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Climate Change and its Impact on Disaster Frequency and Severity in Pakistan



Abstract: Natural disasters today are more severe and frequent around the world because of climate change, but no country is more vulnerable than Pakistan, which suffers from a combination of geographic, socioeconomic, and institutional challenges. This study links climate change with natural disasters in Pakistan using the lens of the Vulnerability Framework with an emphasis on floods, droughts, and heat waves. This paper uses qualitative research methods to examine how recent literature, government reports, and international databanks reveal how factors like poverty, weak infrastructure, and governance gaps amplify the impacts of climate-induced disasters. Rising temperatures, unpredictable rainfall, glacial melting, and their added socioeconomic vulnerabilities have resulted in extensive displacement, economic losses, and devastating environmental degradation in Pakistan, finds. Finally, the study recommends actions to bolster resilience such as strengthening governance, making disaster preparedness efficient, and centralizing vulnerability reduction strategies within climate adaptation policy.

Key Words: Climate Change, Natural Disasters, Pakistan, Vulnerability Framework, Floods, Droughts, Heat Waves, Disaster Management.

Introduction

Climate change has been turning into a defining global challenge that from time to time amplifies natural disasters like floods, droughts, and heat waves. The unique location of Pakistan makes it a very prone country whose climate has been much affected. The country has Himalayan glacial systems, erratic monsoon patterns, and fragile ecosystems. The GCRI (Global Climate Risks Index) keeps Pakistan among the top vulnerable states to climate change (Eckstein et al., 2021).

Disasters like the 2022 floods have had disastrous impacts on Pakistan. It has affected around 33 million people and economically impacted the state (World Bank, 2022). Recurring heat waves in Karachi have triggered multiple health crises; also prolonged droughts in Sindh province and Baluchistan have severely affected agriculture and water resources (Kamal, 2022; Mukhtar, 2020). Pakistan's natural disaster intensity is increasing due to climate change. While these are disasters, they are not alone – they are exacerbated by vulnerabilities of poverty, weak

infrastructure, uncontrolled urbanization, and weak institutional capacity. Existing research regarding disasters typically concentrates on climate drivers, but not how these vulnerabilities worsen the downstream impacts of disaster in Pakistan. The analysis focuses on filling this gap by investigating how climate change interacts with socioeconomic vulnerabilities utilizing the Vulnerability Framework (Cutter et al., 2003).

The key objectives of this study are:

1. To analyze the impact of climate change on the frequency of natural disasters in Pakistan.
2. To identify the socioeconomic and environmental vulnerabilities through which the impacts of these disasters are intensified.
3. To evaluate and develop disaster management policies in Pakistan with gaps related to policies and strategies of

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vulnerability reduction and increasing climate resilience.

The study explores research questions:

1. How is the increase in frequency and severity of floods and heat waves in Pakistan linked with climate change?
2. What socioeconomic and institutional vulnerabilities make Pakistan vulnerable to climate-induced disaster impacts?
3. How effective are Pakistan's existing disaster management and climate adaptation policies in addressing these vulnerabilities?

Pakistan is a case study in this thesis in order to investigate the impact of climate change on disaster trends, with the lessons learned possibly applying to other developing countries with similar issues also affected by the effects of climate change on disaster trends. To identify social, economic, and institutional factors that build the compound impacts of disaster, the study uses the Vulnerability Framework. The output presents ways to further the contingency of actionable strategies to limit vulnerabilities and bolster resilience against climate crisis in areas that are faced with identical impacts.

Literature Review

One of the greatest challenges of the 21st century is climate change, and it has resonance for the patterns of natural disasters. There is a large scholarly consensus that climate change is causing more frequent and severe disasters, including floods, droughts, and heat waves. Lockdown might be the most common solution available to countries worldwide, but it is certainly not the best for those falling below the poverty line, or living in poor and low developing countries like Pakistan. Various factors (geographical, socio-economic, and institutional) make Pakistan vulnerable to natural disasters, which increases people's vulnerability to natural disasters. But climate change alone can't take all the blame, many researchers say. Poor management, inadequate infrastructure, and bad governance all play a role (Heidari, 2020).

