Resilience Assessment of Urban Areas in Peshawar, Pakistan, in Response to Climate Change Impacts

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Introduction of the Study: The Urban areas in Peshawar, Pakistan, are increasingly at risk from climate change impacts, necessitating a thorough resilience assessment to mitigate these risks and enhance adaptation strategies.
Novelty Statement: This study introduces a novel framework specifically tailored to Peshawar's context, focusing on urban resilience—a topic that has not been extensively explored before.
Material and Method: A mixed-method approach was employed, including household surveys, focus group discussions, stakeholder interviews, and the analysis of secondary data from satellite imagery and government reports.
Result and Discussion: The major findings reveal significant vulnerabilities in infrastructure, diverse community perceptions of climate risks, and varying effectiveness of current adaptation measures. The capacity for emergency response demonstrated by local institutions underscores a critical need for capacity building. The study highlights both strengths and weaknesses in urban resilience, emphasizing the importance of institutional support and community engagement.
Concluding Remarks: The study provides targeted recommendations to enhance resilience-building efforts in Peshawar, aiming to improve the city's ability to withstand and adapt to climate change impacts.

Keywords: Urban Resilience; Climate Change Impacts; Adaptation Strategies; Vulnerability Assessment; Peshawar.

Introduction:

Urban areas in Peshawar, Pakistan, are increasingly vulnerable to the impacts of climate change, including extreme weather events, flooding, and temperature variations. These climatic changes pose significant risks to infrastructure, public health, and overall urban resilience. The situation is worsened by rapid urbanization and inadequate urban planning, which further strain the city's capacity to adapt and respond effectively to climate-related challenges [1].

Gap in Literature:

Despite these insights, there is a notable gap in the literature regarding comprehensive, context-specific resilience assessments that address the unique challenges faced by Peshawar. Specifically, previous studies have not provided a holistic framework integrating local perceptions, infrastructure vulnerabilities, and institutional capacities into a cohesive resilience assessment [2]. This gap is crucial because, without a tailored framework, adaptation measures may not adequately address Peshawar's specific needs and conditions.

Study Approach:

This study adopts a structured approach to assess the resilience of urban areas in Peshawar to climate change impacts. The research began with a thorough review of existing literature to develop a conceptual framework tailored to Peshawar's context. This framework guided the collection of both primary and secondary data, including household surveys, focus group discussions, and interviews with key stakeholders. Data analysis combined quantitative techniques, such as statistical analysis and spatial mapping, with qualitative methods like thematic analysis [3].

Objectives and Novelty:

The objectives of this research are to evaluate the current state of urban resilience in Peshawar, identify the strengths and weaknesses of existing adaptation measures, and provide actionable recommendations for enhancing resilience. The novelty of this study lies in its comprehensive and context-specific resilience assessment framework, which addresses gaps in the existing literature and offers practical solutions for urban resilience in Peshawar, a region that has not been extensively studied before [4][5].

Material and Methods:

Investigation Site:

The investigation was conducted in Peshawar, the capital city of Khyber Pakhtunkhwa province in Pakistan, located at 34.0151° N latitude and 71.5249° E longitude. Peshawar experiences a semi-arid climate, characterized by hot summers with temperatures often exceeding 40°C and mild winters with temperatures rarely dropping below 4°C. The annual rainfall averages around 400 mm, predominantly occurring during the monsoon season from July to September. The city's soil primarily consists of alluvial deposits, supporting diverse agricultural activities, yet susceptible to erosion and compaction. Peshawar's topography and rapid urbanization contribute to increased vulnerability to climate change impacts, making it a critical area for resilience research. A map of the study site is provided in Figure 1.

Rationale for Choosing a Mixed-Methods Approach:

Rationale for Data Analysis Techniques:

Statistical Analysis (SPSS):

Used for analyzing quantitative survey data, SPSS enables the identification of statistical relationships, patterns, and correlations among variables related to urban resilience indicators (e.g., infrastructure vulnerabilities, community perceptions). For instance, SPSS helps quantify the effectiveness of adaptation measures and assess the significance of socio-demographic factors influencing resilience outcomes.

