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“Sustainable Architectural Approaches For Reducing Vulnerability To Climate Change In Built Environments- A Cross- Sectional Study Of Institutional Management In Pakistan”

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ABSTRACT

The effects of climate change have been significant, causing disasters in various parts of the world. It is crucial to have a management framework in place to implement a climate-responsive action plan through architectural strategies. Identifying vulnerability and performing risk assessments are essential steps in developing sustainable governance that is risk-free. Architectural solutions that incorporate sustainable approaches can help address problems caused by rapidly changing climatic conditions in small and large-scale settlements, cities, and regions. Combining artificial intelligence and regional knowledge is a promising way to mitigate the challenges caused by climate change. Standardizing building design based on climate performance will help conserve energy. In Pakistan, there is a shortage of qualified technical professionals in the fields of architecture and town planning. The current number of professionals in both disciplines does not meet the country's needs, particularly in remote and underdeveloped rural areas where resilience is critical. The country faces unplanned urban expansion due to an imbalanced mechanism of resource sharing between urban, peripheral, and rural areas. This paper outlines a solution to reduce vulnerability and achieve resilience in human settlements to mitigate the effects of climate change.

KEY WORDS: Climate Change, Pakistan, Vulnerability, Resilient Architecture, Sustainability, Rural Settlements, Women Empowerment)

INTRODUCTION

The variations in climates of various parts of the World are referred as Climate Change. However, in modern era (C. 1900 onwards) it is understood as the changes in climatic conditions which occur as results of actions by humans such as consumption of non-renewable resources and not promoting decomposition/reuse of resources. The raise in global warming has also been a direct consequence of human activities (C. 1900 onwards). The increase in carbon emissions is unprecedented and is recorded as 413 parts per million (Year 2020) and is targeted to be returned to 350 ppm for stabilising the environment. (Pachauri, 2014)

With risky weather conditions there will be high rate of risks in the next decade. These risks include critical changes in Earth systems, biodiversity loss and depletion of natural resources. Collaborative and nature-based approaches are seen as way forward to combat the interlinked crisis of climate change in the world. After the year 2023 as hottest on record, a set of vigilant strategies is mandatory to avoid the rapidly decreasing reservoirs of energy resources that may result in imposing irremediable harms on societies and ecosystems. (Schuijt, 2024)

The World Economic Forum's Global Risks Report 2024 (WEF, 2024) the extremities in weather events and consequent changes in Earth systems have been emphasized as the world's top trepidations for the next decade. Strong policy making and public administration at all hierachal levels are decisive for extenuating these issues. Climate change impacts building designs, cities, and infrastructure, necessitating disassembly and re-use principles. The involvement of stakeholders from local communities is essential for achieving accuracy and sustainability at all stages of decision making for improving the built environment. (Clonadh Raleigh a b, 2007).

In the precise objective of this paper, it is imperative to mention that architectural solutions to deal with the rising ratio of environmental disasters which possibly hit the vulnerable sections of societies the most must be exercise. The foremost solution of designing buildings with lowest carbon emissions the other important dimensions are sustainable land use management, qualified services of architectural design / planning / retrofitting and post construction management be available to population living in remote, low-income and small cities in Pakistan. (Impacts of Climate Change, n.d.)

For climate resilience, buildings need to be designed for a given climate, rather than in spite of it. In Pakistan, the last 50 years have embraced modern construction practices. A proliferation of concrete, glass, steel and brick masonry structures in Pakistan reveal a climatic and cultural disconnect. (Khalid and Sunikka-Blank, 2018) In contrast, vernacular buildings often

show greater evidence of climate resilience than modernist practices and can provide useful learning for disaster-proofing buildings (Cruz-Ramírez, 2022). Contemporary climate-responsive design requires moving beyond a dichotomy of modernity and tradition towards integrated resilience.

Climate risks are natural phenomena that follow the weather cycle. We always have storms, droughts, wildfires, floods and high winds. However, we are now witnessing a new and terrifying scale of destruction and devastation. Last year alone saw a series of devastating climate disasters in many parts of the world such as Cyclone Idai, deadly heat waves in India, Pakistan and Europe, floods in South-East Asia. From Mozambique to Bangladesh, millions of people have lost their homes, livelihoods and loved ones to more frequent and dangerous extreme weather events. (Oxfam International)

Simply put, global climate change is exacerbating climate hazards and increasing the risk of extreme weather disasters. Rising air and water temperatures lead to rising sea levels, more intense storms, higher wind speeds, more intense and longer droughts and wildfire seasons, and more rainfall and flooding. The evidence is compelling and the results are devastating:

- The number of climate-related disasters has tripled in the past 30 years.
- From 2006 to 2016, the rate of global sea level rise was 2.5 times faster than during almost the entire 20th century.
- More than 20 million people are forced to leave their homes each year because of climate change.
- The United Nations Environment Program estimates that climate change adaptation and damage management will cost developing countries between \$140 billion and \$300 billion per year by 2030.

Extreme weather disasters affect all countries, rich and poor. But as we face a future of increased risks, it is essential to face the reality of who bears the brunt of climate change. Climate change is forcing people to leave their homes, worsening poverty. People in poor countries are at least four times more likely to be displaced by extreme weather than people in rich countries. The world faces a race against time to reduce emissions and help the most vulnerable cope with the climate impacts we are facing today and will only increase in the coming years. The time to act is right now. (Charles Perrings, Sustainability, growth and development, 2002)

Effects on the Socio-Economic situation of World and Future Threats

Disasters can cause direct and indirect losses, including deaths and damage to buildings, infrastructure, and natural resources. Indirect losses include reduced production or income, welfare effects, and disruptions in goods and services flow. However, the impact of disasters can be much greater, affecting long-term economic and social aspects such as education, health, productivity, and macroeconomics , as elaborated in Figure 1. Disasters can also bring benefits, such as increased demand for construction materials and expertise, leading to industry growth. (UNDRR)

In Pakistan, rising temperatures, erratic rainfall, and extreme weather events are causing increased stress on infrastructure, water resources, agriculture, and community resilience. Architects can mitigate climate change impacts by incorporating sustainable design principles, promoting energy-efficient structures, and adapting urban planning strategies. Circular architecture, focusing on sustainable materials and resource efficiency, contributes to climate resilience. Incorporating these principles into urban planning can enhance accessibility, reduce environmental impact, and create inclusive spaces, such as green roofs, efficient waste management systems, and universal design.

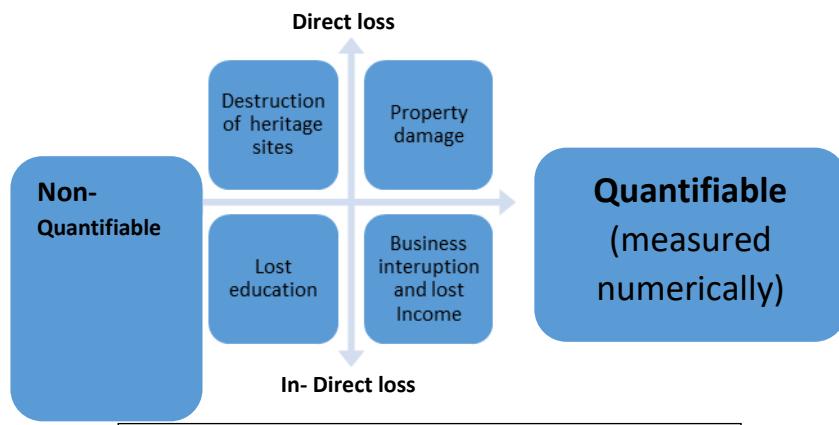


Figure 1 : Direct & Indirect Losses by Disasters

Effects of Climate Change in Pakistan

Pakistan is the sixth most populous country in the world and lies in a mostly arid and semi-arid geographic area prone to recurring large-scale floods, earthquakes, droughts and landslides. Natural disasters, which already disrupt livelihoods and the economy, are expected to increase in frequency and intensity with climate change. A trend of greenhouse gas emissions is shown in Figure 2 that corresponds to usage of non-renewable resources in the country and thus result in undesired climate change overall. Projected temperature increases are expected to be above global averages, negatively impacting agricultural production, water availability and human health. Sea level rise and saline intrusion threaten coastal infrastructure, agricultural lands and aquifers, and water scarcity is a major impediment to planned growth and development, and this is also expressed in data shown in figure 3 & 4.. In cities, peripheral regions, and rural settlements, vulnerability to climate change is evident

through increased exposure to extreme weather events, such as floods and heatwaves. These vulnerabilities exacerbate economic challenges by disrupting agricultural practices, affecting livelihoods, and straining local economies.