Often the worst climate-induced disaster in Pakistan is flooding. Mustak (2022) and Eckstein et al. (2021) show that rising temperatures and

glacial melt have changed monsoon patterns, resulting in increasingly unpredictable, more intense flooding in the Indus River Basin. The 2022 floods in Pakistan, which forced 33 million people from their homes and whose original estimated cost will now be approximately \$30 billion, have been deemed as a 'climate catastrophe' (World Bank, 2022). Excessive monsoon rainfall, largely because of rising sea surface temperatures in the Arabian Sea, overpowered existing infrastructure and flood defenses (Mukhtar, 2020). However, critics say that the floods in Pakistan were devastating partly because of climate change. Poor land use planning, deforestation, and encroaching on the riverbanks, according to Khan et al. (2021), worsen the impacts of floods (much). For example, agricultural land and urban areas have replaced floodplains which once could soak up excessive water and communities are thus more vulnerable to river overflows. Somewhat ironically this indicates the confluence of human action and climate dynamics in amplifying disaster risks.

Less visible but no less problematic for Pakistan are the droughts. Agriculture, water availability, and food security have been badly hit due to prolonged dry spells in Sindh, and Baluchistan areas. Reduced precipitation due to shifting monsoon patterns and a rise in temperature links drought conditions (Mukhtar, 2020). Water scarcity has been worsened by the over-extraction of groundwater and the existence of rural populations dependent on rain-fed agriculture greatly vulnerable. Between 2000 and 2019, Pakistan faced eight major drought events, with devastating socio-economic effects ranging from migration to poverty (Hussain et al., 2020). Although climate change is a significant driver of drought conditions, researchers say that Pakistan's neglect to invest in water management systems like dams and reservoirs has compounded the problem. Poor governance and mismanagement of resources are often said to act as underlying exacerbating factors of the impacts of droughts.

The increasing and intensifying frequency of heat waves, as experienced in urban centers like Karachi and Lahore, is something that the Government cannot ignore, according to the foundation. In the 2015 Karachi heat wave, over 1,200 died in the worst consequences of increasing temperatures and socio-economic vulnerabilities (Kamal, 2022). The creation of heat islands is in

some small way attributed to Urbanization. Since plants do not cover dense areas and concrete surfaces increase, they've been warmed up more than other regions (Abdul et al., 2020). According to Herring et al. (2015) and Khan et al. (2021), low-income populations, who may often also lack access to cooling systems and healthcare, bear a disproportionately high burden of heat wave risks. However, there have been no government proactive policies for dealing the heat-related risks, adding to the crisis. Although climate change is no doubt a major driver of heat wave frequency increase (Mukhtar, 2020), other issues such as poor urban planning and lack of green spaces are impacting heat wave frequency equal to, if not more than, climate change (Mukhtar, 2020).

The impact of disasters in Pakistan is largely determined by socio-economic vulnerabilities. Drawing from their seminal work, Vulnerability Framework (Cutter et al., 2003), in which they argue that disasters are not simply environmental hazards but also a function of socio-economic inequalities, the paper also synthesizes that disasters are not only caused by natural hazards. With high levels of poverty, little education, poor healthcare, and poor financial resources, Pakistan's population is poorly equipped to deal with disasters. In particular, rural communities are disproportionately exposed to climate-induced disasters because of their past dependency on agriculture and limited livelihood diversification (Mukhtar, 2020). It compounds these vulnerabilities in other, often gendered, ways as well. Disasters in the unfortunate use of power and resources, as Khan et al. (2021) and Kamal (2022) report, affect women more due to their lack of access to financial resources and decision-making positions. Nevertheless, certain specialists caution that Pakistan's vulnerability should not be limited solely to a socio-economic dimension. According to Malik et al. (2021), cultural practices (ex. dependence on informal networks for disaster response) shape community resilience.

