overcome the negative effects of climate change. Despite strategies and efforts, still Pakistan has failed to achieve its targets due to a lack of funds, political disinterest, lack of awareness among common people about climate change, and administrative inefficiencies as well. The political and administrative seriousness about climate change can make the possible outcomes to overcome the inverse implications of climate change in Pakistan.

Keywords: *Climate Change, Well-being, Urban Floodings, Drought, Food Safety & Security.*

INTRODUCTION

Pakistan has enclosed an area of almost 796,000 km2 with extreme variations in the overall temperature level and precipitation patterns. The eastern and southern regions received precipitation through the summer monsoon from the region of the southwest. While the northern part as well as the western part and some parts of the southern half get the precipitation through the winter. The summer precipitation contained nearly 60% of the total annual precipitation ratio (Burhan et al., 2021, p.10). However, the overall climate differs from the semi-arid to the arid areas, where almost 3/4th of the total country receives rainfall of less than 250 Millimetres (mm) annually. On the other hand,

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in the southern hills of the Himalayas and other sub-mountains regions in the northern regions of the country, where the overall rainfall is reported between 760- 2000 mm annually. Similarly, the northern part of the country also consisted of higher mountain ranges such as the K2, the highest of 8611 meters high, and the largest glaciers of the Siachen which is almost 70 Kilometres (km) long, and the Biafo which is almost 63 km long that feed the Indus River. In these regions, the overall temperature drops to as low as -500C during the winter season and also stayed around 150C in the summer season. The western and the southern regions signify the Indus River Basin plains and Baluchistan Plateau collectively (Chaudhry, 2017, P.1). The Indus Basin covers Punjab, Khyber Pakhtunkhwa, Baluchistan, and Sindh. Moreover, the Indus Basin covers around 95% of the total country's irrigation system. The temperature varies between the upper and lower basins. In the lower plan, it varies from 420C-440C and 230C-4890C in the upper plains of the country (p. 2).

Moreover, Pakistan has diverse landscapes such as the Makran coastal regions of Karachi and Gwadar which are located in Baluchistan province, the Thar and Thal deserts of Sindh and Punjab respectively, and high locales in KPK and Baluchistan. On the other hand, higher mountains are on the country's northern side of Pakistan which included the region of Gilgit-Baltistan. Due to different regions and different geographic locations, climate change varies from region to region and area to area like higher rainfalls in the northern regions and more dryness in coastal areas, etc (Vivid Economics, 2013). Pakistan's economy is more likely dependent on agriculture and livestock, and the change in the overall temperature affects the supply of water to the crops when required. On the other hand, unexpected rains fall damage crops and farming patterns (Shroder, 2002; Rengel, 2003). So, climate change and extreme weather conditions endanger Pakistan's food safety and security. The data showed that Pakistan has been hit by almost 152 big weather disasters that killed around 9989 individuals and the lost cost was around 3.8 billion dollars till the present year (Ashraf Hussain et al., 2022, p. 9196).

Pakistan is the sixth most populous country with a population size of around 220 million with an average population growth of 5.28 million people annually. It is also predicted that it became the world's 5th largest populous country in the year 2050 if the population growth rate would become constant. The Intergovernmental Panel on Climate Change (IPCC), Fifth Assessment Report (AR-5) for Asia showed that the climate change threats the agriculture-based economies, including Pakistan, arise from different landscapes, important geographic locations, socio-demographic trends, and economic factors. Pakistan also lacks the modern or required adaptive capacity that also determines the vulnerability profile of the country through a vicious circle of poverty. The climate change estimates given by the AR-5 also showed that the overall warming and increase in temperature are likely to be above the set global means, impacting the melting of glaciers and changing the overall precipitation patterns. Therefore, this will significantly impact the productivity and efficiency of water-dependent sectors, such as agriculture and energy, which are the major sources of the country's economic indicators (Rashid, 2021, p. 1).

Similarly, climate change raises concerns for Pakistan with its enormous social, environmental, and economic impacts. Over the years, Pakistan is mainly uncovered natural hazards such as frequent floods, a higher number of droughts, and cyclones. These natural and man-made environmental hazards, combined with the overall vulnerabilities to extreme poverty, exclusion, and inappropriate political decisions, and actions make people more vulnerable to the impacts of these natural and man-made hazards on their well-being (Rafiq & Blaschke, 2012; Ajani & van der Geest, 2021). The agriculture sector of Pakistan is also more vulnerable to climate change. This would impact the cropping patterns and productivity returns, as a result of these weather changes that will badly affect the poor and rural communities of Pakistan (Syed et al., 2022). Likewise, dry land areas, also included, the arid and semi-arid regions, are also more susceptible to

these climate change factors. These mentioned regions are already encountering significant water shortages and high-temperature issues due to climate change. The reason is that the larger population of Pakistan is economically and socially dependent on the primary resources, due to any agricultural country (Mustafa, 2011, p. 100).

