



Designing resilience: Reconstruction of flood affected Areas in Sindh Pakistan: a case of rotary smart villages

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Abstract: Natural and man-made disasters are a big threat to societies across the globe today and architects are now considered to be very important in the management of risks as they design structures that can withstand disaster and In particular, this paper seeks to establish the measures and approaches that may be used in enhancing the overall resilience of the communities in the flood impacted areas of Pakistan. This paper is based on the case study of the Rotarian project of Smart Villages that deals with the reconstruction of flood affected areas in Sindh, Pakistan. It discusses ways and means of enhancing community preparedness and response to flooding in areas that have been flooded. It is for this reason that a framework is required, one that is integrative of the community, NGOs, governments, as well as other professionals. The strategies include infrastructure retrofitting, afforestation, eco-friendly material use, stakeholder involvement, resilient housing, health and sanitation improvement, livelihood restoration, and disaster risk reduction. This study stresses the need to foster more international cooperation, monitoring, and legal regulation of climate change with the help of sustainable development goals. In conclusion, this research assesses the repercussions of flooding in Sindh province now and in the past and aims to guide better and sustainable reconstruction strategies in the area. (Miller, 2024)

Keywords: Resilience, Community, Reconstruction, Sustainable Materials, Climate Change

1.Introduction

Recent times have seen an increase in natural catastrophes and environmental uncertainties, including wars, pandemics, earthquakes, and floods. This trend has transformed the role of architects from mere designers of structures to vital contributors in disaster risk reduction and resilience enhancement (Sciences., 2023). Their responsibilities now encompass anticipation, preparation, response, and recovery phases of disaster management, alongside traditional focuses on aesthetics and engineering precision. By advocating for resilient policies and designing disaster-resistant structures, architects educate stakeholders and oversee post-disaster rehabilitation efforts. They convert tragedies into opportunities for development through a unique blend of beauty and utility that fosters resilient, adaptive communities (Mannucci et al., 2022).

In Pakistan, the frequent catastrophic flooding poses severe challenges to the well-being and livelihoods of its

population (Sheikh, 2022). The necessity for designing resilience in these flood-affected areas has become paramount for sustainable development. Floods not only cause immediate destruction but also have long-lasting repercussions on the economy, agriculture, infrastructure, and public health (Bank, 2023) Given the historical context of devastating floods in the region, this paper outlines a comprehensive strategy for enhancing resilience in flood-prone areas of Pakistan. Key components include infrastructure reinforcement; advanced early warning systems; community engagement; sustainable agricultural practices; promotion of resilient housing; health and sanitation support; livelihood restoration; disaster risk reduction; international collaboration; continuous monitoring and evaluation; legal frameworks; and public awareness campaigns (Hendriks et al., 2018).

Recognizing the unique characteristics of each region in Pakistan is critical for tailoring solutions to address specific challenges and cultural contexts. This approach empowers communities not only to withstand the impacts of frequent flooding but also equips them with tools necessary for swift and effective recovery. By integrating these elements into a cohesive strategy, we aim to foster resilience and reconstruction in flood-affected areas, advocating for a more sustainable future for the people of Pakistan. (Salahuddin, Jamil, & B. M., 2019)

The increasing frequency of natural disasters underscores the urgent need for architects to engage in climate-resilient design practices (Bhatti et al., 2024). The unprecedented floods of 2022 exemplified this urgency as they wreaked havoc across Sindh and Baluchistan provinces, resulting in over 1,700 deaths and affecting 33 million people (UNDP). The floods were driven by extreme precipitation combined with glacial melt, highlighting the need for adaptation strategies to mitigate future risks.

Architectural innovations such as Yasmeen Lari's bamboo housing model demonstrate effective community engagement in building disaster-resilient homes. Lari's approach emphasizes self-building using locally sourced materials while teaching communities essential construction skills. This method fosters self-reliance among disaster victims who are empowered to rebuild their lives rather than relying solely on external aid.

As communities confront the challenges of rebuilding amidst climate change threats, experts emphasize the importance of constructing flood-proof structures. Poor governance and outdated construction standards have exacerbated vulnerabilities in housing and infrastructure (Sheikh, 2022). Initiatives like the Sindh People's Housing for Flood Affected (SPHF) aim to provide resilient housing solutions funded through loans from international organizations.

