Climate Change and Environmental Governance: A Case Study of Floods in Pakistan (2010 & 2022)

By

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DEDICATION

I dedicated this thesis to my parents who have been my constant source of love and encouragement throughout my academic pursuits. Their unwavering support and belief in me have kept me motivated during the most challenging times.

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Nazish Tariq

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List of Abbreviations

ADB ..... Asian Development Bank

BISP ..... Benazir Income Support Program

BMD ..... Bangladesh Meteorological Department

BRICS ..... Brazil, Russia, India, China, South Africa

CDM ..... Clean Development Mechanism

CH4 ..... Methane

CO2 ..... Carbon Dioxide

COP ..... Conference of the Parties

CWC ..... Central Water Commission

FEMA ..... Federal Emergency Management Agency

FRP ..... Floods Response Plan

G7 ..... Group of Seven

G20 ..... Group of Twenty

GCRI ..... Global Climate Risk Index

GCF ..... Green Climate Fund

GDP ..... Gross Domestic Product

GERD ..... Grand Ethiopian Renaissance Dam

GIS ..... Geographic Information Systems

GLOFs ..... Glacial Lake Outburst Floods

GWP ..... Global Warming Potential

H2SO4 ..... Sulfuric Acid

HIV ..... Human Immunodeficiency Virus

HRW ..... Human Rights Watch

IDPs ..... Internally Displaced Persons

IFRC ..... International Federation of Red Cross and Red Crescent Societies

IPCC ..... Intergovernmental Panel on Climate Change

JI ..... Joint Implementation

KP ..... Khyber Pakhtunkhwa

NDC ..... Nationally Determined Contribution

NDMA ..... National Disaster Management Authority

NEOC..... National Emergency Operations Center

NFRCC .....National Flood Response Coordination Committee

NGO..... Non-Governmental Organization

NFPP..... National Flood Protection Plan

PKR:..... Pakistani Rupee

PSSR .....Pakistan Society for the Study of Renewable Energy

PTSD..... Post-Traumatic Stress Disorder

RCC.....Regional Cooperation for Development

REDD+…….. Reducing Emissions from Deforestation and Forest Degradation

SACOF..... South Asian Climate Outlook Forum

SAARC .....South Asian Association for Regional Cooperation

SO2 .....Sulphur Dioxide

UN..... United Nations

UNDP..... United Nations Development Programme

UNFCCC.....United Nations Framework Convention on Climate Change

UNHCR.....United Nations High Commissioner for Refugees

UNICEF .....United Nations Children's Fund

Glossary

Environmental degradation : Environmental degradation is the deterioration of the environment due to human activities, resulting in the depletion of natural resources, pollution, and loss of biodiversity.

Mitigation: Mitigation means lessening the negative impact or severity of something.

Climate adaptation: Climate adaptation means preparing for and adjusting to the impacts of climate change to reduce risks and build resilience.

Meteorology: Meteorology is the study of the Earth's atmosphere, focusing on weather patterns, atmospheric phenomena, and the processes that influence them.

Abstract

This thesis focuses on the serious problems caused by climate change and frequent floods in Pakistan. It highlights the urgent need for global efforts to address the environmental, social, and economic impacts of climate change, especially in a country like Pakistan that is vulnerable to such challenges. The study looks into the reasons behind the floods of 2010 and 2022 in Pakistan , uncovering connected political, social, and environmental factors. It emphasizes the importance of a comprehensive approach that considers power dynamics, environmental damage, and societal vulnerabilities. While acknowledging the government's efforts to manage crises, the study also points out coordination and resource allocation challenges, stressing the importance of effective governance. The research underscores the necessity of distributing resources to benefit all parts of society. Flood management in Pakistan faces problems due to coordination issues, highlighting the need for better planning and involving communities to enhance their resilience. Using qualitative methods and data from various sources, the study explores the causes and consequences of floods in Pakistan, the country's response to climate change, and possibilities for future prevention. The goal is to increase awareness and guide actions to reduce the impacts of climate-related disasters.

Introduction

Over time, amid extensive human development, climate change has evolved into one of the paramount and intricate global challenges of our era. While the term "climate change" is not novel, it is commonly characterized as a prolonged alteration and reconfiguration of temperature and weather patterns in a specific region.[1] Climate change constitutes a universal challenge, with all states sharing equal vulnerability to its effects contingent upon factors such as geographical location, developmental stage, and contributions to greenhouse gas emissions.[2] With the increase in global temperature a variety of different weather patterns and geographical circumstances also emerged. Such as heavy snow, river, lake ice, and sea ice, as well as glaciers, are all directly affected by temperature changes.[3] The ice masses in Antarctica and Greenland are melting at an unprecedented level. Various glaciers from the Alaska, Africa Alps, Rockies, and Himalayas are also melting. Oceans are increasingly absorbing heat, leading to the rising sea levels caused by the melting of glaciers and ice sheets. The elevation of seawater is escalating rapidly and is anticipated to further rise in the future. Consequently, the inhabitants of coastal areas are grappling with the repercussions of sea level elevation, contributing to recurrent floods, heightened storm occurrences, and the potential for more frequent tsunamis. Predominantly, scholars posit that human actions and activities serve as the predominant catalyst for climate change.[4]

Greenhouse gases emission brought on by human-made sources are one of the factor behind climate change . Our atmosphere absorb heat because of greenhouse gases. Greenhouse gases include nitrous oxide, methane, and carbon dioxide.[5] Global warming potential (GWP) determines how the greenhouse gases influence climate change. The GWP measurement clarifies the amount of heat a gas can hold onto and how long it can stay in our environment. Because they absorb more heat, gases with higher GWP contribute more to the Earth's total temperature, which in result warms it. Also when fossil fuels like coal or oil are used for

[1] Fakhara Shahid, Mubeen Ashraf," Climate Change: Impacts on Pakistan and Proposed Solutions," *Pakistan Social Science Review* 5, no. 2 (April-June 2021): 223-235, https://pssr.org.pk/issues/v5/2/climate-change-impacts-on-pakistan-and-proposed-solutions.pdf

[2] Hiedi Cullen, " The Weather of the Future,"(Newyork: Harper, 2010), 329, https://epdf.tips/queue/the-weather-of-the-future.html

[3] Micheal, "Climate Change Primer," *Warm heart worldwide organisation*, accessed April 26, 2023. https://warmheartworldwide.org/what-is-global-warming/

[4] David Well, " The Inhabitable Earth," Tims Duggan Books (Newyork, the Crown Publishing Group, 2019), 38, https://nymag.com/intelligencer/2017/07/climate-change-earth-too-hot-for-humans.html

[5] Eric Wolf, "Climate Change Evidence & Causes," *The Royal Society*, (2020): 12-23, https://royalsociety.org/~/media/royal_society_content/policy/projects/climate-evidence-causes/climate-change-evidence-causes.pdf

industrial purposes, more carbon dioxide is released which effects the temperature of the world. Another cause of climate change is cutting and clearing of trees also known as deforestation. Deforestation for agricultural use, human activities, and for industrial purposes also results in a rise in greenhouse gas emissions, particularly carbon dioxide. [6] In the aftermath of industrial revolution, increase in carbon emissions all across the world due to increase in economic activity. The countries across the world are very concerned about the increase carbon emission because the carbon emission released by countries is more than what the carbon cycle on earth can naturally absorb. With the Industrial Revolution, the climate and weather patterns on Earth have been shifting.

Climate Change and Vulnerability of Pakistan to Natural Disasters

In the realm of climate change, as affirmed by environmental scientists at both the national and international levels, Pakistan currently ranks among the top 20 countries globally that is vulnerable to climate change. This is because of a number of factors, such as geography, deforestation, carbon emission due to industrialization, rapid urbanization, resource scarcity, and socioeconomic conditions. Pakistan is an overpopulated, agriculture-based nation with few resources. Pakistan is currently vulnerable to climate change and facing severe challenges such as massive floods, drought, and long and extreme heat wave that resulted in fatalities, displacement of people, and destruction of economies and infrastructure. In the year 2010, the country faced deadliest disaster affecting more than 20 million people and seriously damaged livestock, infrastructure, and agriculture. [7]Over 1.7 million houses, as well as many crops and agricultural land, were destroyed or damaged by the 2010 floods.[8] Later in the year 2022, Pakistan again faced another deadliest flood but this time affecting more people than past. Approximately 33 million people are affected and one-third of the nations have been flooded. 1,400 lives were lost in the disaster which also had an effect on 3% of Pakistan's GDP.[9] Railway operations experienced unprecedented devastation, with daily losses of Rs. 90 million, and about 13,000 km of roads and highways were devastated.[10]

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[6] Joe Smith, "Estimating Global Impacts from Climate Change," *Organisation for Economic Co-operation and Development*, (Dec 2002): 10

[7] Editors of Encyclopaedia Britannica. "Pakistan Floods of 2010." Encyclopedia Britannica. March 21, 2023. https://www.britannica.com/event/Pakistan-Floods-of-2010.

[8] "Annual Flood Report 2010," Government of Pakistan, *Ministry of Water and power*. Pg no 7-13, https://mowr.gov.pk/SiteImage/Misc/files/2010%20Annual%20Flood%20Report%20of%20FFC(1).pdf

[9] "Pakistan Flood Disaster Affects More Than 33 Million People." ReliefWeb, September 2, 2022. https://reliefweb.int/report/pakistan/pakistan-flood-disaster-affects-more-33-million-people.

[10] "Pakistan Floods 2022: Post Disaster Needs Assessment Report." *Government of Pakistan*, (Oct 2022):16-30

The government has launched National Adaptation Plan and a National Climate Change Strategy in response to all of these difficulties, focusing on various approaches and counter measures to climate change's effects and also established a NDMA to record data of previous disaster and generate counter measures for the future disasters. In an effort to raise awareness among the general public about the value of trees, the Pakistani government also shut down its coal-fired power facilities and began a campaign called "Ten Billion Trees Tsunami." [11]Despite these initiatives, Pakistan still has a lot of work to overcome this issue because of a lack of funding, institutional ability, and political will.

Pakistan is currently experiencing a cascading disaster as a result of the floods; the country's economy has significantly weakened. Since agriculture makes up the majority of Pakistan's GDP, the country's crops and livestock suffered severe damage by the floods. Due to the shortage of food inflation and poverty increased. [12] There was an increase in interstate migration as well as problems with water and food security due to disasters. This will have a cascading effect that will eventually damage the security of our region. Consequently, this won't only be an environmental concern; it will also affect national security and politics. The Pakistani government needs to act immediately on this matter if it wants to avoid a terrifying situation, otherwise the nation will soon face an even worse disaster. Thus, this study will focus particularly on Floods in Pakistan and emphasise Pakistan's reaction to global climate change.[13]

Statement of the Problem

The research seeks to address the pressing issue of climate change in Pakistan, focusing on the profound impact of extreme heat waves, massive floods, and droughts that have resulted in loss of life, displacement of populations, and widespread damage to economies and infrastructure. Specifically, this study aims to investigate the inadequacies in environmental governance, particularly concerning disaster management in the face of recurring floods. Despite country's consistent vulnerability to natural disasters, including earthquakes and

[11] Usman Ashraf, "Participation and exclusion in mega tree-planting projects: a case study of the Ten Billion Tree Tsunami Programme, Pakistan," *International Institute for Environment and Development*, (June 2022):9-12, https://www.fao.org/family-farming/detail/en/c/1601518/

[12] Qamar Zaman, "Climate Change Profile Of Pakistan," Asian Development Bank 3, (2017): 16-76, https://www.adb.org/sites/default/files/publication/357876/climate-change-profile-pakistan.pdf

[13] Anjum Farooqi, Azmat Hayat Khan and Hazrat Mir, "Climate change perspective in Pakistan," *Pakistan Journal of Meteorology* 2, no. 3 (March 2003): 1-11, https://www.semanticscholar.org/paper/Climate change perspective in Pakistan-Farooqi-Khan/e2fae88d823837b56016aa750071779411dc23cd

annual floods, the government's response and safety measures appear insufficient. Factors responsible for inefficiency in disaster management include the lack of dams, excessive rainfall, monsoon patterns, inadequate water storage, absence of precautionary measures, insufficient flood detection systems, negligence of government disaster management policies, and limited financial resources. This dissertation intends to analyze the implications of climate change in Pakistan with a specific focus on the government's response to flood-related disasters, utilizing floods as a case study for a comprehensive examination.

Objectives of the Study

The objectives of the research are :

- To clarify Pakistan's vulnerability to the impact of climate change and environmental disasters.
- To assess the response of Pakistani government and the essential measures taken in addressing recurrent floods.
- To identify the reasons of environmental policy failures regarding climate change.
- To propose recommendations and counter measures to reduce the hazards of floods brought by climate change in Pakistan.

Research Questions

1. How the climate change affected Pakistan?
2. How the 2010 & 2022 floods caused disaster in affected areas?
3. How the government of Pakistan responded to floods (2010 & 2022) disaster?
4. What precautionary measures the government of Pakistan has adopted to avoid future climate disasters?

Literature Review

All states are susceptible to the effects of climate change, which is a global threat. Pakistan has had many of the deadliest floods in recent years as a result of climate change, seriously damaging every aspect of life. Numerous authors and academics have conducted extensive studies on this specific topic. Following are some studies that have been consulted for the formulation of this dissertation while keeping the topic in view:

"The Uninhabitable Earth," penned by author David Wallace-Wells, provides a comprehensive exploration of the causes and consequences of climate change on both the environment and humanity. Well-organized into three distinct sections, the book addresses various facets of climate change. The initial section, titled "Element of the Chaos," succinctly

outlines the primary causes of climate change and their potential impact on human existence. Wallace-Wells underscores the repercussions of global warming, including the melting of glaciers, rising sea levels, extreme weather events, and concerns about water and food security. The escalating Earth's temperature necessitates urgent global action to avert increasing vulnerability among all nations to the impending challenges posed by climate change, ensuring the preservation of their survival in the foreseeable future.[14]

In "Climate Change, Vulnerability, and Migration," edited by Irudaya Rajan and R.B. Bhagat, the narrative underscores the disproportionate impact of environmental challenges on economically disadvantaged populations . The book highlights that climate change-induced environmental challenges disproportionately impact economically disadvantaged populations. It underscores the need to understand how power dynamics contribute to environmental vulnerabilities. It explores how extreme weather events have diminished the diversity of the environment, impacting the ability of ecosystems to provide sustenance and secure livelihoods. This analysis explains the connection between resource access, control, and broader political and economic structures. The narrative emphasizes that migration becomes a crucial survival strategy for those confronting environmental challenges. It examines how resource scarcity and environmental changes drive migration and displacement, shedding light on power imbalances and unequal resource access. The book recognizes remittances as a critical adaptation strategy, delving into how economic and political structures influence coping mechanisms in response to environmental changes. It also investigates the drivers of migration, focusing on the socio-economic and political factors. It explores intricate interplay of social, economic, and political elements in influencing migration patterns.[15]

Renowned climatologist Heidi Cullen authored a book titled "The Weather of the Future," with its concluding chapter, "A Path Forward," underscoring the imperative for collective action from nations, governments, international organizations, individuals, and communities to address the global challenge of climate change. Cullen notes that the rise in global temperatures poses a shared vulnerability to all states. Given that developed nations contribute significantly to greenhouse gas emissions, she advocates for a universal

[14] David Wallace-Wells, *The Uninhabitable Earth*, England: Penguin Books, 2019, https://www.crisrieder.org/thejourney/wp-content/uploads/2019/05/The-Uninhabitable-Earth-David-Wallace-Wells.pdf

[15] Rajan, Irudaya, and R.B. Bhagat, eds. *Climate Change, Vulnerability and Migration*, Routledge, 2017, https://www.researchgate.net/publication/320036262_Climate_change_vulnerability_and_migration

commitment to mitigating carbon output, aiming to prevent a temperature increase exceeding 2 degrees Celsius. Highlighting the threat to human life, Cullen urges nations to adopt policies and implement measures to minimize carbon emissions. In the effort to decelerate global warming, she recommends increased reliance on renewable energy sources and sustainable development. Cullen also stresses the necessity for governments to prioritize and institute robust climate change policies. To mitigate the future risks of climate change, she proposes that affluent nations engage in more international agreements, citing the Paris Agreement as a notable example. Ultimately, she underscores the urgency of addressing climate change as a pressing global issue, necessitating coordinated action without delay.[16]

The research study, "Estimating Global Impacts from Climate Change," authored by Joel Smith and Samz Hitz and published by the World Bank, addresses the widespread implications of climate change, recognizing it as a global threat with equitable consequences for all nations. The authors explore the effects of climate change across various societal sectors, including human health, agriculture, livestock, water resources, and the environment. Emphasizing the consensus among scientists regarding the causes of climate change and global warming, the authors note that industrialized and developed nations contribute disproportionately to global warming, necessitating collective initiatives across all nations to reduce greenhouse gas emissions. The report further examines potential risks and crises stemming from climate change and global warming, such as reduced food production, water scarcity, droughts, floods, extreme heat, and an uptick in diseases and pest infestations. These crises, the study asserts, pose threats to human security and may escalate intrastate conflicts over scarce resources. The authors contend that the future impacts will be more severe unless cooperative efforts are undertaken to address the issue of climate change effectively. [17]

The "Annual Flood Report 2010," issued by the Government of Pakistan under the Ministry of Water and Power, stands as a comprehensive and in-depth examination of the catastrophic floods that occurred in the same year. Representing the first thorough report on the 2010 flood, this study investigates the root causes of the disaster and provides insights into its extensive impact on affected individuals. As one of the countries most vulnerable to climate change, Pakistan witnessed one of its most severe floods in history during 2010,

[16] Heidi Cullen, *The Weather of the Future* (New York: HarperCollins, 2010).
[17] Joel Smith , Sam Hitz, Estimating Global Impacts from Climate Change (OECD, 2003), https://www.oecd.org/env/cc/2482270.pdf.

directly affecting nearly 20 million people, with approximately 14 million individuals losing their homes. The research underscores that the consequences extended beyond the human toll, encompassing significant damage to infrastructure, buildings, schools, crops, and livestock. The report meticulously documents the collaborative efforts of the Pakistani government and the international community in terms of assistance, funding, and relief camps in the aftermath of the 2010 flood. Additionally, the study incorporates recommendations and proposed measures aimed at diminishing the likelihood of future disasters and floods.[18]

The research article titled "Climate Change and its Impact with Special Focus in Pakistan," authored by Zia Mustafa, delves into the overarching causes of climate change, encompassing the release of greenhouse gases, fossil fuel combustion, and deforestation. Mustafa emphasizes the profound effects of these factors on human survival. The second section of the article specifically examines the impacts of climate change on Pakistan, detailing events such as floods, droughts, extreme heat waves, and disruptions in weather patterns. The repercussions extend to the political, social, and economic sectors, exacerbating pre-existing challenges like food insecurity, migration, water security, poverty, and inflation within the nation. Illustrating the tangible consequences, Mustafa references the devastating floods in Pakistan in August 2010. The article's final section provides a comprehensive list of major global agreements formulated to combat climate change. Throughout, the author underscores the urgent need for both national and international action to address this global hazard, emphasizing that all governments are equally susceptible to its effects.[19]

Mubeen Adnan and Fakhara Shahid's research paper, titled "Climate Change: Impacts on Pakistan and Proposed Solutions," was featured in The Pakistan Society for the Study of Renewable Energy (PSSR). The article explains the origins of climate change, its repercussions on Pakistan, presents potential solutions to address these challenges. Pakistan stands out as one of the countries most severely affected by climate change, experiencing heightened monsoon rainfall, altered weather patterns, severe heat waves, floods, and droughts. The research paper also sheds light on how these impacts have compounded issues

[18] *Annual Flood Report 2010*, Government of Pakistan, Ministry of Water and Power, accessed May 6, 2023, http://www.ffwc.gov.bd/images/annual10.pdf.

[19] Zia Mustafa, "Climate Change and its Impact with Special Focus in Pakistan," 290, https://www.pecongress.org.pk/images/upload/books/8-Climate%20Change%20and%20its%20Impact%20with%20Special%20Focus%20in%20Pakistan.pdf

related to migration, energy shortages, food security, and water security in Pakistan. Furthermore, the paper suggests leveraging renewable energy sources as a viable solution to mitigate these concerns. The study highlights collaborative efforts from both the public and private sectors, as well as civil society, aimed at minimizing the adverse effects of climate change.

Core Argument

In Pakistan, inadequate water management, social-economic vulnerability, intense monsoon rains, Poor governance and resource mismanagement disproportionately created a risk of frequent floods. Despite the government efforts during the flood disasters, a lack of sustained pragmatic environmental policy, ineffective coordination among the government departments, and inadequate resource allocation is magnifying Pakistan's vulnerability to climate effects.

Conceptual Framework

The research revolves around the two relevant conceptual frameworks of 'Green Political Theory' and 'Political Ecology'. The Green Political Theory emerged in the second half of the 20th century. The author like Murray Bookchin, who popularized "social ecology" at the same period as Arne Naess, who created the idea of "deep ecology" their work on ecological sustainability and social justice has influenced the core concepts of green political theory, as has the work of other intellectuals such as Robyn Eckersley and John Dryzek. Green political theory advocates for a fundamental change in how societies engage with the natural world by integrating ecological concepts into political and social analysis. By highlighting the necessity of acting within ecological bounds, advancing social and environmental justice, and implementing sustainable and participatory governance methods, it challenges conventional political ideologies. According to green political theory, changing economic structures, cutting back on consumption, and promoting a closer bond between people and the natural world are all necessary to create an equitable and sustainable society. Another conceptual framework applied on this research is Political Ecology. The French scholar Michel Foucault gives the modern concept and term political ecology in the late 1960s. As an interdisciplinary field, this study emerged in the 1970s and 1980s, it aims to study how power politics, economic forces, and the environment interact to affect the distribution of natural resources and environmental concerns. According to the author of Political Ecology, environmental problems and changes are not only a core reason for naturalphenomena and activities but rather are being shaped by political, economic, and social factors. Political ecologists hold the view that the world's governments and powerful

players profit from environmental issues by having uneven power relations.[20]Political Ecology theory sheds light on the global dynamics of climate change, particularly in the context of its disproportionate impact on nations. Climate change is portrayed as a consequence of actions primarily by more powerful nations, while its effects are acutely felt by less powerful nations like Pakistan, illustrating the power imbalances at play in addressing this global issue. Pakistan's vulnerability to climate change is viewed through the lens of Political Ecology as a result of broader global environmental forces, including rising temperatures and unpredictable weather patterns. These vulnerabilities underscore the influence of unequal power relations in the international arena on a nation's susceptibility to climate- related challenges. Furthermore, Political Ecology theory typically examines how power

[20] Sydney Cohen, "What is The Concept of Political Ecology?" Interfaith Sustainable Development

structures influence resource allocation and access. Within the framework of climate change, it suggests that the distribution of resources for endeavors aimed at climate adaptation and mitigation may be subject to the influence of political and economic interests. While Pakistan's urgent need for such measures is evident, the analysis doesn't explicitly delve into how resource allocation might be shaped by power dynamics or political priorities, a critical aspect of Political Ecology analysis. the theory highlights the concept of shared responsibility in addressing environmental issues, emphasizing the necessity of collective action among nations with varying levels of power. It underscores the interconnectedness of the world in dealing with climate change and underscores the shared responsibility of nations to collaborate and seek collective solutions, aligning with the core principles of Political Ecology.

Utilizing the framework of Political Ecology theory to analyze the causal factors and ramifications of the 2010 and 2022 floods in Pakistan reveals a multifaceted nexus of relationships involving political, economic, and environmental dimensions that substantially influenced the occurrence of these catastrophic events. In both cases, environmental degradation resulting from practices like deforestation and inadequate land-use played a pivotal role in elevating the region's vulnerability to flooding. These environmental issues were intrinsically tied to political choices surrounding resource management and land utilization. [21]Moreover, the intensification of weather patterns, leading to such catastrophic floods, can be attributed in part to climate change a global predicament heavily influenced by international political decisions on issues like emissions and environmental policies. Analyzing the aftermath of the 2010 and 2022 floods through the lens of Political Ecology reveals significant disparities in resource allocation, underpinned by political power dynamics. Elites and influential groups seemingly had more favorable access to aid, while marginalized communities experienced resource disparities due to their limited political influence. Additionally, matters concerning displacement and land ownership underscore how political decisions regarding land tenure and land-use policies further exacerbated the impact on different groups. Economic losses and societal consequences, such as migration patterns spurred by these disasters, were also influenced by political choices pertaining to economic policies, trade relations, and approaches to handling refugees. Political Ecology theory offers a comprehensive framework for comprehending the intricate amalgamation of

[21] Bilal Aslam, Shabnam Gul and Muhammad Faizan Asghar," Evaluation of environmental degradation as an unprecedented threat to human security in Pakistan, " *Liberal Arts and Social Sciences International Journal (LASSIJ),* 2021, 5(1), 197-211. https://doi.org/10.47264/idea.lassij/5.1.14

political, economic, and environmental factors contributing to the 2010 and 2022 floods in Pakistan. It emphasizes the necessity of not only addressing immediate environmental triggers but also considering the enduring repercussions and the political decisions that configure vulnerability and response strategies in the face of recurring environmental challenges.

The 2010 and 2022 floods in Pakistan reveals strikingly consistent patterns. In both instances, the distribution of relief resources was heavily influenced by political power dynamics, favoring elites and influential groups while leaving marginalized communities at a disadvantage.[22] Environmental degradation, stemming from issues like deforestation and land mismanagement, significantly exacerbated the severity of the floods, emphasizing the critical role of environmental factors in creating vulnerabilities.[23] Political decisions, particularly those related to infrastructure development, exacerbated the crises by favoring certain interests and neglecting natural drainage patterns. Corruption and mismanagement, often intertwined with political structures, hindered the effectiveness of relief efforts in both cases, leading to instances of embezzlement and corrupt practices. [24]However, it was evident that communities with secure land tenure and sustainable resource management practices demonstrated greater resilience in the face of these disasters, underscoring the importance of local-level engagement and resource management. Addressing these systemic issues, encompassing political power, environmental degradation, infrastructure decisions, corruption, and community resilience, is imperative for enhancing disaster preparedness and response in Pakistan's recurring environmental challenges.

Analyzing the common reasons for environmental policy failures regarding climate change through the principles of political ecology theory reveals a multifaceted landscape of challenges. These challenges can be categorized into several key areas. First, political power and interests often take precedence over long-term environmental goals, with decision-makers influenced by powerful interest groups and short-term economic considerations. Second, structural and systemic factors within policy design and the economy can hinder the effectiveness of climate policies. Governance and accountability issues, such as insufficient funding and bureaucratic complexities, add another layer of complexity to policy

[22] "Floods in Pakistan: Rethinking the Humanitarian Role," SDPI, November 2022, https://www.humanitarianoutcomes.org/sites/default/files/publications/pakistan_floods_1122.pdf.

[23] Environment and Disaster Risk, UNEP (United Nations Environment Programme), accessed June 2023, https://www.preventionweb.net/files/624_EnvironmentanddisasterriskNov08.pdf.

[24] Blair Glencorse ,Fayyaz Yaseen, "Pakistan Is Flooded with Corruption," Diplomatic Courier, September 17, 2022, https://www.diplomaticourier.com/posts/pakistan-is-flooded-with-corruption.

implementation. Public engagement and awareness play a crucial role, as public opposition and limited awareness can be driven by framing and messaging from interest groups. Global and international factors, including coordination challenges and power dynamics among nations, also impact climate policy outcomes. Additionally, technological and scientific uncertainties can be exploited by the interest groups, affecting policy development. Implementation and monitoring present further challenges, with policy reversals driven by shifts in political leadership and industry resistance during implementation. Finally, environmental justice considerations, reflected in inadequate monitoring and reporting mechanisms, can perpetuate power imbalances and environmental injustices. The failures in policy highlight the complex interaction among politics, economics, and the environment within the realm of climate change policy. They emphasize how political power, interests, governance structures, and public engagement play a pervasive role in shaping the outcomes of climate policies. This underscores the necessity for holistic and strategic approaches to effectively tackle these multifaceted challenges.

Research Methodology

Understanding the significance of the research approach in social science is crucial before embarking on any study. The research approach proposed here is qualitative, emphasizing an explanatory and descriptive research design. This means the study aims to provide a detailed understanding and explanation of the floods of 2010 and 2020 in Pakistan. In terms of data collection, primary and secondary methods are employed. Primary data is gathered from government official websites or organizations like United Nations Framework Convention on Climate Change, United Nations Environment Programme, The National Archives UK, NFRCC, USAID, World Meteorological Organization, Asian Development Bank and National Disaster Management Authority (NDMA) to capture firsthand insights. Secondarydata is drawn from existing sources, scholarly articles, books, publications from reputable international research think-tanks, journals, newspapers, and online resources. This diverse range of sources ensured a comprehensive and multi-faceted exploration of the research topic.

The data interpretation in this study was conducted through the utilization of both the case study method and causal analysis. A case study method enabled an in-depth examination of specific instances, the floods in Pakistan in 2010 and 2022. This method proved valuable for exploring the details, context, and complexities surrounding these events within their real-world settings. It provided an opportunity to analyze the causes, responses, and impacts of

the floods in a holistic manner. Causal analysis played a crucial role in research as it aimed to investigate the relationships between climate change, environmental governance, and the occurrence of floods in Pakistan. Employing causal analysis methods was essential in identifying and understanding the causal pathways and relationships between different variables. This approach proved instrumental in establishing connections between climate change, governance practices, and the occurrence of floods, offering a comprehensive understanding of the interplay between these factors.

Significance of the Study

Climate change, posing a grave threat to the survival of human civilization, emerges as a significant challenge for the human species in the current century. In the case study of Pakistan, the recurring annual devastating floods lead to human casualties and substantial property damage. Despite being a regular calamity in the nation, the impact of floods remains profoundly catastrophic. Located in the monsoon zone, Pakistan experiences heavy rainfall during the monsoon season, triggering widespread flooding. The main objective of research is to analyze the root causes of floods in Pakistan, aiming to comprehensively understand the difficulties and risks faced by the nation and its people. Furthermore, the study shedlight on Pakistan's response to the global issue of climate change. Additionally, it aims to aid policymakers, environmentalists, and researchers in formulating more effective and practical plans to mitigate the likelihood of future climate-related natural disasters, including floods.

This research explains Pakistan's vulnerabilities and challenges arising from climate change, offering recommendations for both national and international actions to minimize future risks and disasters. Finally, the study seeks to enhance public awareness regarding the hazardous effects of climate change.

Delimitation

Although climate change is a worldwide problem with worldwide effects, this study only looks at Pakistan's specific impacts. Pakistan has experienced natural disasters since its inception, but this research thesis focus on the floods of 2010 and 2022.

Organizational Structure

Chapter-1: An Overview of Global Climate Change: Impact on Pakistan

Chapter 1 serves as an exploration into the critical issue of climate change, examining its global implications and, more specifically, its profound impact on Pakistan. The chapter

navigates through the historical trajectory of climate change, tracing pivotal scientific discoveries of the 19th century to the collective global efforts of the 21st century. Within the broader context, the focus shifts to Pakistan, a nation uniquely positioned at the nexus of vulnerability to climate change. Delving into its challenges, from rising temperatures and erratic weather patterns to melting glaciers, floods, and droughts, the chapter scrutinizes the multifaceted consequences on sectors. Throughout, the chapter assesses the country's readiness to adapt and mitigate these challenges, discussing the efforts and policies aimed at securing Pakistan's future in the face of this global crisis.

Chapter-2: Climate Change and 2010 & 2022 Floods in Pakistan

This chapter explains why and how floods happened in Pakistan in 2010 and 2022. Floods have been a big problem in South Asia for a long time, and Pakistan is no exception. The location of the country, where major rivers meet during monsoon seasons, makes it prone to flooding. The impact is even worse because of socio-economic issues like too many people, cities growing without a plan, cutting down trees, and not having enough infrastructure. This chapter focused on the floods in 2010 and 2022, comparing them to understand how Pakistan has dealt with these disasters over twelve years. By figuring out why these floods happened, we aim to understand the challenges Pakistan faces in managing and recovering from such natural disasters.

Chapter 3 : Pakistan Government's Response to the Floods (2010 & 2022) and Flood Management

Chapter 3 analyses the Pakistan government dealt with the big floods in 2010 and 2022. It examines what they did well in managing the disasters and where they faced challenges. Dealing with natural disasters, especially floods, is tough for governments all around the world. In Pakistan, a country that often experiences serious floods, people have closely looked at how the government handled these situations. The floods in 2010 and 2022 showed that responding to these disasters is not easy. While some things were done well, like giving out aid quickly and involving the military, there were also problems. Issues included not having early warning systems, troubles coordinating between different levels of government, and problems getting relief supplies to the right places.

Chapter 4 : Analysing the Environmental Governance and Flood (2010 & 2022) Disaster Management in Pakistan: Challenges and prospects

This chapter explains the problems of dealing with floods in Pakistan and looks at many different plans to solve these issues. Pakistan often faces big problems with floods because

of heavy rain. These floods cause a lot of damage every year, and in recent times, they've been happening more often and getting worse. The chapter looks closely at the problems in the current laws, institutions, and plans that make it hard to manage floods well. Even with these challenges, the chapter says it's really important to be ready for future floods. The main goal is to suggest a bunch of good plans and new ideas to make Pakistan stronger and more successful in dealing with floods in the future. It also contains the main findings of the thesis and gives important suggestions to make dealing with floods better.

Chapter 1

An Overview of Global Climate Change: Impact on Pakistan

Introduction

In today's changing world, dealing with climate change is a big challenge. Climate change is a global issue caused mainly by what people do, and it has widespread effects on the environment, society, and the economy. This chapter talks about how Pakistan is heavily affected by climate change, making it especially vulnerable. It explores two main aspects: first, it looks at the global picture of climate change, tracing its history and the reasons behindit. It takes us from important discoveries in the 19th century to the collective efforts we seetoday in the 21st century. Then, it focuses on Pakistan, a country facing its own unique challenges. The chapter looks at how Pakistan is vulnerable to climate change, experiencing rising temperatures, unpredictable weather, melting glaciers, severe floods, and prolonged droughts. These issues not only impact the environment but also affect areas like farming, food security, water, public health, and the overall stability of the country.

1. General Overview of Climate Change in the 18th Century

The 18th century was characterized by limited global communication and transportation networks. As a result, people had a primarily regional or local perspective on weather and climate. Information about weather patterns was not readily available, making it challenging to discern global climate trends. Data collection methods were rudimentary compared to today's sophisticated meteorological instruments and global monitoring networks. Weather observations were often limited to basic measurements like temperature, wind direction, and precipitation, and these were sporadically recorded at best. There was no systematic global network of weather stations collecting and sharing data. Comprehensive, long-term climate records were practically nonexistent. Today, we rely on extensive databases of temperature, precipitation, and other climate-related data that stretch back decades or even centuries. In the 18th century, few such records existed, and those that did were often kept by individual enthusiasts or scholars rather than by organized institutions.

The sophisticated computer models that underpin our understanding of the climate system were not available in the 18th century. These models are essential for simulating and predicting climate changes over time, which was simply impossible at the time. Understanding the causes of climate change requires the ability to attribute observed changes to specific factors like human activities, natural variability, or external influences. In the 18th century, such attribution was extremely challenging due to the lack of comprehensive data .

In the 18th century, people primarily focused on the immediate impacts of weather and climate on their daily lives, such as agricultural practices and disaster responses. Due to limited global awareness, insufficient data collection and record-keeping, rudimentary scientific understanding, and the absence of modern tools and models, the concept of climate change, as understood today, was not widely recognized during this period. It was only in the 19th and 20th centuries, with advancements in technology, communication, and scientific research, that our comprehension of climate change started to transform into the comprehensive field of study it has become today.

1.1. The Industrial Revolution as an Indicator of Climate Change

The late 18th century witnessed a monumental transformation in human society known as the Industrial Revolution. It was a time of fast technological progress and economic growth that went beyond just industry and cities. This period played a role in shaping our early understanding of Earth's climate. Starting in the late 1700s, the Industrial Revolution saw the widespread use of machines, especially in sectors like textiles, manufacturing, and transportation. A key part of this shift was the increased use of fossil fuels, mainly coal, as the main source of energy. Burning coal powered steam engines, factories, and trains, completely changing how things were made and how they were transported. While the Industrial Revolution brought a lot of economic and technological progress, it also unintentionally caused environmental problems. The extensive use of coal and other fossil fuels released a lot of carbon dioxide (CO2) into the air. This unintentional consequence was a significant step in changing the Earth's climate change.[26] In the late 18th century, the scientific understanding of Earth's climate was in its infancy. People primarily relied on localized weather observations and lacked the tools and global perspective necessary to grasp the broader implications of industrial emissions. Concepts like the greenhouse effect, which would later become central to climate science, were not yet developed. The late 18th-century Industrial Revolution marked the beginning of profound changes in human society, including the widespread use of fossil fuels that would later be linked to climate change. During that period, the idea of climate change and its connection to industrial emissions went unnoticed. It was only through subsequent advancements in scientific understanding, comprehensive data collection, and the efforts of innovative researchers that humanity began to acknowledge and comprehend the complex relationship between industrialization and the

[26] Becky Little, "How Early Signs of Climate Change Date Back to the Industrial Revolution," *HISTORY*, April 18, 2023, https://www.history.com/news/industrial-revolution-climate-change.

altering climate. This growing awareness would eventually lay the foundation for global initiatives aimed at mitigating and adapting to the challenges posed by contemporary climate change.

1.2 Foundations of Climate Change Awareness in the 19th Century

During the 19th century, notable scientists such as John Tyndall and Svante Arrhenius made pioneering contributions that significantly advanced our comprehension of the Earth's climate, specifically regarding climate variability and natural factors. In the mid-19th century, John Tyndall, an Irish physicist, conducted ground-breaking experiments that significantly enhanced our understanding of the greenhouse effect. His work illustrated how specific gases can function similarly to the glass of a greenhouse, allowing sunlight to enter while trapping heat inside. Tyndall's experiments demonstrated that certain gases, particularly carbon dioxide (CO2) and water vapor, possess the capacity to absorb and emit infrared radiation, or heat. In the presence of these gases in the atmosphere, They have the capacity to absorb a portion of the heat emitted by the Earth's surface, hindering it from escaping directly into space. This retained heat then warms the atmosphere, akin to the way a greenhouse captures and retains heat. [27]

Tyndall's discoveries suggested that the Earth's atmosphere functions as a natural temperature regulator. In the absence of specific greenhouse gases, the Earth would be significantly colder, rendering it unsuitable for the majority of life forms. While Tyndall's experiments centered on the natural greenhouse effect, his research established the groundwork for comprehending the function of greenhouse gases in controlling the Earth's temperature. This understanding later proved crucial in acknowledging the potential ramifications of increased greenhouse gas emissions resulting from human activities, such as the combustion of fossil fuels.[28]

Svante Arrhenius, a Swedish scientist, played a crucial role in advancing our understanding of the influence of fluctuations in carbon dioxide levels on the Earth's climate. His contributions were pivotal in investigating the connection between atmospheric CO2 and climate change. In the late 19th century, Arrhenius conducted calculations to assess the potential impact of alterations in atmospheric CO2 concentrations on global temperature. His hypothesis posited that an elevation in CO2 levels could amplify the Earth's natural greenhouse effect, ultimately resulting in global warming. Arrhenius proposed that

[27] RAYLEIGH Life and Work of John Tyndall, *Nature 156*, 189–190 (1945). https://doi.org/10.1038/156189a0
[28] Clive Thompson, "How 19th Century Scientists Predicted Global Warming," JSTOR, December 17, 2019, https://daily.jstor.org/how-19th-century-scientists-predicted-global-warming/.

alterations in atmospheric CO2, whether occurring naturally or due to human activities, might trigger both periods of warming and cooling. Arrhenius's ideas established the foundation for subsequent research in climate science.[29]

John Tyndall's experiments illuminated the natural greenhouse effect, highlighting how certain gases trap heat in the atmosphere, while Svante Arrhenius's calculations explored the relationship between carbon dioxide levels and climate variability.

