CLIMATE RISK COUNTRY PROFILE

PAKISTAN

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ADB ASIAN DEVELOPMENT BANK

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ACKNOWLEDGEMENTS

This profile is part of a series of Climate Risk Country Profiles that are jointly developed by the World Bank Group (WBG) and the Asian Development Bank (ADB). These profiles synthesize the most relevant data and information on climate change, disaster risk reduction, and adaptation actions and policies at the country level. The profile is designed as a quick reference source for development practitioners to better integrate climate resilience in development planning and policy making. This effort is co-led by Veronique Morin (Senior Climate Change Specialist, WBG), Ana E. Bucher (Senior Climate Change Specialist, WBG) and Arghya Sinha Roy (Senior Climate Change Specialist, ADB).

This profile was written by Alex Chapman (Consultant, ADB), William Davies (Consultant, ADB) and Yunziyi Lang (Climate Change Analyst, WBG). Technical review of the profiles was undertaken by Robert L. Wilby (Loughborough University). Additional support was provided by MacKenzie Dove (Senior Climate Change Consultant, WBG), Jason Johnston (Operations Analyst, WBG), Adele Casorla-Castillo (Consultant, ADB), and Charles Rodgers (Consultant, ADB). This profile also benefitted from inputs of WBG and ADB regional staff and country teams.

Climate and climate-related information is largely drawn from the Climate Change Knowledge Portal (CCKP), a WBG online platform with available global climate data and analysis based on the latest Intergovernmental Panel on Climate Change (IPCC) reports and datasets. The team is grateful for all comments and suggestions received from the sector, regional, and country development specialists, as well as climate research scientists and institutions for their advice and guidance on use of climate related datasets.

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FOREWORD

Climate change is a major risk to good development outcomes, and the World Bank Group is committed to playing an important role in helping countries integrate climate action into their core development agendas. The World Bank Group (WBG) and the Asian Development Bank (ADB) are committed to supporting client countries to invest in and build a low-carbon, climate-resilient future, helping them to be better prepared to adapt to current and future climate impacts.

Both institutions are investing in incorporating and systematically managing climate risks in development operations through their individual corporate commitments.

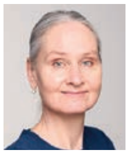
For the World Bank Group: a key aspect of the World Bank Group's Action Plan on Adaptation and Resilience (2019) is to help countries shift from addressing adaptation as an incremental cost and isolated investment to systematically incorporating climate risks and opportunities at every phase of policy planning, investment design, implementation and evaluation of development outcomes. For all International Development Association and International Bank for Reconstruction and Development operations, climate and disaster risk screening is one of the mandatory corporate climate commitments. This is supported by the World Bank Group's Climate and Disaster Risk Screening Tool which enables all Bank staff to assess short- and long-term climate and disaster risks in operations and national or sectoral planning processes. This screening tool draws up-to-date and relevant information from the World Bank's Climate Change Knowledge Portal, a comprehensive online 'one-stop shop' for global, regional, and country data related to climate change and development.

For the Asian Development Bank (ADB): its Strategy 2030 identified "tackling climate change, building climate and disaster resilience, and enhancing environmental sustainability" as one of its seven operational priorities. Its Climate Change Operational Framework 2017-2030 identified mainstreaming climate considerations into corporate strategies and policies, sector and thematic operational plans, country programming, and project design, implementation, monitoring, and evaluation of climate change considerations as the foremost institutional measure to deliver its commitments under Strategy 2030. ADB's climate risk management framework requires all projects to undergo climate risk screening at the concept stage and full climate risk and adaptation assessments for projects with medium to high risk.

Recognizing the value of consistent, easy-to-use technical resources for our common client countries as well as to support respective internal climate risk assessment and adaptation planning processes, the World Bank Group's Climate Change Group and ADB's Sustainable Development and Climate Change Department have worked together to develop this content. Standardizing and pooling expertise facilitates each institution in conducting initial assessments of climate risks and opportunities across sectors within a country, within institutional portfolios across regions, and acts as a global resource for development practitioners.

For common client countries, these profiles are intended to serve as public goods to facilitate upstream country diagnostics, policy dialogue, and strategic planning by providing comprehensive overviews of trends and projected changes in key climate parameters, sector-specific implications, relevant policies and programs, adaptation priorities and opportunities for further actions.

We hope that this combined effort from our institutions will spur deepening of long-term risk management in our client countries and support further cooperation at the operational level.



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KEY MESSAGES

- Pakistan faces rates of warming considerably above the global average with a potential rise of 1.3°C–4.9°C by the 2090s over the 1986–2005 baseline. The range in possible temperature rises highlights the significant differences between 21st century emissions pathways.
- Rises in the annual maximum and minimum temperature are projected to be stronger than the rise in average temperature, likely amplifying the pressure on human health, livelihoods, and ecosystems.
- Changes to Pakistan's rainfall and runoff regimes, and hence its water resources, are highly uncertain, but an increase in the incidence of drought conditions is likely.
- The frequency and intensity of extreme climate events is projected to increase, increasing disaster risk particularly for vulnerable poor and minority groups
- An increase in the number of people affected by flooding is projected, with a likely increase of around 5 million people exposed to extreme river floods by 2035–2044, and a potential increase of around 1 million annually exposed to coastal flooding by 2070–2100.
- Projections suggest yield declines in many key food and cash crops, including cotton, wheat, sugarcane, maize, and rice.
- Temperature increases are likely to place strain on urban dwellers and outdoor laborers, with increased risk of heat-related sickness and death likely under all emissions pathways.
- All of the above should be seen in the context of high and persistent levels of undernourishment and deprivation. There is an urgent need for further research and delivery of effective adaptation and disaster risk reduction measures.

COUNTRY OVERVIEW

Pakistan is characterized by diverse topography, ecosystems, and climate zones. Rich in natural resources, including fertile agricultural lands, natural gas reserves, and mineral deposits, Pakistan faces challenges in balancing competing objectives between economic development and environmental protection. A semi-industrialized country, Pakistan has grown from a primarily agriculture-based to a mostly service-based economy (with services constituting 49.4% of GDP in 2019). As of 2019 agriculture was still the largest employer, occupying 42.6% of the workforce. As of 2013 approximately 29.5% of the population still lived below the national poverty line and 12.3% (2018) of the population remained undernourished (see key indicators in **Table 1**). The majority of Pakistan's 216.5 million people (2019) live along the Indus River, an area prone to severe flooding in July and August. Major earthquakes are also frequent in the mountainous northern and western regions.

The Government of Pakistan established the Ministry of Climate Change and issued its Second National Communication on Climate Change in 2019. The National Climate Change Policy recognizes that while Pakistan is working on a strategy that seeks to conserve energy, improve energy efficiency and optimize fuel mix to support global efforts for reduction in greenhouse gas emissions, the more immediate and pressing task is to prepare itself for adaptation to climate change. Pakistan ratified the Paris Agreement on November 10, 2016, and submitted its Nationally Determined Contribution to the UNFCCC in 2016.

TABLE 1. Key indicators

Indicator	Value	Source
Population Undernourished[1]	12.3% (2017–2019)	FAO, 2020
National Poverty Rate[2]	24.3% (2015)	World Bank, 2019
Share of Wealth Held by Bottom 20%[3]	8.9% (2015)	World Bank, 2019
Net Annual Migration Rate[4]	–0.11% (2015–2020)	UNDESA, 2019
Infant Mortality Rate (Between Age 0 and 1)[5]	6.1% (2015–2020)	UNDESA, 2019
Average Annual Change in Urban Population[6]	2.53% (2015–2020)	UNDESA, 2019
Dependents per 100 Independent Adults[7]	64.4 (2020)	UNDESA, 2019
Urban Population as % of Total Population[8]	37.2% (2020)	CIA, 2020
External Debt Ratio to GNI[9]	27.6% (2018)	ADB, 2020
Government Expenditure Ratio to GDP[10]	21.5% (2019)	ADB, 2020

Notre-Dame GAIN Index Ranking (2019)	
152nd	The ND-GAIN Index ranks 181 countries using a score which calculates a country's vulnerability to climate change and other global challenges as well as their readiness to improve resilience. The more vulnerable a country is the lower their score, while the more ready a country is to improve its resilience the higher it will be. Norway has the highest score and is ranked 1st (University of Notre-Dame, 2020).

Green, Inclusive and Resilient Recovery

The coronavirus disease (COVID-19) pandemic has led to unprecedented adverse social and economic impacts. Further, the pandemic has demonstrated the compounding impacts of adding yet another shock on top of the multiple challenges that vulnerable populations already face in day-to-day life, with the potential to create devastating health, social, economic and environmental crises that can leave a deep, long-lasting mark. However, as governments take urgent action and lay the foundations for their financial, economic, and social recovery, they have a unique opportunity to create economies that are more sustainable, inclusive and resilient. Short and long-term recovery efforts should prioritize investments that boost jobs and economic activity; have positive impacts on human, social and natural capital; protect biodiversity and ecosystems services; boost resilience; and advance the decarbonization of economies.

[1] FAO, IFAD, UNICEF, WFP, WHO (2020). The state of food security and nutrition in the world. Transforming food systems for affordable healthy diets. FAO. Rome. URL: http://www.fao.org/documents/card/en/c/ca9692en/
[2] World Bank (2019). Poverty headcount ratio at national poverty lines (% of population). URL: https://data.worldbank.org/ [accessed 17/12/20]
[3] World Bank (2019). Income share held by lowest 20%. URL: https://data.worldbank.org/ [accessed 17/12/20]
[4] UNDESA (2019). World Population Prospects 2019: MIGR/1. URL: https://population.un.org/wpp/Download/Standard/Population/ [accessed 17/12/20]
[5] UNDESA (2019). World Population Prospects 2019: MORT/1-1. URL: https://population.un.org/wpp/Download/Standard/Population/ [accessed 17/12/20]
[6] UNDESA (2019). World Urbanization Prospects 2018: File 6. URL: https://population.un.org/wup/Download/ [accessed 17/12/20]
[7] UNDESA (2019). World Population Prospects 2019: POP/11-A. URL: https://population.un.org/wpp/Download/Standard/Population/ [accessed 17/12/20]
[8] CIA (2020). The World Factbook. Central Intelligence Agency. Washington DC. URL: https://www.cia.gov/the-world-factbook/
[9] ADB (2020). Key Indicators for Asia and the Pacific 2020. Asian Development Bank. URL: https://www.adb.org/publications/key-indicators-asia-and-pacific-2020
[10] ADB (2020). Key Indicators for Asia and the Pacific 2020. Asian Development Bank. URL: https://www.adb.org/publications/key-indicators-asia-and-pacific-2020

This document aims to succinctly summarize the climate risks faced by Pakistan. This includes rapid onset and long-term changes in key climate parameters, as well as impacts of these changes on communities, livelihoods and economies, many of which are already underway. This is a high-level synthesis of existing research and analyses, focusing on the geographic domain of Pakistan, therefore potentially excluding some international influences and localized impacts. The core data presented is sourced from the database sitting behind the World Bank Group's Climate Change Knowledge Portal (CCKP), incorporating climate projections from the Coupled Model Inter-comparison Project Phase 5 (CMIP5). This document is primarily meant for WBG and ADB staff to inform their climate actions and to direct readers to many useful sources of secondary data and research.

