

Impacts of Climate Change on Adaptation and Mitigation in Pakistan, South Asia: Review Study

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Abstract

Pakistan is predicted to experience a greater rise in temperature than the global average. The country's southern regions are predicted to see an increase in temperature. It is predicted that the number of hot days and nights will rise dramatically. Predictions for rainfall in Pakistan show no discernible patterns of systematic change. A pattern of rising rainfall in the lower and upper Indus Basins. Rising air and sea temperatures are predicted to produce a considerable rise in the frequency of floods. 33 million people could be affected annually by floods in 2030, and the sea-bed area of South Asia will also be submerged. Studies show that corrective measures for adaptation and mitigation should apply. The national performance assessment based on 14 indicators should follow four categories. One of the world's most sensitive regions to the many direct and indirect consequences of climate change is South Asia. These implications include rising sea levels, increased cyclonic activity, altered ambient temperatures, and changed precipitation patterns. The continuous rise in sea level has already flooded many of the low-lying islands in the Sundarbans constituency, forcing thousands of people to evacuate. An assessment of a country's progress toward its Nationally Determined Contributions (NDCs) and 2030 targets.

Keywords: Climate change, adaptation, mitigation, temperature.

1. Introduction

According to the United Nations Intergovernmental Panel on Climate Change (IPCC) projection report 2020, South Asia will experience warmer temperatures, longer monsoon seasons, more frequent droughts, and an increase in temperature of about 1.5 degrees Celsius during the next 20 years (2050). It has long been known that South Asia is vulnerable to climate change; the coastal states of Pakistan, Bangladesh, India, and Sri Lanka are at risk from flooding and rising sea levels. Half of South Asia's population, or around 750–800 million people, have experienced a climate-related calamity in the past ten years (World Bank). Pakistan and India were listed in the 2020 Global Climate Risk Index by the think tank German Watch as two of the twenty nations most impacted by climate change in the twenty-first century.

Pakistan is among the top ten nations experiencing the greatest effects of climate change. Nearly every region of the world has been impacted by climate change, but South Asia has been particularly heavily hit (Ashraf et al., 2024). Pakistan's climate has changed over the past 20 years, having a substantial impact on both the natural ecosphere and human populations (Eckstein et al., 2021). Pakistan's most significant rivers have been affected by the melting of the Himalayan glaciers, in addition to rising heat, drought, and harsh weather in various areas of the country from 1999 to 2018 (Irfan et al., 2020). According to Eckstein et al., (2019), Pakistan is among the ten nation's most severely impacted by climate change, with the province of Sindh being one of the most severely affected. In addition to a variety of other environmental pressures, shifting patterns in temperature and precipitation have increased the frequency and intensity of dangers including heat waves, droughts, and flooding. The current research provides ample evidence of climatic change and related phenomena. The monsoon season is being impacted by the rising temperatures, which in recent summers in Pakistan reached 49°C (Hussain et al., 2022). Warmer air retains more moisture, which increases the intensity of monsoon rainfall by eight times more than usual and causes floods even in normally arid southern regions like Sindh and Baluchistan (Rannard, 2022).

Following the industrial revolution, using fossil fuels in industry and motor vehicles resulted in a sharp rise in greenhouse gas (GHG) emissions into the atmosphere (Nunes, 2023). These gases have a long half-life and a high warming potential, which allows them to continue warming for decades or even centuries. Earth warms due to the trapping of heat by greenhouse gases. The primary cause of greenhouse gas emissions is the combustion of fossil fuels for power, heat, transportation, coal mining, agriculture, and other purposes (IPCC, 2022). India was rated fourth on

the tilt of nations maximum pretentious by climate change in 2015, while Bangladesh and Pakistan were ranked 6th and 7th, correspondingly, on the list from 1996 to 2015 (Mir, 2022). One of the world's most sensitive regions to many direct and indirect consequences of climate change is South Asia. These implications include rising sea levels,

increased cyclonic activity, altered ambient temperature, and altered precipitation patterns (Mamun et al., 2021). According to German Watch's 2020 Global Climate Risk Index, thousands of people have already been forced to evacuate because of the continuous rise in sea level that has drowned various islands with low elevation in the Sundarbans region.