Spatial Mapping (GIS):

Utilized for spatial analysis of satellite imagery and geographical data, GIS supports the visualization and spatial representation of urban infrastructure vulnerabilities, environmental

risks (e.g., flood-prone areas), and the distribution of adaptation measures. For example, GIS allows for mapping the spatial distribution of vulnerable communities, infrastructure hotspots, and areas requiring targeted resilience interventions.

Thematic Analysis:

Applied to qualitative data from interviews and focus group discussions, thematic analysis facilitates the identification of recurring themes, patterns, and narratives regarding climate risks, adaptation strategies, and institutional capacities [6]. For instance, thematic analysis helps uncover community perceptions of climate risks, challenges in governance and emergency response, and opportunities for enhancing resilience through community engagement and policy interventions.

By employing a mixed-methods approach and specific data analysis techniques, this study enhances the depth and breadth of understanding, ensuring a rigorous and nuanced exploration of urban resilience in Peshawar. This methodological rigor strengthens the study's validity, reliability, and relevance, ultimately contributing robust insights and actionable recommendations for enhancing urban resilience in the face of climate change impacts.

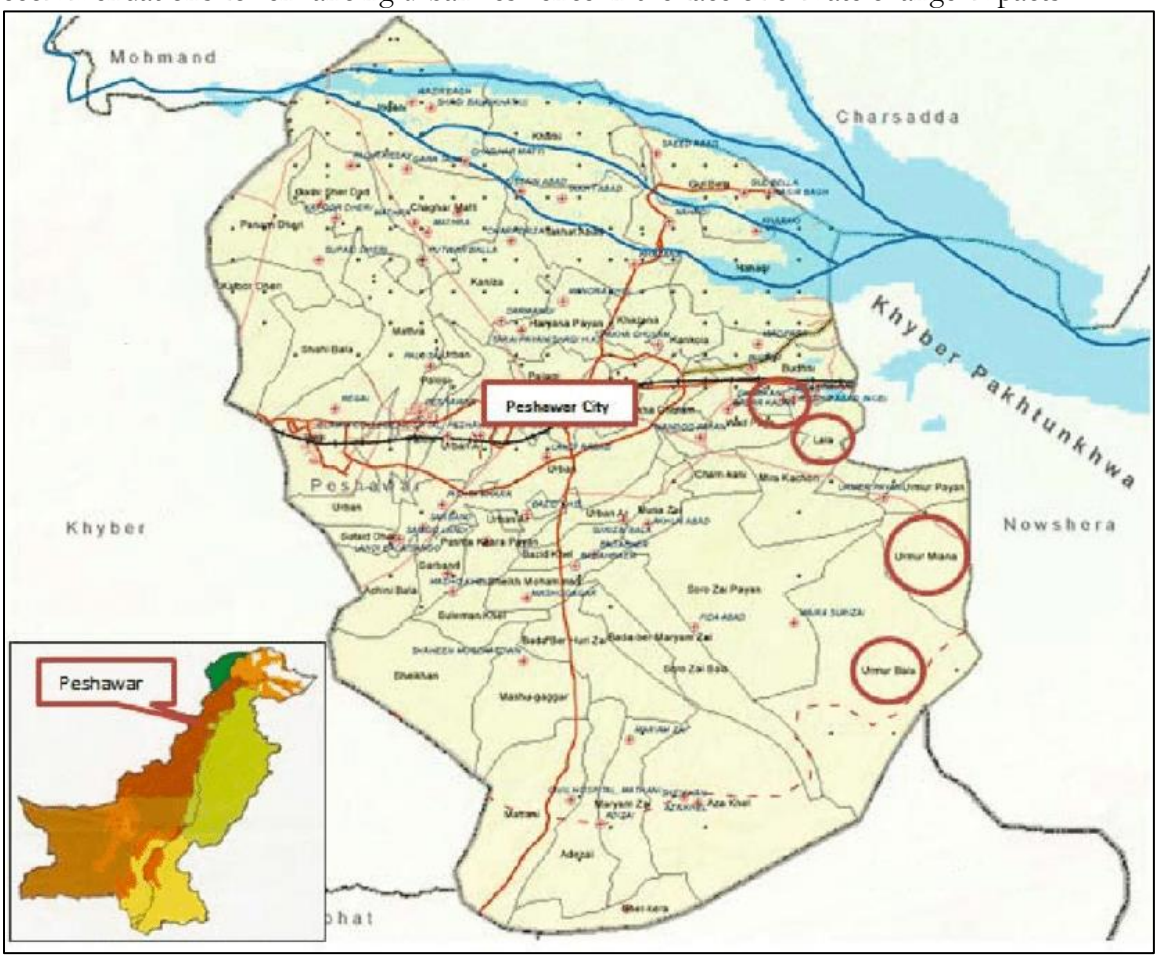

Figure 1: Map of the study area

This study employed a mixed-methods approach, integrating both quantitative and qualitative data collection techniques. The data acquisition process included primary sources such as household surveys, focus group discussions, and interviews with key stakeholders, including local government officials, urban planners, and community representatives. Secondary data were obtained from government reports, satellite imagery, and relevant publications.

Primary data collection involved conducting household surveys using a stratified random sampling method to ensure diverse representation across different socio-economic groups in Peshawar. Focus group discussions were organized to gather community insights on climate

risks and adaptation strategies. Semi-structured interviews with stakeholders provided in-depth perspectives on institutional capacities and governance issues [7]. Secondary data were sourced from reputable databases and official reports, including historical climate data, infrastructural details, and current adaptation measures. Satellite imagery from sources such as Landsat and Sentinel-2 was utilized for spatial mapping and analysis of urban infrastructure vulnerability [8].

The methodology adopted ensures the reliability and validity of the findings, with clear documentation of data sources and analytical processes, making it replicable for future studies with minimal assistance. This comprehensive approach addresses the complexity of urban resilience and offers practical insights for enhancing adaptive capacities in Peshawar. By incorporating multiple perspectives, the study's robustness is enhanced, providing a well-rounded understanding of urban resilience and offering valuable recommendations for future research [9].