CLIMATOLOGY

Climate Baseline

Overview

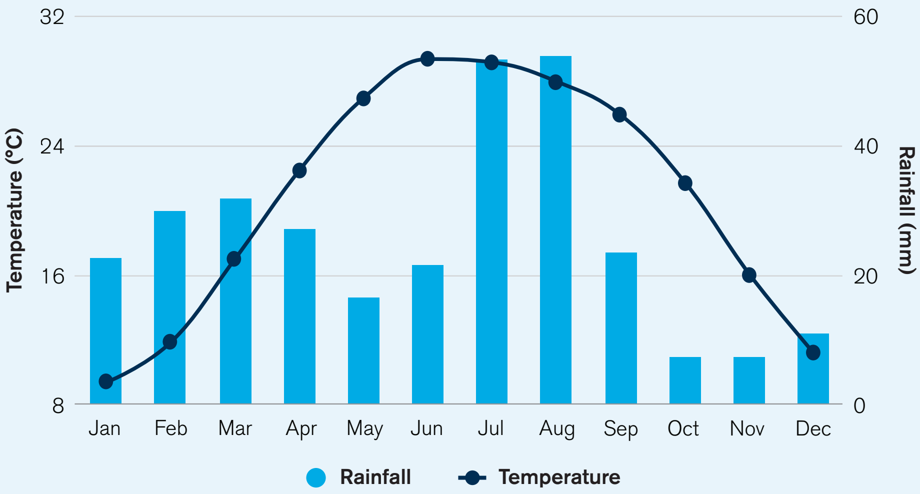
Figure 1 shows Pakistan's annual climate cycle. However, this conceals considerable regional variation. Pakistan lies in a temperate zone and its climate is as varied as the country's topography—generally dry and hot near the coast and along the lowland plains of the Indus River, and becoming progressively cooler in the northern uplands and Himalayas (**Figures 2** and **3**). Four seasons are recognized: 1) a cool, dry winter from December to February; 2) a hot, dry spring from March through May; 3) the summer rainy season, also known as the southwest monsoon period, occurring from June to September; and 4) the retreating monsoons from October to November. A majority of the country receives very little rainfall, with the exception of the Northern regions, where monsoons can bring upwards of 200 millimeters (mm) a month from July to September. Inter-annual rainfall varies significantly, often leading to successive patterns of floods and drought. El Niño is a significant influence on climate variability in Pakistan, with anomalies in both temperature[11] and flood frequency and impact[12] correlated with the El Niño cycle.

[11] del Río, S., Iqbal, M.A., Cano-Ortiz, A., Herrero, L., Hassan, A. and Penas, A. (2013). Recent mean temperature trends in Pakistan and links with teleconnection patterns. International Journal of Climatology, 33, 277–290. URL: https://rmets.onlinelibrary.wiley.com/doi/full/10.1002/joc.3423

[12] Ward, P.J., Jongman, B., Kummu, M., Dettinger, M.D., Weiland, F.C.S. and Winsemius, H.C. (2013). Strong influence of El Niño Southern Oscillation on flood risk around the world. Proceedings of the National Academy of Sciences, 111, 15659–15664. URL: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4226082/

Annual Cycle

FIGURE 1. Average monthly temperature and precipitation in Pakistan (1991–2020)[13]



Spatial Variations

FIGURE 2. Annual mean temperature (°C) in Pakistan over the period 1991–2020[14]

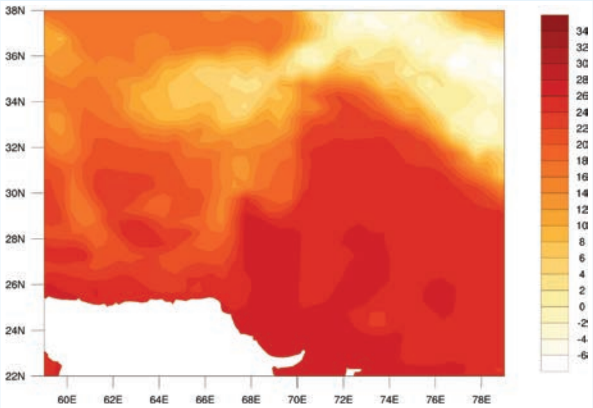
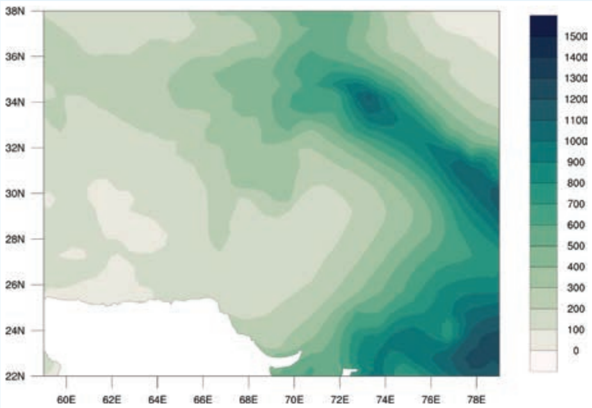


FIGURE 3. Annual mean precipitation (mm) in Pakistan over the period 1991–2020[14]



Maps present the coordinates of Pakistan: latitude 60°48′15″E – 74°36′14″E and 32°50′42″N – 24°25'26″N.

[13] WBG Climate Change Knowledge Portal (CCKP, 2021). Climate Data: Historical. URL: https://climateknowledgeportal.worldbank.org/country/pakistan/climate-data-historical

[14] WBG Climate Change Knowledge Portal (CCKP, 2021). Climate Data: Historical. URL: https://climateknowledgeportal.worldbank.org/country/pakistan/climate-data-historical

Key Trends

Temperature

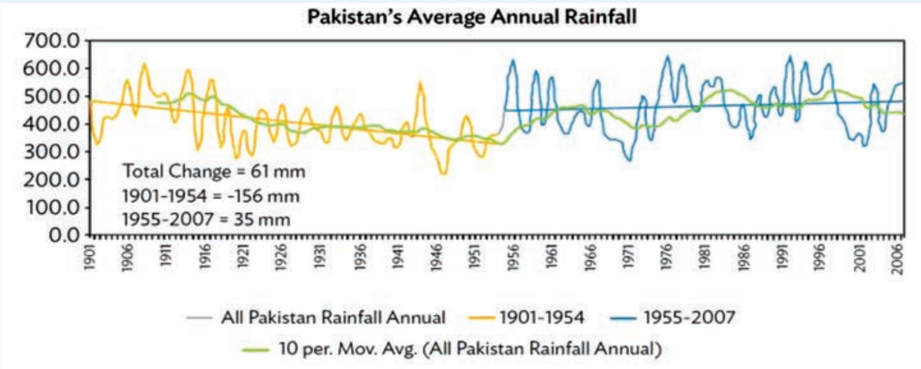
Warming in Pakistan was estimated at 0.57°C over the 20th century, slightly less than the average for the South Asia region of 0.75°C. Warming has accelerated more recently, with 0.47°C of warming measured between 1961–2007. Warming is strongly biased towards the winter and post-monsoon months (November–February). On a sub-national level, warming is also strongly biased towards the more southerly regions, with Punjab, Sind, and Balochistan all experiencing winter warming in the region of 0.91°C–1.12°C over the same period, and Khyber Pakhtunkhwa in the north experiencing only 0.52°C. The rise in average daily maximum temperatures (0.87°C between 1961–2007) has been slightly stronger than the rise in average temperatures. A concurrent increase in the frequency of heat wave days has been documented, particularly in Sindh Province. See ADB (2017)[15] for further information.

The Berkeley Earth Data suggests historical warming has been strongest in western Pakistan. The dataset can also be used to estimate warming between the periods 1900–1917 and 2000–2017, showing 1.3°C of warming in the vicinity of Islamabad compared to 0.9°C of warming in the vicinity of Karachi.

Precipitation

Pakistan has a complex historical precipitation profile. The early 20th century was characterised by a prolonged decline in annual rainfall, but since 1960, a slight increasing trend has prevailed (**Figure 4**). This overall trend hides considerable sub-national variation. Mean rainfall in the arid plains of Pakistan and the coastal belt has decreased by 10%–15% since 1960, contributing to the ongoing degradation of the country's wetlands and mangrove ecosystems. Most other regions have experienced a slight increase, seen both in the monsoon and dry seasons. The number of heavy rainfall events has increased since 1960, and the nine heaviest rains recorded in 24 hours were recorded in 2010. Recent evidence suggests the glaciers in the headwaters of the Indus Basin may be expanding due to increased winter precipitation over the Himalayan region in the last 40 years. See ADB (2017)[16] for further discussion.

FIGURE 4. Historical precipitation in Pakistan, adapted from ADB (2017)[17]



Source: Q. Z. Chaudhry et al. 2009. *Climate Change Indicators of Pakistan*. Technical Report. No. 22. Islamabad: Pakistan Meteorological Department.

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15 ADB (2017). Climate Change Profile of Pakistan. Asian Development Bank. URL: https://www.adb.org/publications/climate-change-profile-pakistan

16 ADB (2017). Climate Change Profile of Pakistan. Asian Development Bank. URL: https://www.adb.org/publications/climate-change-profile-pakistan

17 ADB (2017). Climate Change Profile of Pakistan. Asian Development Bank. URL: https://www.adb.org/publications/climate-change-profile-pakistan

Climate Future

Overview

The Representative Concentration Pathways (RCPs) represent four plausible futures, based on the rate of emissions reduction achieved at the global level. For more background please refer to the World Bank Group's Climate Change Knowledge Portal (CCKP). For reference, **Tables 2 and 3** provide provides information on all four RCPs over two time periods. In subsequent analysis RCP 2.6 and 8.5, the extremes of low and high emissions pathways, are the primary focus. RCP2.6 would require rapid and systemic global action, achieving emissions reduction throughout the 21st century sufficient to reach net zero global emissions by around 2080. RCP8.5 assumes annual global emissions will continue to increase throughout the 21st century. Climate changes under each emissions pathway are presented against a reference period of 1986–2005 for all indicators.

A Precautionary Approach

Studies published since the last iteration of the IPCC's report (AR5), such as Gasser et al. (2018), have presented evidence which suggests a greater probability that earth will experience medium and high-end warming scenarios than previously estimated. Climate change projections associated with the highest emissions pathway (RCP8.5) are presented here to facilitate decision making which is robust to these risks.