2. Methodology for National Performances

In 2017, the CCPI underwent a methodology revision to align with the 2015 Paris Agreement's redesigned climate policy framework. It was lengthened to unite the assessment of a nation's advancement in the direction of the 2030 objectives and the Nationally Determined Contributions (NDCs). In the four areas listed below, 14 indicators are used to evaluate the national performances:

- Green House Gas emissions (weighing 40%)
- Renewable energy (weighting 20%)
- Consumption of energy (weighing 20%)
- Policy climate (weighing 20%)

All four similarly subjective gauges the present level, the current advances (5-year trend), the 2°C compatibility of the present performance, and the 2°C compatibility of the 2030 goal define the three groups 1-3. Two indicators, in addition to twelve, measure how well the nation is performing in terms of the structure and execution of its national climate policy. Every year, data related to "climate policy" are evaluated in an extensive research study. It is based on the evaluations of climate change specialists from universities, think tanks, and non-governmental organizations in the countries under review. Respondents to a questionnaire rank the most significant government initiatives. Ratings for the outcomes include very high, high, medium, low, and very poor (NPR, 2022).

3. Review Study on database performance

Table 1: Significant Impacts on Environment and People in South Asia (7.5 - 8 million in 2022)

Country	CO ₂ Emission Contribution in %	Affected Ranked	Population in % of World	Temperature South Asia	Temperature of Tibet (IPCC)
Afghanistan	>1	---	0.5	Increase 1.8 °C Since 1950	Due to natural disasters
Bhutan, Nipal	Face rising temperatures, drought, and glacial melts increasing the frequency and severity of glacial lake outburst floods (GLOFs)				
Maldiver	As archipelago of low-lying islands , many parts threatened by sea level rise, with some predictions suggesting most of the nation will become uninhabitable during the 21st century.				
India	6.6 (2019)	4 (1996 – 2015) 8 (2022)	17.17	3.3 °C (Range as 2.7 – 4.7 °C) (End of the century)	3.8 °C (2.6 and 6.1 °C) Respectively. Hasher warming condition for Himalayan Watershed (End of the century)
Bangladesh	0.5 (1999-2018)	6 (1999-2018) 7(2020)	2.11		
Sri Lanka	Roughly 50% (22 million) citizens live in low-lying coastal areas are at risk of future sea level rise				
Pakistan	>1 (1990-2016) 408 million tons of CO _{2eq} ; (43% from agriculture; and 46% from energy)	7 (1996-2015) 5 (1999-2018) 5 (2020)	2.83		
2019 Burning fossil gas, coal and oil each emitted around 80 million tons. It has been suggested that stricter measures against air pollution in Pakistan might include actions that would also limit GHG emissions, such as increasing tax on motor fuels (Raihan et al., 2022).					
2020 Prime Minister said that no more coal-fired power stations in Pakistan would be given permits (Mamun, 2021). Pakistan committed to cut 50% of projected emissions by 2030 (Union of Concerned Scientists, 2021).					
2022 Prime Minister said that more solar, wind and hydropower should be built to reduce the fossil fuel (Guardian, 2022).					
According to data from 2020, China, United States, India, and Russia are the world's biggest emitters of CO ₂ (Irfan et al., 2020: Guardian, 2022).					

3.1 Extreme weather events in South Asia

States like Assam are predicted to be pretentious by an upsurge in avalanches and flooding (Kumar et al., 2022). Additionally, it is predicted that ecological disasters will occur more frequently. In 1998, for example, a coral bleaching circumstance triggered by greater ocean temperatures related to global warming killed off over 70% of the corals in the reef ecosystems off Lakshadweep and the Andaman Islands (Union of Concerned Scientists. 2021). Map showing the classification of South Asia.