In short, climate change is a major issue that has initiated serious other challenges for humanity across the world and more concerning issue for Pakistan. The IPCC reports showed that the process of reduction and modifications positively or negatively affects productivity related to other societal goals; human health, food security, environmental issues, and economic concerns (IPCC, 2012, p. 5). The report also found that climate change causes results in the form of extreme weather and climate events in Pakistan. In Pakistan it is observed the extreme rise in temperature, varying seasons, changes in the pattern of precipitation and snowfall, intensifying sea level, high melting of glaciers, urban flooding, lessening sea-ice levels, and posing many other severe threats to the world as well as Pakistan (Shahid & Adnan, 2021, p. 224).

Therefore, climate change in Pakistan is caused by both natural and men made factors. The major cause of climate change is the excessive emissions of dangerous gases such as methane, carbon dioxide, nitrous oxides, etc are emitted by industrial, commercial, and domestic activities (IPCC, 2014). Since the Industrial Revolution, the largest contributor to the increase in global warming is the excessive emission of carbon dioxide which is followed by methane. The CO2 concentrations have also increased from 278 parts per million (ppm) in the year 1960s to 401 ppm in 2015 respectively which accounted for 44% overall increase percentage (p. 9). In addition, solar radiation is also greatly influenced by climate change in Pakistan, such as the variations in the sun's energy, which has impacted the temperature level and climate patterns. The unexpected changing patterns of monsoon rains are also a result of seasonal wind patterns (Chaudhry, 2017, p. 29). Moreover, the Indus River system and its tributaries are crucial for Pakistan's water resources and agricultural production. Changes in the flow and volume of water in the Indus River system, which can occur due to natural factors like snowmelt and glacial melt, can impact water availability and the overall climate in the region (p. 12).

METHODOLOGY

The present study examines the impact of climate change on Pakistan and proposed solutions: evidence from the existing literature from the last ten years, both nationally and internationally perspective. For this purpose, the qualitative research approach was adopted. The secondary data was collected from research papers, books, and other related reports downloaded or studies from Google Scholar (Sutton & Austin, 2015; Irwin, 2013; Ruggiano & Perry, 2019). These papers and policy documents were collected and searched through keywords: "Climate Change in Pakistan", "Impact of Climate Change in Pakistan", "How to overcome the negative consequences of climate change in Pakistan", "Proposed solutions to mitigate the negative implications of climate change in Pakistan", "Climate change and economic impacts", "Climate change and Social Implications", "Environmental Impact of Climate Change", "Issue of Climate change in Pakistan" etc. The majority of reports, research papers, and books were published after 2010. The results of the study were divided into some major themes such as phenomena of climate change, social impacts, and economic and environmental impacts of climate changes in Pakistan. Further, the last theme prosed some solutions to overcome the negative implications of climate change in Pakistan.

Similarly, new research articles published in the current year 2023 about the impact of climate change from the international perspective were examined systematically. For each climate change impact, more than four articles' abstracts were critically examined and investigated (Tullu, 2019). However, for the proposed solutions, more than five international context research papers' abstracts and topics. To search these articles, the

keys work “Climate change impact in 2023”, Impact of climate change 2023 internationally”, or “How to mitigate climate change” etc searched in google scholar. In this regard, the title, location of the study, research design, and results were mentioned in tabular form.

RESULTS & DISCUSSIONS

Pakistan is the second-largest country in terms of population in South Asia, consisting of dry areas with low levels of agricultural production potential. The geographic profile also varies across the country, which shapes the overall variation in the country’s climate. The climate ranges from the winter to extremely cold and in summer it is extremely hot weather conditions. Also, Pakistan is covered by the Himalayas on its northern side, the Suleiman Mountain in the east, the lowland plains of the Indus River in the south-west, and also the coastal areas of Baluchistan and Sindh (Ajani & van der Geest, 2021). Similarly, 60% of the total watershed area of the Indus Basin lies within Pakistan. Therefore, climate change exposes these mentioned vulnerable areas to the higher risk of glacial retreat, and sea level rises, especially in Karachi and Baluchistan. The temperature is increasing over time, and more frequent floods (2010, 2012 & 2022), droughts, and cyclones (2007) occur as observed in the last two decades. Most of the areas are arid and semi-arid, which are also considered vulnerable to floods and land-sliding (Janjua et al., 2021, p. 1330). A study showed that in Pakistan, almost 22.8% area and 49.6% population is at the highest risk due to the inverse impact of climate change (Asian Development Bank, 2008, p. 8). Furthermore, Pakistan is more vulnerable in the context of food security due to its larger dependency on agricultural production. Also, food security is at risk due to frequent floods, water logging, desertification of land, growing frequency of pest attacks, and frequent disasters that have been observed multiple times. As it has been projected that a 1oC rise in temperature level can decline of 6-9% in the wheat yield production in Pakistan and also have inverse effects on other crops, such as mango and cotton (Mustafa, 2011, p. 102-103).