1.2.1 Volcanic Eruptions

The recognition of the impact of volcanic eruptions on global climate during the 19th century was a significant development in understanding of natural factors influencing climate variability. large volcanic eruptions, such as the eruption of Mount Tambora in 1815, can temporarily alter global climate.[30] Volcanic eruptions involve the release of enormous amounts of volcanic ash, gases, and aerosols into the Earth's atmosphere. Significant amounts of sulfur dioxide (SO2) gas are discharged into the atmosphere during volcanic eruptions. Upon reaching the stratosphere, SO2 undergoes a reaction with water vapor, resulting in the formation of sulfuric acid (H2SO4) aerosols. These aerosols can persist in the atmosphere for an extended period, reflecting incoming sunlight back into space. Sulfuric acid aerosols act as a reflective barrier, scattering and diffusing sunlight. Also reduces the solar radiation reaching the Earth. The more significant the eruption, the more aerosols are injected into the stratosphere, leading to a more pronounced cooling effect. The decrease in incoming solar radiation leads to a temporary cooling of the Earth's surface. This cooling phenomenon may endure for several months to a few years, contingent on the scale and duration of the volcanic eruption. The eruption of Mount Tambora in Indonesia in 1815 is one of the most notable examples of a volcanic eruption with a significant climate impact. Mount Tambora's eruption in April 1815 was one of the most powerful volcanic eruptions in recorded history. It released an enormous volume of volcanic ash and SO2 into the stratosphere. The ejected aerosols from the eruption dispersed throughout the stratosphere and reflected a substantial amount of sunlight away from the Earth's surface. This resulted

[29] Svante Arrhenius, "On the Influence of Carbonic Acid in the Air upon the Temperature of the Ground," *Philosophical Magazine and Journal of Science* 41, (April 1896) : 237-276, https://www.rsc.org/images/Arrhenius1896_tcm18-173546.pdf.

[30] Ames, H, "What Were the Effects of the Tambora Eruption?" *Sciencing*. April 2017, https://sciencing.com/were-effects-tambora-eruption-8063429.html.

in a drop in global temperatures.[31] The colder temperatures led to unseasonable frosts and snowfall during the summer months in many parts of the Northern Hemisphere, including Europe and North America. These adverse weather conditions damaged crops and caused widespread agricultural failures. The Year Without a Summer had significant socio-economic consequences.

1.2.2 Ice Core Studies and Climate Change

Ice core studies have been instrumental in advancing our understanding of climate change. They involve the extraction of ice cores from polar ice caps and glaciers, which provide a unique record of Earth's past climate conditions. Ice core studies involve drilling deep into glaciers or polar ice sheets to extract long cylindrical samples of ice that contain information about past climate conditions. [32]These ice cores have been instrumental in advancing our understanding of climate change. Ice cores provide a unique and continuous record of climatic history of Earth. By analyzing the layers of ice, scientists can extract information about temperature, atmospheric composition, and even past climate events like volcanic eruptions. Ice cores serve as valuable proxies for understanding past climate conditions. Gases trapped in the ice bubbles, like CO2 and CH4 offer insights into past atmospheric composition. Isotopic ratios of oxygen and hydrogen in the ice can provide temperature data.[33]

Ice cores provide evidence of natural climate variability, unveiling patterns of ice ages and interglacial periods that demonstrate the Earth's inherent climate fluctuations over geological time scales. Additionally, these studies contribute to our comprehension of human impact on the climate. Through the analysis of atmospheric composition preserved in ice cores, scientists have identified increases in greenhouse gas concentrations, particularly CO2, aligning with the onset of the Industrial Revolution and fossil fuel combustion. The insights gained from ice core research have played role in enhancing public awareness of climate change. As the data has become more accessible and understandable, it has strengthened the acknowledgment that Earth's climate is responsive to alterations in atmospheric composition. The recognition of historical climate changes had a significant impact on

[31] Britannica, The Editors of Encyclopaedia. "Mount Tambora". *Encyclopedia Britannica*, July 14 2023, https://www.britannica.com/place/Mount-Tambora

[32] Bethan Davies, "Ice Core Basics," accessed September 3, 2020, https://www.antarcticglaciers.org/glaciers-and-climate/ice-cores/ice-core-basics/#:~:text=Through%20analysis%20of%20ice%20cores,with%20depth%20and%20record%20duration.

[33] "Precise interpolar phasing of abrupt climate change during the last ice age," *Nature* 520, (2015), 661–665 https://doi.org/10.1038/nature14401

international climate policy and environmental regulations.[34] Ice core studies have been instrumental in expanding our awareness of climate change by providing tangible evidence of past climate variations and human impacts on the environment. The data extracted from these ice cores serve as a crucial link between the geological past and the contemporary understanding of climate change, emphasizing the urgency of addressing the challenges posed by a warming world.

1.2.3 First International Meteorological Congress (Vienna, 1873)

It was held in Vienna in 1873 and its primary focus was on meteorology and weather forecasting, this Congress and its subsequent outcomes were instrumental in laying the groundwork for the awareness. Organized by the Austro-Hungarian Empire, the Congress brought together meteorologists, scientists, and government officials from various countries. The topics discussed included standardizing meteorological measurements, sharing weather observations, and improving weather forecasting techniques. This note explores the historical context of the Congress, its outcomes, and its relevance to the early origins of climate change awareness. The Congress led to the establishment of the International Meteorological Organization (IMO), which later evolved into the World Meteorological Organization (WMO). The WMO is a specialized agency of the United Nations responsible for international cooperation in meteorology, climatology, hydrology, and related fields. While the initial focus of the Congress was meteorology and weather forecasting, the principles and mechanisms of data sharing and cooperation developed during this period laid the foundation for international climate research. The global network of meteorological stations and data-sharing mechanisms created by organizations like the WMO became crucial for understanding climate patterns and trends on a global scale.[35] While the concept of climate change, as we understand it today, had not fully emerged during the 19th century, the Congress and its subsequent developments set the stage for the future evolution of climate science and the recognition of climate change as a global issue. The Vienna Congress was a response to the growing recognition that understanding meteorology and weather patterns required international collaboration.

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[34] Thomas Bauska, "Ice Cores and Climate Change," June 30, 2022, https://www.bas.ac.uk/data/our-data/publication/ice-cores-and-climate-change/

[35] "History of IMO," *World Meteorological Organization*, https://public.wmo.int/en/about-us/who-we-are/history-IMO#:~:text=The%20International%20Meteorological%20Organization%20(IMO,exchange%20of%20weather%20information%20across,

It initially focused on meteorology and weather forecasting. However, the principles of data sharing, standardized measurements, and international cooperation established during this period laid the groundwork for the broader field of climatology. Over time, as scientific knowledge and research methods evolved, climatology emerged as a distinct field concerned with climate patterns and variations. The legacy of the Vienna Congress was the creation of the International Meteorological Organization (IMO), which later became the World Meteorological Organization (WMO). The WMO expanded its focus to include climate change research and monitoring as scientific understanding grew. This transition allowed for a seamless shift from meteorological cooperation to climate research within the existing international framework, benefiting from the infrastructure and collaborative spirit already in place.[36]

1.3 Overview of Climate Transformations in the 20th Century

1.3.1 Industrialization and Increased CO2 Emissions (Early 20th Century)

Industrialization during the early 20th century marked a period of economic growth and technological advancement, and had profound consequences for the environment, particularly in terms of increasing carbon dioxide (CO2) emissions. The industrialization process was characterized by a significant shift from traditional, agrarian economies to industrial and manufacturing-based economies. This transition resulted in a substantial dependence on fossil fuels. Large quantities of fossil fuels were burned to satisfy the escalating energy needs of expanding industries. As industrialization progressed, the amount of CO2 being emitted into the atmosphere increased substantially. Industrialization did not occur in isolation within individual countries. Many industries and factories expanded their operations across national borders, leading to a globalization of economic activities. This meant that the environmental impacts of industrialization, including CO2 emissions, transcended national boundaries. Pollution from one country could affect the climate and environment of neighboring or even distant countries. The accumulation of CO2 impacts climate patterns, sea levels, and ecosystems. While some countries may have been more responsible for emissions than others due to their industrialization levels, the consequences of climate change were and continue to be felt worldwide. Addressing climate change required international cooperation. Individual nations could not effectively mitigate climate change on their own. This realization led to the need for international agreements and

[36] Tannehill, I. R, "The History and Status of the International Meteorological Organization (I.M.O.)," *Bulletin of the American Meteorological Society* 28, no. 5 (1947): 207–19. http://www.jstor.org/stable/26257860.

collaborations to reduce CO2 emissions collectively. The most notable of these agreements is the United Nations Framework Convention on Climate Change (UNFCCC), which led to the Kyoto Protocol in 1997 and the Paris Agreement in 2015.[37]

These international agreements set targets for countries to limit their greenhouse gas emissions and work toward mitigating climate change. They recognize that the responsibility for addressing the consequences of industrialization and CO2 emissions should be shared among nations, taking into account historical contributions to emissions and current capabilities to reduce them. The widespread industrialization during the early 20th century significantly increased CO2 emissions due to the extensive use of fossil fuels. The global nature of climate change, resulting from emissions that transcended national boundaries, highlighted the need for international collaboration and agreements to collectively address the problem and mitigate its impacts on a global scale. This historical context is crucial in understanding the modern-day efforts to overcome climate change.

1.3.2 The Great Smog of London (1952)

The Great Smog of London, also known as the "Killing Fog," occurred in December 1952. This incident serves as a poignant example of the negative environmental and public health impacts associated with rapid industrialization, particularly the widespread use of coal as a primary energy source during the mid-20th century.[38] Coal was a key energy source for powering factories, homes, and transportation. The "Great Smog of London" in December 1952 was a result of intense coal burning for heating and industrial processes in one of the world's leading industrial cities. During this time, London experienced a combination of unusual weather conditions and stagnant atmospheric patterns, which created a temperature inversion. This trapped a layer of cold, dense air close to the ground. The natural fog mixed with industrial emissions, particularly coal smoke laden with pollutants like sulfur dioxide and particulate matter. This mixture led to the formation of a thick and persistent smog that blanketed the city. Visibility dropped to almost zero, and people could barely see a few feet in front of them.[39] The toxic air from the smog had severe health consequences, causing

[37] Maizland, Lindsay. "Global Climate Agreements: Successes and Failures." Council on Foreign Relations, December 5, 2023. https://www.cfr.org/backgrounder/paris-global-climate-change-agreements.

[38] Erin Blakemore, "The Great Smog of London woke the world to the dangers of coal," *National Geographic*, December 5, 2022, https://www.nationalgeographic.com/history/article/great-smog-of-london-1952-coal-air-pollution-environmental-disaster#:~:text=The%20Great%20Smog%20of%20London%20woke%20the%20world%20to%20the,door%20to20landmark%20environmental%20protections.&text=Donald%20Acheson%20knew%20London%20like%20the%20back%20of%20his%20hand.

[39] Martinez, Julia. "Great Smog of London". *Encyclopedia Britannica*, August 10 2023, https://www.britannica.com/event/Great-Smog-of-London.

respiratory problems, exacerbating existing illnesses, and leading to a significant increase in hospitalizations and deaths. It is estimated that thousands of people died prematurely during this event, with vulnerable populations.

The Great Smog of London in 1952 dramatically raised awareness about the immediate and severe public health risks associated with industrial pollution. It also highlighted the broader environmental consequences of unchecked industrialization and pollution.[40] In the years following the smog incident, the British government introduced a series of laws and regulations aimed at reducing air pollution, including the Clean Air Act of 1956. These measures sought to limit coal burning in urban areas, promote cleaner fuels, and improve air quality.[41] While the incident primarily addressed air quality concerns and immediate public health risks, it is now recognized as a historical example of how industrialization. The release of pollutants from coal burning not only harmed human health but also had broader environmental implications, including the emission of greenhouse gases.

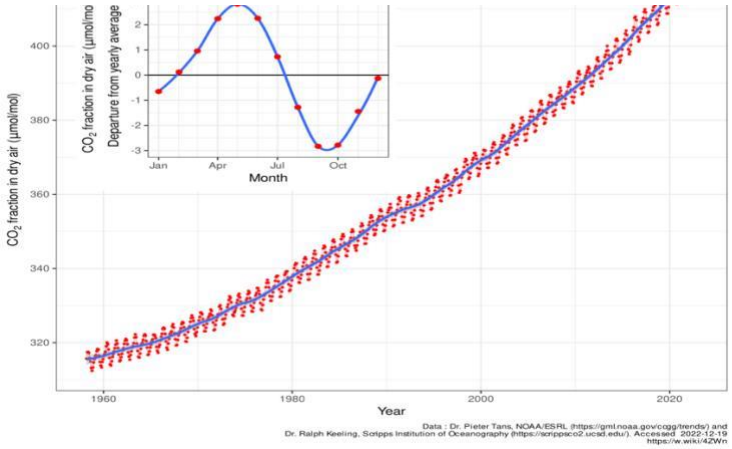
1.3.3 Keeling Curve (1958)

The Keeling Curve, named after Charles David Keeling, depicts the enduring pattern of increased CO2 concentrations in the atmosphere. This curve has been instrumental in advancing our comprehension of climate change induced by human activities and emphasizing the necessity for global cooperation in addressing this widespread issue. In 1958, Charles David Keeling initiated a ground breaking research initiative at the Mauna Loa Observatory in Hawaii, aiming to consistently measure the atmospheric concentration of CO2 over an extended duration. Keeling's research was meticulous and accurate, and he established a method for measuring atmospheric CO2 levels that has since become a standard in climate science. Mauna Loa Observatory was chosen for its remote location, far away from major sources of pollution and human activity, which made it an ideal site for measuring baseline atmospheric CO2 concentrations. The observatory is located at a high elevation, which reduces the influence of local sources of pollution on the measurements. Keeling's measurements consistently showed a clear and undeniable increase in atmospheric CO2 . This trend became known as the Keeling Curve. It demonstrated that concentration of CO2 was increasing steadily, and this increase was directly linked to the burning of fossil

[40] M. Martínez Euklidiadas, "The Great Smog of 1952, The Humanitarian Disaster That Changed the World," *Tomorrow City*, January 06, 2023, https://tomorrow.city/a/great-smog-london-air-pollution.

[41] Mister, Alan A. "Britain's Clean Air Acts." *The University of Toronto Law Journal* 20, no. 2 (1970): 268–73. https://doi.org/10.2307/824870.

fuels.[42] The Keeling Curve provided one of the most compelling and concrete pieces of evidence for human-induced climate change. It showed that the increase in CO2 levels in the atmosphere was unprecedented in geological history and was directly correlated with activities that release CO2 into the atmosphere. This buildup of CO2 acts as a greenhouse gas. The Keeling Curve's data reinforced the urgency of the climate change issue. It underscored that climate change was not a future problem but a present reality. It also highlighted the global nature of the challenge, as rising CO2 concentrations affected countries and ecosystems worldwide. This realization emphasized the need for countries to work together.[43] The Keeling Curve had a profound impact on policy discussions and international negotiations related to climate change. It played a crucial role in the lead-up to UNFCCC in 1992 and subsequent climate agreements. It provided a scientific foundation for setting emissions reduction targets and informed policymakers about the urgency of taking action.[44] The Keeling Curve, based on Charles David Keeling's meticulous measurements of atmospheric CO2 concentrations, provided compelling scientific evidence of human-induced climate change.



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[42] Robert Monroe, "The History of the Keeling Curve," *The Keeling Curve*, April 3, 2013, https://keelingcurve.ucsd.edu/2013/04/03/the-history-of-the-keeling-curve/#:~:text=The%20Keeling%20Curve%20is%20a,until%20his%20death%20in%202005

[43] Howe, Joshua P. "This Is Nature; This Is Un-Nature: Reading the Keeling Curve." *Environmental History* 20, no. 2 (2015): 286–93. http://www.jstor.org/stable/24690733.

[44] HOWE, JOSHUA P., ed. *Making Climate Change History: Documents from Global Warming's Past* (University of Washington Press, 2017), http://www.jstor.org/stable/j.ctvcwnkd5.

[45] Rafferty JP, "Keeling Curve," *Encyclopedia Britannica*, June 5, 2023., https://www.britannica.com/science/Keeling-Curve.

1.3.4 The First Earth Day Celebration (1970)

The first Earth Day, celebrated on April 22, 1970, was a pivotal event in the history of the modern environmental movement. It served as a catalyst for increased global environmental awareness and action, and it had important implications for international relations. Earth Day 1970 marked the birth of the modern environmental movement in the United States and beyond. The event brought together people from all walks of life who were concerned about environmental issues, including pollution, deforestation, wildlife conservation, and the impact of industrialization on the natural world. Earth Day played a critical role in raising public awareness about environmental challenges. It raised awareness among people regarding the repercussions of pollution and the deterioration of natural ecosystems. People understand that environmental problems were not confined to national borders but were global in nature, affecting the entire planet.[46] The widespread participation in Earth Day events exerted significant pressure on governments to address environmental concerns. People demanded that their governments take action to protect the environment and address issues. Earth Day's influence extended beyond domestic policy. It encouraged governments to incorporate environmental considerations into their foreign policy and international relations. Earth Day highlighted the interconnectedness of environmental issues across borders. Governments recognized that environmental problems often had transboundary or global impacts. This realization encouraged countries to cooperate on international environmental agreements and initiatives.[47]

Environmental concerns became a significant component of diplomatic relations between countries. Governments began to engage in negotiations and diplomacy to address shared environmental challenges, such as transboundary pollution, conservation of migratory species, and efforts to combat climate change. Environmental stewardship became a component of a nation's soft power and international reputation. Countries that demonstrated commitment to environmental protection and sustainability were often viewed more favourably on the global stage. The field of environmental diplomacy emerged, with diplomats and negotiators working on issues related to biodiversity conservation, climate change, ozone layer protection, and more. International environmental conferences and

[46] Sarah Gledhill, "Earth Day, The Largest Environmental Movement In History," *Florida Wildlife Federation*, April 21, 2023, https://floridawildlifefederation.org/earth-day-the-largest-environmental-movement-in-history/#:~:text=April%2022%2C%201970%20became%20the,water%20pollution%20were%20the%20norm.

[47] Hultgren, John, 'Earth Day Exclusions', *Border Walls Gone Green: Nature and Anti-immigrant Politics in America*, May 19 2016, https://doi.org/10.5749/minnesota/9780816694976.003.0001

summits became regular events in the diplomatic calendar. So, the first Earth Day increased global environmental awareness. This shift underscored the need for international cooperation to address environmental challenges that transcended national boundaries, making environmental diplomacy a critical aspect of international relations.

1.3.5 Global Climate Models (1970s)

The development of sophisticated Global Climate Models (GCMs) in the 1970s marked a significant milestone in climate science. These models, designed to replicate the Earth's climate system, have significantly contributed to our comprehension of climate change and its connection to global affairs. Global Climate Models are intricate computer programs that mimic the Earth's climate by integrating diverse factors like greenhouse gas concentrations. Models allow scientists to make predictions and projections about how the Earth's climate will respond to changes in these factors.

Global Climate Models are capable of projecting future climate trends based on different scenarios. By inputting diverse data, including future emissions of greenhouse gases, alterations in land use, and other factors, scientists can produce forecasts illustrating how the climate is expected to evolve over time. These projections offer crucial insights into the possible repercussions on global regions and ecosystems.[48] Outputs of GCMs serve as a scientific foundation for climate policy and decision-making. Policymakers, governments, and international organizations rely on the findings of climate models to understand the potential consequences.

Climate models help address issues of equity and responsibility among nations. They provide insights into which countries responsible for greenhouse gas emissions and which countries are most vulnerable to climate change.[49] Climate models foster international collaboration and diplomacy by providing a common scientific basis for negotiations. Countries can evaluate the collective impact of their actions and contributions to global emission reductions, enhancing trust and cooperation among nations. Over time, climate models are used to assess the progress made toward meeting emissions reduction targets and other climate goals outlined in international agreements. This evaluation helps hold countries accountable for their commitments.[50]

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[48] Zeke Hausfather, "Analysis: How well have climate models projected global warming?," *Carbon Brief*, October 5, 2017, https://www.carbonbrief.org/analysis-how-well-have-climate-models-projected-global-warming/.

[49] Chelsea Harvey, "Climate Models Got It Right on Global Warming," *Scientific American*, December 5, 2019, https://www.scientificamerican.com/article/climate-models-got-it-right-on-global-warming/.

[50] Stranadko, N, "Global climate governance: rising trend of translateral cooperation.," *Int Environ Agreements* 22, (2022): 639–657, https://doi.org/10.1007/s10784-022-09575-6

1.3.6 Intergovernmental Panel on Climate Change (IPCC) (1988)

The inception of the Intergovernmental Panel on Climate Change (IPCC) in 1988 represented a crucial turning point in the sphere of international relations regarding climate change. The IPCC has played a pivotal role in bridging the gap between science and policy, fostering international collaboration, and shaping the global response to climate change. Established by the United Nations in 1988, the IPCC's mandate is to evaluate scientific information related to climate change, bringing together scientists, experts, and policymakers worldwide to collaboratively assess climate science, impacts, and strategies for adaptation and mitigation. The primary objective of the IPCC is to regularly furnish policymakers with assessments covering the scientific underpinnings of climate change, potential impacts, and strategies for adaptation and mitigation. Acting as a liaison between the scientific community and governments, the IPCC translates intricate scientific findings into policy-relevant information.

Acknowledged as one of the most authoritative sources on climate change, the IPCC's assessment reports result from extensive reviews of numerous scientific studies and the consensus of experts. Policymakers and governments rely on the IPCC's assessments to make informed decisions about climate policy.[51] The IPCC fosters international collaboration by involving experts and representatives from numerous countries. Its Working Groups consist of scientists and experts from various regions and disciplines who work together to produce comprehensive reports. This collaborative approach promotes trust and cooperation among nations. IPCC reports directly inform international climate negotiations and agreements. They provide the scientific basis for setting emissions reduction targets, assessing progress, and developing adaptation strategies. Policymakers use the information from the IPCC to make evidence-based decisions on climate policy.[52] The IPCC's rigorous and transparent assessment process enhances its credibility. The open review and approval of its reports by governments ensure that the information presented is widely accepted. The IPCC also provides a platform for international negotiations by presenting the latest scientific findings on climate change impacts, risks, and potential solutions. It informs negotiations on issues like emission reduction targets, climate finance,

[51] "About IPCC," Intergovernmental Panel on Climate Change, https://www.ipcc.ch/about/#:~:text=Created%20in%201988%20by%20the,use%20to%20develop%20climate%20policies.

[52] "Intergovernmental Panel on Climate Change (IPCC) Negotiations," International Institute for Sustainable Development (IISD), https://enb.iisd.org/negotiations/intergovernmental-panel-climate-change ipcc?field_start_date_time_value=&field_end_date_time_value=&field_participants_target_id=&page=1.

and adaptation measures.[53] The IPCC's assessments continue to be instrumental in shaping climate policy.

1.3.7 Kyoto Protocol Implementation (1997-2005)

The Kyoto Protocol, ratified in 1997 and effective from 2005 to 2020, represented a significant international agreement with the purpose of tackling climate change. It obligated participating developed nations, known as Annex I countries, to curtail their greenhouse gas emissions. During the period spanning from 1997 to 2005 and the subsequent years leading up to the conclusion of the commitment period in 2012, Annex I countries engaged in a series of endeavors and initiatives to full fill their emissions reduction targets.

Under the Kyoto Protocol, Annex I countries were allocated specific emission reduction targets, often termed as "assigned amounts." These targets were determined based on their historical greenhouse gas emissions and their developmental status. The primary objective was a collective reduction in emissions by an average of 5.2% below 1990 levels during the commitment period lasting from 2008 to 2012.[54]To achieve their objectives, Annex I countries implemented a variety of national measures. These initiatives encompassed policies and actions focused on enhancing energy efficiency, promoting the utilization of renewable energy sources, transitioning to cleaner technologies, and mitigating emissions across sectors like industry, transportation, and agriculture. The Kyoto Protocol introduced flexible mechanisms, including emissions trading (commonly known as cap-and-trade) and the Clean Development Mechanism (CDM). Emissions trading facilitated the exchange of emissions allowances between countries, enabling those exceeding their targets to purchase surplus allowances from countries with excess.[55] An additional mechanism known as Joint Implementation (JI) permitted Annex I countries to invest in emissions reduction projects within other Annex I countries and obtain credits for the achieved emissions reductions. This approach fostered collaboration and facilitated the transfer of technology among developed nations.

During this period some countries made significant progress in reducing their emissions and meeting their targets. However, others struggled to achieve their goals. Factors influencing success or challenges included the strength of domestic policies, economic conditions, and

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[53] Jonathan Lynn, "The IPCC Role, History and Activities," *Cambodia*, May 27, 2019, https://apps.ipcc.ch/outreach/documents/455/1558921201.pdf

[54] "The Kyoto Protocol," *ScienceDirect*, https://www.sciencedirect.com/topics/earth-and-planetary-sciences/kyoto-protocol#:~:text=The%20Kyoto%20Protocol%2C%20a%20legally,(the%20first%20commitment%20period)

[55] "Kyoto Protocol," *United Nations Framework Convention on Climate Change*, https://unfccc.int/kyoto_protocol

the availability of low-carbon technologies. Implementation of the Kyoto Protocol required international collaboration and diplomacy. Countries engaged in negotiations to establish rules and guidelines for monitoring, reporting, and verifying emissions reductions, ensuring transparency and accountability.[56] The period after the Kyoto Protocol commitment period ended in 2012 marked a transition to a new phase of international climate action. The protocol was succeeded by the Paris Agreement in 2015, which established a more flexible and inclusive framework for climate action.[57] The efforts till 2005 included national measures, the use of market mechanisms like emissions trading and the CDM, and international collaboration to address climate change. While there were successes, the Kyoto Protocol experience also highlighted the complexity and challenges of global climate cooperation, ultimately contributing to the development of the more inclusive and flexible Paris Agreement.[58]

1.3.8 Copenhagen Accord (2009)

The Copenhagen Accord was a pivotal climate agreement reached during the United Nations Climate Change Conference held in Copenhagen in 2009 aimed to advance global climate commitments. Countries, both developed and developing, submitted voluntary emission reduction targets and mitigation actions. While these commitments were not legally binding, they marked a significant shift toward a more inclusive and transparent approach to climate action.[59] The agreement acknowledged the necessity of financial assistance to assist developing nations in dealing with the challenges of climate change. The Copenhagen Accord emphasized the importance of transparency and established a process for the measurement, reporting, and verification of emissions reductions, fostering accountability among nations. While not legally binding, the accord recognized the goal of limiting global temperature rise to 2 degrees Celsius above pre-industrial levels and included a reference to

[56] "Kyoto Protocol Mechanisms," *United Nations Framework Convention on Climate Change*, https://unfccc.int/process/the-kyoto-protocol/mechanisms.
[57] M. Kainumaa, Y. Matsuoka, and T. Morita, "Analysis of Post-Kyoto Scenarios: The AIM Model," *Global Environment Division, National Institute for Environmental Studies, 16-2 Onogawa, Tsukuba, 305-0053 Japan; Faculty of Engineering, Kyoto University, Yoshida-Honmachi, Sakyo-ku, Kyoto, 606-8501 Japan*, https://www.oecd.org/dev/1923103.pdf.
[58] Lindsay Maizland, "Global Climate Agreements: Successes and Failures," *Council on Foreign Relations*, November 4, 2022, https://www.cfr.org/backgrounder/paris-global-climate-change-agreements
[59] Veerabhadran Ramanathan and Yang yang Xu, "The Copenhagen Accord for Limiting Global Warming: Criteria, Constraints, and Available Avenues," *Proceedings of the National Academy of Sciences of the United States of America (PNAS)*, April 19, 2010, https://www.pnas.org/doi/10.1073/pnas.1002293107

considering a more ambitious target of 1.5 degrees Celsius. It included provisions related to reducing emissions from deforestation and forest degradation (REDD+).[60]

1.3.9 Cancun Agreements (2010)

The Cancun Agreements, reached during the 2010 United Nations Climate Change Conference in Cancun, Mexico, further solidified the international commitment to addressing climate change. These agreements built upon both the Bali Roadmap and the Copenhagen Accord and introduced several significant elements. The Cancun Agreements reaffirmed the importance of emission reduction targets and mitigation actions. Developed countries agreed to continue efforts to reduce emissions, while developing nations committed to taking voluntary mitigation actions, contributing to a more balanced global response.[61] Building on the Copenhagen Accord, the agreements established the Green Climate Fund (GCF) to channel climate finance to developing countries. This fund aimed to provide more predictable and sustained financial support for adaptation and mitigation efforts.

The accords emphasized the significance of adaptation measures and the transfer of technology to aid vulnerable nations in addressing the repercussions of climate change and adopting cleaner, more sustainable technologies. In alignment with the Copenhagen Accord, the Cancun Agreements acknowledged the importance of mitigating emissions from deforestation and forest degradation (REDD+), endorsing initiatives for forest conservation and sustainable management.[62] These agreements outlined a process for the periodic review of countries' emissions reduction efforts and financial commitments, promoting transparency and accountability.

1.3.10 International Agreements and Amendments

1.3.10.1 Paris Agreement (2015)

The Paris Agreement, ratified in 2015, stands as a pivotal international accord in the battle against climate change, marking a significant accomplishment in the realm of international

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[60] David B. Hunter, "Implications of the Copenhagen Accord for Global Climate Governance," *Sustainable Development Law & Policy* 10, no 2, Winter 2010: Climate Law Reporter, 2010, Article 5, American University Washington College of Law, https://digitalcommons.wcl.american.edu/cgi/viewcontent.cgi?referer=&httpsredir=1&article=1026&context=sdlp.

[61] "The Cancun Agreements," *United Nations Framework Convention on Climate Change*, https://unfccc.int/process/conferences/the-big-picture/milestones/the-cancun-agreements.

[62] "Key Decisions Relevant for Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD+): Decision Booklet REDD+," February 2016, https://unfccc.int/files/land_use_and_climate_change/redd/application/pdf/compilation_redd_decision_booklet_v1.2.pdf

relations and diplomacy. It signifies the global dedication to confronting one of the most urgent challenges of our era. Conceived as a response to the imminent threat of climate change, the Paris Agreement was negotiated within the framework of the United Nations Framework Convention on Climate Change (UNFCCC) and involves virtually every nation on the planet. This underscores the acknowledgment that climate change is a worldwide concern necessitating collaborative action.

The Paris Agreement establishes a framework for countries to establish and attain specific emissions reduction objectives. Each participating country, referred to as a Party to the agreement, submits its own nationally determined contribution (NDC), outlining its commitments to curbing greenhouse gas emissions. These objectives aim to restrict global warming to well below 2 degrees Celsius above pre-industrial levels and strive to limit it to 1.5 degrees Celsius. [63] In addition to endeavors for mitigation, the Paris Agreement places substantial emphasis on adapting to the impacts of climate change. It encourages nations to formulate and implement strategies for adapting to evolving climate conditions, fostering resilience in vulnerable communities and ecosystems. The agreement incorporates provisions for transparency and accountability, necessitating countries to regularly report on their emissions and progress toward their Nationally Determined Contributions (NDCs). This commitment to transparency fosters trust among nations and enables the assessment of collective efforts.

Recognizing the imperative for financial support in aiding developing countries to both mitigate and adapt to climate change, the Paris Agreement acknowledges the commitment of developed countries to mobilize financial resources for these endeavors. This financial support constitutes a crucial element of international cooperation. The negotiation of the Paris Agreement witnessed extensive diplomatic efforts and negotiations among countries with diverse interests and developmental levels, underscoring the significance of diplomacy and cooperation in addressing a complex, global challenge. [64] Within the Paris Agreement, there exists a mechanism for nations to periodically assess and elevate their Nationally Determined Contributions (NDCs). This mechanism, often referred to as "ratcheting-up," motivates countries to consistently amplify the ambition of their climate actions, cultivating

[63] "The Paris Agreement," *United Nations Framework Convention on Climate Change*, https://unfccc.int/process-and-meetings/the-paris-agreement.

[64] Todd Stern, "The Paris Agreement and Its Future," Brookings, October 2018, https://www.brookings.edu/wp-content/uploads/2018/10/The-Paris-Agreement-and-Its-Future-Todd-Stern-October-2018.pdf.

sustained international cooperation. [65] The Paris Agreement stands as a remarkable accomplishment in the field of international relations and diplomacy, symbolizing a worldwide commitment to combatting climate change through the establishment of specific emissions reduction and adaptation targets, the promotion of transparency and accountability, and the cultivation of international cooperation. The negotiation and adoption of the agreement exemplified the ability of nations to unite in addressing a shared global challenge, serving as a model for future international endeavors to confront complex issues through diplomacy and collaboration.

1.3.10.2 Kigali Amendment (2016)

The Kigali Amendment, adopted in 2016, stands as an international treaty extending the Montreal Protocol, a pivotal environmental agreement crafted to safeguard by discontinuing the production and use of substances that deplete the ozone layer, efforts are made to protect and preserve it. The amendment's significance lies in its targeted approach to addressing hydrofluorocarbons (HFCs), a category of synthetic chemicals extensively employed in air conditioning, refrigeration, and various applications. HFCs are potent greenhouse gases characterized by a high global warming potential, indicating their ability to trap heat in the atmosphere surpasses that CO2. In developing countries utilization is high as a consequence of the phase-out of ozone-depleting substances dictated by the Montreal Protocol. [66] Through its focus on HFCs, the amendment aims to combat climate change by substantially curtailing emissions of these highly potent greenhouse gases. The gradual reduction of HFCs holds paramount importance in the worldwide endeavour to restrict global warming and avert some of the most severe impact of climate change. Primary focus of the Montreal Protocol is on ozone depletion, the Kigali Amendment complements this protocol by guaranteeing that any substitutes for HFCs do not adversely affect the ozone layer, thereby upholding the environmental gains achieved by the original protocol.[67] Within the framework of the Kigali Amendment, nations that are part of the agreement pledge to progressively diminish both their production and consumption of HFCs. The phase-down

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[65] "Aligning with the Paris Agreement - Part 1," *UNFCCC*, https://unfccc.int/sites/default/files/resource/Aligning%20with%20the%20Paris%20Agreement%20-%20Part%201%20-%20CPI-I4CE.pdf.

[66] "Kigali Amendment (2016 Amendment to the Montreal Protocol Agreed in Kigali)," *United Nations Environment Programme*, https://ozone.unep.org/treaties/montreal-protocol/amendments/kigali-amendment-2016-amendment-montreal-protocol-agreed.

[67] "World Takes Stand Against Powerful Greenhouse Gases," *UNEP - United Nations Environment Programme*, https://www.unep.org/news-and-stories/press-release/world-takes-stand-against-powerful-greenhouse-gases-implementation

schedules are tailored to the country's level of development, with more developed countries taking earlier and more substantial actions, and developing countries having a longer timeframe for compliance. By adopting the Kigali Amendment, countries are taking a significant step towards addressing both climate change and ozone depletion. It exemplifies international cooperation to tackle environmental challenges and demonstrates how treaties like the Montreal Protocol can evolve to address new and emerging threats to our planet's environment.[68]

1.3.11 Major International Forums and Commitments

1.3.11.1 G7 and G20 Climate Commitments

The Group of Seven (G7) comprises some of the world's most advanced economies, including the United States, Canada, Japan, the United Kingdom, Germany, France, and Italy. Climate change has become a central focus of discussions and commitments within the G7. Member countries of the G7 have pledged to undertake ambitious actions in the fight against climate change, encompassing significant reductions in greenhouse gas emissions. Notably, many G7 nations have committed to achieving net-zero emissions by the middle of the century. G7 countries are also dedicated to providing financial support to developing nations, aiding in their climate adaptation and mitigation endeavors. This commitment extends to contributions to the Green Climate Fund and other climate finance mechanisms. G7 nations are actively investing in the development of renewable energy and clean technologies to transition away from fossil fuels. These efforts include the promotion of electric vehicles, the enhancement of energy efficiency, and substantial investments in renewable energy infrastructure.[69]

1.3.11.2 The Group of Twenty (G20)

The Group of Twenty (G20) is a larger forum, comprising 19 individual countries and the European Union. It includes a diverse range of economies, from highly industrialized nations to emerging economies. G20 discussions on climate change have often reflected the varying interests and challenges faced by member countries. The G20 has made declarations

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[68] "About the Montreal Protocol," UNEP - *United Nations Environment Programme*, https://www.unep.org/ozonaction/who-we-are/about-montreal-protocol#:~:text=Under%20the%20Kigali%20Amendment%2C%20actions,a%20truly%20unparalleled%20contribution%20to.

[69] "What Does the G7 Do?," *Council on Foreign Relations*, June 28, 2023, https://www.cfr.org/backgrounder/what-does-g7-do#:~:text=The%20G7%20is%20an%20informal%20bloc%20of%20industrialized%20democracies%E2%80%94the,international%20security%2C%20and%20energy%20policy.

recognizing the importance of climate action, but the specifics of these commitments can vary.

The G20 acknowledges the principle of "common but differentiated responsibilities," recognizing the distinct responsibilities and capacities of developed and developing countries in addressing climate change. This principle shapes the level of commitment member countries make to specific climate actions. G20 discussions frequently cover subjects pertaining to climate finance, the transfer of technology, and the provision of capacity-building support for developing nations. These discussions aim to address the financial and technological challenges faced by less economically advanced countries in their climate efforts.[70]

1.3.11.3 COP26 (Glasgow, 2021)

COP26, hosted in Glasgow, Scotland, in 2021, marked a crucial juncture in the worldwide effort to address climate change. Building on earlier COP conferences, most notably COP21 in Paris in 2015, which saw the adoption of the Paris Agreement, COP26 aimed to boost global commitment to climate action. Its key objectives included intensifying international efforts to restrict the rise in global temperatures to 1.5 degrees Celsius above pre-industrial levels and concluding the regulations and guidelines necessary for the effective implementation of the Paris Agreement.[71] Countries submitted updated or new Nationally Determined Contributions (NDCs) outlining their climate action plans. Many nations made more ambitious commitments to reduce emissions and address deforestation. COP26 resulted in commitments to enhance climate finance for developing countries, including mobilizing $100 billion per year in climate finance. Support for adaptation and mitigation efforts in developing nations was a significant focus. COP26 demonstrated both the challenges and the progress in international climate negotiations. While it resulted in significant commitments and agreements, it also highlighted ongoing debates and disagreements on issues like climate finance and carbon market rules. The conference saw active involvement from civil society groups and youth activists, who played a crucial role in holding leaders accountable and advocating for more ambitious climate action. COP26 emphasized the need for further global cooperation. It demonstrated that addressing climate

[70] James McBride, Anshu Siripurapu, and Noah Berman, "What Does the G20 Do?" *Council on Foreign Relations*, August 29, 2023, https://www.cfr.org/backgrounder/what-does-g20-do.