Greenhouse gas emissions by gas, Pakistan

Global greenhouse gas emissions by gas source, measured in tonnes of carbon dioxide equivalents (tCO₂e).
Gases are converted to their CO₂e values based on their global warming potential factors.

Our World
in Data

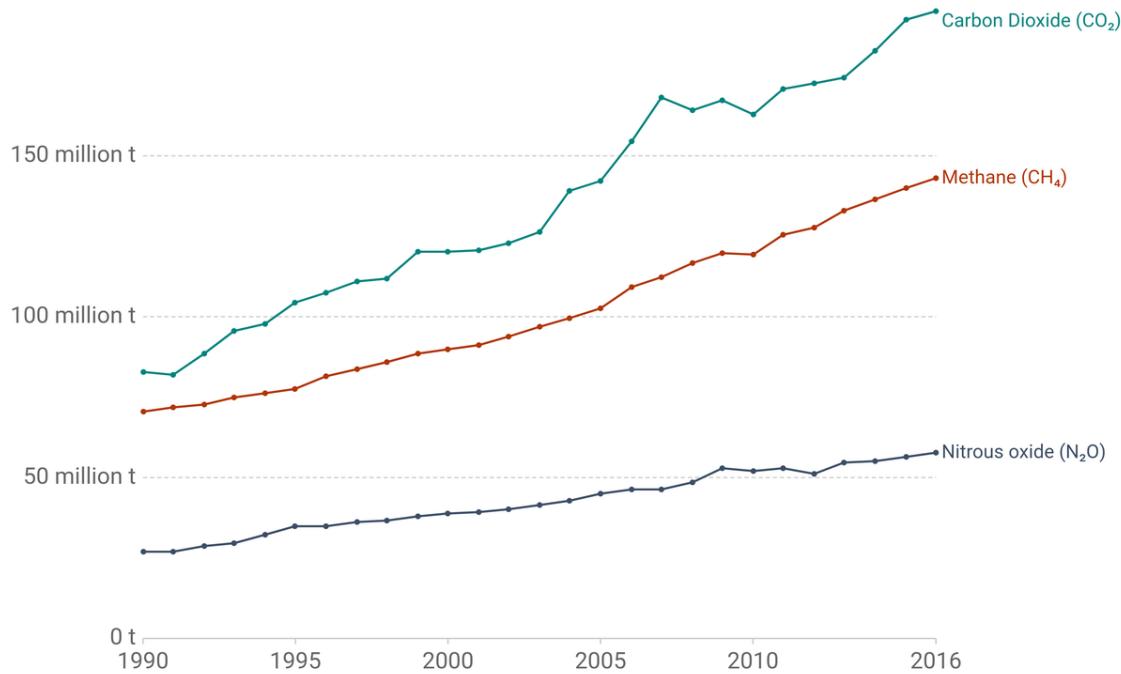


Figure 2 : GHG Emissions by GAS in Pakistan

Temperature change in Pakistan

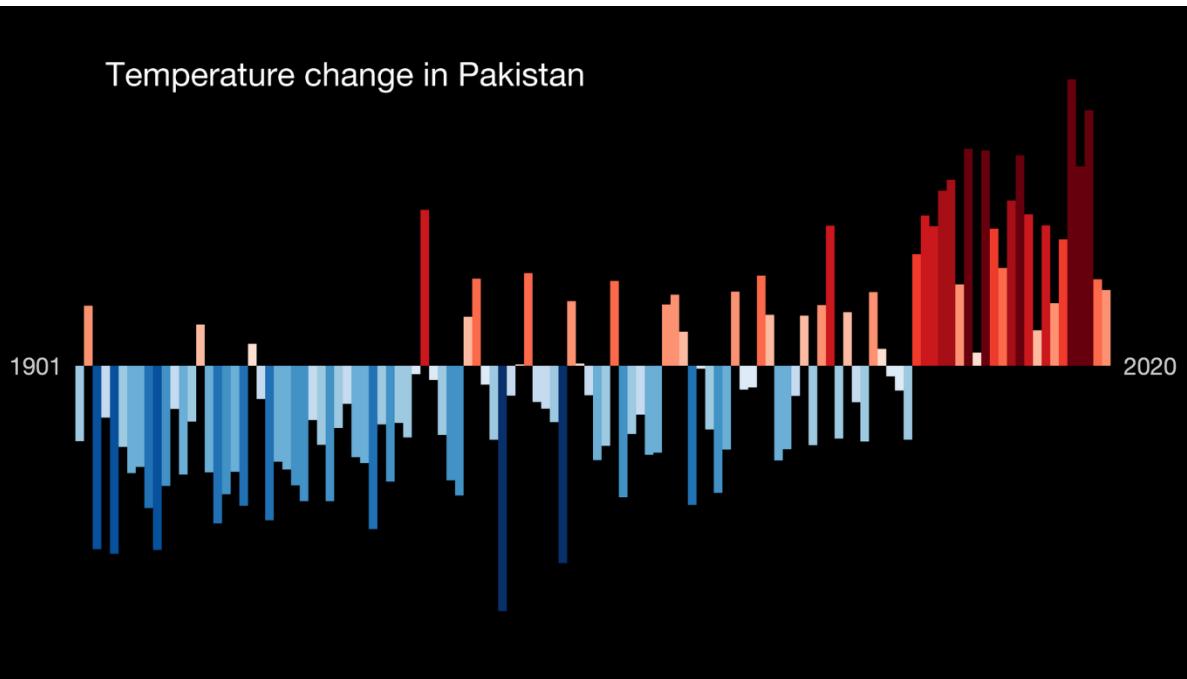


Figure 3 : Variation in Temperature in Pakistan

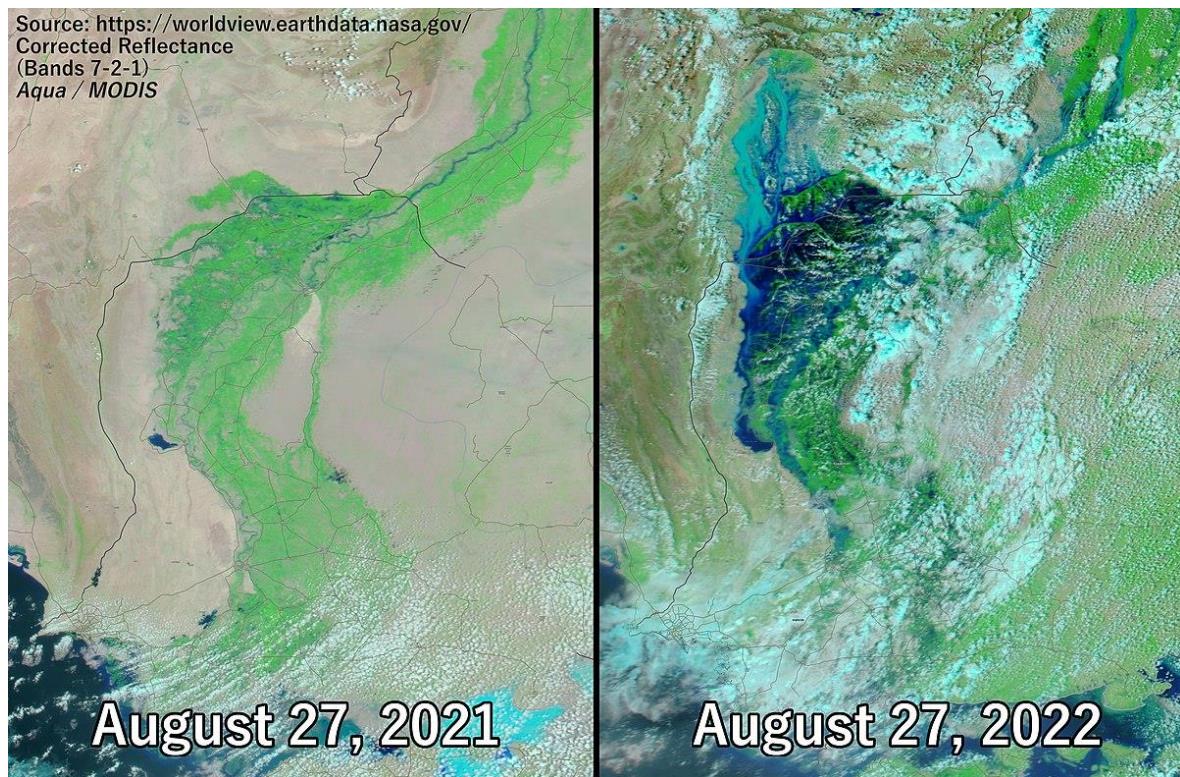
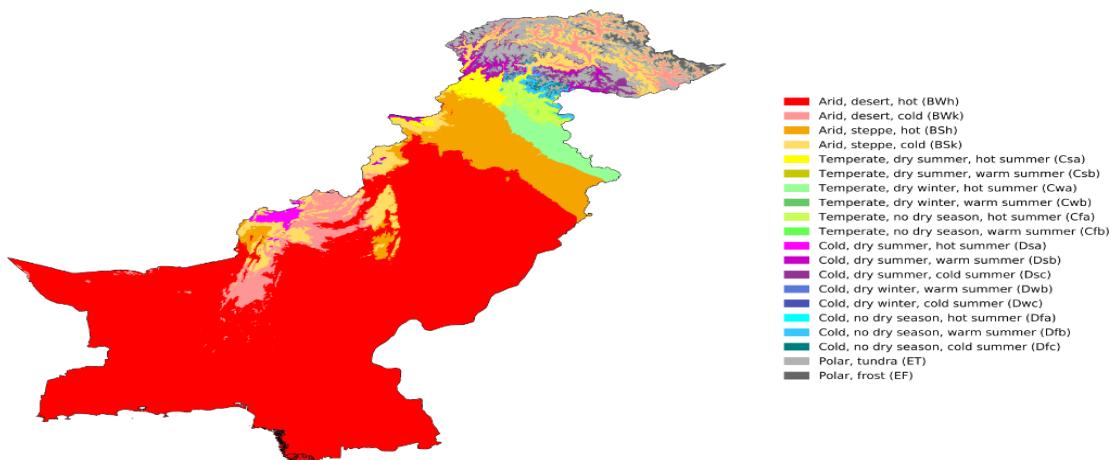


Figure 4 : Reflectance of Climatic Variations from 2021 to 2022 in Pakistan

Living standards vary across different areas in Pakistan; While cities often offer better access to amenities and job opportunities, peripheral regions may face challenges in infrastructure development. Small cities and rural areas, on the other hand, may experience limited access to essential services and employment opportunities, impacting overall living conditions. (Climate, 2013). The climate conditions of Pakistan in the past are shown in Figure 5

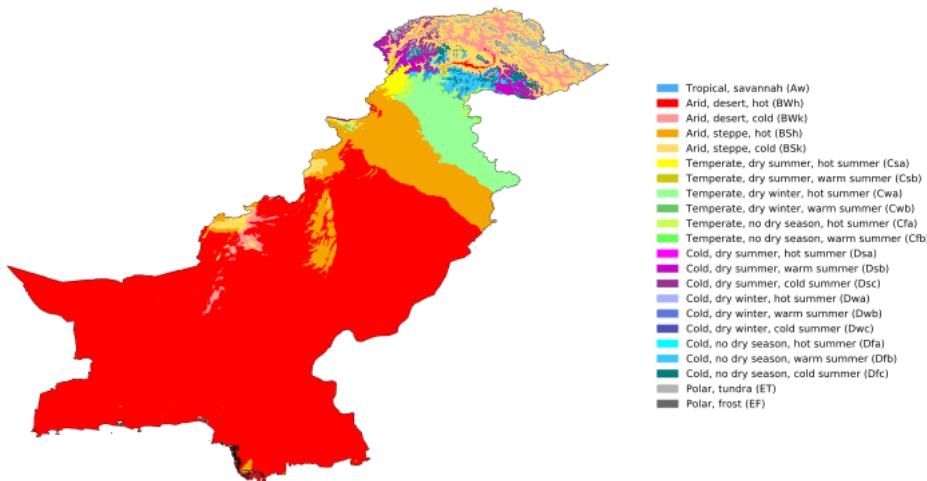
Köppen-Geiger climate classification map for Pakistan (1980-2016)



Source: Beck et al.: Present and future Köppen-Geiger climate classification maps at 1-km resolution, Scientific Data 5:180214, doi:10.1038/sdata.2018.214 (2018)

Figure 5 : Climate Conditions of Pakistan in the Past

Köppen-Geiger climate classification map for Pakistan (2071-2100)



Source: Beck et al.: Present and future Köppen-Geiger climate classification maps at 1-km resolution, *Scientific Data* 5:180214, doi:10.1038/sdata.2018.214 (2018)

Figure 6: Anticipated Climate Conditions of Pakistan

Built Environment & Lack of Architectural Solutions

The built environment, including buildings, infrastructure and public spaces, in Pakistan faces significant challenges due to inadequate architectural solutions. This lack of architectural solutions leads to issues like scarce urban planning and unsatisfactory infrastructure development consequential into deficiency of deliberation for climate resilience. This hinders sustainable development, increases vulnerability to environmental changes and therefore is followed by very minimal redressal to level of SDG index in Pakistan , as referred in Figure 7 A below.