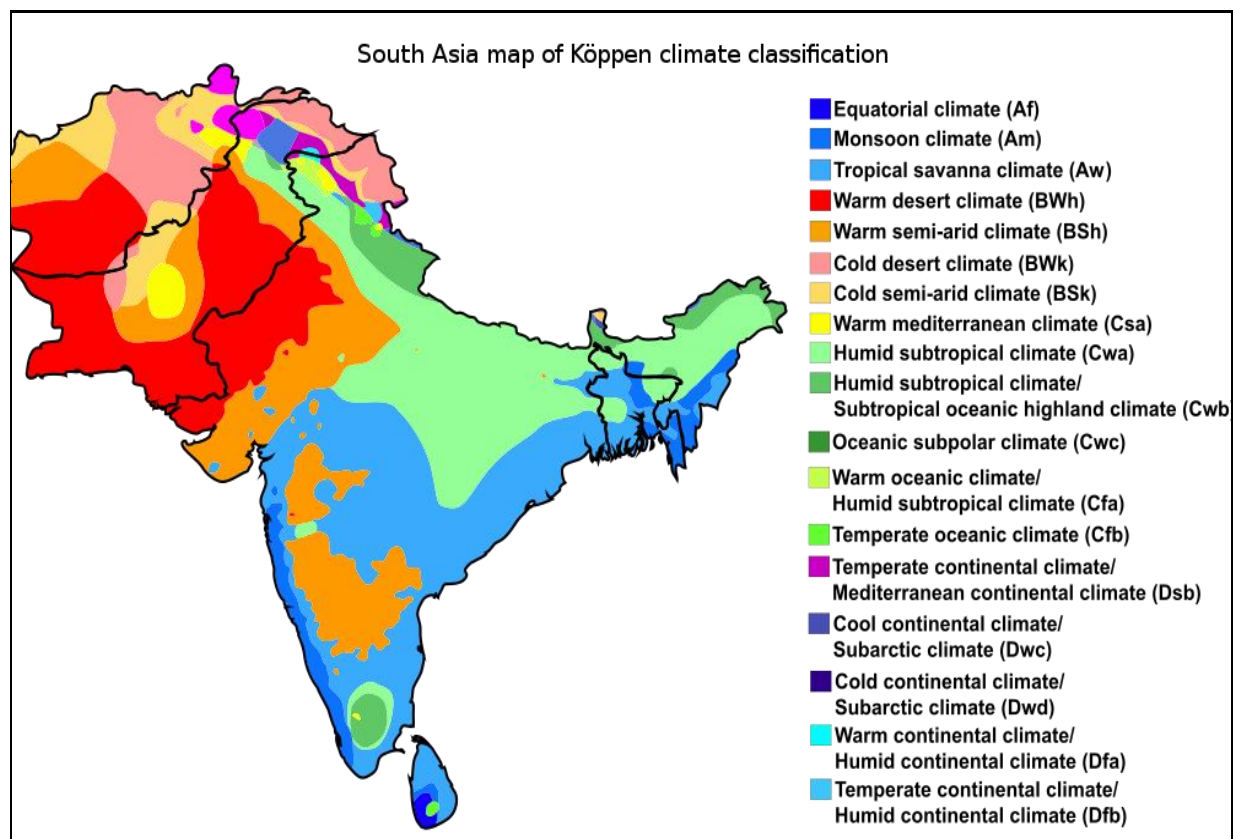


Figure 1: Map showing Climate Classification of South Asia

Table 2: Significant Impacts on Sea Level South Asia

Sea level Rise	Global average/year (1993 to 2003)	Global average/year (2007)	Pakistan (Thatta and Badin) 2019	Pakistan (Thatta and Badin) 2025	India Some Territories (Mumbai, Kolkata, Cuttack , Kochiin) 2030
	3.1mm	1 meter (2100)	Sea is already encroaching 80 acres of land every day (2021)	Would have been swallowed by sea	Some Indian cities will be below tide-level (2019)
By 2050	150 million will be under the water line during high tide and 300 million will live in zones with flooding every year				
By 2100	In high emission scenario, the numbers reach up to 540 million and 640 million, respectively In a low emission scenario, 140 million will be under water during high tide and 280 million will have flooding each year.				
(Irfan et al., 2020; Kulp and Strauss, 2019)					

Table 3: Impacts on Economic and Health in South Asia at 2 °C (Global Temperatures will rise in 2030)