TABLE 2. Projected anomaly (changes °C) for maximum, minimum, and average daily temperatures in Pakistan for 2040–2059 and 2080–2099, from the reference period of 1986–2005 for all RCPs. The table is showing the median of the CCKP model ensemble and the 10–90th percentiles in brackets.[18]

	Average Daily Maximum Temperature		Average Daily Temperature		Average Daily Minimum Temperature	
Scenario	**2040–2059**	**2080–2099**	**2040–2059**	**2080–2099**	**2040–2059**	**2080–2099**
RCP2.6	1.4 (–0.5, 3.3)	1.4 (–0.5, 3.4)	1.4 (–0.1, 2.9)	1.3 (–0.2, 3.1)	1.4 (–0.1, 3.1)	1.3 (–0.3, 3.1)
RCP4.5	1.9 (–0.1, 3.7)	2.7 (0.7, 4.7)	1.8 (0.1, 3.4)	2.6 (0.8, 4.4)	1.8 (0.2, 3.6)	2.6 (0.9, 4.5)
RCP6.0	1.6 (–0.3, 3.5)	3.3 (1.2, 5.5)	1.6 (0.1, 3.1)	3.3 (1.5, 5.1)	1.7 (0.1, 3.2)	3.3 (1.6, 5.2)
RCP8.5	2.6 (0.9, 4.2)	5.3 (2.9, 7.5)	2.5 (0.8, 4.1)	5.3 (3.3, 7.2)	2.5 (0.9, 4.2)	5.4 (3.5, 7.5)

[18] WBG Climate Change Knowledge Portal (CCKP, 2021). Climate Data: Projections. URL: https://climateknowledgeportal.worldbank.org/country/pakistan/climate-data-projections

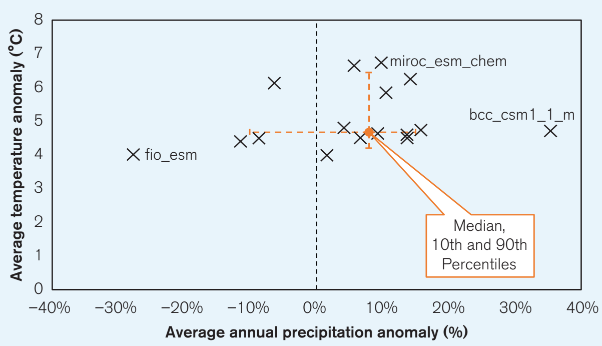
TABLE 3. Projections of average temperature anomaly (°C) in Pakistan for different seasons (3-monthly time slices) over different time horizons and emissions pathways, showing the median estimates of the CMIP5 model ensemble and the 10th and 90th percentiles in brackets[19]

	2040–2059		2080–2099	
Scenario	**Jun–Aug**	**Dec–Feb**	**Jun–Aug**	**Dec–Feb**
RCP2.6	1.2 (–0.8, 3.1)	1.5 (0.1, 3.0)	1.2 (–0.8, 3.2)	1.4 (–0.2, 3.0)
RCP4.5	1.7 (–0.6, 3.4)	1.9 (0.3, 3.5)	2.3 (0.1, 4.5)	2.7 (1.2, 4.4)
RCP6.0	1.5 (–0.6, 3.2)	1.7 (0.2, 3.2)	2.9 (0.9, 5.0)	3.4 (1.7, 5.3)
RCP8.5	2.3 (0.2, 4.1)	2.5 (1.0, 4.1)	4.9 (2.2, 7.1)	5.4 (3.5, 7.3)

Model Ensemble

Climate projections presented in this document are derived from datasets made available on the World Bank's Climate Change Knowledge Portal, unless otherwise stated. These datasets are processed outputs of simulations performed by multiple General Circulation Models (GCM) developed by climate research centers around the world and evaluated by the IPCC for quality assurance in the CMIP5 iteration of models (for further information see Flato et al., 2013). Collectively, these different GCM simulations are referred to as the 'model ensemble'. Due to the differences in the way GCMs represent the key physical processes and interactions within the climate system, projections of future climate conditions can vary widely between different GCMs, this is particularly the case for rainfall related variables and at national and local scales. Exploring the spread of climate model outputs can assist in understanding uncertainties associated with climate models. The range of projections from 16 GCMs on the indicators of average temperature anomaly and annual precipitation anomaly for Pakistan under RCP8.5 is shown in **Figure 5**. Spatial representation of future projections of annual temperature and precipitation for mid and late century under RCP8.5 are presented in **Figure 6**.

FIGURE 5. 'Projected average temperature anomaly' and 'projected annual rainfall anomaly' in Pakistan. Outputs of 16 models within the ensemble simulating RCP8.5 over the period 2080–2099. Models shown represent the subset of models within the ensemble which provide projections across all RCPs and therefore are most robust for comparison.[20]

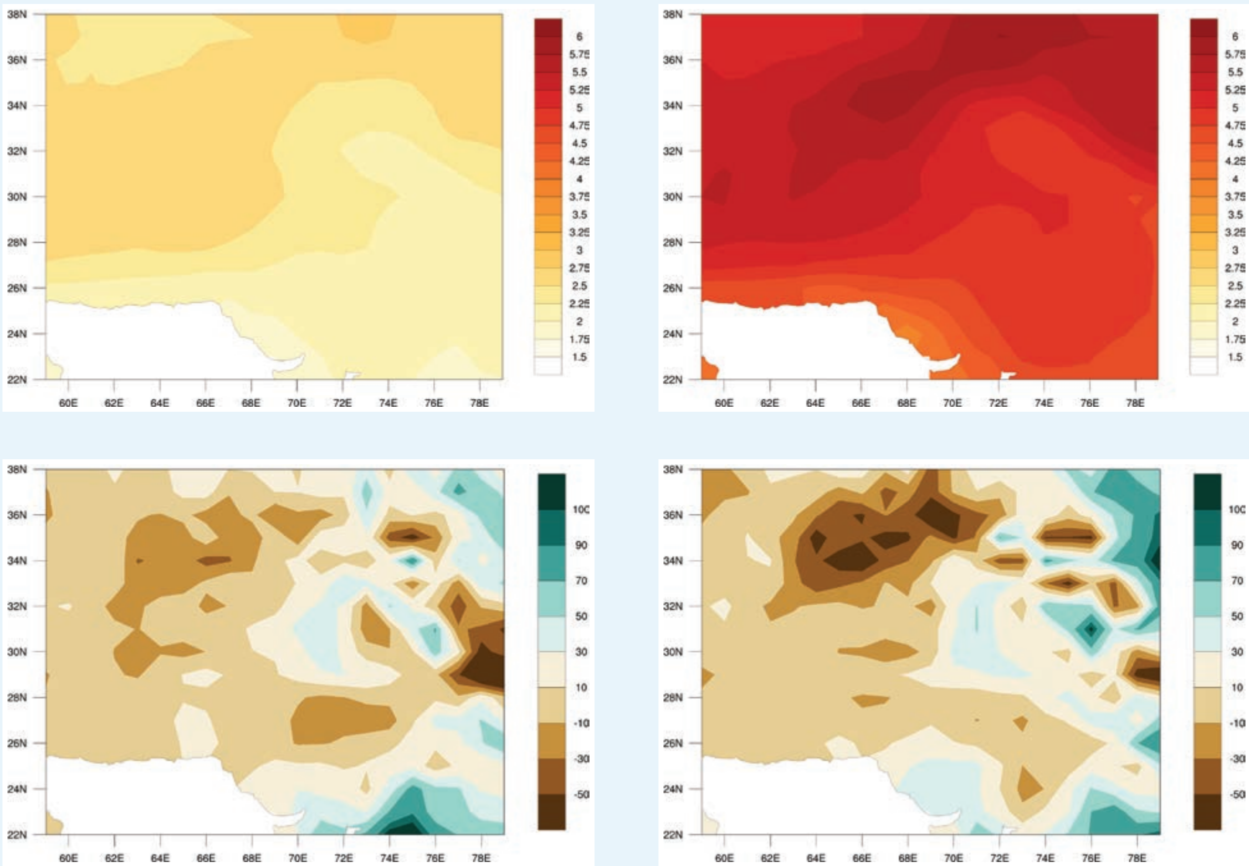


[19] WBG Climate Change Knowledge Portal (CCKP, 2021). Climate Data: Projections. URL: https://climateknowledgeportal.worldbank.org/country/pakistan/climate-data-projections

[20] WBG Climate Change Knowledge Portal (CCKP, 2021). Climate Data: Projections. URL: https://climateknowledgeportal.worldbank.org/country/pakistan/climate-data-projections

Spatial Variation

FIGURE 6. CMIP5 ensemble projected change (32 GCMs) in annual temperature (top) and precipitation (bottom) by 2040–2059 (left) and by 2080–2090 (right) relative to 1986–2005 baseline under RCP8.5



Maps present the coordinates of Pakistan: latitude 60°48′15″E – 74°36′14″E and 32°50′42″N – 24°25′26″N.

Temperature

Projections of future temperature change are presented in three primary formats. Shown in **Table 2** are the changes (or anomalies) in daily maximum and daily minimum temperatures over the given time period, as well as changes in the average temperature. **Figures 7** and **8** display the annual and monthly average temperature projections. While similar, these three indicators can provide slightly different information. Monthly and annual average temperatures are most commonly used for general estimation of climate change, but the daily maximum and minimum can explain more about how daily life might change in a region, affecting key variables such as the viability of ecosystems, health impacts, productivity of labour, and the yield of crops, which are often disproportionately influenced by temperature extremes.

Projected temperature increases in Pakistan are significantly higher than the global average. The IPCC projects a global average temperature increase by 2081–2100 of 3.7°C under the highest emissions pathway (RCP8.5) whilst the model ensemble projects an average increase of 5.3°C for Pakistan in the same scenario. The projected rise in annual maximum temperatures is estimated at 5.3°C. Notably, on the highest emissions pathway (RCP8.5), even the 10th percentile (low) estimate is higher than the projected global average temperature rise, at 3.3°C, demonstrating the level of certainty that Pakistan should prepare for above-average increases. The difference between the end of century estimate under RCP2.6 and RCP8.5 is around 3.1°C demonstrating the large potential benefits of enhanced global emissions reduction efforts in terms of potential reductions in warming. Uncertainty clouds projections on the seasonality of future changes, but the broad trend indicated by the model ensemble matches the historic pattern seen, showing stronger increases Oct–Dec than Jun–Aug.

Global Projections

Unless otherwise stated projections shown here represent changes against the 1986–2005 baseline. An additional 0.61°C of global warming is estimated to have taken place between the periods 1850–1900 and 1986–2005[21] The global average temperature changes projected between 1986–2005 and 2081–2100 in the IPCC's Fifth Assessment Report are:

- RCP2.6: 1.0°C
- RCP4.5: 1.8°C
- RCP6.0: 2.2°C
- RCP8.5: 3.7°C

FIGURE 7. Historic and projected average annual temperature in Pakistan under RCP2.6 (blue) and RCP8.5 (red). The values shown represents the median of 30+ GCM model ensemble with the shaded areas showing the 10–90th percentiles.[22]

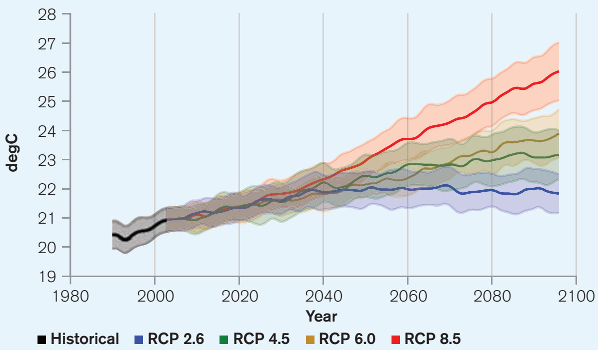
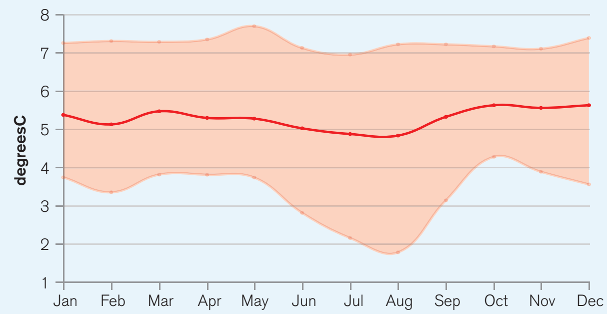


FIGURE 8. Projected change (anomaly) in monthly temperature, shown by month, for Pakistan for the period 2080–2099 under RCP8.5. The values shown represents the median of 30+ GCM model ensemble with the shaded areas showing the 10–90th percentiles.[23]



21 (Kirtman, B., Power, S. B., Adedoyin, A. J., Boer, G. J., Bojariu, R., Camilloni, I., ... Wang, H.-J. (2013). Near-term Climate Change: Projections and Predictability. In Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (pp. 953–1028). Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press. URL: https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter11_FINAL.pdf

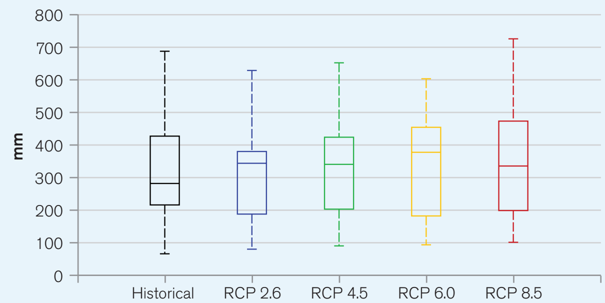
22 WBG Climate Change Knowledge Portal (CCKP, 2021). Climate by Sector. URL: https://climateknowledgeportal.worldbank.org/country/pakistan

23 WBG Climate Change Knowledge Portal (CCKP, 2021). Climate by Sector. URL: https://climateknowledgeportal.worldbank.org/country/pakistan

Precipitation

As shown in **Figure 9** great uncertainty surrounds projections of future precipitation rates in Pakistan, changes on an annual basis for the full model ensemble are not statistically significant. However, of the 16 models analyzed (**Figure 5**) 12 do show an increase in average annual precipitation under the highest emissions pathway (RCP8.5) by the end of the century. A trend towards increased future annual precipitation is supported by published research, including studies such as Amin et al. (2017)[24] which examines RCP6.0. This research also highlights the risk of increased frequency and intensity of flood and drought events due to changes in the seasonality, regularity, and extremes of precipitation. This fits with a global trend, described by Westra et al. (2014),[25] of increased intensity of sub-daily extreme rainfall events.