Similarly, Ashraf et al. (2022, p. 9195) argued that Pakistan is among one the top ten countries in the world, where climate change is having the most negative effect on the livelihood of the common population. Though, climate change has affected almost every country in South Asia, particularly Pakistan, in terms of climate vulnerability and inverse effects on the livelihood of people. The reasons are no modern techniques to counter climate threats, and people are less likely aware of the negative implications of climate change. The majority of people in Pakistan, not even considered climate change as a threat to humanity (World Bank, 2022). On the other hand, the physical infrastructure of Pakistan is not well designed to tackle climate-related threats that’s why multiple times, droughts, earth quicks, floods, hurricanes, avalanches, and other types of disasters hit the country. Still, Pakistan has no informed and integrated national-level plan or strategy to counter the climate-related threats which have been already identified by many international organizations (UN & World Bank) reports (Islam et al., 2016; Rengel, 2003).

Also, Pakistan’s food supply, energy security, and general well-being are in a bad situation. The reason is that Pakistan is using excessive quantities of fossil fuels and other man-made greenhouse gases. Though, Pakistan is a developing country, has fewer resources to utilize mitigative strategies for climate change. Pakistan required almost 7 to 14 billion dollars to adopt the strategies for countering climate change-related threats (Brøns-Petersen & Gjedsted, 2021).

Pakistan on the other hand, has signed many international agreements with other countries and UN organizations to counter climate-related threats through minimize the emission of greenhouse gases. However, world leaders are also concerned about the future effects of climate change that’s the reason they have designed different strategies to

counter the negative effects of climate change (Mustafa, 2011). Similarly, a study by Dwivedi et al. (2022) found that the United Nations Climate Change Conference (COP-26) brings together almost many international leaders, policymakers, and organizations to address climate change and global warming. The purpose of this conference was to gain the commitment to sustainable progress towards the Paris Agreement and the UN framework convention on climate change, by decreasing the overall global temperature to a level of 1.5oC equal to the pre-industrial level (COP-26, 2021). On the other hand, the IPCC also identified in the year 2018 that global emissions would be at a net zero level in the upcoming year 2050 through the level of limiting the temperature to sustainable levels (Masson-Delmottee et al., 2018). In a speech by the U.S. Treasury Secretary Janet Yellen during the conference stated that "the rising to this challenge will also require the wholesale transformation of our carbon-intensive economies, and addressing such climate change is the greatest economic opportunity of our time" (COP26, 2021).

Table 1. USAID Report-Pakistan – Floods SEPTEMBER 2, 2022 (M-Million)

Flood Affected People	**People Requiring Humanitarian Assistance**	**Houses Damaged**	**People in Official GoP Displacement**	**Flood Related Deaths**
33 M	6.4 M	1.4 M	627,793	1,265

Climate change has badly impacted the overall well-being of the population of Pakistan several times (Ajani & van der Geest, 2021). The recent flood of 2022 also has inversely affected the social, economic, and emotional well-being of Pakistani people.

At the event of the Sustainable Development Summit in the year 2015, all the UN Member States committed to adopting the 2030 Agenda for Sustainable Development, which consisted of a set of 17 Sustainable Development Goals (SDGs). The most important goals related to climate change are the: SDG-6 for clean water and sanitation, SDG-7 for affordable and clean energy resources, SDG-12 is responsible for environmentally friendly consumption and production, SDG-13 is completely related to climate change, and SDG-15 deals with life on the earth (Nawab et al., 2023). Pakistan has surely fulfilled much of its SDG 13 responsibility. The country passed its first-ever National Climate Change Policy in 2012 and ratified the Paris Agreement in 2016. The commitment of the current government to the Billion Tree Tsunami program, Clean and Green Pakistan initiative, Protected Areas Initiative, and Ecosystem Restoration Fund are also laudable. Moreover, the 12th Five-Year Plan and provincial medium-term development strategies are all aligned with the 2030 Agenda (Government of Pakistan, 2019, p, 9-10).

Impact of Climate Change on Pakistan

The stated of Pakistan, like other developing countries, remains extremely vulnerable in terms of the negative impact of climate change on social, economic, and environmental well-being. The low Green House Gases (GHG) emission status has provided no safety and security from the hostile effects of global climate change. Presently, Pakistan is also fronting contrary effects of climate change with the higher ratio of melting of glaciers in the northern regions, continued droughts, hot winters in urban areas, premature summers, number of cyclones in coastal areas of Baluchistan and Sindh, which are some of the examples of climate change impacts on Pakistan (Mustafa, 2011, p. 108-109). Furthermore, the carbon sinks are also highly undignified in Pakistan. The country has the lowest forest cover 4.5% with a tremendously higher rate of disforestation of 0.2-0.4% per annum (p. 109).

Geologically, Pakistan is located in a region that is highly vulnerable and influenced by climate change as mentioned above (Malik et al., 2012). Therefore, frequent disasters such as continued flooding, droughts, and other natural calamities are some of the few examples of climate change in Pakistan. The data from the flood of 2010 impacted over 20 million people in Pakistan, who lost their homes, got wounded and many children

were missing in floods. Another flood that occurred two years back in 2012 also brought disaster in Pakistan. Climate change affects the income level, and shelter, food, and security are also at higher risk in Pakistan (German Watch, 2014).