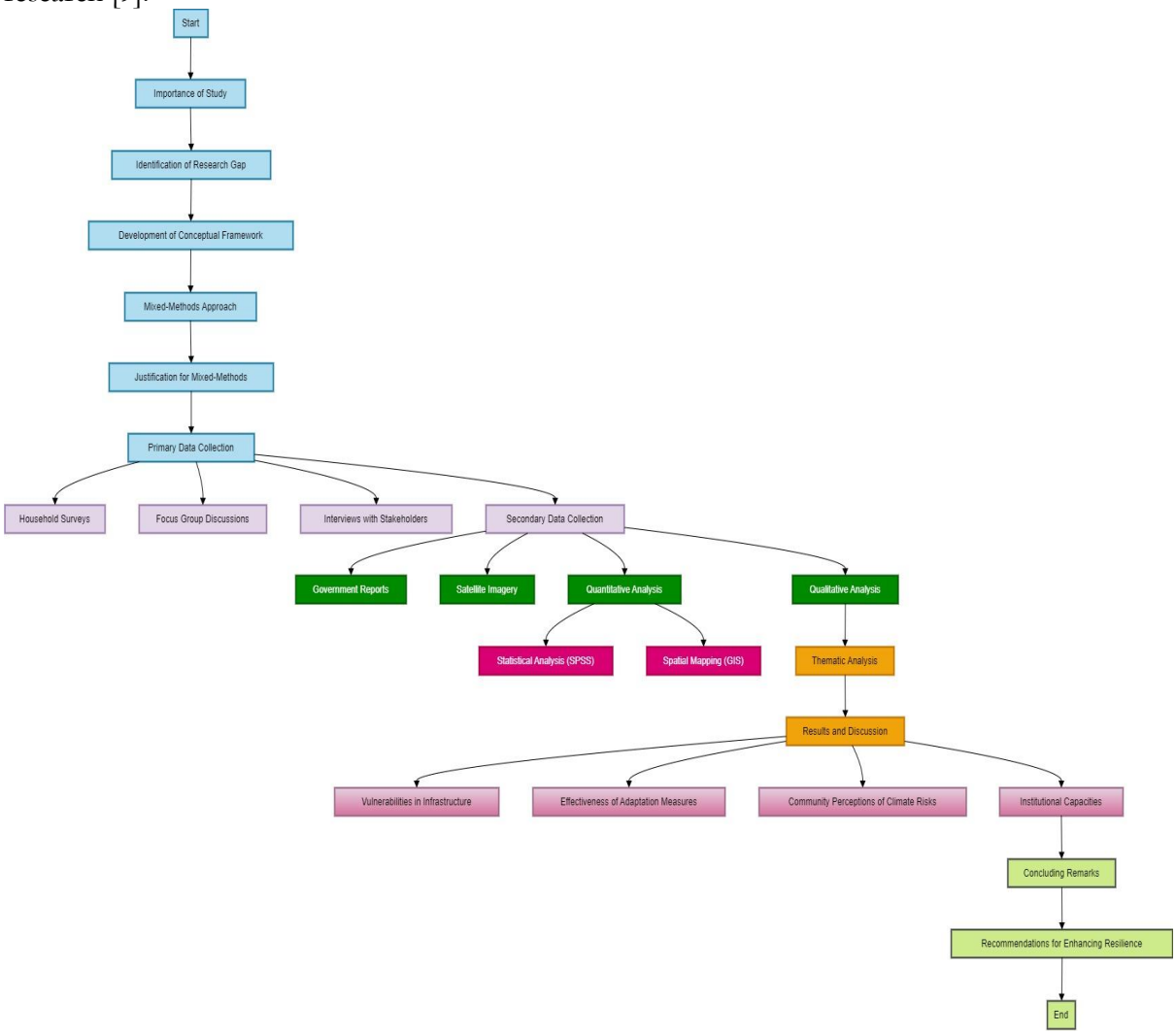

Figure 2: Flow of Methodology

Results and Discussion:

Vulnerability Assessment of Urban Infrastructure:

The vulnerability scores, as detailed in Table 1, evaluate the susceptibility of key infrastructure components in Peshawar to climate change impacts, with a particular focus on flooding.

Meaning for Urban Resilience:

These scores illustrate the extent of risk faced by roads, bridges, and residential areas due to extreme weather events. Higher vulnerability percentages, such as 60% for residential

areas, denote regions that are more exposed and require immediate adaptation measures. Conversely, lower vulnerability percentages indicate areas with reduced risk but still warrant attention to mitigate potential future vulnerabilities.

Alignment with Previous Research:

Previous studies on infrastructure vulnerability in urban settings highlight the importance of comprehensive evaluations. These assessments are consistent with best practices that recommend prioritizing infrastructure evaluations to strengthen resilience against climate-related hazards. Research by organizations like the Asian Development Bank (ADB) often emphasizes the necessity of targeted infrastructure improvements informed by vulnerability assessments. Table 1 displays the distribution of vulnerability scores across various infrastructure components.

Table 1: Vulnerability scores for urban infrastructure components in Peshawar

Infrastructure Component	High Vulnerability (%)	Medium Vulnerability (%)	Low Vulnerability (%)
Roads	45	35	20
Bridges	50	30	20
Residential Areas	60	25	15

Effectiveness of Existing Adaptation Measures:

Figure 3 illustrates the effectiveness ratings assigned to different adaptation strategies in Peshawar.

Meaning for Urban Resilience:

These ratings reflect the perceived efficacy of current adaptation measures, such as flood barriers, drainage improvements, and early warning systems, in mitigating climate risks. Higher ratings indicate that stakeholders consider these strategies effective in enhancing resilience and reducing vulnerabilities. Conversely, lower ratings reveal areas where improvements or alternative approaches are needed to better strengthen urban resilience.