In conclusion, architects play a pivotal role in reshaping disaster management strategies through resilient design practices. By addressing immediate recovery needs while laying the groundwork for long-term resilience through comprehensive strategies like those outlined in this paper, Pakistan can better prepare its communities for future climate-induced disasters. Through collaboration among local communities, government agencies, NGOs, and international partners, we can build a more sustainable future that prioritizes resilience against natural calamities.

2. Literature Review

Architects and urban planners are increasingly recognized as key players in disaster risk management, particularly in designing resilient structures that can withstand environmental challenges. Recent studies emphasize the importance of integrating disaster risk reduction into architectural education and practice (Tschumi, 2020). The capacity of architects to influence community resilience through design has been highlighted in various frameworks that promote sustainable urban development (Leichenko, 2011).

Pakistan is always at risk of being struck by very severe floods which have been worsened by climate change, haphazard city planning and development, and poor infrastructure. The history of flooding in the country shows a destructive phenomenon which needs immediate attention (Khan & Javed, 2019). Emerging data suggests that the effects of floods are not only short term but there are Ripple effects on the affected communities economically and socially (Rehman et al., 2020). Disaster response and recovery involves the participation of local communities and stakeholders inclusive of other NGOs, government departments and private institutions. Community based interventions increase resilience because people become more responsible for the process and designs that meet community requirements (Shah & Bhatti, 2018). The active participation of local communities is highly requisite in the different management procedures in order to create effective solutions (Aldunce et al., 2015).

The use of green products and systems in reconstruction process supports the framework and principles of Sustainable Development Goals (SDGs) especially SDG 11 on sustainable cities and communities (United Nations, 2015). Research has also found that integrating sustainability and better building practices decreases risk of future disasters and shows proper regard for the environment (Mokhtar et al., 2019). Smart Villages initiated by Rotarian in Sindh can be an interesting case study to understand how new models of resilience are being worked out. This strategy embraces new generation technology and climate sensitive approaches in the rural welfare improvement

with focus on vulnerability of affected regions to floods (Khan et al., 2021). Aggressive evaluations of similar projects claim that the concept of smart village projects can fill the infrastructure gap and help the community become resilient to the changing environment (Aftab & Faheem, 2022).

The task of adapting a country to the climate change process requires specially developed legal and policy foundations. The governance citation shows that good governance can contribute positively towards the execution of policies and measures in enhancing disaster risk and climate change bargain (Zubair & Qureshi, 2020). Public education is also important in the campaigns for relaying information concerning climate risks that prevail in various areas and encouraging safe and precautionary measures (Rizvi, 2018). This literature review for reconstructing flood affected areas of Sindh calls for right and proper strategies that building design, people involvement, sustainability issues and a sound governance system. By engaging the Rotarian project of Smart Villages as the object of investigation, this study seeks to join the ongoing discussion on resilience in the face of environmental adversities.

2. Research Methodology

This study employs a mixed-methods approach to evaluate design strategies for enhancing resilience in flood-affected areas of Sindh, Pakistan, focusing on the Rotarian Smart Villages project. The research begins with a comprehensive literature review to identify existing frameworks and challenges related to disaster risk reduction and resilience building, providing a theoretical context for the study (Hendriks et al., 2018).

Data collection will include both primary and secondary sources. Primary data will be gathered through structured surveys distributed to residents in flood-prone areas, capturing quantitative information on demographics, socio-economic status, and perceptions of reconstruction efforts. Additionally, qualitative data will be collected via semi-structured interviews with stakeholders such as architects, urban planners, community leaders, and NGO representatives, aiming to gather insights on local resilience perspectives and needs. Focus group discussions will further explore community views on current reconstruction efforts (Braun & Clarke, 2006).

Secondary data will involve a thorough review of existing literature and relevant reports from governmental and non-governmental organizations regarding flood impacts and recovery efforts. Statistical data related to flooding incidents and demographic changes will also be sourced from government agencies (Creswell, 2014).

The analysis will integrate quantitative data from surveys using statistical software to summarize demographic information and assess relationships between community engagement and perceptions of resilience. Qualitative data will be thematically analyzed, identifying common patterns in community experiences. The Smart Villages project will serve as a case study, examining successful resilience initiatives, community involvement, and sustainability outcomes through field observations and interviews with project implementers (Yin, 2018).

Ethical considerations will be prioritized, ensuring informed consent and confidentiality. The study acknowledges potential limitations, such as challenges in accessing remote areas and response bias in surveys, which may affect the generalizability of findings.