[71] "UK COP26," *The National Archives UK,* April 1, 2023, https://webarchive.nationalarchives.gov.uk/ukgwa/20230401054904/https://ukcop26.org/.

change is a complex and evolving process, requiring ongoing commitment and collaboration at the international level.[72]

1.4 Pakistan under the Influence of Climate change

1.4.1 Environmental Impact and Natural Resource Stress

Climate change manifests profound consequences on the Earth's environment, reflecting a complex interplay of political, economic, and social dynamics. The retreat of glaciers, water scarcity, and sea-level rise, all interconnected phenomena, are outcomes of both global temperature elevation and shifts in weather patterns. These changes pose intricate challenges, particularly within the framework of power relations and social inequality. As glaciers diminish, access to crucial freshwater resources becomes a matter of contention, intensifying existing disparities. Simultaneously, the melting ice contributes to rising sea levels, disproportionately impacting vulnerable coastal communities. The understanding and mitigation of these climate-induced changes are critical not just for environmental sustainability but also for addressing the underlying social and political dimensions, ensuring resilience for both ecosystems and human populations. Pakistan's northern regions, particularly in the Karakoram, Hindu Kush, and Himalayan mountains ranges, are experiencing significant glacial retreat due to global warming. [73]The Siachen Glacier, often referred to as the "Third Pole," is a stark example. This glacier is melting rapidly, impacting the Indus River system, which millions of Pakistanis rely on for their water needs. As glaciers shrink, they initially contribute to increased water flow, leading to glacial lake outburst floods (GLOFs) that pose immediate risks to communities downstream. However, in the long run, this glacial meltwater is depleting, potentially resulting in severe water shortages.[74] The glacial retreat, coupled with changing precipitation patterns, has led to water scarcity. The Indus River, Pakistan's lifeline, heavily relies on glacier meltwater. Reduced water flow from melting glaciers and uneven distribution of rainfall have resulted in severe

[72] "The Glasgow Climate Pact: Key Outcomes from COP26," *United Nations Framework Convention on Climate Change,* https://unfccc.int/process-and-meetings/the-paris-agreement/the-glasgow-climate-pact-key-outcomes-from-cop26#:~:text=UNFCCC%20Nav&text=And%20they%20collectively%20agreed%20to,be%20limited%20to%201.5%20degrees.

[73] Rasul, G., Q. Z. Chaudhry, A. Mahmood, K. W. Hyder, and Qin Dahe. "Glaciers and Glacial Lakes under Changing Climate in Pakistan," *Pakistan Journal of Meteorology* 8, no. 15, http://www.pmd.gov.pk/rnd/rnd_files/vol8_issue15/1_Glaciers%20and%20Glacial%20Lakes%20under%20Changing%20Climate%20in%20Pakistan.pdf.

[74] Arne Siegmund, "Climate change: Glaciers under surveillance," *ReliefWeb*, April 26, 2018, https://reliefweb.int/report/pakistan/climate-change-glaciers-under-surveillanc

water shortages in some regions.[75] For example, the Thar Desert in southern Pakistan faces acute water scarcity, leading to desertification and food insecurity. In urban areas like Karachi, where the population is rapidly increasing, water scarcity is a pressing concern, leading to disputes over water access.[76] While Pakistan's coastline stretches over approximately 1,046 kilo meters along the Arabian Sea, it is not as extensive as some other countries. Nevertheless, the escalation of sea levels presents a substantial risk to coastal communities and ecosystems. Take, for example, Karachi, where the rising sea levels lead to heightened intrusion of saltwater into freshwater reservoirs, impacting the city's water supply. Additionally, coastal regions with lower elevations face susceptibility to storm surges and flooding, placing communities in jeopardy and requiring costly installations of coastal defence infrastructure.[77]

Climate change is disrupting traditional monsoon patterns, leading to erratic and unpredictable monsoons in various regions around the world. This unpredictability manifests in two contrasting but equally devastating ways: increased instances of flooding and prolonged periods of drought. Climate-induced alterations in temperature and atmospheric conditions are causing shifts in monsoon behaviour, resulting in heavier, concentrated rainfall events that often lead to severe flooding. Simultaneously, prolonged dry spells during monsoon seasons contribute to extended droughts, compromising water availability for agriculture, ecosystems, and human populations. These difficulties highlight the pressing requirement for strategies. These strategies aim to tackle the intricate and ever-changing effects of climate change on monsoons and the broader hydrological cycle.

Pakistan heavily depends on the monsoon season for its water supply and agriculture. However, climate change has made monsoons more unpredictable. Variability in monsoon timing and intensity can disrupt agricultural cycles and water availability. For instance, in 2010, Pakistan had severe floods attributed to intense monsoon rains. The flood displaced millions of people and inflicted extensive damage on infrastructure and agriculture. Erratic monsoons, coupled with glacial meltwater, can result in devastating floods. These floods not

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[75] Alexandra Giese, Summer Rupper, Durban Keeler, Eric Johnson, and Richard Forster, "Indus River Basin Glacier Melt at the Subbasin Scale," *Frontiers in Earth Science* 10 (2022), https://doi.org/10.3389/feart.2022.767411.

[76] "REPORT ON PREVAILING DROUGHT LIKE SITUATION IN SINDH WITH PARTICULAR REFERENCE TO DISTRICT THARPARKAR," *National Disaster Management Authority (Government of Pakistan)*, November 2018, https://cms.ndma.gov.pk/storage/app/public/publications/October2020/nRprv5CCqFIhG5F9MblX.pdf.

[77] Golam Rabbani et.al, "The Impact of Sea Level Rise on Pakistan's Coastal Zones– in a Climate Change Scenario," *Conference Proceedings, 2nd International Maritime Conference 2008, Bahria University, Karachi*, March 2008, DOI: 10.13140/2.1.2353.9203.

only displaced millions of people but also damaged critical infrastructure like roads, bridges, and schools. The loss of crops and livestock exacerbated food insecurity and economic hardship for affected communities.[78] Reduced rainfall and higher temperatures have resulted in crop failures, livestock losses, and food insecurity. Droughts not only impact agriculture but also strain water resources, leading to conflicts over water access. The prolonged nature of droughts can have severe socioeconomic consequences, pushing communities deeper into poverty.[79]

Climate change disturbs habitats and ecosystems, causing changes in the distribution and behaviour of species. Certain species may face challenges in adapting or moving, leading to a decrease in biodiversity. Elevated temperatures can interfere with food chains and modify patterns of breeding and migration, resulting in declines in populations and potential extinctions. The decline in biodiversity carries widespread implications, impacting essential ecosystem services like pollination, water purification, and disease control, crucial for human well-being. Climate change exacerbates desertification, a process where fertile land becomes desert due to various factors, including prolonged droughts and soil degradation. Rising temperatures can intensify evaporation, leading to reduced soil moisture. Alterations in precipitation patterns can also contribute to desertification, as irregular and infrequent rainfall can hinder plant growth and lead to soil erosion. The encroachment of desertification poses a substantial menace to agriculture, food security, and the well-being of communities residing in impacted regions. Addressing these issues requires a multifaceted approach that includes mitigating greenhouse gas emissions to limit further climate change, implementing conservation measures to protect vulnerable species and habitats, and adopting sustainable land management practices to combat desertification. Failure to address these challenges not only threatens the planet's biodiversity but also has direct and indirect repercussions for human societies and economies.

Pakistan's diverse ecosystems, from lush Himalayan forests to the unique Indus Delta, are under threat from climate change. Rising temperatures, habitat degradation, and changing precipitation patterns are affecting various plant and animal species.[80] For instance, the melting of glaciers threatens the survival of iconic species like the snow leopard, which is

[78] Bob Henson, "Cruel Echoes of a 2010 Disaster in Pakistan's Catastrophic 2022 Floods," *Yale Climate Connections*, August 30, 2022, https://yaleclimateconnections.org/2022/08/cruel-echoes-of-a-2010-disaster-in-pakistans-catastrophic-2022-floods/.

[79] Ajani, A., van der Geest, K. Climate change in rural Pakistan: evidence and experiences from a people-centered perspective. *Sustain Sci* **16**, 1999–2011 (2021). https://doi.org/10.1007/s11625-021-01036-4

[80] Dr. Muhammad Ashraf, "Changing Climate and its Implications for Pakistan," *Hilal Online*, [https://www.hilal.gov.pk/eng-article/detail/NTMzOQ==.html

adapted to cold mountain environments. Furthermore, the heightened occurrence of extreme weather disturb ecosystems and jeopardize species that are particularly susceptible. In Pakistan, desertification emerges as a notable issue, especially in arid and semi-arid areas such as Thar and Cholistan. Climate change exacerbates this process by reducing rainfall and increasing temperatures, leading to land degradation. Overgrazing and unsustainable land use practices further contribute to desertification. As arable land turns into desert, it not only affects the environment but also has profound socio-economic impacts, including displacement of communities and loss of livelihoods.[81]

1.4.2 Human Sufferings

The escalating impact of climate change on the frequency and intensity of heatwaves globally reveals a nexus with political ecology dynamics. The rise in temperatures, driven by the accumulation of greenhouse gases, is not merely an environmental concern but intricately tied to socio-political factors. Vulnerable populations bear a disproportionate burden during prolonged periods of high temperatures, with heat-related illnesses and mortality becoming more prevalent. The strain on energy resources amplifies the socio-political vulnerability, as increased demand for cooling systems heightens the risk of power outages, affecting communities differently based on socio-economic factors.. Agricultural disruptions, damage to animal habitats, and the increased threat of wildfires create an intricate web of socio-ecological challenges. These manifestations of climate change intersect with power relations, social vulnerability, and resource distribution, emphasizing the need for nuanced socio-political analyses to address the multifaceted impacts of rising temperatures. Extreme heat have profound implications for both public health and the environment. The 2015 heatwave in Karachi serves as a poignant example of this phenomenon. Karachi, the largest city in Pakistan, endured a lethal heatwave, with temperatures soaring beyond 45°C (113°F). The unprecedented heat overwhelmed the city's healthcare facilities, resulting in a healthcare crisis. Hospitals were inundated with cases of heat-related illnesses, and the morgues were unable to cope with the number of bodies. 2015 heatwave resulted in the tragic deaths of over 1,200 people. Such heatwaves not only pose

[81] Shamsheir Haider, Fazlul Haq, Basit Nadeem, Malik Abuhala, and Raheem Baksh. "IMPACT OF DISASTERS ON NATURAL RESOURCES IN THE CHOLISTAN DESERT," *Pakistan Journal of Physical and Mathematical Sciences (PJPMS*) 1, no 2, 2022, Department of Geography, Bahauddin Zakaria University, Multan 60800, Pakistan. file:///Users/user/Downloads/Article+Shamsheir+Haider+final.edited.pdf

immediate health risks but also strain healthcare systems and infrastructure, making cities more vulnerable to future extreme heat events.[82]

Climate change has significant impact on health, including proliferation of vector-borne diseases. The warming climate and altered weather patterns are creating conditions conducive to the spread of disease-carrying vectors, leading to increased health risks for populations around the world. Altered rainfall patterns and warmer temperatures have the potential to extend the geographical reach of these vectors, exposing populations that were previously unaffected to diseases like malaria, dengue fever. Elevated temperatures can expedite the development of the malaria parasite within mosquitoes, potentially leading to heightened transmission rates. The warmer conditions can also broaden the geographic range of malaria-carrying mosquitoes to higher altitudes and previously unaffected regions. The spread of diseases, particularly vector-borne ones like malaria, dengue fever transmitted by insects such as mosquitoes and ticks, is significantly influenced by climate change. Changes in temperature and rainfall patterns can create conducive environments for disease vectors, leading to health risks for Pakistan's population. Dengue fever outbreaks in Pakistan's urban areas, such as Lahore and Karachi, have become increasingly common. Elevated temperatures and amplified rainfall establish optimal breeding environments for Aedes mosquitoes, the carriers of the dengue virus. The escalation in the presence of these vectors results in surges of dengue cases, imposing added pressure on healthcare systems. Vulnerable communities, often living in crowded urban neighbour hoods with inadequate sanitation and healthcare access, are at higher risk. Controlling these vector-borne diseases becomes more challenging as climate conditions become more favourable for disease transmission, making it a pressing public health concern.[83]

Climate change stands as a significant catalyst for migration, displacement, and social disparities, profoundly affecting communities and societies facing its impacts. As climate change disrupts ecosystems, intensifies resource scarcity, and triggers extreme weather events, many individuals find themselves compelled to leave their residences in pursuit of more secure and sustainable livelihoods. This type of migration is commonly termed as climate-induced or environmental migration. Climate change contributes to severity of

[82] I Masood, Z Majid el at, "The Deadly Heat Wave of Pakistan, June 2015." *International Journal of Occupational and Environmental Medicine (IJOEM)*6, no4 , (October 6 2015): 247–248, doi: 10.15171/ijoem.2015.672

[83] Katie Anders and Alex Jackson. "Is Dengue the Next Threat in Flood-Hit Pakistan?" *World Mosquito Program*, September 06, 2022,https://www.context.news/climate-risks/opinion/is-dengue-the-next-threat-in-flood-hit-pakistan

extreme weather events. These occurrences can result in abrupt and extensive displacement of populations, often leaving little time for preparation or relocation planning. The loss of livelihoods may drive people to migrate, either within their own countries or internationally, seeking new opportunities. Climate change-induced consequences have the potential to instigate population displacement and migration. This displacement can exacerbate social inequities and create complex challenges for affected communities. The Thar Desert in Pakistan is grappling with desertification and water scarcity due to climate change. As arable land diminishes and water resources dwindle, rural communities, particularly those dependent on agriculture, face severe economic hardships. In some instances, this leads to internal migration, with people relocating to urban areas in search of livelihood opportunities. However, these migrants often confront social and economic marginalization in cities, including inadequate access to education, healthcare, and basic services. This situation perpetuates a cycle of climate-induced displacement and social inequity, as those who are most vulnerable are least equipped to adapt.[84]

1.4.3 Economic Challenges and Infrastructure Vulnerability

Climate change, influencing global agriculture and food security, reflects a complex interplay of environmental, social, and political factors. The altered weather patterns and extreme events disrupt traditional farming practices, affecting staple crops and livestock. The increased incidence of pests and diseases is linked to changing climate conditions, contributing to agricultural losses. Shifts in precipitation patterns and glacier melting impact water access, revealing issues of resource control and distribution. The need for adjusting crop types and planting schedules highlights adaptive strategies influenced by social and economic factors. Livestock challenges underscore vulnerabilities in agricultural systems, shaped by socio-political dynamics. The shifts in marine ecosystems and their impact on coastal communities reveal the intricate relationship between climate-induced changes and societal well-being. The consequences of reduced food production, higher prices, and disrupted supply chains underscore the political and economic dimensions of climate-related food security risks, particularly affecting marginalized populations.

Pakistan's agricultural sector is exceptionally susceptible to climate change due dependence on seasonal rainfall and irrigation. Changes in temperature significantly impact crop yields and food security. Changing climate is affecting Pakistan's staple crop, wheat. Rising

[84] Salik, Kashif Majeed, Maryam Shabbir Abbasi and Khansa Naeem. 2020. "Climate Induced Displacement and Migration in Pakistan," December 31, 2020, https://sdpi.org/climate-induced-displacement-and-migration-in-pakistan/publication_detail

temperatures can reduce wheat yields, and irregular rainfall patterns can lead to water shortages for irrigation. In recent years, Pakistan has faced wheat shortages, leading to rising food prices and increased food insecurity. Such disruptions in crop production can have cascading effects on the entire food supply chain, affecting not only the availability of food but also its affordability, which particularly impacts vulnerable populations.[85]

Climate change carries substantial economic ramifications and can impact a country's GDP in various ways, arising from both direct and indirect consequences. Climate change can result in significant damage to infrastructure like roads, bridges, buildings, and utilities. The expenses incurred in repairing and reconstructing this infrastructure can be considerable, diverting resources from other productive investments and impeding GDP growth. Changes in temperature disrupts agriculture. Droughts, heatwaves, and excessive rainfall may lead to reduced crop yields and heightened food prices. Given agriculture's substantial contribution to many economies, disruptions in this sector can have a cascading impact on GDP. Treating climate-related health problems can escalate healthcare costs, straining healthcare systems and diminishing economic productivity.

Ecosystems, crucial for services like pollination, water purification, and flood control, face disruption due to climate change, resulting in increased costs for alternatives and potential economic losses when these services are unavailable. Climate-induced events can compel people to migrate or be displaced, leading to heightened demands on social services and infrastructure in receiving areas, potentially stressing local economies. As efforts toward climate change mitigation progress, a transition toward cleaner energy sources away from fossil fuels may occur. While essential for reducing greenhouse gas emissions, this shift can initially result in higher energy costs and job displacement in the fossil fuel industry, impacting regional economies. Climate change has significant economic implications for Pakistan. The disruptions caused by climate-related events can lead to direct and indirect economic losses, affecting the country's Gross Domestic Product (GDP). Flooding events in Pakistan, like the 2010 flood, have resulted in substantial economic losses. The destruction of infrastructure, damage to agriculture, and displacement of communities all contribute to economic downturns. In 2010 alone, the economic losses from the floods were estimated at around $10 billion, equivalent to approximately 5% of Pakistan's GDP at the time. These

[85] Chaudhry, Qamar Uz Zaman. "Climate Change Profile of Pakistan." *Asian Development Bank*, https://www.adb.org/sites/default/files/publication/357876/climate-change-profile-pakistan.pdf.

losses can set back economic development efforts, diverting resources away from long-term development goals and exacerbating poverty and inequality.[86]

Climate change also effects infrastructure worldwide. As climate continues to change, the vulnerability of various types of infrastructure increases due to a range of environmental factors. Rising sea levels can affects coastal infrastructure such as ports, airports, roads, and bridges. It also threatens critical facilities like power plants and water treatment plants located near coastlines. Heavy rainfall flooding weakens foundations and wash out roads and bridges, while high winds can damage buildings and power lines. Rising temperatures can cause heat-related damage to infrastructure. High temperatures can lead to the expansion of materials like asphalt and cause roads to buckle. Extreme heat can also strain power grids as demand for cooling increases. Changes in precipitation patterns, including prolonged droughts or heavy rainfall, can affect the reliability of water supply systems, reservoirs, and dams. Droughts can reduce the availability of water for agriculture and urban use, impacting food production and economic activities. Storm surges associated with hurricanes and cyclones can inundate low-lying coastal areas and damage infrastructure, especially in areas with poor flood defences. Storm surges can also breach levees and flood protection systems. The infrastructure in Pakistan, encompassing roads, bridges, and energy systems, is susceptible to the repercussions of climate change. Climate-resilient development is necessary to mitigate these risks. The vulnerability of infrastructure was evident during the 2010 flood. Thousands of kilo meters of roads and railways were washed away, cutting off communities and disrupting supply chains. Furthermore, the energy sector is susceptible to climate change, as higher temperatures can reduce the efficiency of thermal power plants, leading to power shortages during heatwaves.[87] To address these vulnerabilities, Pakistan needs to invest in climate-resilient infrastructure, develop flood defences, and diversify its energy sources to ensure a reliable supply, even in the face of extreme weather events.

Pakistan heavily relies on hydropower as a key source of electricity generation, with major dams and reservoirs strategically located across the country. Hydropower plants utilize the flow of water to generate electricity. However, climate change-induced alterations in precipitation patterns, glacier melt, and shifts in river flow can substantially affect water availability, resulting in reduced hydropower generation. The Tarbela Dam and the Mangla

[86] Mumtaz, Jazib. "Economic Impact of Floods in Pakistan." *Tribune*, September 08, 2022, https://tribune.com.pk/story/2375390/economic-impact-of-floods-in-pakistan.

[87] "Pakistan Floods 2010 Preliminary Damage and Needs Assessment," *Asian Development Bank*, November 2010, https://www.adb.org/sites/default/files/linked-documents/44372-01-pak-oth-02.pdf.

Dam, situated on the Indus River, are pivotal sources of hydropower generation in Pakistan. Reduced water flow in the Indus River due to irregular glacier melt and changing precipitation patterns has, at times, led to diminished electricity production. This has profound consequences for Pakistan's energy sector and overall economy. Energy stress emerges as a consequence, manifesting as power shortages and an increased reliance on fossil fuels for electricity generation.[88] Not only does this exacerbate greenhouse gas emissions, but it also leads to higher energy costs for consumers, affecting both industries and households. Energy stress disrupts daily life, hampers economic growth, and strains energy resources, making it a pressing challenge for Pakistan to address. As temperatures rise due to climate change, particularly during heatwaves, the demand for cooling and air conditioning surges. People turn to cooling solutions to maintain habitable indoor temperatures, which places additional stress on the energy grid. Karachi, Pakistan's largest city, faced a severe heatwave in 2015, with temperatures soaring above 45°C (113°F). Homes, businesses, and industries rely heavily on these technologies to provide respite from the scorching heat. This heightened cooling demand strains the energy grid, leading to power outages and rolling blackouts. The interruptions in power supply not only cause inconvenience to the general population but also pose health risks, especially for vulnerable groups like the elderly and individuals with medical conditions. Additionally, the heightened demand for energy to support cooling systems frequently depends on fossil fuels, such as coal and natural gas, which release greenhouse gases, thereby contributing to the ongoing issue of global warming. This creates a problematic feedback loop where extreme heat exacerbates energy demand, leading to power shortages, which further impact the well-being and productivity of the population.

Conclusion

This chapter thoroughly explores climate change, looking at it globally and then focusing on how it affects Pakistan. We learn about the history of climate change, understanding that it's always changing and needs urgent attention. When we turn our attention to Pakistan, we see how rising temperatures and unusual weather patterns create many problems in different areas. The chapter emphasizes the urgent need for specific actions to help Pakistan adapt to these changes. In summary, the chapter says that while climate change is a global issue, its effects are seen locally, especially in Pakistan. Pakistan's situation is like a small version of

[88] Shahmir Janjua, Ishtiaq Hassan and Afzal Ahmed, "Water management in Pakistan's Indus Basin: challenges and opportunities," *Water Policy* 23, no. 6 (December 1, 2021): 1329–1343, https://doi.org/10.2166/wp.2021.068.

the bigger climate crisis, showing that we all need to work together to solve this problem. The chapter provides detailed examples of how climate change impacts specific places and communities, stressing the importance of tailored solutions. It also talks about how countries worldwide are working together to fight climate change, discussing what has worked well and what hasn't. The role of technology is explored, showing how new ideas can help us respond to climate change sustainably. The chapter also looks at how climate change connects with social justice, highlighting that some communities are more affected than others. It calls for a fair and inclusive approach to solving these climate challenges. This chapter lays the groundwork for upcoming sections, which will go deeper into topics like disaster plans, policies, and community efforts to stay strong in the face of climate issues.

Chapter 2

Climate Change and the 2010 & 2022 Floods in Pakistan

Introduction

Floods have been a recurrent and devastating natural disaster in the South Asian region forcenturies, and Pakistan's susceptibility to these catastrophic events is no exception. The country's geographical location plays a pivotal role in its vulnerability, as it is situated in a region where monsoon patterns and the convergence of major rivers create a perfect storm for flooding. Moreover, intricate interplay of socio-economic elements, encompassing swiftpopulation expansion, haphazard urbanization, deforestation, and insufficient infrastructure,exacerbates the consequences of floods on communities in Pakistan.[89]Over the years,Pakistan has experienced a series of significant flood events, but two stand out for their sheermagnitude and impact: the catastrophic floods of 2010 and the more recent inundation of 2022. These two events provide a unique opportunity for a comparative analysis, as they occurred twelve years apart, allowing us to assess the evolution of the nation's response mechanisms overall resilience in the face of such disasters. By delving into the background causes and contributing factors behind these floods, this chapter seeks to unravel the complexities surrounding flood management in Pakistan, while also shedding light on the far-reaching consequences.

2.1 The Case Study of the 2010 Pakistan Flood Disaster

The catastrophic natural disaster in Pakistan in 2010 resulted from heavy monsoon rains, glacier melting, and insufficient infrastructure, leading to devastating floods. This prolonged and exceptionally heavy rainfall led to rivers overflowing and flooding vast areas. Approximately 20 million people were affected, losing homes, livelihoods, and possessions. Slow response from authorities and aid agencies compounded the crisis, and disease outbreaks added to the suffering. Efforts were made to improve disaster preparedness and recovery, with international assistance playing a crucial role in aiding affected communities. Overall, the 2010 Pakistan floods underscored the need for disaster preparedness, climate change mitigation, and international cooperation in addressing such catastrophic events. The causative factors and impacts of flood 2010 are discussed below.

2.1.1 Causative Factors of 2010 Flood

The destructive natural disaster in Pakistan in 2010 was shaped by a complex interplay of factors. These floods were primarily set in motion by intense and prolonged monsoon rains, resulting in widespread flooding and effect infrastructure and agriculture. However, the magnitude of the calamity was heightened by political factors, such as inadequate water management and governance issues, leaving the nation unprepared for the crisis. Social factors were also at play, with vulnerable populations, particularly those in low-lying areas

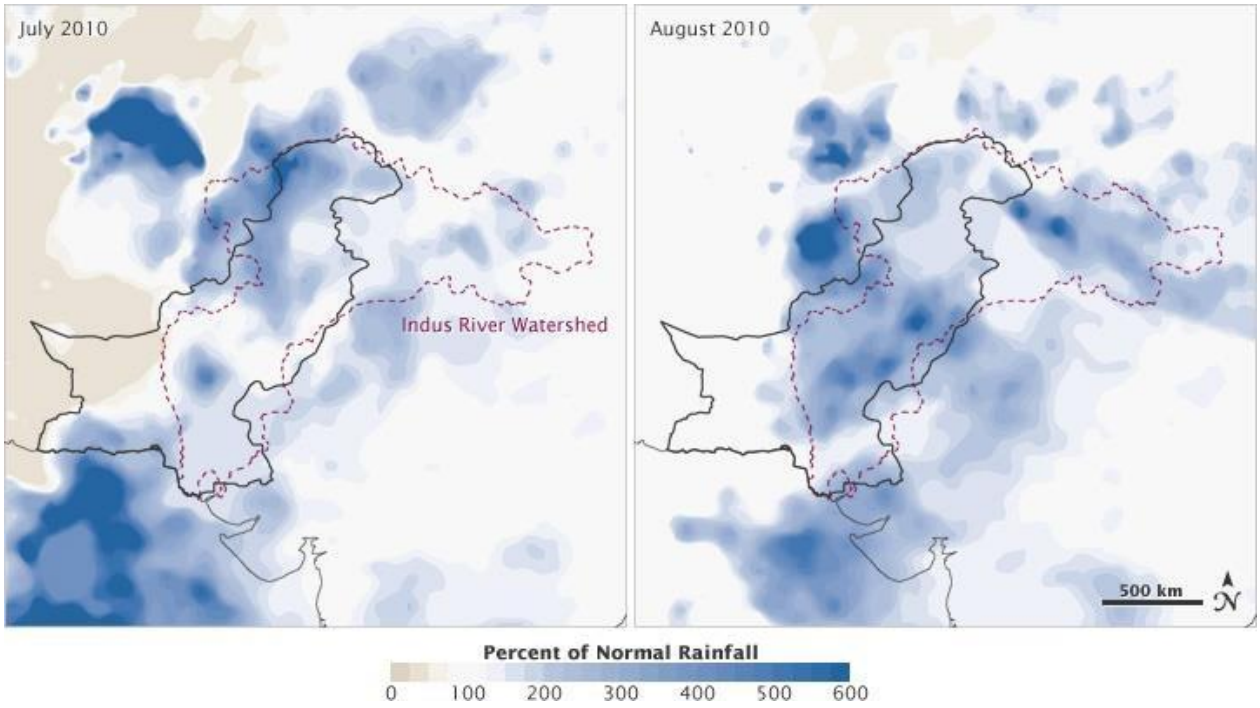
[89] Ayaz Gul, "Flood-Ravaged Pakistan Among 5 Nations 'Least Resilient' to Disasters," Voice of America News, September 23, 2022, https://www.voanews.com/a/flood-ravaged-pakistan-among-5-nations-least-resilient-to-disasters/6760177.html.

and informal settlements, facing disproportionate hardships due to limited access to resources and healthcare. The 2010 flood in Pakistan highlighted the need for comprehensive disaster management and mitigation strategies that take into account the complex interplay of environmental, political, social, and economic factors to better prepare for and respond to such calamities.

2.1.1.1 Environmental Factors

The unusually intense monsoon rains in 2010 had widespread effects on multiple areas of Pakistan, with the most devastating outcomes observed in the provinces of Khyber Pakhtunkhwa, Punjab, and Sindh. These regions underwent prolonged and exceptionally heavy rainfall, resulting in catastrophic flooding. Situated in the north western part of Pakistan, this province bore severe consequences due to the monsoon rains in 2010. The heavy rainfall led to the Swat River and other water bodies overflowing their banks. The flooding in the Swat Valley inundated towns and villages, causing extensive damage to infrastructure and displacing thousands of residents. Punjab, a province in eastern Pakistan, also faced significant consequences due to the heavy monsoon rains. Excessive rainfall overwhelmed the drainage systems in cities like Lahore. Urban areas experienced severe flooding, which not only damaged property but also disrupted daily life for residents. The southern province of Sindh, particularly Karachi, Pakistan's largest city, experienced devastating flooding as well. The rainfall exceeded the capacity of drainage systems in Karachi, leading to urban flooding and waterlogged streets. This had a profound impact on the city's residents and businesses.[90]

[90] Editors of Encyclopedia Britannica, "Pakistan Floods of 2010," Encyclopedia Britannica, March 21, 2023, https://www.britannica.com/event/Pakistan-Floods-of-2010.



Source: Earth Observatory

During the 2010 monsoon, some areas in these regions received more than ten times their typical rainfall. This excessive precipitation was well beyond the capacity of the land and infrastructure to absorb or manage. In Khyber Pakhtunkhwa, the heavy rainfall caused rivers like the Swat River to burst their banks. This resulted in the inundation of towns and villages along the riverbanks, leading to extensive damage to homes, farmlands, and critical infrastructure. In Punjab and Sindh, the qualitative data showed that the rainfall overwhelmed the urban drainage systems, causing widespread urban flooding. In cities like Lahore and Karachi, streets turned into rivers, and buildings and vehicles were submerged, creating a challenging situation for city dwellers. The 2010 monsoon in Pakistan was exceptional not only for the volume of rain but also for its prolonged duration. The monsoon persisted for weeks, continuously feeding water into the rivers. This extended period of rainfall exacerbated the flooding, as it allowed rivers to swell and remain at flood stage for an extended period. The combination of heavy, continuous rainfall and prolonged monsoon resulted in massive flooding. Rivers reached unprecedented levels, affecting a vast area of land. This flooding persisted for an extended duration, making it difficult for affected communities to recover and rebuild.[91]

The occurrence of GLOFs was indeed a significant contributing factor to the devastating floods in Pakistan in 2010. The Himalayan region is home to numerous glaciers, which are

[91] Michon Scott, "Heavy Rains and Dry Lands Don't Mix: Reflections on the 2010 Pakistan Flood," Earth Observatory, NASA, April 6, 2011, https://earthobservatory.nasa.gov/features/PakistanFloods.

crucial sources of freshwater for the rivers and communities downstream. Over time, rising temperatures, primarily attributed to climate change, have accelerated the melting of these glaciers. As glaciers melt, they give rise to glacial lakes in the mountain valleys.[92] The increasing global temperatures led to accelerated glacier melt in the Himalayas. As glaciers retreated, they left behind depressions in the landscape, which filled with meltwater, forming glacial lakes. These lakes are typically dammed by ice or moraine, natural barriers composed of rocks and debris. GLOFs occur when the natural barriers holding back the water in glacial lakes give way or are breached. This can happen due to various triggers, including increased pressure from the accumulating meltwater, erosion of the dam, or even seismic events. When a GLOF occurs, it results in the sudden and massive release of water from the glacial lake.[93] In 2010, the acceleration of glacier melts in the Himalayan region was a significant factor. This increased volume of water stored in glacial lakes, making them more susceptible to outburst events. When glacial lakes overflowed or burst their natural dams, they released a tremendous volume of water downstream. The increased melting of glaciers and the heightened risk of GLOFs have become pressing concerns at Himalayan region due to ongoing climate change. As temperatures continue to rise, glaciers will likely continue to shrink, leading to the formation of more glacial lakes. This poses an ongoing threat of GLOFs and the potential for future flooding events.[94]

Over time, rivers naturally accumulate sediment and silt as a result of erosion, weathering, and the flow of water. This sediment settles at the bottom of the riverbed, gradually filling up the available space. The process of siltation is typically slow and continuous. As sediment and silt accumulate in riverbeds, they reduce the natural capacity of the river to carry water. Essentially, the riverbed becomes shallower, and the volume of water the river can hold without overflowing decreases. This is particularly problematic during periods of heavy rainfall or high water flow.[95] During the heavy monsoon rains of 2010, the reduced capacity of the rivers due to siltation made them more prone to overflowing. When intense rainfall

[92] Fran, "The Causes and Impacts of the Melting Himalayan Glaciers," FutureLearn India, FutureLearn Local, April 22, 2021, https://www.futurelearn.com/info/futurelearn-international/causes-impacts-melting-himalayan-glaciers.

[93] Ben Clarke, Friederike Otto, and Luke Harrington, "Pakistan Floods: What Role Did Climate Change Play?" Down to Earth, Monday, September 5, 2022, https://www.downtoearth.org.in/blog/climate-change/pakistan-floods-what-role-did-climate-change-play--84727.

[94] Ben Clarke, Friederike Otto, and Luke Harrington, "Pakistan Floods: What Role Did Climate Change Play?", September 5, 2022, https://www.socsci.ox.ac.uk/article/pakistan-floods-what-role-did-climate-change-play.

[95] "The Sediment Problem," *Flood Control Series, No.* 5, United Nations, https://repository.unescap.org/bitstream/handle/20.500.12870/3604/ESCAP-1953-RP-sediment-problem.pdf?sequence=1&isAllowed=y.

occurred, the rivers couldn't accommodate the increased water volume effectively, leading to rapid rises in water levels and subsequent flooding.[96] The provinces of Punjab and Sindh were particularly vulnerable to the impact of riverbed siltation. These regions are crisscrossed by major rivers like the Indus and its tributaries, which had experienced significant siltation over the years. 97As a result, when the 2010 monsoon brought heavy rains, the rivers in these provinces had limited capacity to handle the increased water flow. Deforestation can increase soil erosion, leading to more sediment being carried into rivers. Changes in land use, such as urbanization and agriculture, can alter the natural flow of water and contribute to silt deposition in rivers. The accumulation of sediment in riverbeds contributed to the severity of the flooding in 2010. When rivers overflowed due to siltation, they inundated surrounding areas, causing extensive damage to homes, farmlands, and infrastructure.

2.1.1.2 Political Factors

The floods in Pakistan were profoundly influenced by poor governance and corruption, crucial factors that magnified the disaster's impact. Within a framework of inadequate governance, resources were mismanaged, leading to inefficient allocation for disaster preparedness and response. This failure in governance manifested in insufficient funding for essential projects related to flood control, early warning systems, and disaster management agencies. The pervasive corruption further intensified the crisis as funds earmarked for infrastructure development were unlawfully diverted, resulting in the implementation of substandard or incomplete projects. The intricate interplay of political decisions, resource allocation, and corrupt practices underscored how environmental challenges are deeply entwined with the socio-political dynamics, echoing the central tenets of political ecology. This lens highlights the need for a comprehensive understanding of the political landscape to address the environmental repercussions of natural disasters effectively.[98] The Mangla Dam, a crucial reservoir in Pakistan serving multiple purposes, including flood control, experienced corruption and mismanagement in its construction and maintenance over the

[96] Dr. Syeda Benish Ali, "Floods in Pakistan: Wrath of Nature or Man-Made Calamity?" Stratagem, accessed September 20,20203,https://stratagem.pk/cover-story/floods-in-pakistan-wrath-of-nature-or-man-made-calamity/.

[97] Muhammad Irfan et.al, "Vulnerability of Environmental Resources in Indus Basin after the Development of Irrigation System" (June 25, 2019), https://www.intechopen.com/chapters/67846.

[98] Nouman Khadim et.al, "Effects of Corruption on Infrastructure Projects in Developing Countries," Researchgate, May 2021, https://www.researchgate.net/publication/351528989_Effects_of_Corruption_on_Infrastructure_Projects_in_Developing_Countries.

years. Funds meant for maintenance and repairs were not effectively used, potentially reducing the dam's capacity to control flooding during the monsoon. Inefficient governance and corruption led to the construction of poorly designed embankments along rivers. Such embankments could not withstand the pressure of rising water levels, and they breached or failed during heavy flooding. These breaches resulted in sudden and devastating floods, affecting communities downstream. Inefficient governance also affected disaster management agencies' ability to respond effectively during floods. Delays in mobilizing resources, lack of coordination, and mismanagement of relief efforts worsened the impact of flooding, leading to delays in providing essential aid to affected populations.[99] Inefficient governance and corruption also resulted in a lack of disaster preparedness. This included the absence of well-maintained early warning systems, inadequate training of disaster response teams, and insufficient planning for flood mitigation strategies. Without proper preparedness, the response to disasters like the 2010 flood was chaotic and ineffective.[100]

Inadequate infrastructure, characterized by poorly designed and maintained dams, embankments, and drainage systems, was a significant contributing factor to the 2010 flood in Pakistan. In many cases, the infrastructure in Pakistan was not adequately designed to handle the scale of the floods experienced in 2010. This includes dams, embankments, and drainage systems that were not built to accommodate exceptionally heavy rainfall or the rapid melting of glaciers. Political decisions related to infrastructure investment and priorities can influence the vulnerability of certain areas to flooding. In some instances, there may have been a lack of investment in resilient infrastructure projects that could have better protected communities from the impacts of flooding. Pakistan has several dams and reservoirs used for water storage and flood control. However, some of these dams may not have been adequately maintained or upgraded to handle the increased water volumes associated with the 2010 monsoon.

Embankments along rivers are essential for preventing floodwaters from inundating surrounding areas. However, poorly constructed or maintained embankments can be vulnerable to breaches during heavy flooding. In some cases, political decisions may have led to substandard construction or a lack of maintenance. The breach of embankments in 2010 contributed to the extensive flooding in affected regions. Urban areas, especially cities

[99] Kiyya Baloch, "Pakistan's Floods Are a Man-Made Disaster," The Diplomat, September 25, 2022, https://thediplomat.com/2022/09/pakistans-floods-are-a-man-made-disaster/.

[100] "Pakistan Floods 2010: Preliminary Damage and Needs Assessment," November 2010, https://www.adb.org/sites/default/files/linked-documents/44372-01-pak-oth-02.pdf.

like Karachi and Lahore, heavily rely on drainage systems to manage excess rainwater. However, inadequate drainage systems can lead to urban flooding. Political decisions related to urban planning and infrastructure development may have resulted in insufficient drainage capacity in some cities, exacerbating the impact of heavy monsoon rains.[101] Inadequate infrastructure exacerbated the severity of the 2010 flood. When critical flood control structures failed or were overwhelmed, floodwaters spread rapidly, affecting communities, farmlands, and critical infrastructure.[102]

Political decisions regarding land use policies, encompassing zoning regulations and building permits, wield a direct influence on the patterns and nature of development. This impact becomes particularly evident when construction is permitted in areas prone to floods, exposing communities to risks during intense rainfall events. The inadequate enforcement of zoning regulations and urban planning leads to unregulated urban development in zones vulnerable to flooding. When these regulations lack effective enforcement, it allows for the construction of residential, commercial, and essential infrastructure in regions susceptible to floods. In numerous Pakistani cities, rapid and unplanned urban expansion has transpired without due consideration of flood risk. A notable example is Karachi, the nation's largest city, where substantial urban sprawl into low-lying areas and floodplains has heightened its vulnerability to urban flooding. This perspective, rooted in the understanding of political ecology, unveils the intricate connections between political decisions, land-use practices, and environmental vulnerabilities and need to address the environmental implications of such decisions .[103] In some cases, political decisions have allowed informal settlements to develop in areas prone to riverbank erosion and flooding. These settlements lack proper infrastructure and are highly vulnerable during floods.[104]

In some regions, deforestation and changes in land use practices, driven by political decisions or lax enforcement, have increased soil erosion and the runoff of rainwater into rivers. This contributes to higher water levels during heavy rains, worsening the flood risk. Land use policies that permit construction in flood-prone areas and weak enforcement of

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[101] Government of Pakistan Ministry of Water and Power, "Annual Flood Report 2010," https://mowr.gov.pk/SiteImage/Misc/files/2010%20Annual%20Flood%20Report%20of%20FFC(1).pdf.

