



Case Report Post-Flood Risk Management and Resilience Building Practices: A Case Study

Hafiz Suliman Munawar ¹, Sara Imran Khan ², Numera Anum ³, Zakria Qadir ^{4,*}, Abbas Z. Kouzani ⁵, and M. A. Parvez Mahmud ⁵

- School of Built Environment, University of New South Wales, Kensington, Sydney, NSW 2052, Australia; h.munawar@unsw.edu.au
- ² Faculty of Chemical Engineering, University of New South Wales, Kensington, Sydney, NSW 2052, Australia; saraimrankhan17@gmail.com
- ³ Department of Urban and Regional Planning, National Institute of Transportation, National University of Science and Technology, Islamabad 44000, Pakistan; numerasyed@gmail.com
- ⁴ School of Computing Engineering and Mathematics, Western Sydney University, Locked Bag 1797, Penrith, NSW 2751, Australia
- ⁵ School of Engineering, Deakin University, Geelong, VIC 3216, Australia; abbas.kouzani@deakin.edu.au (A.Z.K.); m.a.mahmud@deakin.edu.au (M.A.P.M.)
- * Correspondence: z.qadir@westernsydney.edu.au

Abstract: The study was conducted to assess the post 2010 flood risk management and resiliencebuilding practices in District Layyah, Pakistan. Exploratory research was applied to gain knowledge of flood risk management to embed the disaster risk reduction, mitigation, and adaptation strategies at the local government and community level. Around 200 questionnaires were collected from the four devastated areas/union councils. Primary data from the field uncovered flood risk management practices by organizations, local government, and the community. It highlights resilience-building practices undertaken by the community through rehabilitation, community participation, and local indigenous practices. The role of the District Layyah's local government and organizations to mitigate the 2010 flood and their contribution towards flood resilience in affected communities was investigated, as no comparable studies were carried out in the riverine belt of District Layyah previously. Moreover, the tangible and non-tangible measures to lessen the vulnerability to floods and improve flood risk governance at a local level were identified. This study makes a valuable contribution in strengthening the resilience building of vulnerable communities by recommending few changes in existing practices concerning flood risk at a local level.

Keywords: flood; integrated flood risk management; resilience building; emergency planning; disaster risk reduction; community participation; disaster preparedness

1. Introduction

An extreme weather event is defined as a phenomenon that leads to injuries, health disparities, or loss of human lives. Besides this, the disaster also causes damage to the properties, economy, and ecosystem. These losses are such that the community cannot cope with them using their present resources [1,2]. Over the last decades, Pakistan has suffered different natural hazards, which cost numerous lives and a considerable effect on the economy. Such as the 2005 massive earthquake in Kashmir taking the lives of more than 75,000 people [3]. In 2010, Pakistan was struck with the worst flood in its history, with a death toll of 1800 and a total of about 21 million affected. The 2010 flood in Pakistan was highly devastating and is recalled as the 'super flood' by the Government of Punjab. Followed by the floods in 2013 and 2014, which took the lives of 178 and 367 people, respectively [4,5]. The vulnerabilities in the system for disaster management, its prevention, and socio-culture issues aggravate the effects of these events resulting in larger shocks. Hence, its management calls for coordination of government institutions, private



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Copyright: © 2021 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https:// creativecommons.org/licenses/by/ 4.0/). sector, community, national and international organizations during, pre and post-disaster situation [3,4]. Amongst all-weather events, floods are most common. There is a trend of increasing urbanization and it is estimated that 61% of the world population will live in cities by 2030 [5]. The persistent urban growth and shortage of diligent planning boost the cities' vulnerability to flooding disasters [6]. So, understanding flood risk is very crucial to manage and make timely decisions to address flood challenges. The European Flood Directive (2007) has defined flood risk as an association of the likelihood of flood disaster and its possible detrimental impacts on the environment, health, culture, and economic life of human beings [7]. Floods are a bare opportunity for a city to get rightful economic and social advantages, and the relative potency of institutions that take part in flood risk management can be scrutinized against their area.

In developing countries like Pakistan reactive practices have been adopted to mitigate flood hazards and using ad hoc structural inventions for diverting flood risks rather than reducing them. These practices are deemed to be effective partially. Risk, hazard, vulnerability, exposure, resistance, resilience, coping, and adaptive capacity of communities; form an ally to describe flood risk management. Flood risk management needs a strategy that can stabilize sustainability with present needs. So, integrated flood risk management includes a combination of both structural and non-structural measures [8–11]. River defenses such as the construction of levees, dams, dikes, embankments, and channelization are included in structural measures. While nonstructural measures reduce the impacts of floods and the vulnerability of people and communities with the help of early flood warning systems, flood emergency response, disaster risk reduction (DRR), and evacuation schemes.

There is a need to improve existing structural measures by increasing the water storage capacity. Pakistan's existing reservoir capacity is 9% which is quite lower than the world average, i.e., 40%. The current storage capacity is 22.8 bcm which is expected to reduce by 57% by 2025 [12–14]. A lot of emphases have been laid on developing small dams which can provide irrigation facilities to small-scale farmers. The country has heavily invested in its water infrastructure, however, due to lack of management, much of the infrastructure is decaying and needs an asset management plan [15–17]. The budget allocated for the maintenance and repair of the infrastructure is very limited. These strategic structures are susceptible to unforeseen events and damages. The deteriorating conditions of the watercourses, gates, and drainage outlets result in low performance and water losses. The government needs to pay attention to the delayed maintenance, and a shortage of rehabilitation [18–20].

A holistic framework is needed to address the needs, develop policies to enhance capacity building in flood management. However, a lack of coordination between different departments at the provincial and federal levels will also limit the effective implementation of flood management approaches [21-24]. Moreover, it is of extreme importance to focus on the resilience for unforeseen events involving important decision making, innovative and technological solutions for addressing community problems, achieve speedy recovery to normalcy, and adaptation to changing environment. The resilience formalizations bring along added value as it is based on the knowledge of both the normal functioning of a system as well as its functioning in problematic scenarios [12]. However, due to the increase in flood events, recognition that flooding cannot always be prevented, and increased uncertainty of weather events, a shift towards flood resilience has been achieved within the traditional Flood Risk Management (FRM). The concept of resilience has gained greater popularity, thus leading to a plethora of definitions, measurements, and applications. Therefore, the formulation of the resilience framework requires the integration of the FRM approaches (i.e., top-down and bottom-up) along with a more interdependent holistic approach [13].