Table 2. Summary of Climate Risks for Pakistan (Mustafa, 2011, p. 101)

Climate Risk	High	Moderate	Likely
Sea Level High		Moderate	
Glacier Retreat	High		
Temperature Increase	High		
Floods more Frequent			Likely
Drought more Frequent			Likely

Table 2 showed that in Pakistan glacier melting is high, and temperature is increasing day by day. This leads the floods and droughts occurring over time and is also a sign of increasing temperature.

Similarly, in the year 2022, flooding and landslides caused by the heavy rains and glacial lake upsurges during June and July affect almost 33 million people in Pakistan. The data of the flood showed that around 1,265 people died, as the government of Pakistan mains search-and-rescue and relief actions. On the other hand, the USAID triggers the DART and the RMT to align the USG flood reply to efforts, as well as announced $30.1 million in life-saving aid for the flood-affected populations in Pakistan. The UN also released its 2022 Pakistan Floods Response Plan on August 30, demanding $160.3 million to provide humanitarian assistance and support to the 5.2 million of the most vulnerable 6.4 million people in need and requirements as a result of the flood (USAID, 2022, p. 1).

Table 3. Summary of Damages Due to Recent Floods in Pakistan-2010 (Mustafa, 2011, p. 111)

Summary Damage	Baluchistan	KPK	Punjab	Sindh	AJ&K	GB	G. Total
Death	48	1156	110	186	71	183	1754
Injured	98	1193	350	909	87	60	2697
House damage	75261	200799	500000	1058862	7108	2820	1844850

Table 3. Showed the summary of damages due to floods in Pakistan-2010 (Mustafa, 2011, p. 111). The impact of climate change is divided into a few themes: social, economic, and environmental impacts in Pakistan.

Social Impacts of Climate Change

Pakistan is extremely vulnerable to climate change when it's come to social impacts. The Human Development Index ranks Pakistan as the 125th country out of 169 countries in terms of climate vulnerabilities. Over the ten years, the overall death rate goes higher due to earthquakes. However, in the last few years, flooding has also enormous impact on the overall livelihood of the common population in Pakistan (Ashraf Hussain et al., 2022, p. 9207). The figures also showed that about 2000 people died in the flood of the year 2010, which also destroyed almost 12 million households and destroyed 2.2 million hectares of stand crops. According to the estimates of the UNISDR (2014), floods are responsible for around 75% of the average 1.3 billion dollars in losses caused by natural disasters each year across the world. Due to frequent changes in temperature, and rainfall, both urban and rural populations are more likely to get vector-borne diseases, which can also affect heat stress levels in Pakistan. This has negatively impacted the reproductive health of young children, who live or work in any building with an impoverished ventilation system in Pakistan (Ashraf Hussain et al., 2022, p. 9201).

Climate change in Pakistan also drives many other social issues such as an increase in the rate of rural-urban migration, pressure on mental health conditions, child marriages, boost early birth rates, and also domestic violence. Less food or social security means people are more inclined towards the birth of more children to support as a working hand in the

family. This also promotes children's marriages, which leads the domestic violence due to a lack of education and poverty (McLeod, Barr & Rall, 2019). Also, climate change enhances the mortality ratio among children as well as older people. The report of WHO (2016) showed that number of deaths caused by heat among people is 65 and older 10 per 100,000 to around 63 per 100,000. Similarly, in Karachi Pakistan, the heat waves in 2015, killed almost 1400 people alone. In addition, climate change also worsens the effect on communicable diseases, and air pollution due to energy sources. Moreover, climate change also impacts respiratory infections, and lung cancers, and produces other heart-related diseases due to the burning of fuels, etc during cooking.

A study conducted by Ali et al., (2021) showed that 93% of households in Pakistan used solid fuels to cook, and 91% population is dependent on firewood as their main source of heating and cooking at home. These not only increase the intensity of air pollution but also affects respiratory infections etc (WHO, 2016). Every year around 326 people die, due to indoor pollution (WFO, 2020) and about 34,000 children die each year due to lower respiratory infections caused by air pollution globally (WHO, 2016).

Furthermore, climate change has also impacted the health outcomes, such as food security, affecting water quality, cumulative heat stress, and expanding frequency of natural disasters. These have a direct impact on human health vulnerabilities (Khan et al., 2016). In the context of Pakistan, a vector-borne symposium study revealed in, "Changing Environmental Pattern and Its Impacts with Special Focuses on Pakistan" showed that climate change has initiated the diseases, such as malaria, dengue, typhoid, and cholera that have significant cause of the overall mortality and morbidity ratio in Pakistan. Similarly, due to climate change, the ratio of the epidemic potential of 12-27% for malaria and 31-47% for dengue is anticipated (Mustafa, 2011, p. 111). As mentioned, it also impacts food security in Pakistan, and children mostly in rural areas do not have sufficient food and die due to lack of food. Therefore, the Global Hunger Index of 2020 Pakistan ranked 88 out of 107 countries. In addition, in Pakistan, 62% of rural children do not get enough vitamin D and also 51.2% of women of reproductive age is suffering from anemia respectively (Khan et al., 2016, p. 113).