Overall, this methodology aims to provide a robust framework for evaluating reconstruction efforts in flood-affected areas of Sindh, generating actionable insights for architects, policymakers, and communities striving for sustainable recovery.

4. Discussion on the Design Approaches for Resilience

4.1 Relevance of the Study

In several ways, this study is quite pertinent to architects. First of all, as Hendriks et al., (2018) said, it enables architects to be forefront in the formulation of sustainable and flood resilient designs in infrastructures and buildings in flood affected regions of Pakistan. Through study, architects are in a good position to design buildings that can withstand floods, minimize losses and provide shelter during and after floods to noble clientele of these areas. (FEMA, 2022). Also, this research could be helpful to develop more localized architectural solutions that would enhance flood resistance and enhance the overall quality of life for people who live in flood affected areas. It focuses on how a knowledgeable and empathetic process in design can help during disasters or contribute to sustainable development and safety of communities. In addition, by the findings that revealed that architects have been involved in the development of codes and policies relating to resilience the study can contribute to policy implications. It can enhance collaboration between professionals concerned with disaster risk reduction, identify resilience design approaches, assess the economic and social implications of practice in the field of architecture, and offer relevant recommendations for development. Professionals could benefit from this study, and it can enhance academic knowledge and raise awareness about the roles that architects assume. The writer is already

involved in the Rotary International Smart Villages projects to which he has input data from some of his published articles and professional practice. Therefore, in that case, this chance to finish the PhD with the related project will contribute to the filling of the gaps, both, in the theoretical and practical aspects of Pakistan's disaster management. ((Farah, 2019)

4.2 Study Areas

1. Indus River Basin: The yearly monsoon floods are caused by the Indus River and its tributaries, especially in the provinces of Sindh and Punjab. Some of Pakistan's worst floods in recorded history have occurred in this region.

2. Sukkur Barrage: is an essential flood control structure situated in Sindh on the Indus River; however, the areas upstream and downstream are vulnerable to flooding.

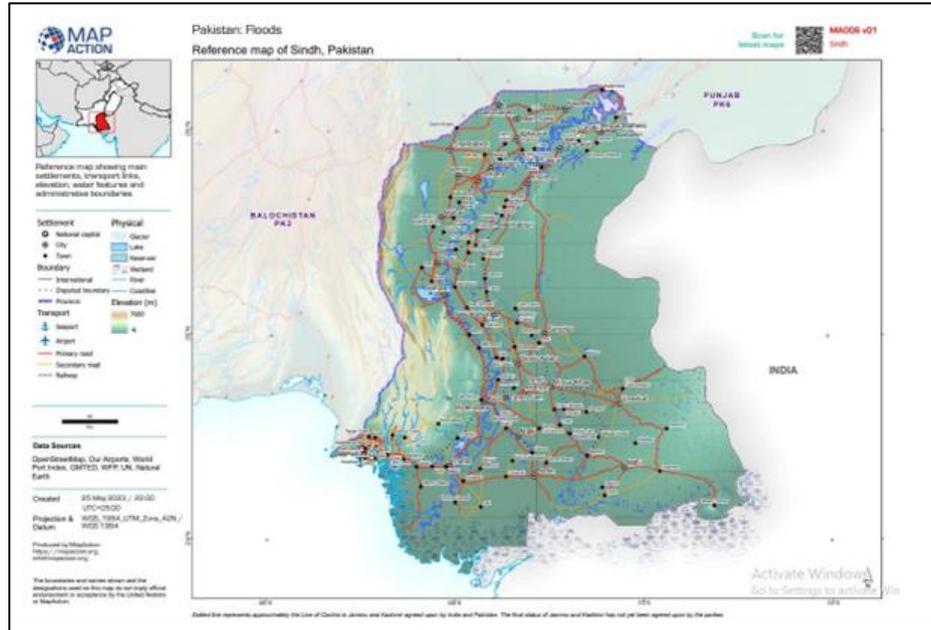


Figure 1 Source; Pakistan Monsoon rains and EU response - DG ECHO Daily Map 09.09.2022 <https://www.globalfloods.eu/news/108-Floods%20in%20Pakistan,%20June%20to%20September%202022/>