Generally, for flood risk management three different types of conceptual resilience frameworks have been reported in literature including; engineering, ecological, and social– ecological frameworks. The application of engineering resilience has benefitted the design and functionality of both the technological systems and the flood resilient technological frameworks. Whereas socio-ecological resilience displays a broader perspective as it is based on human interaction with natural systems. However, the design of the socio-ecological resilience framework in flood risk management is based on an adaptive approach that entails a set of short-term measures and monitoring criteria. Moreover, it is well established in literature that the utilization of ecological and socio-ecological resilience frameworks in the developing and developed country can help in providing guidance for the formulation of a more resilient flood risk management framework that deals with flood protection, prevention, and preparedness [14].

To sum up, a resilient flood risk management strategy focuses on reducing the impacts of floods via efficient warning systems, evacuation plans, building regulations in flood-prone areas, and the applications of spatial planning [15,16]. Hampering of floods is difficult, but damages and exposure of flooding to risk-lain communities can be minimized with flood risk management [15,17-20]. Additionally, there has been a change from structural flood protection measures towards resilient or integrated flood risk management over the past ten years as many studies have revealed that communities adapted to shocks and disturbances rather than resistance are more durable [21]. Forrest and coworkers have shown the importance of time and place in understanding the ways in which a contribution can be made to the local level flood resilience by the civil society members. It is recommended for the policymakers to critically recognize the significance of both time-related variations for the involvement of citizens and the place-based capacities in local floodresilience policies [22]. The findings of the semi-structured qualitative interviews with the flood affectees of both urban and rural areas of northern England have been reported elsewhere [23]. Through the utilization of the proposed 'conscious community' concept, a complex relationship between attachment to the communal identities, locality, and the local networks was revealed in the study. The concept of 'conscious community' builds on the conceptualization of community as an inevitable linkage of the cultural, spatial, and social elements of the local community. For the local communities, a shift to the localized and community-based approach to the FRM was variable. Whereas the flood experience in the context of the urban area emerged as an important factor in the construction of community and generating responses after flooding. Yet, a better understanding of the local community construction is highly necessitated to prepare the local communities for flooding [23].

Furthermore, the EU Directive (2007/EC/60) proclaimed that flood control plans demand the identification of tangible and non-tangible measures which are efficient enough to lessen the vulnerability to floods and improve flood risk governance [17]. For understanding flood challenges due to the intensity of flooding impacts, there is a need to enhance the policies, technical knowledge, and strategies [24,25]. It, therefore, calls for the systematic assessment at a local level and the use of more featured datasets and analysis of the flood risk areas. Hence, the objective of the paper is to assess the post 2010 flood risk management and resilience-building practices in the selected case study. The study also provides some observations and draws conclusions about coping strategies against the flood challenges. Moreover, it also elaborates the community awareness and level of preparedness based on the review of the flood risk management in the riverine area of district Layyah.

2. Literature Review

Secondary research included a review and analysis of the existing literature on floods, disaster risk reduction, community resilience, annual reports prepared by government departments and organizations, and the updates on the flood relief and the response of 2010 floods in district Layyah. A detailed literature review was carried out for this study, and a VOSVIEWER analysis was conducted based on the most used keywords in this research area, as shown in Figure 1. Popular and widely used search engines were opted to retrieve research articles for the current study, such as Scopus, Google Scholar, Science

Direct, Elsevier, Springer, ACM, and MDPI. A set of queries were formulated to perform an exhaustive search for a maximum number of research articles relevant to the area of interest. It was found that articles retrieved for this research revolved around the same keywords used in this study. The articles were screened based on (1) publication period: 2010–2021 (2) no duplicates (3) document selection based on research article and book chapter, and (4) published in English language only. The detailed screening process is shown in Figure 2.



Figure 1. Keywords found in the articles retrieved for this research.



Figure 2. The Detailed Screening Process.

Secondary data was collected through content analysis of government policies, schemes, and reports prepared by various organizations at the local, national, and international levels. Organizations' reports and Government documents were utilized to get descriptive data of flood-affected communities in the case study area. Precisely, this literature review was focused on answering the following research questions:

Q1. What are the existing methods and technologies for flood disaster management in Pakistan?

Q2. What is the Perception of the community about the disaster response and recovery during past flood events?

3. Research Methodology

The mixed-method research approach incorporates the characteristics of quantitative and qualitative research to give aggregate results obtained from complicated research questions [26]. A mixed-method research design has been used for this study because it is descriptive as well as exploratory in nature. Descriptive research is applied to describe the major gaps in the flood response plans of the Government and other non-governmental humanitarian sectors during and post 2010 flood events in District Layyah and how did they play their role [22]. The exploratory dimension of research relates to gaining knowledge of flood risk management and explore how to embed the Disaster Risk Reduction, mitigation, and adaptation strategies at the local government and community development planning level. It also helps to investigate the structures if they are resilient against floods.

A questionnaire survey technique has been employed and 200 samples were drawn from residents of the four most devastated Union Councils of Layyah District. The survey was conducted in 2013. The survey team comprised three members, including the researcher and two volunteers from a local NGO (IDSP). Each questionnaire respondent was the head of his/her family. The sample drawn from each Union Council was 50 each (randomly selected from the list of the residents within each union council and was ensured that the selected respondents were victims of the 2010 floods), as it is stated by Sudman and Glenn [27,28], that for each subgroup at least 20 to 50 sample size is sufficient for analysis. The major issue associated with the sample size is the selection of number (size) to perform the data analysis adequately and precisely. While using descriptive statistics (e.g., mean, frequencies), then nearly any sample size will serve well. Generally, a sample size of 200–500 is a good size sample when we need to perform multiple regressions, analysis of covariance, or log-linear analysis. This type of analysis is often applied to perform more rigorous state impact evaluations. Therefore, the selection of the sample size should be made appropriately for the planned analysis. Particularly, for the comparative analysis of subgroups (e.g., an evaluation of program participants with nonparticipants), an adjustment in the sample size might be required. It is clearly established by Sudman (1976), that a minimum of 100 samples is required for each major group or subgroup in the sample and for each minor subgroup sample size of 20 to 50 elements is obligatory (Sudman 1976, Israel 1992). Based on this observation, we set the sample size of all small union councils to 50, which is sufficient for analysis by keeping in mind the targeted population. However, there are certain limitations of using a sample of the population for a questionnaire-based survey, such as (1) failure in the identification of the target population (2) consideration of inadequate survey population (3) the bias due to non-responses (4) bias due to respondents (5) questionnaire related problems in terms of content and wording, (6) questions should not be misleading, double-barreled, or ambiguous, rather they should be direct and clearly relevant to the survey objectives, (7) processing errors (8) misinterpretation of the results in relevance to the conducted survey (9) time period bias.