Status of SDG targets for Pakistan (% trend indicators)

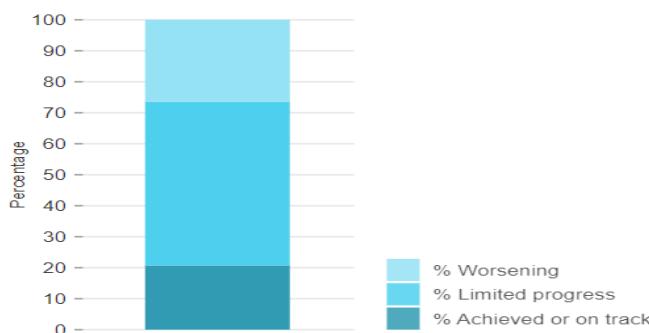


Figure 7 A : SDG Targets for Pakistan

In a report by Common Wealth Association of Architects , the presence of qualified Architects in Pakistan , the current strength of architects meets only6 % of the actual requirement in the country (Commonwealth Association 2021). Moreover there is a shortage of Higher Education institutions awarding relevant degrees in disciplines of Architecture, Construction Management , Advanced Tools for Architectural Design , Sustainable Architecture , Urban Designers , Building Scientists and Disaster Management Professionals . The architects with specialised knowledge and expertise for rural development exist in nill ; and same deficiency is reflected in the curriculums of Architectural education taught at undergraduate and post graduate levels . (Yasmeen Ahmed , 2021). The few examples of quality architectural design in terms of energy efficiency , sustainability and resilience is through private practice which predominantly deals with unitary architectural projects and a very minimal ratio of projects of regeneration or master planning of urban or rural settlements and therefore the performance of construction industry in preview of Sustainable development goals stays very subsidised as shown in figure 7 B

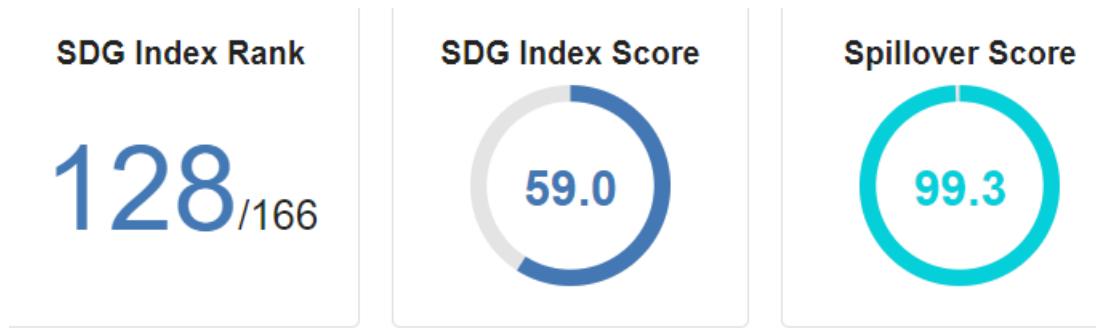


Figure 7 B : Status of Pakistan in achieving SDG Targets

The built environment in Pakistan faces challenges in disaster management particularly in vulnerable communities, and income disparities. Architectural management and adherence to local bye-laws in peripheral and suburban areas are crucial for improving living standards and fostering community well-being. The land use management in rural settlements exhibits absolute absence of standardised planning as there are no offices or even help desks to propose or guide any solution / service to daily life services related to construction, post construction and mechanical installations. This threat to built environment exists in communities where population faces a sharp downfall in economics , literacy and localised governance systems , (Yasmeen A. 2022). This situation becomes elevated when a natural / man made disaster hits the region and the complexity of below standard living condition becomes non -liveable at once. Henceforth, the planning of land use as well as Disaster Risk Reduction strategies should be utilised in these areas as regular terms of references for the local authorities responsible for architectural works.

RESEARCH METHODOLOGY

A combination of qualitative, quantitative and analytic data collection techniques, is employed to evaluate the efficacy of existing quality of management in urban and rural communities and; therefore, this research is aimed to propose design and management solutions. Drawing upon international, regional, and national best practices, the synergies for making built environment increasingly functional for inhabitants. The adoption of innovative construction materials, environmentally sustainable architectural practices, and privileging resilience rather than maximizing performance are going to be validated as solutions for regenerating cities.

The very critical areas of built environment of the country are peculiarly the ones where there is no availability of private practitioners belonging to disciplines of Architecture & Town Planning. Where there is an imperative need of all professionals to be working in coalition with the government at municipality, rural development, city planning, district and provincial headquarters neither the execution nor policy making in the government involves the required role of architects in dealing with procedures of infrastructural and urban/rural health of the communities. A broader connectivity of architects , urban designers , urban scientists with their potential participation for communities is explained in this paper ; and the study will also validate that the public health engineering and standardised architectural practices will not only uplift the quality of living environment but will also establish resilience in built environment for subsequent elimination of vulnerability of society in Pakistan. The objective will be attained through as the adopted research methodology shown in Figure 8 below:

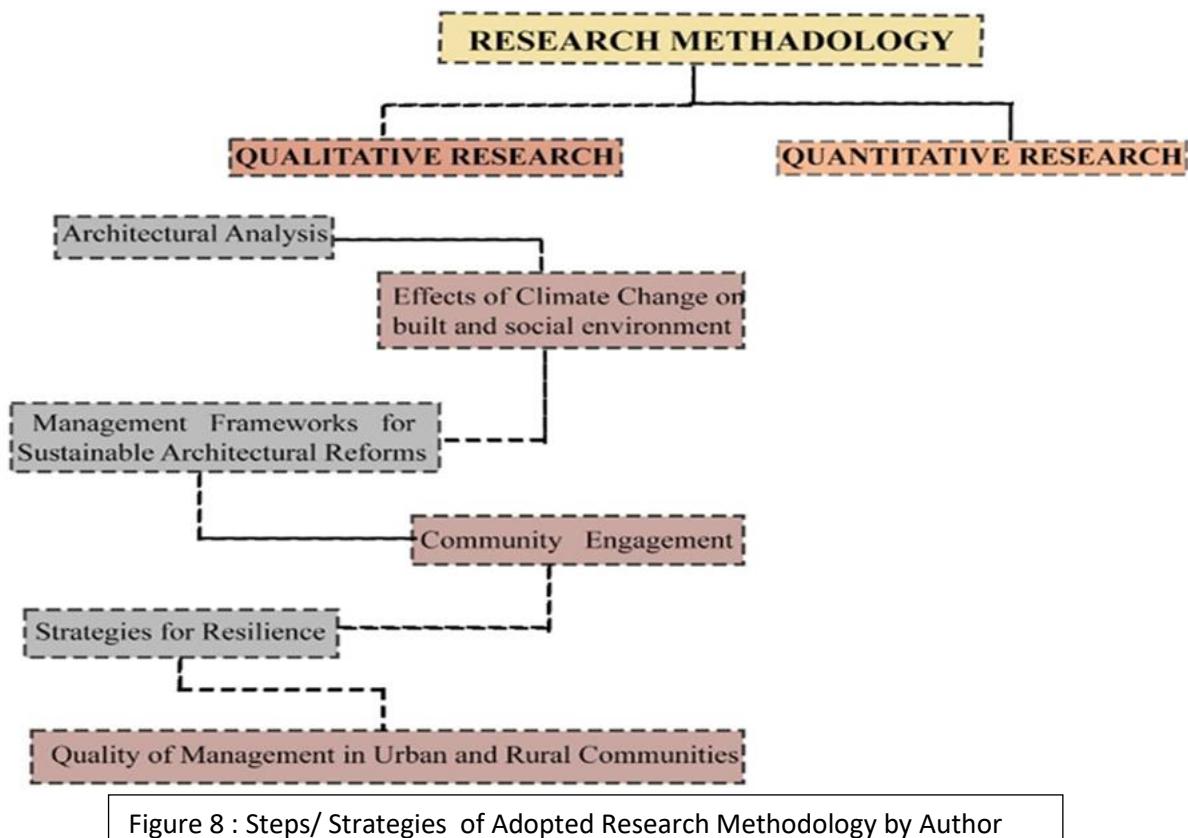


Figure 8 : Steps/ Strategies of Adopted Research Methodology by Author

The evident lack of pathways to achieve the Disaster Risk Management in architectural education leads to the understanding that the architectural practice has not been very dynamic in recovery and rehabilitation process of disaster hit communities and thus sustainability will remain an issue if the situation does not advance in curriculums. A list of success stories in chronological order where architects played significant role in evolving resilience has been given in Figure 9 below. In order to improve the standards of environmental safety and disaster management, the architectural design must behold clear cut responses to recovery and framework to reduce vulnerability of population, infrastructure, living species and by large buildings. (Yasmeen A. 2022)

The American Institute of Architects as an advocacy of architects has recommended that architects must coordinate and execute the architectural practice blended with local building authorities and emergency management agencies. In addition to this if the pre-disaster management will occur with involvement of community representatives then the need for temporary housing will reduce substantially. (Kelly, 1996).

