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FLOOD RISK MANAGEMENT AND SOCIAL VULNERABILITY IN PAKISTAN: UNDERSTANDING THE NEXUS BETWEEN NATURAL HAZARDS AND SOCIOECONOMIC DISPARITIES

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ABSTRACT

Climate change, inefficient urban planning, deforestation, and lack of disaster preparedness have caused more susceptible and severe floods in Pakistan over the course of the last few decades. This article examines the relationship between the flood risk management and social vulnerability. It also emphasizes that floods are not purely natural disasters; instead, they are socio-political constructions of inequality and marginality. Using a qualitative research design and secondary data analysis, the researchers applied Braun and Clarke's methods along with the Pressure and Release PAR model to analyze the data collected from governmental reports, academic sources, publications from international organizations, and the media from 2018 to 2025. The floods have afflicted Pakistan in mass ways, and studies show the floods are managed in a rather reactive fashion, where the provided solutions do not focus on the population that is at utmost risk. On one hand, lack of good governance hampers efforts towards providing structural solutions such as the construction of embankments, on the other hand the learning of communities as well as participatory planning both are seldom implemented when it comes to non-structural solutions. The study proposes a paradigm shift to equity-driven, community-centred flood risk governance and recommends integrating vulnerability appraisal to comprehensive planning in order to bolster resilience and adaptive capacity.

Keywords: *Flood risk management, social vulnerability, disaster resilience, Pakistan, PAR model, community-based disaster management*

INTRODUCTION

Pakistan's geographical location as well as its climate profile indicates that the country is susceptible to many natural disasters. Out of these, floods are the most destructive. (Shah et al., 2023). In the Country, floods, flash floods, and glacial lake outburst floods (GLOFs) occur frequently that affect the lives of millions, in addition to greatly impacting the economy. (Ahmed & Khan, 2022). Floods alone in 2022 have impacted more than 33 million people, inundated 1/3 of the country, and caused more than 30 billion dollars' worth of damages, presenting the factors of the impending disaster in Pakistan (NDMA, 2023). Also, the frequency and severity of floods have been increasing over time, which may be due to the ongoing climate crisis, unplanned city development, and environmental destruction. (Rahman et al., 2024).

The diverse topography of Pakistan, ranging from the Himalayas to the coast of the Arabian Sea, creates intricate flood risks that need to be managed strategically, approaching the realm of the unfathomable (Mazhar et al., 2024). However, current approaches to flood risk management still tend to focus on engineering structures such as dams, embankments, and drainage systems, neglecting to address the social dimensions of susceptibility to flooding (Hashmi et al., 2022).Regardless of the extensive investment in flood control infrastructure and the creation of different disaster management authorities, Pakistan keeps facing a devastating impact of floods that disproportionately affect vulnerable groups (Ali & Hussain, 2023). The consistent severe flooding-induced fatalities, displacement, and economic losses highlight the inadequacies of current flood risk management strategies. These deficiencies are particularly pronounced when one considers the impact of floods on various social groups because the impact is disproportionately borne by marginalized populations compared to wealthier groups (Nazir et al., 2024). The present-day approach to flood risk management in Pakistan does not guarantee the underlying issues of vulnerability to floods. Even though structural measures offer a certain degree of security, they tend to ignore the interconnectedness of natural hazards and social vulnerabilities, to an unacceptable degree, resulting in inadequate and even inequitable disaster risk reduction. (Tariq et al., 2023). The disconnection between the technical components of flood management and the components of social vulnerability is one of the most urgent areas of concern that requires immediate attention.

This study fills this gap by investigating the link between flood risk management activities and the social vulnerability patterns in Pakistan by responding to a number of clear objectives. Firstly, it assesses the specific case in the flood risk management systems of the Country, highlighting its strengths and weaknesses. Secondly, it analyzes the different social and demographic subsystems of vulnerability to flooding in specific regions and communities, which demonstrates the degree to which context, including geography, socioeconomic status, gender, and availability of infrastructure, shape vulnerability. Thirdly, It investigates ways in which these social vulnerability factors interact with current practices in flood risk management, which may fortify or alleviate the risk.