Country	Impact	Economic	Health
Afghanistan	Increase 1.8 °C (Since 1950)	Due to natural disasters, agriculture dependency and sever socio-economic hardship	
India	Major Crops 40% (Rice, Wheat) and 7-Million people are projected to be displaced Number and severity of droughts in India will have markedly increased by the end of the present century	< 400 Million population (make poor) More than 56% of people work in agriculture will be affect	11 of 15 warmest years have occurred since 2004 Rising sea levels will submerge neighboring low-lying areas 33 million people were affected and coastal areas could be underwater in Less Than 9 Years Due to Climate Change, 2021.
Bangladesh	Socio-economic factors, including its high population density, levels of poverty, dependence on agriculture. (Greenhouse Gas Emissions in India, 2021).		
Pakistan	Frequency increased of heat, drought and extreme weather in parts of the country, the melting of glaciers in the Himalayas has impacted some of the important rivers of Pakistan. 1999-2018 ranked 5th in the countries affected by extreme weather caused by climate change (How melting glaciers contributed to floods in Pakistan		
Bhutan	Tangible climate change has resulted in the warming and increasing frequency and severity of glacial lake outburst floods (GLOFs). They are also shifting agriculture patterns due to climate change		Increasing frequency and severity of glacial lake outburst floods
Maldives	Many parts are threatened by sea level rise, with some predictions suggesting most of the nation will become uninhabitable during the 21st century.		
Nepal	28.6% of the population living in multidimensional poverty, more than 80% of property loss due to disasters (climate hazards, particularly water-related events such as floods, landslides and glacial lake outburst floods (GLOFs).		80% of property loss due to climate disasters & hazards,
Sri Lanka	Consequences of Climate change may cause: Affecting agricultural productivity, causing natural disasters like floods and droughts, increasing the spread of infectious illnesses, and finally undermining the living standards (UNDP in Sri Lanka, 2020).		< 50% (22 million) populations live in low-lying coastal areas in the west, south, and south-west of the island, and are at risk of future sea level rise
(Abeyssekara et al., 2024; Thomas et al., 2020)			

3.2 Temperature and Heat Wave in Pakistan

Pakistan and India witnessed a heat wave in May 2022. It got as high as 51°C. Climate warming has increased the likelihood of these heat waves by 100 times. Heat waves that are even more intense than those that occurred in 2010 are expected to happen once every 312 years due to the absence of climate change. It is nowadays expected that they will occur every three years (Ashraf et al., 2024). Overall, South Asia's climate change estimates in the IPCC Sixth Assessment Report point to increased frequency and intensity of heat waves and humid heat stress as well as increased yearly and summer monsoon rainfall with more year-to-year volatility. As a product, this will have a substantial influence on the efficiency and output of water-dependent trades like energy and agriculture (Raihan et al., 2022).

3.3 Extreme weather in Pakistan

Pakistan is expected to see more cyclones and strong monsoons due to rising air and sea temperatures (Hussain et al., 2022). Government estimates point to a marked upsurge in the incidence and concentration of extreme climate actions as well as erratic monsoon rains that cause repeated and severe droughts and floods. Over 150 instances of extreme weather were reported in Pakistan between 1998 and 2018 (Khan et al. 2021). Devastating floods struck the nation in 2022. Climate change-related increases in rainfall and glacier melting were the primary culprits (Mamun et al., 2021). "Has exceeded every boundary, every norm we've seen in the past," according to the climate minister (Khan et al.,

2021). There were 33 million affected people (These Indian Cities Could Be Underwater Due to Climate Change in Less Than 9 Years, 2021).



Figure 2: Floods in Sindh Pakistan 2010 & 2022 and Floods in Karachi Pakistan 2020 & 2022.

Table 4: Sea level rise (SLR) Impacts in Pakistan

Sea Level Rise	Duration	Change in Sea Level	Areas
1.1 mm/year	1856 - 2000	Thermal expansion of the oceans and the melting of glacier mass (Early Warning Signs: Coral Reef Bleaching". Union of Concerned Scientists, 2005)	Karachi toward <u>Keti Bander</u> , Indus River delta
1.7 mm/year	1901 -2010		
3.2 mm/year	1993 - 2010		
1 -10 mm/year	20th century	Early 20th century is reported, erosion, subsidence and lack of sedimentation	Indus River delta 3 million acres of land Thatta, Badin and Saiawal (<u>during 40 years</u>) and 1 million people migrated

