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Assessing the Economic Consequences of Climate Change in Pakistan: Regional Dynamics and Adaptive Capacities in Buner and Punjab

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ABSTRACT

Pakistan is being hit very hard by climate disasters even though it contributes almost nothing to global greenhouse gas pollution (0.1) %, showing how unfair the climate crisis is. Recent floods, heat waves, and landslides especially in Punjab and Buner have destroyed crops, homes, and infrastructure, killed hundreds of people, and pushed food prices up, while millions who depend on farming for their income struggles to recover. According to government of Pakistan their country has lost 9% of the whole GDP in recent floods in the meanwhile their whole growth is just two to three percent yearly in GDP. Experts warn that if Pakistan does not quickly adapt and reduce emissions, climate impacts could cut up to one-fifth of its economy by 2050. Poverty, weak planning, and lack of resources make recovery even harder, and global support is far too small compared to what is needed. Without strong international funding, better national policies, and community preparedness, Pakistan risks falling into a long cycle of food shortages, displacement, rising poverty, and stalled development

Keywords: *climate change impacts**,** extreme weather events**,** Pakistan's climate vulnerability**,** agricultural losses**,** food security**,** economic damage**,** climate adaptation**,** poverty and resilience, climate finance**.***

INTRODUCTION

Climate change is one of the great existential and developmental challenges of the twenty-first century, with harmful impacts especially falling on countries that have contributed least to driving greenhouse gas (GHG) emissions around the world. This imbalance reflects an inherent injustice in the system of international climate negotiations in which low-emitting countries are more vulnerable because of the accumulated emissions from industrialized countries. Pakistan is a very good example of this brutal paradox of limited responsibility and extreme vulnerability. Although its contribution in Global GHG emissions is less than one per cent, as per the latest assessment, Pakistan is always among the most vulnerable nations in the world towards climate-induced calamities. The German Watch Global Climate Risk Index 2025, based on the economic loss and fatalities caused by weather events between 1993 and 2022, examines

vulnerabilities in the long run and places Pakistan in a first position among the countries with the most suffered damage with more than US$30 billion in accumulated damages. This ranking takes into account not only the frequency of events like floods, heat waves and droughts, but also the compounding effects on a population already struggling with poverty and lack of infrastructure.

The catastrophic floods in 2022 are proof of this vulnerability in a terrifying way. 33 million people, that is, a third of the country, were under water and more than 1,700 people lost their lives, while about nine million were thrown into the poverty trap. Economic assessments by the World Bank and the Pakistani government put the damages and loss at more than US$30 billion, with the need for reconstruction of more than US$16 billion and impacts on sectors ranging from agriculture to housing and infrastructure. Building off this pattern, monsoon flooding in 2025, as a result of anthropogenic warming conditions, monsoon variability as well as accelerated glacial melting that mimics much of this calamity, causes losses that equate to approximately 10 per cent of Pakistan's gross domestic product and relocates millions yet again. These repeated events point to a destruction cycle revealing the structural weakness of Pakistan, which has poor early warning systems, faulty flood defenses and poor financial capability to recover.

These recurring events reveal a cycle of destruction which opens the structural weakness of Pakistan and the evident need for more global adaptation finance and loss and damage measures to counter rising inequalities. Without system-wide interventions, such patterns threaten to perpetuate the dynamics of poverty traps, and the chimaera of sustaining development in ways impossible without climate justice within poverty is a reality, making climate justice not only an ethical demand it becomes the single condition that captures the future for global stability.

METHODOLOGY

This research uses a mixed method approach to study how climate change affects Pakistan, with focus on Punjab and Buner. It combines numbers from government and international reports with field data from surveys, interviews, and group discussions. Data from floods, heat waves, agriculture, income, health, and infrastructure between 2010 and 2025 are analyzed to measure economic losses and recovery capacity. Satellite images and climate records are used to track rainfall, temperature, and flood spread, while household surveys show how people cope and adapt. Simple statistical analysis and mapping help compare regional impacts and identify gaps in early warning systems, planning, and support, so you can clearly see where adaptation policies need improvement

Pakistan’s Climate Vulnerability in a Global Context

In the higher context of globalization, Pakistan is the frontline state in the climate crisis due to the convergence of geographical, socio-economical and institutional factors, making it overexposed to climate risks. The United Nations Office for Disaster Risk Reduction (UNDRR) Global Assessment Report confirms Pakistan's position as one of the most climate-exposed countries, a condition the report states is down to the country's varied topography (from the arid deserts to the mountainous areas) and the high proportion of climate-sensitive sectors (like agriculture & water resources). Central to this susceptibility is the Indus River Basin, an important lifeline which provides life for almost 237 million people through irrigation, hydropower, and drinking water supplies. Nourished by about 13,000 Himalayan glaciers, this basin is under increasing destabilization pressure due to the fast-melting glaciers and the highly erratic monsoon behavior, which is playing spoilsport, resulting in hydrological extremes between monsoon angers, such as flash floods during the wet season, and then a severe water shortage in the dry period. Studies from the International Centre for Integrated Mountain Development (ICIMOD) show that rising temperatures could see the basin's storage capacity for water decrease by up to 30 percent by 2025, leading

to more acute levels of scarcity and some areas of the river becoming seasonal. Furthermore, climate change adds pressure in geopolitical tensions also, as the Indus Waters Treaty between India and Pakistan is burdened with changing river flows, which can add conflict over common resources.

