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Research Article

Pakistan's Climate Change Crisis: Climate-Induced Events, Cloud Burst, Glacial Lake Outburst Floods and Critical Responses

*[1]Fahad Hameed Khan

About Article

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About Author

[1] Asia e University, Malaysia

Contact @ Fahad Hameed Khan
drfahadhameedkhan@gmail.com

ABSTRACT

Pakistan is at a crossroads with the impacts of climate change having a severe and escalating effect on the country which is a minimal contributor to climate change with contribution of less than 1% of global greenhouse gas emissions. Pakistan is ranked in the top most climate vulnerable countries and is one of the most affected nations in the world to experience a complete transformation of the hydrological cycle (restructuring of weather system) that has replaced predictable and stable weather systems with intense and localized destructive weather phenomena. The phenomena of "Cloud Burst" and Glacial Lake Outburst Floods (GLOFs) have become new, more powerful, frequent and more prevalent form of climate change, causing destructive flash floods and landslides in urban and mountainous regions. This article presents different ways in which global warming and climate disasters affect Pakistan's water, agriculture and socioeconomic sectors. The startling disconnect between Pakistan's ambitious climate policies and implementation has not only been profound, but it has been deeply recurring. No doubt, the country is equipped with comprehensive national strategies and contingency plans, but it suffers from a highly reactive response crippled by daunting institutional, financial, political and climate adaptation funding gaps. Over-reliance on external finance undermines climate adaptation funding and creates a highly unpredictable and unstable planning for climate-induced events, coupled with lack of coordinated governance between the federal and provincial governments. Embracing a proactive, climate-compatible development approach is crucial for Pakistan's defending its future. Adapting this integrated framework requires greater authority alongside optimizing and mobilizing domestic physical resources. Strengthening local communities, empowering them, building local resilience and clarifying institutional mandates are imperative and needs of the time.

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1. INTRODUCTION

The severity and number of climate-induced catastrophes such as cloudbursts, torrential rains, droughts, storms, flash floods and heat waves have increased and become new-normal in some parts of the world. At least 9,400 extreme climate-induced events occurred from 1993 to 2022 which caused almost 800,000 lives and damage to economy estimated around $4.2 trillion. According to experts reverence, climate related events will cause attrition to economy up to $ 38 trillion annually (Ejembi & Muhammad, 2025). Most effected countries to climate related disasters are the one having limited financial and technical capabilities to manage and adopt damages and losses (Germanwatch, 2025). The human tragedy is expected to continue and keep worsening until humanity accept the challenge of decelerating and bringing to halt climate change. Dr Edward Maibach suggested the most practicable way do so is to accelerate the transition away from fossil fuel and in order to protect people from devastating effects of climate change, there is a need to make efforts to increase their climate resilience (Germanwatch, 2025)..

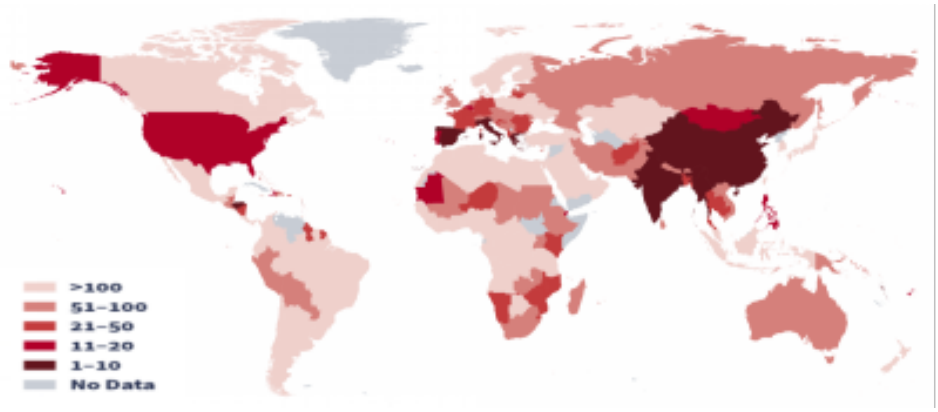

Figure 1. Countries vulnerabilities 1993 to 2022
Source: Climate Risk Index, 2022

1.1. Pakistan on the front-line: the paradox of vulnerability and emission

The role of Pakistan in the deteriorated global climate narrative is characterized by paradox of unjust, tragic and striking. In 2018, Pakistan's total greenhouse gas emission was estimated 499 million metric tons of carbon dioxide (MtCO2e) which accounts for less than 1% of the world's greenhouse gas emissions (World Bank CCDR, 2022). This figure is significantly less than that of the major industrial economies (Germanwatch, 2025).

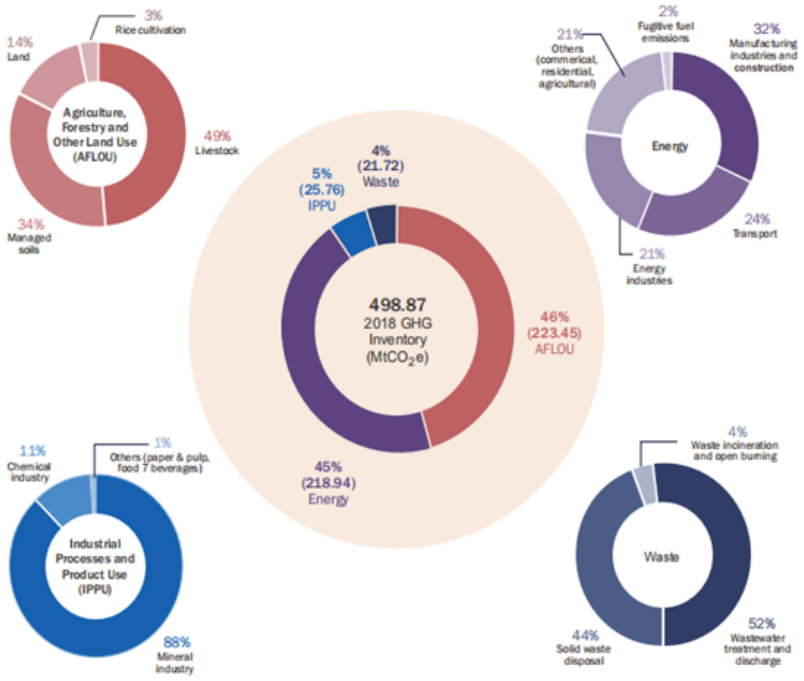

Figure 2. Pakistan GHG Inventory in 2018
Source: World Resources Institute, "Global Historical GHG Emissions," CLIMATEWATCH (2022).