CASE STUDY

Integrating Architecture into Disaster Management and Urban-Rural Planning in Muzaffargarh Pakistan

In the dynamic context of Pakistan, the integration of architecture into disaster management and urban and rural planning emerges as a key imperative. The country faces multifaceted challenges, from environmental hazards such as floods and earthquakes to complex issues of urbanization and rural development. In this complex context, the built environment plays a central role, shaping both vulnerability and resilience. This case study examines the comprehensive integration of architectural solutions at different administrative levels, focusing on the complex web of government, policy and community engagement. By exploring specific cases, such as Muzaffargarh, this study seeks to illustrate how thoughtful architectural interventions contribute to sustainable disaster management and promote resilience. urban-rural ecosystem in the context of Pakistan's diverse and growing challenges. Muzaffargarh, a district in southern Punjab, Pakistan, faces many environmental challenges, including frequent flooding due to its location along the Chenab River. The case study examines how architecture can be seamlessly integrated into management systems to address disasters, vulnerability and urban and rural planning in the specific context of Muzaffargarh. A list of basic complexities the community faces after flood hits is narrated in Figure 9

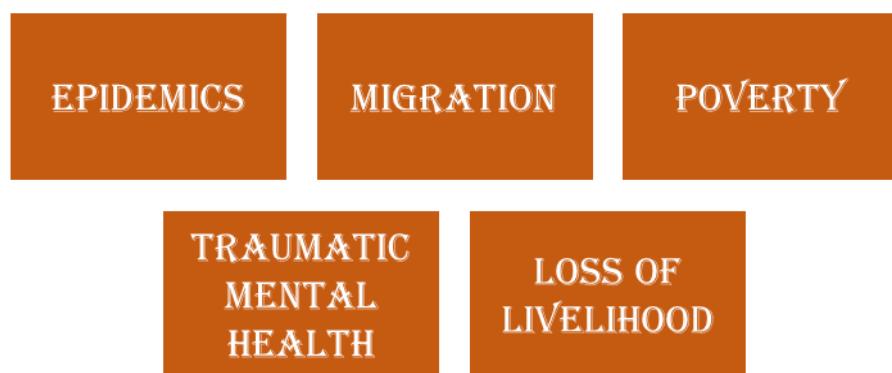


Figure 9: Effects of Flood on Community

Effects of Floods on Community



Figure 10 : Lessons from International Practices of Architectural Solutions for Resilience & Sustainability through Disaster Risk Management

Hierarchy of Disaster Management Framework in Pakistan

The country with a large number of population living in rural sector faces the most hazardous situations caused by various disasters in the villages. This is a standard occurring phenomena across all provinces of Pakistan. The floods and earthquakes as most pronounced disasters turn around the living conditions of the population in altogether social, psychological, financial and thus leaving long-term impacts ; therefore finally acquire rehabilitation and re-construction. The underlying poverty and low quality of provision of services takes the affected population even down the very basic accepted standards of living. It is pertinent to review the hierarchy of Disaster Management frameworks in the country, as shown in Figure 11 which is mobilised only to respond in extreme times of on-going disasters ; and not posing any substance for engineered pre-disaster and post-disaster planning / management.

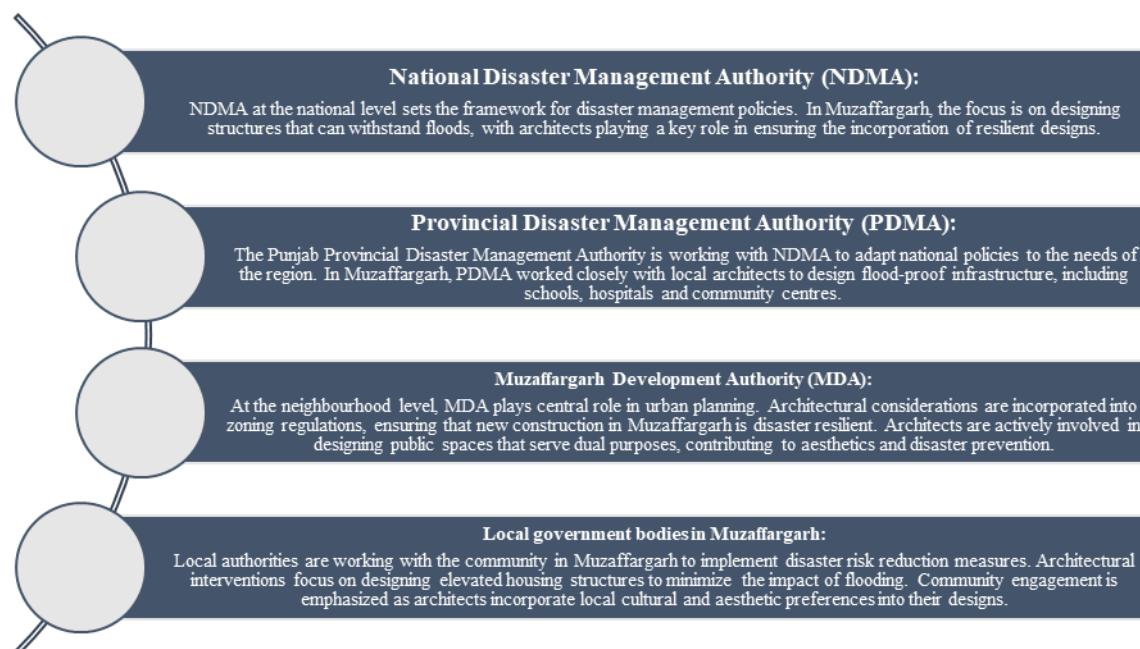


Figure 10: Order of Disaster Management Hierarchy for Muzaffargarh – Selected Case Study

Floods in Muzaffargarh District

Frequent floods pose challenges to rural communities and agricultural lands in Muzaffargarh. Vulnerability is due to poorly designed and constructed structures. To solve this problem, architectural solutions include the adoption of elevated housing designs to minimize the impact of flooding. Traditional architectural elements are integrated to ensure cultural relevance. Collaboration with local communities is prioritized, integrating indigenous knowledge into the design process. Implementation strategies include PDMA collaborating with local architects to develop flood-proof housing prototypes tailored to the specific context of Muzaffargarh. Community workshops and awareness campaigns promote adoption of new architectural designs. Capacity building programs are deployed to train local architects and builders in disaster-resilient construction measures. The results of these efforts include reducing vulnerability to flooding, improving living conditions through disaster-resilient housing, and strengthening community resilience through the integration of local knowledge and participation in the architectural design process. The case study highlights the importance of a tailored approach to disaster management and urban and rural planning in Muzaffargarh, showing how architecture can contribute to solutions sustainability to address the region's unique challenges.