4.3 Framework for Resilient Reconstruction in Pakistan's Flood-Prone Regions

Rebuilding, recovery of the destructed flood affected regions of Pakistan and progress of constructiveness and sustainability that is possible only with equal emphasis on sustainable development and public interest can be best only with a design strategy platform. Strategic objectives include assessing risk for the purpose of balancing fragility with coping capacity, improving the systems that support sustainability of function, and indicating danger signs for disaster preparedness. Residents' funded Community training programs are effective in flood prevention and response (Linnenluecke & McKnight, 2017). Promoting the new flood-proof built environment development and adaptation of existing buildings reduce risks and enhance habitation (Hendriks et al., 2018). Epidemic prevention and control through safe water and hygiene, revive communities' economy through business development and vocational training. The main lessons identified are the need to improve linking involving DRR to the Regional Spatial Development and international cooperation that provides the required technical experience and financing. Moreover, continuous evaluation and examination of the resilience programs and regs that underpin also contribute to community resilience (PDMA, 2022).

These objectives offer an intervention point of contact in order to construct communities and for preparation of floods and also improvement of welfare of people in regions (ADB, Benson, 2016). Tabular examples include Spatial identification and mapping of the most vulnerable regions, Risk Management of the facilities and infrastructures and Training sessions in case of event occurrence (Linnenluecke & McKnight, 2017). One should also identify legal domains where legal frameworks do not possess the capacity to build resilience.

They are architectonic design principles that hint at potency in the notion of material quality and functioning (Davidsson, 2020). Additional population engagement is made possible by architects engaging in the formulation of the related policies in addition to the assessment of the implemented outreach programs as recommended by

Charise and Krecsy (2022) Baroudi and R. Rapp (2014). On this aspect, the study demonstrates the part played by architects in developing flood safe designs as well as in shaping policies concerning resilience for enhancing safety in the community (Hendriks et al., 2018; FEMA, 2022). The study outcomes emanating from Rotarian smart villages are some of the positive changes that must be scaled up in other areas to foster more success in community mobilization and disaster response intervention with relevance globally (Khan et al., 2021; Farah, 2019).

4.4 Practical Application; Rotary Smart Villages, Pakistan

Regarding Pakistan and the recent floods more often happening in Sindh province, it has never been more important to build sustainable and more resilient architectural solutions. The 2022 floods significantly affected the region; several coastal cities with a population of over 33 million people have been left devastated due to floods, washed out homes, health facilities, and means of earning a living. In a recent development, the United Nations Environment Programme and Organization for Economic Cooperation and Development said the total climate aid shortfall was now approaching \$30bn, which increases humanity's perilous risks. Another report published on February 2023 by the Brookings Institution exposed how 90% of the pledged recovery aid at the international donors' conference in Geneva was in the form of loans that further burdened an economy that was already under pressure before the disaster.

To meet these challenges, Pakistani Rotarians spearheading by RI Director Muhammad Faiz Kidwai and Arch | Yasmeeen Lari introduced the idea of Rotary Smart Villages. These interventions are a set of specific projects that are aimed at areas of Pakistan, particularly Sindh province, that are vulnerable to floods – and therefore, they constitute a good example of flood-resistant architecture as well. The structures within the Smart Villages not only assist in the short-term relief efforts but, in addition; they offer lasting solutions to mitigate the impacts of future flood disasters. It is divided not only to meet the humanitarian crises needs of affected populations but wants to get at the 'spirit' of communities to be resilient in the event of future disasters' (Villages, 2023; Miller, 2024).