(Kulp et al., 2019; Guardian, 2022)

Table 5: Impact on natural environmental in Pakistan

Years	Duration	Temp. variation	Variation of temp./year	Floods	High Precipitation	Heat wave
1996-2016	10 Years	1.5 °C	0.075°C /Year	Yes in 2003, Sindh, 2007 KPK, 2009 Karachi, 2010 all Pakistan, 2011 Sindh, 2012 All PK, 2013 Some areas, 2014 Punjab and <u>Jammu</u> .	1997, 2001, 2009, 2010, 2011, 2012, 2013, 2014.	Yes in 2007, 2015
2017-2022	05 Years	0.4°C	0.1°C/ Year	Yes in 2019 PK, 2021 Islamabad and 2022 Pakistan	2020 and 2022	Yes in 2017 and 2022
2023-2028	05 Years	0.75°C	0.15°C/Year	Expected	Expected	Expected

(Kulp et al., 2019; Guardian, 2022)

4. Adaptation and Mitigation in Pakistan

To control the influence of the transportation sector, inducements might be offered for electric automobiles or communal transportation (e.g., campaigns to transition to solar power or parallel activities). The energy and agricultural sectors are the primary focus of mitigation initiatives aimed at lowering greenhouse gas emissions.

Integrating energy policy and climate change objectives is crucial in the energy sector since investments made today, like those in the Thar coalfield, will "lock in" the fuel, technologies, and infrastructure for usage for many years to come. The infrastructure for building and transportation constructed today should be able to accommodate future design requirements. Consequently, long-term transportation planning and the inclusion of energy efficiency criteria in construction regulations will become crucial.

Rainwater can be collected, and rivers can be made to flow again to restore wetlands and the natural processes of sediment, nutrient, and wildlife flow.

Within the Pakistani government, several adaptation and mitigation-focused programs have been developed. Most of that capacity has been led by a cabinet-level ministry since 2017.

In 2019, AP-PLAT, the Asia-Pacific Climate Change Adaption Information Platform, was introduced. Its goal is to give data on climate change to countries in Asia and the Pacific and transform it into adaptation and resilience strategies.

5. Pakistan's laws and policies

Pakistan's National Climate Change Policy, launched in 2012, lays the groundwork for the country's approach to tackling climate challenges. It acknowledges the rising threat of extreme weather events linked to climate change and identifies the sectors, regions, and communities most at risk. Union of Concerned Scientists, "Early Warning Signs: Coral Reef Bleaching," 2005.

The report's top threats related to climate change include:

1. A plausible rise in extreme weather events' frequency and intensity
2. Increasingly frequent and strong floods leading to the siltation of major dams.
3. Increasing temperatures that intensify the heat and water stress situations, especially in arid and semi-arid areas, resulting in decreased agricultural output.
4. A further reduction in the amount of forest cover due to too quickly a change in the climate to let negatively impacted plant species migrate naturally.
5. Increasing seawater incursion into the Indus delta, coastal cities negatively impacting mangroves, fish breeding sites, and coastal agriculture.
6. The anticipated rise in sea level and the heightened cyclonic activity brought on by warmer sea surface temperatures pose a threat to coastal regions.
7. Enhanced health hazards and migration brought on by climate change (Union of Concerned Scientists, 2021).

6. Conclusion

Pakistan might face significant challenges because of climate change. Pakistan is expected to see frequent heat waves and temperatures that are higher than the global average. Temperature increases are anticipated in the southern parts of the nation. As a result of greenhouse gas emissions raising global temperatures, there will be a noticeable increase in the frequency of hot days and nights. Rainfall predictions for Pakistan indicate a pattern of growing rainfall in the lower and upper Indus Basins but no prominent systematic change. Rising air and sea temperatures are predicted to produce a considerable rise in the frequency of floods, droughts, cyclones, famines, and many more that are causing difficulty for people. Urban infrastructure and population migration should be regulated by the policy. Transport is the main temperature producer; it should be replaced by public transport. 2.7 million people could be affected annually by floods in 2030. Pakistan should have a sustainable development strategy with an eco-friendly approach to mitigating the effects of climate change and adjusting to it, as well as implementing a commitment to cut 50% of predictable emissions by 2030.

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