FIGURE 9. Boxplots showing the projected average annual precipitation for Pakistan in the period 2080–2099[28]



Changes are expected to vary across Pakistan's subregions and changes in the Indus basin will be of particular national significance. Rajbhandari et al. (2015)[26] use downscaled modelling to suggest that precipitation may increase in the Upper Indus basin, and decrease in the Lower Indus basin. However, significant uncertainty remains in these results (see Water section below). Work by Amin et al. (2018)[27] focused just on the Southern Punjab region of Pakistan also highlights the seasonality of potential precipitation changes (under RCPs 4.5, 6.0 and 8.5), with declines projected in the period January to April and increases over May-December. Increases projected for the Southern Punjab region exceed 10% by 2050 in the month of September, October and November.

The poor and inconsistent performance of climate models in projecting precipitation trends in Pakistan (see Latif et al., 2018)[29] links in part to their weak performance simulating future changes in the South Asian monsoon (Sperber et al., 2013).[30] Uncertainty also remains regarding the future dynamics of the El Niño Southern Oscillation.

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24 Amin, A., Nasim, W., Mubeen, M., Kazmi, D. H., Lin, Z., Wahid, A., … Fahad, S. (2017). Comparison of future and base precipitation anomalies by SimCLIM statistical projection through ensemble approach in Pakistan. Atmospheric Research, 194(March), 214–225. URL: https://ui.adsabs.harvard.edu/abs/2017AtmRe.194..214A/abstract

25 Westra, S., Fowler, H. J., Evans, J. P., Alexander, L. V., Berg, P., Johnson, F., Kendon, E. J., Lenderink, G., Roberts, N. (2014). Future changes to the intensity and frequency of short-duration extreme rainfall. Reviews of Geophysics, 52, 522–555. URL: https://agupubs.onlinelibrary.wiley.com/doi/10.1002/2014RG000464

26 Rajbhandari, R., Shrestha, A. B., Kulkarni, A., Patwardhan, S. K., & Bajracharya, S. R. (2015). Projected changes in climate over the Indus river basin using a high resolution regional climate model (PRECIS). Climate Dynamics, 44(1), 339–357. URL: https://link.springer.com/article/10.1007/s00382-014-2183-8

27 Amin, A., Nasim, W., Mubeen, M., Sarwar, S., Urich, P., Ahmad, A., . . . Ali, Q. S. (2018). Regional climate assessment of precipitation and temperature in Southern Punjab (Pakistan) using SimCLIM climate model for different temporal scales. Theoretical and Applied Climatology: 131: 121–131. URL: https://ui.adsabs.harvard.edu/abs/2018ThApC.131..121A/abstract

28 WBG Climate Change Knowledge Portal (CCKP, 2021). Climate by Sector. URL: https://climateknowledgeportal.worldbank.org/country/pakistan

29 Latif, M., Hannachi, A. and Syed, F.S. (2018). Analysis of rainfall trends over Indo-Pakistan summer monsoon and related dynamics based on CMIP5 climate model simulations. International Journal of Climatology, 38, e577-e595. URL: https://rmets.onlinelibrary.wiley.com/doi/abs/10.1002/joc.5391

30 Sperber, K.R., Annamalai, H., Kang, I.S., Kitoh, A., Moise, A., Turner, A., Wang, B. and Zhou, T. (2013). The Asian summer monsoon: an intercomparison of CMIP5 vs. CMIP3 simulations of the late 20th century. Climate Dynamics, 41, 2711–2744. URL: https://link.springer.com/article/10.1007/s00382-012-1607-6

CLIMATE CHANGE AND NATURAL HAZARD RISK

Pakistan faces some of the highest disaster risk levels in the world, ranked 18 out of 191 countries by the 2020 Inform Risk Index (**Table 4**). This risk ranking is driven particularly by the nation's exposure to earthquakes and the risks of internal conflict. However, Pakistan also has high exposure to flooding (ranked jointly 8th), including, riverine, flash, and coastal, as well as some exposure to tropical cyclones and their associated hazards (ranked jointly 40th) and drought (ranked jointly 43rd). Disaster risk in Pakistan is also driven by its social vulnerability. Pakistan's vulnerability ranking (37th) is driven by its high rates of multidimensional poverty. Pakistan scores slightly better in terms of its coping capacity (ranked 59th). The section which follows analyses climate change influences on the exposure component of risk in Pakistan.

TABLE 4. Selected indicators from the INFORM 2019 Index for Risk Management for Pakistan. For the sub-categories of risk (e.g. "Flood") higher scores represent greater risks. Conversely the most at-risk country is ranked 1st.[31]

Flood (0–10)	Tropical Cyclone (0–10)	Drought (0–10)	Vulnerability (0–10)	Lack of Coping Capacity (0–10)	Overall Inform Risk Level (0–10)	Rank (1–191)
8.9	3.8	5.1	5.7	5.6	6.2	18

TABLE 5. Summary of Natural Hazards in Pakistan from 1900 to 2020[32]

Disaster Type	Disaster Subtype	Events Count	Total Deaths	Total Affected	Total Damage ('000 US$)
Drought	Drought	1	143	2,200,000	247,000
Earthquake	Ground movement	35	144,116	7,435,786	5,376,755
Epidemic	Bacterial disease	3	142	11,103	0
	Parasitic disease	1	0	5,000	0
	Viral disease	2	130	56,338	0
	Others	5	131	371	0
Extreme temperature	Cold wave	3	18	0	0
	Heat wave	15	2,936	80,574	18,000
Flood	Flash flood	24	3,590	22,114,253	10,184,118
	Riverine flood	43	9,229	34,967,357	9,727,030
	Others	39	5,286	23,863,294	2,670,030
Landslide	Avalanche	12	567	4,435	0
	Landslide	9	222	29,707	18,000
	Mudslide	2	16	12	0
Storm	Convective storm	15	402	1,906	0
	Tropical cyclone	7	11,555	2,599,940	1,715,036
	Others	7	184	2,988	0

[31] Emergency Events Database (EM-DAT) of the Centre for Research on the Epidemiology of Disasters (CRED). Assessed on Nov 26, 2018 at https://www.emdat.be/.

[32] INFORM (2020). Index for Risk Management. Inter-Agency Standing Committee Reference Group on Risk, Early Warning and Preparedness. Available at: http://www.inform-index.org/

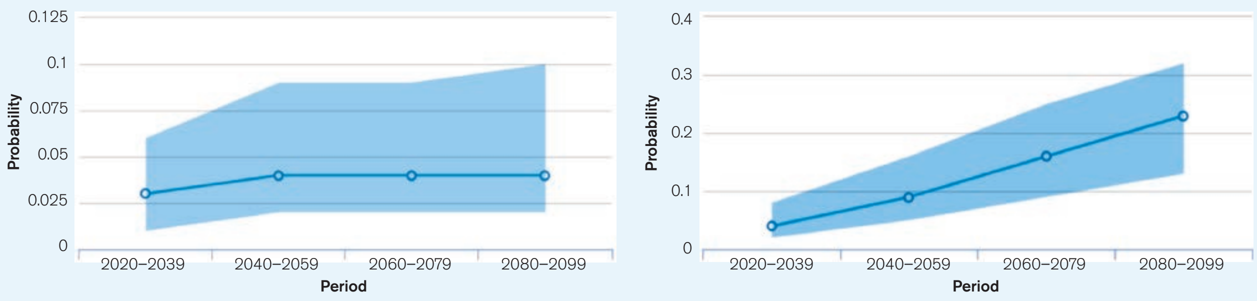
Heat Waves

Pakistan regularly experiences some of the highest maximum temperatures in the world, with an average monthly maximum of around 27°C and an average June maximum of 36°C. The current median annual probability of a heat wave occurring in any given location in Pakistan is around 3%.[33] A large proportion of the population are exposed to this risk, as demonstrated by estimates that over 65,000 people were hospitalized with heat stroke during the 2015 heatwave in Pakistan.[34]

Many regions of Pakistan experience temperatures of 38°C and above on an annual basis, when weather patterns converge to deliver prolonged periods of heatwave serious human health impacts can result. Nasim et al. (2018)[35] estimates that Pakistan experienced 126 heat waves between 1997–2015, around 7 per year, and detect an increasing trend. Over 1,200 heat-related deaths resulted from a severe heatwave in 2015, primarily focused in Sindh Province. Matthews et al. (2017)[36] identify both Karachi and Lahore among the cities most vulnerable to increases in extreme heat where, even under lower emissions pathways, temperature currently considered heatwave and associated with high mortality risk becomes a regular occurrence.