[102] Ahsan Abbas, Eatzaz Ahmed, and Fazal Husain, "Political and Economic Uncertainty and Investment Behavior in Pakistan," The Pakistan Development Review 58, no. 3 (2019): 307-331], https://www.jstor.org/stable/27125028.

[103] Mir Sher Baz Khetran, "Issue Brief on 'Urban Flooding in Pakistan,'" August 8, 2023, https://issi.org.pk/issue-brief-on-urban-flooding-in-pakistan/.

[104] Fawad Yousafzai, "Pakistan: Provinces asked to remove encroachments in river waterways," PreventionWeb, June 27, 2019, https://www.preventionweb.net/news/pakistan-provinces-asked-remove-encroachments-river-waterways.

regulations directly contributed to 2010 flood. Urban development at vulnerable zones increased the exposure of communities to floodwaters, resulting in extensive damage and displacement. Political priorities and development decisions can influence where infrastructure and housing projects are undertaken. In some cases, the focus may have been on short-term economic gains from construction rather than considering the long-term consequences of flooding.

2.1.1.3 Economic Factors

The devastating floods in Pakistan in 2010 were exacerbated by deforestation, especially in the northern regions of the country. Deforestation, driven primarily by economic activities like logging and expanding agriculture impacts floods . Northern regions of Pakistan, such as KPK and parts of Azad Jammu and Kashmir (AJK), witnessed extensive deforestation over the years. Trees in these areas help absorb and store large quantities of rainwater, acting like natural sponges during heavy rainfall events.[105] However, as forests were cleared for timber and agricultural expansion, this vital function was compromised. In Khyber Pakhtunkhwa (KP), extensive deforestation in the Swat Valley and other areas significantly reduced the region's capacity to absorb rainwater. When heavy monsoon rains hit in 2010, this contributed to the massive flooding in KP. In Azad Jammu and Kashmir (AJK), similar deforestation occurred in regions like Neelum Valley. The loss of forest cover made these areas more vulnerable to flooding during the 2010 disaster. With the loss of forest cover, the ability of the land to absorb and hold rainwater was greatly diminished. Instead of being soaked up by trees and forested areas, rainwater began running off the deforested slopes more rapidly.

The accelerated surface runoff from deforested areas led to a higher volume of water entering rivers has surge the water flow made rivers swell and overflow their banks more easily during heavy rain, increasing the risk of flooding. The rivers flowing from the northern regions, including Indus River, made their way downstream through various provinces and cities, such as Punjab and Sindh. As the floodwaters reached these lower-lying areas, they had already gained significant momentum due to the increased surface runoff, which made the flooding more severe and widespread. The Indus River, which flows through multiple provinces, including Punjab and Sindh, experienced higher water levels and increased flooding due to the amplified water flow from deforested upstream areas. The rise in surface

[105] Muhammad Tariq and Riffat Aziz, "An Overview of Deforestation Causes and Its Environmental Hazards in Khyber Pukhtunkhwa," *Journal of Natural Sciences Research* 5, no. 1 (2015): 52, https://core.ac.uk/download/pdf/234655483.pdf.

runoff due to deforestation exacerbated the magnitude and intensity of the 2010 flood in Pakistan, impacting millions of individuals and resulting in widespread damage to residences, infrastructure, and agriculture. It explains how the economic pursuit of logging and agriculture can have significant and far-reaching environmental consequences, ultimately leading to devastating natural disasters like floods.[106]

According to the lens of Green Political Theory the devastating floods in Pakistan in 2010 were further compounded by a combination ofurbanization, land development, and infrastructure projects. Rapid urbanization andeconomic growth often lead to the expansion of cities and construction in areas that aresusceptible to flooding. In many cases, infrastructure development includes the constructionof roads, buildings, and parking lots. These non-absorbent surfaces hinder the absorption ofrainwater into the ground, leading to swift runoff during periods of heavy rainfall. In the cityof Nowshera, Khyber Pakhtunkhwa (KP), urbanization and land development hadencroached upon floodplains and low-lying areas. This reduced the natural capacity of theseregions to absorb excess rainfall. When the heavy monsoon rains arrived in 2010, the cityexperienced severe flooding, displacing thousands of residents and causing extensivedamage to infrastructure.[107] While infrastructure projects like dams, levees, and bridges canprovide economic benefits, they can also alter natural river systems and potentiallyexacerbate flood risks. Poorly designed or maintained infrastructure can fail during extremeflood events, intensifying the impact on downstream communities. The Tarbela Dam, oneof the largest earth-filled dams in the world, is located on the Indus River in Pakistan. Whileit serves important purposes like irrigation and electricity generation, its role in the 2010 flood was complex. The dam's operators had to release water to prevent the dam from overflowing, which added to the floodwaters downstream. Additionally, the presence of the dam altered the natural flow of the river, potentially contributing to increased flood risk in certain areas. The combination of rapid urbanization, land development in flood-prone areas, and infrastructure projects like dams played a significant role in the 2010 Pakistan floods.

The concentration of economic activities like manufacturing, agriculture, and real estate development in areas prone to flooding can significantly exacerbate the economic losses and disruption caused by floods. Pakistan's agricultural sector is a vital component of its economy, and many agricultural activities are concentrated in fertile floodplains along rivers

[106] Inam Rahim, "Human Amplification of Climate Hazards: 2010 Floods in Pakistan," Academia, accessed September 22, 20203 , https://www.academia.edu/30913299/Human_amplification_of_climate_hazards_2010_floods_in_Pakistan.

[107] "One-third Area of KP Vulnerable to Floods," Dawn, August 9, 2011, August 6, 2011,

https://reliefweb.int/report/pakistan/one-third-area-kp-vulnerable-floods.

like the Indus. These areas are highly susceptible to seasonal monsoon flooding. When the floods of 2010 hit, large swaths of agricultural land were inundated, causing extensive crop damage and livestock losses. The province of Sindh, known for its fertile lands, witnessed severe agricultural losses during the 2010 flood. Crops like rice, cotton, and sugarcane were heavily affected, leading to food shortages and economic hardship for farmers.[108] Many manufacturing industries, including textile mills and factories, are often located in urban and semi-urban areas near water bodies for easy access to transportation and resources. When these areas are hit by floods, manufacturing operations can come to a standstill, causing production losses, damage to machinery, and job displacement. The city of Karachi, Pakistan's economic hub, houses numerous manufacturing facilities. During the 2010 flood, parts of Karachi experienced significant flooding, disrupting manufacturing operations, supply chains, and trade activities.

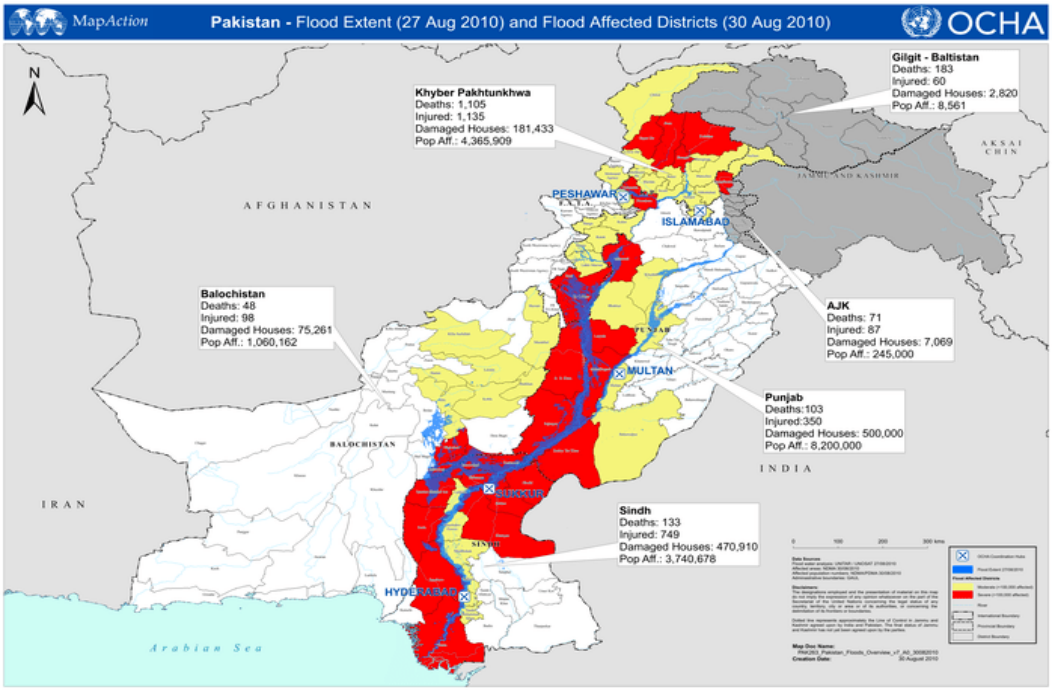
Real estate development in flood-prone areas, including informal settlements along riverbanks and low-lying urban areas, can lead to substantial property and infrastructure damage during floods. Residents and businesses in these areas often lack proper flood defenses and face higher risks.. Homes and businesses in these areas suffered extensive damage, and residents were displaced.[109] The concentration of economic activities in vulnerable areas during the 2010 Pakistan floods had far-reaching consequences. It resulted in significant economic losses, job displacement, food shortages, and infrastructure damage, ultimately affecting the livelihoods and well-being of millions of people.

2.2 Impact of 2010 Flood in Pakistan

The floods in Pakistan had significant social, economic, and political impacts. Socially, they led to a humanitarian crisis with millions affected, causing displacement and posing challenges to access basic necessities. Economically, the destruction of crops and infrastructure resulted in substantial financial losses and strained resources. Politically, the government's response highlighted weaknesses in governance and disaster preparedness, leading to public trust erosion and discussions about policy reforms.

2.2.1 Social Impact

[108] Zulfiqar Kunbhar, "Floods after Drought Devastate Sindh's Agriculture," *PreventionWeb*, August 26, 2022, https://www.preventionweb.net/news/floods-after-drought-devastate-sindhs-agriculture.
[109] Jumaina Siddiqui, "In Karachi, Flooding Lays Bare City's Governance Issues," USIP, October 13, 2020, https://www.usip.org/publications/2020/10/karachi-flooding-lays-bare-citys-governance-issues.



Among the most catastrophic natural disasters in Pakistan's history were the 2010 flood, stemming from abnormally intense monsoon rains and the melting of glaciers in the northern regions. This led to the overflowing of rivers, submerging extensive areas of land. The consequences of these floods included widespread displacement and homelessness, as well as a profound impact on the affected population and the region as a whole. The 2010 flood in Pakistan forced millions of people to leave their homes abruptly. Many families had to abandon their houses, belongings, and farmlands as the rapidly rising waters engulfed their communities. This resulted in large-scale forced migration. Rural areas were particularly affected, as agriculture is a primary livelihood for many Pakistanis. The flooding of farmlands and destruction of crops and livestock made it impossible for people to sustain themselves in their native villages. Consequently, rural population had to move to urban centres in search of shelter and livelihood opportunities. Some individuals and families were temporarily relocated to makeshift camps set up by the government and humanitarian organizations. These camps provided basic necessities like food, clean water, and shelter in the form of tents. However, these were often overcrowded and lacked adequate sanitation facilities.

The Swat Valley in Khyber Pakhtunkhwa was one of the worst-hit regions. Entire villages were submerged, and the population was forced to flee to higher ground or urban areas. Many took refuge in schools or other public buildings, living in cramped conditions. The flooding led to the complete or partial destruction of numerous homes. Mudslides and

erosion exacerbated the damage, leaving countless families without a place to return to.[110] With such a massive influx of displaced people into cities, the demand for shelter skyrocketed. Rental prices surged, making it difficult for many to find affordable housing. This circumstance rendered a considerable portion of the affected population without homes. To address the housing crisis, some displaced individuals and families opted to establish informal settlements in and around urban areas. These settlements often lacked proper infrastructure. In Sukkur thousands of people who had evacuated from flooded areas created makeshift shelters along the riverbanks. These settlements were susceptible to flooding and posed substantial health risks due to inadequate sanitation. The 2010 flood in Pakistan impacts individuals of all age groups, including women, children, and the elderly. Various factors contributed to these casualties, such as drowning, waterborne diseases, and related issues. The profound consequences of the 2010 flood in Pakistan extended to the lives of millions, causing widespread displacement and homelessness. Families were uprooted from their homes, and many struggled to find adequate shelter in the aftermath.

These floods created a severe health crisis, with contaminated floodwaters increased spread of waterborne diseases. This situation resulted in a multitude of health issues among the flood-affected populations. Contaminated water sources provided an ideal breeding ground for cholera bacteria. Floodwaters contaminated with human waste and bacteria were a prime cause of dysentery, a gastrointestinal infection. This disease often results in bloody diarrhea, abdominal pain, and fever. The ingestion of water or food contaminated with the bacterium Salmonella typhi led to outbreaks of typhoid fever. Symptoms include high fever, weakness, abdominal pain, and in severe cases, intestinal perforation. In the aftermath of the floods, there was a significant increase in cholera cases in the Sindh province. Over 150,000 cases of cholera were reported, and the disease spread rapidly due to the contaminated water supply. Displaced individuals often had to rely on contaminated water sources, leading to frequent diarrhea and vomiting. These conditions, combined with the hot and humid climate, increased the risk of dehydration. The floods disrupted the food supply chain, causing food shortages and rising food prices. Many people, especially children and the elderly, experienced malnutrition, which weakened their immune systems and made them more susceptible to diseases.

[110] Thomas D. Kirsch, Christina Wadhwani, Lauren Sauer, Shannon Doocy, and Christina Catlett, "Impact of the 2010 Pakistan Floods on Rural and Urban Populations at Six Months," August 22, 2012, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3441151/.

In Punjab and Khyber Pakhtunkhwa, where food shortages were prevalent, cases of malnutrition were reported among children, and many suffered from dehydration due to contaminated water sources. In makeshift camps and informal settlements, flood-affected populations often lived in overcrowded and poorly ventilated conditions. This increased the risk of respiratory infections, including pneumonia and bronchitis. The flooding and subsequent dampness in homes and shelters provided an environment conducive to mold and fungal growth. Breathing in mold spores can lead to respiratory problems and exacerbate existing conditions. In Balochistan, where many people were living in temporary shelters, cases of respiratory infections increased, particularly among children and the elderly. The trauma of losing homes, possessions, and loved ones, combined with the uncertainty of the future, led to significant psychological distress among flood survivors. Many flood-affected individuals lost their livelihoods and faced economic hardships. The stress of these financial challenges further exacerbated mental health issues.[111] In the Swat Valley, where entire villages were submerged, residents who lost their homes and livelihoods struggled with psychological trauma and required mental health support. Additionally, the conditions in temporary shelters and the disruption of food supplies further compounded the health challenges faced by flood survivors.

These floods impacts agriculture, resulting in severe food insecurity and malnutrition. The floods damaged crops and livestock, disrupted the food supply chain, and caused a sharp increase in food prices. The floods inundated vast agricultural areas, submerging fields and destroying crops like rice, wheat, sugarcane, and cotton. Farmers lost their livelihoods as their harvests were washed away or rendered unsalvageable. In some cases, even after the floodwaters receded, the soil remained saturated, making it difficult for farmers to replant crops. This led to delayed planting and reduced agricultural productivity.[112] In Punjab, known as Pakistan's "breadbasket," thousands of acres of wheat and rice crops were destroyed by the floods, resulting in massive losses for farmers and reduced food production. Many livestock animals, including cows, goats, and poultry, drowned in the floods or succumbed to waterborne diseases. This loss of livestock further diminished the availability of meat, milk, and eggs. Livestock is a crucial source of income for rural communities. Losing livestock not only affected food availability but also the economic stability of these

[111] Haider Warraich, Anita KM Zaidi, and Kavita Patel, "Floods in Pakistan: a public health crisis," *PLoS Med* 8, no. 5 (2011),https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3044252/

[112] Michael Kugelman, "Flooded With Food Insecurity in Pakistan," New Security Beat, August 11, 2010, https://www.newsecuritybeat.org/2010/08/flooded-with-food-insecurity-in-pakistan/.

communities. In Sindh, where agriculture and livestock farming are significant sources of income, many farmers lost their entire herds of cattle and poultry due to the floods.

The flooding damaged roads, bridges, and transportation infrastructure, making it difficult to transport food from surplus-producing regions to areas in need. This disruption in the food supply chain resulted in localized food shortages. Limited food supplies, coupled with increased demand from affected populations, led to a surge in food prices. Staple foods like rice, wheat, and vegetables became unaffordable for many. In Khyber Pakhtunkhwa, the disruption of transportation routes and the increased demand for food in flood-affected areas led to significant price hikes, making it difficult for people to access essential food items. Many families affected by the floods struggled to secure enough food for their daily needs. This resulted in food insecurity, where individuals did not have reliable access to an adequate quantity of nutritious food. Limited access to diverse and nutritious foods, especially for children and pregnant women, resulted in malnutrition. Malnourished individuals were more susceptible to diseases and experienced stunted growth and developmental issues.[113] In Balochistan where food shortages were prevalent, reports emerged of children suffering from malnutrition, with alarming rates of stunted growth and underweight.

The floods damaged or repurposed schools, leading to long-term educational setbacks for affected children. More than 24,000 schools have been damaged or destroyed . An estimated 3.5 million children have had their schooling disrupted..[114] Many school buildings were inundated by floodwaters, causing structural damage and rendering them unsafe for use. This forced students and teachers to abandon their educational facilities. Flooding often resulted in the destruction of textbooks, school supplies, and learning materials, further hindering the resumption of classes. In Khyber Pakhtunkhwa, numerous schools were damaged or destroyed by the floods, leaving students without a safe and conducive learning environment. In the aftermath of the floods, schools were often repurposed as temporary shelters for displaced families. While this was a necessary response to provide immediate relief, it meant that schools were unavailable for educational purposes. Schools-turned-shelters were often overcrowded, with families living in classrooms and common areas. This further delayed the resumption of classes, as it took time to vacate and repair these facilities. In Sindh, where

[113] Emma Hooper, "Pakistan's Food Crisis: Water, Energy, Agriculture & Power: The Conflict Ahead," December 25, 2010, https://www.files.ethz.ch/isn/126043/notes_internacionals_25.pdf.

[114] Jaime Saavedra ,Lynne Sherburne-Benz, "Pakistan's Floods are Deepening its Learning Crisis," World Bank Blogs, September 28, 2022, https://blogs.worldbank.org/endpovertyinsouthasia/pakistans-floods-are-deepening-its-learning-crisis#:~:text=Initial%20assessments%20indicate%20that%20across,have%20had%20their%20schooling%20disrupted.

large-scale displacement occurred, schools in many areas were converted into shelters to accommodate flood-affected families. Many teachers and students were themselves displaced by the floods. Families who lost their homes often had to relocate to different areas, making it challenging for children to attend their original schools. Flood damage to roads and bridges, as well as the prolonged shelter use of schools, hampered students' physical access to educational facilities. Some children, especially those from economically disadvantaged families, were unable to return to school after the floods due to financial hardships, ultimately leading to higher dropout rates.[115]

2.2.2 Economic impact of 2010 flood in Pakistan

The floods impacts the country's agriculture sector, which is a significant contributor to its economy . The floods inundated millions of acres of farmland, resulting in the destruction of crops, loss of livestock, and damage to irrigation systems. This, in turn, led to massive agricultural losses. The agriculture sector experienced a documented total loss of Rs. 429 billion. The most substantial crop cultivation losses were observed in Punjab, covering an area of 661,637 hectares, with Sindh following closely at 357,372 hectares. Additionally, KPK reported losses on 191,020 hectares, and PAK recorded losses on 92,370 hectares.[116] The floods submerged vast agricultural areas, including fields of rice, wheat, sugarcane, cotton, and more. These crops were either completely washed away or rendered unsalvageable due to waterlogging and soil erosion. Even after the floodwaters receded, many fields remained waterlogged, making it difficult for farmers to replant crops. This resulted in delayed planting and reduced agricultural productivity. In Sindh, one of Pakistan's primary rice-producing provinces, extensive rice fields were inundated by floodwaters, leading to substantial losses in rice production. Many livestock animals, including cattle, goats, and poultry, drowned in the floods or succumbed to waterborne diseases. This not only resulted in the loss of valuable livestock but also had a long-term impact on milk and meat production. Livestock farming is a crucial source of income for rural communities. The loss of livestock meant not only reduced food availability but also financial hardships for

[115] Amir Nawaz, Amjad Ali, "Implication of Floods—2010 on Education Sector in Pakistan," in Climate Change and the Sustainable Use of Water Resources,Springer, January 1, 2013, https://link.springer.com/chapter/10.1007/978-4-431-54255-1_7.

[116] Syed Iazaz Ahmad, Shahid Hassan Rizvi, "Impact of 2010 Floods on Pakistan's Agriculture," *Journal of Environmental & Analytical Toxicology* (03-Jan-2017,https://www.hilarispublisher.com/open-access/impact-of-2010-floods-on-pakistans-agriculture-2161-0525-1000424.pdf.

farming households. In Punjab, known for its dairy farming, numerous cattle and poultry farms were severely affected by the floods, leading to significant economic losses.[117]

The floods damaged irrigation canals and infrastructure, disrupting the supply of water to farmlands. This further hindered crop cultivation and affected the timing of crop cycles. Floodwaters brought silt and debris into canals and rivers, leading to silt deposition in fields. This reduced the fertility of the soil, affecting future crop yields. In Khyber Pakhtunkhwa, where the canal system is critical for agriculture, the floods caused extensive damage to irrigation infrastructure, affecting the availability of water for crops. The damaged transportation infrastructure and the disruption of the food supply chain made it challenging to transport food from surplus-producing regions to areas in need. This disruption resulted in localized food shortages. Limited food supplies, coupled with increased demand from flood-affected populations, led to significant price hikes. Staple foods like rice, wheat, and vegetables became unaffordable for many. In Balochistan, where food shortages were prevalent, reports emerged of soaring food prices, making it difficult for people to access essential food items.[118]

The 2010 flood in Pakistan inflicted significant damage on critical infrastructure, including roads, bridges, railways, and communication networks. This widespread infrastructure damage disrupted transportation and trade, making it challenging for goods to move within the country, thereby hampering economic activity. Furthermore, the floods also impacts power generation facilities resulting in electricity shortages that further impacted industrial production and economic growth. The floods washed away or severely damaged many roads and highways. This hindered the movement of people, goods, and emergency relief efforts. It also disrupted supply chains, making it difficult for essential goods to reach flood-affected areas.[119] Floodwaters destroyed numerous bridges and river crossings, making it challenging for vehicles to traverse rivers and access cut-off regions. The destruction of the Kalam Bridge in Swat Valley, Khyber Pakhtunkhwa, isolated entire communities and disrupted transportation for both people and goods. The floods damaged railway tracks and stations, disrupting the functioning of the railway system. This affected the movement of freight and

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[117] Pakistan: Flood Impact Assessment," Special Section 2, accessed September 25,2023, https://www.finance.gov.pk/survey/chapter_11/Special%20Section_2.pdf.

[118] S. Chughtai, Pakistan Floods Emergency: Lessons from a Continuing Crisis (2012), https://oxfamilibrary.openrepository.com/bitstream/handle/10546/210829/bn-pakistan-floods-emergency-160212-en.pdf?sequence=3&isAllowed=y.

[119] "Floods Damage Bring Havoc to Road Infrastructure," Daily Times, August 29, 2022, https://dailytimes.com.pk/988909/floods-damage-bring-havoc-to-road-infrastructure/.

passengers. The flood-induced damage to railway tracks in Sindh impacted the transportation of goods to and from the Karachi Port, which is crucial for trade.[120]

Floods often led to the disruption of mobile and landline communication services. Flooding also affected internet connectivity, limiting access to vital information and hindering communication between affected regions and the rest of the country. In various flood-affected areas, including parts of Punjab and Sindh, communication networks were severely disrupted, causing additional challenges for emergency response and coordination. The floods damaged hydropower plants along rivers, reducing electricity generation capacity. These facilities provide a significant portion of Pakistan's electricity. Floods also affected thermal power plants by disrupting the supply of coal or natural gas and damaging equipment. This reduced the capacity to generate electricity from fossil fuels.[121]

The 2010 flood in Pakistan impacts industrial areas, leading to disruptions manufacturing and production. Many factories and businesses were forced to shut down, either temporarily or even permanently, as a result of the flooding. These disruptions resulted in job losses and reduced economic output. Industrial areas and factories located in flood-prone regions were inundated by floodwaters. This led to the temporary shutdown of manufacturing facilities, as it was unsafe and impractical to continue operations under such conditions. Floodwaters damaged machinery, equipment, and raw materials in factories, rendering them inoperable. This resulted in significant financial losses for businesses.[122] The industrial city of Hattar in Khyber Pakhtunkhwa, which houses numerous manufacturing units, experienced severe damage due to the floods. Many factories were temporarily closed to assess and repair the damage. The floods damaged roads, bridges, and railway lines, making it difficult for industries to receive raw materials and transport finished products to markets. This disrupted supply chains and delayed production. Some factories had to halt production abruptly due to the flooding also resulting loss of finished goods and unsold inventory. In the industrial city of Faisalabad in Punjab, which is known for its textile industry, the floods disrupted transportation routes, affecting the delivery of raw materials and the shipment of finished textile products. Many businesses were forced to lay off workers temporarily as a result of factory closures. This led to a loss of income for workers and their families.

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[120] Imran Iqbal, Zafar Iqbal, and Shirish Ravan, Lessons Learnt from Floods in Pakistan, SUPARCO, https://www.un-spider.org/sites/default/files/150112_SUPARCOBooklet_online.pdf.

[121] 2010 Pakistan Floods," Wikipedia, https://en.wikipedia.org/wiki/2010_Pakistan_floods.

[122] Jehangir Karamat, "Pakistan's Water World: The Political and Economic Impact of the Recent Floods," Brookings, August 17, 2010, https://www.brookings.edu/articles/pakistans-water-world-the-political-and-economic-impact-of-the-recent-floods/.

In cases where factories sustained severe damage or faced prolonged closures, some businesses were unable to recover. In Karachi, where various industrial sectors are prominent, several small-scale manufacturing units and businesses had to shut down permanently due to the flooding, leading to job losses. The disruptions in industrial production contributed to a reduction in economic output and growth. This, in turn, had broader implications for the national economy. Industries such as textiles and manufacturing are major contributors to Pakistan's exports. The slowdown in industrial production affected the country's export earnings. The textile sector experienced a decline in production and exports due to the flood-induced disruptions.[123]

2.2.3 Political impact

The government's response during the 2010 flood faced widespread criticism for its perceived sluggishness and inadequacy, sparking public dissatisfaction and protests. This delayed response and the apparent inefficiency in disaster management carried significant political implications for the ruling party at the time. A crucial point of contention was the government's lack of preparedness for such a massive disaster, revealing a disconnect between political decisions and the region's vulnerability to floods, a well-known environmental challenge. Despite the recurring nature of floods in Pakistan, the authorities were ill-equipped to handle a crisis of this magnitude, highlighting shortcomings in governance structures.

The floods began in late July 2010, yet it took several weeks for the government to fully comprehend the scale of the disaster and initiate a comprehensive response. This delay allowed the situation to worsen, resulting in more extensive damage. When relief efforts eventually commenced, reports emerged of inefficiency and corruption in the distribution of relief supplies. Many affected individuals and communities did not receive the assistance they urgently needed. Numerous reports suggested that relief supplies were diverted by corrupt officials, hindering their delivery to those in need. These incidents intensified public anger and frustration, emphasizing the interconnectedness of political decisions, governance practices, and environmental challenges. Analyzing this situation through the lens of political ecology theory underscores the theory's assumption that environmental issues are deeply entangled with political and social structures. The government's failure to proactively address a well-known environmental risk demonstrates how political decisions can amplify

[123] Syed Shabib ul Hasan, Shahid Zaheer Zaidi, "Flooded Economy of Pakistan," *Journal of Development and Agricultural Economics* Vol. 4, no. 13 (November 2012): 331-338, https://academicjournals.org/article/article1379428409_Hasan%20and%20%20Zaidi.pdf.

the impacts of natural disasters. Moreover, the reported corruption in relief distribution highlights the intricate relationship between political structures and environmental factors, shaping the vulnerability and response of communities in the face of such crises.

During the 2010 flood in Pakistan, controversies surrounding the distribution of aid and resources emerged, leading to accusations of favouritism and corruption in aid distribution. These issues had a significant impact on public trust in the government, resulting in calls for transparency and accountability in resource allocation. [124] There were widespread accusations that aid and relief resources were being distributed based on political affiliations, with allegations that supporters of the ruling party were receiving preferential treatment. Reports surfaced of relief supplies, including food and tents, being distributed to individuals and communities with close ties to the ruling party while bypassing those in opposition-held areas. The distribution of aid was marred by allegations of corruption, with reports of relief materials being sold in black markets rather than reaching the intended beneficiaries. In some instances, relief officials and local leaders were accused of embezzling relief funds and diverting aid meant for flood victims, leading to public outrage.[125]

The controversies and allegations of corruption eroded public trust in the government's ability to effectively manage and distribute relief resources during a crisis. Many flood victims and their families expressed frustration and disillusionment with the government's response, which they viewed as tainted by corruption and favouritism.[126] The perception of corruption in aid distribution contributed to a political backlash, with opposition parties and civil society organizations intensifying their criticism of the government. As allegations of corruption and favouritism grew, there were increasing calls from civil society, media, and opposition parties.

Civil society groups organized protests and campaigns demanding independent oversight of relief efforts to ensure that aid reached those in need. In response to public pressure and criticism. The government established the National Disaster Management Authority (NDMA) and the Provincial Disaster Management Authorities (PDMAs) to coordinate relief efforts and ensure greater transparency in the distribution of resources.[127] The media played

[124] "Corruption in Flood Relief Distribution," Observer Research Foundation, September 11, 2010, https://www.orfonline.org/research/corruption-in-flood-relief-distribution/.

[125] Ahmed Rashid, "Pakistani Flood Relief Must Start with Fighting Corruption," The Washington Post, September 6, 2010, https://www.almendron.com/tribuna/pakistani-flood-relief-must-start-with-fighting-corruption/.

[126] "Billions Meant for Flood-Hit People Misused," Dawn, February 17, 2012, https://www.dawn.com/news/696102/billions-meant-for-flood-hit-people-misused-report.

[127] Pakistan Flood 2010: Learning from Experience, National Disaster Management Authority (NDMA), accessed

a crucial role in exposing corruption and advocating for transparency. Journalists and media outlets conducted investigative reports and provided a platform for whistle blowers to come forward. Media reports on corruption allegations in aid distribution prompted government investigations and increased public awareness of the issue.

2.2 The Case study of 2022 Flood in Pakistan

In August 2022, Pakistan was again plunged into an unprecedented catastrophe wreaked havoc across Balochistan, Sindh, and southwest Punjab. Triggered by above-normal monsoon rainfall, the calamity unfolded gradually, beginning in July and intensifying exponentially throughout August. This deluge left a staggering impact, affecting approximately 33 million people throughout the country. By mid-August Sindh province was submerged under floodwaters, a testament to the relentless rain and exceptionally high incidental rainfall events, including a remarkable 142 mm of rain recorded in a single day in Naushahro Feroze District on August 11, 2022. The gravity of the situation prompted Pakistan to declare a state of emergency on August 25, 2022. This devastating flood not only stood as the deadliest global flood since the 2020 South Asian floods but was also recorded as the worst in Pakistan's history, ranking among the costliest natural disasters worldwide. However, the question of what precisely triggered this catastrophic flood remained unanswered. Various factors were identified as possible catalysts, encompassing intense rainfall, contributions from glacial melt, and the formation of an intense low-pressure system induced by the blistering summer heatwaves that engulfed the nation from May to June.[128]Notably, the summer of 2022 in Pakistan witnessed exceptional and prolonged heatwaves, with temperatures exceeding 51°C in certain regions. These heatwaves may contribute to the escalation of precipitation during the subsequent monsoon season, fortifying low-pressure systems over land and affecting the behaviour of the monsoonal depression along the Arabian Sea. Furthermore, the occurrence of La Niña, characterized by cooler sea surface temperatures in the eastern Pacific in 2022, heightened the precipitation event and intensified low-pressure systems. The floods in 2022 surpassed the peak flow rate observed during the 2010 flood in Pakistan, drawing parallels between the two events, including the presence of La Niña and specific high-altitude jet stream formations. [129]

September25,2023,https://cms.ndma.gov.pk/storage/app/public/publications/October2020/F9ouj1geVV4LUoiiVLm3.pdf.

[128] "Pakistan: 2022 Monsoon Floods - Situation Report No. 03," *ReliefWeb,* 26 Aug 2022https://reliefweb.int/report/pakistan/pakistan-2022-monsoon-floods-situation-report-no-03-26-august-2022.

[129] J. S. Nanditha et.al, "The Pakistan Flood of August 2022: Causes and Implications," *Earth's Future* 11 (2023): e2022EF003230, https://doi.org/10.1029/2022EF003230.

2.2.1 Causative Factors of 2022 Flood

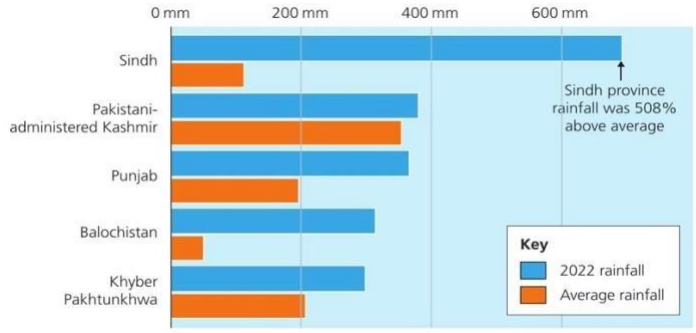
The 2022 flood were primarily due to combination of natural factors like heavy and prolonged rains ,swollen rivers, and climate-related patterns. These meteorological conditions led to widespread flooding, inundating regions and causing significant damage to infrastructure and agriculture. Additionally, poor land management practices, inadequate drainage systems, and deforestation further exacerbated the impact of the floods. The causative factors are discussed in detail below:

2.2.1.1 Environmental Factors

August 2022, Pakistan witnessed severe floods, particularly in Sindh and Balochistan, which exceeded the historical averages for that month. These floods were a result of extraordinarily heavy rainfall driven by a combination of monsoon dynamics. This marked continuation of the phenomenon observed in recent years, where the monsoon season brought excessive rainfall, causing significant flooding in these regions. During the 2022 flood, Sindh experienced rainfall levels nearly eight times higher than the typical August averages, while Balochistan received five times more rainfall. These extreme percentages reflected the severity of the rainfall anomaly that contributed to widespread flooding, leading to displacement of communities, damage to infrastructure, and agricultural losses.[130] Prior to the floods in 2022, the South Asian Climate Outlook Forum (SACOF) had issued forecasts indicating above-normal monsoon rainfall. These predictions accurately foreshadowed the heavy rains that effects many parts of the country during the monsoon season, including Sindh and Balochistan.

The heavy rainfall overwhelmed drainage systems and led to flash floods. Even incidental or additional rainfall during the 2022 flood worsened the flooding situation in specific districts.[131] Given that the ground was already saturated and rivers were swollen from continuous monsoon rainfall, any additional precipitation had a compounding effect on flooding in these districts.

[130] "2022 Pakistan Floods," Wikipedia, https://en.wikipedia.org/wiki/2022_Pakistan_floods.
[131] "2022 Pakistan Floods," National Center for Disaster Philanthropy, https://disasterphilanthropy.org/disasters/2022-pakistan-floods/.



Source: Pakistan Meteorological Department. Note that average rainfall figures are for 1961–2010 132

In 2022, rising temperatures in South Asia had contributed to increased evaporation rates, which, when coupled with heavy rainfall, exacerbated the severity of the floods. High temperatures accelerated water loss from rivers, lakes, and soil, making areas more susceptible to flooding during the monsoon season. Prior to the 2022 flood, Pakistan had experienced accelerated warming. This warming had primed the region for extreme weather events, including floods. Higher temperatures can lead to faster snow and glacier melt in the mountains, contributing to increased river flow and flood risks.[133] The increased likelihood of heatwaves in Pakistan had created conditions conducive to flash floods. Prolonged heatwaves dried out the soil and vegetation, reducing their capacity to absorb water, making areas more vulnerable to flooding when heavy rains hit. In 2022, an unprecedented spring heatwave intensified the drying of soil and vegetation in Pakistan. This set the stage for a heightened risk of flooding when the monsoon rains arrived later in the year.

In 2022, extreme high temperatures, such as the recorded 51°C in Jacobabad, exacerbated soil and vegetation drying. These conditions increased the region's susceptibility to flooding when heavy rains occurred, as they did during the monsoon season.[134] Climate change had been altering the annual monsoon rainfall patterns in the years leading up to 2022. This change had made the rainfall more intense and less predictable, which was a contributing factor to the heavy rainfall that resulted in flooding that year. The rapid melting of glaciers in the Himalayas and Karakoram in previous years had contributed to increased water flows

[132] Pakistan floods: Map and satellite photos show extent of devastation, BBC News, August 31, 2022, https://www.bbc.com/news/world-asia-62728678

[133] "Climate Change Likely Increased Extreme Monsoon Rainfall, Flooding Highly Vulnerable Communities in Pakistan," World Weather Attribution, September 14, 2022, https://www.worldweatherattribution.org/climate-change-likely-increased-extreme-monsoon-rainfall-flooding-highly-vulnerable-communities-in-pakistan/.