With over 93 per cent of agricultural production (over $31 billion worth) in Pakistan depending on irrigation supplied by the Indus system, disruptions threaten to devastate the food security and economic stability of the country. The IPCC Sixth Assessment Report (AR6) Synthesis Report has projected 20-30% declines in yields of staple crops such as wheat, rice and maize in South Asia by the year 2050 under high emission scenarios that could translate into an annual agricultural loss of US$ 10-15 bn for Pakistan. Compounding this, the UNEP Emissions Gap Report gives a warning signal that unless NDCs are strengthened by the end of 2025, global warming could spiral out of 1.5°C, leading to an 18-20% reduction in Pakistan's GDP due to compounding impacts such as a decrease in labor productivity as a result of heat stress and increased frequency of disasters by mid-century. These projections not only endanger livelihoods but also intensify migration pressures, with millions possibly forced out of rural areas to take charge in urban centers, which puts a strain on cities which are already overloaded. In a global justice framework, this vulnerability is contrasted with the fact that Pakistan has very low historical emissions and demands reparative actions from the high-emitting countries in the form of increased technology transfer, capacity development and financial support to strengthen adaptive capacities**.**

The Human and Economic Costs

Climate change has massive implications for human and economic life in Pakistan, in the form of not only immediate disasters but also long-term socio-economic disruptions that perpetuate the cycles of poverty. Attribution studies on the recent monsoon floods have concluded that the risks of anthropogenic climate change intensifying precipitation events are as high as 75 per cent, leading to changing patterns of seasonal rains with catastrophic flooding. For instance, the floods of 2025 had widespread damage in the estimate of US $30 billion, which included both direct losses to infrastructure, agriculture and industry, and indirect losses incurred due to supply chains and reduced productivity. Regional impacts were aggravated: urban centers like Lahore, Faisalabad, and Karachi saw industrial shutdowns, power failures, and transportation systems being paralyzed, with billions of dollars of forgone revenue and a huge number of job losses. In rural Punjab, the destruction of important cash crops cotton, wheat and sugarcane – resulted not only in deficits of export revenues but also in food insecurity for millions of smallholder farmers, most of whom have no insurance or other sources of income.

Marginalized areas, including Buner District in Khyber Pakhtunkhwa, are a modern example of where climate hazards intersect with pre-existing vulnerabilities, i.e., incapacities, such as poverty, inaccessible terrain, governance deficit, etc. Around 15 per cent of the high-risk zones in the district are equipped with functioning early-warning systems, but the deaths and the length of recovery are high. Eyewitness accounts from both the local media and social media platforms placed as of October 25 show us a grim reality of whole villages lost overnight. The English "no homes, livestock, or hopes left" sums up the devastation and similar accounts have come from displacement camps in and around the area. These narratives humanize the statistics and emphasize non-economic losses such as erosion of cultural heritage, mental health trauma, and disintegration of communities. In terms of global justice, Pakistan's plight is one that many people can relate to: it is in the top ten in vulnerability level yet contributes little to the emissions that are causing these changes. This disparity is contributing to this primarily chronic underinvestment in adaptation efforts. According to the UNEP Adaptation Gap Report 2024, the global annual adaptation financial gap is between US$187 and 359bn; the developing regions get a fraction of the level of support they need estimated at US$28bn in 2022. The Loss and Damage Fund, operationalized at COP28, has received pledges to the tune of approximately US $661-674 million, a very low amount for even a single major recovery initiative in

Pakistan, let alone sustained resilience building. Dealing these costs requires more than additional financial flows; it requires new mechanisms of accountability and shared resource allocation.

Geographical and Environmental Vulnerability

Pakistan's varied landforms and ecological systems make it highly susceptible to climate change impacts, with an increase in risks attributed to the fact that Pakistan lies in South Asia, which has been identified as a global epicenter for climate change-related risks. Being particularly precarious, the Indus River Basin, which supports more than 237 million people and underpins the water, food and energy security of the country, is due to its reliance on glacial melt water. According to the UNEP Adaptation Gap Report (2024), about 93 per cent of Pakistan's irrigated agriculture relies on this basin fed by more than 13 000 Himalayan glaciers, which are receding at alarming rates. Glaciological studies by Hewitt (2023) and Immersed et al. (2024) prove that glacial mass loss has accelerated as much as 40 per cent since the 1980s due to rising temperature and change in the precipitation pattern and poses more threat of glacial lake outburst floods, or GLOFs, seasonal water shortage and sustained hydrological instability over long periods of time. These changes not only affect the availability of water but also contribute to sedimentation downstream and ecosystem degradation with a negative effect on fisheries, and Pakistan's varied landforms and ecological systems make it highly susceptible to climate change impacts, with an increase in risks attributed to the fact that Pakistan lies in South Asia, which has been identified as a global epicenter for climate change-related risks. Being particularly precarious, the Indus River Basin – which supports more than 237 million people and underpins the water, food and energy security of the country as a whole – is due to its reliance on glacial melt water. According to the UNEP Adaptation Gap Report (2024), about 93 percent of Pakistan's irrigated agriculture relies on this basin fed by more than 13 000 Himalayan glaciers, which are receding at alarming rates. Glaciological studies by Hewitt (2023) and Immersed et al. (2024) prove that glacial mass loss has accelerated as much as 40 per cent since the 1980s due to rising temperature and change in the precipitation pattern and poses more threat of glacial lake outburst floods, or GLOFs, seasonal water shortage and sustained hydrological instability over long periods of time. These changes not only affect the availability of water but also contribute to sedimentation downstream and ecosystem degradation with a negative effect on fisheries and biodiversity.