Yet, Pakistan is one of the countries that is most vulnerable to climate change, consistently ranking as one of the top 10 worst affected countries on the Global Climate Risk Index and first among most affected countries by extreme weather events in 2022 as reported by Germanwatch Climate Risk Index 2025 (CRI, 2025).

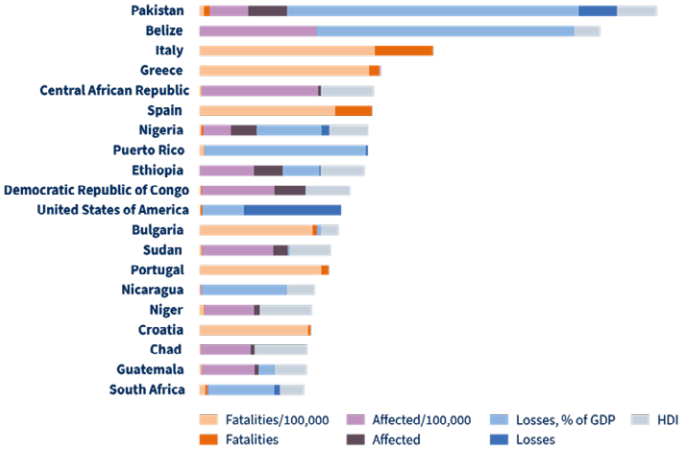

Figure 3. 10 countries most affected in 2022 (HDI-corrected)
Source: Climate Risk Index, 2025

These disasters and the country's overall climate vulnerability not only disrupt the lives of millions, but also put a substantial economic burden on the country. Pakistan's vulnerability is not a distant threat, but a present reality. The socio-economic toll of climate-related disasters, already raised by 40% in the past 20 years (Camila *et al.*, 2024). The severity and frequency of such events, particularly cloudbursts and floods underlines a significant imbalance between localized suffering and global responsibility.

This paradox presents profound geopolitical and economic implications. Pakistan's Nationally Determined Contributions (NDCs) strive to achieve an ambitious 50% reduction in projected emissions by 2030, however, this remains a conditional target with most emissions reduction spending reliant on international financial support. This is often viewed as a calculated response to the theory of climate justice where Pakistan seeks reparations for the destruction of infrastructure and environmental degradation inflicted by developed countries. Nonetheless, over reliance on foreign aid leads to uncertain long-term planning and unclear project implementation. While it sounds like a workable negotiating strategy, but it does not bring immediate solution to humanitarian crises created due to climate change which need immediate, greater and focused attention driven by self-reliant and domestic action. Pursuing foreign aid and mobilizing domestic resources is cardinal challenge and this "Money in, Money out" syndrome is a fundamental paradox of Pakistan on climate change.

1.2. Climate-induced catastrophe - recent history of Pakistan

Pakistan suffered devastating droughts and flash flood in 2022. Initially, a record breaking heat wave which was recorded 1-in-1000 years, hit plains of Punjab, Sindh and Balochistan in which temperature remains above 45 degree for most of the summers, destroying crops, caused power outrage and forest fire (World Bank CCDR, 2022). Then in monsoon season, Pakistan witnessed heaviest, most concentrated and unprecedented torrential rain. Pakistan faced enormous losses due to flood; hundreds of people lost their lives, at least 10 million were displaced and 2 million houses were damaged (PDNA, 2022). Important infrastructure like roads, bridges, schools, etc were washed away with maximum livestock and Kharif (summer) crop destroyed. Post Disaster Needs Assessment (PDNA) 2022 estimated the damages of $ 14.9 billion and overall losses estimated to $ 15.2 billion with almost complete halt of growth. Immediate rehabilitation and relief costed around $ 16.3 billion to support basic needs. Poverty rate was projected to increase by 3.7 % meaning by pushing 9.1 million people into poverty (PDNA, 2022).

In 2025, Pakistan is facing even more wild flood than 2022. Deaths and damages are yet to be evaluated, but according to experts opinion, losses may cross the figures of 2022 catastrophe.

1.3. Research gap

Previous findings strongly indicate not one but several knowledge gaps as appended below:

i. Limited understanding of how climate change shifts monsoon patterns and subtropical jet stream behaviour affecting cloudburst frequency in Pakistan.

ii. Insufficient data and coordination among government departments on climate-induced events and definitions and monitoring (eg cloudburst vs heavy rain).

iii. Gaps in disaster readiness and institutional coordination to respond effectively to cloudburst-induced floods.

iv. Weak integration of mitigation strategies in local level planning and adaption framework.

1.4. Research objectives

To analyze the impact of climate change on the frequency and severity of cloudburst and other climate-induced events in Pakistan and propose effective mitigation measures for Pakistan.

1.5. Research question

i. How climate change influencing the occurrence and intensity of cloudburst and other climate-induced events in Pakistan?

ii. How effective are current policies and strategies to mitigate and managing climate-induced events?

iii. What additional measures can be recommended to enhance resilience and disaster preparedness in Pakistan?

1.6. Significance of study

The findings of this article will have far-reaching benefits, theoretically and practically. Because there had previously been almost no such research study that focused on influence of climate change and shortcomings in government policies to help reduce risks of climate-induced events and build resilience to mitigate its effects.

2. LITERATURE REVIEW

2.1. Contextualizing Pakistan's climate vulnerability

2.1.1. Development and climate

Pakistan is striving to reduce poverty and over the past 2 decades managed to reached the status of middle-income country, however, the macro fiscal vulnerabilities and uncertainties are major obstacles to sustain the progress and further enhance the growth.

The junction where climate risk intersects with other social disadvantages needs to be evaluate critically to ensure equity in climate actions. Disparities in socio-economic status and poverty in Pakistan is much pronounced. The gap is significant not only through urban and rural divide but also visible across districts of same province.