[134] Sana Arshad et.al, "Geospatial Assessment of Early Summer Heatwaves, Droughts, and Their Relationship with Vegetation and Soil Moisture in the Arid Region of Southern Punjab, Pakistan," *Journal of Water and Climate Change* 13, no. 11 (2022): 4105–4129, https://iwaponline.com/jwcc/article/13/11/4105/91880/Geospatial-assessment-of-early-summer-heatwaves.

in rivers during 2022. This higher water flow played a role in river flooding during heavy rainfall events. In 2022, the La Niña phenomenon impacted weather patterns and increased the likelihood of above-average rainfall in South Asia. This La Niña influence likely contributed to the heavy monsoon rains that led to the flooding in Pakistan that year.[135] Climate change has led to shifts in weather patterns, including the monsoon. Rising global temperatures can lead to increased moisture in the atmosphere, which, when combined with monsoonal circulation patterns, can result in more intense and prolonged rainfall events. This additional moisture-laden air contributed to the heavy and sustained rainfall in Pakistan during 2022 The heavy rainfall during the monsoon season led to an increased inflow of water into rivers throughout Pakistan. Rivers act as natural drainage systems, collecting water from various sources, including rain, snowmelt, and runoff from the surrounding landscape.[136] As the rainfall persisted and intensified, the river basins in Pakistan began to receive more water than they could effectively channel and discharge into the sea. The rivers, including the Indus, were overwhelmed by the volume of water, causing them to swell and breach their banks. Pakistan's river system is intricately connected, with the Indus River serving as the main artery. The Indus is fed by several major tributaries, such as the Jhelum, Chenab, Ravi, and Sutlej, which originate from various mountain ranges, including the Himalayas. The heavy rainfall during the 2022 monsoon season was not limited to the Indus River basin but also extended to the basins of its tributaries. The mountainous regions where these tributaries originate received substantial rainfall, leading to rapid snowmelt and runoff. As the rainfall and runoff from the tributaries increased, they swelled beyond their usual levels. These swollen tributaries, flowing from different directions, converged into the Indus River at various points along its course. The combined flow of water from the overflowing tributaries, coupled with the already high-water levels in the Indus due to the heavy rainfall in its basin, exceeded the capacity of the Indus River channel. This resulted in the spilling of water onto the surrounding floodplains and the inundation of adjacent areas. The overflow of tributaries into the Indus River caused widespread flooding along the entire course of the Indus. This flooding impacted not only the riverbanks but also vast areas of adjacent land, submerging towns, villages, farmland, and infrastructure.[137]

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[135] "El Niño/La Niña Update ,"*ReliefWeb,* August 2022, https://reliefweb.int/report/world/el-ninola-nina-update-august-2022

[136] Syed Raza Hassan and Asif Shahzad, "South Pakistan Braces for Yet More Flooding as Waters Flow Down from North," *Reuters*, September 1, 2022, https://www.reuters.com/world/asia-pacific/south-pakistan-braces-surge-flood-water-flowing-north-2022-09-01/.

[137] Nanditha et.al, "The Pakistan Flood of August 2022: Causes and Implications." Earth's Future, March 13, 2023. https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2022EF003230.

2.2.1.2 Political Factors

Pakistan had faced challenges in modernizing its river management systems. Inefficient practices, outdated procedures, and a lack of coordination among relevant authorities hindered effective flood control and response in Pakistan. Pakistan's infrastructure for flood control hadn't kept pace with the increasing demands and changing climate conditions. Outdated infrastructure such as dams, reservoirs, and flood control channels in Pakistan limited the country's ability to manage the excess water during the 2022 flood.[138] Proper maintenance of river channels was crucial for Pakistan to ensure smooth water flow. Inadequate maintenance led to silt buildup and reduced channel capacity, making rivers in Pakistan more prone to overflowing.. Modern technology played a crucial role in monitoring river conditions and predicting floods in Pakistan. The limited use of advanced technology and data-driven forecasting systems hindered early warning systems and timely response efforts during the 2022 flood in Pakistan.[139]

The neglect of river channel maintenance, the importance of levees and embankments, and the role of modern technology in flood prediction can be seen through a political ecology lens. The decisions related to the maintenance of river channels, design of flood control structures, and the adoption of technology are influenced by political and social factors. Political decisions, resource allocation, and governance structures play a role in determining how effectively a country addresses environmental challenges like floods.

Pakistan's early warning systems faced significant shortcomings during the 2022 flood, and political factors influenced these issues. Inadequate funding, a dearth of political commitment to prioritize disaster preparedness, and bureaucratic inefficiencies impeded the establishment and upkeep of efficient early warning systems. Political decisions and priorities played a role in the inadequate response to this critical aspect of flood risk management. The limited resources allocated for disaster preparedness and response in Pakistan before the 2022 flood were influenced by political factors. Budget allocation decisions, corruption, and resource mismanagement contributed to inadequate funding for disaster preparedness efforts.

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[138] Shahid Azam, "Pakistan Needs a National Development Program to Combat Future Floods and Droughts," UNDRR, September 8, 2022, https://www.preventionweb.net/news/pakistan-needs-national-development-program-combat-future-floods-and-droughts.

[139] Waseem Ishaque, Mudassir Mukhtar, and Rida Tanvir, "Pakistan's Water Resource Management: Ensuring Water Security for Sustainable Development," *Frontiers in Environmental Science* (January 20, 2023), https://www.frontiersin.org/articles/10.3389/fenvs.2023.1096747/full.

Political factors, including decisions related to infrastructure spending and development priorities, played a role in Pakistan's inadequate investment in flood-resistant infrastructure. Political leaders prioritized other projects over flood control and infrastructure upgrades, leaving communities vulnerable to the impact of the 2022 flood. The absence of comprehensive floodplain zoning and effective land-use planning in Pakistan was influenced by political factors. Political decisions and interests, including those related to urban development and land ownership, contributed to the lack of regulatory oversight in flood-prone areas. Political considerations often played a part in allowing unchecked expansion into flood-prone regions, exacerbating the vulnerability of the population.[140] Political factors significantly contributed to the constrained capacity for risk reduction measures in Pakistan leading up to the 2022 flood. These factors affected decisions related to early warning systems, resource allocation, infrastructure investment, floodplain zoning, and public awareness efforts. Addressing these political factors is essential for effective preparedness and measures in the future to better protect communities from flood disasters.

2.2.1.3 Economic Factors

In the past, rapid urbanization was a significant issue in Pakistan, driven by robust economic growth and a rapidly expanding population. This phenomenon resulted in the widespread creation of impervious surfaces like roads and buildings. As cities expanded, these surfaces covered large areas, increasing the runoff of rainwater during heavy downpours. Consequently, this exacerbated flood conditions in urban areas across the country. For example, in cities like Karachi, Lahore, and Faisalabad, the unchecked growth of infrastructure and unplanned urban expansion led to a significant increase in impervious surfaces. During the monsoon season, when heavy rains were common, the rainwater could not be absorbed by the ground due to the extensive concrete and asphalt surfaces. This excess runoff would flow into streets and low-lying areas, causing urban flooding. Homes and businesses were often inundated, leading to property damage and displacement of residents. Improper land use practices were another prevalent issue in Pakistan's history. Economic interests sometimes took precedence over sound land use planning, resulting in poor zoning decisions and construction in flood-prone areas. This exposed communities to greater flood

[140] Pakistan Floods 2022 Post-Disaster Needs Assessment, October 2022, https://thedocs.worldbank.org/en/doc/4a0114eb7d1cecbbbf2f65c5ce0789db-0310012022/original/Pakistan-Floods-2022-PDNA-Main-Report.pdf.

risks.[141] in the past, some areas along the banks of the Indus River were designated for residential and industrial purposes, despite their susceptibility to flooding.

One of the most devastating instances of this was the Pakistan flood of 2011. During that year, exceptionally heavy monsoon rains caused the Indus River to overflow, leading to one of the worst floods in Pakistan's history. The rapid urbanization and improper land use practices mentioned earlier significantly exacerbated the impact of this disaster. The extensive impervious surfaces in urban areas amplified the floodwaters, leading to widespread inundation of cities and towns. Additionally, inadequate land use planning left many communities ill-prepared to deal with the deluge, resulting in widespread devastation and loss of life.[142] Impervious surfaces from urban development increased runoff during heavy rains, aggravating flooding, while economic interests often led to inadequate land use planning and construction in flood-prone zones, putting communities at greater risk during catastrophic events like the 2011 flood.

In the context of Pakistan's history of floods, poverty and vulnerability have been critical factors exacerbating the impact of flooding on certain communities. Economic disparities and poverty often made these communities more susceptible to flood-related damages, and this was evident in the areas affected by the floods of 2022. The floods of 2022 disproportionately affected impoverished communities in regions such as Sindh and Balochistan. Many of these communities lacked access to essential resources such as safe housing, clean water, and adequate healthcare even before the floods. When the floods occurred, these already marginalized communities were ill-equipped to prepare for or respond to the disaster. They often lacked the financial means to stock up on emergency supplies or construct flood-resistant homes. Poorer communities in areas like Jacobabad and Dadu in Sindh and Kech in Balochistan were frequently located in regions with substandard infrastructure, including weak or makeshift housing structures. These areas lacked proper drainage systems, embankments, and flood protection measures. Consequently, when the floods struck in 2022, their impact was particularly devastating, as the infrastructure was ill-prepared to handle the deluge. Poverty and restricted mobility were evident in flood-affected regions such as Ghotki in Sindh and Turbat in Balochistan during the floods of 2022. Many impoverished individuals and families in these areas could not easily evacuate their homes

[141] Bakhtiar Iqbal, "Flooded Cities: Managing Stormwater in Pakistan," Devpakblog, October 24, 2019, https://devpakblog.com/2019/10/24/urban-flooding-monsoon-rains-and-stormwater-management-in-lahore/.
[142] Mir Sher Baz Khetran, "Issue Brief on 'Urban Flooding in Pakistan,'" ISSI, August 8, 2023, https://issi.org.pk/issue-brief-on-urban-flooding-in-pakistan/.

when floods were imminent. They lacked access to transportation or the financial means to relocate temporarily to safer areas. As a result, they often found themselves trapped in flood-prone zones, increasing the risk to their lives and property.[143] The floods of 2022 devastated agriculture and livestock in regions like Khairpur in Sindh and Awaran in Balochistan. These areas were home to many families whose livelihoods depended on farming and herding. The loss of crops and livestock due to the floods plunged these families deeper into poverty, making it even harder for them to recover from the disaster. Poverty and inadequate access to healthcare were exacerbated by the floods of 2022. The loss of assets and income-generating opportunities during the floods pushed already impoverished communities into a cycle of deeper poverty, making it even more challenging for them to escape the vicious cycle.[144]

2.2.2 Impact of 2022 Flood

2.2.2.1 Social Impact

The floods in Pakistan in 2022 caused a lot of problems, especially a high number of people getting hurt or passing away. A few things came together to make this happen. Pakistan's geography and weather make it prone to heavy and unexpected rain, which quickly makes rivers get really big. Flash floods happened suddenly, and many people didn't have enough time to go somewhere safe, especially in places with few ways to get warnings. The structures and plans to deal with floods were not good enough, with weak walls, not enough safe places, and not many plans to help people leave. Also, many people live in areas where floods are likely to happen, and it's hard to help everyone get away in time. After the floods, broken roads and bridges made it tough for help and medicine to reach affected areas quickly, making more people get hurt or pass away. Families and communities suffered a lot, with people losing their homes and having to leave to find safer places. It was a big problem for the government and local groups to help everyone because the disaster was so huge.

People who had to leave their homes faced many problems, like not having jobs or places to live, and it was especially hard for older folks and kids. There was not enough food and water, and getting medical help became difficult. This made the tough situation even worse for the people affected by the floods. Looking at all these issues, we can see that it's not just about the environment but also about decisions made by leaders and how ready communities

[143] "Pakistan Floods: Need for Tackling Development from a Different Perspective," *Reliefweb*, February 3, 2023, https://reliefweb.int/report/pakistan/pakistan-floods-need-tackling-development-different-perspective.
[144] "Pakistan Floods 2022: Resilient Recovery, Rehabilitation, and Reconstruction Framework (4RF)," UNDP Pakistan, December 29, 2022, https://www.undp.org/pakistan/publications/pakistan-floods-2022-resilient-recovery-rehabilitation-and-reconstruction-framework-4rf.

are for disasters. The idea of political ecology helps us understand how these things are connected. It shows us the complex relationship between nature, political choices, and how communities are affected by big disasters.[145]

The floods in Pakistan in 2022 not only caused widespread damage but also had severe consequences for healthcare, adding another layer to the crisis. The destruction of medical facilities created a major hurdle in meeting the urgent health needs of those affected by the floods. This resulted in a shortage of crucial medical supplies, skilled healthcare professionals, and even basic necessities like clean water and electricity. The impaired functioning of health centres not only affected the immediate response to flood-related injuries, illnesses, and childbirth complications but also hindered the ability to address emerging health crises, such as outbreaks of waterborne diseases like cholera. The long-lasting impact of the damage to health infrastructure became evident as the rebuilding and restocking of these facilities stretched over years, leaving communities without access to essential healthcare services during that period. The floodwaters, often contaminated with sewage and debris, became breeding grounds for harmful pathogens. People exposed to these waters or consuming contaminated food and water faced a high risk of infection. Waterborne diseases like diarrhea, which could be fatal, became more prevalent due to poor sanitation and the absence of clean water.

Moreover, the stagnant water left by the flooding created ideal conditions for disease-carrying mosquitoes, leading to a surge in vector-borne illnesses like dengue fever and malaria. The overcrowded conditions in temporary shelters and displacement camps further facilitated the transmission of diseases. The combination of inadequate sanitation, limited healthcare access, and the prevalence of infectious agents resulted in secondary health crises that were as devastating as the initial flood itself.[146]

Viewing this situation through the lens of political ecology theory, we can understand the complex interplay between environmental policies, governance decisions, and their impact on public health. The insufficient attention to environmental concerns, inadequate infrastructure planning, and governance issues contribute to a scenario where communities are vulnerable not only to environmental disasters but also to health crises that follow in

[145] "Pakistan: 2022 Flash Floods - Situation Report No. 02," Reliefweb, August 12, 2022, https://reliefweb.int/report/pakistan/pakistan-2022-flash-floods-situation-report-no-02-12-august-2022.

[146] WHO Pakistan Floods Situation Report, *Reliefweb* Issue 2, September 3, 2022, https://reliefweb.int/report/pakistan/who-pakistan-floods-situation-report-issue-2-3-september-2022#:~:text=Almost%20634%2C000%20displaced%20people%20living%20in%20camps.&text=Over%201460%20health%20facilities%20affected,damaged%20and%201%2C028%20partially%20damaged.

their wake. Flood survivors often experienced profound mental health challenges in the aftermath of the disaster. Women, in particular, faced unique mental health challenges due to the lack of adequate toilet facilities and overcrowded living conditions. The loss of privacy and safety concerns contributed to heightened stress and anxiety. The mental health impact extended beyond individuals to entire communities, as people grappled with the emotional trauma of the disaster. Long-term mental health support was crucial to help survivors cope with their experiences and rebuild their lives.

In the 2022 Global Hunger Index, Pakistan was placed 99th out of 121 countries, indicating a significant level of food insecurity. Furthermore, the devastating flash floods of 2022 exacerbated the situation, pushing an extra 2.5 million individuals in Pakistan into a state of extreme hunger, bringing the total number of severely food-insecure Pakistanis to a record high of 8.6 million.[147] The combined impact of infrastructure damage, livestock losses, and crop destruction created a dire food security situation following the 2022 Pakistan floods. Food became scarce, and prices soared, making it difficult for many households to access adequate nutrition. This led to widespread hunger and malnutrition, particularly among vulnerable populations. Furthermore, food insecurity had broader social and economic consequences, including potential social unrest. The disturbance in of food supply and the loss of livelihoods in the agriculture sector exacerbated these issues, and addressing food insecurity became a top priority for humanitarian organizations and the government. Sustained efforts were required to rebuild agricultural capacity, provide food assistance to affected communities, and ensure long-term food security, as the consequences of food insecurity in the wake of the 2022 flood continued to impact the overall well-being and resilience of the population for years to come.

The Pakistan floods of 2022 took a heavy toll on the country's agricultural sector, resulting in the loss of approximately 700,000 livestock. These losses included cattle, goats, and other farm animals, which were not only important sources of income for many families but also vital for their sustenance. Livestock served as a means of livelihood through the sale of milk, meat, and other products, and their loss disrupted the economic stability of countless

[147] Saher Liaqat ,Abu Hurrairah , "Post-Flash Floods in Pakistan: Navigating the Food Crisis and Mapping a Way Forward," South Asian Voices, April 24, 2023, https://southasianvoices.org/post-flash-floods-in-pakistan/#:~:text=The%202022%20Global%20Hunger%20Index,high%20of%208.6%20million%20Pakistanis.

households. The loss of livestock had long-lasting consequences for the affected communities, as it took years to rebuild herds and recover from the devastating losses.[148]

The destruction or damage of 1.8 million homes was not just a matter of material loss; it was a profound disruption to the lives of millions of people. Homes were not just shelters; they provided security, stability, and a sense of belonging. When homes were destroyed, families were left in a state of shock and vulnerability. In many flood-affected areas, houses were constructed using materials like mud bricks, which were particularly vulnerable to water damage. Even homes built with more resilient materials suffered structural damage, rendering them uninhabitable. This often forced people to live in makeshift shelters, camps, or with extended family members, further straining already limited resources. The loss of personal belongings, documents, and sentimental items also took an emotional toll on individuals and communities. The need for immediate shelter, clean water, food, and other essentials became paramount, adding to the challenges of recovery.

The loss of 50% of sanitation and hygiene facilities in Sindh Province compounded the already dire situation. Proper sanitation and hygiene were fundamental for preventing the spread of diseases, especially in densely populated areas like displacement camps. Without access to clean and safe toilets, people were forced to resort to open defecation or use unsanitary communal facilities, increasing the risk of disease transmission. The lack of clean water for personal hygiene further exacerbated the problem. This situation was especially problematic for women and girls, who faced additional challenges related to privacy, safety, and menstrual hygiene. The sanitation and hygiene crisis not only affected physical health but also dignity and overall well-being. It highlighted the importance of rapid response efforts to provide clean water, sanitation facilities, and hygiene education to mitigate the health risks associated with the Pakistan floods in 2022.[149]

The damage or destruction of 22,000 schools disrupted the education in flood-affected areas. This disruption not only affected their immediate academic progress but also had consequences for their future opportunities. Children were not only deprived of their right to education but also missed out on the support services provided through schools, such as nutrition programs and psychosocial support. Displaced families often struggled to find suitable alternatives for their children's education, as many schools were damaged or

[148] "2022 flood losses push prices of sacrificial animals up ahead of Eid Al-Adha in southwest Pakistan," Arab News PK, September 23, 2023, https://www.arabnews.pk/node/2328081/pakistan

[149] IOM, "Pakistan – Damage to Houses Due to Floods & Existing Population Density (17 September 2022)," September 19, 2022, https://dtm.iom.int/reports/pakistan-damage-houses-due-floods-existing-population-density-17-september-2022.

unavailable. The disruption of education perpetuated the cycle of poverty and vulnerability, as children were deprived of the skills and knowledge needed to build a better future. Addressing the educational disruption caused by the Pakistan floods in 2022 was essential for the long-term recovery and development of affected communities.[150]

2.2.2.2. Economic Impact

The Pakistan floods of 2022 had a profound impact on the country's infrastructure. Approximately 150 bridges were damaged or destroyed during the disaster. These bridges played a crucial role in connecting communities, facilitating trade, and providing access to emergency services. The destruction of these vital structures disrupted the flow of goods and people, isolating affected areas and impeding the distribution of much-needed relief supplies. This hampered the timely response of rescue and relief teams and made evacuations more challenging, particularly in remote regions. Rebuilding these bridges and repairing over 3,500 damaged roads became a top priority in the aftermath of the floods, as restoring these critical transportation links was essential for reconnecting isolated communities and jumpstarting the process of recovery.[151]

One of the most crippling consequences of the Pakistan floods in 2022 was the prolonged power outage that lasted for more than 10 days in many areas. The floodwaters damaged power generation facilities, transmission lines, and distribution infrastructure, leading to widespread electricity disruptions. This had cascading effects on various aspects of daily life. Communication systems were severely impacted, making it challenging for affected individuals to seek help or stay informed about the evolving situation. Hospitals and healthcare facilities struggled to operate, leading to delays in medical treatment and potentially life-threatening situations. Moreover, the lack of electricity disrupted refrigeration, causing food spoilage and exacerbating food scarcity issues, compounding the challenges faced by flood-affected communities.[152]

The destruction of crops in the Pakistan floods of 2022 was particularly devastating, encompassing approximately 3.6 million acres of land, with a significant focus on rice and

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[150] Freya Perry, Juan D. Barón, Lauren Dahlin, "How are the children of Pakistan's 2022 floods faring?" *World Bank blogs*, July 26, 2023, https://blogs.worldbank.org/endpovertyinsouthasia/how-are-children-pakistans-2022-floods-faring#:~:text=During%20the%20monsoon%20of%202022,being%20left%20behind%20and%20forgotten.

[151] Qamer, F.M et .al,A framework for multi-sensor satellite data to evaluate crop production losses: the case study of 2022 Pakistan floods. *Sci Rep* 13, 4240 (2023). https://doi.org/10.1038/s41598-023-30347-y

[152] Syed Raza Hassan, "Pakistan races to keep floodwaters out of power station that supplies millions," *Reuters*, September 14, 2022, https://www.reuters.com/world/asia-pacific/pakistan-races-keep-floodwaters-out-power-station-that-supplies-millions-2022-09-12/.

sugar cane cultivation. Rice is a staple food in Pakistan, and sugar cane is a vital cash crop for the country's sugar industry. The damage to these crops resulted in reduced food availability, contributing to food shortages and significantly higher prices for essential goods. Additionally, the destruction of sugar cane had a profound impact on the sugar industry, affecting employment and export revenues. This disrupted the overall economic stability of the nation and necessitated long-term efforts for agricultural recovery. The consequences of this crop destruction rippled through the food supply chain, affecting both urban and rural populations, and required extensive measures to rehabilitate the agricultural sector and address the food security concerns that persisted long after the floodwaters receded.[153]

2.2.2.3 Political Impact

During the Pakistan floods of 2022, the country faced significant challenges related to its disaster management systems. The flood warning mechanisms were deemed insufficient, falling short in delivering timely and accurate information to communities at risk. The inefficacy of disaster preparedness and response systems worsened the repercussions of the floods, leaving numerous vulnerable populations without sufficient support and protection. The aftermath of the 2022 flood highlighted the pressing need for substantial improvements in Pakistan's disaster management infrastructure. The frequent changes in government in the lead-up to and during the Pakistan floods of 2022 had a detrimental effect on flood preparedness and response efforts. Political instability hindered the consistent implementation of flood preparedness plans and policies, leading to a lack of continuity in disaster management strategies. This instability resulted in delays in decision-making, allocation of resources, and coordination among government agencies and with international aid organizations. It also contributed to public disillusionment with the government's ability to effectively respond to such crises. Addressing political instability and establishing a stable and proactive approach to disaster management became imperative in the wake of the 2022 flood.[154]

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[153] "The 2022 Pakistan floods: Assessment of crop losses in Sindh Province using satellite data," ICIMOD, September 9, 2022, https://reliefweb.int/report/pakistan/2022-pakistan-floods-assessment-crop-losses-sindh-province-using-satellite-data#:~:text=The%20flood%20inundation%20is%20highest,flood%20inundation%20remained%20relatively%20lower.

[154] Michael Kugelman, "How Bad Governance Exacerbated Pakistan's Flooding," *Foreign Policy*, September 1, 2022, https://foreignpolicy.com/2022/09/01/pakistan-flooding-crisis-climate-change-governance/.

2.2.2.4 Long-Term Impact of Pakistan Floods 2022

The Pakistan floods of 2022 inflicted severe and lasting economic losses, particularly in the agricultural sector. Extensive crop damage, including rice and other staple crops, resulted in reduced agricultural output. These losses had long-lasting repercussions on the livelihoods of farmers and economy. Recovering agriculture sector took years, impacting income generation and economic stability for many affected households. Efforts to rebuild agricultural infrastructure and provide financial support to farmers were essential to mitigate the prolonged economic fallout of the floods. The floods in Pakistan in 2022 had long-term health implications, with concerns about malnutrition and waterborne diseases persisting well after the disaster. Food shortages and contaminated water sources contributed to malnutrition among vulnerable populations, especially children and pregnant women. Waterborne diseases, such as cholera and dysentery, remained a threat due to damaged sanitation infrastructure and limited access to clean water. Addressing these health issues required sustained efforts in healthcare provision, nutrition support, and water quality improvement to prevent ongoing suffering and health crises among flood-affected communities.

The inability to plant food crops for the 2023 growing season due to the extensive damage caused by the Pakistan floods of 2022 left the country heavily reliant on international aid and food imports. The loss of agricultural production meant that Pakistan had to rely on external assistance to meet its food needs. This dependency placed significant strain on the country's resources and international relief efforts. It also highlighted the importance of building resilience in the agricultural sector to reduce vulnerability to future disasters and decrease the reliance on external assistance for food security. The global consequences of the Pakistan floods in 2022 extended beyond the country's borders. The interconnectedness of global food markets meant that disruptions in one region could have far-reaching consequences. The 2022 Pakistan floods served as a stark reminder of the need for international cooperation and disaster preparedness to address the global repercussions of such natural disasters and to ensure food security for vulnerable populations worldwide.

Conclusion

In conclusion, the floods that occurred in 2010 and 2022 served as powerful examples of how natural disasters and political actions are deeply intertwined. These devastating events, rooted in the impacts of climate change and environmental factors, laid bare the profound consequences of governance and political responses. How the government managed these

crises, including its level of preparedness, effectiveness in providing relief, and transparency in distributing resources, significantly shaped how the public perceived and trusted its leadership. Beyond the immediate disaster relief efforts, these floods also became tools for political maneuvering, with opposition parties using them to highlight and critique government actions. This highlighted the critical role that political strategies play in the overall management of disasters. As Pakistan worked tirelessly to recover and rebuild, the lessons learned from these floods emphasized the urgent need for robust disaster preparedness, ethical governance, transparency, and accountability in political actions. Looking forward, the nation faces the imperative task of addressing the broader issue of climate change, strengthening disaster management capabilities, and fostering a political landscape where the well-being of citizens during times of crisis remains a top priority. The floods of 2010 and 2022 were not merely natural disasters; they served as potent reminders of the inseparable link between politics, policy, and the overall welfare of a nation's people when confronted with adversity. It underscores the fact that a nation's ability to handle such challenges effectively relies on a harmonious interaction between political decisions and the well-being of its citizens.

Chapter 3

Pakistan Government's Response to the Floods (2010 & 2022) and Flood Management

Introduction

Floods poses significant challenges to governments worldwide, demanding swift and effective responses to mitigate their impact on affected communities. In the case of Pakistan, a nation prone to recurrent and devastating floods, the government's response to such calamities has been a subject of critical examination and debate. The floods 2010 and 2022 highlighted complexities of disaster response and management. While the government, alongside national and international organizations, launched extensive emergency relief efforts, several shortcomings marred the response.[155] Positive aspects included rapid aid distribution and military involvement. However, issues like the absence of early warning systems, coordination problems between federal and provincial governments, inadequate disaster management infrastructure, and difficulties in relief supply distribution were apparent. Challenges in funding, accessibility, and supply chains also hampered efforts. Additionally, a long-standing lack of trust in government agencies led citizens to seek support from non-governmental and religious organizations. To address these challenges, a comprehensive approach is needed, focusing on disaster preparedness, improved coordination, infrastructure development, transparency, and trust rebuilding. Strategic planning for transitioning from immediate relief to long-term recovery is crucial for building resilience in affected communities. This chapter explores these facets, drawing lessons from Pakistan's experiences in disaster response and management.

3.1 Government Response to 2010 Flood in Pakistan

The government's response to floods in 2010 were marked by both positive efforts and notable shortcomings. In the face of such a colossal disaster, Pakistan's government undertook numerous initiatives to provide relief, rescue stranded citizens, and mitigate the impact of the floods. However, these efforts were marred by challenges related to coordination, resources, and long-term recovery planning.

[155] Nicole Laframboise, Boileau Loko, "Natural Disasters: Mitigating Impact, Managing Risks" *(International Monetary Fund*, October 2012), https://www.imf.org/external/pubs/ft/wp/2012/wp12245.pdf.

3.1.1 Immediate Response of Pakistan's Government during 2010

3.1.1.1 Floods Emergency Relief Efforts

The floods in Pakistan in 2010 stood as one of the most severe natural disasters in the nation's history, impacting millions of individuals and resulting in extensive devastation. Reacting to this crisis, the Pakistani government, in collaboration with various national and international organizations, commenced comprehensive relief endeavors to offer immediate help. The most pressing needs during a disaster is ensuring that affected populations have access to food. The government and organizations like the World Food Programme (WFP) distributed food packages that included rice, wheat, lentils, and cooking oil to affected communities. These distributions were essential in preventing widespread hunger.[156] Flooding often contaminates water sources, increasing the risk of waterborne diseases. Various organizations, including UNICEF, provided clean drinking water to communities by setting up water filtration systems and distributing water purification tablets. This helped mitigate the risk of waterborne diseases like cholera.[157] Access to medical care is crucial during a disaster, as injuries and illnesses can become more prevalent. Relief efforts included provision of medical supplies like first-aid kits and medicines. These services helped treat injuries and prevent the spread of diseases.[158]

With homes and infrastructure destroyed by the floods, providing shelter was a top priority. Organizations like the Red Crescent Society and UNHCR distributed tents and temporary shelters to displaced families, ensuring they had a safe place to stay.[159] At the early stages people were helpless and needed to be rescued. The Pakistani military, along with various international search and rescue teams, conducted extensive evacuation operations, rescuing people from rooftops and isolated areas. Some relief efforts included providing cash assistance to affected families. This allowed individuals to make choices about their most immediate needs, whether it was purchasing food, clothing, or other essentials. The UN and various international organizations performed well in coordinating relief efforts. They

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[156] "Distribution of Household Food Consumption, 2010," West Africa Brief, November 2016, http://www.west-africa-brief.org/content/en/distribution-household-food-consumption-2010

[157] Anwar Baig , Irfan Ahmad, "Provision of Safe Drinking Water for Flood Affected Areas" (https://pecongress.org.pk/images/upload/books/10-Provision%20of%20Safe%20(Dr.%20Anwar%20Baig)-11pt.pdf).

[158] Gabrielle A. Jacquet et.al, "Health Care Access and Utilization after the 2010 Pakistan Floods," Prehospital and Disaster Medicine, published online by Cambridge University Press, August 30, 2016, https://www.cambridge.org/core/journals/prehospital-and-disaster-medicine/article/abs/health-care-access-and-utilization-after-the-2010-pakistan-floods/DD38A13497E81CF371A2A2738926EF46.

[159] Vivian Tan, "School and Shelter for Pakistan's Flood Victims," *UNHCR News*, October 22, 2007, https://www.unhcr.org/news/school-and-shelter-pakistans-flood-victims.

worked with the Pakistani government to ensure that aid reached the most vulnerable and remote areas.[160] Public awareness campaigns were launched to educate the affected population about hygiene and disease prevention measures. These campaigns helped reduce the spread of waterborne diseases. In addition to immediate relief efforts, there were long-term recovery and rehabilitation programs aimed at rebuilding infrastructure, restoring livelihoods, and helping communities become more resilient to future disasters. The 2010 flood in Pakistan showcased the importance of national and international collaboration in responding to large-scale disasters. These efforts saved countless lives and helped communities recover and rebuild after the devastating floods. Various organizations, including the World Food Programme (WFP), UNICEF, the Red Crescent Society, and international search and rescue teams, played critical roles in these relief operations.

3.1.1.2 Establishment of Flood Emergency Cells

The government set up flood emergency cells and control rooms to coordinate relief and rescue efforts. This helped streamline communication and response efforts at the federal and provincial levels. The establishment of these flood emergency cells ensured a centralized approach to disaster management. This was crucial because it allowed for a unified response across various administrative levels. At the federal level, the National Disaster Management Authority (NDMA) played a pivotal role in coordinating efforts. They were able to communicate directly with provincial and district-level authorities, ensuring a synchronized response throughout the country.[161] With comprehensive data at their disposal, the flood emergency cells could allocate resources swiftly and effectively to areas in dire need. If a district was identified as facing imminent flooding, the relevant control room could dispatch rescue teams, boats, and medical supplies promptly to mitigate the impact and save lives.[162] The control rooms served as central communication hubs, enabling seamless information exchange among government agencies, relief organizations, and international partners. When international agencies like Médecins Sans Frontières (Doctors Without Borders) and UNICEF needed to coordinate their efforts with the Pakistani government, the control rooms provided a single point of contact, ensuring efficient collaboration. The control rooms issued timely flood warnings through various media channels, including radio and television,

[160] "Pakistan Floods 2010: Preliminary Damage and Needs Assessment," *Asian Development Bank*, November 2010, https://www.adb.org/sites/default/files/linked-documents/44372-01-pak-oth-02.pdf.
[161] "Pakistan Flood 2010: Learning from Experience" (National Disaster Management Authority, September 2011), https://cms.ndma.gov.pk/storage/app/public/publications/October2020/F9ouj1geVV4LUoiiVLm3.pdf.
[162] "Humanitarian Aid: Remembering the 2010 Floods in Pakistan, Helping Recovery," ReliefWeb, August 1, 2011, https://reliefweb.int/report/pakistan/humanitarian-aid-remembering-2010-floods-pakistan-helping-recovery.

allowing people to evacuate or take precautions before floodwaters arrived. Centralized control rooms facilitated rapid decision-making in response to evolving situations. If floodwaters were rising rapidly in a specific area, the control room could make quick decisions to send additional resources or evacuate residents to safer locations.[163] The flood emergency cells were instrumental in coordinating international assistance, ensuring it was effectively integrated into the overall response plan. The United States provided financial aid and dispatched military helicopters to assist with rescue and relief operations. The control rooms helped coordinate the reception and distribution of this international support.[164] So the establishment of flood emergency cells and control rooms during the 2010 flood in Pakistan was a critical component of the disaster response infrastructure. These centralized structures facilitated efficient coordination, data-driven decision-making, and international collaboration, ultimately saving lives and providing valuable lessons for future disaster preparedness and response efforts.

3.1.1.3 Deployment of Military and Civilian Resources

During the 2010 flood in Pakistan, the involvement of the Pakistani military played a pivotal role in providing relief and rescue operations. As the floodwaters began to inundate various regions of Pakistan, the government quickly recognized the need for a large-scale, organized response. Given their training, resources, and logistical capabilities, the Pakistani military was a natural choice to lead this effort. One of the primary roles of the military was conducting rescue operations. This involved deploying military personnel, including soldiers and divers, along with specialized equipment such as boats and helicopters, to reach stranded and isolated individuals in flood-affected areas. Military helicopters were used to airlift people from rooftops and other high-ground locations where they were trapped by rising floodwaters. The military played a crucial role in evacuating civilians from areas at high risk of flooding. This was especially important to ensure the safety of vulnerable populations, including women, children, and the elderly. Military personnel evacuated residents from flood-prone areas and transported them to safer locations, such as relief camps and government buildings. In addition to search and rescue operations, the military provided medical assistance to those injured or in need of medical attention due to flood-related injuries and illnesses.

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[163] "Information and Communication Technology Usage in the 2010 Pakistan Floods," ReliefWeb, September 9, 2011, https://reliefweb.int/report/pakistan/information-and-communication-technology-usage-2010-pakistan-floods.

[164] "U.S. Response to Pakistan's Flooding Disaster," *ReliefWeb*, September 1, 2010, https://reliefweb.int/report/pakistan/update-us-response-pakistans-flooding-disaster-1-sep-2010.

Mobile military medical units were set up to provide immediate medical care to flood victims. These units treated injuries and illnesses and administered vaccinations to prevent the outbreak of diseases. The military's logistical capabilities were crucial in delivering relief supplies to remote and hard-to-reach areas. Military trucks and helicopters were used to transport relief items such as food, clean water, tents, and medical supplies to areas that were cut off by floodwaters. Military engineers played a key role in repairing and reinforcing critical infrastructure such as dams, levees, and bridges, which had been damaged or threatened by the floods. Military engineering teams worked to reinforce embankments and prevent further breaches that could worsen flooding in certain areas. The military coordinated their efforts with civilian agencies to avoid duplication of efforts and to prioritize areas in need of immediate assistance. Military also played a role in maintaining security and order in affected areas. Military personnel ensured that relief distribution was conducted in an organized and secure manner, preventing potential looting or violence.[165] Beyond immediate relief efforts, the military continued to be involved in long-term Recovery and reconstruction activities, including rebuilding damaged infrastructure and providing ongoing support to affected communities. Military engineers were involved in repairing and reconstructing infrastructure contributing to overall recovery efforts. the deployment of military and civilian resources, particularly the Pakistani military, was essential during the 2010 flood in Pakistan. Their expertise, resources, and ability to respond swiftly to emergencies played a critical role in saving lives, providing relief to affected populations, and contributing to the overall recovery and resilience-building efforts in the aftermath of one of Pakistan's most devastating natural disasters.

3.1.1.4 International Aid Coordination

During the 2010 flood in Pakistan, international aid coordination was a critical component of the disaster response efforts. The Pakistani government actively sought assistance and cooperation from foreign governments, humanitarian organizations, and the United Nations to mobilize resources and expertise for flood relief. The government of Pakistan issued international appeals for assistance early in the crisis. This appeal conveyed the severity of the situation and requested support from the international community to address the humanitarian needs arising from the floods. Pakistan's President Asif Ali Zardari made an urgent appeal to the international community for assistance, highlighting the scale of the

[165] "Pakistani Army Plays Leading Role in Relief Operations," *DW News*, August 20, 2010, https://www.dw.com/en/pakistani-army-plays-leading-role-in-relief-operations/a-5928935.

disaster and the need for immediate help. The UN's Office for the Coordination of Humanitarian Affairs assists Pakistani government and facilitate the arrival and effective distribution of aid. OCHA established a coordination hub in Islamabad to facilitate communication and collaboration between UN agencies, humanitarian organizations, and the Pakistani government. Numerous international humanitarian organizations, including the Red Cross , Oxfam, mobilized resources and personnel to provide immediate relief and medical assistance to flood-affected communities. The International Federation of Red Cross and Red Crescent Societies launched a global emergency appeal to support the relief efforts in Pakistan, raising funds and deploying teams to provide essential relief items.[166] Many countries, including US, UK, China, and Saudi Arabia, provided bilateral aid to Pakistan. This aid consisted of financial contributions, relief supplies, and technical assistance. The United States government pledged substantial financial aid to Pakistan, which was used to support relief operations, provide food and clean water, and rebuild infrastructure. Pakistan also received assistance through multilateral channels, such as the World Bank and the Asian Development Bank . These institutions provided financial support for long-term recovery and reconstruction efforts. The World Bank approved a significant loan to Pakistan for flood recovery and rehabilitation projects, including rebuilding infrastructure and restoring livelihoods. International donor conferences were organized to mobilize financial support for Pakistan's flood relief and recovery efforts. These conferences brought together countries and organizations willing to pledge financial assistance. The International Donors' Conference for Flood Relief in Pakistan, held in Brussels in 2010, resulted in pledges of substantial financial support from various nations and organizations. International agencies and organizations worked closely with the Pakistani government to align their assistance with the country's priorities and needs. Coordination ensured that aid reached the most affected areas and populations. Humanitarian organizations and UN agencies collaborated with local authorities to conduct needs assessments and prioritize relief efforts in flood-affected regions. International assistance included food, clean water, medical supplies, shelter materials, and hygiene kits. Efforts were made to ensure equitable and efficient distribution of aid to the affected communities. Aid agencies partnered with local organizations and government authorities to distribute relief items directly to those in need, particularly in remote and hard-to-reach areas. International organizations and donor

[166] "Pakistan Flood 2010: Learning from Experience" National Disaster Management Authority, September 2011), https://cms.ndma.gov.pk/storage/app/public/publications/October2020/F9ouj1geVV4LUoiiVLm3.pdf.

countries supported initiatives to rebuild schools, hospitals, and roads, as well as to improve flood preparedness and response mechanisms.[167] International aid coordination during the 2010 flood in Pakistan was instrumental in addressing the humanitarian crisis and supporting the country's recovery efforts. It exemplified the global community's willingness to collaborate and provide timely assistance in the face of a devastating natural disaster, ultimately helping Pakistan cope with and rebound from the extensive damage caused by the floods.