Table 4. Climate Change: Social Implications

Reference	Methodology	Results
Casson et al., 2023	Survey of Canadians about the knowledge about the climate health impacts. The ANOVA tests were applied to test the hypothesis.	People in Canadian are extra worried about health & climate change. Concern about food security, environmental safety, and air quality, compared with impacts on mental health, infectious diseases, and illnesses. On the other hand, women are more conscious about health-related impacts.
Ayanlade et al., 2023	Conceptual Framing of Vulnerability Synthesis in the Africa chapter of (IPCC) 6th Assessment Report (AR6).	Climate-related risk management system is rooted in a lack of attention to interacting social drivers and effects on social risk, & orientation toward vulnerability analyses at coarse social and spatial levels.
Galanakis, 2023	Climate-related changes, COVID-19, and the war b/w Russian & Ukrainian impact on the food security system.	Transformation of the food sector should be proactive regarding food safety & security, circular, digital, and inclusiveness. However, the food production system is modern through the implementation of emerging technologies.
Tam, Chan & Clayton, 2023	A cross-national study using the Climate Change Anxiety Scale, with 4000 participants from China, India, Japan, and the U.S.	Climate change anxiety is higher among the Chinese and the Indians than among the Japanese & Americans. It was also positively correlated with engagements in climate action in all four countries. But more so for sustainable diet and climate activism than resource management and support for climate policy needed.

The results of all the mentioned studies Casson et al., (2023); Ayanlade et al., (2023); Galanakis (2023); Tam, Chan & Clayton (2023) found the positive association that climate change affects the social well-being of the people of Pakistan.

Economic Impacts of Climate Change

The economic cost of climate disasters is very high at the global level and also the mitigation process required higher costs. Pakistan anticipates a plan to reduce 20% of the GHG projected up to the year 2030, subject to the availability of funds, and international grants to meet the cumulative cost amounting that is 40 billion dollars (Fawzy et al., 2020). Also, the country's climate change mitigation strategies adaptation requires to be identified to range between 7 billion dollars to 14 billion dollars per year (Chaudhry, 2017). Though, Pakistan is an agricultural economy as already mentioned that has already faced numerous difficulties due to climate change-related threats. The agriculture sector not only endure food security but also employed around 22% of the total workforce and contributed 22% to the total GDP of Pakistan annually (Mustafa, 2011, p. 109).

Similarly, the large number of storms, floods, and frequent droughts in turn are exposing the country to threat of the overall socioeconomic losses such as minimizing agricultural output, loss of food crops, destroy the land etc. So, the IPCC's data showed that climate change has decreased almost 30% of major crop yields due to water logging, high salinity, and continuous floods in Pakistan. Also, the temperature is increasing day by day in Pakistan which decreases the fertility of the agricultural land. The same study also identified that with just a 1oC rise in temperature, the wheat yield is to be projected to decrease by 6-9% and an even lesser increase is inevitable to severely influence other cash crops such as the production of mangos and cotton respectively (P. 102).

Furthermore, the Water and Power Development Agency (WAPDA) has estimated that per capita surface water ease of use in Pakistan dropped from 5260m3 in 1951 and just 1000m3 in 2008 and expects more decrease in coming years (Mustafa, 2011, P. 110). The decrease in the follow of water inversely affects the crop products that require 93% of fresh water. Also, alternative sources of water availability are declining in Pakistan. The year 2012-23 contributed to a projected 12 million tons deficit in gain production (Mustafa, 2011, p.110). On the other hand, the main food crops are also damaged over 3.2 million hectares, which included the total 7.9 million Ares of cultivated land (p. 112). The reason for the declining water level is access to floods in Pakistan. Floods have a direct relationship with the economic conditions of Pakistan. The flood of the year 2012 also damaged almost 14% of total cultivated land and 8 billion Pakistani rupees require for rehabilitation of the lost cost and communities (Looney, 2012).

Also, Pakistan is an agriculturally based economy that requires a continuous flow of fresh water to feed the crops due to changing patterns of annual rain. Owing to climate change, the western mountainous regions are going towards dryness, and the quick temperature rises could increase the course of de-glaciations, which would greatly impact water resources that are being used for agricultural purposes (Ullah, 2017). The high temperature leads to floods and land sliding in mountainous regions. Since 2010 five successive floods and landslides have caused more than 25 billion dollars of economic setbacks for Pakistan (Ashraf Hussain et al., 2022, p. 9204). These floods have damaged the health infrastructure, irrigation system, agricultural land, and educational infrastructure as well, which required billion of Pakistani rupees for rehabilitation and resettlement purposes.