The multi-model ensemble projects an increase in the median annual probability of a heatwave in any given region from 3% to 4%–23% depending on the emissions pathway (**Figure 10**).[37] Nasim et al. (2018)[38] estimate the change

FIGURE 10. Projected change in the probability of observing a heat wave in Pakistan under RCP2.6 (left) and RCP8.5 (right) estimated by the full IPCC model ensemble in 10th, 50th, and 90th percentiles. In this model a 'Heat Wave' is defined as a period of 3 or more days where the daily temperature is above the long-term moving 95th percentile of daily mean temperature.[39]



[33] WBG Climate Change Knowledge Portal (CCKP, 2021). Climate by Sector. URL: https://climateknowledgeportal.worldbank.org/country/pakistan

[34] Saleem, M., Shafiq, A., & Syed, Z. S. (2018). Heat wave killings in Pakistan and possible strategies to prevent the future heat wave fatalities. Research and Reviews on Healthcare, 57(March), 1–5. URL: https://lupinepublishers.com/research-and-reviews-journal/fulltext/heat-wave-killings-in-pakistan-and-possible-strategies-to-prevent-the-future-heat-wave-fatalities.ID.000113.php

[35] Nasim, W., Amin, A., Fahad, S., Awais, M., Khan, N., Mubeen, M., . . . Jamal, Y. (2018). Future risk assessment by estimating historical heat wave trends with projected heat accumulation using SimCLIM climate model in Pakistan. Atmospheric Research: 205: 118–133. URL: https://ui.adsabs.harvard.edu/abs/2018AtmRe.205..118N/abstract

[36] Matthews, T., Wilby, R.L. and Murphy, C. 2017. Communicating the deadly consequences of global warming for human heat stress. Proceedings of the National Academy of Sciences, 114, 3861–3866. URL: https://www.pnas.org/content/114/15/3861

[37] WBG Climate Change Knowledge Portal (CCKP, 2021). Climate by Sector. URL: https://climateknowledgeportal.worldbank.org/country/pakistan

[38] Nasim, W., Amin, A., Fahad, S., Awais, M., Khan, N., Mubeen, M., . . . Jamal, Y. (2018). Future risk assessment by estimating historical heat wave trends with projected heat accumulation using SimCLIM climate model in Pakistan. Atmospheric Research: 205: 118–133. URL: https://ui.adsabs.harvard.edu/abs/2018AtmRe.205..118N/abstract

[39] WBG Climate Change Knowledge Portal (CCKP, 2021). Climate by Sector. URL: https://climateknowledgeportal.worldbank.org/country/pakistan

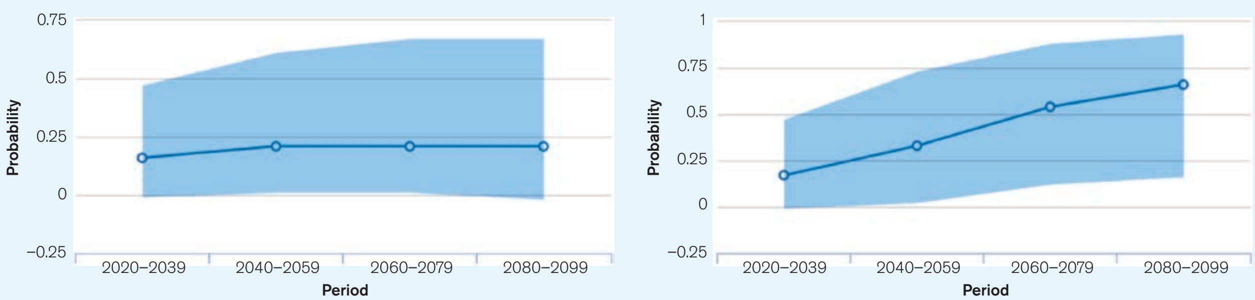
in probability as a percentage increase over the probability in 1995, albeit with a different and smaller set of models, showing probability increases in the range of 62%–140% depending on emissions pathway, with the highest increases always seen under RCP8.5. However, these estimates are distorted by the continual rising temperatures, which make exceptional heat difficult to define. Another lens through which to view heat risk is the frequency of days with a Heat Index (a function of both temperature and humidity which better represents the threat to human health) above 35°C. The frequency of days meeting this criterion may more than double by 2080–2099 under the highest emissions pathway (RCP8.5), representing a significant threat to human health and livelihoods.

Drought

Two primary types of drought may affect Pakistan, meteorological (usually associated with a precipitation deficit) and hydrological (usually associated with a deficit in surface and subsurface water flow, potentially originating in the region's larger river basins). At present Pakistan faces an annual median probability of severe meteorological drought of around 3%,[40] as defined by a standardized precipitation evaporation index (SPEI) of less than –2.

The probability of meteorological drought is projected to increase under all emissions pathways, and with very strong increases. While uncertainty is high, the CMIP5 ensemble projection would suggest that severe drought conditions (SPEI <–2) may be experienced with an annual probability of 25%–65% across Pakistan, with higher probability under higher emissions pathways (**Figure 11**). These high values reflect the transition of large areas of Pakistan to ecological zones which are effectively chronically drought affected. As reported by Ahmed et al. (2018)[41] drought frequency is increasing in already arid and semi-arid areas. The work of Nauman et al. (2018)[42] however, shows increases in the frequency of severe drought in Pakistan's wetter northern areas, where what

FIGURE 11. Projected change in the annual probability of experiencing at least severe drought conditions (–2 SPEI index) in Pakistan under RCP2.6 scenario (left) and RCP8.5 scenario (right) estimated by the full CMIP5 model ensemble in 10th, 50th, and 90th percentiles[43]



[40] WBG Climate Change Knowledge Portal (CCKP, 2021). Climate Projections. URL: https://climateknowledgeportal.worldbank.org/country/pakistan/climate-data-projections

[41] Ahmed, K., Shahid, S., & Nawaz, N. (2018). Impacts of climate variability and change on seasonal drought characteristics of Pakistan. Atmospheric Research, 214, 364–374. URL: https://www.sciencedirect.com/science/article/pii/S016980951830646X

[42] Naumann, G., Alfieri, L., Wyser, K., Mentaschi, L., Betts, R. A., Carrao, H., . . . Feyen, L. (2018). Global Changes in Drought Conditions Under Different Levels of Warming. Geophysical Research Letters, 45(7), 3285–3296. URL: https://agupubs.onlinelibrary.wiley.com/doi/10.1002/2017GL076521

[43] WBG Climate Change Knowledge Portal (CCKP, 2021). Climate Projections. URL: https://climateknowledgeportal.worldbank.org/country/pakistan/climate-data-projections

is currently an extreme drought occurring 1 in 100-years under current climate may have a return period of 1 in 50-years under 1.5°C of warming or 1 in 20-years under 3°C of warming.

Droughts are in some cases associated with El Niño events and can cause significant damage to crop and livelihoods, as in the consecutive droughts of 1999 and 2000, which caused crop failure and mass famine in Pakistan. Climate change interactions with El Niño are currently poorly understood, and poorly simulated by current climate models,[44] and further research is required to better constrain future drought risk in Pakistan.

Flood

The World Resources Institute's Global Flood Analyzer AQUEDUCT can be used to establish a baseline level of flood exposure. As of 2010, assuming protection for up to a 1 in 25-year event, the population annually affected by flooding in Pakistan is estimated at 714,000 people and expected annual impact on GDP at $1.7 billion. Development and climate change are both likely to increase these figures. The climate change component can be isolated and by 2030 is expected to increase the annually affected population by 1.5 million people, and the impact on GDP by $5.8 billion under the RCP8.5 emissions pathway (AQUEDUCT Scenario B).[45]

The unusually large rainfall from the 2010 monsoon caused the most catastrophic flooding in Pakistan's history, flooding one-fifth of the country, affecting 20 million people, and claiming over 2,000 lives. The impact of this event emphasised the nation's vulnerability to flooding also in economic terms. UNISDR (2014)[46] place Pakistan's average annual losses to flood at around $1 billion (slightly lower than the AQUEDUCT estimation). Given this vulnerability, the uncertainty around issues such as glacial melt, average precipitation, and extreme precipitation change is a major concern. Work by Willner et al. (2018)[47] estimates that by 2035–2044 an additional five million people will be affected by extreme river flooding annually (**Table 6**). Pakistan's mountain regions also hold vulnerability to glacial

TABLE 6. Estimated number of people affected by an extreme river flood (extreme river flood is defined as being in the 90th percentile in terms of numbers of people affected) in the historic period 1971–2004 and the future period 2035–2044. Figures represent an average of all four RCPs and assume present day population distributions (Willner et al., 2018).[48]

Estimate	Population Exposed to Extreme Flood (1971–2004)	Population Exposed to Extreme Flood (2035–2044)	Increase in Affected Population
16.7 Percentile	4,158,091	9,220,336	5,062,245
Median	5,709,314	11,238,400	5,529,086
83.3 Percentile	7,929,955	13,378,717	5,448,762

44 Yun, K.S., Yeh, S.W. and Ha, K.J. (2016). Inter-El Niño variability in CMIP5 models: Model deficiencies and future changes. Journal of Geophysical Research: Atmospheres, 121, 3894–3906. URL: https://ui.adsabs.harvard.edu/abs/2016JGRD..121.3894Y/abstract

45 WRI (2018). AQUEDUCT Global Flood Analyzer. Available at: https://floods.wri.org/# [Accessed: 22/11/2018].

46 UNISDR (2014). PreventionWeb: Basic country statistics and indicators. Available at: https://www.preventionweb.net/countries [accessed 14/08/2018].

47 Willner, S., Levermann, A., Zhao, F., Frieler, K. (2018). Adaptation required to preserve future high-end river flood risk at present levels. Science Advances: 4:1. URL: https://advances.sciencemag.org/content/4/1/eaao1914

48 Willner, S., Levermann, A., Zhao, F., Frieler, K. (2018). Adaptation required to preserve future high-end river flood risk at present levels. Science Advances: 4:1. URL: https://advances.sciencemag.org/content/4/1/eaao1914

lake outburst floods, triggered when ice melt and moraine failure releases large volumes of water trapped at high altitudes. With an uncertain future for glaciers in and neighbouring Pakistan, including temperature rises and changes in the precipitation regime, there is a need for further research and precautionary disaster risk reduction measures.[49]

CLIMATE CHANGE IMPACTS

Climate Change Impacts on Natural Resources

Water

While increases in the severity of extreme events of both flood and drought seem likely, there is some uncertainty regarding the long-term outlook for water resources in Pakistan. Uncertainty surrounds projections of change in annual rainfall, some shifts in seasonality seem likely. In the context of Pakistan's heavy reliance on the Indus Basin for its water resource, the uncertainty around future glacial change is significant. The impact of climate change on the Karakoram glaciers has been the subject of debate, with some studies suggesting glaciers have been increasing in size due to increased winter rainfall. However, a review conducted by UNDP (2017)[50] shows shortcomings in these studies, particularly related to the lack of a comprehensive inventory of Upper Indus Basin glaciers. In addition, it suggests that in the shorter-term the climate change impact on water resources in Pakistan may be of lesser significance in comparison with the issues presented by growing human demand for water and other issues including the poor efficiency of Pakistan's irrigation and water storage systems.[51] However, UNDP (2017)[52] emphasize the strong likelihood that longer-term temperature rises will result in glacial loss, and reductions in the runoff which feeds the Indus, as well as changes to its seasonal profile. The extent to which changes in rainfall might offset this loss is uncertain. Archer et al. (2010)[53] provide a useful overview of the potential impacts of climate change in the Indus Basin. Issues highlighted include the declining and insufficient capacity of Pakistan's reservoirs to serve its needs under future development and climate change scenarios, and the likely pressure this will place on groundwater.

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[49] Ashraf, A., Naz, R., & Roohi, R. (2012). Glacial lake outburst flood hazards in Hindukush, Karakoram and Himalayan Ranges of Pakistan: implications and risk analysis. Geomatics, Natural Hazards and Risk, 3(2), 113–132. URL: https://www.researchgate.net/publication/254238697_Glacial_lake_outburst_flood_hazards_in_Hindukush_Karakoram_and_Himalayan_Ranges_of_Pakistan_implications_and_risk_analysis

[50] UNDP (2017). The vulnerability of Pakistan's water sector to the impacts of climate change: identification of gaps and recommendations for action. United Nations Development Programme. URL: https://www.iisd.org/publications/vulnerability-pakistans-water-sector-impacts-climate-change-identification-gaps-and

[51] ADB (2017). Climate Change Profile of Pakistan. Asian Development Bank. URL: https://www.adb.org/publications/climate-change-profile-pakistan

[52] UNDP (2017). The vulnerability of Pakistan's water sector to the impacts of climate change: identification of gaps and recommendations for action. United Nations Development Programme. URL: https://www.iisd.org/publications/vulnerability-pakistans-water-sector-impacts-climate-change-identification-gaps-and

[53] Archer, D. R., Forsythe, N., Fowler, H. J., and Shah, S. M. (2010). Sustainability of water resources management in the Indus Basin under changing climatic and socio economic conditions, Hydrology and Earth System Sciences, 14, 1669–1680. URL: https://hess.copernicus.org/articles/14/1669/2010/hess-14-1669-2010.pdf

Coastal Zone

Sea-level rise threatens significant physical changes to coastal zones around the world. Global mean sea-level rise was estimated in the range of 0.44–0.74 m by the end of the 21st century by the IPCC's Fifth Assessment Report[54] but some studies published more recently have highlighted the potential for more significant rises (**Table 7**).