3.1.2 Shortcomings of Government Response to Floods in 2010

3.1.2.1 Delay in Response and Coordination

The 2010 flood in Pakistan underscored the challenges in the government's response, highlighting intricate socio-political dynamics. The delays and inefficiencies in relief efforts revealed not only coordination issues between federal and provincial levels but also underlying power struggles and resource disputes. The shared responsibility for disaster management became a source of contention, emphasizing the broader political ecology. The lack of coordinated decision-making and resource allocation reflected a complex interplay of political interests and governance structures. This not only impeded timely assistance but also revealed the political dimensions influencing disaster response. The conflicts over responsibilities and resources echoed the broader issues within the political ecology, where decision-making and resource access are entangled in power dynamics and governance complexities.[168]

The sheer scale of the flooding made it challenging to deliver aid and relief supplies to remote and inundated regions. Insufficient transportation and logistical support further slowed down response efforts. In some cases, aid shipments were delayed because of difficulties in transporting relief supplies to areas that were cut off by floodwaters, leading to shortages of essential items. Floodwaters submerged roads and bridges, making it difficult for relief teams and aid convoys to reach affected communities. This limited access contributed to delays in providing assistance. Many villages and towns were completely isolated, with no access by road or air. It took time to establish alternative routes and deploy resources to these areas. Pakistan, like many countries prone to natural disasters, faced challenges in terms of disaster preparedness. A lack of pre-positioned relief supplies and

[167] "Pakistan Floods 2010: Preliminary Damage and Needs Assessment" (Asian Development Bank, November 2010), https://www.adb.org/sites/default/files/linked-documents/44372-01-pak-oth-02.pdf.
[168] "Ready or Not: Pakistan's Resilience to Disasters One Year On from the Floods," Oxfam, July 26, 2011, https://oxfamilibrary.openrepository.com/bitstream/handle/10546/138689/bp150-ready-not-pakistan-resilience-disasters-floods-260711-en.pdf?sequence=1&isAllowed=y.

well-defined disaster response plans resulted in a slower initial response. Relief agencies and government departments struggled to mobilize resources and personnel quickly because there were no well-practiced emergency response plans in place.[169]

Bureaucratic red tape and administrative hurdles within the government slowed down the procurement and distribution of relief supplies. Delays in obtaining necessary approvals and paperwork for the purchase and transport of aid items hindered the timely distribution of relief. Inadequate communication infrastructure in many flood-affected areas meant that requests for assistance and information about needs were not reaching the authorities in a timely manner. Local communities often struggled to communicate their urgent needs to government officials, resulting in delays in resource allocation. Even when aid arrived in certain areas, distribution challenges, such as a lack of trained personnel and equitable distribution systems, further delayed relief efforts. Reports emerged of relief supplies being unevenly distributed, with some communities receiving more aid than others due to poor coordination at the distribution points. The demand for trained personnel in disaster response far exceeded the available resources, leading to delays in implementing relief and rescue operations. There were not enough trained search and rescue teams and medical personnel to respond promptly to the scale of the disaster.[170] The 2010 flood in Pakistan exposed systemic issues in disaster response and coordination, resulting in slow and inefficient relief efforts. Delays were exacerbated by poor coordination between federal and provincial governments, logistical challenges, limited access to affected areas, inadequate preparedness, bureaucratic hurdles, communication gaps, and distribution challenges. These delays had a significant impact on the affected population, as timely assistance and relief were crucial in mitigating the suffering caused by the devastating floods.

3.1.2.2 Corruption and Mismanagement

During the 2010 flood in Pakistan, reports of corruption and mismanagement emerged, significantly affecting the distribution of relief supplies and funds. These issues diverted resources away from the most vulnerable populations, exacerbating the challenges faced by flood-affected communities. Reports and investigations uncovered instances where relief funds intended for flood victims were misappropriated or embezzled by corrupt officials. In Sindh province, allegations of corruption and mismanagement led to protests by flood

[169] Thomas D. Kirsch, Christina Wadhwani and Christina Catlett, "Impact of the 2010 Pakistan Floods on Rural and Urban Populations at Six Months," August 22, 2012, doi: 10.1371/4fdfb212d2432.

[170] Tatsushi Arai, "Rebuilding Pakistan in the Aftermath of the Floods: Disaster Relief as Conflict Prevention," *Journal of Peacebuilding & Development* 7, no. 1 (2012): 51–65, https://www.jstor.org/stable/48603409.

victims who accused officials of diverting funds meant for their assistance. These protests highlighted the misallocation of relief resources. There were instances where corrupt individuals exploited the relief registration process to include fictitious beneficiaries or exclude genuine flood victims, diverting aid to undeserving parties. In some areas, local officials were found to have manipulated beneficiary lists, resulting in aid being distributed to non-existent or politically influential individuals, rather than those in genuine need. Reports indicated that relief supplies, including food and shelter materials, were sometimes sold on the black market by corrupt individuals instead of being distributed to the intended beneficiaries. News stories highlighted cases where relief supplies provided by humanitarian organizations and the government ended up for sale in local markets, depriving flood victims of essential items. Bureaucratic red tape and corrupt practices slowed down relief efforts. Officials demanding bribes or engaging in corrupt practices hindered the efficient distribution of aid. There were reports of local officials demanding bribes from affected families to expedite the processing of aid applications, delaying assistance to those who couldn't afford to pay.

Corrupt practices often led to the unequal distribution of aid, with influential individuals or communities receiving a disproportionate share of relief resources. In certain areas, political affiliations or connections played a role in determining who received aid, disadvantaging marginalized and vulnerable populations.[171]Corruption and mismanagement disproportionately affected vulnerable populations who often lacked the means to navigate corrupt systems or seek help. The perception of corruption eroded trust in relief efforts, making it more challenging for humanitarian organizations and the government to effectively reach those in need. Community members in flood-affected areas expressed disillusionment and frustration, undermining the overall effectiveness of relief efforts. Corruption and mismanagement significantly marred the response to the 2010 flood in Pakistan, diverting relief supplies and funds away from the most vulnerable populations. These corrupt practices not only hindered the efficient distribution of aid but also eroded trust in relief efforts, exacerbating the challenges among communities.

3.1.2.3 Inadequate Infrastructure

During the 2010 flood in Pakistan, inadequate infrastructure also worsens the situation. The country's infrastructure was ill-equipped to handle such a large-scale event, and the lack of

[171] Susanne Mahrwald, "Pakistan after the Flood: Needs and Challenges for a Sustainable Reconstruction," Heinrich Böll Stiftung, January 10, 2011, https://www.boell.de/en/2014/01/20/pakistan-after-flood-needs-and-challenges-sustainable-reconstruction-internal-security.

proper drainage systems exacerbated the flooding. Pakistan's drainage systems, particularly in urban areas, were often insufficient to cope with heavy rainfall and flash floods. Inadequate drainage exacerbated flooding in many regions. In cities like Karachi and Lahore, outdated and poorly maintained drainage systems struggled to accommodate the excessive rainfall, resulting in waterlogging and further inundation of low-lying areas during the floods. Pakistan's infrastructure, including roads, bridges, and embankments, was in various states of disrepair and was not adequately maintained. Reports highlighted instances where roads and bridges collapsed under the force of floodwaters, cutting off access to affected communities and hindering relief efforts.

In rural areas along riverbanks, the absence of proper flood protection measures meant that villages and agricultural lands were often submerged, leading to extensive crop damage and displacement of residents. Silt build-up in riverbeds and canals reduced their capacity to carry water, leading to overflow and flooding during heavy rains. The Indus River, Pakistan's largest river, experienced significant siltation over the years, reducing its ability to channel floodwaters effectively. This contributed to widespread inundation. Rapid urbanization without proper city planning often led to the encroachment of floodplains and waterways. This left urban areas highly vulnerable to flooding. In cities like Islamabad and Rawalpindi, urban expansion without regard for natural drainage patterns resulted in severe flooding during the 2010 disaster. Many communities were caught off guard by the sudden rise in water levels, as there were no reliable flood warning systems in place to provide advance notice. Flooding disrupted agricultural infrastructure, including irrigation systems and storage facilities. The inundation of farmlands and damage to irrigation canals and infrastructure led to crop losses and reduced agricultural output, affecting both farmers' livelihoods and food availability. The 2010 flood underscored the need for investments in flood control infrastructure . Subsequent to the 2010 flood, the government and international organizations initiated infrastructure projects aimed at strengthening flood protection measures and improving water management systems.[172] The state of the country's infrastructure, combined with rapid urbanization and environmental factors like silted riverbeds, highlighted the need for comprehensive planning and investment in resilient infrastructure to mitigate the devastating effects of such large-scale disasters in the future.

[172] Samar Deen, "Pakistan 2010 Floods: Policy Gaps in Disaster Preparedness and Response," *International Journal of Disaster Risk Reduction* 12 (June 2015): 341-349, https://www.sciencedirect.com/science/article/abs/pii/S2212420915000308.

3.1.2.4 Insufficient Relief Efforts

During the 2010 flood in Pakistan, relief efforts, while initiated, were frequently criticized for not being extensive enough to reach all affected communities and individuals. Several factors contributed to this insufficiency, leading to significant challenges . The sheer scale of the 2010 flood in Pakistan, which affected millions of people and inundated vast areas, overwhelmed relief organizations and government agencies, making it challenging to provide comprehensive assistance. UN estimated that over 20 million people were affected and relief efforts struggled to keep pace with the scale of the disaster. Relief organizations often faced resource constraints, including funding, personnel, and relief supplies, which limited their capacity to reach all affected areas. Some humanitarian organizations reported shortages of essential relief items like food, clean water, and shelter materials, which prevented them from meeting the needs of all flood-affected communities.[173]

Funding shortages and delays in securing financial support from donors hampered the scale and effectiveness of relief operations. The United Nations' initial appeal for funding to assist flood-affected communities faced delays in donor contributions, which hindered the timely rollout of relief efforts. The floods disrupted transportation and logistics, making it difficult to access remote and isolated areas, further limiting the reach of relief efforts. Flooded roads and damaged infrastructure impeded the delivery of relief supplies and the deployment of aid workers to some of the worst-affected regions. Coordination challenges among relief organizations, government agencies, and international partners sometimes resulted in duplication of efforts and gaps in assistance. In certain areas, multiple organizations distributed relief supplies independently, while others struggled to gain access, leading to uneven coverage and potential inefficiencies.[174] Some flood-affected areas were difficult to access due to the extent of inundation and the absence of suitable transportation options. Communities in remote and hard-to-reach regions, including those cut off by floodwaters, faced prolonged delays in receiving assistance due to limited accessibility.

Relief organizations often prioritized high-density population centres and areas with the most immediate needs, leaving less populated or remote areas with limited assistance. While major cities and densely populated regions received substantial aid and attention, smaller villages and isolated communities sometimes received less assistance or faced delays in

[173] Britannica, T. Editors of Encyclopaedia. "Pakistan Floods of 2010." Encyclopedia Britannica, March 21, 2023. https://www.britannica.com/event/Pakistan-Floods-of-2010.

174 "Unequal Flood Relief in Pakistan," Al Jazeera, September 8, 2010, https://www.aljazeera.com/news/2010/9/8/unequal-flood-relief-in-pakistan.

relief distribution. In some cases, women and girls reported challenges in accessing sanitation facilities and health services, highlighting the gaps in relief services for specific populations.[175] The insufficiency of relief efforts during the 2010 flood exposed resource limitations, funding constraints, logistical challenges, coordination issues, accessibility problems, and prioritization of high-impact areas. These challenges underscore the need for more comprehensive disaster preparedness and response strategies to ensure that all affected communities receive the assistance they require during large-scale disasters.

3.2 Government Response to 2022 Flood in Pakistan

The floods that inundated Pakistan in 2022 presented yet another significant challenge for the nation, reminiscent of the devastating floods experienced in 2010. As in the past, the government's response to this natural disaster exhibited a mixture of positive actions and notable shortcomings. When faced with the immense task of addressing the 2022 flood crisis, Pakistan's government initiated a range of measures aimed at providing immediate relief, rescuing stranded individuals, and minimizing the flood's adverse effects. However, these efforts were not without their challenges, encompassing issues related to coordination, resource allocation, and long-term recovery planning.

3.2.1 Immediate Response

3.2.1.1 Army Deployment and Search & Rescue Operations

During the devastating 2022 flood , deployment of army troops and extensive search and rescue operations were crucial components of the disaster response efforts.. In response to the 2022 flood, the deployment of over 20,000 army troops underscored the magnitude of the disaster. Given the widespread nature of the floods across Pakistan's provinces, a substantial military presence was required to provide aid and support. The utilization of hundreds of helicopters and C1-30 aircraft sorties during the 2022 flood showcased the military's commitment to swift and efficient response. These aircraft were instrumental in reaching remote and isolated areas that were cut off by floodwaters, ensuring that aid and relief supplies could be delivered promptly during the 2022 flood. The army troops not only provided immediate relief during the 2022 flood but also contributed to logistical support, including the transportation of relief materials, medical supplies, and personnel to the areas affected by the 2022 flood. This logistical infrastructure was vital in ensuring the efficient distribution of aid during the 2022 flood. The deployment of army troops during the 2022

[175] "Early Recovery-Floods 2010," National Disaster Management Authority, March 2012, https://cms.ndma.gov.pk/storage/app/public/publications/October2020/Z4ieyJrvrNiiR2o1oupF.pdf.

flood also allowed for a centralized command structure, facilitating better coordination among various relief agencies and ensuring a more organized and effective response to the crisis posed by the 2022 flood.[176] The motorboats were crucial in reaching people stranded in flooded areas swiftly during the 2022 flood. During the 2022 flood, the primary objective of search and rescue operations was to save lives. Floodwaters can rise rapidly, trapping individuals in their homes or on rooftops. The use of motorboats during the 2022 flood enabled the timely evacuation of those in immediate danger, reducing the risk of casualties. Floods during the 2022 flood often rendered roads impassable, making traditional modes of transportation ineffective. Motorboats were an ideal choice for navigating through flooded streets and accessing areas that would have otherwise been unreachable during the 2022 flood.[177]

In addition to evacuations, these motorboats during the 2022 flood were equipped to provide emergency medical assistance to those injured or in need of medical attention. This comprehensive approach ensured that not only were people rescued during the 2022 flood but also provided with essential medical care. These actions during the 2022 flood demonstrated the country's commitment to saving lives, providing immediate relief, and ensuring that aid reached even the most remote and isolated communities affected by the disaster. The coordination and resources employed in these efforts reflected a determined response to the crisis posed by the 2022 flood.

3.2.1.2 Financial Assistance

During the 2022 flood in Pakistan, financial assistance alleviates the suffering of affected communities and supporting their recovery efforts. The allocation of Rs 70 billion by the federal government for flood relief assistance, with 63 percent of this aid distributed through the Benazir Income Support Program (BISP), was a significant initiative aimed at providing financial support to flood-affected individuals and households. The allocation of Rs 70 billion by the federal government during the 2022 flood demonstrated the government's recognition of the widespread destruction caused due to floods and the urgent need for financial assistance to help affected communities recover.178 The Benazir Income Support Program (BISP) also helped in the distribution of financial assistance during the 2022 flood.

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[176] "Floods in Pakistan: Rethinking the Humanitarian Role," November 2022, https://www.humanitarianoutcomes.org/sites/default/files/publications/pakistan_floods_1122.pdf.

[177] Sajjad Shaukat, "Armed Forces' Flood Relief Operations Continue," *Pakistan Today*, October 14, 2022, https://www.pakistantoday.com.pk/2022/10/14/armed-forces-flood-relief-operations-continue/.

[178] Haseeb Hanif, "Distribution of Aid Among Flood Victims Questioned," *The Express Tribune*, December 07, 2022, https://tribune.com.pk/story/2389823/distribution-of-aid-among-flood-victims-questioned.

Established to provide cash transfers to low-income families and vulnerable populations, BISP was well-equipped to the needs of flood-affected individuals. BISP's extensive network and database of beneficiaries allowed for a targeted and efficient distribution of financial aid. This approach ensured that assistance reached those most in need during the 2022 flood. The decision to distribute 63 percent of the allocated funds through BISP indicated a deliberate effort to leverage an existing social safety net program to provide immediate relief to those affected by the 2022 flood.[179]

The financial assistance provided during the 2022 flood could be used by affected individuals and households to meet a range of urgent needs. This included purchasing essential food and non-food items, repairing damaged homes, and covering medical expenses for flood-related injuries or illnesses. Financial aid also played a crucial role in helping families rebuild their lives after the 2022 flood, as it could be used for long-term recovery efforts, such as rebuilding homes and replacing lost assets. The 2022 flood not only caused immediate physical damage but also inflicted economic hardship on affected communities. Financial assistance aimed to mitigate this hardship, providing a safety net to help individuals and families regain their economic stability. By distributing a significant portion of the allocated funds through BISP, the government demonstrated a commitment to addressing both the immediate and longer-term economic challenges. The financial assistance not only provided immediate relief to those affected by the floods but also contributed to their economic recovery and resilience-building. It exemplified the commitment to supporting vulnerable populations during times of crisis.

3.2.1.3 Distribution of Relief Supplies

The distribution of relief supplies during the 2022 flood in Pakistan was a critical aspect of the disaster response, aimed at providing essential aid to the affected populations and helping them cope with the immediate challenges posed by the floods. The scale and coordination of this effort involved multiple agencies, organizations, and international assistance, demonstrating a comprehensive approach to addressing the needs of flood-affected communities. The quantity and variety of relief supplies distributed were indicative of the extensive impact of the 2022 flood on Pakistan. tents were provided to offer shelter to displaced individuals and families, while tarpaulins were distributed to create makeshift shelters in areas where setting up tents was not feasible. The distribution also included 3.5

[179] "BISP Starts Distribution of Rs25000 Assistance Among Flood Victim Families," Radio Pakistan, August 28, 2022, https://radio.gov.pk/28-08-2022/bisp-starts-distribution-of-rs25000-assistance-among-flood-victim-families.

million mosquito nets, recognizing the heightened risk of vector-borne diseases in flood-affected regions. Additionally, WFP 2.8 million food packs were distributed to address immediate food security concerns among affected populations.[180] Relief efforts during the 2022 flood involved a collaborative approach among various entities. These included the NDMA, provincial disaster management authorities (PDMAs), foreign assistance, humanitarian groups, and the Armed Forces.[181]This collaboration was essential in pooling resources, expertise, and logistics to ensure efficient and widespread distribution of relief supplies. The NDMA and PDMAs played a crucial role in coordinating relief efforts at the national and provincial levels, respectively. They helped identify priority areas, assess needs, and oversee the distribution process. Foreign assistance, such as aid from international organizations and foreign governments, contributed significantly to the relief supplies. This support was instrumental in expanding the available resources and reaching a larger number of flood-affected individuals. Humanitarian groups played a vital role in mobilizing volunteers, managing distribution points, and providing essential services to affected communities. The involvement of the Armed Forces, with their logistical capabilities and personnel, ensured the efficient transportation and distribution of relief supplies to even the most remote and hard-to-reach areas impacted by the floods.[182]

The relief supplies addressed fundamental needs of the affected populations during the 2022 flood. Tents and tarpaulins provided shelter and protection from the elements, particularly important for those displaced from their homes. The distribution of mosquito nets aimed to prevent the spread of vector-borne diseases, which can become a significant health risk in flood-affected regions where stagnant water creates breeding grounds for mosquitoes.[183] Food packs ensured that people had access to nourishment during a period of disrupted livelihoods and limited access to food resources. the distribution of relief supplies during the 2022 flood in Pakistan was a massive and coordinated effort involving multiple agencies and organizations. This comprehensive approach helped in immediate needs providing shelter

[180] World Food Programme (WFP).,"Pakistan Floods Situation Report, 16 December 2022," ReliefWeb, https://reliefweb.int/report/pakistan/wfp-pakistan-floods-situation-report-16-december-2022.

[181] "Floods in Pakistan: Rethinking the Humanitarian Role," SDPI, November 2022, https://www.humanitarianoutcomes.org/sites/default/files/publications/pakistan_floods_1122.pdf.

[182] "PAKISTAN FLOODS 2022 Post-Disaster Needs Assessment," *The World Bank*, https://thedocs.worldbank.org/en/doc/4a0114eb7d1cecbbbf2f65c5ce0789db-0310012022/original/Pakistan-Floods-2022-PDNA-Main-Report.pdf

[183] "UNHCR Hands Over 7,000 Tents, Thousands of Emergency Relief Items to Khyber Pakhtunkhwa Government," UNHCR Pakistan, September 2, 2022, https://www.unhcr.org/pk/14781-unhcr-hands-over-7000-tents-thousands-of-emergency-relief-items-to-khyber-pakhtunkhwa-government.html.

and access to food. The collaborative efforts of various entities demonstrated the importance of coordination and cooperation in responding effectively to large-scale disasters.

3.2.1.4 Comprehensive Health Response During Pakistan's 2022 Flood

The comprehensive health plan implemented during the 2022 flood in Pakistan was crucial in addressing the healthcare needs of the affected populations and mitigating the health risks associated with flooding. This plan involved a multi-faceted approach that included the establishment of medical camps, collaboration with provincial healthcare facilities, armed forces medical camps, and support from international and national organizations. The primary objectives were disease monitoring, the distribution of medicines, and ensuring access to healthcare services in the affected areas. Medical camps were set up in flood-affected regions to provide immediate healthcare services to those in need. These camps served as essential hubs for medical assessment, treatment, and monitoring of health conditions. The proximity of medical camps to affected communities ensured that individuals could access medical care without having to travel long distances, which might have been challenging due to damaged infrastructure and flooding.[184] Collaboration with provincial healthcare facilities was a key aspect of the health plan. This partnership allowed for the integration of medical resources and expertise, ensuring that the healthcare response was well-coordinated and efficient. Provincial healthcare facilities could provide advanced medical services and facilities, such as hospitals and specialized treatment, which complemented the services offered at medical camps. The involvement of the armed forces in establishing medical camps was significant. The armed forces have well-trained medical personnel and logistical capabilities that were invaluable during the disaster response. These medical camps operated in areas where access was challenging, thanks to the armed forces' ability to deploy resources quickly and efficiently to remote and isolated locations.[185]

International and national organizations played a crucial role in providing support, including medical supplies, personnel, and expertise. International organizations often have experience in responding to similar disasters globally and can bring best practices to the local response

[184] Rahul Basharat, "Emergency Health Camps Offer a Lifeline to Flood-Affected Families in Pakistan," Vaccineswork, October 13, 2022, https://www.gavi.org/vaccineswork/emergency-health-camps-setup-across-pakistan.

[185] Umair Jamal, "Military Helps With Rescue and Relief Efforts in Flood-Ravaged Pakistan," *The Diplomat*, September 28, 2022, https://thediplomat.com/2022/09/military-helps-with-rescue-and-relief-efforts-in-flood-ravaged-pakistan/.

efforts.[186]Adequate stocks of medicines, including antibiotics and vaccines, were made available . The comprehensive health plan implemented during the 2022 flood in Pakistan highlighted the importance of a well-coordinated and multi-pronged approach to healthcare delivery during a disaster. The establishment of medical camps, collaboration with provincial healthcare facilities, support from the armed forces and international organizations, and the focus on disease monitoring and medicine distribution were all critical components of the plan.

3.2.1.5 Rehabilitation and Reconstruction

Rehabilitation and reconstruction efforts are crucial to assist affected communities. These initiatives go beyond immediate relief and focus on restoring homes, infrastructure, and livelihoods, enabling long-term recovery and resilience. One of the primary goals of rehabilitation and reconstruction efforts is to rebuild or repair damaged or destroyed homes. Many families are left homeless or with severely damaged dwellings after floods, making shelter a top priority. These efforts typically involve providing construction materials, technical assistance, and financial support. This enables them to reconstruct or repair their homes, providing a sense of stability and security. Rehabilitation efforts aim to restore these vital components of communities. Rebuilding infrastructure not only enhances access to essential services but also supports economic activities by ensuring the smooth flow of goods and people. It promotes the overall well-being and development of the affected regions.[187] The 2022 flood in Pakistan disrupted the livelihoods of many individuals and communities, particularly those dependent on agriculture or small businesses. Rehabilitation efforts include programs and initiatives to revive and strengthen these livelihoods. This support may involve providing seeds, livestock, or financial assistance to farmers and small business owners. By restoring livelihoods, communities can regain economic stability and reduce their dependence on external aid. Beyond physical reconstruction, rehabilitation efforts often incorporate community-based approaches to enhance resilience. This may include disaster preparedness training, early warning systems, and the development of sustainable practices that reduce vulnerability to future floods. Strengthening community resilience empowers residents to better cope with and respond to future disasters, ultimately reducing the impact

[186] "Joint Launch of 2022 Pakistan Floods Response Plan by Government of Pakistan and the United Nations," *ReliefWeb*, August 30, 2022, https://reliefweb.int/report/pakistan/joint-launch-2022-pakistan-floods-response-plan-government-pakistan-and-united-nations.

[187] "Rebuilding after 2022 Pakistan Floods: IFRC Reiterates Continued Need for Support," *ReliefWeb*, September 14, 2023, https://reliefweb.int/report/pakistan/rebuilding-after-2022-pakistan-floods-ifrc-reiterates-continued-need-support.

of such events. The government typically takes the lead in coordinating and implementing these rehabilitation and reconstruction efforts. They allocate funds, establish policies, and collaborate with international organizations and NGOs to ensure a comprehensive and effective response.188 It's important to emphasize that rehabilitation and reconstruction efforts are part of a long-term recovery process. Recovery can take years, and ongoing support and monitoring are essential to ensure that communities can rebuild their lives and become more resilient to future disasters. rehabilitation and reconstruction efforts following floods in Pakistan are vital for the recovery and resilience of affected communities. These efforts encompass restoring homes, rebuilding infrastructure, supporting livelihoods, and strengthening community resilience. While immediate relief is crucial, long-term recovery efforts are essential for ensuring that individuals and communities can regain stability and thrive in the face of future challenges.

3.2.1.6 Role of NDMA

In Pakistan, the primary role in disaster management is entrusted to the National Disaster Management Authority (NDMA). The fundamental mission of the NDMA revolves around guaranteeing preparedness, efficient response, and resilient recovery measures to alleviate the impacts of various natural disasters, such as floods, earthquakes, and droughts .[189] In the wake of the 2022 flood, the NDMA took decisive action by activating the National Emergency Operations Center (NEOC). This activation aimed to centralize and streamline the national response efforts, deploying emergency response teams to the areas most affected. The NDMA collaborated closely with provincial and district-level disaster management authorities and partnered with non-governmental organizations and international aid agencies to provide urgently needed relief to affected populations. The NDMA's response strategy encompassed a multifaceted approach to cater to immediate requirements. This involved search and rescue missions, the evacuation of affected communities, the provision of essential food and shelter, and the delivery of crucial medical assistance. Additionally, the NDMA gave top priority to the restoration of critical

[188] Zaira Manzoor et.al, "Floods and Flood Management and Its Socio-Economic Impact on Pakistan: A Review of the Empirical Literature," *Frontiers in Environmental Economics and Management*, Volume 10, 2022, https://doi.org/10.3389/fenvs.2022.1021862.

[189] National Disaster Risk Management Framework Pakistan, March 2007, https://cms.ndma.gov.pk/storage/app/public/plans/September2020/Wj3qeqvxfZguSu7NWLI2.pdf.

infrastructure, including roads and bridges, to facilitate aid distribution and support economic recovery efforts.[190]

Despite the myriad challenges faced, the NDMA's role in Pakistan's disaster management landscape remains pivotal. It continues to worked in ensuring the government's readiness to respond to natural disasters. Moreover, it actively contributes to enhancing disaster risk reduction measures, such as investing in advanced early warning systems, fortifying community resilience, and fostering disaster preparedness at all levels of society. The 2022 flood in Pakistan serve as a reminder of the importance of disaster management. It underscores ongoing necessity for concerted efforts to enhance preparedness and response in anticipation of future natural disasters. In this endeavour, the NDMA's role remains indispensable. Collaboration with fellow government agencies, civil society organizations, and international partners will be imperative.

3.2.1.7 Role of NFRCC

The establishment of the National Flood Response Coordination Committee (NFRCC) by the Government of Pakistan is a commendable step towards effective disaster management. The formation of NFRCC, comprising federal and provincial stakeholders along with the Pakistan Armed Forces, reflects a well-organized and coordinated approach to disaster response. Having various agencies and levels of government involved ensures a more efficient and comprehensive response to flood disasters. The inclusion of multiple agencies in NFRCC, including the military, enables a diverse range of resources and expertise to be leveraged during flood responses. This collaboration can lead to quicker and more effective disaster relief efforts. The establishment of NFRCC showcases the government's proactive stance towards disaster management. Being prepared with a designated committee before disasters occur allows for a more rapid and organized response, ultimately saving lives and reducing the impact of flooding.[191] The government's willingness to request assistance from the United Nations and the international community demonstrates a commitment to working with the global community to address disaster-related challenges. This openness to collaboration can enhance the effectiveness of relief efforts and bring in much-needed resources. The launch of the PKR 37.2 billion flood relief cash program for 1.5 million affected families underscores the government's dedication to providing immediate financial

[190] Wardah Sattar, "Pakistan Floods of 2022 & the Role of NDMA," CSSPMS Current Affairs, February 24, 2023, https://csspmscurrentaffairs.com/pakistan-floods-of-2022/#:~:text=III.&text=In%20response%20to%20the%202022,district

[191] https://nfrcc.gov.pk/

assistance to those directly impacted by flooding. This direct support can help affected families meet their basic needs and begin the process of recovery.[192]

Collaborating with the United Nations to launch the 2022 Pakistan Flood Response Plan (FRP) signifies a structured and well-thought-out approach to addressing the humanitarian needs of flood-affected populations. Such plans ensure that relief efforts are targeted and effective, addressing critical areas of concern. the government's initiatives, including the establishment of NFRCC, seeking international assistance, implementing a flood relief cash program, and launching the Pakistan Flood Response Plan, collectively demonstrate a proactive and comprehensive approach to disaster management and relief efforts in the face of flooding in Pakistan. These actions reflect a commitment to safeguarding the well-being of the population and mitigating the impact of natural disasters.

3.2.1.8 Floods Response Plan (FRP)

The 2022 Pakistan Floods Response Plan (FRP) was jointly launched by the Government of Pakistan and the United Nations in Islamabad and Geneva. It is a response to devastating rains, floods, and landslides affecting more than 33 million people in Pakistan. It focused in assisting 5.2 million people with life-saving activities, requiring US$ 160.3 million in funding. It covers various sectors, including food security, agriculture and livestock, shelter, nutrition. The plan is comprehensive and multi-sectoral, addressing the diverse needs of affected populations. The Government of Pakistan collaborates with the UN and other partners to address the humanitarian crisis. The FRP outlines the government's efforts to manage the challenges and sets a coordinated plan of action. It is inclusive, encompassing thematic clusters such as food security, health, education, protection, shelter, and more. Foreign Minister Bilawal Bhutto Zardari highlights the nation's support for the government's efforts. He mentions the Prime Minister's Flood Relief Fund 2022, designed to facilitate contributions for flood relief. The appeal is acknowledged as a part of the broader effort to address the crisis.[193] The international community's support and solidarity are emphasized as crucial in alleviating suffering and rebuilding communities.

UN Secretary General Antonio Guterres acknowledges the severe impact of heavy rains and flooding on Pakistan. The government's swift response and release of national funds are

[192] Syed Irfan Raza, "Rs37.2bn Cash Assistance for Flood-Hit People Launched," *Dawn*, August 20, 2022, https://www.dawn.com/news/1705837/rs372bn-cash-assistance-for-flood-hit-people-launched.

[193] "CURTAIN RAISER: Launch of UN Flash Appeal – 2022 Pakistan Floods Response Plan," Ministry of Foreign Affairs of Pakistan, https://mofa.gov.pk/curtain-raiser-launch-of-un-flash-appeal-2022-pakistan-floods-response-plan/#:~:text=The%20%E2%80%9C2022%20Pakistan%20Floods%20Response,simultaneously%20in%20Islamabad%20and%20Geneva.

noted. The scale of needs is described as increasing and requiring the collective attention of the world. The launch of FRP is a joint effort by the Government of Pakistan and the United Nations to address extensive humanitarian crisis caused by floods. The FRP aims to provide life-saving support to 5.2 million people across various sectors, with a focus on collaboration and inclusivity. International support and solidarity are crucial in helping Pakistan recover and rebuild in the face of this disaster.

3.2.1.9 International Cooperation

Pakistan's cooperation with the international community extends beyond receiving foreign aid during crises like the 2022 flood. The country actively engages in regional and global initiatives, hosting refugees, countering terrorism, addressing climate change, providing humanitarian assistance, and participating in multilateral diplomacy. The United Nations played a pivotal role in coordinating the global response to Pakistan's flooding crisis. Recognizing the severity of the situation, the United Nations revised its humanitarian aid appeal for Pakistan five-fold, increasing it from $160 million to $816 million.[194] This substantial increase in funding aimed to address the immediate and long-term needs of the affected population, which included coping with water-borne diseases and food shortages exacerbated by the floods. The United Nations' commitment to raising this considerable sum underscored the gravity of the situation and the urgency of international assistance. The United States, a long-standing partner of Pakistan in times of crisis, swiftly mobilized its resources to aid flood-affected communities. The U.S. Agency for International Development (USAID) deployed a Disaster Assistance Response Team to lead the humanitarian response, ensuring the rapid delivery of aid to those in need. [195] Furthermore, the United States provided over $200 million in humanitarian and development assistance to Pakistan in response to the 2022 flood, solidifying its commitment to supporting the country during its recovery.[196] Malaysia, too, extended its solidarity and support to Pakistan during this challenging period. The Malaysian government contributed USD 200,000 to the flood victims through the Pakistani Prime Minister's Flood Relief Fund. This gesture

[194] "Government of Pakistan and the United Nations Launch the Revised Flash Appeal of US $816 Million to Respond to the Needs of People Affected by Unprecedented Climate-Induced Floods," *ReliefWeb*, October 4, 2022, https://reliefweb.int/report/pakistan/government-pakistan-and-united-nations-launch-revised-flash-appeal-us-816-million-respond-needs-people-affected-unprecedented-climate-induced-floods.

[195] "USAID Announces Funding to Support Flood-Affected Communities in Pakistan." usaid.gov, June 6, 2023. https://www.usaid.gov/news-information/press-releases/jun-06-2023-usaid-announces-funding-support-flood-affected-communities-pakistan.

[196] "USAID Deploys A Disaster Assistance Response Team To Respond To Flooding In Pakistan," USAID, September 2, 2022, https://www.usaid.gov/news-information/press-releases/sep-02-2022-usaid-deploys-a-disaster-assistance-response-team-to-respond-to-flooding-in-pakistan.

exemplified the spirit of international cooperation as Malaysia recognized the immense suffering, loss of life, and infrastructure damage experienced by Pakistan. Malaysia's contribution was channelled through a local Affin Bank account opened by the High Commission of the Islamic Republic of Pakistan in Kuala Lumpur, ensuring efficient and transparent aid distribution.[197]

3.2.2 Shortcomings During 2022 Flood in Pakistan

3.2.2.1 Delayed Government Response

Delays in responding to flood disasters exacerbated the crisis. Slow reactions in terms of evacuations, distributing relief, and conducting rescue operations led to increased damage and a higher loss of life. Effective and timely responses play a pivotal role in reducing the impact of disasters and ensuring the safety and welfare of affected communities. Although the floods commenced in mid-June, the announcement of the establishment of a new National Flood Response and Coordination Centre was considerably delayed, occurring on August 29.[198] This delay in setting up a dedicated response centre highlights a significant gap in the government's ability to respond promptly to natural disasters. The NGO sector's rapid and coordinated response to the 2022 flood stands out as a positive aspect. A coalition of 34 national and international NGOs worked together to quickly assess the situation within 24 hours of the disaster for rescue operations, sometimes even preceding government efforts. Despite their effective and timely response, many of these NGOs have faced restrictions or expulsion from Pakistan. These restrictions are attributed to a broader trend of closing civic spaces and an increasing securitization of governance within the country. The delayed government response to the 2022 flood and the restrictions on NGOs are seen as indicators of a governance failure. This failure has broader implications, eroding public trust in the government's ability to manage disasters effectively.[199] In the context of the 2022 flood, these delays in government response and the subsequent restrictions on NGOs highlight the need for more robust disaster management mechanisms and governance reforms. The experiences of 2022 flood underscore the importance of preparedness, coordination, and inclusivity in disaster management efforts.

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[197] "Malaysia Contributes $200,000 to PM Flood Relief Fund," *Business Recorder*, October 24, 2022, https://www.brecorder.com/news/40204740/malaysia-contributes-200000-to-pm-flood-relief-fund.

[198] Shandana Khan Mohmand and Miguel Loureiro. "Pakistan's Floods Are a Failure of Governance." Institute of Development Studies, August 31, 2022. https://www.ids.ac.uk/opinions/pakistans-floods-are-a-failure-of-governance/.

[199] Shandana Khan Mohmand ,Miguel Loureiro, "Pakistan's Floods Are a Failure of Governance," Institute of Development Studies, August 31, 2022, https://www.ids.ac.uk/opinions/pakistans-floods-are-a-failure-of-governance/.

3.2.2.2 Lack of Resources

The 2022 flood in Pakistan revealed significant challenges stemming from a lack of resources, which hampered the government's ability to respond effectively to the disaster. Pakistan's budget for disaster management and relief efforts has historically been insufficient to deal with the scale of natural disasters, including floods. This funding gap often results in delays in procuring necessary resources such as boats, helicopters, and relief supplies. In the case of the 2022 flood, the financial burden of response and recovery efforts was immense, with estimates of direct losses reaching 40,000 million US dollars. The government struggled to allocate the necessary funds promptly, delaying critical response activities.[200] Responding to flooding emergencies requires a well-trained and coordinated team of personnel, including disaster management experts, first responders, and healthcare professionals. Pakistan has faced challenges in having an adequately trained workforce ready to respond quickly to disasters. The shortage of skilled personnel was evident in the 2022 flood, where the demands for search and rescue operations, medical aid, and shelter management outstripped the available workforce, leading to delays in providing assistance. The effectiveness of flood response depends on having the right equipment and infrastructure in place. This includes boats, helicopters, communication systems, and flood barriers. In Pakistan, the shortage of these resources has been a recurring issue. During the 2022 flood, a lack of boats and helicopters made it difficult to access and rescue people in inundated areas promptly. Additionally, the absence of adequate flood protection infrastructure left communities vulnerable to recurring floods.[201] The 2022 flood in Pakistan underscored the urgent need for increased funding, investment in personnel training, and the acquisition of modern equipment and infrastructure. Addressing these resource limitations is crucial for minimizing impacts of flood disasters.

3.2.2.3 Poor Coordination

The 2022 flood in Pakistan unveiled significant challenges rooted in the intricate dynamics of political ecology. The poor coordination among government agencies, local authorities, and relief organizations reflected not just logistical hurdles but underlying power struggles and governance complexities. The flood response, requiring collaboration between entities

[200] Ashfaq Ahmad Shah, Ayat Ullah, Nasir Abbas Khan, Muhammad Haroon Shah, Rasheed Ahmed, Syed Tauseef Hassan, Muhammad Atiq Ur Rehman Tariq, and Chong Xu, "Identifying Obstacles Encountered at Different Stages of the Disaster Management Cycle (DMC) and Its Implications for Rural Flooding in Pakistan," *Frontiers in Environmental Science*, Volume 11, 2023, https://doi.org/10.3389/fenvs.2023.1088126.
[201] Waseem Ahmad, Asif Ali Sherazi, and Shahin Ashraf, Towards a Resilient Pakistan: Moving from Rhetoric to Reality, 2023, https://islamic-relief.org/wp-content/uploads/2023/08/TowardsAResilientPakistan-WEBx.pdf.

like the National Disaster Management Authority (NDMA), provincial disaster management authorities, and local bodies, faced hurdles due to political interests and disparities. The slow sharing of information and resources highlighted deeper issues within the political ecology, where decision-making and cooperation are entangled in power dynamics. Disparities among provinces in coordination efforts further emphasized how political intricacies impact operational efficiency in disaster response. The lack of uniformity in strategies pointed to the broader challenges within the political ecology, influencing the effectiveness of flood response efforts.[202] Effective communication is a cornerstone of successful disaster response. During the 2022 floods, communication breakdowns were a common problem. In some areas, damaged infrastructure, including communication networks, disrupted the flow of information. This hindered the timely deployment of resources and the coordination of rescue and relief operations.