4.5 Concept and Design Principles

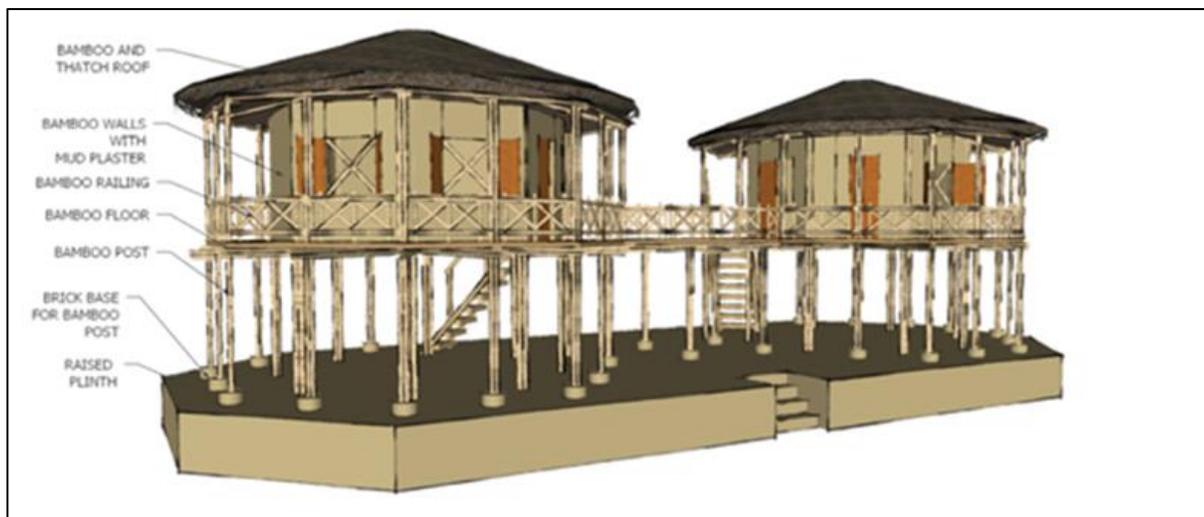


Figure 2 Modular structure design proposal for the flood hit targeted areas. Source: Villages, R. S. (2023). Smart Villages. <https://rotarypakistansmartvillages.org/the-concept/>

The Rotary Smart Villages are majorly developed based on core values of sustainability and elasticity. Or rather, Lari stresses the necessity to use the natural resources of Tanzania such as mud and bamboo in construction as they are not only sustainable but also familiar to culture. It also includes the use of elevated structures, whereby plinth levels are raised in an effort to avoid contact with flood water. Also, passive design elements such as ventilation and thermal storage increase comfort and reduce energy use. (Florian, 2023; Villages, 2023)



Figure 3 Single unit modular structures. . Source: Villages, R. S. (2023). Smart Villages. <https://rotarypakistansmartvillages.org/the-concept/>

4.6 Community Engagement and Capacity Building

A significant aspect of Rotary Smart Villages is community involvement. Lari's method of operation guarantees that people within those areas are involved in planning and development. But more than that, this participatory model used a way that enables the residents to have control over the newly built environment. Community cultural architecture developments involving skills in construction and training programs assist in empowering the members in their homes for future shocks, strengthening the community members' skills to maintain changes. (Villages, 2023).



Figure 4 Community participation, especially women, in the making of the Smart Villages. Source: Modular structure design proposal for the flood hit targeted areas. Source: Villages, R. S. (2023). Smart Villages. <https://rotarypakistansmartvillages.org/the-conc>



Figure 5 Installation of pumping wells to access aquifers

4.7 Integrated Water Management

Noting the problems presented by flood waters on the livelihood of communities, the design of these villages includes water management solutions. Flood control, grey water management, and creation of water bodies also serve a number of purposes in addition to water control such as maintaining water quality. This reduces the possibilities of water logging but increases the number of habitant species, thereby making the space much more livable. (Florian, 2023).