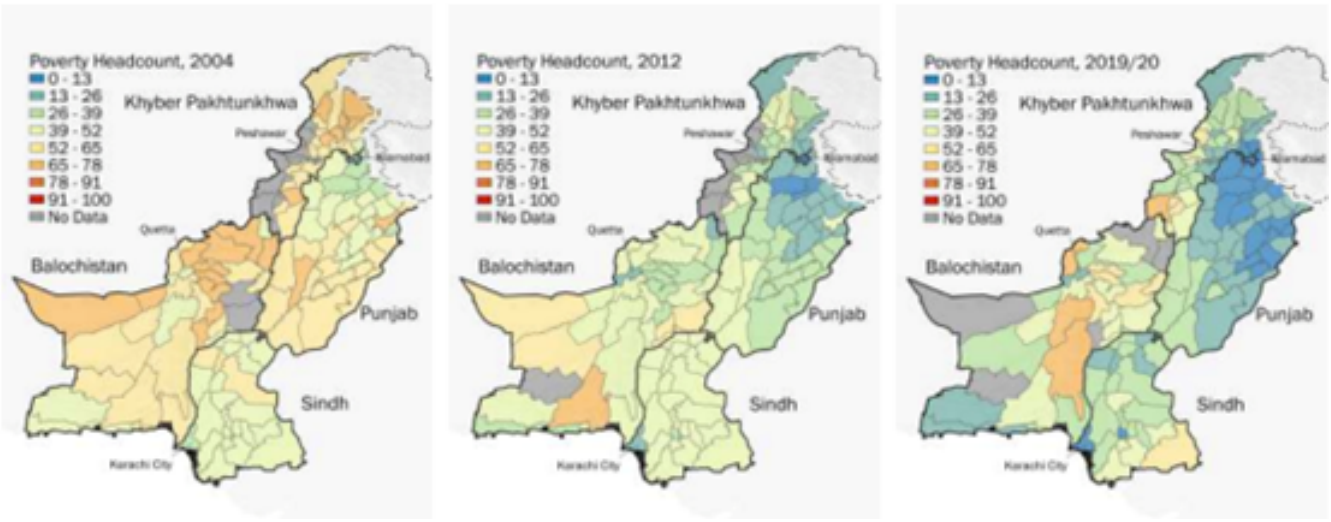

Figure 4. District level poverty rate in pakistan - 2004, 2012 and 2019/20.
Source: World bank CCDR, 2025

Figure 4 above show momentous variation in poverty rate among districts. Poverty rates of districts of South Punjab, North and Sindh are between 26 to 39 percent whereas, districts of South East Sindh, Balochistan and bordering areas between Khayber Pakhtunkhwa and Balochistan lies in bracket of 40 to 60 percent poverty rate. These districts are already deprived of many necessities like education, clean drinking water, sanitation, electricity and other services, making these districts more vulnerable and hazardous if hit by any climate-induced catastrophe.

Pakistan faces one of the highest observed temperature in region which put hundred of millions at risk of heat stroke, heat stress and fast glacier melt. In majority places of Pakistan, temperature remains above 30 degree for most part of the year with maximum temperature reaches above 40 degrees. Populated cities became Urban Heat Islands (UHIs) having lack of natural cover and dense concentration of concrete where buildings absorb, retain and repulse heat, traffic congestion causing air and noise pollution beside aggravating heat output. Figure 5 below shows heat hazards (left) and exposed population (right) of Pakistan.

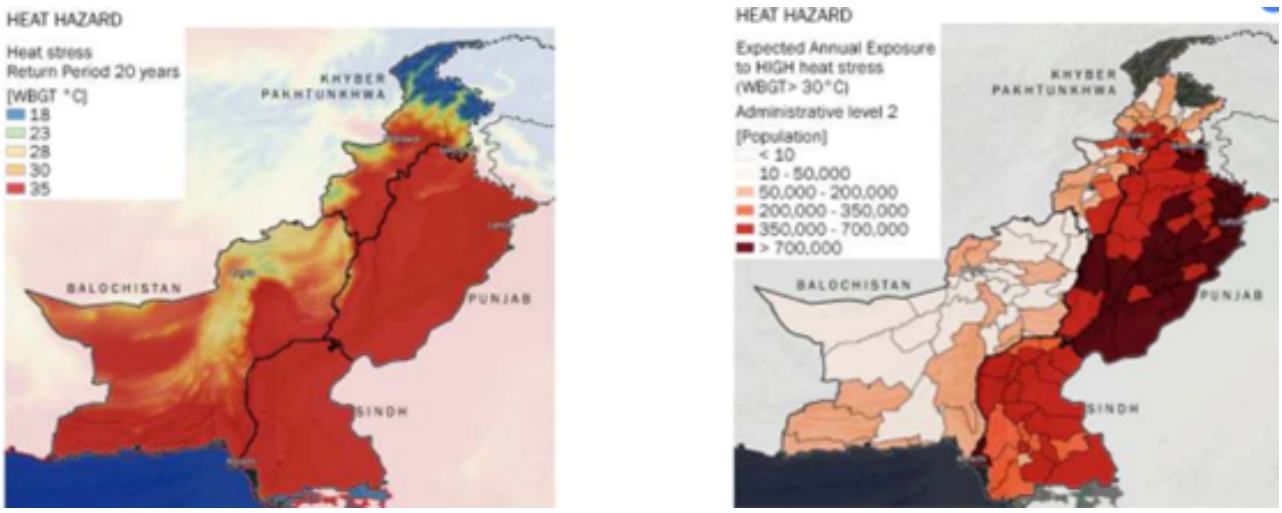

Figure 5. Heat hazard and population exposed to heat
Source: World bank CCDR, 2025

Due to extreme heat waves, Pakistan is on high risk of droughts. According to Climate Risk Country Profile worked-out by World Bank and Asian development Bank in 2021. Pakistan ranked 43rd in draught risk countries (WB and ADB 2021).