Dra Ghazi Khan has been severely flooded, causing chaos and starvation among residents. Floods and heavy rains have caused panic in Muzaffargarh, particularly in Kot Addu and Jatoi territories, where river erosion has occurred. Over 500,000 acres of cotton have been damaged, causing difficulties for farmers and tenants who have to repay their debts. The district administration has yet to investigate the loss of crops and houses, and growers have demanded that the Punjab government declare the district a disaster zone. Deputy Commissioner Ali Annan Qamar announced that 300,000 acres of land were inundated and over 50,000 people had to be evacuated. The recovery process is expected to take a month. River erosion continues at Kot Addu/Head Taunsa dam, and authorities have mobilized teams to repair leaks in the groin dam.

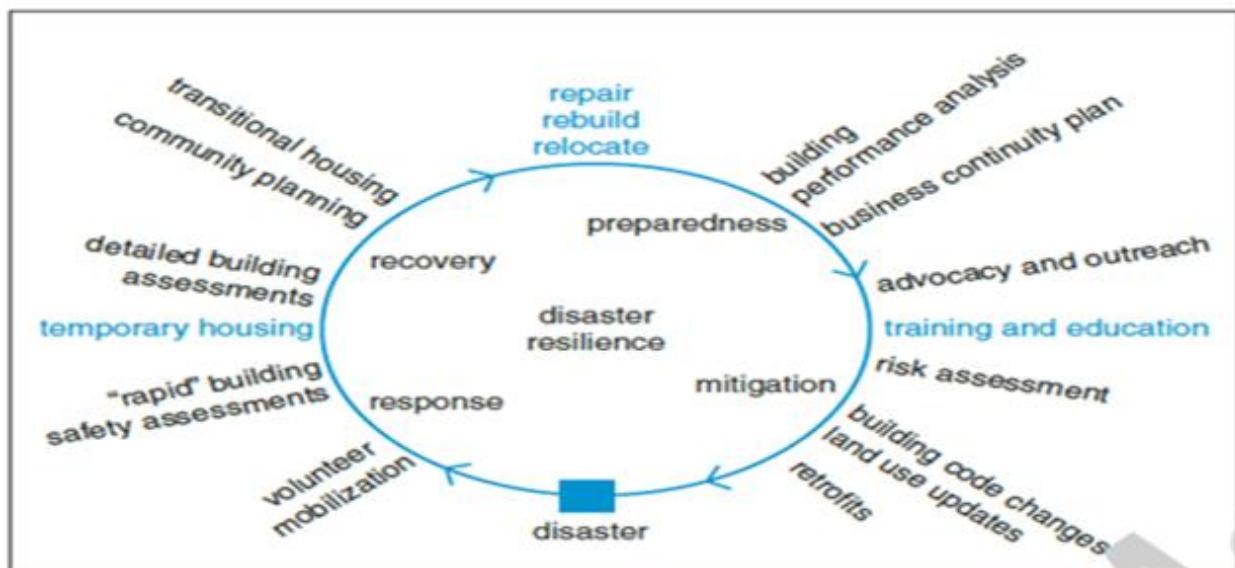
Comparison of the situations of architects and urban planners in Pakistan and the Philippines regarding disaster sustainability

Similarities	Differences
Natural Disaster Vulnerability: Both Pakistan and the Philippines are prone to natural disasters such as earthquakes, floods, typhoons, and landslides. This shared vulnerability necessitates a focus on disaster sustainability and resilience in the built environment.	Geographical Context: The specific types of natural disasters each country faces may vary due to their geographical locations. For example, the Philippines is more prone to typhoons and earthquakes, while Pakistan faces challenges such as floods and earthquakes.
Role of Architects and Urban Planners: In both countries, architects and urban planners play vital roles in designing and planning structures and communities that are resilient to natural disasters. They contribute to the development of sustainable infrastructure and urban spaces that can withstand or mitigate the impact of disasters.	Climatic Factors: The climate in each country is different, influencing architectural and urban planning considerations. For instance, considerations for climate-responsive designs in the Philippines might involve addressing tropical conditions, while in Pakistan, arid or semi-arid climates may impact design choices.
Government Regulations: Both countries likely have government regulations	Government Initiatives and Policies: The approaches taken by the respective governments in

and building codes that guide architects and urban planners in incorporating disaster-resilient designs into their projects. Compliance with these regulations is essential for ensuring the safety and sustainability of structures.	terms of disaster risk reduction and sustainable development may differ. Government initiatives, policies, and the level of implementation can impact the effectiveness of architects and urban planners in promoting disaster sustainability.
	Capacity and Resources: The capacity and resources available for disaster-related initiatives can vary between the two countries. This includes the availability of funds for implementing resilient designs, the capacity of professionals to integrate sustainable practices, and the accessibility of relevant training and education.
	Community Awareness and Engagement: The level of community awareness and engagement in disaster resilience efforts can differ. Architects and urban planners may need to tailor their approaches based on the community's understanding of disaster risks and their willingness to adopt sustainable practices.

SOLUTIONS

The incorporation of architects for formulating the building standards responding to localised requirements is an essential step to be taken by the government of Pakistan. In this line the first stage is the collaboration of Pakistan Council of Architects and Town Planners with all the stakeholder authorities / directorates and Ministries dealing with housing , planning & development , construction and rural development , referring to responsibilities of an architect as in Figure 12.



Role of Architects in Disaster Mitigation

Figure 12 : Scope of Architectural Practice in Resilience & Sustainability

The set of solutions as shown in Figure 13 A , B & C elaborates that the in the context of Pakistan where there are multiplicity of cultures , diversity of weather , variation in the finances and overall an unbalance in the resource sharing mechanism the ultimate goal should be to strengthen the local government through capacity building of the public sector organisations dealing with construction and planning industry. Revolutionising the policies with artificial intelligence and advanced calculations will be productive for demographics ; however the execution is very important through qualified technical persons in authorities such as Public Works Department , Communication & Works Department , Public Health Engineering Departments , Planning & Developments Department and all allied civil , environmental and development authorities through hiring architects on permanent roles ; and this strategic cycle of management will be effective as shown in Figure 10 A below :

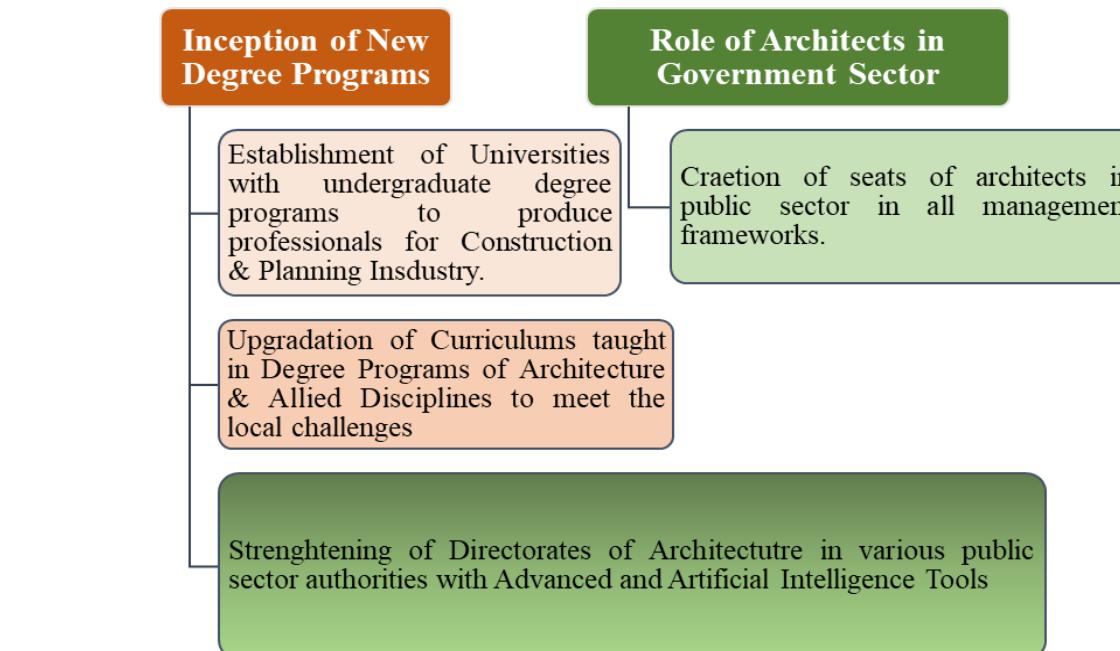


Figure 13 A : Cyclic Order of Long –Term Approaches for Sustainable Development & Resilience in Living Environment of Pakistan