Among the 200-sample size, there were 140 male respondents and 60 female respondents. The questionnaires for the community consisted of both open-ended and closedended questions to help in determining the socio-economic status of the local people, their concerns about the existing situation, their level of preparedness, and construction patterns of their structures while living in flood-prone areas. The first section of interview questions was related to the background information of the participants such as gender, age, locality, highest education level, family system, household size, number of bread earners, and occupation [24,25]. After gathering the background information, all the questions that were asked by the participants were based on existing flood risk management practices, rehabilitation process, community participation, local indigenous practices, regain in livelihood, infrastructure resilience, and level of satisfaction against emergency relief in 2010 floods. After gathering the results for the top research questions, the data was cross-tabulated, and results were filtered. The statistical significance of the data was evaluated based on sample size, its accuracy within confidence level, and margin of error [26]. To analyze the satisfaction level of the respondents, Yeh's satisfaction index (YSI) method was used on the collected datasets. It is given by the equation below:

$YSI = Satisfied - Dissatisfied / total respondents \times 100$

The obtained numerical values may be zero, positive or negative. Zero indicates that there is no satisfaction. The satisfaction level may be minimum, moderate, or strong if the result is under 25%, 50%, or 75%. While if the values fall under -25%, -50%, or -75% then dissatisfaction level is minimum, moderate, or strong [26].

Calculating resilience index: Four resilience components, i.e., social, economic, physical, and institutional resilience was measured by taking percentages of all selected variables to avoid the normalization process. Weights were assigned to each variable using the subjective method [27] The component resilience index (CRI) was calculated by taking an average of the respective variable resilience index.

In Punjab Pakistan, a union council is an area within a district consisting of one or more revenue census villages, census blocks, or revenue estates. These are divided into rural and urban areas in a way the population remains the same with each area [27]. There were 14 Union Councils of a riverine belt which got affected in 2010 flood, and the selected Union Councils were the most damaged ones as expressed by an official from one of the National Organizations, which is a member of District Disaster Management Authority (DDMA). Figure 3 below shows the four selected union councils, including Lohanch Nashaib, Bakhri Ahmed Khan, Kotla Haji Shah, and Sahu Wala. The former three are part of Tehsil Layyah, while the latter one is included in Tehsil Karor. Twelve sample villages were selected among the most vulnerable villages where government and NGOs had implemented various risk reduction, relief, early recovery, and response plans, as mentioned in Table 1. The villages included are ThallaInayat Wala (Sahu Wala), Arif Abad (Sahu Wala), Qazi Wala (Sahu Wala), Khokkar Wala (Kotla Haji Shah), GurmaniSikandary (Kotla Haji Shah), Tali Musa Khan (Kotla Haji Shah), Mancharay Mohana (Lohanch Nashaib), Chandia Wala (Lohanch Nashaib), Siraye Janube (Lohanch Nashaib), Majhi (Bakhri Ahmed Khan), Shah Wala (Bakhri Ahmed Khan) and ChahKhoay Wala (Bakhri Ahmed Khan).



Figure 3. Case study areas within a riverine belt of district Layyah. Reprinted from the ref. [28].

• V_{sw1} SW • V_{sw2} • V_{sw3}		N V_{ln2} V_{ln1} V_{ln3}
• <i>V</i> _{ks2} KS • <i>V</i> _{ks1} • <i>V</i> _{ks3}	•V _{bk}	1 • V _{bk2} •V _{bk3} BK
Legend:		
UC—Union Council		V-Village
	V_{sw1}	Qazi Wala (QW)
SW—SahuWala	V_{sw2}	Thalla Inayat Wala (TIW)
	V_{sw3}	Arif Abad (AA)
	V_{ln1}	Siraye Janube (SJ)
LN—LohanchNashaib	V_{ln2}	Mancharay Mohana (MM)
	V _{ln3}	Chandia Wala (CW)
	V_{ks1}	Talli Musa Khan (TMK)
KS—Kotla Haji Shah	V_{ks2}	Gurmani Sikandary (GS)
	V_{ks3}	Khokkar Wala (KW)
	V_{bk1}	Chah Khoay Wala (CKW)
BK—Bakri Ahmad Khan	V_{bk1}	Shah Wala (SW)
	V _{bk1}	Majhi (M)

Table 1. Sample Villages in selected union councils from district Layyah.

4. Floods 2010 in Pakistan

According to [29], Pakistan has had seven major flood events which affected approximately 40 million people since 1973. Pakistan experienced the utmost cruel flood in August 2010 in the history of the country. Floods are a recurring natural hazard and among the population influenced by natural hazards; 90% of it is affected by floods in Pakistan [30–32]. The 2010 flood was highly devastating and is recalled as the 'super flood' by the Government of Punjab. The flood accompanied the annual monsoon season and reached unusual levels in the history of the Indus River system in Pakistan. Moreover, 78 districts were heavily affected by the floods. In Punjab, 200 villages, 1800 casualties, 500,000 homes, 1.7 million acres of cultivated land, and billion dollars' value of livestock and seasonal crops were destroyed [29]. Also, it has been identified that people residing in rural areas, associated with the agricultural sector, and having low income are the most vulnerable group having the low-income status, minimal access to education, health services, water supply, and sanitation [27]. In particular, the homes, infrastructure, transport system, and schools of this vulnerable group were destroyed due to the 2010 flood. In district Layyah, 172,607 people were affected by the 2010 flood, and 6459 houses were fully damaged [33]. Hence, The Human Development Report (2009) reveals that Pakistan's HDI was 0.572 thus, placing it at a rank of 141 while, Pakistan's GDP per capita was \$955 hence, ranking it at 132nd position out of 182 countries [29].