The policy response of Pakistan to climate-induced disasters has been criticized as being ill-prepared, reactive, and without long-term planning. In 2007 an agency, the National Disaster Management Authority (NDMA) was created to coordinate disaster response across the country. In early warning systems and post-disaster reliefs the NDMA has made progress but to address the root

causes of vulnerabilities including weak infrastructure and unregulated urbanization (World Bank, 2022). According to Hussain et al. (2020), the NDMA's centralized, top-down approach, has resulted in inefficiencies since the provincial as well as local departments lack the requisite capacity or resources to effectively implement the plans of Disaster management. The UNDP (2019) also adds that Pakistan saturated less than 0.1% of its GDP in disaster risk reduction, which is lower than that mandated by international organizations. Also limiting the country's ability to invest in resilience-building measures, and underutilization of international climate financing, including the Green Climate Fund (GCF), further exacerbates the situation (Fahad et al., 2021).

While these challenges are of concern, the vulnerabilities may nevertheless be reduced by community-based adaptation strategies, according to certain researchers. Furthermore, Kamal (2022) illustrates examples of grassroots initiatives like self-designed early warning systems by local NGOs in flooded areas. They have proved themselves to reduce casualties by allowing for timely evacuation. Likewise, traditional water harvesting knowledge in Baluchistan used by Mustafa et al. (2018) also argues for integrating indigenous knowledge with modern disaster management. Nevertheless, such strategies are underutilized because of institutional support and funding deficits.

International cooperation is indispensable to Pakistan to address its climate vulnerabilities. Although Pakistan contributes less than 1 percent of the world's greenhouse gas emissions, it is yet among the top ten of the countries most impacted by climate change (Eckstein et al., 2021). The consequences of this disparity are extraordinary and drive the point home about the need for climate justice and developed nations' assistance in adaptation in vulnerable countries. As mentioned by The World Bank (2022) and UNDP (2019), International funding mechanisms including the GCF and the Climate Adaptation Fund offer Pakistan chances to spend on resilient climate infrastructure and disaster mitigation projects. Nevertheless, bureaucratic inefficiencies and the absence of transparency impeded the tapping of these resources in totality (Fahad et al., 2021).

The literature shows consensus between climate change and natural disasters in Pakistan however, there are some home works. The focal emphasis on environmental drivers has blinded us to vulnerability's organizational, political, and economic components. Concurrently, studies on weaknesses in Pakistan's disaster management systems tend to lack recommended, actionable ways to strengthen policy implementation and governance. Further research should then lead to the design of integrated approaches to reduce vulnerability and combine these responses with the emerging concerns for climate adaptation and sustainable development.

Theoretical Framework

This research is based on the central role of the Vulnerability Framework to provide a structured framework of the interaction between environmental risks and their associated socioeconomic strengths and weaknesses. Developed by Cutter et al. (2003), this framework identifies three key components of vulnerability; exposure, sensitivity, and adaptive capacity. The value of this framework is accentuated in the context of Pakistan given this enables an analysis of how the impacts of disaster scale with climate-induced risks and social, economic, and institutional realities.

Exposure

Pakistan is highly exposed to risks induced by climate. Millions live in Himalayan glacial systems, dependent on the Indus River Basin, and are exposed to erratic monsoon patterns and natural disasters in the form of floods and droughts (Eckstein et al., 2021). River overflow is significantly caused by recurrent floods, for instance, as a result of the melting of glaciers. Moreover, the monsoon patterns have shifted so that Sindh and Baluchistan have experienced prolonged droughts, which have had a big impact on agricultural productivity (Mukhtar, 2020).

Sensitivity

Sensitivity is the extent to which a population or system is intrinsically affected by exposure to climate-related hazards. Pakistan is sensitive to climate change due to its reliance on climate-sensitive sectors such as agriculture, widespread

poverty, and unplanned urbanization (Kamal, 2022). Disasters like floods and heat waves disproportionately impact vulnerable people (including small-scale farmers and women) and marginalized communities. Inadequate cooling infrastructure and lackluster urban planning contribute to Karachi and other urban centers living through a heat wave-induced health crisis (Barbara et al., 2017).