This research has been conducted to study how varying socioeconomic categories are affected by floods in different ways. It looks at distinction in exposure, response, as well as recovery. It investigates the role of current flood risk management regimes in contributing to floods risks disproportion being faced by various social groups. It provides social policymakers and practitioners with evidence-based guidelines on integrating social vulnerability into more inclusive and effective flood risk management policies. Finally, it points out challenges that are hindering the successful integration of social vulnerability into flood risk management policies and practices.

The study adds to the increasing evidence in the literature on the subject of disaster risk reduction in the developing nations laying out empirical evidence to the linkages of flood risk management and social vulnerability in a unique Pakistani setting. The results of the study are of significant value in terms of policy formulation, resources allocation, and community-based disaster management programs. This scholarly inquiry helps refine the definition of flood vulnerability within social contexts and proposes more integrative and effective frameworks for managing flood risk by blending technical and social elements of flood resilience.

Theoretical Framework

This paper utilizes Blaikie et al.'s (1994) Pressure and Release (PAR) model, which was updated by Wisner et al. (2004) to interpret floods vulnerability in Pakistan. The PAR model takes into consideration every aspect of a disaster by viewing it as a natural hazard alongside a set of preconditioned and socially, economically, and politically created vulnerable factors.

Understanding disaster risk incorporates the PAR model where vulnerability is defined by three entities—exposure to a hazard, interconnected levels of a hazard, and exposure. These processes are the primary societal, political, demographic, and economic factors which shape the power dynamic and allocation of power and resources. The causes of persistent and dormant conflicts in Pakistan can be summarized as limited access to resources, equity neglecting economic-development paradigms that prioritize growth, and politically marginalizing some groups

(Mustafa, 2023). Such root causes form the basis of vulnerability in the sense that they determine who is entitled to resources, the decision-making process and protective security. These are the activities and functions that transform root causes into hazardous situations. Absence of local organizations, deficits in training and adequate skills, lack of ethical norms in the public sphere, press freedom, and scheduled debt repayment are some of the examples.

In Pakistan, dynamic pressures are experienced in the form of excessive urbanization with lack of planning, environmental destruction, population burden, and epidemic illness lie that erode the resilience of the community (Khan et al., 2024). Here, we express the precise outlines of the manifestation of weakness or vulnerability of an individual along with a risk, within a spatial-temporal context. Vulnerable societies result in dangerous human activities that worsen the local economy, weaken the economy, and societal activities. Such unsafe conditions are noted in the spatially protected areas of construction, unprotected infrastructural development and construction, lacking disaster preparedness and early warning capabilities within the context of people residing in flood-prone areas of Pakistan. (Ahmed et al., 2023). The PAR model fits well with the flood vulnerability case study from Pakistan because it recognizes the fact that disasters do not happen only because nature decides to intervene; rather, they happen when natural calamities meet with vulnerabilities, and in this case, the vulnerabilities have been socially and politically constructed. It shifts the concern from the mechanical description of goods as if they are isolated from the social, economic, and political life that give and maintain the vulnerability to floods.

This model when is applied in Pakistan's context can also be used to understand why there is a strong variability of flood effects between areas and social categories even though both are similar with regard to hazard exposure. It gives a structure of how historical processes of development, structures of governance and patterns of resource distribution have established a different vulnerability which are consequently triggered in case of flooding (Hassan & Ali, 2024). The PAR model's emphasis on building primary causes and dynamic stresses aligns with contemporary views on disaster risk management which stress the need to tackle the underlying factors of vulnerability, rather than just concentrating on the hazard itself. This perspective supports the rationale for integrating social vulnerability issues into flood risk management, thus highlighting the need for multi-sectoral approaches to coordinate all the factors which determine vulnerability (Rahman & Shah, 2023).

Methodology

This study analyzes the relationship between flood risk management and social vulnerability in Pakistan through the lens of qualitative research and secondary data analysis. A qualitative approach was taken to explore the interplay of social intricacies deeply and to depict how flood risk management is sensitive to vulnerability in different contexts. Secondary data has been gathered from a variety of sources to ensure comprehensive coverage of the research area: Information about floods, their management, and related policy data were accessed through the sponsored reports of NDMA, PDMAs, Pakistan Meteorological Department, and other ministries concerned with disaster management.