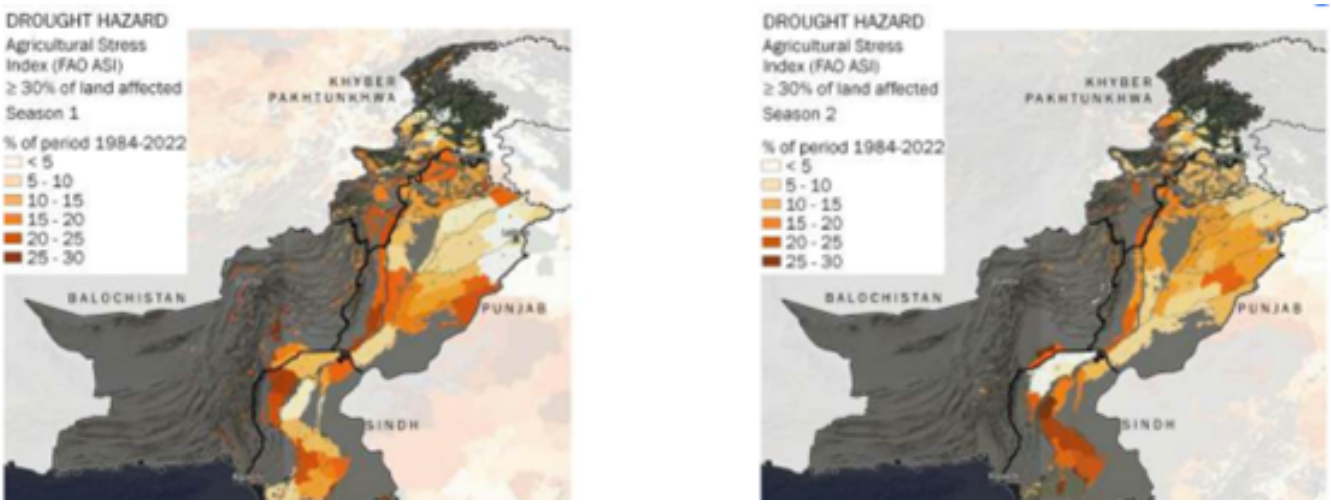

Figure 6. Draught hazard for agriculture in kharif (left) and rabi (right) seasons
Source: World bank CCDR, 2025

Pakistan is facing high risks of both pluvial flooding (surface water flooding - caused due to torrential rain, lack of drainage and ground absorption capacity) and fluvial flooding (due to overflow of rivers, stream and glacial melt) as experienced in 2022 and 2025 flooding. Figure 7 shows expected annual impact of flood on built-up assets (left) and on agriculture (right).

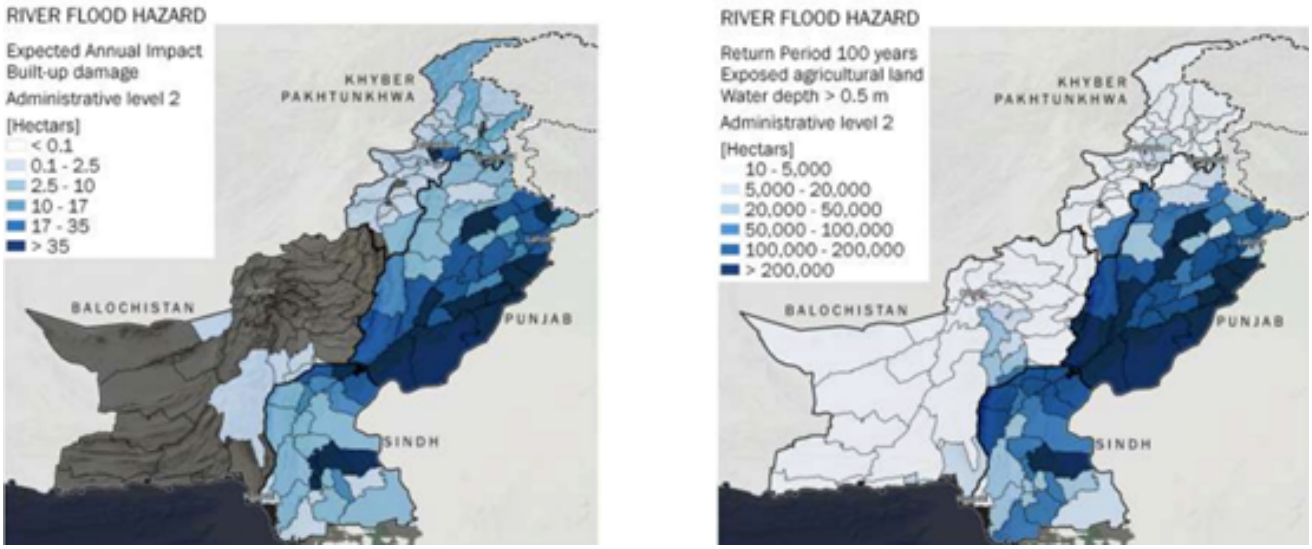

Figure 7. Expected annual impact of flood on built-up assets (left) and on agriculture (right)
Source: World bank CCDR, 2025

2.1.2. A shift in the hydrological cycle

The evident global warming and climate change effects in Pakistan are not just temperature fluctuation but a fundamental, significant and perpetual alteration of country's hydrological cycle. Global warming effects on mountainous region of Pakistan resulted in rise of over 2.5 degree Celsius in the last 50 years causing heatwaves to become both severe and more frequent (Somani, 2023). This warming phenomenon causing major changes in hydrological cycle. Pakistan's rain observational data reveals decreasing of winter rains and shifting of monsoon rains westward conjointly with increased intensity and severity (Salma, 2012). This change and shift from sustained precipitation and predictable to high-intensity, short duration downpours and torrential rain are characteristics of new climate reality.

This change has destructive and cascading effects. Rapid, intense and torrential rainfall overpower soil's ability to absorb water, resulting a significant erosion and surface runoff which subsequently causes flash flood and landslides. This phenomenon is peculiarly hazardous in regions which experience less rain and are unaccustomed to heavy and torrential rain such as arid parts of northern Sindh, which were devastated by the 2022 floods.

The same warming phenomenon and persistent heat anomaly

which altered hydrological cycle, also aggravate melting of snow and glacier at Hindu Kush, Karakoram and Himalayan (HKH) ranges. This synchronous occurrence of torrential rain and accelerated snow / glacier melt pose compounded threat to river system leading to dual risk of both cloudburst-induced flash flood and Glacial Lake Outburst Floods (GLOFs).