Adaptive Capacity

Pakistan's adaptive capacity is its capacity to respond to and recover from disasters. However, Pakistan has weak governance and poor disaster preparedness mechanisms, leaving limited adaptive capacity and ensuring insufficient investment in resilient infrastructure. For instance, the implementation of effective early warning systems and post-disaster rehabilitation by the National Disaster Management Authority (NDMA) has been limited to some extent, during for instance, the floods of 2022 (World Bank, 2022). The country's ability to mitigate future disasters is constrained without signification improvements in governance and resource allocation

Application of the Vulnerability Framework to Pakistan's Context

This places The Vulnerability Framework as especially significant for Pakistan since it outlines a systematic modality of how socioeconomic conditions are shaped by environmental risks. The following applications are central to this study:

Flood Vulnerability

2022 floods due to unprecedented monsoon rains show how excessive exposure (glacial melt, river overflow), high sensitivity (farming dependency, informal housing), and little adaptive capacity (poor early warning systems, lack of infrastructure resilience) can result in costly devastation. More than 33 million people were affected, with great loss of life and economic damage valued at \$30 billion (World Bank, 2022).

Heatwave Vulnerability

The experience of Karachi's heat waves proves the point that unplanned urbanization widens the scope of disaster impacts. Hundreds of heat-

related deaths are due to poor housing conditions, limited access to cooling systems, and lack of heat wave response policies.

Drought Vulnerability

The drought-prone areas of Sindh and Baluchistan show how dependent rain-fed agriculture and excessive groundwater extraction have made the communities highly vulnerable to climate variability (Sultan et al., 2022).

This research extends this beyond purely an environmental analysis, incorporating social and institutional variables into a framework of Vulnerability to provide a systemic view of disaster risk in Pakistan. In this framework, a gaze is offered through the lens of exposure, sensitivity, and adaptive capacity, with the identification of areas most in need to engage interventions to mitigate disaster impacts and promote resilience. For example, the framework can be employed to identify which resilient infrastructure, poverty alleviation programs, and improved disaster governance are strategy areas that can reduce vulnerabilities.

In the case of Pakistan, it informs sensitivity, adaptive capacity, and exposure to disaster risk. This research specifies these components as possible areas of critical intervention. Poverty alleviation, institutional reforms, and resilient infrastructure development comprise the intervention elements that reduce vulnerability and enhance climate resilience (IPCC, 2023).

Methodology and Research Design

This research analyzes the impacts of climate change on the frequency and severity of the natural disasters that occur in Pakistan through qualitative research design. This is a qualitative study as it gives clarity into contextual factors including governance, socio-economic variations, and policy gaps that impact disaster outcomes (Creswell, 2018). The synthesis of such data sources as academic literature, government reports and international datasets is possible with ease in this method since it allows for the synthesis of said different inputs into cohesive themes that could help to analyze the subject of the research in a holistic way.

Thematic analysis is used as the core analytical framework for the research. A widely used qualitative method for identifying, analyzing, and reporting patterns within textual data is thematic analysis (Braun & Clarke 2006). This approach is particularly apt in analyzing complex phenomena (i.e. climate change, and its socio-political and environmental consequences) in disaster-enhanced societies like Pakistan. The thematic analysis involves three core steps: This involves data familiarization by reviewing and annotating a subset of academic papers, government reports, and case studies; open coding of observations to discover key ideas and recurring concepts; and theme synthesis, in which codes are placed in larger thematic areas related to research questions including 'flooding trends', 'urban heatwave vulnerabilities', and 'policy challenges' (Nowell et al., 2017).