For this study, peer-reviewed journal articles, conference proceedings, and academic documents published from 2018 to 2024 were reviewed to assess existing information about flood risk management and social vulnerability in Pakistan and other relevant contexts. In addition, reports from international organizations, including the World Bank, the Asian Development Bank, the UN Office for Disaster Risk Reduction, and several other humanitarian organizations, were included in the review for their comparative and technical value. Documentary and news-based sources were also scanned to understand the public narrative and the lived experience of community members on flooding and vulnerability.

To explore the secondary data relevant to this study, we conducted a systematic literature review. Using the terms flood risk management, social vulnerability, Pakistan, and community resilience, we searched for information on Google Scholar, Scopus, and institutional repositories. Only documents published from 2018 to 2024 which addressed flood risk or social vulnerability in Pakistan, that were reputable, and available in English or Urdu were included. Thematic analysis

was conducted based on Braun and Clarke (2006) to familiarize with and analyze the data by creating initial codes, searching, reviewing, defining, and naming themes until producing a final report. The findings were organized, and underlying causes, pressures, and unsafe conditions were applied using the PAR Model to analyze the underlying causations leading to Flood Vulnerability in Pakistan. The other regions and communities were compared to emphasize the similarities and differences.

Since the data was secondary, some limitations need to be mentioned. The information gaps, differing data quality from various sources, and the inability to verify every detail independently posed challenges. Furthermore, focusing on published research tends to emphasize sensational and outlier cases, while everyday experiences go underrepresented.

Current Flood Risk Management in Pakistan

The flood risk management system in Pakistan is built on multiple tiers of structure established after the 2005 earthquake and revised after major floods. In 2007, the National Disaster Management Authority (NDMA) was created and placed in charge of coordinating management of disasters. This was followed by the establishment of the smaller management units at the provincial and district levels (PDMAs and DDMAs) which handle local operations (Iqbal et al., 2023). The institutional structure relies on a top-down, command-and-control system with very little engagement from stakeholders at the community level. Somewhat similar is the case in terms of National Disaster Risk Reduction Policy (2013) which, while recognizing the need to address community contributions, in practice relies predominantly top-down approaches where the input of only select, vulnerable communities is minimally engaged in planning and decision-making (Sadiq & Noorani, 2022).

Structural Measures

Pakistan's flood risk management system has a hierarchical structure that emerged after the October 2005 earthquake, and got further improved following severe floods in 2010. Historically, flood management in Pakistan has focused on erecting structural solutions like dams, barrage, embankments and drainage systems. Comprehensive infrastructure projects like Tarbela and Mangla dams, along with newer projects like the Diamer-Bhasha dam, were designed to offer flood control, water and energy storage, and hydroelectric power (Ali et al., 2024). Nevertheless, some researchers suggest that systems pertained to management of structures, especially ones devoted to building up self-containment, are proved insufficient to address the flood control system challenges in Pakistan. This was illustrated by the flood of 2010 that attempted to put to test the infrastructure systems in place (Khan & Ahmed, 2023). Furthermore, self-containment systems of management, especially ones devoted to dwellings of impermeable nature, may create additional challenges.

Non-Structural Measures.

Flood management in Pakistan covering non-structural components includes rehabilitation contingency plans, early flood warning, and their respective forecasting, and land use planning. The forewarning and forecasting is done at the Federal Flood Commission (FFC) and Pakistan Meteorological Department (PMD) as the latter two have the capacity to issue flood warning to the public and the authorities (Hassan et al., 2022).However, shortage of trained personnel, lack of basic education, and poor infrastructure for communications as well as inadequate trust in public institutions by the public continue to create gaps in the community preparedness and capacity building areas (Nazir & Khan, 2024). As a result of these issues, planning at the land use level is poor, and because of the poorly enforced building codes, the ongoing population growth drives construction in flood-prone areas.