3. METHODOLOGY

This study employs a comprehensive desk review and critical analysis of available historical data/literature to achieve its research objectives. These approaches were selected to explore the vulnerabilities and causes of climate-induced catastrophes in Pakistan and shortfalls in mitigating the risks of such events with a view to proposed practicable measures to enhance national preparedness for climate related disasters. The methodology involves analyzing extreme weather events. Data drawn from various international reports, the International Disaster Database, World Bank, United Nations groups reports, and scholarly articles on the subject. The primary research method for data collection is in-depth document analysis to draw a comprehensive understanding of the complex scenarios where different level of governance lacks coordination and face difficulties in the implementation of strategies and policy framework formulated at the federal level.

4. RESULTS AND DISCUSSION

4.1. The multifaceted impacts of climate change on Pakistan

The degree of risk posed to Pakistan due to climate change is immense and viewed by experts as a major obstacle in the sustainable development of country. Climate-induced catastrophe impacts all aspects of the economy and has a cascading effect that further diminishes the growth projection of a country by diverting already limited financial resources to recovery and relief efforts from development and growth projects. Particularly, the agriculture sector is severely affected, thus looming risks of food insecurity, widespread poverty, and malnutrition. Additionally, climate-induced events also set stage for major disruptions of society like mass displacement and greater pressure on cities which are unprepared to accommodate migrants and influx. Figure 8 below shows total occurrence and average economic damage (percentage of GDP) from natural disasters in Pakistan between 1960 and 2019.

Figure 8. Total Occurrence and average economic damage (percentage of GDP) from natural desasters in pakistan between 1960 and 2019.
Source: The international disaster database
Note: Decadal figures are measured as the annual sum over the subsequent ten-year period.

4.1.1. Economy-wide impact of climate risks

Climate-induced events have economy-wide impact on fiscal space, development, growth, poverty and employment. Such events have multidimensional affects on economy such as impacts on human capital, infrastructure, livelihoods, productivity and derailment of economic growth and development.

4.1.2. Threats to water security and the hydrological cycle

Pakistan's existing water stress is further aggravating

manifolds due to climate change, pushing country a further step down from "water-stressed" to "water-scarce" country in 2025. The water requirement for non-agricultural purpose is expected to increase manifolds with climate change. Under the scenario of high growth (4.9% annually) and high warming (3 degree by 2047), water demand is projected to increase by 60% (World bank CCDR, 2022). As per world bank report of 2022, important factors which drives Pakistan to this transition are uncertain/ unpredictable impact of climate change and rapid population growth which is projected to reach 255 million by end of 2025 (Worldometer, 2025). This high demand will deprive downstream users from their water rights and this rapid declining trend of per capita supply of water is expected to last for decades.

The consequences for Pakistan's hypercritical water resource, the Indus River Basin, are enormous. Indus River is lifeblood of the country, feeding 90% of its total agriculture production (Heureux *et al.*, 2022). Indus and its tributaries charged primarily by ice and snow melting from Hindu Kush, Karakoram and Himalayan (HKH) mountains. Alteration of water flow in this basin whether due to altered monsoon pattern or due to immoderate melt of snow and ice at HKH mountains, has significant impact on food security (Heureux *et al.*, 2022). Additionally, the declination in water availability surely brings persistent decline in water quality. Contamination from industrial waste, geological factors and inadequate disposal of wastewater pollutes both surface water and groundwater, posing serious threat to public health and hindering the country's effort to achieve / uphold United Nations Sustainable Development Goal - 6 (UNSDG-6). The combination of water scarcity and contamination is mostly viewed as a challenge to national security which has the potential to ignite disputes among provinces on water distribution.

4.1.3. Impacts on the agricultural and socio-economic landscape

Agriculture sector of Pakistan employs a significant portion of workforce and is catastrophically exposed to climate change. Climate-inflicted damages to crops production is expected to have far-reaching and profound economic impact. Loss to rice and wheat yields alone due to climate change is expected to reach $19.5 billion to Pakistan's Real Gross Domestic Product by 2050, accompanied by inflation and rise in commodity prices coupled with decrease in private consumption (Khan *et al.*, 2020). According to World Bank Country Climate and Development Report, the agricultural yields could drop by another 50% by 2050 (World bank CCDR, 2022). Beside these direct losses, a ripple effect can expand beyond agricultural sector to industrial and business and other sectors.

The impact on socio-economic sector is also profoundly inequitable. Decline in production effects unevenly across different households. High commodity prices effects most to urban households and rural non-farm as they mostly rely on market to meet their food demand. This sector is expected to experience significant blunt and decrease in real income. On the contrary, rural households which consume their homegrown crops and are able to sell additional crops at market, may able to generate profit. Balochistan province is likely to be effected most from this inequality as most households in Balochistan are already facing a sever decline in real income and are the subjected to climate change and price hikes. This uneven effect uncovers a critical social dimension to the climate crisis that a just and equitable adaptation strategy must address.

4.1.4. Public health and urban resilience challenges

Climate change's impact on people is severe and affects their well-being directly. Heavy rainfalls and flooding occur more often, which increases the chance of bad water quality which can harm people's health. Contamination of water, particularly in rural regions, is a concerning issue, as laboratory tests conducted in Balochistan reveal that water samples often do not comply with both domestic and global health criteria. Health workers noticed an increase in waterborne illnesses like malaria and cholera after floods hit their areas, straining already limited healthcare resources.

In addition to rural regions, Pakistan's fast-growing cities also face significant threats. Karachi, Lahore, and Faisalabad suffer from poor drainage and lack of infrastructure, leading to more frequent flooding during heavy rains. The issue arises from dense populations and considerable population engaged in the informal economy, living at encroached land of river or nullahs. Additionally, undue influence and corruption in government offices allows influential elites and property tycoons to construct housing societies on land re-claimed from sea, river or other water channel. First and forefront victims of heavy rain and flash flood are residents of such societies which are constructed on such re-claimed land. A weak healthcare network, exhausted infrastructure, corrupt officials and defenseless people put Pakistan's cities in severe and increasing strain.