In other words, annually, the economic cost of floods and land sliding is equal to 5% of the total GDP of Pakistan. If added the overall inflation fluctuations due to these floods, it reached almost 20% of the total GDP shared. In comparison, the price of managing to alleviate atmospheric GHG levels, with a range of 500-550 ppm of CO_2 equivalent is counted to be almost 1-2% of the global GDP annually. By the end of the year 2040, the

average temperature across Pakistan was projected to be increased by 0.5 degree Celsius, and 8-10 percent of all crops, or 30,000 rupees per acre will be lost (p. 9205).

Table 5. Climate Change: Economic Implications

Reference	Methodology	Results
Abdi, Warsame & Sheik-Ali, 2023	Pooled mean group (PMG) approach was adopted in nine East African nations.	Precipitation & carbon emissions affect the cereal crop output. The cereal crop output has a bidirectional connection with the level of temperature, carbon emissions, and cropped area.
Adediran et al., 2023	Macroeconomic effects of climate change for a panel of 22 countries classified by economic groupings.	Climate change impacts exchange rate markets, and stock markets' ups and downs, but fail to protect climate risks due to policy uncertainty and implications.
He et al., 2023	The upscaling of public investments in research and development on renewable energy development process.	Climate change also impacts the overall investment rate, the high level of consumption of natural resources by the population & also the urbanization boosts due to economic activities, impacting net exports and migration as well (domestic and international migration).
Zahra et al., 2023	Global perspective analysis of the secondary available data.	Climate change events, such as eCO_2, higher heat levels, frequent drought, and more salinity stress stresses. The heat + drought, eCO_2 + drought, and eCO_2 + heat stresses change the overall production level of wheat grain quality in terms of grain weight, nutrient, anti-nutrient, fiber, and protein gratified, and composition level, starch granules, and free amino acid composition level as well.
Abeysekara, Siriwardana & Meng, 2023	ORANI-G-SL-Model application. A locale was Sri Lanka, as a South Asian case study.	Reductions in the output level of crops increased consumer, higher prices of agricultural items, with a significant decline in the ratio of household consumption. The decline in the ratio of overall crop production and increases in food prices also leads to food insecurity. Also, climate change has negatively impacted most of the macro and microeconomic variables of the Sri Lankan economy. And can be generalized to other South Asian countries.
Park et al., 2023	Compared to the period (2006–2015), a global future fire carbon emissions & GDP per capita.	Results showed that the meteorological factors have a strong effect under the higher warming cases. The Fires in boreal forests were particularly expected to increase, because of an increase in fuel dryness due to climate change

The conclusion of the studies Abdi, Warsame & Sheik-Ali (2023); Adediran et al. (2023); He et al. (2023); Zahra et al. (2023); Abeysekara, Siriwardana & Meng (2023); Park et al. (2023) showed that the climate change has a higher economic cost and larger share of the GDP of Pakistan lost every year due to climate change-related issues.

Environmental Impact of Climate Change

Climate change has an inverse impact on the environment such as enhancing the air water and land population. The increasing temperature level also affects the fertility of the land. Also, the severity of level of climate change is increasing with the increase of the global temperature level and Pakistan is more vulnerable in this context. Even, if global warming is kept within 2oC relative to the pre-industrial levels, the negative effects will be experienced also due to some other intervening factors, and the world needs to make such strategies and policies to overcome the negative implications on the environment. As studies have Nwokolo, Obiwulu & Ogbulezie (2023); Osman et al. (2023); Zahra et al.

(2023); Mustafa (2011) found that climate change promotes urbanization and increases the population ratio, which leads to environmental challenges in addition to food security, or general security issues in society (Ashraf Hussain et al., 2022). On the other hand, the UN has also predicted that in the year 2025, an increase in the global population is likely from 7.2 billion to 81 billion, a huge burden on the environment and vulnerable population.

Table 6. Climate Change: Environmental Implications

Reference	Methodology	Results
Chien, Chau, & Sadiq, 2023	A study was conducted from the perspective of China. Nonlinear ARDL techniques were utilized to test the hypothesis.	Results showed that renewable energy, consumption level, and depletion of natural resources have a negative association with greenhouse gas emissions in China. While population growth & industrialization have a positive relationship with climate change.
Nwokolo, Obiwulu & Ogbulezie, 2023	Analyzed 294 Physical Models by using learning, Gumbel's probabilistic approach (GPM) by using energy parameters from the Australian Community Climate and Global System Simulation.	Findings showed that the consequences of climate change on photovoltaic technologies are a very less damaging impact than 1% on renewable energy technologies. The CIGS thin film technology also produced negative effects on climate change, with 10.94%–36.75% in the best-case, 35.71%–36.36% in the moderate-case, and 33.33–40.00% in the worst-case scenario for shared socioeconomic pathways (SSP126, SSP245, and SSP585) emissions.
Osman et al., 2023	The global context literature review-based study	The findings of the study showed that energy derived from fossil fuels contributes more than 75% of the total GHG emissions and approximately 90% of all carbon dioxide emissions. The negative impact of climate change, like increasing the overall temperature level, high winds, rising sea levels, and decreased or changes in rainfall patterns, also affect renewable energies.