5. Case Study Area

For the current study, villages were selected from four union councils of district Layyah, located in South Punjab, as it is one of the least developed areas and has been subject to annual flooding due to its proximity to the bank of River Indus that flows nearby. Flood is a common feature in the lives of residents of district Layyah. Moreover, between Chenab and Indus rivers, the associated districts are prone to flood every summer season. From (February-September), the rainy period is usually 7.5 months long and at least with a sliding 31-day rainfall of 13mm rainfall. The total area of the district taken into consideration for this case study is 6291 km² [East-West], which is (55 mi) East-Width, and (45 mi) North-South. It is a sandy block of land located between Chenab River and Indus River. Seasonal Monsoon rainfall coupled with other local factors such as poor drainage, poverty, negligence of local government institutions towards flood risk management results in severe damages to the properties, livestock, crops, livelihood, and loss of lives. Enhancing community resilience has been identified as the most influencing factor of disaster risk reduction by the 2009 Global Platform for Disaster Risk.

6. Results and Discussions

6.1. Literature Review Results

Pakistan is a disaster-prone country as evident from its disaster profile. Frequent floods, earthquakes, cyclones, landslides make the affected region vulnerable. Each year Pakistan faces the loss of lives, flora, fauna, infrastructure, and economic instability in the affected region. Furthermore, different factors contribute to the vulnerability and severity of disasters such as lack of effective early warning systems, poor infrastructures, lack of awareness about disaster management, poor communities living in disaster-prone areas, lack of coordination between disaster management authorities and limited skilled manpower to provide an early response to victims.

Pakistan has developed an institute known as Natural Disaster Management Authority (NDMA) at the federal level to respond to disaster scenarios. The NDMA plan outlines how different stakeholders will work jointly for disaster management and mitigation [8–10]. The monetary support from donors is directed towards disaster reduction. Different UN agencies such as JICA, ADB, EU and USAID work with local NGOs, however, NDMA has been set up for coordination with different agencies [21–23]. The major devastation during the 2010 floods attracted a large number of aids from international countries, relief agencies and local civil societies which helped NDMA being the central institute to carry out relief activities [24–26].

At the provincial and local level, NDMA constituted a Provincial Disaster Management Authority to manage disaster events and help people to recover from the loss of property, food, and their livelihood. PDMA provides a platform to bring all provincial organization together to provide timely disaster response and mitigate flood risk. The limitation of PDMA is the lack of risk management and making communities resilient towards extreme weather events such as floods. They focus more on response with little importance to longterm strategies for making communities more adaptive to floods. Agricultural losses are not addressed by PDMA, indicating that there are no plans for the management of framing communities to save their crops and reduce losses. Furthermore, disaster management authorities at the district level are not fully function and are equipped to assist communities during a disaster event.

Ashfaq et al. [27] surveyed the household vulnerability and resilience to flood disasters in two districts within Khyber Pakhtunkhwa after the 2010 floods. Data were collected from 600 households through interviews. Variability and resilience indices were calculated based on the selected variables for community households in the district of Charsadda and Nowshera. Higher vulnerability index along with lower resilience index indicated that communities in Nowshera were more vulnerable to flood disasters as compared to those in Charsadda. The study suggested that the local authorities need to create awareness about flood mitigation and prevention practices among the district and emphasize strengthening social, physical, and economic resilience. Educating communities about flood disaster management and effective zoning strategies to prevent houses from being built in floodprone areas will reduce casualties. Through awareness about infrastructure material, people can move from traditional materials such as clay to more resistant and durable material, i.e., concrete or bricks.

Baig et al. [28] investigated community needs and perception about the rehabilitation process and the support from the government and NGOs during the 2010 floods in Swat, Pakistan. No humanitarian aid reached the community after the first ten days as the main road was washed away. When the roads were partially opened, a few NGOs were observed distributing water disinfectants while the community was waiting for food and shelter. After the 2010 floods, the drinking water quality deteriorated and affected sanitation systems in many districts of Pakistan. In Swat and Sukkur high microbial load was observed in collected water samples. Federal level NDMA and Provincial level PDMAs collaborated with all the NGOs to enhance the humanitarian aid work. Around 36 NGOs were registered to help the communities. During the initial three months, NGOs focused on providing clean drinking water, setting up latrines, hygiene awareness, etc., after the emergency response period was over, attention was laid on mid to long-term development interventions. As per the reported activities carried out by the NGO, it was assumed that all field activities have been carried out smoothly; however, the on-ground reality was quite different, and people were not satisfied with the relief response by the government and NGOs.

Pakistan's measures on flood forecasting, early warning systems, and evacuation plans are not developed yet. A lot of work needs to be done in this space to develop effective systems for flood management. Lack of disaster preparedness and management leads to huge losses and damage to lives, infrastructure, and livestock [21]. The government needs to improve flood warning and response systems across the country. Implementation of cutting-edge technology and equipment which can assist in decision making, creating awareness among the community, developing flood maps, and evacuation plans are highly necessitated. Satellite imagery and big data analysis will help authorities in flood predictions. Important consideration must be given to wetland restoration, and cleaning river basins will also facilitate the flood retentions [22–24]. Installation of radar will improve gathering information of real-time data on precipitation, accuracy in forecasting, and improved planning. Other environmental factors such as soil characteristics, infiltration rates, and vegetative cover are important to comprehend catchment response to flood vents. Urban planning and land use also play a vital role tool [25–27].

6.2. Survey Results

After data collection from the community through a questionnaire survey, it was analyzed by comparing results from the four localities. The results assessed flood risk management and resilience-building practices in district Layyah. Using the statistical findings, we can draw conclusions and recommendations for future advancement in flood risk management and resilience-building of local communities.