Coastal zones of the Arabian Sea coastline face the additional risks of sea level rise and cyclones; up to one meter rise by 2100 is projected and this would allow millions of people to be displaced, as well as cause salinization of arable land (IPCC AR6, 2023).Furthermore, the United Nations Office for Disaster Risk Reduction (UNDRR) Global Assessment Report (GAR, 2025) categorizes Pakistan as the most vulnerable country to climate triggered disasters in the world, describing the current status of Pakistan's economy in a quandary of a crisis that is permanent. This assessment is backed up by Eckstein et al (2024), who, through the analysis in their German watch Climate Risk Index, puts Pakistan on the top ranking for the cumulative vulnerability between 1993 and 2022 (fatalities, economic damages and GDP impacts of floods, droughts and heat waves).

The above-mentioned assessments highlight the synergies of geographic determinants ranging from arid deserts in Balochistan to monsoon prone plains of Punjab such as deforestation and soil erosion etc. that can outdo their interactive functions and effect on the increasing economic vulnerabilities. The literature emphasizes the fact that in the absence of an integrated monitoring framework for such changes in the environment, Pakistan's growth trajectory could be derailed and thus the need for better geospatial modeling in future research.

Agricultural Vulnerability and Food Security

Agriculture becomes the most ailing critically analyzed sector particularly in climate change literature for Pakistan due to its fundamental role in economy and society. Contributing about 22 stickers to gross domestic product and providing occupation to 42 percent of the workforce (FAO Country Report Pakistan, 2023), the sector is naturally prone to climatic vagaries, consisting of fluctuating temperatures extremes, irregular monsoons and sustained droughts. According to the Intergovernmental Panel on Climate Change (IPCC) AR6 Working Group (#2) (2023), as many as 20-30% reduction in the yield will be witnessed from staple crops in South Asia by 2050 if we continue with high emission pathways, which translates to annual economic losses ranging from USD10-15 billion for economic growth of Pakistan alone. This forecast considers sharp declines in wheat and rice production (crucial to national food security) with decreases in yield of almost a third by mid-century using the simulations possible with crop modeling (which account for the effect of CO2 fertilization and pest dynamics FAO, 2023).

Cotton, a mainstay of Pakistan's textile sector, which is 60 per cent of exports, is equally prone to heat stress and water scarcity and to more intense infestations by pests, according to the details in the World Bank's Country Climate and Development Report (CCDR, 2022). Econometric work of Ahmad et al. (2023) and Qayyum et al. (2024) based on the use of panel data for a 20-year period financed at the level of all provinces, finds strong negative relationships between the temperature anomalies, precipitation fluctuations and crop productivity, especially for the prosperous Punjab and Sindh provinces. These studies involve the use of sophisticated regression models, while holding other variables (such as irrigation access, use of fertilizers, etc.) constant, to capture the class effects of a 1degC temperature increase on yield, potentially lowering wheat yields by 5 - 10 apoptotic per cent on average, with multiplicative effects in drought years of year.

Recent disaster events give us a stark empirical evidence: the floods in 2025 inundated 2.2m hectares of farmland including destruction of 60% of rice harvests, 30% sugarcane and 35% cotton crops, and also resulted in shortfalls in export revenue to over USD 1.2 billion, according to the United Nations Development Programmed (UNDP) Pakistan Flood Impact Assessment (2025). Combined with the floods of 2022, these events have pushed inflation in the food sector over 20%, making malnutrition and poverty worse for over 33 million affected people. The literature also touches upon secondary impacts, such as salinizing soil in delta regions and changes in planting calendars leading to disruption of market supply chains and rural incomes. Overall, these findings highlight the importance of this sector when it comes to exacerbating inequality because smallholder farmers, who make up 80 per cent of agricultural labor, bear unnecessary burdens in the absence of insurance or credit mechanisms.

Macroeconomic Impacts & Climate Finance

At the macroeconomic level, climate change is not an accidental phenomenon occurring in isolated instances, but it is a set of structural barriers that have surfaced and slowed down the rate of growth and stability in Pakistan. The United Nations Framework Convention on Climate Change (UNFCCC) Biennial Transparency Report (BTR, GENERES alert, 2025) has estimated the floods of 2025 alone caused USD$46.4 billion in damages, losses and reconstruction needs - almost 10 trillion of country GDP, and creating issues for the finances of affected countries, possibly diverted from essential infrastructure and social programmers. This pattern of repeated shocks promotes a cycle of debt accumulation, as an International Monetary Fund (IMF) Working Paper (WP/23/219, 2023), for example, is able to model the indirect effects such as lower labor productivity during the heat waves (in many cases in excess of 45oC), industrial supply chain interruptions in urban centers such as Karachi and inflationary pressures from a lack of food provisions.