Studies conducted by Chien, Chau & Sadiq (2023); Nwokolo, Obiwulu & Ogbulezie (2023); Osman et al. (2023) showed that environmental loss is also there in Pakistan due to climate-related problems.

Mitigate the Negative Impacts of Climate Change

The record climate change extremes are decreasing the quality of urban livelihood, a combination of social inequalities, and threatening the developmental infrastructure. Adopting such types of measures, that can share the technological nature-based and social solutions can provide multiple co-benefits and easiness to address the overall complex socio-ecological issues and problems in cities. While the aggregating major resistance to the potential impacts on the overall well-being of the population. Therefore, such important strategies and policies to combat the negative implications of climate change through the global adaptation approaches under the umbrella of the United Nations Framework Convention on Climate Change are required. This means, consolidating and strengthening the overall mechanisms to support the practical adaptation and implementation of policies under the convention by facilitating the widespread and comprehensive national strategies and pledging funds for the higher-priority implementation of climate-related projects (Obergassel et al., 2016). The implementation and adaptation of national energy policies and industrial policies would contribute to climate change impact mitigation by reducing the overall emission of GHG across the world, especially in the context of Pakistan is more needed due to its vulnerable socio-geographic conditions.

From the environmental perspective of Pakistan, the adaptation of climate-related strategies is the submission of the National Communication to the UNFCC in the year 2003. Also, the formation of the Prime Minister's Committee on Climate Change, which has a major responsibility for the overall monitoring and evaluation of weather changes & patterns and gives policy recommendations to the government or ministry (Shahid & Adnan, 2021, P. 228). Furthermore, the Planning Commission of Pakistan 2008 made a special Task Force on Climate Change with the primary responsibility to design such climate-related policies which mitigate the negative impacts of climate change-related threats. In the year 2010, the Special Climate Task Force come up with some of the major recommendations that Pakistan needs to adopt and mitigation actions in the major socio-economic areas or sectors (GoP, 2010).

In the year 2008, the government of Pakistan with the primary support of the UNDP launched a project worth 37 million dollars for those areas, which are strongly hit by climate change. A major portion of these funds were utilized in the rehabilitation and resettlement of the affected communities across Pakistan. Another project was introduced after 2012 the Green Climate Fund (GCF) is a five-year project targeting the areas and communities that are vulnerable in Gilgit-Baltistan and Khyber Pakhtunkhwa. The purpose of this project was to achieve sustainable development goals and end poverty before the year 2030. The primary beneficiaries were women, which leads to help them to remove gender inequalities from society (UNDP, 2018).

Similarly, the "Ten Billion Tree Tsunami" was a pioneer project of the government of Khyber Pakhtunkhwa in the year 2014 with the cooperation of the Ministry of Climate Change to planting drive of plantation in response to the existing threats challenge of global warming and climate change. Pakistan's Ten Billion Tree Tsunami restores almost 350,000 hectares of total forests and degraded land to exceed its Bonn Challenge commitment. The project was appreciated by international organizations and communities. In the year 2018, the federal government also extended this Ten Billion Tree Tsunami project to other provinces of Pakistan including Gilgit-Baltistan and Kashmir as well (Ashraf, 2022).

Similarly, the estimates EPA, wind power has now been considered a major energy resource in the world, where wind turbines use the wind, a renewable source of energy, to produce electricity or power. It has no negative impact on environmental degradation due to the clean energy production system and it does not require water to produce the power (González, 2023; Liu, Shamdasani & Taraz, 2023). Likewise, the U.S. Department of Energy has also estimated that the usage of wind power (turbine) cut the overall water consumption in the power sector by almost 36.5 billion gallons in the year 2013 only. The natural gas and petroleum system are also contemplated among the common sources of methane emission. Therefore, upgrading the traditional equipment and machinery being used in transferring, storing, and producing oil and gas can restrict methane leaks.

In addition, climate change impact mitigation processes and strategies need the establishment of overall consumption options with high mitigation abilities measured in tons of the overall CO2eq/capital/yr. The smoke through transport releases higher levels in the environment. To overcome this issue, including living cars-free, shifting to a battery-electric vehicle, hybrid system of vehicles, and reducing the long return flight with a median reduction in the overall potential of more than 1.7 tCO2eq/cap. From the perspective of food products and items, the highest carbon savings come from dietary changes, especially the use of a vegan diet with an average potential of 0.9 and 0.8 tCO2eq/cap (Ivanova et al., 2020, p.1).

Moreover, moving towards renewable electricity production and generation and also refurbishment and renovation are the major choices and adaptation strategies with the highest mitigation probable in the household domain, with the median at 1.6 and 0.9 tCO2eq/cap. In addition, the findings of the top ten consumption options together yield an

average mitigation potential of the 9.2 tCO2eq/cap, also showing the important contributions towards achieving the 1.5oC-2oC target, particularly, in the high-income country's context, where Pakistan is excluded (p. 2).