Dimensions of Social Vulnerability to Flooding

In Pakistan, poverty remains a crucial issue linked with people's vulnerability to floods, especially for low-income families, who face the brunt of the impacts because they lack the means to protect, evacuate, or recover afterward (Tariq et al., 2023). According to a report, low-income communities typically do the following in the aftermath of a flood:

Due to lack of housing options, pay a cheaper price for land which puts them in high-risk flood zones; have scarce financial resources for construction, and thus cannot use flood resistant materials or techniques; do not have the means to stock supplies for emergencies or pay for

evacuations; depend on weak and unstable livelihoods undermined by flooding.

The lack of access to insurance and credit further exacerbates these households' vulnerabilities by financially restricting them from recovering flood-related losses and investing in risk mitigation. Rural communities are more disadvantaged due to their limited earning opportunities in agriculture, which is highly dependent on climatic conditions (Khan et al., 2021).

Geographical and Environmental Vulnerability.
The topographical diversity within Pakistan means that there are varied risk profiles amongst the flood prone regions of the country. The types of flooding also vary, where riverine flooding covers the population that resides along major rivers especially in Punjab and Sindh provinces, whereas flash flooding endangers the population in mountainous areas of Khyber Pakhtunkhwa and Balochistan (Shah et al., 2023). Cyclonic storms and rise in the sea-level pose further risks in coastal regions. The problem of vulnerability has been compounded by increasing environmental degradation of deforestation, destruction of wetlands and urbanization of natural flood plains. According to some, the communities residing in the environmentally poor regions are subjected to worse floods based on the lack of natural drain and the increase in surface run off (Rahman et al., 2024). Climate change may worsen these vulnerabilities in a more disastrous manner by creating major flood risks due to the extreme precipitation and glacial meltdowns.

Social and Cultural vulnerability.
The cultural context in Pakistan dictates that gender, age, and social status are the key factors that influence a person's exposure to floods. Due to cultural limitations in mobility together with lack of access to information and resources, Women's vulnerability to the disasters heightens due to such considerations as cultural limits in mobility and lack of access to information and resources. Moreover, in emergencies they have to bear with the additional responsibilities of looking after their homes and families (Bibi et al., 2023). Thus, even with the available expert knowledge of local conditions and community needs, they often fail to participate effectively in disaster planning and response measures due to these conventional gender roles. Children, elderly people and those with disabilities are also more vulnerable because they lack mobility, usually require other people to assist them and have special needs that might not be met when preparing for emergencies (Ali & Hassan, 2022). Local community disaster management programs may not adequately address the needs of religious and racial minorities, presenting additional challenges to accessing support.

Political and institutional vulnerability.
The flood related vulnerabilities in Pakistan have also been exacerbated by two other factors; the ineffective State and government machinery and institutional incapacities. Our analysis indicates that the processes of political patronage contribute to the problem of resource allocation in relation to disaster management when favorable communities are given preference with regard to protective infrastructures and assistance after the disaster touched (Mustafa & Khan, 2023). Cases of corruption and transparency in the management of disaster processes compromise the success of risk management procedures and the recovery plans in an organization. Local areas that have poor political power tend to have no voice in the planning activities and can be sidelined in support decisions (Iqbal et al., 2024). These gaps in institutions are most pronounced in remote rural areas and among marginalized groups with limited access to the formal political sphere.

Interplay of Flood Risk Management and Social Vulnerability
The current approaches to managing flood risks in Pakistan lead to inequity in safeguarding different social groups and regions. It has been noted that flood protective works are usually located in economically driven areas, such as the major cities, industrial facilities, and agriculture land, while vulnerable and sparse rural communities in peri-urban regions receive inadequate protection (Ahmed et al., 2023). This protection imbalance in space is indicative of more general inequality in the distribution of resources and political power. More affluent urban areas typically have sophisticated infrastructure for managing floods, such as drains, flood alerts, and emergency services. In contrast, rural areas tend to overlook even basic flood control systems. (Khan et al.,

2024). These disparities deepen already existing vulnerabilities within society, and may lead to more unequal impacts of flood on different communities.