6.2.1. Reflection on the Socioeconomic Status of a Case Study Community

The socioeconomic data of community gave the insight into gender, age, locality, highest education level, family system, household size, number of bread earners, and occupation. The age of respondents was categorized into five groups and the respondents in the age group of 36–40 years dominated the other age groups. Both male and female respondents were asked questions while working in the fields as the data was collected at

the time of sugar-cane crop harvesting in the district Layyah. It was observed that people of all age groups worked in the fields on daily wages. The results showed that 74% of the respondents had a joint system in their families, and only 26% had a single-family. It was observed in a field survey that people lived close to each other, and communities had a strong connection with each other in all the four localities of the riverine area in district Layyah. The adaptive capacity of a community lies in living in sheer vicinity as [34] claimed that there are dense networks of concern and association within the village periphery. Most people live in a combined family system, each household in the family shares courtyard and baths while having separate kitchens. They share happiness and sorrows, which makes them socially resilient to any stress or pressure, and hazard. Many examples boost the influence of social capital as a principle for resilient communities against disaster [35–37]. According to [38], coordinated actions provide materialist and emotional aids, and endangered communities are ought to work together manageably to figure out problems [34]. Moreover, in the community resilience model by [39], social capital addresses three elements that are (i) community participation (ii) social bonds (iii) social support. The socioeconomic status of people living in LN was found comparatively low as 74% population belonged to the laborer occupation. During a field survey in one of the villages named MM, an old man reported the 2010 flood to be a major disaster as he lost his home. One local NGO helped him to rebuild his house, but the help was limited. He said, "I live in a tent with my wife after the 2010 flood, whereas the NGO helped to build only one room, bathroom, and kitchen. Since my son got married, I have been living in a tent under severe environmental conditions". Both males and females work in flood-affected areas to fulfill their basic needs (Figure 4). During the infield survey, it was observed that females are the major contributors to family income in riverine areas. When asked by one female respondent in union council LN about her earning source, she said, "All women from our locality work from morning to evening in fields. We get up early in the morning, and after leaving our children for school, we go to work. As it is sugarcane season, so nowadays we go for cutting off this crop". Seasonal crop harvesting was the major occupation of people living close to the riverine belt. Infield survey, the education level in 4 union councils was found varyingly. During a survey in LN, SW, and KHS, respondents highlighted a lack of education facilities in their areas for their daughters, especially as there was only a primary school in each union council for girls, although there was a high school in each union council for boys only. One of the female respondents from village MM in union council LN asked for a permanent place in Layyah city so their children's education would not be affected by annual flooding. As she mentioned, schools remain closed when the flood hits the area, and school buildings get deteriorated each year. Many respondents in union council SW and KHS criticize the unjust educational facilities, as they want higher education in their areas. When asked for a reason behind criticism, one of the female respondents from KHS who was carrying out her bachelor's degree briefed that, female and male students have to travel daily to the city for higher secondary education and to attend university. Child labor was observed in all localities, but in LN higher rate of child labor was observed after floods. These results are in line with the survey conducted to capture the Bangladesh flood event in 2005 through a semi-structured survey. It was found that the effects of flood were more prevalent in low-income areas, people who lacked ownership on land and suffered economic inequality. An adaptive strategy to overcome income inequality was income diversification. Similarly, Ruffat et al. [35] reviewed and analyzed the drivers of social vulnerability in almost 70 case studies based on flood disasters. The most frequently occurring drivers for social vulnerability were found to be demographics, coping capacity, health, land tenure, risk perception, and socioeconomic status. The influence of each indicator is variable depending on the disaster stage and the setting of the country.



Figure 4. An old woman making mat with date leaves in union council S.

6.2.2. Emergency Relief Measures in the Case Study Area

Figure 5 depicts the flood risk management practices in the district. When the flood hit the riverine area in 2010, emergency shelter and rescue were the priority of the government and NGOs. Almost 47% of flood-affected communities reported in favor of the government in providing them emergency shelter. While 24% of respondents claimed that their relatives gave emergency shelter when the flood came, and 18% got emergency shelter provided by NGOs. When asked about relief camps, it was found that the government declared few schools, colleges, and district Layyah jail as camps for flood-affected communities. After the 2010 flood, the government has started to do this practice of shifting people to different schools of Layyah city annually (Figure 6). In KHS, 23% of people got emergency shelter, while in LN 17% of the people received emergency shelter. In relief camps, 50% of the population got the food from the local, national and international organizations.



Figure 5. Flood risk management in district Layyah.



Figure 6. Rescue operation (2010) by district Police Layyah: Transferring flood affected family and its assets in Government College for Women Layyah.

The provision of food was mostly carried out by various organizations, as 42% of respondents claimed they received cooked and non-cooked food items from the different organizations and 8% said they received food from relatives in the city. In contrast, the government did not play a role in providing food in relief camps. Around 15% of people claimed to receive food in KHS, while only 2% of respondents in BAK got food. When the level of flood water became low, people went back to their homes and started living there in deteriorated houses and tents provided by the organizations. The government had started a scheme to provide financial assistance to the flood-affected community. A cash transfer scheme named Watan Cards were distributed by the government as compensation for flood victims. Debit cards carrying compensation money were distributed to transfer money in the future, depending on the need of the people [36]. The system faced some technical and administrative difficulties such as delays in money transfers, lack of monitoring corruption and black marketing, and including the name of people in beneficiaries list based on political influence. Some female-headed households were not eligible for Watan cards as they did not have identification cards [37,38].

Around 9% of respondents got these cards in BAK as its local representatives have strong support from the government. Contrary to it, in LN only 2% of people got Watan cards. Watan cards were issued to married men/women, through which they received 20 thousand rupees (equivalent to 165 AUD). In LN, respondents were not satisfied with financial help. The cards were given to only a few deserving people, while the majority were given to those who had support from the government and political references. Only 10% of respondents got a soft loan in BAK and KHS from their relatives. One of the male respondents in KHS said he got a soft loan of five thousand rupees (equivalent to 41.26 AUD) from his cousin to get food and other non-food items for his family. On other hand, one old respondent in LN said: "I do not like to take anything from anybody; flood-hit not only our homes but also our self-respect. I felt ashamed of getting any help from relatives". Hence, it is concluded that there is a gap in flood risk management concerning the integration of structural and non-structural measures in district Layyah. These responses are in line with the study conducted by Farman Ullah et al. [39] who determined the flood risk perception and its determinants in rural households of two communities in Khyber Pakhtunkhwa province. A survey was carried out in two districts through a questionnaire from 382 respondents. It was found that around 50% of respondents received high-risk perception based on education, flood experience, location of the house near stream bank, and the distance from the river. Also, respondents in flash flood-prone regions experienced a lower risk than those in the riverain flood-prone areas.