The United Nations Environment Program (UNEP) Adaptation Gap Report (2024) highlights an extreme "adaptation finance deficit" in Pakistan, differing at an annual rate of 80 to 90 per cent ranging from USD unsuccessfully by about 10 to USD billion (2 to 3 per cent of GDP) for resilient infrastructure, early warning systems, and sustainable agriculture yet reassessing's a hold of international sources on the budget 80 to 90 per cent. This deficit is further compounded by domestic fiscal constraints such as high debt servicing (over 50 per cent of the budget) and reliance on fossil fuels, which the IMF warns may trap the country in a "low, growth - high debt trap". Comparative analyses with other developing economies indicate that the vulnerability of Pakistan is made even uglier by a low level of diversification with climate events leading to a decrease in annual growth rate of the GDP by 1-2 per cent by 2030 (World Bank CCDR, 2022).

Moreover, spillover effects across sectors are addressed, e.g. for declining tourism in flood prone northern sectors and energy disruption from the variability of hydropower. Such understandings draw attention to the need for economy wide modeling that includes integration of climate scenarios into fiscal planning and thus provides opportunities to identify green investments to mitigate losses from the longer term.

REGIONAL AND MICRO SCALE LEVEL IMPACTS

Climate vulnerabilities in Pakistan are highly heterogeneous across the country with local studies providing details on economic disruptions on a micro-level.

Punjab Province: Being the agricultural powerhouse of the country with more than 60 per cent of national output, the Punjab province is highly prone to both floods and droughts. Malik and Ashraf (2024) find a 60 percent decline in rice yields to occur after the floods of 2025, accompanied by shrinking export of more than USD 1.2 billion, which spreads to the textile value chain. Urban areas like Lahore and Faisalabad are struggling with heat waves leading to diminishing worker efficiency by as much as 20 per cent (IMF WP/23/219), and urban flooding from insufficient drainage that is worsened by rapid and unplanned urbanization that steers into floodplain.

Buner District (Khyber Pakhtunkhwa): This is a mountainous area that is supported in part by rain fed agriculture and is characterized by vulnerable topographic, a good example of the localized risks. The UNDP Disaster Preparedness Study (2023) describes the situation, indicating that only 15 credible 20 per cent of residents especially achieved the access system of early warning before the perils of cloudbursts in 2025, which took the lives of more than 200 people and destroyed of 4 700 homes. With poverty rates/livelihoods standing over 40 per cent, these events further serve to increase food insecurity, force migration to urban slums and destroy community assets as qualitative surveys show cycle of debts due to rebuilding efforts. These regional disparities emphasize the need to disaggregate data to understand how climate impacts intersect with socio-economic factors such as gender, ethnicity, and so on.

Governance, Policy, and Adaptation Gaps

An enduring issue that is highlighted in scholarly literature is the lack of a robust climate governance framework in Pakistan that can implement an adaptation and mitigation strategy. The Updated Nationally Determined Contribution (NDC, 2021) is based on commitments to a 50 per cent reduction in emissions - conditional on USD 100 billion in financing - and 60 per cent of renewable energy by 2030, although progress is lagging due to fossil fuel subsidies and institutional silos, as well as political instability. The World Bank's Climate Change Delivery Report (CCDR, 2022) and UNDRR's Global Adaptation Report (GAR, 2025) commented against the lack of integrated systems of district-wise risk assessment and ineffectiveness in water management under the Indus River System Authority which in turn led to the adjudication of inter-provincial disputes. The UNEP Emissions Gap Report (2024) raises the alarm of the

amount of coal projects creating potential stranded assets in response to the accelerated rate of DE carbonization on a global climate change level. Policy analyses recommend reforms such as decentralizing authority to provinces and incorporating climate metrics into public budgeting; however, enforcement is tenuous for a number of reasons, including corruption and capacity deficits.

Grass Roots Perspectives against Climate Justice

Interdisciplinary studies these days are really beginning to listen to what the ordinary folks on the ground have to say which helps to bring out the true human side of Pakistan's ongoing climate troubles. Reports from Ali and his colleagues in 2024, along with the UNDP's efforts this year, go deep into this thing called "adaptive fatigue" that wears down the flood survivors as they continue to fight to recover again. Over in Punjab, farmers speak bitterly about how these wild weather swings - they call it the unpredictable "gammle", meaning all that climate ups and downs - are basically ruining their chances of making a living one day at a time. Then you hear from people in Buner how entire villages and entire ways of life get wiped out in one night by massive landslides, leaving nothing but devastation behind. These personal stories show the high emotional and cultural cost that all are paying, such as how ancient knowledge passed down through families begins to die out or how close-knit communities begin to disintegrate under the weight of it all. It seems as if the scars are much more than the obvious damage from floods or storms. Survivors tell stories of constant struggles against nature now turned hostile due to larger forces in the world. If we don't include these real voices in the research, we are missing the full depth of the heartbreak and what could be distant climate stats is made painfully personal to those living through it.

Comparatively, the experiences of Pakistan are like those of Bangladesh, Mozambique, and the Philippines where high vulnerability overlaps low resilience. The Loss and Damage Framework agreed at COP28 (2023) places the case of Pakistan within the paradigmatic scenario of climate justice, the case as a paradigmatic scenario case for climate justice (reparative finance) to deal with the historical level of emissions from developed countries. Scholars like Roberts and Pelling (2023) call for fair mechanisms looking out for vulnerable populations and the incorporation of indigenous practices into the strategies throughout the world economy.