This approach is guaranteed to make systematic identification and organization of patterns across different datasets and always provide a fixed and reproducible set of results. In order to avoid a bias related to the biased choice of data sources, the study solely relies on secondary data sources. Primary data used in this analysis include disaster response and preparedness situations and historical trends of floods, droughts, and heatwaves recorded through reports of the National Disaster Management Authority (NDMA); climate data on monsoon variability, glacial melt, and temperature anomalies from the Pakistan Meteorological Department (PMD); the United Nations Development Programme's (UNDP) documentation of people sector vulnerabilities and adaptation strategies; and global and regional climate impacts documented in the Sixth Assessment Report (2021) of the Intergovernmental Panel on Climate Change (IPCC). I used secondary data sources including peer-reviewed journal papers published from 2018 to 2023 in journals such as *Climate Dynamics*, *Environmental Science and Policy*, and *Sustainability*; NGO reports from Germanwatch, World Bank, and Asian Development Bank (ADB), related to climate change impacts in South Asia; and case studies of specific disaster events like the 2022 Pakistan floods to explore the interplay of climate drivers and governance weaknesses.

Following Braun and Clarke's (2006) step-by-step thematic analysis guidelines, the collected data were categorized under four primary headings: We explore flooding trends, which emphasize intensified rainfall, glacial melt, and socio-economic impacts; heatwave impacts, predominantly urban vulnerability attributable to bad urban planning and lacking cooling infrastructure; drought and water scarcity, focusing on agricultural challenges and water resource depletion; and policy gaps and governance challenges consisting of institutional inefficiency and poor preparedness for climate adaptation. In order to uphold key qualitative research standards, the study was methodologically rigorous. Information was collected using only verified and reputable sources including peer-reviewed journals, government reports, and UN publications in which findings were cross-referenced to maintain credibility.

Analytical Discussion

In the past two decades, Pakistan has witnessed an increasing frequency and growing severity of natural disasters, ranging from floods to heat waves, to drought. The country was among the ten most affected countries in the world by climate-induced disasters between 2000 and 2023 (Eckstein et al., [2021](#) - Global Climate Risk Index 2021). In 2022 alone, 33 million people were displaced, over 9 million acres of farmland and 13,000 kilometers of roads were destroyed and economic losses exceeded \$30 billion (NDMA, [2022](#), World Bank, [2022](#)). Heatwaves have been more dangerous, for example, in urban centers such as Karachi where on 26 May 2022 record temperatures topping 49.5°C (Kamal, [2022](#)) killed hundreds. By the same token, droughts in Sindh and Balochistan have become more severe because rainfall has fallen compared to past records, resulting in hefty losses in agriculture and persistent water scarcity that has affected more than 5.8 million people suffering from prolonged dry spells (Mukhtar, [2020](#)).

Major Disaster Types in Pakistan

Pakistan constitutes a highly vulnerable ground to various types of climate-induced natural disasters, each of which brings with itself different challenges to the country's socio-economic fabric

and its environment. Specifically, floods, heat waves, and droughts are the most prevalent and resurrecting disasters, as the impact of climate change increases. In addition to threatening human lives and livelihoods, these disasters also compromise Pakistan's agricultural economy, infrastructure, and urban and rural resilience.

Floods

However, flooding remains the most frequent and destructive of all-natural disasters in Pakistan, due mainly to climate-induced factors including glacial melt and erratic monsoon patterns. Excessive rainfall and mismanagement of water technologies leave the Indus River Basin, the basin that supplies water to Pakistan's agricultural economy, particularly susceptible to flooding. For instance, the 2022 floods occurred after 400% more monsoon rains than usual and accelerated glacial melting this year alone (World Bank, 2022). Flood destruction has gone so far as to cause huge displacements, crop loss, and infrastructure destruction. Further risks have been amplified by the encroachment in flood plains and poor urban planning, with more than 45 percent of flood-affected land in 2022 being unregulated settlements (NDMA, [2022](#)).