Table 1. Indicators of climate change impact with details

Key Indicators of Climate Change Impact	Details	Sources
Economics Losses	Projected loss of $19.5 billion to Pakistan's GDP by 2050 from agricultural production decline alone, with a multiplier effect on other sectors.	Khan *et al.* Economic Effects of Climate Change -Induced Loss of Agriculture Production by 2050:A case Study of Pakistan. Sustainability, 2020
Agricultural Impact	Crop yields for wheat, rice, and other major crops projected to drop by 50% by 2050.	Ali *et al.* Climate Change and Its Impact on the Yield of Major Food Crops: Evidence from Pakistan. MDPI, 2017

Water Security	Pakistan is transitioning to a "water-scarce" country starting in 2025 due to rapid population growth and climate change impacts.	Ministry of Planning and Development, (Uraan Pakistan Project, 2024) www.uraanpakistan.com
Vulnerability	Consistently ranked among the top 10 most vulnerable countries to climate change, and was the most affected in 2022 and in 2025.	Germanwatch Climate Risk Index Report, 2025
Human Toll	• The 2022 monsoon season alone resulted in at least 1,700 deaths and displaced over 8 million people, causing an estimated $40 billion in damages. • Estimates of damage and losses caused by flood of 2025 is yet to access.	Germanwatch Climate Risk Index Report, 2025
Public Health	A greater risk of water-borne diseases like malaria and cholera is likely due to increased floods and poor water quality.	BritishRedCross, Why waterborne diseases are a threat after the Pakistan floods.2025 Update

4.2. The "cloud burst" phenomenon: science, nexus, and consequences

4.2.1. Defining cloudbursts: a technical perspective

Cloudburst refers to abrupt, localized, drenching a small area with an extremely heavy downpour. In other words, its dumping of enormous amount of water in short span of time. The phrase, stemming from an erroneous belief that clouds might burst like balloons filled with water, continues to be used today to denote this harmful atmospheric phenomenon. A widely recognized definition classifies a cloudburst by heavy rain falling at least 100 millimeters in an hour across a limited region measuring about 20 to 30 square kilometers.

The meteorological mechanism behind cloudbursts involves violent updrafts of warm, moist air within a cumulonimbus cloud. These powerful air currents prevent condensing raindrops from falling to the ground, allowing a massive amount of water to accumulate at high altitudes. When these updrafts weaken, the accumulated water is released all at once, leading to the characteristic torrent of a cloudburst. The small-scale and rapid nature of these events makes them exceptionally difficult to forecast, as they often go undetected by weather satellites, whose resolution is typically inadequate for such localized precipitation.

4.2.2. The climate nexus: why they are intensifying

Global warming links closely to frequent and intense rainstorms and cloudburst phenomenon in Pakistan. For each degree rise in temperature, the air can carry about 7% more water vapor (Copernicus, 2024). Moist warm air behaves as a sponge, storing extra water. When encountering mountainous areas, air rises and cools quickly, leading to rapid condensation and a heavy rain shower known as cloudburst.

A specialist from Climate Analytic explained how something works in that area. The warming Earth forces the subtropical jet stream, which starts over the Mediterranean, moving further south during summers. Colder air from the jet stream mixes with low-level clouds during the monsoon, creating a towering, unstable cloud system that produces heavy rain abruptly, quickly and all at once.

Glaciers melting because of warmer weather reveal dark soil beneath. This exposed land absorbs more solar radiation than icy surfaces, further warming the air. This makes atmosphere more volatile and also increases the chances of cloudburst. These events are part of a dangerous cycle that gets worse over time.

4.2.3. On the ground: a chronicle of catastrophe

Pakistan saw catastrophic events due to cloudbursts, which have been misunderstood by theory. The phenomenon is now found beyond the country's northern part or mountainous region and reached to plains and cities as well.

i. Buner experienced heavy rainfall and flash flood in monsoon 2025 due to a cloudburst in the Hindu Kush mountains, causing over 200 deaths (exact deaths and damages are not yet confirmed). The torrential rain (150 mm in one hour) unleashed massive floods, sweeping away houses at the mountain's edge, an unusual event posing new threats.

ii. Gilgit-Baltistan has experienced multiple cloudburst-induced flash floods that frequently ravage various valleys, destroying crucial infrastructures like bridges, roads, and hydroelectric plants, and isolating entire settlements and cutting off connectivity of several villages.

iii. Islamabad/Rawalpindi: In 2001, an important case was set as a warning example. A sudden shower caused an extraordinary 620 millimeters of rain in just 24 hours, which was the most in history of 100 years. The worst-ever flash flood occurred in the Nulla Lai stream, flooding low-lying areas and destroying hundreds of homes.

iv. Karachi experiences frequent heavy rains which although not officially classifies as cloudburst. However, torrential rain causes urban flooding, disrupts operations, and flood major roads and homes, resembling cloudburst phenomenon.

4.2.4. Distinguishing cloudbursts from GLOFs

Cloudbursts and GLOFs are usually confused but they are separate phenomena. Their analysis below explains how they differ, why it happens (causes), what are the results (consequences) and also clarifies that why their co-existence in northern region of Pakistan poses parallel destructive threat?

Table 2. Difference Between Cloudburst and GLOF

Feature	Cloud Burst	Glacial Lake Outburst Flood (GLOF)
Core Cause	A sudden, extreme downpour from a cumulonimbus cloud.	The catastrophic failure of a natural dam (ice or moraine) containing a glacial lake.
Primary Trigger	The rapid condensation of moisture-laden air caused by atmospheric instability, often due to orographic lift (mountains) or temperature differences.	Rapid glacier melt due to extreme heatwaves, which swells lakes until they breach their dams.
Geographic Location	Can occur in both mountainous areas and urban centers.	Occurs in high-altitude glaciated valleys and affects downstream communities.
Nature of Flood	Rapid, intense flash floods and landslides that overwhelm local drainage systems and soil absorption.	A sudden, massive torrent of water, often laden with debris, that scours riverbeds and washes away large-scale infrastructure far downstream.
Relationship to Climate Change	Global warming increases atmospheric moisture, making the conditions for intense precipitation more frequent.	Global warming accelerates glacier melt, leading to the formation of new glacial lakes and the expansion of existing ones.