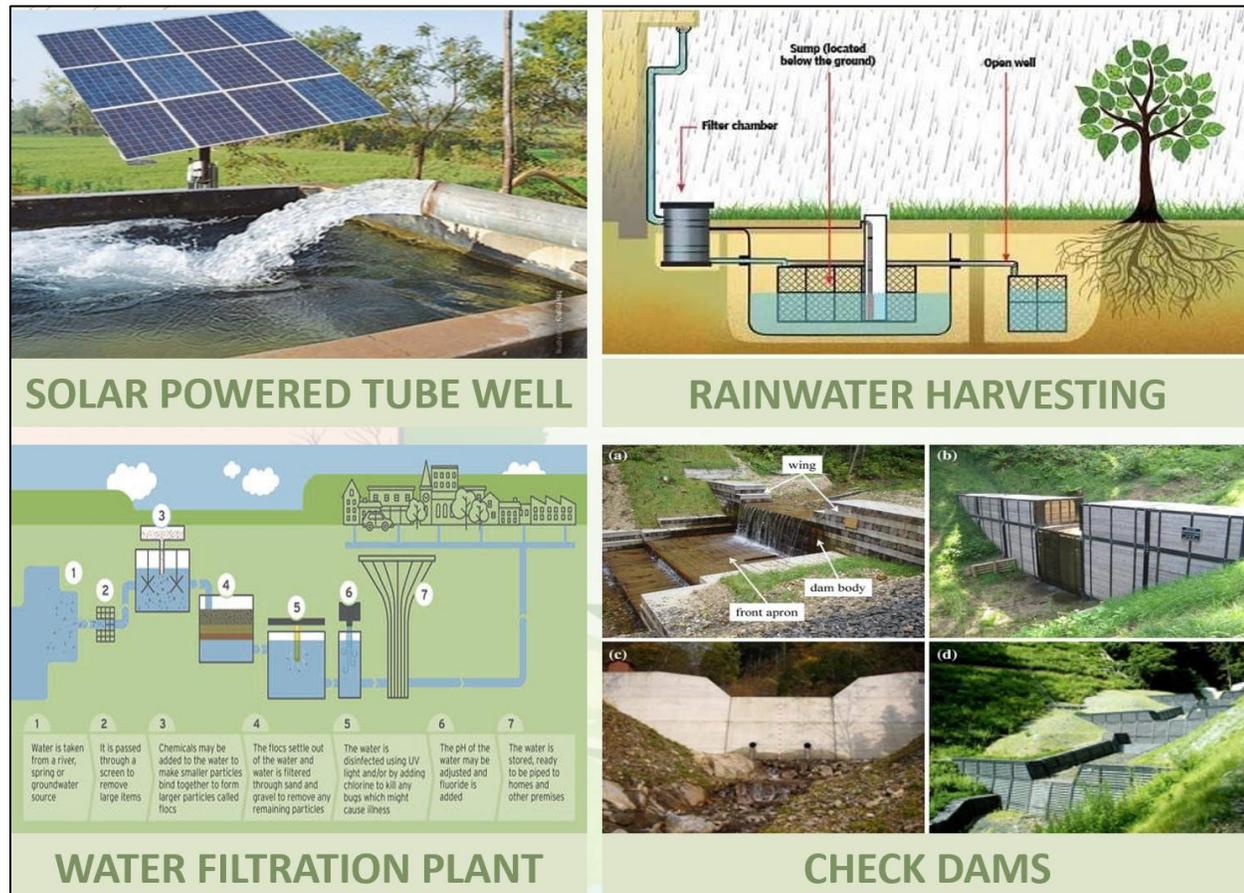


Figure 4 Methodologies to prevent flooding and to utilize the excessive rainwater. Source: Villages, R. S. (2023). Smart Villages. <https://rotarypakistansmartvillages.org/the-concept/>

4.8 Socioeconomic Impact

The Rotary Smart Villages being an innovation have important socioeconomic impacts. In as much as they afford security in housing and infrastructural facilities, they promote a better standard of living as should be expected of everyone. Availability of public utilities including water, hygiene, and electricity improves the quality of life among people, while installation of common facilities facilitates unity and convergence of people. The living condition that has been enhanced by accelerated development enables economic activities that will help to build strength of the community.

4.9 Scalability and Replication

The success of the Rotary Smart Villages serves as a model for other flood-prone areas in Pakistan and beyond, with Sindh specifically highlighted as a prototype area for this initiative. The design principles and community engagement strategies developed in these villages can be adapted to various contexts, making it possible to scale these solutions to meet the needs of different populations. This adaptability is crucial in a country where climate change continues to exacerbate the frequency and intensity of flooding (Villages, 2023; Khan et al., 2021). By leveraging the lessons learned from the Smart Villages project in Sindh, similar approaches can be implemented in other vulnerable regions, enhancing resilience and sustainability across Pakistan and in comparable global contexts. Click or tap here to enter text.



Figure 5 Concept Plan of the Smart villages. Source: Villages, R. S. (2023). *Smart Villages*. <https://rotarypakistansmartvillages.org/the-concept/>

5. Conclusion

The reconstruction process in the flood hit regions of Pakistan balances risk and possibilities for adaptive preparedness in the context of climatic change. As parts of this research, it has also provided the screams for calling for better and more sustainable architectural intervention solutions, for instance, rotary smart villages initiated by Rotary International Director Muhammad FaizKidwai under the supervision of Ar. YasmeenLari along with providing physical necessities and shelter for the affected people, creates the base for future resilience too. Integrated water management and the use of local materials and community participation exhibition in these projects show how design can promote the social and economic status of the local society for better development. (Villages, 2023)

Secondly, trying to match the volatility of the international donor aid is vital to avoid rehabilitation interfering in practical recovery efforts of smashed economies. The practice of engaging local knowledge with international support can open opportunities for positive stock transformation. Finally, this study highlights the significance of resilience integration in development and designing of viable communities that are ready for future climate risks. The priority of these principles will help Pakistan build a more robust tomorrow: the one where not only the consequences of past calamities are addressed, but also the effects of the future ones prevented.

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