Maladaptive Practices

In Pakistan, managing flood risk can sometimes backfire, leaving more vulnerable groups worse off. When authorities invest heavily in expansive levees, canals, and dams, the protection achieved in one area can simply push flood water into downstream neighborhoods. These downstream communities, already under financial strain, often receive no equivalent investments or protective measures, leaving them to shoulder the new hazard with few coping resources.(Hassan & Ali, 2024). Resettlement programs following large flooding events have at times moved at-risk populations to sites without proper roads, water, schools, or viable income-generating options, unintentionally intensifying their existing insecurities (Nazir et al., 2024). Such unintended consequences underscore how critical it is for flood risk strategies to incorporate thorough evaluations of all the dimensions of vulnerability, not just hazards.

Poor Community Participation

Although national and provincial policies call for community participation, real engagement in Pakistan's flood risk management is still limited. Evidence shows that consultation processes usually rely on formal community leaders, leaving women, minorities, and other marginalized groups absent. Their insights are vital for mapping local vulnerabilities yet are often overlooked in practice (Rahman & Shah, 2023). When participation is merely ceremonial, flood-response plans drift away from what actual neighborhoods need, ignoring both the lived realities of residents and their lived expertise. Residents track river rhythms, keep crates of sandbags on hand, and tell each other the quickest paths to safety across muddy fields. Local communities may have extensive knowledge of the behavior of local floods, evacuation routes and adaptive measures that may be used to improve the management of risks (Tariq & Ahmed, 2024).

Impacts on Distinct Social Groups

Rural Disparities / Urban Disparities

Floods hit rural and urban areas very differently, with rural communities bearing the worst and longest-lasting consequences. In the countries and regions that are still developing, weaknesses such as unreliable early warning systems, weak emergency and response services, and no solid recovery plans compound the threat and leave even bigger wounds. These shortcomings lead to higher death tolls and keep families and communities in recovery mode for far longer than the norm. (Ali et al., 2024). Farming communities face unique hurdles after the destruction of fields, herds, and the farm support systems, heightening the dangers to both the nation's food supply and the farmers' livelihoods. Although people in cities have gained quicker access to emergency and recovery help, that same support came in smaller scale when the challenges emerged in urban centers rather than in countryside. Meanwhile, the very same services are rendered less effective in cities by relentless growth and poor drainage. Overcrowded districts on the fringes—where makeshift housing clings to the edges of subsiding earth—expose the poorest urban residents to flooding when the drainage fails, compounded by the absence of the basics needed for recovery and by limited routes into formal disaster relief. (Ahmad & Khan, 2023).

Gender-Differentiated Impacts.

In Pakistan, rigidly defined gender responsibilities coupled with entrenched sociocultural norms mean that flooding affects men and women in starkly different ways. When the waters rise and families are uprooted, the same acute crisis magnifies the normal divisions of labor—women, already expected to shoulder the management of the home, find that the flood does not relieve them of these duties; rather, it intensifies them. They are the ones who carry small children and elderly relatives to higher ground, ration dwindling food and water supplies, salvage whatever can be dried and reused, and struggle to re-establish some semblance of order in the midst of dislocation.(Bibi et al., 2023). In many contexts, the movement of women is curtailed by deeply rooted cultural barriers, impeding their ability to reach food, medicines, and routes of safer departure. Still, women respond with remarkable resilience, turning

adversity into adaptive skill, and becoming essential silk threads that hold communities together and carry knowledge from household to household. Nevertheless, their absence from flood-risk planning and leadership tables reveals a glaring oversight; their experience is not formally valued, even though specializing in their inclusion would sharpen the resilience plans of entire regions, making them wider, smarter, and more compassionate. (Hassan & Ahmed, 2024).

Livelihood-Based Vulnerabilities.