6.2.3. Recovery from Disaster Rehabilitation

Figure 7 shows the pattern and sources of recovery from disaster in flood-hit localities. As the 2010 flood caused havoc in the riverine area, houses were destroyed, almost 74% population reported that they had to rebuild their houses. In BAK, 80% of respondents rebuilt their houses. Moreover, 26% of the population repaired houses with a maximum number of respondents from SW. In the case study area, katcha and pakka houses (mud or adobe houses) were seen. People use mud, bamboo, sheets made of bamboo sticks, wood, and bricks as a building material for the construction of their houses. Besides, 48% of respondents reported that Non-government and International organizations helped them to rebuild their houses. In LN, 70% reported that their houses were rebuilt by NGOs and 20% in SW got help from the government to rebuild their houses. In KHS, 64% population informed that they helped themselves to repair and rebuild their houses by taking soft loans from relatives or by selling their livestock. It can be concluded that the government and organizations responsible for post-disaster recovery did not satisfy the community in KHS and SW. Figure 8a below depicts the repairing of a deteriorated house in 2010 and after floods in KQN (one of the villages of LN). While Figure 8b depicts the rebuilt houses by the Integrated Development Support Program (IDSP), which is one of the local NGOs working in district Layyah. Hence it can be concluded that NGOs (IDSP and Awami Development Authority) and self-help of the community were the two prominent factors in rehabilitation with minimum contribution from the local government after the 2010 floods in district Layyah.



Figure 7. Rehabilitation practices and sources in flood-affected localities.

Community Participation

Figure 9 shows the community participation to get their lives back to a normal routine after the flood when they reached their communities from flood relief camps. 56% of the whole community responded that they gathered materials from their deteriorated buildings and helped themselves to fix their houses, while 70% population of LN reported similar findings. In BAK, the maximum population reported that they did nothing to help themselves as their locality was fully devastated and waited for assistance from organizations and government, while 22% of the community did not respond. As concluded by [40], community flood disaster risk management relies upon the participation and active role of the stakeholders in each locality. Moreover, The Global Platform for Disaster Risk Reduction (2009) stated that the best way to reduce the disaster risks is to strengthen the communities around the world and increase their resilience so that they can combat

adverse situations [17,41,42]. Similarly, the Hyogo Framework (2005–2015) perceived the necessity of producing resilient communities plus established methods to build it by (1) Preparing policies that are integrated with disaster prevention, preparedness, mitigation, and reduction of vulnerability (2) Increasing the local capacity to build hazard resilience (3) Introducing the attributes of risk reduction, emergency preparedness, response, recovery, and reconstruction into the policies for the disaster management [43,44]. Figure 10 illustrates that people live in a hazardous area despite the river erosion.





Figure 8. (a): A repaired house by an old respondent in LN, district Layyah. (b): Rebuilt houses in a row for one of the villages of union council, LN, district Layyah.



Figure 9. Community participation in flood-affected community.



Figure 10. People living with the highest risk of soil erosion in River Indus, district Layyah.

Local Indigenous Practices

Figure 11 shows the local indigenous practices taken during and post-flood conditions, along with the knowledge gained by the community from the 2010 flood event in district Layyah. 36% of people said that they started using a tractor tube for crossing, rescuing their family and other assets by themselves. 5% of the population reported that they use Sandhari for crossing flood water to reach a rescue point in case of emergency. Sandhari is a type of outfit made with goatskin which is used by the cobblers of the locality. 37% of the community reported that they started a practice of raising the platform of their houses by 4 to 5 feet after the 2010 flood disaster. This practice was seen in four localities during the field survey. When asked about the knowledge gained after the 2010 flood, 22% of people said that they have learned to evacuate their localities as soon as possible after an early warning was received. One of the male respondents in LN said: "We did not consider the 2010 flood warning, and when a flood hit our area it was havoc that destroyed us". Moreover, it was concluded that resilience is not only the capacity of the system to return to its original state but to do advancement in it by learning from past experiences and adaptation [43]. Mustafa [44] surveyed to gather information from the farmers in Pind Patekhan flood plains. To prevent water from entering the house, most of the farmers-built houses on the elevated mounds of muds. This indigenous practice was adopted by most of the locals. However, some of the tenant farmer houses lacked such features, either due to lack of funds or influence on the landlord to lend them government-owned bulldozers. The tenant farmers were in worse condition, as they were unsure of the future and it is not feasible to spend money on building elevated mounds.



Figure 11. Local indigenous practices for flood risk management in affected union councils of district Layyah in 2010 floods.

Livelihood Regain

The results in Figure 12 showed that 53% of the population from district Layyah regained their livelihood by cutting vegetables in fields located in their respective union councils on a daily wage of 300 to 400 rupees (equivalent to 2.48 to 3.30AUD). As the flood victims had to shift in relief camps in city Layyah from their communities. The males had started working in brick kilns and in block making local industries on daily wages during their stay in relief camps so that they could get enough savings to feed their children after leaving flood relief camps in Layyah city. The major occupation of males and females in flood-affected communities is mentioned in Section 6.1 above. As shown in Figure 13 men, women, and children are harvesting sugar-cane crops near the river, while in Figure 14, an old man is cutting the crop. Holling defined resilience as the capacity of the system to endure tough situations and manage the changes and perturbations such that the relationship between the state and the community remains undisturbed [15].



Figure 12. Major livelihood sources in flood-affected areas of district Layyah.



Figure 13. Men, women and children are cutting sugar-cane crop near the river in LN, district Layyah.



Figure 14. A man cutting crop on daily wages in SW, District Layyah.