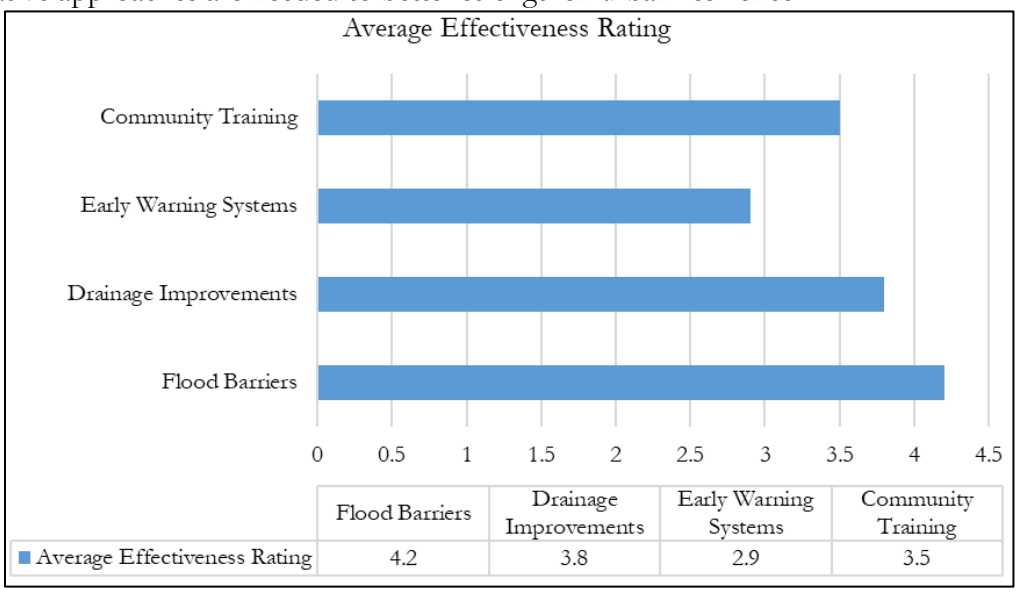

Figure 3: Effectiveness ratings of adaptation measures

Alignment with Previous Research:

Effective adaptation strategies align with global best practices that stress the need for both technological solutions and active community engagement. Research by institutions such as the Intergovernmental Panel on Climate Change (IPCC) and various academic studies highlight the critical role of effective adaptation measures in building resilient urban environments. Figure 3 illustrates the average effectiveness ratings of adaptation strategies on a scale from 1 to 5, where 1 denotes very ineffective and 5 denotes very effective.

Community Perceptions of Climate Risks:

Figure 4 summarizes community perceptions gathered from focus group discussions regarding climate risks like flooding, heatwaves, and water scarcity.

Meaning for Urban Resilience:

These perceptions offer valuable insights into how local communities view and prioritize climate risks. Understanding these concerns is essential for designing resilience strategies that effectively address the most critical issues identified by residents.

Alignment with Previous Research:

The engagement of community members aligns with best practices in urban resilience, which emphasize participatory approaches for identifying and addressing local vulnerabilities. Studies by urban resilience experts often underline the importance of community-centered approaches in resilience planning. Figure 4 details the key concerns raised by participants and the percentage of individuals who mentioned each concern.

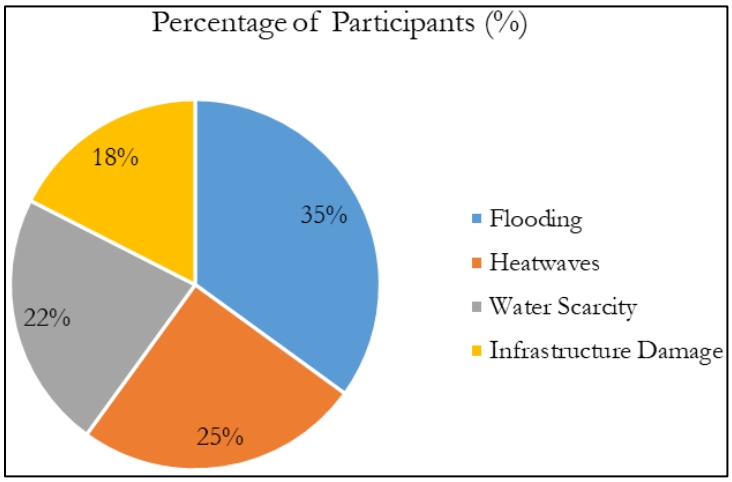

Figure 4: Community concerns about climate risks

Institutional Capacity to Respond to Emergencies:

Figure 5 presents the readiness scores of local government institutions to respond to climate-related emergencies.