Pakistan Council of Architects & Town Planners

The Pakistan Council of Architects and Town Planners Ordinance 1983 is authorised to establish the responsibilities of architects and town planners ; not only to give recognition to both the professions but also to ensure the practices being accomplished in the right objectivity of sustainability and responsive towards climatic and social requirements in Pakistan. The broad spectrum of powers of the Council covers important aspects of conduct of professionals to the engineered solutions for not only various types of construction but also public realm , environmental safety , sustainability and resilience . PCATP assures to assist the Government & National Institutions in solving challenges related to the professions, promotion of reforms in the professions, promotion of education of these professions, reviewing and advising the Government in the matter of Architecture and Town Planning education, etc. All these need based solutions as pragmatic approaches to resolve the deteriorating quality of environment in the country as well as promoting resilience in the socio-economic conditions of the society have been explained in cyclic forms in Figure 10 A , B & C

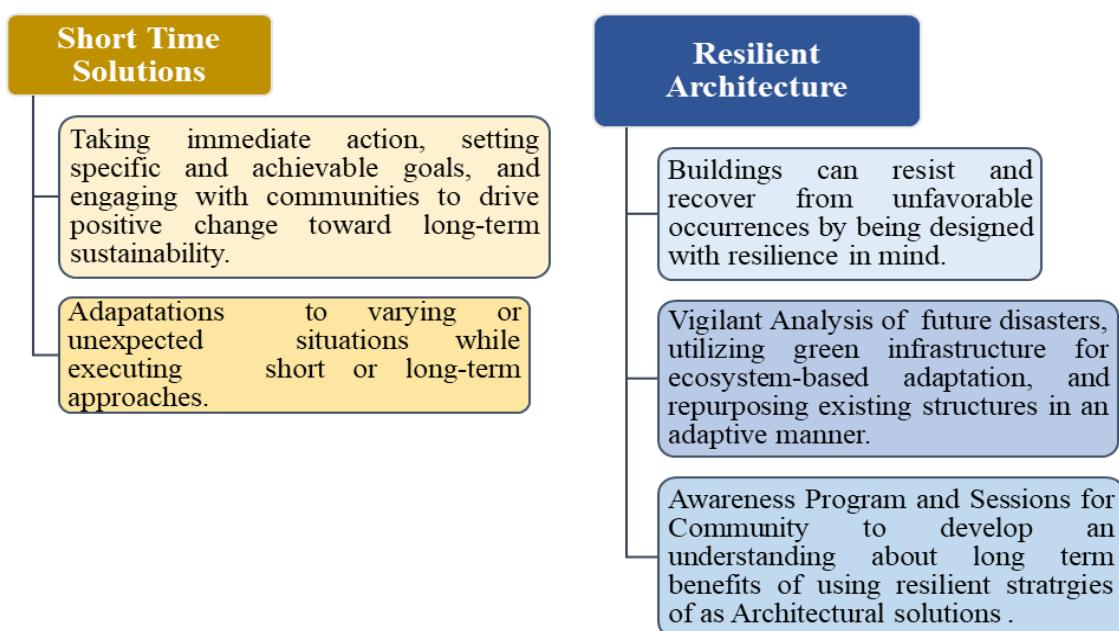


Figure 13 B: Solutions to achieve Sustainable Development Goals in Pakistan for better living environment

Sustainable Architectural Approaches for Reducing Vulnerability to Climate Change in Built Environments

The responsive architectural solution include Barefoot Social Architecture , as innovative and ethnic practice for affordable and environmental friendly Architecture – by Ar. Yasmeen Lari –Pakistan s first female architect – her prolific services of educating communities in the principle of Self- Help strongly empowered communities . She focussed on strengthening role of women in the disaster hit communities and made the most impactful mark in history of Architecture in Pakistan after being acknowledged with Royal Gold Medal by RIBA for her humanitarian Architecture. Public Housing Plans with Community Engageemnt in some of the cases of Punjab Housing & Town Planning Authority , Govt of Punjab is another good case study of establishing low income housing set ups for those who cannot afford to buy or make their own houses.