6.2.4. Infrastructure Resilience

Figure 15 below shows the infrastructure protection practices in the case study area. Two practices were found to be common that was protection bund around houses and raised platform of houses. In SW, 75% population reported that they had protection bund/embankment around their community, while in LN, 81% of respondents reported that they had raised platforms of their houses. Even though this practice is not sustainable, however, contributes towards infrastructure resilience in localities of riverine area. Figure 16 shows the practice and construction of houses at a raised level which is considered flood resilient in the community. As resilience is also defined by Bruijn and Klijn in terms of flood risk management, and it focuses on the minimization of impacts by living with floods instead of fighting with them [15]. One form of resilience is 'process-related resilience. This is developed utilizing a long and continuous process of learning about increasing the capacity for managing disasters. This is considered highly important at the level of communities as the mitigation and relief process largely rely upon the resilience of the affected populations. Moreover, the hazard mitigation strategies and increased capacity are related to the awareness and resilience of the people [45]. Ahmed and Afzal [46] reviewed the advanced adaptation measures for improving building resilience against floods. Four mitigation strategies were widely practiced and supported by the government i.e., using reinforced material for building houses, building houses on the elevated ground floor, strengthening the foundation, and precautionary savings to overcome future uncertainties. The government needs to focus on developing strategies for adapting advanced measures, spatial planning, and improved practices for infrastructure building.



Figure 15. Infrastructure resilience practices in flood-affected communities in district Layyah.



Figure 16. Practice of raised plinth level in flood-prone communities of LN, district Layyah.

6.2.5. Comparison of Resilience Indices

Based on the collected data resilience, indices were calculated of the households across the four severely affected communities of LN, BAK, KHS, and SW (Figure 17). Four components of resilience i.e., social, physical, economic, and institutional resilience were calculated. Social resilience depicted the ability of the community to deal with the flood risk and was based on different social variables such as education, past flood experience, and the social network of the community. The economic resilience looked at the livelihood sources within the community. While institutional resilience considered the support provided by the government and NGOs, recovery, rehabilitation, and restoring livelihood. Physical or infrastructure resilience was based on variables such as the raised platform of houses and flood protection bund around the community. From the findings, it was revealed that the BAK, KHS, and SW were less vulnerable to floods, as higher infrastructure and social resilience were observed for these communities. Also, these communities were economically resilient as compared to LN. LN was found to be socially resilient, having a high index of 0.5.



Figure 17. Comparison of resilience indices among the districts.

6.2.6. Satisfaction Level of Communities towards Government and Organization Role Comparison of Satisfaction Level against Emergency Relief in 2010 Flood between Government and NGOs

The emergency services and response plans are the variables for the institutional Dimension of community resilience, as stated by [43,45]. Table 2 below represents the findings of a comparison of satisfaction level between government and NGOs against emergency relief received by the affected community of 2010 flood in four localities of district Layyah using Yeh's Index of Satisfaction [47]. The results show that respondents had a very low satisfaction level in SW (-1.56) and KHS (-1.76) for the government. This indicates that these two areas did not get any emergency relief from the government. In SW and KHS, flood victims were overlooked due to the negligence of local government and local representatives of areas. As SW is in Tehsil Karor and KHS is adjacent to it, so both union councils could not get emergency relief as the focus of government and NGOs were Tehsil Layyah being the main city in tehsil Layyah. Although in LN and BAK, the values of the index were 1.54 and 1.62, which showed that the satisfaction level was very high due to political biases. In these two localities, the community that experienced the 2010 flood reported vast destruction. LN is the nearest union council from the city of Layyah. While in BAK, political persons had a strong connection with district disaster management authority (DDMA) Layyah.

Table 2. Comparison of satisfaction level against emergency relief in 2010 floods between Government and NGOs.

	Localities	For Government		For NGOs	
Factor: Emergency Relief		Value of Index	Satisfaction Level	Value of Index	Satisfaction Level
	LN	1.54	Very High	1.70	Very High
	BAK	1.62	Very High	-1.70	Very Low
	KHS	-1.72	Very Low	-1.72	Very Low
	SW	-1.56	Very Low	-0.54	Very Low

On the other side, the satisfaction level for NGOs in BAK, KHS, and SW was very low as the value of the index is below 0.2 in these three localities, which indicated that organizations did not play any part in relief works such as evacuation, rescue, and first aid. While in LN, the affected community responded positively against NGOs role in emergency relief activities during and after the 2010 flood event [48].

Comparison of Satisfaction Level against Response after 2010 Flood between Government and NGOs

Table 3 below depicts the comparison of results for the satisfaction level of response plans between government and NGOs in four localities of district Layyah. The findings show that values of the index were negative in LN (-1.72), KHS (-0.28), and SW (-1.32), indicating a very low satisfaction level of respondents for the government. Lack of political support and coordination between local government, NGOs, and international donors were the major reasons for low satisfaction within the community. The satisfaction level for the government was very high, with the value of the index being positive (1.78) in BAK. As the local representatives of this union council were active and had connections with disaster managing departments in district Layyah local government. So, political influence was the main reason for the high satisfaction level of the affected community. During the field survey, the community had shown favorable behavior for government long-term assistance in BAK, which included the issuance of Watan cards, installation of hand pumps, and flood protection bunds around the union council [49].

Factor: Response Plans	Localities -	For Government		For NGOs	
		Value of Index	Satisfaction Level	Value of Index	Satisfaction Level
	LN	-1.72	Very Low	0.00	Acceptable (Very low)
	BAK	1.78	Very High	-1.70	Very low
	KHS	-0.28	Very Low	-0.44	Very Low
	SW	-1.32	Very Low	-0.62	Very Low

Table 3. Comparison of satisfaction level against flood response received after the 2010 floods between Government and NGOs.

Contrary to this, the satisfaction level for NGOs in three localities was found very low as the index values were negative. For LN, the value of the index is 0.0, which is acceptable according to YIS. People criticized the NGOs support after the 2010 flood event. Many respondents informed that organizations helped them rebuilt their houses. However, after reconstructing their houses, there was no monitoring and evaluation system as the houses get cracked and were in critical conditions.