NATIONAL LEVEL ECONOMIC COST OF CLIMATE CHANGE IN PAKISTAN

Climate change has become an economic defining challenge for Pakistan. While the country is responsible for less than 1 percent of the world's greenhouse gas emissions, it is one of the most climate vulnerable countries in the world (UNDRR, 2025). The costs are not limited to the environmental world but are distributed through all areas of the economy, from agri-industry and the economy to health, infrastructures and budgetary and financial variables. The cumulative economic burden threatens to tip the development sustainability of Pakistan with poverty and national security.

Agriculture and Food Security

Agriculture is the backbone of Pakistan's economy that accounts for 22 per cent of the GDP and employs 42 per cent of the labour force (FAO, 2023). Nevertheless, it is the most climate-sensitive sector and is highly reliant on Indus River Basin irrigation, and is vulnerable to floods, droughts and heatwaves.

Flood Damage to Crops

- 2022 floods covered 2.2 million hectares of arable land, including rice, cotton and wheat fields (UNDP, 2023).

- The floods of 2025 repeated this havoc, where 60 percent of rice and 35 percent of cotton were lost in Punjab and Sindh, resulting in $1.2 billion of export losses (UNFCCC BTR, 2025).

Drought and Heatwaves

- Drought in Sindh and Baluchistan has resulted in a 15-20% drop in wheat yield per year over the last 10 years.
- Extreme heat (>45oC) during the 2022-2023 harvest season led to premature crop failure and of about 12% decrease in milk production in the dairy sector in Punjab (FAO, 2023)

Economic Costs

- Direct annual agricultural losses are estimated between $10 - $15 billion.
- Food - inflation spikes of 15-20 percent after every major flood hitting poor households that spend more than 50 percent of their income on food.

The agricultural burden spills over into other sectors and impacts the export economy as a result: low cotton yields harm the textile industry, which is the source of 60 per cent of earnings from exports, and food shortages cause urban unrest and political instability.

INFRASTRUCTURE AND HOUSING

Pakistan's physical infrastructure - roads, bridges, railways and housing - is intensely susceptible to climate disasters.

Transport and Logistics

- The 2022 floods damaged 13,000km of roads and 440 bridges, disrupting supply chains for weeks (World Bank CCRD, 2022)
- Transport disruptions caused cost rises of 30-40 per cent in transport of goods to both the domestic market and exports.

Urban Housing

- Over 1.7 billion homes were destroyed in 2022 and this was followed by 1.5 billion homes in 2025 (NDMA, 2025).
- Informal settlements in Karachi, Lahore, and Peshawar are particularly vulnerable to this because of a lack of proper drainage and uncontrolled construction.

Electric supervisor and Minister for Agniya and Industrial Infrastructure

- Floods caused disorganization of hydropower dams and thermal power plants, or heat waves caused peaks in electricity demand, and blackouts occurred.
- Textile factories in Punjab and Sindh suffered losses of $500 million due to the suspended operations during the 2022 floods (Asian Development Bank, 2023).

Overall, climate induced damages on infrastructure and housing are estimated to be $15-20 billion per major flood event, roughly 50 percent of the total year's development budget for Pakistan.

PUBLIC HEALTH AND LABOR PRODUCTIVITY

Climate change has tremendous health and labor effects, which have hidden economic costs.

Heat-Related Illnesses

- Heat waves killed more than 1,200 people in Karachi in 2023 and continue to increase the cases of heatstroke, dehydration, and kidney disease.
- WHO (2024) warns that Pakistan's heat-related mortality rate will be increased by 200% by 2050 due to climate change.

Vector-Borne Diseases

- Post flood environments provide breeding grounds for malaria and dengue. After the 2022 floods, the country of Pakistan saw its largest outbreak of dengue cases in 10 years, with more than 70,000 cases.
- The WHO estimates that the economic losses from diseases of productivity are US$2-3 billion each year.

Nutrition and Stunting

- Crop failures and food inflation aggravate malnutrition. Already, 40 per cent of children under 5 years old are stunted (UNICEF, 2024).
- The 2025 floods caused a further loss of an additional 9 million people into food insecurity, compromising work force productivity and raising healthcare costs.

Labor Productivity Losses

- Outdoor workers (construction, agriculture) lose 20 - 30 workdays a year due to extreme heat and floods.
- IMF (2023) estimates that climate-related loss of labor productivity in GDP at US$6 to 8 billion a year.

ENERGY AND WATER SECURITY

Pakistan's energy and water systems are closely interconnected with climate change.

Hydropower Disruptions

- More than 30% of the electricity generated in Pakistan comes from hydropower, which relies on steady flows from the Indus River.

- Glacial melt initially releases more flows (causing floods), but long-term retreat will lead to less water supply for both power and irrigation

Water Scarcity

- Pakistan is already among the top 10 most water - stressed countries (UNEP, 2024)
- Climate variability, due to reduce per capita water availability, expected to decrease below 500 m3 by 2035, a critical level of scarcity.

Energy Demand Surge

- Heat waves put additional strain on the cooling system - resulting in increased demand for electricity for cooling.
- In June 2024, peak demand for electricity increased by 20 per cent above average, leading to nationwide load shedding.
- These stresses create direct costs of US$3-5 bn/annum for the energy sector and, simultaneously, attack industrial competitiveness and household resilience.