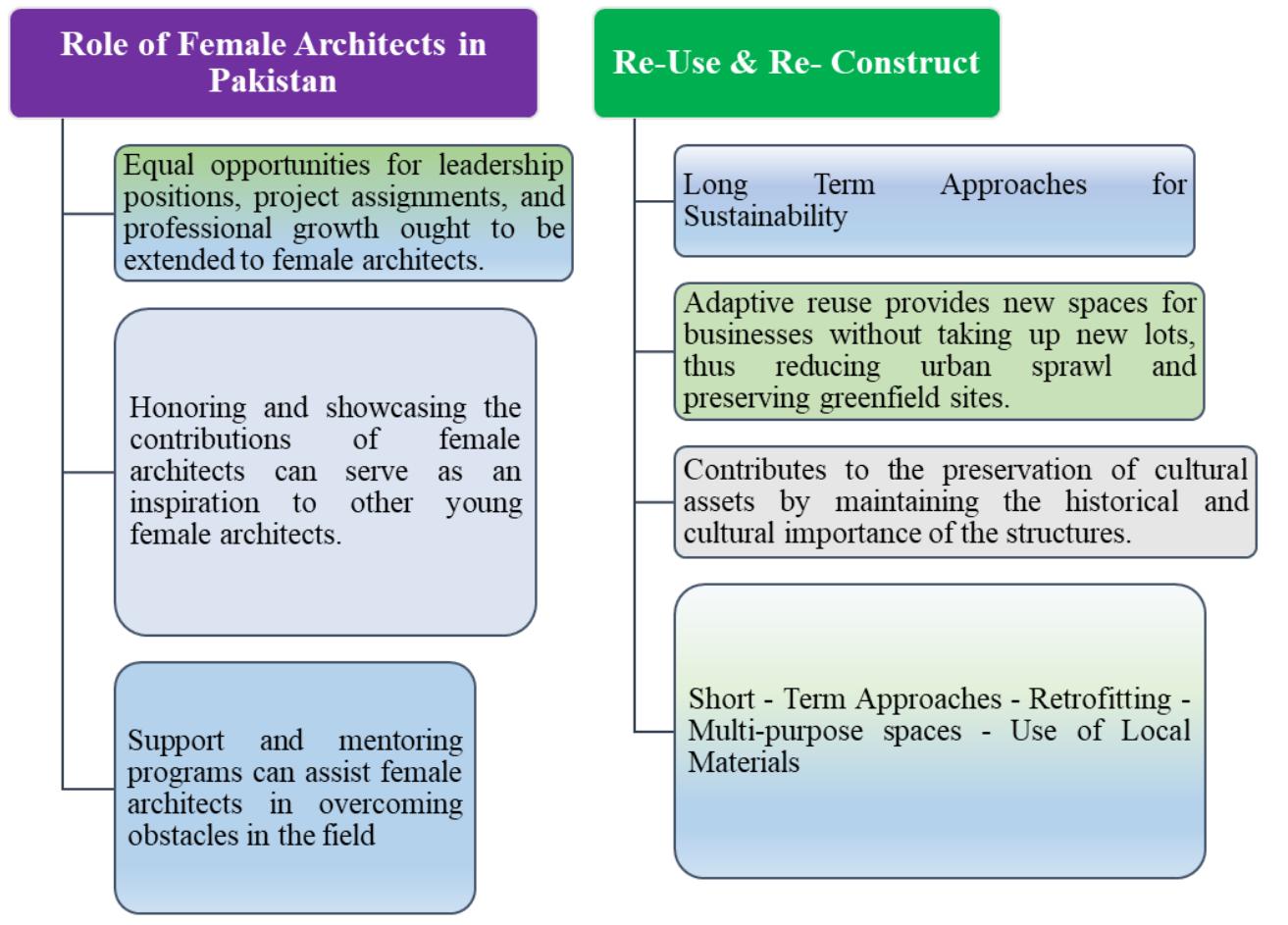


Figure 13 C : Solutions to achieve Sustainable Development Goals in Pakistan for better living environment

CONCLUSION

In conclusion, Pakistan is not an exception to the global trend of climate change making the earth more prone to disasters. It is essential to use sustainable architecture to lessen the effects of climate change. By employing energy-efficient design, sustainable materials, and sustainable building methods, architects can significantly contribute to lowering the carbon footprint of buildings. Combining artificial intelligence with local vernacularism can be a potential technological combination to lessen the increasingly severe challenges that any region is facing as a result of climate change. Building standardization according to climatic performance scales will preserve energy resources. But in Pakistan, there is a clear shortage of skilled technical workers in the fields of town planning and architecture. Resilience in the nation, particularly in isolated and impoverished rural communities, requires an urgent management response. Pakistan may foster economic growth and development by incorporating sustainability as a top priority in building design and construction, resulting in a cleaner, healthier, and more sustainable built environment. (Charles Perrings, 2000)

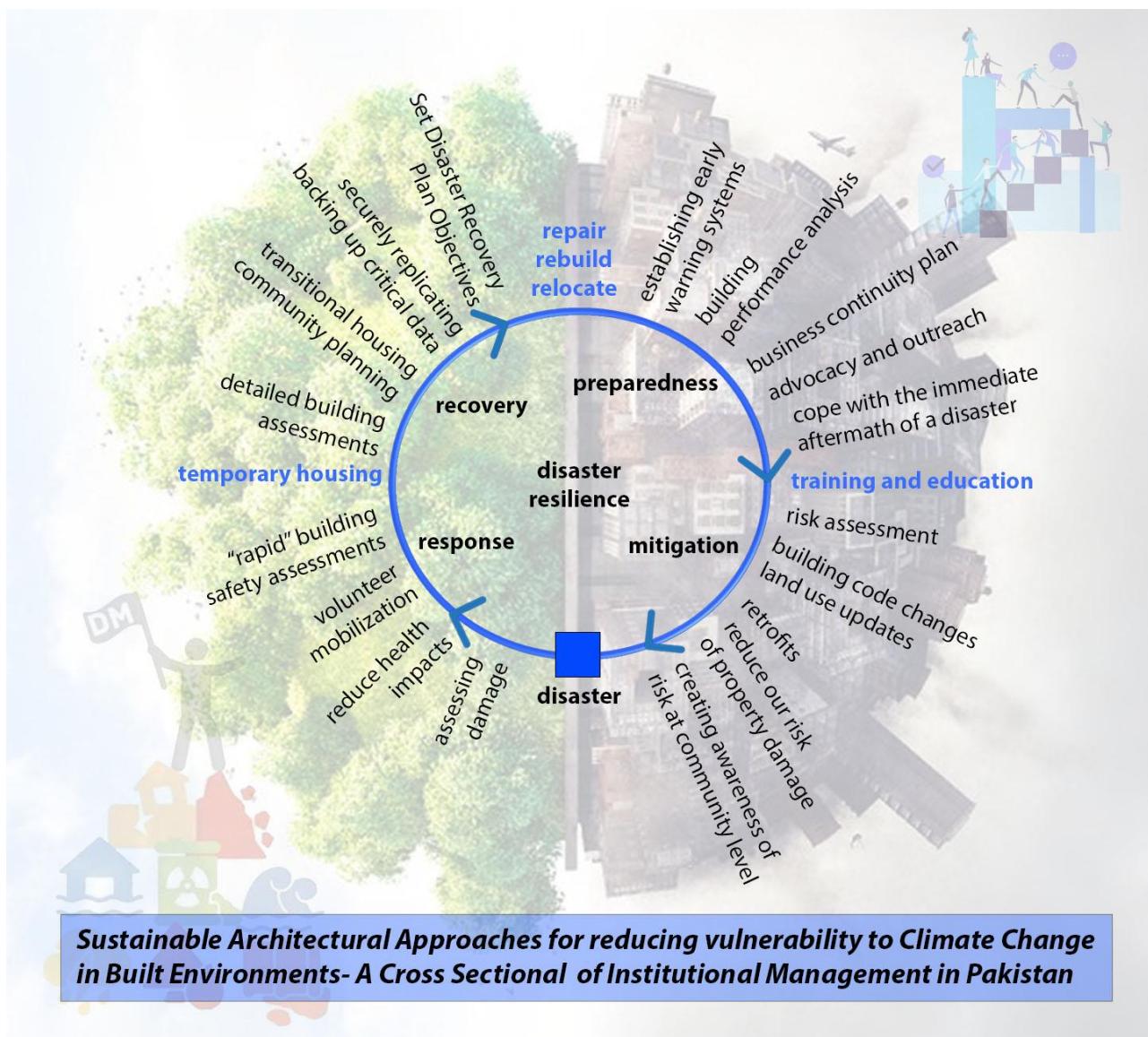


Figure 14 : Role of Architects for Resilience & Sustainability Source : Author

The utilization of renewable resources, Adaptive reuse of existing infrastructure, energy-efficient design, sustainable architecture, resilient architecture and the usage of green construction materials must all be given top priority. (Fisher-Gewirtzman*) Pakistan may reduce the effects of climate change, encourage resource efficiency as well as sustainable solution in young graduates to create a built environment that is healthier and more robust by adopting sustainable architectural principles.

The trends of architectural practice in good objectivity of facilitating the humble income groups of society are elevated in female architects as per recent surveys. (Report by Pakistan Council of Architects & Town Planners 2023). As per survey of PCATP , 65 % of registered architects and paid up members are females out of the total membership of architects in Council. This number of female architects is directly proportional to their involvement in public sector roles . The faculty members in majority of the Institutes offering Architectural education are females and similarly the public sector directorates reflect a large number of female architects at various positions. He strength of female architects. Lahore College for Women University (LCWU) alumni and architects are significantly advancing in the discipline of architecture. They have established a strong presence in the public sector by securing employment opportunities in a variety of ministries and departments at the local, provincial, and federal levels. Moreover, Alumni of Architecture Department at LCWU have achieved success in securing positions as architects and scholars around the country, demonstrating their influence on the field and education. To conclude the role of architects and pertinently female architects in the country needs to be strengthened with capacity building of offices , authorities , managements , ministries and national level agencies to combat disastrous effects of climate in long term and short term mechanisms. .

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