NGOs and relief organizations play a crucial role in flood response, often filling gaps in government efforts. However, in Pakistan, there have been instances of challenges in coordination between government agencies and NGOs. These issues can stem from bureaucratic hurdles, differences in priorities, and a lack of trust. Such challenges can slow down response efforts and limit the overall impact of relief operations. Effective flood response also requires engaging with affected communities. Local authorities and relief organizations need to work closely with communities to understand their specific needs and ensure their active participation in relief and recovery efforts. Inadequate community engagement during the 2022 flood may have resulted in a lack of information on the ground, making it challenging to prioritize and address the most pressing issues. The poor coordination observed during the 2022 flood in Pakistan revealed the need for improved inter-agency collaboration, better communication infrastructure, and enhanced cooperation between government bodies and relief organizations. Addressing these coordination challenges is vital for streamlining future flood response efforts and reducing the impact of such disasters on affected communities.

3.2.2.4 Political Considerations

Political factors may at times influence the government's reaction to floods. Relief efforts might become subject to political agendas, and resource allocation may be uneven due to political considerations. Political factors can lead to uneven resource allocation among

[202] Adnan Khan, "Are Pakistan's Floods a Governance Failure?" The Geopolity, September 8, 2022, https://thegeopolity.com/2022/09/08/are-pakistans-floods-a-governance-failure/.

different regions and provinces. Governments may prioritize areas that hold more political significance or have greater electoral importance. For example, in the 2022 flood, critics argued that resource allocation favoured some regions over others due to political affiliations, potentially leaving vulnerable communities without adequate support. Political indecision or disputes can lead to a delayed response to floods. Decision-making processes may be hindered by political wrangling, preventing swift action when it is most needed. In the case of the 2022 flood, the announcement of a National Flood Response and Coordination Centre in late August, several weeks after the floods began, raised concerns about the impact of political considerations on response timelines. Political considerations can sometimes influence the distribution of relief supplies. There have been instances where relief materials, including food and shelter, were distributed based on political affiliations rather than need. Such practices can exacerbate the suffering of flood-affected communities and undermine the effectiveness of relief efforts.203

Political considerations can also impact the role of NGOs and international aid organizations in flood response. In some cases, governments may impose restrictions on the activities of these organizations, particularly if they are perceived as operating independently of government control. During the 2022 flood, certain NGOs faced limitations and were accused of political bias, affecting their ability to provide aid. Political considerations can influence the portrayal of flood response efforts in the media and public discourse. Governments may seek to control the narrative surrounding relief efforts to maintain a positive image or deflect criticism. Conversely, political opponents may use flood response as a tool to discredit the ruling party, potentially further politicizing the issue.[204] For example, during the 2022 flood, there were allegations that relief efforts were influenced by political considerations. Critics argued that the distribution of aid and resources may not have been entirely needs-based and that political affiliations could have played a role in determining which communities received support promptly. Such perceptions can erode public trust in government response efforts and hinder the overall effectiveness of flood relief.

While it is essential for governments to consider the broader political context, including electoral factors, in disaster response, it is equally crucial to prioritize the needs of affected communities above political considerations. Transparency, accountability, and an equitable

[203] Huzaifa Nasir, "Pakistan: Unequal Distribution of Flood Relief in Umerkot District," Minority Rights Group Trends, https://trends.minorityrights.org/pakistan/.

[204] Menaal Munshey, "The Limits of Loss and Damage: A Cautionary Tale from Pakistan," The New Humanitarian, November 21, 2022, https://www.thenewhumanitarian.org/opinion/2022/11/21/loss-and-damage-Pakistan-floods-women-climate-change.

distribution of resources should guide relief efforts to ensure that political factors do not compromise the well-being of vulnerable populations during flood disasters.

3.2.2.5 Lack of Trust in Government

There was pervasive lack of trust among Pakistani citizens in government agencies, particularly those responsible for relief efforts following natural disasters such as floods. Many citizens prefer to channel their donations towards non-governmental organizations (NGOs), welfare organizations, individual aid workers, and religious political parties, rather than entrusting the government with their contributions. This mistrust primarily stems from citizens' personal experiences with government agencies. Interactions with these agencies have sown doubts about their commitment to effectively delivering essential social services. Over the years, many citizens have experienced inefficiencies and corruption within government agencies. Funds allocated for disaster relief and preparedness often do not reach those in need, leading to scepticism about the government's ability to manage resources transparently and effectively. Government bureaucracies can be slow to respond to crises, which can result in delayed relief efforts. Citizens may have encountered bureaucratic hurdles when seeking assistance, such as lengthy paperwork or unclear procedures, which erode trust in the government's ability to provide timely help. There have been cases where disaster relief has been distributed inequitably, favouring certain regions or communities over others for political reasons. This unequal distribution of aid exacerbates mistrust among marginalized or vulnerable populations. Efforts may become subject to political agendas, and resources might be allocated based on political affiliations rather than the severity of need. Such actions erode public confidence in the government's commitment to impartially serve all citizens. Past failures in disaster response and recovery efforts, such as those following the 2010 flood, have left a lasting impact on public perception. These failures included delayed responses, inadequate relief distribution, and the mismanagement of resources, contributing to a sense that government agencies are ill-prepared or unwilling to address such crises effectively.[205]

In contrast, NGOs, civil society groups, and religious political parties often appear more agile and accountable in their relief efforts. These organizations can quickly mobilize resources, respond to immediate needs, and maintain a transparent approach to aid distribution, earning the trust of the public. Extensive media coverage of government

[205] "Conflicts in the Aftermath of the 2010 Pakistan Floods," climate-diplomacy.org, https://climate-diplomacy.org/case-studies/conflicts-aftermath-2010-pakistan-floods.

shortcomings during disaster response can further erode trust. Citizens witness first-hand the challenges faced by affected communities and the inadequacies in the government's response efforts, amplifying their doubts.[206] In some cases, communities themselves have taken the initiative to organize relief efforts, bypassing government agencies entirely. This grassroots approach can foster a sense of self-reliance and community trust while diminishing reliance on government assistance. In the case of the 2022 flood in Pakistan, this lack of trust likely influenced citizens' decisions to direct their donations and support toward alternative channels rather than relying solely on government agencies. Rebuilding trust in government institutions in the context of disaster management will require not only improved performance but also increased transparency, accountability, and citizen engagement in the decision-making processes surrounding disaster relief and recovery.

Conclusion

In essence, the floods of 2010 and 2022 in Pakistan brought to light the intricate nature of responding to natural disasters. The government, alongside national and international entities, demonstrated positive efforts by swiftly initiating emergency relief measures. These encompassed the distribution of crucial supplies, the establishment of flood emergency centres, active coordination with international partners for aid, and the deployment of military and civilian resources for search and rescue operations. These actions were instrumental in addressing the immediate aftermath of the disasters. However, amidst these commendable efforts, notable shortcomings in the government's response were evident. The lack of adequate preparedness posed a significant challenge, hindering the effectiveness of the overall response. Coordination issues between federal and provincial governments added complexity, leading to delays and confusion. The existing infrastructure for disaster management revealed inadequacies, amplifying difficulties in the distribution of relief supplies and hindering long-term recovery and rehabilitation efforts. The floods in 2022 underscored the crucial role of the army, financial assistance, and efficient supply distribution in disaster response. While these elements played key roles, challenges such as funding constraints, accessibility issues, and disruptions in the supply chain persisted. Furthermore, the enduring lack of trust among Pakistani citizens in government agencies posed a substantial hurdle. Historical inefficiencies in managing flood-related disasters have eroded public confidence, with many individuals opting to contribute to non-governmental

[206] Fizza Batool, "Pakistan’s Floods and the Role of Media," South Asian Voices, September 23, 2022, https://southasianvoices.org/pakistans-floods-and-the-role-of-media/.

organizations, welfare groups, or religious political parties. The negative repercussions of flood disasters, including funding shortages, difficulties in reaching affected areas, and disruptions in the supply chain, further complicated the government's endeavors to provide timely and effective relief. In summary, the experiences of the 2010 and 2022 flood underscore the intricate dynamics of disaster response, emphasizing the need for enhanced preparedness, streamlined coordination, and rebuilding public trust for more effective future interventions.

Chapter 4

Analysing the Environmental Governance and Flood (2010 & 2022) Disaster Management in Pakistan: Challenges and prospects

Introduction

Pakistan, situated in a region prone to monsoons and seasonal rains, has endured the relentless and devastating impact of floods for generations. Annually, these calamitous events unleash havoc upon the nation, wreaking havoc on communities, vital infrastructure, and the fragile economy. In recent years, the frequency and severity of these flood events have surged, casting an ominous shadow over the nation's stability and development.[207] This ominous trend serves as an unignorable clarion call for urgent action in addressing the recurring crisis of floods. This chapter delves deeply into the crux of the matter, meticulously examining the shortcomings prevalent within Pakistan's existing flood laws, institutional structures, and planning frameworks. These inadequacies have, regrettably, impeded the nation's capacity to effectively manage and mitigate the catastrophic consequences of these natural disasters. Moreover, it casts an illuminating spotlight on the immediate and critical issues plaguing the nation's efforts to control floods, notably the woefully insufficient investments allocated to flood control initiatives Yet, amidst these challenges, there is an undeniable and paramount need for heightened preparedness in the face of impending flood events. It is this dire backdrop, characterized by inadequacies, underinvestment, crumbling infrastructure, and a pressing need for readiness, against which the chapter's central objective takes shape. In the subsequent sections, this chapter embarks on the journey of presenting a comprehensive suite of meticulously crafted policies and innovative strategies. These are not only intended to confront and address the present challenges posed by floods but also to fortify Pakistan's resilience against future flood events. In navigating Pakistan's flood management challenges, solutions that transcend immediate relief efforts, envisioning a future where the threat of floods is met with resilience, adaptability, and the collective determination to build a more secure and prosperous Pakistan have explained.

[207] Mansoor Ahmad, "Economic Havoc," *The News*, February 5, 2023, https://www.thenews.com.pk/print/1037535-economic-havoc.

4.1 Critical Aspects of Flood Management Challenges of Pakistan

4.1.1 Political Instability

Political instability in Pakistan has indeed played a significant role in hindering effective long-term planning and the implementation of critical projects, such as flood control measures. Pakistan has experienced numerous changes in government, often resulting from political crises, corruption allegations, or military interventions. These frequent transitions in leadership lead to short government tenures, with some governments lasting only a few years. [208]This short-term focus discourages leaders from investing in projects with long-term benefits, such as flood control measures, as they may not be in power to take credit for these initiatives when they eventually come to fruition. In 2008, the Pakistan People's Party (PPP) came to power, and they initiated the National Flood Protection Plan (NFPP) to address the recurring issue of floods. However, due to political instability and frequent changes in leadership, the implementation of this plan faced delays and inconsistencies, preventing its effective execution.209 Political instability also leads to a lack of policy continuity. When new governments take office, they often abandon or modify the policies and projects initiated by their predecessors, creating a sense of uncertainty and disrupting long-term planning.[210] The construction of large-scale infrastructure projects, such as dams and reservoirs, is crucial for flood control. The Kalabagh Dam project has been discussed for decades in Pakistan. However, changes in government and political disagreements between provinces have prevented its realization. Different governments have taken varying positions on this project, leading to its perpetual postponement.[211] Frequent changes in government can result in limited accountability for past decisions and projects. Leaders may be less inclined to prioritize flood control measures if they know that they can shift the blame for previous failures to their predecessors. The floods in 2010 reflects the lack of preparedness and inadequate infrastructure for flood control. While there were discussions about improving flood management systems and infrastructure, these discussions were often overshadowed by political battles and the focus on immediate crises, leading to inadequate long-term

[208] Fizza Batool, "Political Crisis in Pakistan: Is Democracy Responsible?" ECPR's Political Science Blog, May 20, 2022, https://theloop.ecpr.eu/political-crisis-in-pakistan-is-democracy-responsible/.
[209] "National Flood Protection Plan-IV," Federal Flood Commission, accessed at October 13, 2023, https://ffc.gov.pk/national-flood-protection-plan-iv/.
[210] Jumaina Siddiqui, "Amid Devastating Floods, Pakistan's Leaders Must Learn from the Past to Avoid Future Mistakes," Just Security, September 2, 2022, https://www.justsecurity.org/82928/amid-devastating-floods-pakistans-leaders-must-learn-from-the-past-to-avoid-future-mistakes/.
[211] Zainab Haseeb, "The Kalabagh Dam Issue: An Unrealized Dream," Paradigm Shift, March 4, 2021, https://www.paradigmshift.com.pk/kalabagh-dam-issue/.

planning and investment. Political instability can lead to fragmented decision-making, with different governments pursuing their own priorities without a comprehensive, consistent approach to issues like flood control. This fragmented approach hampers the effectiveness of flood mitigation efforts.[212] Political instability in Pakistan has been a major obstacle to effective long-term planning and implementation of flood control measures. Frequent changes in government, lack of policy continuity, limited accountability, and fragmented decision-making have all contributed to the ongoing challenges posed by annual floods in the country. To address this issue, Pakistan would need stable governance, bipartisan commitment to long-term projects, and effective coordination between different levels of government.

4.1.2 Short-term Economic and Political Interests

Pakistani politicians often prioritize short-term economic and political gains over long-term environmental sustainability. Flood control and management require substantial investments disaster preparedness. These measures may not yield immediate political benefits, especially when compared to initiatives like infrastructure development or industrial growth, which can provide visible and tangible benefits that garner more support from the electorate.[213] As a result, politicians may be more inclined to focus on projects that offer quick wins and popularity. Politicians often allocate resources to visible infrastructure projects, such as roads and buildings, as they can showcase immediate results and contribute to economic growth.[214] In contrast, flood control and management investments, which may not yield visible outcomes in the short term, can be deprioritized. Allocating funds to build a new highway can provide a tangible improvement in transportation and generate positive publicity, whereas investing in flood prevention measures may not produce immediate, visible results. The Diamer-Bhasha Dam project in Pakistan is an example of a large-scale infrastructure project that garnered significant political attention and funding. It was aimed at addressing water and energy needs but received substantial resources compared to flood management efforts. Despite Pakistan's vulnerability to annual floods, resources and

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[212] Samar Deen, "Pakistan 2010 Floods: Policy Gaps in Disaster Preparedness and Response," *International Journal of Disaster Risk Reduction*, 12 (June 2015): 341-349, https://www.sciencedirect.com/science/article/abs/pii/S2212420915000308.

[213] Abdul Waheed Bhutto, "Pakistan's Path to Climate Action Needs Strong Political Leadership," *The Diplomat*, August 4, 2023, https://thediplomat.com/2023/08/pakistans-path-to-climate-action-needs-strong-political-leadership/.

[214] Gabe Alpert, "Can Infrastructure Spending Really Stimulate the Economy, " *Investopedia*, August 20, 2023https://www.investopedia.com/articles/markets/080816/can-infrastructure-spending-really-stimulate-economy.asp.

political will for flood management and early warning systems have often been insufficient. The construction of mega-dams like Diamer-Bhasha, while important for water storage and power generation, took precedence over comprehensive flood control measures.[215] Promoting industrial growth and attracting foreign investments can be seen as politically advantageous, as it creates jobs and boosts the economy. [216]This often leads to lax environmental regulations and enforcement. Encouraging the expansion of factories and industries can lead to increased pollution and degradation of natural resources. Although this may result in immediate economic advantages, it can lead to enduring environmental repercussions, such as water pollution and the destruction of habitats. The Margalla Hills National Park near Islamabad has witnessed extensive deforestation due to illegal logging and land encroachment. Local politicians have been reluctant to take stringent action against illegal loggers, as it can upset influential groups. The short-term interests of those involved in illegal logging, including politicians who may receive support from these groups, have contributed to the degradation of this crucial natural habitat, increasing the risk of landslides and environmental damage.[217]

Pakistan's agriculture sector is crucial for its economy, but outdated farming practices and inefficient water management contribute to water scarcity and exacerbate flood risks.218 Politicians hesitate to enforce water conservation measures or invest in modern irrigation systems due to concerns of upsetting influential agricultural lobbies, even though such measures could improve water availability and reduce flood vulnerability in the long term. In Sindh province, inefficient water management practices have led to disputes among political factions and influential landlords. Politicians often hesitate to implement reforms to address water scarcity and improve irrigation methods, fearing backlash from powerful agricultural lobbies. This short-term focus on political stability and appeasement of interest groups has perpetuated water mismanagement, contributing to water scarcity and flooding

[215] Muazzam Sabir, "Infrastructural Projects, Land Use Conflicts and Socioeconomic Impacts Nexus: A Case Study of Diamer Bhasha Dam Project, Pakistan," HAL Open Science, 2018, https://theses.hal.science/tel-01862810/document.

[216] Ashfaque H. Khan and Yun-Hwan Kim, "Foreign Direct Investment in Pakistan: Policy Issues and Operational Implications," *EDRC* Report Series no. 66, Economics and Development Resource Center, 1999, https://www.adb.org/sites/default/files/publication/28178/er066.pdf

[217] "Conservation and Reforestation of the Margalla Hills National Park," *Urban Nature Atlas*, April 2023, https://una.city/nbs/islamabad/conservation-and-reforestation-margalla-hills-national-park.

[218] Riaz Hussain Qureshi and Muhammad Ashraf, "Water Security Issues of Agriculture in Pakistan," Pakistan Academy of Sciences, 2019, https://www.paspk.org/wp-content/uploads/2019/06/PAS-Water-Security-Issues.pdf.

problems in the region.[219]Elected officials often prioritize policies that gain popularity among their constituents, even if these policies have negative environmental impacts. This can include subsidizing fossil fuels, which contributes to climate change and its associated environmental problems. Offering subsidies on fossil fuels can lower energy costs in the short term, making it a politically attractive option. However, this hinders the transition to cleaner energy sources and perpetuates environmental degradation.[220] Successive governments in Pakistan have subsidized energy, including fossil fuels, to keep energy costs low for consumers. While this may be a popular move to gain political support, it has discouraged investment in cleaner energy sources and hindered efforts to combat air pollution and climate change. The focus on short-term energy affordability has come at the expense of long-term environmental sustainability and transitioning to renewable energy sources.

The pursuit of short-term economic and political gains often takes precedence in decision-making over long-term environmental sustainability in Pakistan. This tendency is reinforced by the visibility and immediate benefits associated with certain projects and policies, while environmental investments may not offer the same level of instant gratification or political support, leading to a cycle of environmental challenges like annual floods.

4.1.3 Absence of Flood Laws

The lack of comprehensive flood laws in Pakistan is a significant issue that hampers effective flood management in the country. This gap in legislation and governance has led to various operational challenges, and the absence of floodplain regulations further exacerbates the problem.[221] Pakistan's existing water laws, such as the 1991 Water Accord and the 1998 National Water Policy, were primarily designed for water resource allocation and development. They lack detailed provisions related to flood management, including early warning systems, floodplain zoning, and disaster response coordination. In the absence of clear flood management laws, there is often confusion regarding which government agency or department is responsible for flood control and disaster response. This lack of clarity can

[219] Engr Toufique Ahmed, "Managing Water Resources and Flood Risks in Sindh, Pakistan: Strategies for Sustainable Development," May 1, 2023, https://www.linkedin.com/pulse/managing-water-resources-flood-risks-sindh-pakistan-abbasi/.

[220] Richard Bridle, Shruti Sharma, Mostafa Mostafa, and Anna Geddes, "Fossil Fuel to Clean Energy Subsidy Swaps: How to pay for an energy revolution," GSI, June 2019, https://www.iisd.org/system/files/publications/fossil-fuel-clean-energy-subsidy-swap.pdf.

[221] Muhammad Aslam, "Flood Management Current State, Challenges and Prospects in Pakistan: A Review," *Mehran University Research Journal of Engineering and Technology*, 2018, 37 (2), 297 - 314. ff10.22581/muet1982.1802.06ff. ffhal-0174492

result in delayed responses and inadequate coordination during flood events.[222] Without robust floodplain regulations, communities and industries have been allowed to encroach upon flood-prone areas. For instance, housing developments, factories, and agricultural activities often take place in floodplains. This exacerbates flood risks and increases damage during flood events. The 2010 flood in Pakistan are a prime example, where extensive encroachments on floodplains exacerbated the disaster's impact. Comprehensive flood laws should make for the establishment of early warning systems to alert communities and authorities about impending flood events. The absence of such laws has hindered the development of effective early warning systems, leaving people vulnerable to sudden floods. Comprehensive flood laws should specify roles and responsibilities for various government agencies, ensuring efficient coordination during flood events.[223] The absence of such laws has resulted in fragmented disaster response efforts. For instance, during the 2010 flood, there was a lack of coordination between federal and provincial authorities, leading to delays in relief efforts. The absence of comprehensive laws may discourage private and public investment in flood control infrastructure, leaving the country ill-prepared for future flood events.[224] Pakistan shares rivers with neighboring countries like India and Afghanistan. A lack of comprehensive flood laws makes it challenging to negotiate and implement international agreements related to transboundary river management and flood control, potentially leading to conflicts over water resources.[225] Pakistan's lack of comprehensive flood laws has far-reaching consequences. To address these challenges, there is a critical need for the development and implementation of comprehensive flood management laws that encompass all aspects of flood control and disaster response.

4.1.4 Institutional Issues

Flood management institutions in Pakistan do not have technical expertise, knowledge, and human resources required to effectively plan, coordinate, and execute flood control and

[222] Akhtar Ali, *Indus Basin Floods: Mechanisms, Impacts, and Management* (Asian Development Bank, 2013), https://www.adb.org/sites/default/files/publication/30431/indus-basin-floods.pdf.
[223] Ashfaq Ahmad Shah, Ayat Ullah, Nasir Abbas Khan, Abid Khan, Muhammad Atiq Ur Rehman Tariq, and Chong Xu, "Community Social Barriers to Non-Technical Aspects of Flood Early Warning Systems and NGO-Led Interventions: The Case of Pakistan," *Frontiers in Earth Science*, 11 (2023): https://doi.org/10.3389/feart.2023.1068721.
[224] Zaira Manzoor et.al, "Floods and Flood Management and Its Socio-Economic Impact on Pakistan: A Review of the Empirical Literature," *Frontiers in Environmental Science* 10, Research Topic: Eco-Innovation and Green Productivity for Sustainable Production and Consumption (December 2022): https://doi.org/10.3389/fenvs.2022.1021862.
[225] Muhammad Uzair Qamar, Muhammad Azmat, and Pierluigi Claps, "Pitfalls in Transboundary Indus Water Treaty: A Perspective to Prevent Unattended Threats to Global Security," *npj Clean Wate*r 2, Article number: 22 (November 5, 2019), https://www.nature.com/articles/s41545-019-0046-x.

response strategies. This deficiency hampers their ability to make informed decisions and respond swiftly to flood events, leading to delays in relief efforts and increased damage. During the 2010 flood in Pakistan, the NDMA had difficulties in quickly assessing the extent of the disaster and mobilizing resources due to limited technical capacity. This resulted in delayed relief efforts, leading to increased suffering among flood-affected populations.[226] In 2022, the mismanagement of river embankments within provincial irrigation departments exacerbated flooding in certain areas. This mismanagement was attributed to the lack of expertise among irrigation engineers in managing floodwaters effectively. Effective flood management involves the cooperation and coordination of multiple government agencies and departments. When institutions fail to coordinate effectively, resources may be allocated inefficiently, response efforts may be disjointed, and critical information may not be shared promptly, all of which can impede the overall flood management process.[227] In 2010, poor coordination among various government agencies led to disjointed efforts in disaster response. Relief distribution was hampered due to confusion, as different agencies worked independently, and there was a lack of synergy in relief efforts.

Flood management institutions require well-trained personnel equipped with the latest knowledge and technology to respond effectively to flood events. Inadequate training programs and outdated technology can result in personnel lacking the necessary skills to make informed decisions and use available resources efficiently during floods.[228] Modern technology, such as advanced weather forecasting systems and early warning mechanisms, is essential for accurate and timely flood prediction and alert dissemination. When institutions do not fully adopt and harness such technology, the precision of forecasts and warnings can suffer, diminishing their ability to provide timely information to at-risk communities. Provincial irrigation departments play a critical role in managing river systems and floodwaters. However, if engineers within these departments lack the expertise needed to make informed decisions regarding flood control measures, it can result in errors. Limited financial resources can severely restrict the ability of flood management institutions to invest

[226] Analysis: How Effective is Pakistan's Disaster Authority?" *Reliefweb*, April 4, 2014, https://reliefweb.int/report/pakistan/analysis-how-effective-pakistan-s-disaster-authority.

[227] Manzoor, Zaira, Muhsan Ehsan, Muhammad Bashir Khan, Aqsa Manzoor, Malik Muhammad Akhter, Muhammad Tayyab Sohail, Asrar Hussain, Ahsan Shafi, Tamer Abu-Alam, and Mohamed Abioui. "Floods and Flood Management and Its Socio-Economic Impact on Pakistan: A Review of the Empirical Literature." *Frontiers in Environmental Science* 10 (2022). doi: 10.3389/fenvs.2022.1021862.

[228] Muhammad Aslam, "Flood Management Current State, Challenges and Prospects in Pakistan: A Review," *Mehran University Research Journal of Engineering and Technology*, 2018, 37 (2), pp.297 - 314. ff10.22581/muet1982.1802.06ff. ffhal-01744925f

in essential infrastructure, technology upgrades, and training programs. This constraint can hinder their preparedness, response, and recovery efforts during flood events.[229]

Resource constraints have been an ongoing issue for institutions like the NDMA and FFC. Limited budgets have often restricted their capacity to invest in modern technology and disaster management infrastructure, affecting preparedness and response efforts. When institutions collectively face these issues, it often leads to delayed responses during flood events. Delays can significantly worsen the impact of floods on communities, as timely evacuation, relief distribution, and infrastructure protection may not be possible, resulting in increased casualties and damage. In 2022, slow responses and poor coordination among various agencies exacerbated the impact of the floods in Balochistan. Delayed relief efforts resulted in significant losses in terms of lives and property.[230] This reflects the institutional challenges in institutions in Pakistan and the resulting implications for flood response and mitigation efforts.

4.1.5 Planning Issues

Effective flood management strategies rely on scientific research and data-driven decision-making. In Pakistan, inadequate support for research hinders the understanding of flood dynamics and the ability to predict and mitigate flood events effectively. This results in reactive rather than proactive flood management. In 2010 , the lack of comprehensive research on flood patterns and river dynamics contributed to delayed response efforts and insufficient flood control measures.[231] Basin-level flood management plans consider entire river basins, including upstream activities, tributaries, and downstream consequences. In Pakistan, the absence of such plans impedes coordinated and sustainable flood management efforts across regions. Pakistan has faced recurring floods in different river basins, such as the Indus River Basin. The lack of comprehensive basin-level planning has resulted in varying levels of preparedness and response across regions, impacting the overall effectiveness of flood management.[232] Effective flood management should be integrated into broader national development policies to allocate resources, attention, and long-term risk

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[229] "Options to Strengthen Disaster Risk Financing in Pakistan," *The World Bank*, https://documents1.worldbank.org/curated/en/858541586180590633/pdf/Options-to-Strengthen-Disaster-Risk-Financing-in-Pakistan.pdf.

[230] Amin Ahmed, "Floodwaters Still Inundate 13 Districts of Sindh, Balochistan: UN," *Dawn*, December 7, 2022, https://www.dawn.com/news/1725091/floodwaters-still-inundate-13-districts-of-sindh-balochistan-un.

[231] Samar Deen, "Pakistan 2010 Floods: Policy Gaps in Disaster Preparedness and Response," *International Journal of Disaster Risk Reduction* 12 (June 2015): 341-349, https://doi.org/10.1016/j.ijdrr.2015.03.007.

[232] "Indus Basin Floods: Mechanisms, Impacts, and Management," Asian Development Bank, 2013, https://www.adb.org/sites/default/files/publication/30431/indus-basin-floods.pdf.

reduction measures. When flood management is not mainstreamed, it may not receive the necessary focus.

In Pakistan, flood management planning has often been treated as a separate process, rather than integrated into national development policies. This approach has led to underinvestment in long-term flood risk reduction measures, leaving communities vulnerable to recurrent flooding.[233] Comprehensive planning includes the development of infrastructure like dams, reservoirs, levees, and floodplain zoning. The absence of basin-level planning in Pakistan has resulted in insufficient investment in critical flood control infrastructure projects. This lack of planning and infrastructure development exacerbates flood impacts, causing extensive damage to communities and agriculture.[234] Planning for flood management in Pakistan often prioritizes short-term, reactive measures, such as immediate relief and response efforts. Long-term strategies for flood vulnerability reduction are sometimes overlooked. While immediate relief efforts are essential during floods, it has led to insufficient long-term planning and mitigation efforts, leaving communities exposed to recurring flood risks. Climate change has increased the frequency and intensity of extreme weather events, including floods. Integrated planning is crucial for adapting to these changing conditions and reducing future flood risks. Pakistan's failure to integrate climate change adaptation into flood management planning has left the country vulnerable to more frequent and severe floods, as witnessed in recent years.[235]

4.1.6 Lack of Effective Flood Preparedness

Effective flood preparedness requires well-defined policies, strategies, and actions that encompass early warning systems, disaster response plans, and community preparedness. In Pakistan, the absence of comprehensive flood preparedness measures exacerbates flood situations. The 2010 flood in Pakistan were unprecedented in scale, affecting over 20 million people. Despite recurring floods in the past, the government lacked a robust flood preparedness policy that could address the magnitude of the disaster effectively. This led to

[233] Dr. Asad Sarwar Qureshi, "Managing Floods in Pakistan: From Structural to Nonstructural Measures," https://pecongress.org.pk/images/upload/books/107-114-302%20Managing%20flod%20Asad%20Sarwar%20Qureshi.pdf.

[234] Shahmir Janjua et.al, "Water Management in Pakistan's Indus Basin: Challenges and Opportunities," *IWA Water Policy* 23, no. 6 (2021): 1329–1343, https://doi.org/10.2166/wp.2021.068.

[235] Sahar Khan and Jumaina Siddiqui, "Pakistan's Flooding Is a Combination of Corruption, Mismanagement, and Climate Change," USIP, September 8, 2022, https://www.usip.org/publications/2022/09/why-pakistan-drowning.

delayed responses, inadequate relief efforts, and extensive damage.[236] In 2022, Pakistan experienced severe flooding in various regions, particularly in Sindh and Balochistan. The lack of a well-coordinated flood preparedness strategy was evident as communities were caught off-guard, and there was a delay in deploying relief efforts, leading to loss of life and property. Effective flood preparedness requires a prompt and well-coordinated government response. In Pakistan, the government's response to flooding has often been inadequate and lacks a comprehensive approach to addressing flood problems.[237]

During the 2010 flood, the government struggled to provide timely assistance and coordination of relief efforts. This inadequacy in response was due to a lack of comprehensive flood preparedness plans and the inability to deploy resources promptly. The 2022 flood in Pakistan saw a similar pattern of inadequate government response. Despite previous flood events, there was a lack of a coordinated approach to flood preparedness. Relief efforts were not effectively mobilized, leaving communities vulnerable and exacerbating the impact of the floods. Effective flood preparedness relies on robust early warning systems that can provide timely alerts to at-risk communities. In Pakistan, weaknesses in these systems have hindered the ability to respond proactively to flood threats. In 2010, the early warning system in Pakistan was not well-developed or widely accessible. As a result, many communities were not adequately informed about the impending floods, leading to a lack of timely evacuations and increased casualties.

In 2022, despite some improvements in early warning systems, challenges remained. The flood alerts were not always effectively communicated to vulnerable communities, causing delays in evacuation and response efforts. Community involvement and preparedness are essential components of flood resilience. In Pakistan, efforts to engage and educate communities about flood risks and preparedness have been inadequate. During the 2010 flood, many communities were not well-prepared to respond to the disaster. There was a lack of awareness about evacuation procedures, safe shelters, and emergency supplies, leading to increased vulnerability. The 2022 flood demonstrated similar challenges in community preparedness. Many communities were not adequately informed about flood risks and did

[236] "Pakistan Flood 2010: Learning from Experience," *National Disaster Management Authority*, https://cms.ndma.gov.pk/public/October2020Pakistan%20Flood%202010%20Learning%20from%20Experience

[237] Ilan Kelman, "Pakistan's Floods Are a Disaster – But They Didn't Have To Be," *UNDRR*, September 20, 2022, https://www.preventionweb.net/news/pakistans-floods-are-disaster-they-didnt-have-be

not have access to emergency resources, making them more susceptible to the impact of the floods.[238]

So, the lack of effective flood preparedness in Pakistan has resulted in inadequate government responses, weaknesses in early warning systems, and communities ill-prepared to cope with floods. These issues have led to significant human and economic losses during flood events. To address this problem, Pakistan must prioritize comprehensive flood preparedness measures, including improved policies, government response mechanisms, early warning systems, and community engagement.

4.1.7 Community Deficiency: Flood Hazard Awareness and Mitigation Education

Comprehensive awareness and education about flood risks are essential for community preparedness. In Pakistan, many communities often lack a deep understanding of the nature and magnitude of flood hazards, which can lead to inadequate preparation and response.[239] During the 2010 flood, numerous communities in Pakistan were not adequately informed about the extent and potential consequences of the impending flood. This lack of awareness resulted in delayed evacuations, increased vulnerability, and higher casualties, as people were not adequately prepared to protect themselves and their property. For instance, communities may not have been aware of flood-resistant construction techniques for homes and safe evacuation routes. In 2022, a similar issue emerged as communities often lacked a comprehensive understanding of the flood hazards they faced. This limited awareness made it challenging to evacuate people promptly, potentially increasing the loss of life and property. Effective flood risk reduction requires close coordination between flood management authorities and local communities. Weak coordination can lead to insufficient communication of flood-related information and a lack of community involvement in mitigation efforts.

In 2010, coordination between flood management authorities and communities was often inadequate. Communities were not actively engaged in flood preparedness and response efforts, leading to gaps in information sharing and disaster management. As a result, people

[238] Ashfaq Ahmad Shah et.al , "Community Social Barriers to Non-Technical Aspects of Flood Early Warning Systems and NGO-Led Interventions: The Case of Pakistan," *Frontiers in Earth Science* 11 (2023), https://doi.org/10.3389/feart.2023.1068721.

[239] Awais Piracha and Muhammad Tariq Amin Chaudhary, "Better Awareness for Better Natural Hazards Preparedness in Pakistan," *International Journal of Built Environment and Sustainability 2*, no. 4 (November 2015), doi:10.11113/ijbes.v2.n4.92.

were not adequately informed about evacuation routes, early warning systems, or emergency measures.[240]

During the 2022 flood, similar coordination issues were evident. Limited communication between flood managers and communities hindered the dissemination of critical flood warnings and instructions, making it challenging for communities to respond effectively and evacuate in a coordinated manner. For instance, communities may not have received timely information about the flood's progression and the need for evacuation. Building the capacity of communities to cope with floods is essential for resilience. In Pakistan, many communities often lack the knowledge and skills required to respond effectively to flood hazards.[241]

In 2010, communities faced difficulties in responding to the floods due to their limited capacity. They often lacked knowledge about safe evacuation procedures, the construction of flood-resistant shelters, and the storage of emergency supplies. This left them vulnerable during the disaster, as they were not adequately equipped to protect themselves and their families. The 2022 flood highlighted similar challenges in community capacity. Many communities were ill-equipped to cope with flood-related challenges, including a lack of knowledge about emergency response, the construction of safe shelters, and basic flood mitigation measures. This increased their vulnerability during the floods, as they struggled to take effective protective measures. By providing communities with accurate information and awareness about flood hazards, they can make informed decisions and take necessary precautions.

During the 2010 flood, there were limited communication and outreach efforts to educate communities about flood risks. This lack of information dissemination contributed to inadequate preparedness and response, as people were not aware of the impending danger or how to protect themselves. Communities may not have received clear guidance on evacuation routes or safety measures. In 2022, despite some improvements, communication and outreach efforts were not extensive enough to reach all vulnerable communities. As a result, some areas remained unaware of the impending flood risks and how to mitigate them, leading to preventable losses. Pakistan must prioritize comprehensive education and awareness programs, enhance coordination efforts, and empower communities with the knowledge and skills needed to mitigate flood risks effectively.

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[240] *Pakistan Floods 2010 Preliminary Damage and Needs Assessment,* Asian Development Bank, accessed October 22, 2023, https://www.adb.org/sites/default/files/linked-documents/44372-01-pak-oth-02.pdf.

[241] Hina Sheikh, "In Pakistan, many communities often lack the knowledge and skills required to respond effectively to flood hazards," *IGC,* November 16, 2022, https://www.theigc.org/blogs/climate-priorities-developing-countries/lessons-flood-risk-mitigation-pakistan.

4.1.8 Absence of Flood Management

In Pakistan, the conventional strategy for flood management has predominantly centered around the development of flood protection infrastructure, including embankments, spurs, barrages, and the regulation of reservoirs. While these elements are essential, relying solely on them without an integrated approach can lead to shortcomings in flood management. During the 2010 flood, the focus on flood protection infrastructure was evident. Over-reliance on infrastructure alone proved inadequate in the face of unprecedented flooding. In 2022, a similar emphasis on traditional flood protection measures was observed. While these measures provided some level of protection, they were not sufficient to manage the extensive and widespread floods that affected various regions. The lack of an integrated approach became apparent when multiple systems reached their capacity, leading to flooding in some areas.

Effective flood management encompasses a range of strategies, including floodplain management, early warning systems, community preparedness, and sustainable water resource management. During the 2010 flood, the absence of an integrated and holistic flood management strategy became evident. While embankments and barrages were in place, there was limited focus on managing floodplains or engaging communities in flood preparedness. As a result, the floods caused widespread devastation, and the lack of coordination among various aspects of flood management became apparent. In 2022, the importance of an integrated approach was underscored once again. While some improvements had been made in early warning systems and community engagement, a comprehensive, integrated flood management strategy was still lacking. This hindered the ability to respond effectively to the floods, especially in areas where floodwaters exceeded the capacity of existing infrastructure.

Integrated flood management recognizes that effective flood control cannot rely solely on structural measures. It incorporates a combination of structural and non-structural measures, including community awareness, and sustainable water resource management. This approach ensures resilience against floods and minimizes their impact. Many countries around the world have adopted integrated flood management strategies. For example, the Netherlands, known for its effective flood control, combines structural measures like dikes with non-structural measures such as comprehensive flood risk assessments, community engagement, and adaptive planning. This integrated approach has helped the country withstand significant flooding events. Pakistan's historical focus on traditional flood protection infrastructure, without an integrated and holistic flood management strategy, has

limitations. The examples from the 2010 and 2022 flood underscore the need for a comprehensive approach measures, floodplain management, early warning systems, community engagement, and sustainable water resource management. Embracing integrated flood management is vital for effectively reducing the impact of floods and enhancing resilience against future flooding events in Pakistan.