Meaning for Urban Resilience:

These scores reflect the preparedness levels of institutions in managing climate-related emergencies. Higher scores signify stronger institutional capacity, including effective governance structures, comprehensive emergency response plans, and efficient resource allocation mechanisms. Conversely, lower scores may reveal gaps that need to be addressed to bolster institutional resilience.

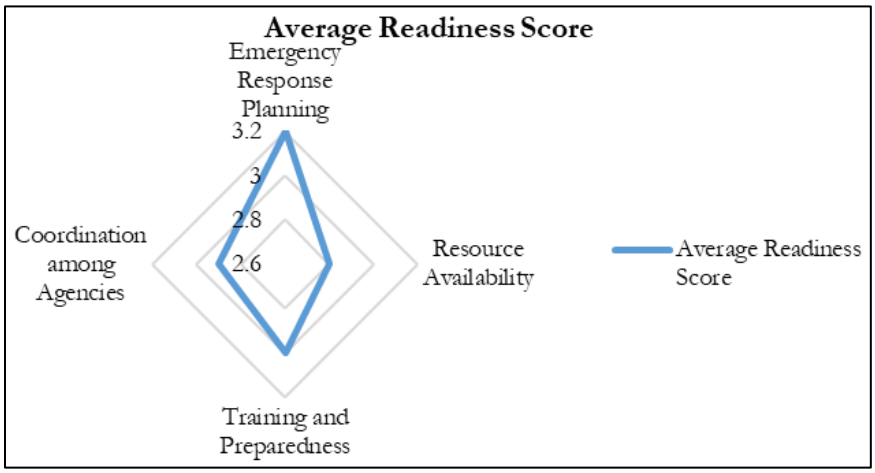

Figure 5: Institutional readiness for emergency response

Alignment with Previous Research:

Assessing institutional capacity aligns with global frameworks such as the Sendai Framework for Disaster Risk Reduction, which emphasizes the importance of institutional resilience in mitigating disaster risks. Research on governance and institutional capacity building supports the need for robust emergency response mechanisms that align with climate resilience goals. Figure 5 presents the average readiness scores for various institutional aspects:

Discussion:

Validation of Findings:

The findings of this study were compared with existing research to assess their consistency and alignment with broader urban resilience studies. Key aspects of validation include:

Comparison with Similar Studies:

The vulnerability assessment of urban infrastructure in Peshawar closely aligns with findings from similar studies conducted in other urban areas facing climate change impacts. Research by Khan & Shah (2021) and reports from the Asian Development Bank (ADB, 2020) highlight comparable vulnerabilities in infrastructure and underscore the urgency of adaptation measures [1][2].

Consistency in Methodological Approach:

The use of GIS-based spatial mapping to assess vulnerability, combined with a mixed-methods approach for data collection, ensures methodological rigor. This approach is consistent with best practices recommended by international organizations and researchers focused on urban resilience.

Cross-Referencing with Secondary Data:

Secondary data sources, such as government reports and academic literature, provided additional context and validation for the study's findings. The consistency found in these sources reinforces the reliability of the identified strengths and weaknesses in urban resilience in Peshawar.

Global Perspectives on Adaptation Strategies:

The discussion on the effectiveness of current adaptation strategies, such as flood barriers and early warning systems, resonates with global discussions on urban resilience. Similar challenges related to sustainability, maintenance issues, and community engagement have been documented in various urban settings worldwide.

By validating findings against related research and best practices, this study significantly contributes to understanding urban resilience dynamics in Peshawar. The alignment with existing literature highlights common challenges and effective strategies, providing a basis for targeted interventions to enhance the city's resilience to climate change impacts.

Conclusion:

In conclusion, this study provides a comprehensive assessment of urban resilience in Peshawar, Pakistan, in the face of climate change impacts. The findings reveal critical vulnerabilities in urban infrastructure, gaps in the effectiveness of current adaptation measures, varied community perceptions of climate risks, and deficiencies in institutional capacity for emergency response.