TABLE 7. Estimates of global mean sea-level rise by rate and total rise compared to 1986–2005 including likely range shown in brackets, data from Chapter 13 of the IPCC's Fifth Assessment Report with upper-end estimates based on higher levels of Antarctic ice-sheet loss from Le Bars et al., 2017.

Scenario	Rate of Global Mean Sea-Level Rise in 2100	Global Mean Sea-Level Rise in 2100 Compared to 1986–2005
RCP2.6	4.4 mm/yr (2.0–6.8)	0.44 m (0.28–0.61)
RCP4.5	6.1 mm/yr (3.5–8.8)	0.53 m (0.36–0.71)
RCP6.0	7.4 mm/yr (4.7–10.3)	0.55 m (0.38–0.73)
RCP8.5	11.2 mm/yr (7.5–15.7)	0.74 m (0.52–0.98)
Estimate Inclusive of High-End Antarctic Ice-Sheet Loss		1.84 m (0.98–2.47)

Pakistan's coastline holds considerable vulnerability to sea-level rise and its associated impacts. Work by the Met Office (2014) suggest that without adaptation around one million people faces will face coastal flooding annually by the period 2070–2100 (**Table 8**). The largest area of vulnerability is the Indus Delta, around 4,750 km^2 of which sits below 2 m above sea-level.[55] It is estimated that around one million people live in the delta. This is substantially fewer than historically resided in the area after many years of migration driven by the upstream diversion of fresh water resources away from the delta. Saline intrusion continues to be a major challenge in the coastal zone, degrading land quality and agricultural yields. These issues are likely to intensify, affecting many marginal and deprived communities.

TABLE 8. The average number of people experiencing flooding per year in the coastal zone in the period 2070–2100 under different emissions pathways (assumed medium ice-melt scenario) and adaptation scenarios for Pakistan (UK Met Office, 2014)

Scenario	Without Adaptation	With Adaptation
RCP2.6	950,300	1,040
RCP8.5	1,207,740	2,190

[54] Church, J. a., Clark, P. U., Cazenave, A., Gregory, J. M., Jevrejeva, S., Levermann, A., . . . Unnikrishnan, A. S. (2013). Sea level change. In Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (pp. 1137–1216). Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press. URL: https://www.eea.europa.eu/data-and-maps/indicators/sea-level-rise-5/nicholls-et-al-2010-sea

[55] Syvitski, J. P. M., Kettner, A. J., Overeem, I., Hutton, E. W. H., Hannon, M. T., Brakenridge, G. R., . . . Nicholls, R. J. (2009). Sinking deltas due to human activities. Nature Geoscience, 2(10), 681–686. URL: https://www.nature.com/articles/ngeo629

Land and Soil

Issues of land degradation, desertification and dryland expansion are a major concern in Pakistan. Around 80% of Pakistan's area is arid or semi-arid, processes linked to human development such as overgrazing, over-exploitation of water resources and over-cultivation, and excessive use of fertilisers are combining to degrade land quality and expand drylands. MOCC/IUCN (2017) reports on the challenges Pakistan has faced in implementing the National Action Programme to Combat Desertification.[56] Huang et al. (2016)[57] suggest there is significant potential for climate change to drive an increase in the land categorized as hyper-arid (the driest category) under higher emissions pathways. This phenomenon has already been documented in some regions, as droughts become more frequent in arid and semi-arid areas.[58] Potential impacts of the expansion of drylands and desertification include the sedimentation of reservoirs, generation of dust storms, and loss of biodiversity. Initiatives such as "Clean Green Pakistan" aim to restore Pakistan's natural environment, including through major tree planting efforts over the period 2016–2021.

Climate Change Impacts on Economic Sectors

Agriculture

Climate change will influence food production via direct and indirect effects on crop growth processes. Direct effects include alterations to carbon dioxide availability, precipitation and temperatures. Indirect effects include impacts on water resource availability and seasonality, soil organic matter transformation, soil erosion, changes in pest and disease profiles, the arrival of invasive species, and decline in arable areas due to the submergence of coastal lands and desertification. On an international level, these impacts are expected to damage key staple crop yields, even on lower emissions pathways. Tebaldi and Lobell (2018)[59] estimate 5% and 6% declines in global wheat and maize yields respectively even if the Paris Climate Agreement is met and warming is limited to 1.5°C. Shifts in the optimal and viable spatial ranges of certain crops are also inevitable, though the extent and speed of those shifts remains dependent on the emissions pathway.

A further, and perhaps lesser appreciated influence of climate change on agricultural production is through its impact on the health and productivity of the labor force. Work by Dunne et al. (2013)[60] suggests that labor productivity during peak months has already dropped by 10% as a result of warming, and that a decline of up to 20% might be expected by 2050 under the highest emissions pathway (RCP8.5). In combination, it is highly likely that the above processes will have a considerable impact on national food consumption patterns both through direct impacts on internal agricultural operations, and through impacts on the global supply chain.

[56] MoCC / IUCN Pakistan (2017). National Action Programme to Combat Desertification in Pakistan. IUCN Pakistan, Pakistan. xii+87 pp. URL: https://www.iucn.org/sites/dev/files/pk_nap_desertification_report.pdf

[57] Huang, J., Yu, H., Guan, X., Wang, G., & Guo, R. (2016). Accelerated dryland expansion under climate change. Nature Climate Change, 6(2), 166–171. URL: https://www.nature.com/articles/nclimate2837?proof=t

[58] Ahmed, K., Shahid, S., & Nawaz, N. (2018). Impacts of climate variability and change on seasonal drought characteristics of Pakistan. Atmospheric Research, 214, 364–374. URL: https://www.sciencedirect.com/science/article/pii/S016980951830646X

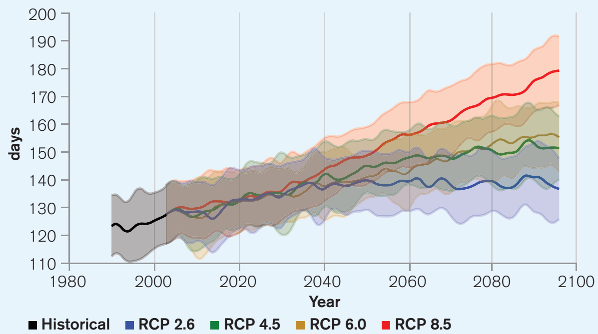
[59] Tebaldi, C., & Lobell, D. (2018). Differences, or lack thereof, in wheat and maize yields under three low-warming scenarios. Environmental Research Letters: 13: 065001. URL: https://iopscience.iop.org/article/10.1088/1748-9326/aaba48

[60] Dunne, J. P., Stouffer, R. J., & John, J. G. (2013). Reductions in labour capacity from heat stress under climate warming. Nature Climate Change, 3(6), 563–566. URL: http://www.precaution.org/lib/noaa_reductions_in_labour_capacity_2013.pdf

Agriculture employs 38.57% of the Pakistan's workforce and contributes 22% to gross domestic product (GDP), making potential climate impacts and adaptation needs in the sector a high priority. The five most important crops in the country, wheat, rice, cotton, sugarcane, and maize, are grown predominantly by subsistence farmers, and a large proportion of the nation's agricultural land is degraded. Around 80% of Pakistan's agricultural production area is irrigated.[61] Damage to key cash crop yields, such as cotton, is a particular concern. Pakistan is the fifth largest producer of cotton in the world—the industry contributes 10% of the country's GDP and employs approximately 30% of the country's farmers, many of whom are rural women.

Studies suggest Pakistan's crops are highly sensitive to changes in temperature and water availability, and that temperature rises in the region of 0.5°C–2°C could lead to around an 8%–10% loss in yield (Dehlavi et al., 2015).[62] Many crops are particularly sensitive to extreme heats and days of T>35°C are projected to increase in frequency (**Figure 12**). With the exception of the northern mountainous region, projected yield declines are widespread, particularly for crops such as cotton, wheat, sugarcane, maize, and rice.[63,64] Yu et al. (2013)[65] suggest rice and sugarcane are worst affected under a high emissions scenario, experiencing 25% and 20% yield reductions, respectively. The impacts of climate change on the livestock sub-sector are less clear and further study is required. However, the impact of the extended drought period between 2015–2017 which reduced livestock output by 48% in the worst affected districts highlighted the potential threat of future increases in drought frequency.

FIGURE 12. Annual average number of hot days (>35°C) in Pakistan under two emissions pathways. RCP2.6 (Blue) and RCP8.5 (Red). The values shown represents the median of 30+ GCM model ensemble with the shaded areas showing the 10–90th percentiles.[66]



[61] ADB (2017). Climate Change Profile of Pakistan. Asian Development Bank. URL: https://www.adb.org/publications/climate-change-profile-pakistan

[62] Dehlavi, A., Gorst, A., Groom, B., Zaman, F. (2015). Climate change adaptation in the Indus ecoregion: A microeconomic study of the determinants, impacts and cost effectiveness of adaptation strategies. WWF-Pakistan. URL: https://d2ouvy59p0dg6k.cloudfront.net/downloads/110215_idrcstudy_1.pdf

[63] ADB (2017). Climate Change Profile of Pakistan. Asian Development Bank. URL: https://www.adb.org/publications/climate-change-profile-pakistan

[64] Yu, W., Yang, Y.-C., Savitsky, A., Alford, D., Brown, C., Wescoat, J., Debowicz, D., Robinson, S. (2013). The Indus Basin of Pakistan: The impacts of climate risks on water and agriculture. The World Bank. URL: http://documents1.worldbank.org/curated/en/650851468288636753/pdf/Indus-basin-of-Pakistan-impacts-of-climate-risks-on-water-and-agriculture.pdf

[65] Yu, W., Yang, Y.-C., Savitsky, A., Alford, D., Brown, C., Wescoat, J., Debowicz, D., Robinson, S. (2013). The Indus Basin of Pakistan: The impacts of climate risks on water and agriculture. The World Bank. URL: http://documents1.worldbank.org/curated/en/650851468288636753/pdf/Indus-basin-of-Pakistan-impacts-of-climate-risks-on-water-and-agriculture.pdf

[66] WBG Climate Change Knowledge Portal (CCKP, 2021). Climate by Sector. URL: https://climateknowledgeportal.worldbank.org/country/pakistan/climate-sector-energy

The impact of extreme climate events on the agricultural sector in Pakistan can be very significant, raising concerns regarding any increase in their frequency attributed to climate change. Floods inundate fertile land, kill livestock, destroy standing crops, and reduce or eliminate yields. This was demonstrated in the major flood of 2010, during which an estimated 2.4 million hectares of unharvested crops were lost, worth approximately $5.1 billion. Droughts can be equally devastating to rural livelihoods. From 1999–2002, droughts in the Sindh and Baluchistan provinces killed two million livestock and necessitated emergency relief to provide drinking water and food aid to farming communities. Even minimal changes in precipitation patterns over prolonged periods can alter the country's food production by placing greater pressure on the water resources the country's irrigation network depends on. Further research is needed to provide greater certainty around future water resource trends.