4.1.9 Obstruction of Climate-Friendly Policies

In Pakistan, as in many other countries, climate-friendly policies have faced significant challenges and obstructions, often driven by various interest groups. The country's vulnerability to annual floods due to changing weather patterns and climate change impacts makes it an illustrative case for examining how lobbying efforts by specific interest groups can hinder climate-friendly policies. Agriculture is a significant sector in Pakistan, and it heavily relies on water resources. However, due to inefficient water management practices and outdated irrigation systems, the country often experiences devastating floods during the monsoon season. Climate-friendly policies that promote sustainable water management and modernization of irrigation systems have been obstructed by powerful agricultural lobbies. These lobbies resist changes that could impact their control over water resources or force them to adopt more water-efficient practices. Efforts to introduce water-saving technologies and improve irrigation practices might face opposition from influential landowners who have political clout. They may lobby against these policies to maintain the status quo.[242]

Pakistan's sugar industry is known for its water-intensive practices, exacerbating water scarcity issues in the country. Climate-friendly policies aimed at regulating water usage by the sugar industry have faced opposition from powerful sugar barons who hold significant political influence. These interest groups have managed to delay or dilute regulations that could promote sustainable water management.[243] In many rural areas of Pakistan, landlords hold significant power and influence over water resources due to their control of irrigation systems. Climate-friendly policies aimed at redistributing water resources for more equitable and sustainable use have faced resistance from these influential landlords who prioritize their agricultural interests over broader environmental concerns.[244]

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[242] Waseem Ishaque, Rida Tanvir, Mudassir Mukhtar, "Climate Change and Water Crises in Pakistan: Implications on Water Quality and Health Risks", *Journal of Environmental and Public Health*, vol. 2022, Article ID 5484561, 12 pages, 2022. https://doi.org/10.1155/2022/5484561

[243] Uzair Sattar, "Sugar and Water in Pakistan," *LSE*, September 22, 2020, https://blogs.lse.ac.uk/southasia/2020/09/22/sugar-and-water-in-pakistan/.

[244] Muhammad Jawad Sajid and Muhammad Habib ur Rahman, "The Nexus between Environmental Impact and Agricultural Sector Linkages: A Case Study of Pakistan," *MDPI* 12, no. 9 (2021): 1200, https://doi.org/10.3390/atmos12091200 (accessed September 16, 2021).

Pakistan heavily depends on particularly coal so Transitioning to renewable energy sources like wind and solar could significantly reduce greenhouse gas emissions. However, powerful interests within the fossil fuel industry, including coal mining and power generation companies, resist such transitions. Invest in renewable energy projects could face opposition from coal industry lobbyists who argue for the preservation of jobs and economic interests in the coal sector. The Thar Coal project in Pakistan's Sindh province is one of the world's largest coal reserves. Despite potential environmental impact and contribution to greenhouse gas emissions, the project has received substantial support from the government and influential coal industry lobbies.[245] These organizations have effectively advocated for the growth of coal mining and power in the area, impeding initiatives aimed at transitioning to more environmentally friendly energy sources.

Climate-friendly policies that aim to curb these practices and promote sustainable urban development may encounter resistance from real estate developers and construction industries. Lobbying efforts by these interest groups may hinder the enforcement of zoning regulations or building codes designed to mitigate climate risks by limiting construction or promoting green building practices. Deforestation is a critical issue in Pakistan, contributing to climate change and floods. The timber lobby, with ties to political elites, has historically resisted efforts to implement strict regulations on logging and deforestation. These interests have hindered reforestation and afforestation initiatives that are essential for carbon sequestration and climate mitigation. Rapid urbanization in Pakistan has often occurred without proper urban planning and environmental considerations. The construction industry, along with political connections, has opposed climate-friendly policies that call for sustainable urban development, floodplain preservation, and green building standards. This has led to increased vulnerability to climate-related disasters, including annual floods.

Corruption and political influence often play a significant role in obstructing climate-friendly policies. Politicians with vested interests in industries detrimental to the environment may use their power to derail or dilute climate-related legislation. Elected officials receiving campaign contributions from industries contributing to environmental degradation may resist climate-friendly policies to protect their financial backers.[246] In Pakistan's case, the annual recurrence of floods is indeed a severe issue that warrants urgent climate-friendly

[245] Ms. Zarka Khan, "The Thar Coal Power Project: Balancing Environmental Sustainability and National Security," September 26, 2023, https://pakistanhouse.net/the-thar-coal-power-project-balancing-environmental-sustainability-and-national-security/?print=print.

[246] Jumaina Siddiqui, "Pakistan's Climate Challenges Pose a National Security Emergency," *USIP*, July 7, 2022, https://www.usip.org/publications/2022/07/pakistans-climate-challenges-pose-national-security-emergency.

policy measures. However, the interests of powerful stakeholders in various sectors have, at times, hindered the implementation of such policies. These examples illustrate the challenges that arise when climate-friendly policies clash with the economic and political interests of influential groups, ultimately delaying progress in addressing climate change and its impacts.

4.2 Flood Mitigation and Management Policies for Pakistan

4.2.1 Policy for Comprehensive Flood Management

A comprehensive policy is crucial for a country like Pakistan, which faces annual flood challenges. Such a policy combines various strategies and approaches to effectively mitigate, respond to, and manage floods. Countries like the Netherlands, the US, and Japan have set strong examples of flood management by adopting integrated policies that blend structural and non-structural measures. These nations have recognized the multifaceted nature of flood risk and have consequently developed comprehensive approaches that include elements such as early warning systems, floodplain management, and community engagement.[247] Pakistan, facing its own set of challenges stemming from climate change, rapid population growth, and resource scarcity, would greatly benefit from following suit. By adopting a similar integrated flood management policy, Pakistan can enhance its resilience against increasingly frequent and severe floods, safeguard its communities and livelihoods, and harness the potential for sustainable development. Drawing lessons from the experiences of these nations and applying them within Pakistan's unique context is not just advisable but imperative for a more secure and prosperous future in the face of growing flood risks.

Pakistan should continue to invest in structural measures like dams, levees, and embankments to control floodwaters. These structures can help regulate water flow during heavy rainfall and prevent excessive flooding in downstream areas. Efficient management of reservoirs, such as Tarbela and Mangla dams, is essential. These reservoirs have the capacity to retain surplus water in monsoon seasons reducing the risk of downstream flooding. Implementing strict land-use regulations in flood-prone areas is critical. Discouraging construction in floodplains and promoting sustainable land development practices can reduce flood vulnerability.[248] Developing and maintaining early warning

[247] Faith Ka Shun Chan, Liang Emlyn Yang, Gordon Mitchell, Nigel Wright, Mingfu Guan, Xiaohui Lu, Zilin Wang, Burrell Montz, and Olalekan Adekola, "Comparison of Sustainable Flood Risk Management by Four Countries – the United Kingdom, the Netherlands, the United States, and Japan – and the Implications for Asian Coastal Megacities," *Nat. Hazards Earth Syst. Sci.* 22 (2022): 2567–2588, https://doi.org/10.5194/nhess-22-2567-2022

[248] Muhammad Adnan Khan, Jürgen Stamm, and Sajjad Haider, "Simulating the Impact of Climate Change with Different Reservoir Operating Strategies on Sedimentation of the Mangla Reservoir, Northern Pakistan," *Water* 12, no. 10 (2020): 2736, https://doi.org/10.3390/w12102736

systems is vital which can alerts communities in flood-prone areas, enabling them to evacuate and take necessary precautions. Actively involving local communities in flood management is essential. Training communities to respond effectively during floods, establishing community-based disaster risk reduction committees, and promoting awareness campaigns can enhance preparedness and resilience. Implementing policies to promote sustainable water resource management is essential to mitigate the impact of floods. This includes proper watershed management, efficient irrigation practices, and reducing water wastage.[249]

The government should coordinate efforts across various sectors, including agriculture, urban planning, and environmental conservation, to address the root causes of flooding. Collaborate with neighboring countries, particularly India and Afghanistan, to share hydrological data and coordinate dam operations to manage transboundary rivers effectively. Ensure the strict implementation and enforcement of flood management policies and regulations. This includes holding accountable those who violate land-use regulations in flood-prone areas. After a flood event, focus on rapid recovery efforts and long-term resilience building. This includes providing support for affected communities, rebuilding infrastructure, and incorporating lessons learned into future policies.[250]

4.2.2 Zoning and Planning for Floodplain Land Use

It is imperative for Pakistan to pay close attention to planning measures to mitigate the recurring flood-related problems. Pakistan experiences annual floods primarily due to the overflow of major rivers like the Indus. To effectively address this, the government should define high-risk flood-prone areas by assessing historical flood data and topographical information. These areas typically include the floodplains along the major rivers. Once the flood-prone areas are identified, the government should establish and enforce floodplain zoning regulations. These regulations would restrict or prohibit construction and development within these high-risk zones. It is essential to create legally binding policies that clearly specify the restrictions and penalties for non-compliance.

Strict enforcement of floodplain zoning regulations is crucial. Government agencies, local authorities, and planning departments should monitor compliance and ensure that development adheres to the established zoning guidelines. Regular inspections and permits

[249] Brayshna Kundi, "Pakistan's Water Crisis: Why a National Water Policy Is Needed," *Reliefweb*, November 1, 2017, https://reliefweb.int/report/pakistan/pakistan-s-water-crisis-why-national-water-policy-needed.

250 Anthony Antoniou, "Post-Flood Recovery Management: Building Resilience in the Aftermath," LinkedIn, September 25, 2023, https://www.linkedin.com/pulse/post-flood-recovery-management-building-resilience-anthony-antoniou/.

can be used to control construction activities.[251] Effective land use planning is essential to identify areas that are safe for development and infrastructure projects. Geographical information systems (GIS) can be used to map out flood-prone zones, helping in the selection of safer areas for new construction. Pakistan should direct urban expansion and infrastructure development away from flood-prone zones. This involves creating master plans and zoning regulations that designate specific zones for various land uses, focusing on flood-resilient urban development. In cases where existing infrastructure or settlements are in high-risk flood-prone areas, the government should consider relocation or retrofitting measures to reduce vulnerability. Safe and well-planned relocation can save lives and property during floods.

The Netherlands, known for its advanced flood management strategies, has comprehensive floodplain zoning and land use planning in place. They use a system of dikes and levees to protect low-lying areas and have strict regulations on land use in flood-prone areas.[252] New developments and urban expansion are carefully planned to reduce flood risks. United States: The U.S. has implemented effective floodplain zoning and land use planning policies. The Federal Emergency Management Agency (FEMA) establishes flood hazard areas, and local governments enforce zoning regulations to restrict construction in these zones. FEMA provides flood risk maps to guide land use decisions, and many states and municipalities have adopted these regulations to mitigate flood risks.[253] China has taken measures to address its flood challenges, particularly in regions along the Yangtze River. The country has implemented land use planning to manage and control development in flood-prone areas. They designate specific zones for agriculture, urban development, and flood storage, helping to reduce flood impact.[254] Bangladesh, prone to seasonal monsoon floods and cyclones, has implemented land use planning to protect its vulnerable coastal areas. The country has established regulations for construction and development in low-lying regions to minimize

[251] LAND USE PLANNING FOR URBAN FLOOD RISK MANAGEMENT, *UFCOP*, April 2017, https://www.gfdrr.org/sites/default/files/publication/UFCOPKnowledgeNoteMay.pdf.

[252] Jaapjan Zeeberg, "Flood Control in the Netherlands: A Strategy for Dike Enforcements and Climate Adaptation," ResearchGate, January 2010, doi:10.13140/RG.2.1.5127.9445.

[253] "Understand the Differences Between FEMA Flood Zones," *RiskFactor*, accessed October 24, 2023, https://help.riskfactor.com/hc/en-us/articles/360048256493-Understand-the-differences-between-FEMA-flood-zones.

[254] Yoshiaki Kobayashi and John W. Porter, Flood Risk Management in the People's Republic of China: Learning to Live with Flood Risk, Asian Development Bank, 2012, https://www.adb.org/sites/default/files/publication/29717/flood-risk-management-prc.pdf.

damage during flooding events. [255]By adopting floodplain zoning and land use planning similar to these examples, Pakistan can significantly reduce the risk of annual floods and minimize the damage to communities and infrastructure. It's essential to enforce these policies effectively and integrate them into broader flood management strategies to ensure long-term resilience and disaster risk reduction

4.2.3 Systems for Timely Warnings

Advanced warning systems is a crucial component of flood management, especially in a flood-prone country like Pakistan. It can significantly reduce the loss by providing timely and accurate information to at-risk communities. Pakistan experiences annual floods, primarily due to the monsoon rains and the overflow of its major rivers, including the Indus. These floods often lead to displacement, and extensive damage to infrastructure and agriculture. Early warning systems are essential because they provide timely alerts to communities in flood-prone areas. These warnings allow people to take necessary precautions, including evacuations, moving valuable belongings to higher ground, and seeking shelter, all of which can save lives and reduce property damage.[256]

Pakistan should invest in advanced early warning systems that use modern technology, including weather radars, satellite imagery, and computer modeling, to predict floods accurately. These systems can provide forecasts that are more reliable and have longer lead times. It's crucial that these early warning systems are accessible and understandable for the general population, including those in remote and rural areas. Warnings should be disseminated through multiple channels, including radio, TV, mobile phones, and community meetings. Information should be provided in local languages and be simple to understand. In addition to investing in the technology, Pakistan should work on community engagement. Local communities need to be trained on how to respond effectively to flood warnings. Establishing community-based disaster risk reduction committees and conducting awareness campaigns can enhance preparedness and resilience.

Timely warnings can lead to the evacuation of at-risk populations, reducing the risk of casualties during floods. People can move valuable assets to safer locations and take preventive measures to protect their homes and infrastructure. Early warning systems can

[255] "Tackling Flooding in Bangladesh in a Changing Climate," LSE, August 2023, https://www.lse.ac.uk/granthaminstitute/wp-content/uploads/2023/08/Tackling-flooding-in-Bangladesh-in-a-changing-climate.pdf.

[256] Ashfaq Ahmad Shah et.al, "Community Social Barriers to Non-Technical Aspects of Flood Early Warning Systems and NGO-Led Interventions: The Case of Pakistan," *Frontiers in Earth Science* 11 (2023): https://doi.org/10.3389/feart.2023.1068721.

help authorities coordinate disaster response efforts more effectively. By reducing flood damage, Pakistan can minimize the economic losses associated with annual floods.[257]

India has established a sophisticated flood forecasting and warning system. The Central Water Commission (CWC) in India operates a network of hydro-meteorological stations and issues flood alerts and warnings to communities in flood-prone regions. The system has been instrumental in minimizing flood-related casualties and damages.[258] Bangladesh, with its vulnerability to seasonal monsoon floods and cyclones, has developed an extensive early warning system. The Bangladesh Meteorological Department (BMD) provides real-time information on weather and flood conditions. The country's experience in managing annual floods and cyclones underscores the importance of effective early warning systems.[259]

Vietnam, prone to both riverine and coastal flooding, has improved its early warning systems significantly. The Vietnam Disaster Management Authority (VDMA) disseminates flood forecasts and warnings to vulnerable communities, allowing them to prepare and evacuate when necessary.260 Germany has a well-developed early warning system, which includes flood forecasting and alerts. The German Weather Service (Deutscher Wetterdienst) issues warnings and provides valuable information to the public, helping reduce the risks associated with flooding events.261 Investing in advanced early warning systems, as seen in these countries, is essential for Pakistan to safeguard its population. These systems empower at-risk communities to take appropriate measures and enhance overall disaster preparedness and resilience.

4.2.4 Community Awareness and Education

Community awareness and education programs are essential in the context of Pakistan, a country prone to annual floods. These programs can help inform people about flood risks, safety measures, and evacuation procedures, ultimately increasing community preparedness and resilience. Pakistan faces annual floods due to monsoon rains and river overflows, which can lead to floods. Communities in flood-prone areas are particularly vulnerable. Community awareness and education programs empower individuals and communities with

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[257] J. Thielen-del Pozo et.al , "The Benefit of Continental Flood Early Warning Systems to Reduce the Impact of Flood Disasters," European Commission, 2015, doi:10.2788/46941.

[258] Nanditha J.S. and Vimal Mishra, "On the Need of Ensemble Flood Forecast in India," *ScienceDirect*, Volume 12, April 2021, https://doi.org/10.1016/j.wasec.2021.100086.

[259] Muzammel Haque Tarafder, Bangladesh Meteorological Department, accessed October 25, 2023, https://oceanexpert.org/downloadFile/19042.

[260] Lan Huong et.al, "Disaster Risk Management System in Vietnam: Progress and Challenges," *Heliyon* 8, no. 10 (2022): e10701, doi:10.1016/j.heliyon.2022.e10701.

[261] Julian Hofmann, Holger Schüttrumpf, "Risk-Based Early Warning System for Pluvial Flash Floods: Approaches and Foundations," *Geosciences* 9, no. 3 (2019): 127, https://doi.org/10.3390/geosciences9030127.

knowledge about flood risks, warning signs, and safety measures. Informed communities can take proactive steps to protect themselves and their belongings during floods. During the floods, timely and well-executed evacuations can save lives. Educating communities about evacuation procedures, safe routes, and assembly points is vital. Regular drills and exercises can familiarize residents with these procedures.

Community members often have valuable local knowledge about flood patterns, vulnerable areas, and traditional coping strategies. Combining this knowledge with official guidance can enhance the effectiveness of flood response and preparedness efforts. Awareness programs can educate communities about the importance of early warning systems and how to respond to alerts. This includes understanding the language of warning signals, interpreting forecasts, and recognizing evacuation orders.[262] Informed communities are more likely to respond to early warnings and evacuate in a timely manner, potentially saving lives. Education and drills can reduce panic during emergencies, as people are better prepared and know what to expect. Community members can take steps to safeguard their property, such as moving belongings to higher ground, which can reduce damage. These programs build resilience within communities, helping them to recover more quickly after a flood event.[263] When communities are educated and engaged, they can work more effectively with government agencies and relief organizations during flood emergencies. To effectively implement community awareness and education programs, Pakistan should work with local governments, non-governmental organizations, and community leaders to organize the programs for the vulnerabilities of different regions. Regular drills and exercises should be conducted to ensure that communities are well-prepared for flood emergencies. These efforts will contribute to the overall flood resilience of the country and help protect the lives and well-being of its citizens.

4.2.5 Management of Water Resources

Management of resources is essential for Pakistan, a country that experiences annual floods and relies on the Indus River system for its water supply and agriculture. In the context of Pakistan, implementing sustainable water resource management practices can help regulate water flows, reduce the impact of monsoon floods, and enhance overall water management. Several countries have worked on implementing sustainable water resource management

[262] "Public Awareness and Public Education for Disaster Risk Reduction: A Guide," accessed October 26, 2023, https://www.climatecentre.org/wp-content/uploads/Public-awareness-and-public-education-for-disaster-risk-reduction-a-guide.pdf.

[263] Leon J. M. Rothkrantz , Siska Fitrianie, "Public Awareness and Education for Flooding Disasters," June 27, 2018, doi: 10.5772/intechopen.74534, https://www.intechopen.com/chapters/59739.

practices, especially concerning dam management, water storage, and flood control reservoirs. Australia has an extensive system of water resource management, including the operation of dams and reservoirs. The Murray-Darling Basin Plan, for example, emphasizes sustainable water use, environmental protection, and efficient water allocation, balancing the needs of agriculture, industry, and the environment.[264] India has made efforts to improve water resource management by constructing multipurpose dams and reservoirs. The Sardar Sarovar Dam on the Narmada River, for instance, not only provides water for irrigation but also helps in flood control and hydropower generation.[265]

Brazil has invested in the management of its water resources, particularly in the Amazon Basin and semi-arid regions. Dams such as the Sobradinho Dam on the São Francisco River serve various functions, including flood control, irrigation, and the generation of electricity.[266] Thailand has implemented water management practices to address monsoon flooding. The Royal Irrigation Department has developed a comprehensive system of dams, reservoirs, and canals to manage water resources efficiently and reduce flood risks.[267] These countries have demonstrated the importance of integrated water resource management in regulating water flows and mitigating the impacts of floods. Pakistan could benefit from adopting similar practices, especially given its vulnerability to monsoon floods and the need for sustainable water use and flood control measures. Integrated water resource management contributes to enhanced disaster resilience and sustainable development.

Pakistan faces a dual water challenge - water scarcity during dry periods and monsoon-related floods during the wet season. Integrated water resource management can help balance these extremes. Sustainable water resource management involves efficient utilization of water resources. It aims to reduce water wastage and promote efficient practices in agriculture and other sectors. Pakistan has significant dams like Tarbela and Mangla, which serve multiple purposes, including water storage and flood control. Effective management of these dams is crucial. During the monsoon season, dams can store excess water,

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[264] H. Downey , T. Clune, "How Does the Discourse Surrounding the Murray Darling Basin Manage the Concept of Entitlement to Water?" *Critical Social Policy* 40, no. 1 (2020): 108-129, https://doi.org/10.1177/0261018319837206.

[265] Himanshu Thakkar, "Sardar Sarovar Creates Avoidable Flood Disaster in Bharuch," September 2, 2020, *SANDRP*, https://sandrp.in/2020/09/02/sardar-sarovar-creates-avoidable-flood-disaster-in-bharuch/.

[266] Hersília De Andrade e Santos, Paulo Pompeu, and Danilo Lessa Okuma, "Changes in the Flood Regime of São Francisco River (Brazil) from 1940 to 2006," *Regional Environmental Change* 12, no. 1 (March 2012): doi:10.1007/s10113-011-0240-y.

[267] "Enhancing Climate Resilience in Thailand Through Effective Water Management and Sustainable Agriculture," UNDP, May 20, 2021, https://www.undp.org/sites/g/files/zskgke326/files/migration/th/UNDP_TH_ESMF_ENG.pdf.

preventing downstream flooding. During dry periods, controlled releases can ensure a stable water supply. Building and maintaining water storage infrastructure, such as reservoirs and ponds, can help mitigate the impact of floods. Storing excess monsoon water for use during dry periods can stabilize water supply and reduce flood risks. Developing flood control reservoirs or basins, especially in flood-prone areas, can provide a buffer zone to contain floodwaters and reduce downstream flooding. Efficient water management can control the release of water from dams, reducing the risk of downstream flooding during heavy rainfall. Proper water storage and management ensure a stable water supply for agriculture and domestic use during dry seasons. Sustainable water use helps preserve ecosystems by maintaining adequate water levels in rivers and wetlands. Optimized irrigation practices can enhance crop yields and reduce the water footprint of agriculture.[268]

By minimizing the impact of monsoon floods and ensuring a stable water supply, Pakistan can enhance economic resilience and reduce losses due to flooding. It's important for Pakistan to invest in infrastructure and technology that support integrated water resource management. This includes improving data collection and analysis, enhancing dam and reservoir management, and regulating groundwater use. Additionally, public awareness and cooperation among stakeholders, including local communities, are crucial to the success of these initiatives. By implementing sustainable water resource management practices, Pakistan can reduce annual flood challenges.

4.2.6 Environmental Conservation and Reforestation

Environmental conservation and reforestation efforts in upstream areas are vital for reducing the impact of annual floods in Pakistan. The upper reaches of Pakistan, especially in the Himalayan and Karakoram regions, serve as the primary sources of river systems like the Indus. These upstream areas play a significant role in controlling the quantity and speed of water flow downstream.[269] Deforestation and unsustainable land use practices in upstream areas can lead to increased soil erosion. When trees and vegetation are removed, soil becomes more susceptible to erosion, which can exacerbate downstream flooding. Trees and forests act as natural sponges, absorbing excess rainfall and slowing the flow of water into

[268] UN Environment Program, "Advancing Integrated Water Resources Management," accessed October 26, 2023, https://www.unep.org/explore-topics/water/what-we-do/advancing-integrated-water-resources-management#:~:text=Integrated%20Water%20Resources%20Management%20(IWRM,the%20sustainability%20of%20vital%20ecosystems.

[269] "The Vulnerability of Pakistan's Water Sector to the Impacts of Climate Change: Identification of Gaps and Recommendations for Action," UNDP, accessed October 26, 2023, https://www.undp.org/sites/g/files/zskgke326/files/migration/pk/Report.pdf.

rivers. When forests are intact, they help regulate runoff, reducing the volume of water that flows downstream during heavy rainfall.[270]

Healthy ecosystems in upstream areas contribute to better water flow regulation. Reforested areas can store and release water gradually, reducing the risk of flash floods in downstream regions. Healthy ecosystems and reforestation help mitigate the impact of floods by reducing the volume and speed of water flowing into rivers during heavy rainfall. Reforestation efforts prevent soil erosion, which can reduce sediment loads in rivers and improve water quality downstream. These efforts also promote biodiversity and ecosystem health in Pakistan's mountains and upstream regions. Reforested areas can act as natural reservoirs, contributing to improved water resource management and consistent water supply. Environmental conservation and reforestation contribute to long-term sustainability, helping protect against the increasing risks of climate change-induced extreme weather events.[271]

Involving local communities in reforestation and conservation efforts can generate employment opportunities, foster environmental stewardship, and strengthen local resilience. Pakistan should prioritize environmental conservation and reforestation efforts in upstream areas. This includes enforcing laws against illegal logging and unsustainable land use, promoting tree planting initiatives, and engaging with local communities. Such measures can significantly contribute to flood management and help reduce the recurring impact of floods in the country. Several countries around the world have recognized the significance of environmental conservation and reforestation in reducing the impact of floods .Vietnam has been actively engaged in reforestation projects in its upland areas to prevent soil erosion and reduce flood risks. Initiatives like the Forest Sector Support Partnership have helped in restoring forest cover, preserving biodiversity, and regulating water flow, thereby minimizing the impact of flooding in downstream areas.[272] Costa Rica is renowned for its commitment to environmental conservation and reforestation. The country has established protected areas, national parks, and reforestation projects that have preserved biodiversity and mitigates the impact of landslides and flooding in critical watersheds.[273]

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[270] Dede Sulaeman, Thomas Westhoff, "The Causes and Effects of Soil Erosion, and How to Prevent It," *WRI*, February 7, 2020, https://www.wri.org/insights/causes-and-effects-soil-erosion-and-how-prevent-it.

[271] Kateryna Sergieieva, "Reforestation: Pros, Cons and Effects on Planet," *EOS*, May 29, 2023, https://eos.com/blog/reforestation/.

272 Thi Kim Phung Dang, "The Discourse of Forest Cover in Vietnam and Its Policy Implications," *Sustainability* 14, no. 17 (2022): 10976, https://doi.org/10.3390/su141710976.

[273] "Costa Rica's Forest Conservation Pays Off," The World Bank, November 16, 2022, https://www.worldbank.org/en/news/feature/2022/11/16/costa-rica-s-forest-conservation-pays-off.

Ethiopia, facing its share of flooding and soil erosion challenges, has implemented large-scale reforestation initiatives. The "Green Legacy" program, for instance, aims to plant billions of trees to combat deforestation, control runoff, and regulate water flows.[274] Madagascar, an island nation prone to cyclones and flooding, has focused on reforestation to improve soil stability and reduce the impact of heavy rains. Various organizations and government efforts aim to restore forests and protect unique ecosystems.[275] By promoting environmental conservation and reforestation in upstream areas, Pakistan can significantly reduce soil erosion, control runoff, and regulate water flows, ultimately mitigating the impact of floods downstream. These examples highlight the effectiveness of such measures in various contexts and underscore the importance of sustainable land management for disaster risk reduction.

4.2.7 Climate Change Adaptation

Incorporating climate change adaptation measures into flood management policies is essential for Pakistan, given its vulnerability to floods and the changing climate patterns. Pakistan is experiencing shifts in climate patterns, resulting in unpredictable and extreme weather events. Increased temperatures, changing precipitation patterns, and more intense monsoons are contributing to the country's flood challenges. Climate change is amplifying the risks associated with flooding. Higher temperatures can lead to the accelerated melting of glaciers and increased snowmelt, contributing to river flows. The unpredictability of monsoons can result in more intense and erratic rainfall, causing flash floods. Pakistan's coastal areas are vulnerable to sea-level rise due to climate change, which can exacerbate flooding in these regions. Integrated coastal management and adaptation strategies are needed to protect coastal communities.[276]

Climate change affects agriculture, a critical sector in Pakistan. Irregular rainfall can lead to reduced crops while extreme floods can destroy standing crops, disrupting food security. Floods triggered or intensified by climate change can have severe health impacts, including waterborne diseases and injuries. They can also damage infrastructure, homes, and

[274] Habtemariam Kassa, Abrham Abiyu, Niguse Hagazi, Mulugeta Mokria, Tibebu Kassawmar, and Vincent Gitz, "Forest Landscape Restoration in Ethiopia: Progress and Challenges," *Frontiers in Forests and Global Change* 5 (2022): https://doi.org/10.3389/ffgc.2022.796106.

[275] Remi Rolland Andriamanalinarivo, Aritiana Fabien Faly, and Julot Herman Randriamanalina, "Madagascar, a Country Resilient to the Effects of Hazards and Protected from Damage for Sustainable Development," *PreventionWeb*, accessed October 27, 2023, https://www.preventionweb.net/files/66376_f346finalrandriamanalinamadagascarr.pdf.

[276] "Climate Crisis in Pakistan: Voices from the Ground," *Reliefweb*, June 22, 2023, https://reliefweb.int/report/pakistan/climate-crisis-pakistan-voices-ground.

livelihoods, particularly in vulnerable communities. Climate change adaptation measures in flood management policies help build resilience to the changing climate. These strategies allow for more effective response and recovery during flood events. Planning and building infrastructure that can withstand extreme weather events and flooding, such as resilient roads, bridges, and flood defenses, are vital components of adaptation. Incorporating climate considerations into water resource management can ensure a consistent water supply and reduce flood risks.

Involving local communities in climate change adaptation strategies ensures that their specific vulnerabilities and needs are addressed. Pakistan should work with neighboring countries to coordinate transboundary river management and share climate data.[277] Climate adaptation efforts require access to climate data, research, and innovation for developing context-specific strategies. It is imperative for Pakistan to recognize the changing climate patterns and integrate adaptation measures into its flood management policies. This includes enhancing early warning systems to account for changing precipitation patterns, implementing sustainable water resource management practices, and strengthening infrastructure to withstand climate-related challenges.

4.2.8 International Cooperation

In the context of Pakistan, international cooperation in flood management is of paramount importance. Here's an explanation of why Pakistan should collaborate with neighboring countries and some authentic platforms through which such cooperation can take place. Pakistan shares its major rivers, including the Indus, with neighboring countries such as India, Afghanistan, and China. Transboundary rivers and shared river basins require collaborative flood management efforts as floods do not respect national borders.[278] Access to accurate and timely hydrological data from upstream countries is essential for effective flood management. Sharing data on river flow, rainfall, and dam operations can help Pakistan anticipate and prepare for incoming floodwaters. Coordination in dam operations is critical. Neighboring countries should work together to ensure that dam releases do not exacerbate

[277] "Assessing the Costs and Benefits of Climate Change Adaptation," *EEA*, April 25, 2023, https://www.eea.europa.eu/publications/assesing-the-costs-and-benefits-of#:~:text=These%20include%20reducing%20future%20risks,benefits%20and%20improving%20ecosystem%20services.

[278] "Flood Forecasting and Early Warning in Transboundary River Basins," *ESCAP*, accessed October 29, 2023, https://www.unescap.org/sites/default/files/Flood_toolkit_LowRes.pdf.

flood risks downstream. Timely communication about dam operations is crucial to minimize flood impacts.[279]

Collaborative efforts provide more comprehensive and accurate flood alerts, allowing downstream countries to prepare in advance. Collaborative disaster response and relief efforts can be more efficient when neighboring countries have a framework for cooperation. This includes mutual assistance during flood emergencies and sharing best practices in disaster response. International organizations such as the United Nations and its agencies, like UNICEF and UNDP, provide support and platforms for regional cooperation on disaster management and risk reduction. Bilateral agreements between Pakistan and its neighbors can also facilitate cooperation on flood management, data sharing, and early warning systems. Pakistan should actively engage in international cooperation with neighboring countries, especially those sharing river basins, to develop coordinated flood management strategies and information-sharing mechanisms. Collaborative efforts are essential to address the challenges of transboundary floods and to enhance the effectiveness of flood management in the region. Platforms like the Indus Waters Treaty, SAARC, and RCC, among others, provide authentic avenues for such cooperation.

Conclusion

In conclusion, this chapter extensively addresses the pressing issue of flood management in Pakistan, shedding light on the urgent need for comprehensive reforms to mitigate the devastating impacts of floods. Pakistan, grappling with the recurring havoc caused by floods, finds itself at a critical juncture that demands immediate attention. The increasing frequency and severity of flood events paint a concerning picture, posing a threat to the nation's stability and developmental progress. The chapter examines Pakistan's existing framework, encompassing laws, organizations, and plans designed to deal with floods. Unfortunately, the scrutiny reveals significant deficiencies in these structures, hindering the effective management of disasters. Inadequate financial investments in flood control initiatives further compound the challenges, resulting in the deterioration of buildings and infrastructure and leaving the country ill-prepared for future floods. However, amidst these challenges, the chapter underscores the paramount importance of enhancing preparedness for impending flood events. The central objective revolves around presenting a suite of well-thought-out policies and innovative strategies. These proposed initiatives transcend the immediate

[279] Transboundary Flood Risk Management, *UNECE*, 2009, https://unece.org/DAM/publications/oes/Transboundary_Flood_Risk_Management_Final.pdf.

challenges and aspire to fortify Pakistan's resilience against future flood events. In essence, the chapter envisions a future where the detrimental impacts of floods are significantly reduced. It aspires to see Pakistan emerge as a strong, prepared, and prosperous nation, where the adverse effects of floods are minimized. By addressing the intricate challenges associated with flood management, the chapter aims to lay the foundation for a resilient and proactive approach, imperative for safeguarding the well-being of the nation against the recurrent crisis of floods. Through this comprehensive discussion, the chapter aims to initiate a robust plan that will pave the way for Pakistan to navigate through the recurring flood crisis successfully.

Conclusion

This thesis delves into the intricate challenges arising from climate change and the recurring floods in Pakistan, emphasizing the necessity for a sophisticated and interconnected strategy. It meticulously outlines the urgency of global cooperation to address climate change, a complex phenomenon shaped by human activities that resonate across the environment, society, and global economies. In this vast global context, Pakistan emerges as a microcosm of the broader crisis, requiring not only immediate adaptation but also the implementation of effective mitigation measures and the formulation of well-informed policies. The overarching goal is to ensure socio-economic stability and protect the most vulnerable populations from the escalating impacts of climate change. A closer examination of the causal factors behind the 2010 and 2022 flood unravels the intricate interplay of political, social, and environmental elements. The mismanagement of these interconnected factors exacerbates the impact of such calamities. Inadequate governance structures, coupled with disparities in resource access and the environmental triggers of these floods, underscore the imperative of adopting an integrated approach. This comprehensive strategy should encompass a thorough understanding of power dynamics, environmental degradation, and societal vulnerabilities. It reflects the interconnected web of factors influencing the occurrences of disasters and underscores the need for a holistic approach to disaster management. While acknowledging the commendable relief and rescue efforts by the government during these crises, it is crucial to recognize the existing challenges in coordination and resource allocation. These challenges highlight the significance of efficient governance and resource management in disaster response. Effective governance becomes a linchpin for ensuring equitable resource distribution, aiming to benefit all segments of society impacted by these disasters. The effective management of floods in Pakistan relies on harmonized efforts, optimized resource allocation, and the reduction of community vulnerability through holistic strategies. This involves not only the development and implementation of early warning systems but also the creation of resilient infrastructure and active community engagement in decision-making processes.

In essence, this thesis underscores the dual nature of climate change, revealing both its global and localized impacts. It intricately weaves together the narratives of global climate change and Pakistan's vulnerabilities, emphasizing the shared responsibility among nations to collaboratively address this critical issue. Furthermore, it accentuates the indispensable need for effective governance, equitable resource distribution, and community involvement to

build resilience in the face of recurring environmental challenges. These guiding principles are seamlessly interwoven with the core tenets of political ecology, subtly forming the foundation for understanding and addressing the intricate environmental issues facing Pakistan and the broader global community. This comprehensive exploration sets the stage for a holistic and proactive approach to climate change mitigation and disaster management.

Findings

- Climate change is a global crisis primarily driven by human activities. The text traces its historical trajectory, underlining the urgent need for worldwide action to combat its far-reaching environmental, social, and economic consequences.
- Pakistan is exceptionally vulnerable to climate change, facing rising temperatures, erratic weather, glacier melt, floods, and droughts. These challenges impact agriculture, food security, water resources, public health, and socio-economic stability, necessitating swift adaptation, mitigation, and policy implementation.
- The causal factors of the 2010 and 2022 flood in Pakistan reveal a complex web of interrelated factors. Politically, inadequate water management and governance issues played a significant role in exacerbating both disasters. Socially, vulnerable populations in low-lying areas and informal settlements faced disproportionate hardships due to limited access to resources and healthcare. Environmentally, intense and prolonged monsoon rains were the primary triggers of the floods.
- The floods of 2010 and 2022, with their extensive damage to infrastructure and agriculture, revealed the consequences of inadequate governance and resource mismanagement. Vulnerable populations bore the brunt, reflecting inequalities in resource access. These events underscore the imperative of addressing the interconnected political, social, and environmental factors to build resilience and ensure equitable recovery.
- The government's response to the 2010 and 2022 flood in Pakistan showcased commendable efforts in relief and rescue operations. This finding underscores the capacity for effective crisis management even in the face of monumental challenges.
- Despite positive efforts, the government faced notable challenges related to coordination and resource allocation, highlighting the significance of efficient governance and resource management in disaster response.
- The management of floods in Pakistan is hindered by challenges in coordinating efforts among various government bodies and stakeholders. Additionally, resource allocation

for flood mitigation and management is often inadequate, emphasizing the need for improved coordination and resource planning.

Recommendations

- Implement strict zoning regulations to restrict construction in flood-prone areas and relocate vulnerable communities to safer locations.
- Enhance and expand early warning systems that utilize weather forecasting, river level monitoring, and community alert mechanisms to provide timely flood alerts.
- Promote afforestation and reforestation to reduce soil erosion and increase natural water retention. Construct check dams and retention ponds to slow down and store floodwaters.
- Construct and manage reservoirs and dams strategically to regulate river flow and release water gradually during heavy rainfall periods.
- Promote climate-smart agriculture practices that include drought-resistant crops and improved water management to reduce the impact of floods on agriculture.
- Incorporate flood-resistant building techniques and green infrastructure in urban planning to minimize damage during floods.
- Develop a comprehensive water management strategy that includes water storage, distribution, and efficient use to reduce pressure on rivers and prevent flooding.
- Conduct awareness campaigns to educate communities about flood risks and preparedness, including evacuation plans and first aid training.
- Strengthen disaster response teams, equip them adequately, and conduct regular drills to ensure swift and effective response during flood emergencies.
- Encourage and facilitate the availability of flood insurance to help individuals and businesses recover from flood-related losses.
- Develop long-term strategies for climate change adaptation, considering the changing patterns of precipitation and temperature in the region.
- Continuously collect and analyze data on flood patterns, climate trends, and vulnerability assessments to inform evidence-based policies and strategies.
- Encourage public-private partnerships for investment in flood management infrastructure and technology.
- Support local communities in building resilience through livelihood diversification, community-based disaster risk reduction, and access to resources.
- Regularly assess and evaluate the effectiveness of flood mitigation measures and adjust strategies as needed.

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