Heat waves

In the case of Karachi and Lahore, the urban centers have become hot spots for extreme heatwaves. But poor urban planning along with the effect of an urban heat island made these cities more prone to rising temperatures. Hanif ([2017](#)) finds that Karachi's population density and lack of infrastructure for cooling have greatly raised mortality rates during heat waves.

Droughts

Less visible but longer-term, droughts affect rural communities of Sindh and Baluchistan. The Pakistan Meteorological Department (2022) mentioned that these regions' rainfall has gone down by 16% in the last two decades, and more than 20% of the groundwater reserves are depleted.

Trends of Disaster Frequency and Severity

Over the last two decades, Pakistan has seen an

increase in both the number and the scale of natural disasters, such as floods, heat waves, and droughts. The Global Climate Risk Index 2021 (Eckstein et al., 2021) reports that Pakistan ranks among the top 10 most affected countries globally by climate-related disasters between 2000 and 2020.

Below (table 1) shows how the annual economic impact of flood incidents has risen dramatically since 2000. The 2010 super floods and the 2022 historic floods are some of the key examples of how climate change has increased rainfall intensity and melting of glaciers to cause catastrophe.

Table 1

Flood Incidents in Pakistan (2000–2023) and Economic Impacts

Year	Major Event	Death Toll	Displaced Population	Economic Loss (\$ Billion)
2005	Northern Floods	520	1.2 million	1.1
2010	Super Floods	1,985	20 million	10.1
2012	Monsoon Floods	571	4.8 million	2.6
2022	Historic Floods	1,739	33 million	30.0

Sources: NDMA (2022); World Bank (2022); Germanwatch (2021).

In fact, the 2022 floods in Pakistan were the most dramatic in that country’s history, displacing 33 million people and destroying assets worth 8% of the country’s GDP (World Bank, 2022). Its damages were 439 bridges, 13,000 kilometers of roads, and 9 million acres of agricultural land. Pakistan lacks disaster-resilient infrastructure and Readiness which is reflected in these losses, which also demonstrates the increasing intensity of floods.

Similarly, trends in heat waves and droughts are upward. As tabulated in Table 2, heat waves have been happening more severely in urbanized places like Karachi and Lahore, as manifested. As one example, over 1,200 deaths from Karachi’s 2015 heat wave and record-breaking temperatures of 49.5°C in the 2022 heat wave worsened health crises and economic losses (Kamal, 2022). Similarly, table 3 summarizes the drought impacts on Sindh and Baluchistan.

Table 2

Heatwave Statistics in Major Urban Centers (2015–2023)

Year	Location	Peak Temperature (°C)	Death Toll	Economic Loss (\$ Million)
2015	Karachi	49°C	1,200	300
2018	Lahore	47°C	200	80
2022	Karachi	49.5°C	400	450

Sources: NDMA (2022); Kamal (2022); Pakistan Meteorological Department (PMD, 2022).

Table 3

Drought Impacts in Sindh and Baluchistan (2000–2023)

Year	Rainfall Reduction (%)	Affected Population	Crop Yield Loss (%)	Economic Cost (\$ Million)
2000–2005	12%	3.5 million	20%	500
2010–2015	15%	4.2 million	28%	800
2015–2023	16%	5.8 million	34%	1,200

Sources: Mukhtar (2020); UNDP (2019).