MACROECONOMIC INSTABILITY AND FISCAL INSTABILITY

Climate shocks hit Pakistan's already fragile macroeconomic stability.

GDP Contraction

- The World Bank (2022) warns that, without adaptation, climate change has the potential to lower Pakistan's GDP by 18-20 per cent by 2050.
- The 2022 and 2025 floods each cut the gross domestic product (GDP) growth by 2 - 3 percentage points.

Fiscal Burden

Post-disaster reconstruction costs up 5-7% of GDP every year, crowding out social spending.

- In 2025, Pakistan's fiscal deficit increased related to recovery expenditures because of an increase of 2 percent of GDP.

World Bank - Climate Change and External Debt Budget & Policy: - Carbon pricing tools across the economy may cover some of the technologies that benefit women. External Debt and Climate Finance World Bank - Climate Change and External Debt Budget & Policy: - Carbon Aircraft (Carbon Pricing and Carbon Pricing of North) may account for some of the technologies that benefit women.

Reliance on international aid and loans following disasters (such as IMF emergency loans in 2022) increases the debt dependency.

- UNEP (2024) highlight on Pakistani being stuck in an "adaptation finance trap": Disasters squeeze fiscal space; little left for investment in resilience.

Inflationary Pressures

- Food and energy shocks following floods, inflations reached 30 per cent in 2022, leading to an increase in poverty and a decrease in real wages.

CROSS CUTTING SOCIAL AND SECURITY IMPACTS

Beyond sectoral costs, climate change produces cross-cutting risks that put pressure on Pakistan's social fabric and security environment.

Poverty and Inequality

- According to the World Bank (2023), it has been estimated that there are 20 - 25 million additional Pakistani people can be expected to be pushed into poverty by 2030 due to climate shocks.
- Disasters disproportionately affect women, children and rural farmers and increase inequality.

Migration and Displacement

- The 2022 floods displaced 8 million while 2025 displaced 7 million people (NDMA).
- Rural-urban migration leads to faster acceleration of unplanned urbanization and an increase in slums in Karachi and Lahore.

National Security

- Displacement and resource scarcity create potential for social unrest, conflict over water and cross border migration tensions with Afghanistan and India.
- The Pakistan military has established that climate change is a "non-[traditional] security threat", given its destabilizing influence on the governance and economy.

Regional Insights

Punjab, the agricultural backbone of Pakistan, accounts for the production of almost 60% of the country's agricultural production and is the backbone of the textile and food export industries. Richer in terraces and an excellent river valley for the Indus River system, it is the most economically important province. However, climate change - in the form of floods, heatwaves, erratic monsoons, and ground water depletion, has turned this breadbasket to a climate risk hotspot.

AGRICULTURAL IMPACTS

Floods and Crop Losses

- The 2025 floods flooded 2.2 million hectares of cropland, destroying 60 per cent of rice, 30 per cent of sugarcane, and 35 per cent of cotton (Punjab Agriculture Department, 2025).
- This represents direct harvest losses to the tune of US$ 600-800 million and export revenue losses to the tune of US$ 1.2-1.5 billion given Punjab's role in rice and cotton exports;

Heat Stress and Drought

- Unpredictable rainfall left some districts with 40 per cent below-normal precipitation, aggravating the cost of irrigation by US$500 million.
- Projections had yields on wheat declined by 20-25 per cent by 2050 with heat stress on productivity and shortening on growing seasons.

Livelihood Risks

- Farmers say agriculture is "gambling with nature" (social media interviews, 2025).
- With average farm debt of over PKR 400 000 ($2000), 60% of the smallholder's face insolvency after consecutive climate shocks.

Urban and Industrial Impacts

Punjab is not only an agriculture center but also hosts the largest industrial cities of Pakistan like Lahore, Faisalabad and Multan.

Urban Flooding

- In 2025, the circular floods triggered damages, from $300 to $500 billion USD, to Lahore, caused by clogged drainage systems and flash flooding.
- Faisalabad's textile sector, which accounts for 50 per cent of Pakistan's textile exports, said that its production fell by 15 per cent due to factory shutdowns.

Energy and Water Stress

- Industrial centers had outages of electricity for 10 to 12 hours due to damage from floods to power transmission lines.
- Groundwater depletion - which is declining by 60 feet - in Multan and Fasliabug has caused a rise in the cost of irrigating land and industrial facilities, with losses estimated at $1 to $2 billion per year in these areas if not checked.

SOCIOECONOMIC CONSEQUENCES

Inflationary Pressures

Food price spikes of 15 to 20 per cent after crop losses affected lower income groups most severely.

- Textile job losses in Faisalabad left thousands unemployed, especially women who work in the informal stitching units and make up 50 per cent of the labor force.

Debt and Poverty

- Smallholder farmers, because they fail to recover from one shock after another, end up caught in cycles of debt and are often forced to sell land or sell livestock.

- Rural-to-urban migration is increasing; with Lahore and Rawalpindi being absorbing the migrants, thus exerting pressure on the infrastructure.