Research shows that both GLOFs and cloudbursts are increasing in frequency and intensity because of underlying climate factors. A GLOF unleashes an overwhelming flood from a glacial lake; meanwhile, a sudden cloudburst might cause landslides that halt rivers, forming temporary lakes with their own risks and burst possibility. Northern Pakistan faces an unprecedented danger from these two climate disasters that frequently occur together in the same region.

4.3. Discussion

4.3.1. Critical gaps and challenges in policy implementation

i. Institutional and political barriers: Pakistan faces momentous institutional and political barriers which have hampered implementation of policies despite having comprehensive and robust policy framework. An overview of the National Climate Change Policy (NCCP) revealed that it lacks clarity setting priorities and and figuring out relevant authority with open-ended and widely-worded provisions missing specific details like responsibilities and allotted sources. Said ambiguity is further enhanced by "institutional divide" between the Federal and Provincial governments, specially after the 18th amendment of Constitution in which environmental regulations devolved to Provinces. This has led to choppy enforcement that lacks coordination vertically and horizontally.Moreover, political instability, inconsistency and competing short-term interest impede consistency, sustainability and continuity of long term climate policy. This insufficient political will especially at provincial level, leads to a poor governance and subsequent to governance-failure. The deficient administrative capacity hampers the effective implementation of national policies thereby limiting its impact.

ii. Financial and technical constraints: The gap in implementation of policy is widely perceived due to technical and financial constraints. No budget allocated for climate related tasks and climate-related actions are basically funded via donor projects or reactive relief efforts. Over reliance on outside funding makes planning uncertain. Provinces mostly lacks budget to co-finance such projects which further slow down the progress.

Beside financial ability, the technical capacity to put into effect and monitor climate actions is also weak, specially at provincial level. Limited training and technical knowledge of local officials creates a significant technological gap formulating micro level practicable policies and deployment of mechanism for tracking, monitoring, reporting, and verification (TMRV). This accumulation of economic and technical shortfalls prevents Pakistan from successfully assembly its climate commitments and development of necessary resilience.

iii. The gap between national vision and local action: The profound gap between the national vision and its practical implementation on ground is the most critical challenge for Pakistan. Wishful policies and ambitious frameworks developed at federal level mostly fails to materialize at the provincial, community and local level. Where National Climate Change Policy (NCCP) accentuates measures to reduce flood risk, local department often ignores climate hazards while planning infrastructure. The basic state of early-warning and evacuation plans in areas other than major cities highlights this miscoordination, disconnect and fragmented result.

Ultimately, success and failure of climate policy of Pakistan will be decided through the degree of its effective implementation at local and district level. The unclear mandate, non-availability of resources, ineffective coordination between federal, provincial and district level are some fundamental barriers in effective implementation of policies and provision of tangible results.

4.4. Recommendations

4.4.1. Short-term mitigation and emergency response strategies

i. The early warning paradox: policy vs. Reality: The National Disaster Management Authority (NDMA) in Pakistan developed extensive strategies and measures to handle weather-related catastrophes. The NDMA devised several preventive measures, such as the Monsoon Contingency Plan 2025 and the Summer Hazards Contingency Plan 2025, designed to assist all parties in achieving readiness and executing a successful resolution. The NDMA employs an early warning system that uses

satellite images and weather data from Pakistan Meteorological Department (PMD) to alert local officials, who subsequently inform the public. There's a big difference between the way things should be done in theory and how they're actually carried out practically on ground. For instance, residents were upset after flooding in Buner. They blamed officials for not sending out immediate alert and warnings in traditional method (through mosques' speakers), thus caused delayed reaction from people and resulted in excessive damages and deaths. The government has claimed that the heavy rainstorm was unexpected and sudden, so early or timely warning could not be extended. However, this doesn't explain why there's still a problem with the early warning system. The real issue seems to be that the system can't reach people who need immediate help. In Gilgit-Baltistan, the GLOF-II projects governmental early warning systems had badly failed, whereas villagers' lives were saved due to timely warnings from local shepherds and community members. This clearly shows a breakdown and failure in trust, communication and translation of technical data into community level actionable warnings.

ii. Enhancing coordinated response: The cyclical pattern of lethal flash floods in Pakistan exposes the inadequacy of current reactive response system. Notably, though Pakistan Army and the humanitarian agencies which includes United Nations do undertake rescue and relief operations for food, shelter and medical care to disaster stricken, this fire fighting, reactionary approach is unsustainable and incapable to build long term resilience.

A short term quick fix for now should be integrated with a big picture and long term plan. New houses built after 2022 lacked raised foundations and proper drainage systems, making them susceptible to flooding. Demonstrates lack of integrating resilience in post-disaster rebuilding. An enhanced coordinated response should not only provide immediate relief but also ensure that every reconstruction effort is "climate-proofed" and that a rapid-response disaster management fund is established to avoid the delays and uncertainties of a donor-dependent model.

4.4.2. Long-term adaptation and policy frameworks for resilience

i. Implementing a climate-compatible development agenda: Pakistan devises strategies for incorporating climate change into its economic plans. The National Climate Change Policy (NCCP) of 2021 outlines a detailed plan covering 14 main goals aimed at enhancing resilience in infrastructure, securing water and food supplies, and fostering sustainable economic growth through reduced carbon emissions. The nation has both a National Adaptation Plan (NAP) and has initiated major programs such as the Ten Billion Tree Tsunami Project (TBTTP), aiming to enhance ecosystem protection and carbon storage through these initiatives. However, it's found that these policies have an uneven mix. Initiatives such as the TBTTP represent beneficial actions but should not be considered a "cure-all" solution for tackling the nation's carbon emission issues. The government is forcing the nation onto an energy path that relies heavily on coal by supporting more coal-fired power stations through the China-Pakistan Economic Corridor (CPEC). Fossil fuel dependence, supplying 40% of Pakistan's primary energy, clashes with immediate energy demands against future climate objectives. A nation that has great potential for solar and wind power faces challenges in transitioning to renewable due to delayed policies and continued use of imported oil and gas. This highlights the necessity for policymakers to realign their focus towards sustainable energy solutions.

ii. Reforming water governance and infrastructure: A lasting plan for water safety needs to change our way of thinking from relying heavily on big projects like embankments and dams to looking for holistic approach. New methods need smart policy, technology, nature-friendly and eco-based solution. Recommendations for Pakistan are:

- *Floodplain zoning and land use planning:* Avoiding construction in high-risk, low-lying zones; these areas should be designated for agriculture or as natural flood channels, which should essentially be "non-structural" zones; the aspect which is frequently go unnoticed and unaddressed due to either incompetency or corruption of government institutions or undue influence of elites / property tycoons / real estate giants on local development authorities to allow mushrooming of housing authorities at river beds, high-risk, low-lying zones.
- *Climate-Resilient Agriculture:* Promoting water-saving technologies such as drip irrigation and switching to climate-resilient crops can enhance agricultural resilience and reduce strain on water resources.
- *Ecosystem-Based Approaches:* Investing in sustainable water resource management, rainwater harvesting, watershed development, and the restoration of wetlands and forests through ecosystem-based approaches can help ecosystems naturally absorb excess water and mitigate flood risks. These methods succeed through a change in focus from just preventing floods to minimizing damage by allowing the river space.

iii. Mobilizing climate finance and fostering international cooperation: Nevertheless, financial and technological barriers make the achievement of Pakistan's climatic dreams infeasible right now. A study from World Weather Attribution finds Pakistan requires $152 billion from 2023 to 2030 for implementation of its climate adaptation plan but most of that is unfunded. The revised Nationally Determined Contributions (NDCs) Pakistan, which heavily depends on foreign funding further enhanced this large financial gap. In order to address this issue, World Bank published Country Climate and Development Report on Pakistan which suggests a comprehensive and integrated financial support strategy; along with foreign financial resources, there should be domestically earned income generated through new municipal or tax base expansion of property and efforts to attract private sector involvement. Additionally, shifting the perception from a 'failure narrative' to that of 'success stories' will establish credibility, and could convince sufficient foreign capital and technology transfer.

iv. Building societal resilience and public awareness: long-term resilience is a societal effort, not just a governmental one. The National Disaster Management Authority's (NDMA's) National Disaster Risk Reduction Strategy (NDRRS) 2025-2030 recognizes this through emphasizing "inclusive governance" and network-based community training to ensure protection of vulnerable population and their involvement in resilience-building efforts.

however, societal and political factors continue to be a barrier in implementation. Experts and researchers have also observed lack of public pressure on policymakers to put into effect existing climate policies, indicating "other issues" are perceived as more urgent. This shows that a top-down approach is not enough without addressing the underlying socio-economic gap that is making communities vulnerable. Spreading awareness and empowering vulnerable communities with knowledge, awareness and resources, is crucial for building a resilient society.

5. CONCLUSION

5.1. A call for a paradigm shift

The observable facts highlighted in this article shows unequivocal conclusion; Pakistan's existing approach to deal with climate change is directed towards persevered disaster. The "Cloudburst" phenomenon and climate-generated catastrophes should not be viewed as an isolated events, rather they are symptoms and warnings of a bigger, systemic crisis which is exposing the profound vulnerabilities of nation. The fragmented, reactive, and extern dependant approach to deal with catastrophe management is unsustainable. A genuine resilient nation can not be constructed at the back of reactive relief but on a essential paradigm shift, closer to a proactive, inclusive, coordinated, and climate-compatible improvement model that embeds climate resilience into every sector and at every degree of governance.

5.2. Actionable recommendations for a resilient Pakistan

Phased recommendations for a comprehensive national climate strategy deduced from analysis are appended below:

Table 3. Phased recommendations with details

Phased Recommendations for Climate Resilience	Details and Rationale
Short-Term (0-1 Year) - Immediate Response and Preparedness	i. Establishment of Rapid-Response Disaster Management Fund: Create a dedicated domestic fund to ensure immediate relief and reconstruction. Less reliance on foreign funding so that efforts not delayed due to shortfall of international funding. ii. Implement a "Last-Mile" Early Warning System: Beyond high-tech systems, prioritize the development of multi-channel alert mechanisms that effectively reach vulnerable communities through a variety of trusted communication channels (e.g., mobile alerts, Announcements through loud speakers, mosques, local radio, community leaders etc). iii. Conduct a Nationwide Infrastructure Review: Perform an urgent and comprehensive review of all flood protection infrastructure and illegal construction on river beds/ re-claimed land, targeting removal of illegal housing / constructions and repairs and maintenance to address critical vulnerabilities before the next monsoon season. iv. Launch a Public Awareness Campaign: Initiate a nationwide campaign to educate the public on climate risks, emergency protocols, and the importance of community-led preparedness.
Medium-Term (1-5 Years) - Strategic Reforms and Capacity Building	i. Strengthen Horizontal and Vertical Coordination: Create a formal, constitutional mechanism to clarify roles and responsibilities and ensure seamless cooperation between federal, provincial, and district disaster management authorities. ii. Invest in Climate-Resilient Agriculture: Scale up the adoption of climate-smart agricultural practices and water-saving technologies such as drip irrigation, as recommended by the World Bank. iii. Integrate Technology for Disaster Risk Reduction: Invest in and scale up the use of real-time monitoring systems, AI-driven predictive analytic, and drone technology for flood forecasting, damage assessment, and early warning, leveraging successful approaches seen in the region. iv. Develop Dedicated Climate Budgeting: Allocate a specific, ring-fenced budget for climate action to reduce reliance on external aid and enable proactive, long-term planning.
Long-Term (5+ Years) - Foundational Transformation	i. Embed Climate Resilience into All Development Planning: Make climate risk management a mandatory component of all national and provincial development plans and infrastructure projects, ensuring that all new construction can withstand the impacts of a changing climate. ii. Implement National Floodplain Zoning and Land-Use Planning: Enact and enforce regulations to prevent encroachment in high-risk floodplains, a key "non-structural" measure that can minimize future damage and loss of life. iii. Prioritize a Just Energy Transition: Systematically phase out reliance on coal and other fossil fuels and accelerate investments in renewable energy infrastructure, aligning energy policy with long-term climate goals and moving away from a fossil fuel-dependent path. iv. Empower Local Communities: Invest in community-based adaptation initiatives, providing local communities—especially marginalized groups—with the resources, knowledge, and institutional support needed to lead their own resilience efforts and serve as the most effective line of defense.

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