7. Conclusions

From the finding of the systematic literature review, it can be concluded that in Pakistan, disaster preparedness is higher for floods than other disaster events. The authorities continuously monitor and provide information on any emergency crisis. However, these authorities lack the technical skill and equipment to deal with large-scale disaster events such as the 2010 floods. There is a need to develop the capacity to respond to the emergency crisis, effectively relocate, rescue, and rehabilitate the victims in the affected regions. It has been observed that delayed response of government and NGOs during crisis further deteriorated the condition of the victims. Lack of clean drinking water, food, and shelter increased the suffering of the community. Despite having frequent floods proper awareness and education programs are not given to the people to prepare themselves for the disaster. Lack of coordination between government and NGOs is evident. The reported humanitarian relief work carried out is different from what is being carried out. The community was not satisfied with the relief response, reconstruction of houses by NGOs, and financial assistance provided by the government. The authorities at the district and sub-district level are unable to implement medium to long-term emergency plans and interventions to mitigate the floods [47–49].

It can be concluded from the case study that the socioeconomic status of people living in the district of Layyah was found to be low and most people worked as laborers and on the farms. After the floods, 74% population reported that they had to rebuild their house, and the support was mostly provided by NGOs instead of the Government. The local indigenous practices such as using tractor tubes and Sandhari for crossing over floodwaters were used. Houses were built on raised platforms and protection bund/embankments were built around their community as a protection against floods. The satisfaction level of the community for flood response by the Government and NGO was found to be high in LN and BAK, while very low satisfaction level was evident in SW and KHS. The flood risk management can be upgraded by integrating community resilience. The BAK, KHS, and SW community can fundamentally restore their living status and curtail long-run vulnerability using their local resources in addition to government and NGOs support. These three communities were considered as social and infrastructural resilient. The concept of community resilience to disasters has gained significant impact over the last decade, which could help policymakers and practitioners to identify the strengths and vulnerabilities of populations endangered by floods [34]. Although LN is not infrastructurally and economically resilient, however, people of LN were found to be socially resilient. There was no planning and coordination between Government and NGOs for flood risk management, due to which the satisfaction level of affected communities in all four UCs towards the government's emergency relief and rescue was found to be very low. In BAK, the satisfaction level was found to be very high due to the government's long-term assistance as compared to the other three localities which depict the bias of government officials. While people were not satisfied with organizations long term assistance, NGOs helped in reconstruction and resilience, the building of community, but there was no monitoring and evaluation system. The national and international NGOs come forward with projects only during a disaster event and leave right after the completion of their projects [50–52].

8. Recommendations

The most important measure of increasing flood resilience in a community is to increase the level of awareness and train the locals so that they are well prepared to deal with floods. Some of the preparations include a supply of sandbags, building the houses on an elevated platform, avoiding storage of food in basements, evacuation plans, being able to recognize the early warnings, and knowing the emergency procedures [53]. NGOs have limited time and budget so the Government should focus on the training and mock drills to the flood-prone community for first aid and emergency response, including evacuation. The study by [17] contributes towards tackling challenges and adds details about the opportunities and ways to promote resilience and truly bring it into practice. The findings revealed that the participation of all stakeholders and communities enhance the resilience against flood. They are well-prepared, have better awareness, and are quite knowledgeable about the risks, and respond in case of a flood [54,55]. Among the plausible explanation for these findings are resilience indicators in the context of flood risk management. The utilization of the different tools for flood management, like the management plans and the early warning systems, can act as catalysts towards increasing awareness and preparedness. Similarly, risk communication during an event falls under the domain of risk communication and perception. Moreover, institutional cooperation and coordination, preparation of emergency services, and spatial planning are primary indicators for the resilience of policies and institutions [17,56].

There is a need to build a proper channel of communication between line departments, NGOs, and the community. Due to a lack of education and awareness, people cannot differentiate between the understanding of their rights and obligation [57]. People give less time for training and awareness programs, so NGOs provides them with a daily wage to compensate for their loss. For example, the Bangladesh Red Crescent Society in Bangladesh has a community-based disaster preparedness scheme in coastal areas of the Cox Bazar district [58–60]. The objective of the program is to strengthen the self-help capability of vulnerable communities and the major initiative is the establishment of Village Disaster Preparedness Committees. Similarly, after the 1998 floods, Care Bangladesh took many community-based initiatives [61]. This includes "floodproofing" by food for work to support the community. The works include plinth level upraising of the house for five-year flood stratum, schools to 20-year flood level, and village level safety plans that enable to meet emergency relief services [47,59-61]. Furthermore, policymaking and risk analysis help in understanding and predicting the responses of the public to flood hazards by improving communication among the locals, the professionals, and all the decisionmakers [62]. Communication includes spreading awareness among people and to increase their preparedness for dealing with disasters. Awareness and communication should mainly include correct and up to date information about the risks of floods during the crisis, announcing alerts, and making decisions during emergencies as it is clear that the perception of risk stems from communication about the risks and determines how the locals will apprehend these risks [63–65]. The government should build flood protection bunds, and NGOs should focus on gender sensitivity issues for DRR training in the local community. Flash floods are the main cause of flooding in district Layyah. There is a need to focus on community awareness and periodic sessions on WASH (Water Sanitation and Hygiene), DRR (Disaster Risk Reduction), environment, and health. There is also a need for updated flood maps of the riverine area by a special task committee [65–70]. In Manipur

and Rajasthan states, legislation for flood plain zoning has been ordained with teamwork of the National Natural Resources Management System (NNRMS) in1999 by the Ministry of Water Resources. To enable appropriate flood zoning, the readiness of survey maps on a large scale is required. So, about 55,000 km² flood plains were surveyed, and 570 maps were composed. The government should take steps to lessen the soil erosion in the riverine delta. The process of soil erosion is still ongoing in two union councils of the district named LN and BAK. Provincial Disaster Management Authority (PDMA) did not appoint any representative in the district since 2011 [71,72]. To make DRR effective government should adopt a strategy that can give a permanent solution like the regulation of Lala Kareek with fixed equipment. Need assessment and resource planning are very crucial. Government and organizations should focus on preparedness, early recovery, and livelihood sources of the affected community. Modern cutting-edge technologies including image processing, machine learning, and AI can be used to deal with disaster situations and save disastrous victims [73–75]. A community should follow the seasonal calendar so that crop damages can be reduced. The government should appoint proper staff for the management of relief camps instead of patwari (local representative) and teachers. Contingency planning technique at the district level might improve the adequacy of emergency relief but, it also displays considerable needs in terms of efficiency in response plans and flood risk management. There must be a contingency plan at the union council and village level for flood risk management, and guidelines must be followed by community and line departments.

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