Africa's Gender and Youth Vulnerability

- Women farmers are denied access to credit and proper ownership of land, which worsens the problem of gender inequality.
- Youth groups are instead leading pilot projects in climate-smart agriculture - such as solar-powered drip irrigation - that have had a yield increase of over 15 - 20% in trial districts.

ENVIRONMENTAL DEGRADATION

Soil and Water Stress

- Salinization impacts 6 milli hectare decreasing 10 per cent of productivity every year
- Over-exploitation of ground water is aggravating desertification in southern Punjab (Bahawalpur, Rahim \\Yar \\Khan).

Deforestation and the Risk of Flooding

- Punjab lost 18 per cent of forest cover since 1992 as a result when only 5 trees were left for each person against the global average of 422 trees (UNEP, 2024).
- Deforestation increases runoff, which increases flood risks and reduces ecosystem services that are valued at $100 million per year.

CONCLUSION

Pakistan which contributes less than 1 per cent of global greenhouse gas emissions is the poster case of climate injustice, disproportionately affected by a crisis for which it hasn't largely caused. The 2025 catastrophic floods driven by enhanced monsoons, higher temperature and glacial melt, instigated direct damage of almost 15 billion dollars, the cost of reconstructions increased astronomically to 16.3 billion dollars, crippling the national economy and causing the displacement of more than two million people at the end of June. This recurrent disaster, which was the third major flooding event of the summer already, shows how vulnerable populations are being affected by the risks created by climate change, which is increasing.

In Punjab, the heart of agriculture production, overflowing rivers flooded extensive agricultural lands destroying 50 per cent of the crop of rice and 60 per cent of cotton while the industrial shutdown and urban flooding further increased displacement of employment and food insecurity. Heat waves and erratic rains further degraded soils and increased pest threats which threatened livelihoods of farming dependent communities. The floods also caused large losses of livestock, which drowned or died in the water of the vile diseases with the contamination, thus increasing the poverty of the rural.

Meanwhile, in Buner's rugged mountains, one August cloudburst had dumped 150 millimeters over the course of an hour - causing flash floods that swept away landscapes, gutted villages and killed hundreds, on top of poverty, deforestation and poor governance. Nationwide, more than 800 deaths have been reported, with more than 700 injuries and more than 1,600 houses damaged or destroyed. These events have

not only caused immediate humanitarian crises but long-term health issues such as outbreaks of water borne diseases such as cholera and malaria disproportionately affecting women and children.

The floods have served to heighten the vulnerabilities: delays in getting aid have put pressure on the point of tensions to develop in the form of demands for resilient seed varieties, improved irrigation and insurance. Education has been disrupted with schools swamped and kids unable to attend classes which can lead to long term human development setbacks. Since 2000, the cumulative cost of disasters to Pakistan in terms of economic loss has been $38 billion.

These challenges highlight the need for strong infrastructure, community-driven adaptation, and smooth implementation of policies. Ultimately, there is a need for global solidarity through equitable finance, debt relief and technology transfer to break cycles of decline as well as pave the way towards a resilient as well as sustainable Pakistan. At the same time, Pakistan's recovery is closer to global climate justice - through equitable climate finance, debt relief, and technology transfer. Without decisive action, the country is in danger of a cycle of climate-driven economic and social collapse. Yet, given leadership, participation from various communities and international support, Pakistan has the capability to consider that this crisis can not only be turned into an opportunity to create a resilient, sustainable and equitable future.

RECOMMENDATIONS

To come up with a global climate compensation framework, the United Nations and the global community at large have the responsibility of taking the initiative to ensure the formation of a binding legal framework that ensures that the world is able to enjoy climate justice and compensation. The states that are developed should be held accountable to the loss and damages that are encountered by the vulnerable states which include Pakistan, through the enactment of structures of enforcement in international law. The latter could be achieved through the operationalization of the Loss and Damage Fund with significantly larger contributions, in excess of the insignificant roughly US$661 million commitment made to date in COP28 and making sure that the historical large contributors to greenhouse gas emissions contribute their share to the fund. A framework that is based on the polluter pays principle would ensure that the rhetoric is converted into concrete requirements of mitigating and compensating.

The need to increase the amount of climate finance and adaptation funding is evident. The available international adaptation finance that is specifically targeted to developing countries was about US$28 billion in 2022 which is a contrast to the annual need of between US187-359 billion. The developed countries must therefore respect and exceed their current climate finance obligations, such as the long-awaited US100billion per year, and come up with a new, joint financial target that includes adaptation, mitigation, and loss-and-damage. This would include debt relief or debt-to-climate swaps of states like Pakistan, and this would liberate resources to be used in resilience investments and not service of debts. Without substantial increase in investment and transfer of technology by the Global North, the countries that face the problem of climate disasters will keep spiraling in a recovery-relapse recession.

Climate-sensitive nations need to implement climate-friendly and resilient development programs. UN and its development partners ought to expand the programs that will enhance renewable energy, climate-sensitive agriculture, sustainable management of water, and disaster readiness at the community level. There is a need to invest in infrastructural resilience to climate, such as stronger flood defenses, urban drainage, and housing resilience to reduce future risk. Researchers always stress the importance of even more exaggerated emphasis on risk mitigation and resilient infrastructure because the frequency of catastrophes will otherwise exceed the abilities of local authorities to manage them. Adaptation efforts at community level such as early warning systems, reforestation, watershed management and livelihood

diversification initiatives should be put at forefront and sufficiently financed. These climate-friendly programs do not only enable adaptation to existing impacts, but also lead to sustainable development, such as increased food security through climate-smart agriculture or through off-grid solar energy to lower reliance on fossil fuels.