Urban and Energy

Research has established a reasonably well constrained relationship between heat stress and labor productivity, household consumption patterns, and (by proxy) household living standards.[67] In general terms the impact of an increase in temperature on these indicators depends on whether the temperature rise moves the ambient temperature closer to, or further away from, the optimum temperature range. The optimum range can vary depending on local conditions and adaptations.

The effects of temperature rises and heat stress in urban areas are increasingly compounded by the phenomenon of Urban Heat Island (UHI), which has been documented in urban conurbations around the world. Dark surfaces, residential and industrial sources of heat, absence of transpiring vegetation and air pollution[68] can push temperatures higher than those of the rural surroundings, commonly anywhere in the range of 0.1°C–3°C in global mega-cities.[69] For instance, night time UHI as high as 13°C has been reported in Karachi.[70] As well as impacting on human health (see Impacts on Communities) the temperature peaks that will result from combined UHI and climate change, as well as future urban expansion, are likely to damage the productivity of the service sector economy, both through direct impacts on labor productivity, but also through the additional costs of adaptation.

Research suggests that on average a one degree increase in ambient temperature can result in a 0.5%–8.5% increase in electricity demand.[71] Notably this serves business and residential air cooling systems. This increase in demand places stress on energy generation systems which is compounded by the heat stress on the energy generation system itself, commonly due to its own cooling requirements, which can reduce its efficiency.[72]

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67 Mani, M., Bandyopadhyay, S., Chonabayashi, S., Markandya, A., Mosier, T. (2018). South Asia's Hotspots: The Impact of Temperature and Precipitation changes on living standards. South Asian Development Matters. World Bank, Washington DC. URL: https://documents.worldbank.org/en/publication/documents-reports/documentdetail/201031531468051189/south-asia-s-hotspots-the-impact-of-temperature-and-precipitation-changes-on-living-standards

68 Cao, C., Lee, X., Liu, S., Schultz, N., Xiao, W., Zhang, M., & Zhao, L. (2016). Urban heat islands in China enhanced by haze pollution. Nature Communications, 7, 1–7. URL: https://www.nature.com/articles/ncomms12509

69 Zhou, D., Zhao, S., Liu, S., Zhang, L., & Zhu, C. (2014). Surface urban heat island in China's 32 major cities: Spatial patterns and drivers. Remote Sensing of Environment, 152, 51–61. URL: https://europepmc.org/article/agr/ind605450314

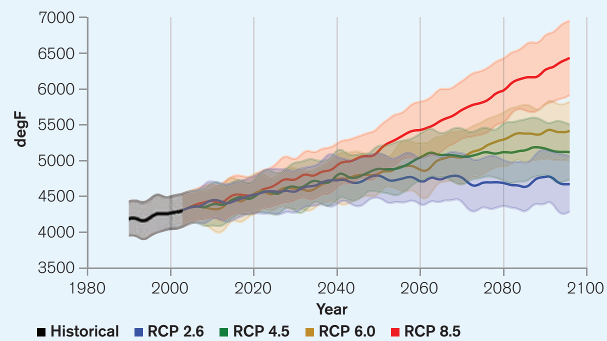
70 Sajjad, S. H., Blond, N., Batool, R., Shirazi, S. A., Shakrullah, K., & Bhalli, M. N. (2015). Study of Urban Heat Island of Karachi by Using Finite Volume Mesoscale Model. Journal of Basic & Applied Sciences, 11, 101–105. URL: https://www.lifescienceglobal.com/pms/index.php/jbas/article/view/2724

71 Santamouris, M., Cartalis, C., Synnefa, A., & Kolokotsa, D. (2015). On the impact of urban heat island and global warming on the power demand and electricity consumption of buildings—A review. Energy and Buildings, 98, 119–124. URL: https://www.sciencedirect.com/science/article/abs/pii/S0378778814007907

72 ADB (2017). Climate Change Profile of Pakistan. Asian Development Bank. URL: https://www.adb.org/publications/climate-change-profile-pakistan

Pakistan faces increases in average temperatures significantly above the global average. Cities in its northern regions will be strongly impacted. These rises add to already high baseline temperatures. Under higher emissions pathways the number of days per year with temperatures over 35°C may rise from around 120 to over 150 by the middle of the 21st century. These changes will place extreme pressure on urban environments, and the energy systems which support them. Changes should be seen in the context of the increasing impact of the urban heat island effect, driven by urbanization, and identified in cities such as Lahore and Peshawar. The requirement for cooling is expected to increase (**Figure 13**) and simultaneously the strain on the nation's energy system will also increase. ADB (2017)[73] suggest particular challenges related to cooling nuclear and thermal power plants which may reduce their efficiency. The energy system is also vulnerable to the effects of extreme climate events, which are expected to intensify under climate change.

FIGURE 13. Annual cooling degree days in Pakistan calculated by taking the sum of daily T – 18.3°C for two emissions pathways, RCP2.6 (Blue) and RCP8.5 (Red). The values shown represents the median of 30+ GCM model ensemble with the shaded areas showing the 10–90th percentiles.[74]



Climate Change Impacts on Communities

Vulnerability to Climate-Related Disaster

Pakistan holds considerable social vulnerability to disaster. High poverty and malnutrition rates prevail (see **Table 1**), and many communities and minority groups are marginalized by socio-economic status, location, and political circumstances. Pakistan sits 125th out of 169 countries on the Human Development Index. Pakistan's high exposure to multiple natural hazards and its likely exposure to above average climate changes should be seen in the context of its vulnerability. Over decadal timeframes mortality attributable to natural hazards is dominated by Pakistan's exposure to earthquakes. However, in recent years flooding has also had a very significant impact. Approximately 2,000 people were killed by the major flood in 2010, with 12 million homes and 2.2 million hectares of crops damaged or destroyed. According to UNISDR (2014),[75] of an estimated $1.3 billion of average annual losses to natural hazards, around 75% are attributable to flood. GermanWatch (2017)[76] put a higher estimate on Pakistan's average annual losses, at $3.8 billion.

73 ADB (2017). Climate Change Profile of Pakistan. Asian Development Bank. URL: https://www.adb.org/publications/climate-change-profile-pakistan

74 WBG Climate Change Knowledge Portal (CCKP, 2021). Climate by Sector. URL: https://climateknowledgeportal.worldbank.org/country/pakistan/climate-sector-energy

75 UNISDR (2014). PreventionWeb: Basic country statistics and indicators. Available at: https://www.preventionweb.net/countries [accessed 14/08/2018].

76 GermanWatch (2017). Global Climate Risk Index 2017. GermanWatch, Bonn. URL: https://germanwatch.org/sites/germanwatch.org/files/publication/16411.pdf

Human Health

Nutrition

The World Food Programme (2015)[77] estimate that without adaptation action the risk of hunger and child malnutrition on a global scale will increase by 20% respectively by 2050. Work by Springmann et al. (2016)[78] has assessed the potential for excess, climate-related deaths associated with malnutrition. The authors identify two key risk factors which are expected to be the primary drivers: a lack of fruit and vegetables in diets and health complications caused by increasing prevalence of people underweight. They project that there will be approximately 9.32 climate-related deaths per million population per year linked to lack of food availability in Pakistan by the year 2050 under RCP8.5, which is comparatively better than many other developing nations. This estimate does not include the impact of potential climate-related changes to the nutritional content of food.

Heat-Related Mortality

Research has identified a threshold of 35°C (wet bulb ambient air temperature) on the human body's ability to regulate temperature, beyond which even a very short period of exposure can present risk of serious ill-health and death.[79] Temperatures significantly lower than the 35°C threshold of 'survivability' can still represent a major threat to human health. Climate change will push global temperatures closer to this temperature 'danger zone' both through slow-onset warming and intensified heat waves. Matthews et al. (2017)[80] identify both Karachi and Lahore as cities likely to face extreme exposure to deadly temperatures even on lower emissions pathways. Work by Honda et al. (2014),[81] which utilized the A1B emissions scenario from CMIP3 (most comparable to RCP6.0), estimates that without adaptation, annual heat-related deaths in the Central Asian region, will increase 139% by 2030 and 301% by 2050.

Disease

Further research is required into the complex relationship between climate changes and disease prevalence. Only coarse estimates of changes in the distribution of a small number of diseases are currently available. The World Health Organization (WHO)[82] project that, under a high emissions scenario (RCP8.5), 46 million people in Pakistan will be at risk of contracting malaria by 2070. However, if global emissions are decreased significantly (RCP2.6) this number is projected to be around 12 million by 2070. Diarrhoeal-related deaths are projected to decrease significantly by 2050, but the proportion of those attributable to climate change is expected to rise, under a high emissions scenario this will be from 11.7% in 2030 to 17% by 2050.

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77 WFP (2015). Two minutes on climate change and hunger: A zero hunger world needs climate resilience. The World Food Programme. URL: https://docs.wfp.org/api/documents/WFP-0000009143/download/

78 Springmann, M., Mason-D'Croz, D., Robinson, S., Garnett, T., Godfray, H. C. J., Gollin, D., . . . Scarborough, P. (2016). Global and regional health effects of future food production under climate change: a modelling study. The Lancet: 387: 1937–1946. URL: https://pubmed.ncbi.nlm.nih.gov/26947322/

79 Im, E. S., Pal, J. S., & Eltahir, E. A. B. (2017). Deadly heat waves projected in the densely populated agricultural regions of South Asia. Science Advances, 3(8), 1–8. URL: https://advances.sciencemag.org/content/3/8/e1603322

80 Matthews, T., Wilby, R.L. and Murphy, C. (2017). Communicating the deadly consequences of global warming for human heat stress. Proceedings of the National Academy of Sciences, 114, 3861–3866. URL: https://www.pnas.org/content/114/15/3861

81 Honda, Y., Kondo, M., McGregor, G., Kim, H., Guo, Y-L, Hijioka, Y., Yoshikawa, M., Oka, K., Takano, S., Hales, S., Sari Kovats, R. (2014). Heat-related mortality risk model for climate change impact projection. Environmental Health and Preventive Medicine 19: 56–63. URL: https://pubmed.ncbi.nlm.nih.gov/23928946/

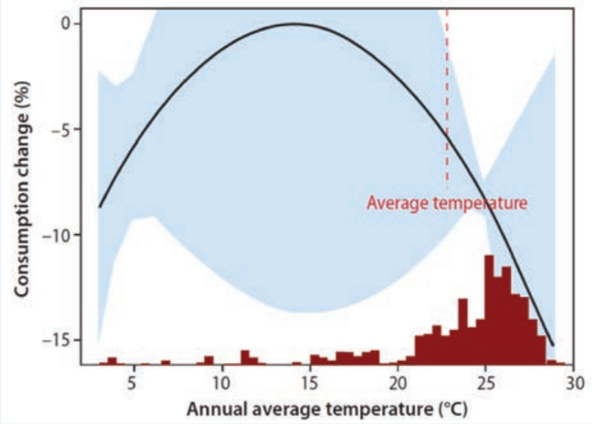
82 World Health Organization (2015). http://apps.who.int/iris/bitstream/handle/10665/246150/WHO-FWC-PHE-EPE-15.28-eng.pdf;jsessionid=C65C70B12A378437312D491DAD93E531?sequence=1

Poverty and Inequality

Many of the climate changes projected are likely to disproportionately affect the poorest groups in society. Heavy manual labour jobs are commonly among the lowest paid whilst also being most at risk of productivity losses due to heat stress.[83] Poorer businesses are least able to afford air conditioning, an increasing need given the projected increase in cooling days, and poorer farmers and communities are least able to afford local water storage, irrigation infrastructure, and technologies for adaptation. The high temperature increases projected for Pakistan present particular challenges in a nation where the agricultural sector remains the largest employer. Ahmed and Gautam (2013)[84] estimate that only 17.5% of the people below the poverty line in Pakistan are in urban areas. Rural groupings include those who are owners of small farms (20%), those who are landless farmers (10%) and agricultural laborers (12%) all of whom are likely to be among the most affected by the above pressures.