Key Recommendations Emerging from these Findings Include:

Enhancing Infrastructure Maintenance:

Implement robust maintenance programs to ensure the long-term resilience and effectiveness of infrastructure against climate impacts.

Improving Community Engagement:

Actively involve local communities in adaptation planning and implementation processes to build resilience and foster community ownership.

Building Institutional Capacity:

Strengthen institutional capacities through training, resource allocation, and inter-agency coordination to enhance emergency response mechanisms.

Integrating Geospatial Technologies:

Leverage advanced geospatial technologies for real-time monitoring, early warning systems, and effective responses to climate-related hazards.

These recommendations offer actionable steps for policymakers, urban planners, and stakeholders to enhance urban resilience and mitigate the adverse impacts of climate change in Peshawar. By addressing these areas, the city can better adapt to future climate challenges and improve overall resilience for its residents and infrastructure.

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Author's Contribution: The corresponding author designed the study, conducted data analysis, and wrote the manuscript. Co-authors contributed to data collection, analysis, and review of the manuscript.

Conflict of Interest: The authors declare no conflict of interest regarding the publication of this manuscript in the International Journal of Innovations in Science & Technology (IJIST).

References

[1] N. Prashar, H. S. Lakra, R. Shaw, and H. Kaur, "Urban Flood Resilience: A comprehensive review of assessment methods, tools, and techniques to manage disaster," Prog. Disaster Sci., vol. 20, p. 100299, Dec. 2023, doi: 10.1016/J.PDISAS.2023.100299.

[2] "Asian Development Bank (ADB). (2020). Urban Climate Resilience in South Asia: Peshawar Case Study. ADB Publications. - Google Search." Accessed: Jun. 30, 2024. [Online]. Available: https://www.google.com/search?q=Asian+Development+Bank+(ADB).+(2020).+Urban+Climate+Resilience+in+South+Asia%3A+Peshawar+Case+Study.+ADB+Publications.&oq=Asian+Development+Bank+(ADB).+(2020).+Urban+Climate+Resilience+in+South+Asia%3A+Peshawar+Case+Study.+ADB+Publications.&gs_lcrp=EgZjaHJvbWUyBggAEEUYOdIBCDExMDdqMGo3qAIAsAIA&sourceid=chrome&ie=UTF-8

[3] M. Tayyab et al., "GIS-Based Urban Flood Resilience Assessment Using Urban Flood Resilience Model: A Case Study of Peshawar City, Khyber Pakhtunkhwa, Pakistan," Remote Sens. 2021, Vol. 13, Page 1864, vol. 13, no. 10, p. 1864, May 2021, doi: 10.3390/RS13101864.

[4] "Creating Resilient and Sustainable Communities in Pakistan after Climate Devastation - Commentaries." Accessed: Jun. 30, 2024. [Online]. Available: https://www.buildingsandcities.org/insights/commentaries/resilient-communities-pakistan.html

[5] "A case study of climate change adaptation governance in Peshawar Valley of Khyber Pakhtunkhwa, Pakistan | Request PDF." Accessed: Jun. 30, 2024. [Online]. Available: https://www.researchgate.net/publication/321398354_A_case_study_of_climate_change_adaptation_governance_in_Peshawar_Valley_of_Khyber_Pakhtunkhwa_Pakistan

[6] Kang, S., Moon, H., & Lee, J. (2022). Thematic analysis in qualitative research: A practical guide. Qualitative Research Journal, 22(1), 33-50.

[7] Dodman, D., Archer, D., & Satterthwaite, D. (2019). Addressing urban poverty and vulnerability in a changing climate. International Journal of Urban and Regional Research, 43(2), 227-246.

[8] Sharma, R., & Singh, P. (2018). The role of GIS in urban resilience planning: A case study of Peshawar. Geospatial World, 22(5), 90-102.

[9] Creswell, J. W., & Plano Clark, V. L. (2018). Designing and Conducting Mixed Methods Research (3rd ed.). SAGE Publications.