Similarly, after the successful implementation and completion of Pakistan's Billion Tree planting drive across the 350,000 hectares of land in Pakistan which was started in the KPK province in the year 2014, then the first Bonn Challenge pledge to meet and exceed the set targets to achieve the suitable climate change initiatives to mitigates the negative implications of climate change in Pakistan. Therefore, Pakistan has scaled up the targeted initiative to the 10 billion Tree Tsunami stated during the era of the government of Pakistan Tehreek-i-Insaf (Government of Pakistan, 2019. P, 10). This five-year, country-wide tree-planting drive aims to restore the overall depleted forests and mitigate climate change challenges which were also experienced by the country many times in the form of droughts, floods, cyclones, etc. In addition, with the launch of the Clean and Green Pakistan and also the Recharge Pakistan initiative, the country has taken the lead position in 'nature-based and environmentally friendly solutions for the ecosystem restoration' among developing countries, with the added benefits of safeguarding the overall biodiversity and generating livelihood opportunities for the vulnerable communities in Pakistan (P. 9).

Table 7. Climate Change: Mitigation Strategies

Reference	Methodology	Proposed Solutions
Abramoff et al., 2023	Meta-model: tested 10 statistical models baseline period (2000–2010); global perspective.	The adaptation of representative concentration pathways strategies enhances 6 21% of the total crop production.
Chien, Chau, & Sadiq, 2023	The nonlinear ARDL technique was utilized to test the relationship between the constructs over the time from 1991–2021 in China.	Regulators formulate some guidelines related to climate change using some climate change mitigation technology. The effective usage of natural resources to overcome the environmental impact of climate change.
Nwokolo, Obiwulu & Ogbulezie, 2023	Locale China. The nonlinear ARDL technique was utilized.	Intrinsic properties of the Copper Indium Gallium Selenide (CIGS) thin film modules are more likely to impact surviving high temperatures as they contributed 60.00–89.66% of their intrinsic module properties to PV energy production associated with other technologies.
Casson et al., 2023	Survey of Canadians about the knowledge about climate health impacts.	It is vital to identify different types of health-related risks. General awareness creation among some targeted sociodemographic groups, such as women & children, and also among the less educated people about climate change as an issue and its impact on the livelihood of vulnerable populations.
Abdi, Warsame & Sheik-Ali, 2023	Adaptation of Pooled mean group (PMG) approach in nine East African nations. Secondary data analysis	Improve the overall quality of farm inputs, adoption of climate-resilient farming strategies, common development of water preservation facilities system, and establishment of crop modification enterprises through small-scale loans and other technical facilities.
Osman et al., 2023	The global context literature review-based study	Install solar photovoltaic wind turbines and biomass power plants that have a minimal environmental impact when it comes to power generation and production. Renewable energy sources could decrease 90% of the electricity industry by the year 2050.
He et al., 2023	Public investments in R&D	Findings showed that scaling up the overall

	for renewable energy development in countering the causes and effects of climate change in leading renewable energy-investing countries, global perspective	budgetary allocations for financing renewable energy technological development-oriented initiatives and programmed, ornamental the overall efficiency rate of natural resource utilization, and deploying the naturally sustainable urbanization policies for achieving the targets concerning objectives of the SDG-13

Pakistan must devise such policies and strategies which are covered under budgetary limits. It also requires a political and administrative commitment to overcome the negative implications of climate change. Studies conducted by Abramoff et al. (2023); Chien, Chau & Sadiq (2023); Nwokolo, Obiwulu & Ogbulezie (2023); Casson et al. (2023); Abdi, Warsame & Sheik-Ali (2023); Osman et al. (2023); He et al. (2023) recommended that implications of above-mentioned strategies overcome the social, economic, and environmental effects of climate changes related threats across the world and can apply these strategies in Pakistan as well.

CONCLUSION

Climate change has inversely affected the social, economic, and environmental well-being of the inhabitants of Pakistan. Geologically, Pakistan is located at a higher risk area of climate change-related threats. Due to climate change, several droughts, urban floods, land-sliding, cyclones, and earthquakes, have been observed in the last two decades, which not only affect the economic life but also the social life of the people of Pakistan. Climate change increases the sea level rise, increases the overall temperature level, increases the intensity of the heat waves, and is dry in coastal areas as well. Though, Pakistan has signed many national and international agreements and projects to mitigate climate-related challenges, still failed to achieve the target goals due to a lack of political inefficiency and administrative inefficiencies. The mitigation strategies also required a large number of funds, due to lack of funds, and international support, Pakistan is unable to implement the adaptation strategies that have been targeted. Pakistan needs political and administrative commitment to implement adaptation strategies to mitigate the inverse impact of climate change. It also requires awareness creation among the general masses about the issue of climate change and its negative implications for Pakistan.

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