One lens through which to view the impact of changes is through the correlation of consumption patterns with temperature. Work by Mani et al. (2018) describes this relationship, and particularly the way consumption (used as an indicator of living standards) drops off past a certain temperature threshold. The work by Mani et al. (2018) suggests that Pakistan's average temperature is already higher than the optimal level for maximum consumption (**Figure 14**) and that further increases, through their impact on the productivity of labour (particularly linked to health issues), will reduce living standards. Pakistan has faced particular challenges addressing undernourishment, with the absolute number of people undernourished increasing year-on-year between 2006–2008 and 2014–2016. Around 20% of Pakistan's population remains undernourished and climate change looks likely to challenge Pakistan's attempts to alleviate undernourishment, poverty and deprivation. Mani et al. (2018)[85] suggest all of Pakistan's provinces will experience some living standards declines associated with temperature increases, with Sindh province the worst affected.

FIGURE 14. The relationship between temperature and consumption in Pakistan, shaded areas represent 90% confidence intervals.[86]



[83] Kjellstrom, T., Briggs, D., Freyberg, C., Lemke, B., Otto, M., Hyatt, O. (2016). Heat, human performance, and occupational health: A key issue for the assessment of global climate change impacts. Annual Review of Public Health: 37: 97–112. URL: https://www.annualreviews.org/doi/abs/10.1146/annurev-publhealth-032315-021740

[84] Ahmed, S., Gautam, M. (2013) Agriculture and water policy: Towards sustainable inclusive growth. World Bank Policy Paper Series. URL: https://documents.worldbank.org/en/publication/documents-reports/documentdetail/570291468083332554/agriculture-and-water-policy-toward-sustainable-inclusive-growth

[85] Mani, M., Bandyopadhyay, S., Chonabayashi, S., Markandya, A., Mosier, T. (2018). South Asia's Hotspots: The Impact of Temperature and Precipitation changes on living standards. South Asian Development Matters. World Bank, Washington DC. URL: https://documents.worldbank.org/en/publication/documents-reports/documentdetail/201031531468051189/south-asia-s-hotspots-the-impact-of-temperature-and-precipitation-changes-on-living-standards

[86] Mani, M., Bandyopadhyay, S., Chonabayashi, S., Markandya, A., Mosier, T. (2018). South Asia's Hotspots: The Impact of Temperature and Precipitation changes on living standards. South Asian Development Matters. World Bank, Washington DC. URL: https://documents.worldbank.org/en/publication/documents-reports/documentdetail/201031531468051189/south-asia-s-hotspots-the-impact-of-temperature-and-precipitation-changes-on-living-standards

Gender

An increasing body of research has shown that climate-related disasters have impacted human populations in many areas including agricultural production, food security, water management and public health. The level of impacts and coping strategies of populations depends heavily on their socio-economic status, socio-cultural norms, access to resources, poverty as well as gender. Research has also provided more evidence that the effects are not gender neutral, as women and children are among the highest risk groups. Key factors that account for the differences between women's and men's vulnerability to climate change risks include: gender-based differences in time use; access to assets and credit, treatment by formal institutions, which can constrain women's opportunities, limited access to policy discussions and decision making, and a lack of sex-disaggregated data for policy change.[87]

Migration

Work by the World Bank Group[88] suggests South Asia will experience an estimated 17–36 million internal climate migrants by 2050 as a result of slow-onset climate changes. The range in this estimate reflects different future development pathways with differing levels of emissions reduction and inequality in development outcomes. Under all scenarios, the poorest and most climate-vulnerable communities are likely to be hardest hit. Without significant mitigation action, beyond 2050 the climate-induced migration rate is likely to accelerate considerably. It is expected that 'hotspots' of in and out-migration are likely to form. As shown in **Figure 15** the large majority of migrants in South Asia are expected to come from communities dependent on rain-fed croplands for their livelihoods.

Rigaud et al (2018) also establish migration as an effective adaptation strategy, if well planned and supported by upskilling and job creation and conducted with sensitivity to the impacts on the communities already living in receiving areas. Climate-induced migration remains a poorly understood area, and investment is needed to understand push and pull factors, where hotspots may form, and how communities might be supported in different local contexts. Research can support governance which embeds migration across sectoral planning.

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[87] World Bank Group (2016). Gender Equality, Poverty Reduction, and Inclusive Growth. URL: http://documents1.worldbank.org/curated/en/820851467992505410/pdf/102114-REVISED-PUBLIC-WBG-Gender-Strategy.pdf

[88] Rigaud, K., de Sherbinin, A., Jones, B., Bergmann, J., Clement, V., Ober, K., Schewe, J., Adamo, S., McClusker, B., Heuser, S., Midgley, A. (2018). Groundswell: Preparing for internal climate migration. World Bank Group, Washington DC. URL: https://openknowledge.worldbank.org/handle/10986/29461

FIGURE 15. Projected net climate migration in and out of livelihood zones in South Asia under three scenarios (2020 and 2050), positive numbers indicate outmigration from the respective livelihood zone, from Rigaud et al. (2018).[89]

POLICIES AND PROGRAMMES

National Adaptation Policies and Plans

TABLE 9. Key national adaptation policies, strategies, and plans

Policy/Strategy/Plan	Status	Document Access
Nationally Determined Contribution (NDC) to Paris Climate Agreement	Submitted	November, 2016
Technology Needs Assessment for Climate Change Adaptation	Completed	March, 2016
National Disaster Risk Reduction Policy	Active	February, 2013
National Climate Change Policy	Active	September, 2012
National Communications to the UNFCCC	Two submitted	Latest: August, 2019

[89] Rigaud, K., de Sherbinin, A., Jones, B., Bergmann, J., Clement, V., Ober, K., Schewe, J., Adamo, S., McClusker, B., Heuser, S., Midgley, A. (2018). Groundswell: Preparing for internal climate migration. World Bank Group, Washington DC. URL: https://openknowledge.worldbank.org/handle/10986/29461

Climate-Related Priorities of ADB and the WBG

ADB – Country Partnership Strategy

ADB's Country Partnership Strategy with Pakistan (2021–2025)[90] holds three priority areas which intersect with climate change adaptation. The actions in these three areas are summarized below.

TABLE 10. Priority areas of ADB's Country Partnership Strategy with Pakistan

Areas of Concern	Interventions
Building Livable Cities	ADB will combine reforms and investments with assistance in building livable cities that are green, resilient, inclusive, and competitive. Such cities will enhance urban mobility, improve citizens' health, promote gender equity, and protect environmental sustainability. City governments will be encouraged to explore new sources of funding to meet infrastructure requirements and bring in sustainable planning processes by integrating climate resilience and disaster risk management considerations. ADB will invest in sovereign and non-sovereign projects to improve water supply and sanitation systems as well as urban transport infrastructure, including bus rapid transit and nonmotorized transport systems. Smart cities will be promoted through the application of technology, including digital access to services, digital payments, smart water meters, and charged parking
Building Climate and Disaster Resilience	ADB will maintain its support for building the resilience of communities and infrastructure to climate change and for strengthening climate change adaptation and disaster risk management. This includes investing in the sustainable management of watersheds and mangrove forests; improving the management of water resources; strengthening flood risk management in vulnerable coastal districts; bolstering climate policy, financing, and planning frameworks; upgrading the management of solid waste; and providing safe water in cities and towns. ADB will continue backing the National Disaster Risk Management Fund, including through recapitalization, to help implement national plans to reduce disaster risks and enhance preparedness. It will step up efforts to boost climate change mitigation through technology-based interventions with a focus on low-carbon and renewable energy, energy efficiency and conservation, and mass transit systems in urban areas
Disasters	Pakistan is prone to natural disasters triggered by natural hazards, such as flooding in Karachi in 2020. It is also highly vulnerable to epidemics and pandemics, such as COVID-19. If large-scale disasters and/or pandemics occur, they could delay the government's reforms and divert scarce fiscal resources from planned projects. In collaboration with development partners, ADB will assist the government in enhancing disaster resilience through instruments to finance disaster risk reduction and preparedness for health emergencies.

[90] ADB (2020). Country Partnership Strategy, Pakistan 2021–2025. URL: https://www.adb.org/sites/default/files/institutional-document/674016/pak-cps-2021-2025.pdf

WBG – Country Partnership Framework

The WBG Country Partnership Framework with Pakistan (2017–2020)[91] identifies climate change adaptation and mitigation in public and private sectors, focusing on energy, water, and agriculture investments as its third cross-cutting theme. Specifically, the World Bank Group aims to reduce vulnerability, improve readiness and achieve low-carbon green growth and resilient development. This would involve supporting (i) preparedness towards disasters and climate related emergencies; (ii) water conservation and management by modernizing irrigation networks and installing high efficiency irrigation systems; (iii) efforts for low-carbon development, particularly in energy (renewables) and industries. The WBG is in the process of a series of consultations with stakeholders across Pakistan, as it begins to prepare for the new five-year strategy, 2022–26.

TABLE 11. Priority areas of the World Bank's Country Partnership Framework with Pakistan

Areas of Cooperation	Interventions
Water conservation and management	Given Pakistan's widening gap between water supply and water demand and the potential impact of climate change to exacerbate water deficiencies, the Bank can support GOP to develop a policy framework that emphasizes demand management and conservation and pricing schemes for water use. As part of such national policy formulation, Pakistan may consider implementing regulations that monitor and enforce water use schemes. In parallel, the Bank can support investment in water conservation, modernize current/traditional irrigation networks and install high efficiency irrigation systems in water-scarce areas.
Low carbon development	Support access to climate finance for low-carbon/low-water development. Pakistan formally requested access to the Clean Technology Fund (CTF) in April 2013. CTF will consider the question of new membership in June 2014 when the outlook for operationalization of the Green Climate Fund will be clearer. Explore possibility of a low-carbon growth study. This will facilitate readiness to access climate finance by Pakistan. The study would identify and prioritize low-carbon interventions for the next 5–10 years consistent with longer-term vision for green growth. A low carbon study should identify options based on consensus within different on reference scenario emissions, specific mitigation measures and financing needs.
Improved preparedness towards climate related emergencies	Improve Early Warning Systems and access to risk information. To meet the challenges arising from the increased risk of hydro-meteorological disasters resulting from a change in the climatic conditions, Pakistan needs to have access to better risk information for better targeting of mitigation investments. It also needs to have a mechanism for communicating risk information through the creation of multi-hazard early warning systems going down to the community levels to better warn the vulnerable communities for improved preparedness.
	Support establishment of a Glacier Monitoring and Research Center. The Hindu Kush-Himalaya (KHK) region's 18,495 glaciers are an important source of water to the Indus River Basin, which covers 65 percent of Pakistan. Data on most glaciers is lacking. Policy makers need better data to prepare for hydrological changes.

[91] WBG (2016). Country Partnership Strategy. Pakistan for the period: FY17-FY20. URL: http://documents1.worldbank.org/curated/en/163401481660770129/pdf/108727-REVISED-PUBLIC-Afghanistan-CPF-27-Oct-final-12082016.pdf

CLIMATE RISK COUNTRY PROFILE

PAKISTAN

WORLD BANK GROUP

ADB ASIAN DEVELOPMENT BANK