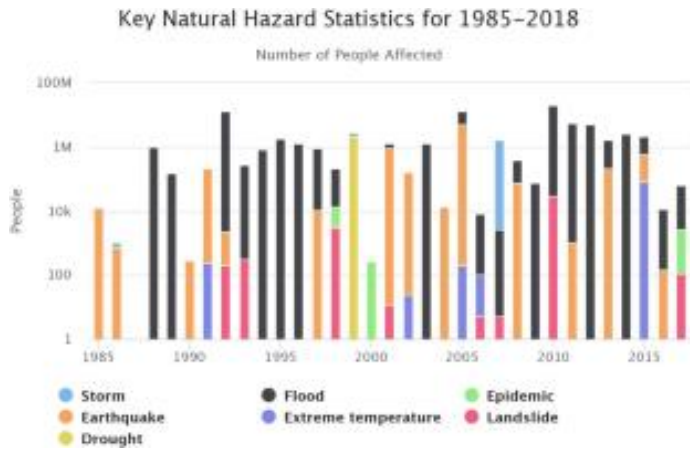
Impact Analysis of Climate Change

Economic Impacts

Disasters are staggeringly costly on an economic basis. Losses due to floods alone have topped \$50 billion since 2000, wiping out wealth primarily in agriculture. During the 2022 floods rice fields were ruined in 31 percent and cotton in 45 percent, causing food shortages and inflation (World Bank, 2022).

Figure 1

Key Nature Hazard Statistics for 1985-2018



Source: Hussain et al (2019)

Environmental Impacts

Floods cause erosion of the soil, pollution of water sources, and destroy biodiversity. Meanwhile,

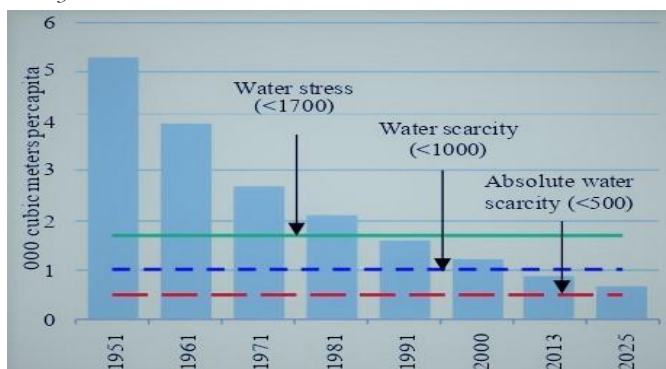
Social Impacts

Vulnerable populations are disadvantaged in disasters. In the 2022 floods, more than 8 million people were displaced and many are still living in temporary shelters. Women and children are additionally in danger of malnutrition and restricted access to well-being mind (Khan et al., 2021).

droughts aggravate the desertification of Sindh and Balochistan, making the area increasingly unagriculturally viable (Mukhtar, 2020). Figure 3 shows per capita water availability since 1951.

Figure 1

Per capita Water Availability in Pakistan, 1951-2025



Source: Maqbool (2023)

Policy and Governance Issues

While there has been progress in disaster response at the National Disaster Management Authority (NDMA), the body remains starved of adequate funding and is poorly coordinated with provincial bodies. The lack of funding leaves critical projects underfunded, as Pakistan only spends less than 0.5% of its GDP on climate adaptation according to the World Bank (2022). Additionally, communities lack comprehensive land use planning which has further exposed them to recurring disasters.

The investigation has revealed a transparent correlation between climate change and the intensification of natural disasters felt in Pakistan. Floods, heatwaves, and droughts are worsening, and their effects are being exacerbated by governance legacies and policy gaps. These issues will demand big investments in adaptation to climate change, infrastructure resilience, and institutional reforms.

Conclusion and Recommendations

For Pakistan, the frequency and severity of climate-induced disasters such as floods, heat waves, and droughts are on the rise. While the socio-economic vulnerabilities, poor urban

planning, and governance gaps compound these disasters, they cause massive economic, social, and environmental costs. Even the 2022 floods alone forced 33 million reasons and \$30 billion in damages — representing the increasingly dire urgency of building global climate action. To get there, we need to tackle these problems from multiple angles.

Recommendations

1. **Policy Reform:** NDMA's capacity should be strengthened, land use regulations enforced, and federal-provincial coordination among others should be improved.
2. **Infrastructure Investment:** Infrastructures are developed for urban cooling, waters are managed and flooding-resistant infrastructure is promoted.
3. **Climate Adaptation:** Invest 2 percent of GDP in disaster preparedness, and place adaptation in development plans.
4. **International Support:** Use the Green Climate Fund (GCF) and establish international collaborations in order to leverage our partners.

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