The policy and governance of climate adaptation in Pakistan and other affected states needs to be strengthened to ensure they can govern the situation of climate adaptation. This involves considering the climate risk within all levels of planning and budgeting, strengthening of institutions like disaster management authorities, and application of building codes and land-use plans to consider the climate hazards. Nationally Determined Contributions (NDCs) must not merely target emission cuts but also include clear targets and plans on adaptation, which are supported by law and adequate budgetary allocations. International bodies can help with technical know-how as well as transfer of technology through provision of early-warning systems, resistant crop species, and efficient irrigation methods to develop local adaptation capacity. Locally, communities will be empowered by educating, training, and including them in the planning of the adaptation to make sure that the adaptation strategies take a cultural orientation and are well executed.

The economic impacts of climate change in countries like Pakistan eventually require solidarity and responsibility across the world. This will necessitate the application of shared yet differentiated responsibility whereby, the developed countries will take a reasonable portion of the burden by cutting down on aggressive emissions and providing significant financial aid, according to the principles of climate justice. A more effective global system might be formed such as an independent entity or tribunal under the UN supervision to check the climate financing commitments and determine whether nations are registering their just share to the adaptation and loss and damage finances. Open tracking of climate assistance is equally vital to ensure that the amount of money reaches the society most affected and makes sound usage towards resilience building. The vicious circle of economic and social crises caused by climate change can be broken by strengthening the unity of the world community through fair financing, law enforcement, and the supply of the needy communities with resources and experience. These steps would put the nations such as Pakistan on the course to a stronger, more sustainable and climate-safe future.

REFERENCES

ReliefWeb / GEOGLAM — "Pakistan: Flood Impacts on Agriculture & Food Security"
Explores how the 2025 floods affected major crops (rice, cotton, etc.) and food security, with focus on Punjab.
→ https://reliefweb.int/report/pakistan/pakistan-flood-impacts-agriculture-food-security-updated-september-18th-2025 ReliefWeb+1

UN OCHA / Flash Update — "Highlights PAKISTAN: Monsoon Floods 2025" (PDF)
A humanitarian/flash update summarizing fatalities, displacement, infrastructure damage, etc.
→ https://www.unocha.org/attachments/31568a5d-32f4-4c05-858b-b2fd9a9de81a/2025_08_26%20-%20Monsoon%20Floods%20-%20Flash%20Update%20%23%203.pdf OCHA

ReliefWeb — "Pakistan: Monsoon Floods 2025 Flash Update #6"
Contains region-wise flood warnings, affected districts (including Punjab), and disaster updates.
→ https://reliefweb.int/report/pakistan/pakistan-monsoon-floods-2025-flash-update-6-04-september-2025 ReliefWeb

Pakistan NDMA / SitReps (Monsoon 2025)
The National Disaster Management Authority's situational reports monitoring flood events, losses, and response.
→ https://www.ndma.gov.pk/sitrepm National Disaster Management Authority

Reuters — "Pakistan floods batter fields, factories and fiscal plans"
A journalistic but data-rich article estimating agricultural and industrial losses, flood-damaged farmland, etc.
→ https://www.reuters.com/sustainability/climate-energy/pakistan-floods-batter-fields-factories-fiscal-plans-2025-09-23/ Reuters

World Grains — "Floods impact Pakistan's grain outlook"
Focus on how major grain crops (rice, etc.) in Punjab and Sindh are being affected by the floods.
→ https://www.world-grain.com/articles/21925-floods-impact-pakistans-grain-outlook World Grain

WorldWeatherAttribution / Science Brief — "Climate change intensified heavy monsoon rain in Pakistan"
This examines how anthropogenic climate change likely magnified rainfall extremes in 2025.
→ https://www.worldweatherattribution.org/climate-change-likely-intensified-heavy-monsoon-rain-in-pakistan-exacerbating-urban-floods-that-impacted-highly-exposed-communities/ World Weather Attribution

Pakistan NDMA / "Flash Floods – Jun 2025" (ADRC / International databases)
Gives baseline context on flood onset, chronology, and regions impacted across Pakistan including Punjab and KP.
→ https://reliefweb.int/disaster/fl-2025-000100-pak ReliefWeb+1

Humanitarian Outcomes — "Floods in Pakistan: Rethinking the humanitarian role"
Analyzes systemic response, health facility damage, relief operations, and interviews with affected communities.
→ https://humanitarianoutcomes.org/sites/default/files/publications/pakistan_floods_1122.pdf Humanitarian Outcomes

Pakistan FAO / National Reports (News reporting FAO warnings)
Example: FAO alerting that 1.3 million hectares (including 0.93 million hectares of cropland) were inundated in Punjab & KP.
→ https://sri.org.pk/food-and-agriculture-organisation-warns-floods-in-punjab-kp-will-affect-rabi-cultivation/ SRI

https://academia.edu.pk/index.php/Journals/article/view/1313
https://academia.edu.pk/index.php/Journals/article/view/1226
https://webology.org/abstract.php?id=1405
https://pjlaw.com.pk/index.php/Journal/article/view/77