Flood vulnerability is not uniform; it intersects closely with the kinds of livelihoods that sustain communities. In regions where agriculture is core to subsistence, the onset of flooding translates into multi-faceted dangers to standing crops, the survival and productivity of livestock, and the long-term productivity of soil and water resources. Smallholder farmers sit at the centre of this exposure, often possessing insufficient savings, credit, or means to invest in adaptive technologies that might hasten recovery or minimize future risk.(Shah et al., 2024). Fishermen stand to watch their boats and nets vanish, to be banned from the waters where they earn their living, and to risk falling ill from polluted rivers and estuaries. Workers who make up the informal labor market in cities—those who carry bricks for a paycheck, hawk tea and biscuits on crowded pavements, or scrub floors in the working day—face similar ruin. When waters overflow, their stalls and toolboxes are swept away, and day after day without pay compounds their losses. Few in this sector are anchored by labor laws or safety nets; the protections carved into documents and applied in offices rarely reach their hands and wallets, leaving them exposed to ruin whenever calamity strikes (Iqbal & Rahman, 2023).

Conclusion

The importance of enhancing climate particularly flood resilience through implementation of socially inclusive strategies cannot be overstated. One of the most important implications is the need to incorporate social vulnerability assessments into flood risk management planning. This requires that planners formally consider the social factors that add to vulnerability, as well as analyze physical hazards. There is an urgent need to create vulnerability indicators that are contextually sensitive so that protection measures are crafted specifically to meet the needs of the most exposed individuals.

Another prominent implication relates to the use of community-based approaches. The participation of vulnerable communities in the planning and implementation of flood risk management programs leads to favorable impacts for such communities through improved decision-making. This involves the recognition and use of local knowledge, available capacities, and traditional coping strategies while overcoming the structural problem of exclusion as well as the representational obstacles that prevent marginalized groups from accessing decision-making spaces. More importantly, coordination across sectors is another issue when it comes to social vulnerability. Successful flood risk management is impossible in a vacuum; rather, it requires linkage with other sectors like health, education, social protection, and economic development. This approach recognizes that vulnerability is influenced by an interplay of complex factors, thus arguing that any interventions in pursuit of disaster risk reduction should be supportive of larger development and poverty reduction efforts. Finally, the findings of this study draw attention to the need to tackle the underlying causes of vulnerability, such as poverty, inequality, and gaps in governance. With the aim of achieving sustainable and inclusive development, strategies for disaster risk reduction must be integrated into national development planning and policy to support long-term flood resilience, rather than providing solely short-term gains.

This study offers important policy recommendations. Firstly, there is a need to conceptualize vulnerability mapping. This should be a dynamic process with thorough assessments meant to develop an appreciation of the communities that are most vulnerable to flooding, thus enabling interventions to be shaped according to where the communities are and strategic resource allocation where the community will benefit the most. Secondly, the build-up of a disaster management system that is fortified at the community level is essential. This involves investment in interlocal capacity development programs and the establishment of genuine participatory mechanisms that empower marginalized groups to fully participate in decision-making processes that impact their safety

and well-being in the event of flooding. Thirdly, measures should be taken to strengthen early warning systems so that the most vulnerable populations receive warnings in time. These involve adopting diverse communication modalities, sharing information in diverse local languages, and issuing warnings through trusted sources to enable effective and timely responses. Finally, it is important to align social protection with flood risk management activities. The frequent association of disaster risk undertakings with social safety nets means that vulnerable communities and households should be supported at the time of a disaster, thus enabling long-term resilience development.

The experience of repetitive flooding in Pakistan offers lessons for other developing nations about effective flood management strategies. The paper has illustrated that technical measures alone cannot be adequate for mitigation and management of complex disaster risks, which exist naturally in social, economic, and political settings. In order to develop true flood resilience, there is a need to keep confronting the root vulnerability drivers through inclusive and community-based strategies, appreciating the social aspects of disaster risk.

The future pathway depends on fundamental shifts in the attitudes and approaches to managing flood risk, moving away from obscure assessments of the flood risk solution towards more holistic frameworks that integrate flood and vulnerability issues. This requires political will, resource allocation, and restructuring or institution building which focuses on the needs and rights of the most excluded communities as a priority agenda. It is through these holistic responses only that Pakistan can achieve true flood resilience that can protect the entire population, especially the most vulnerable people negatively impacted by flooding in modern contexts

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