Natural Disaster Resilience and Resource Depletion: Bamboo Construction in Eco Villages, Pakistan

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When developing disaster relief mitigation and response strategies, it is not often that the Westernized world looks towards the impoverished as pioneers in resilience and ‘green’ innovation. However, embarking on ten days volunteering in Pakistan’s Sindh rural regions, it is the varied applications of zero carbon materials and consequent community resilience which became a key takeaway. Emphasizing the process by which humane, resistant, and zero-carbon buildings might actually be achieved and sustained in the long-term, rather than individually importing externally engineered solutions, could signal a path forward towards greater global climate resilience. Thus, I will follow a focused investigation based on primary data from two villages, PONO Colony and Kewal Kohli, considering Dr Yasmeen Lari’s ‘four zeros’ methodology to achieving sustainable and inclusive spatial development: ‘zero carbon, zero waste, zero cost, leading to zero poverty.’ Lari is the pioneering humanitarian architect responsible for the Heritage Foundation of Pakistan, which currently sustains the implementation of new approaches to disaster relief and mitigation I was involved in and was thus central to my experience and perspective. The grassroots model I will be overviewing concerns her ‘Zero Donor Villages’, which were developed in place of the increasingly unsustainable ‘international colonial charity model’ conventionally applied to developing countries, and widespread in response to the devastating 2005 Kashmir earthquake and 2022 monsoonal floods and landslides. Although this is a specific investigation concerning developing rural communities, the overarching relevance of zero-carbon, co-creation approaches to climate resilience is significant in a contemporary climate of increasingly frequent natural disaster induced humanitarian crises. As we face a global turning point in climate action the disastrous consequences felt by Pakistan were echoed at COP27 by Spain and Nigeria, fellow nations most impacted by climate change in the form of drought, rising temperatures and violent floods, respectively. I approach my analysis through the perspective of zero-carbon materiality and successful local-resource urbanisation, with the aim of understanding the efficacy of ‘barefoot social architecture’ in action: community self-empowerment and education-oriented initiatives for longer-lasting resistance in developing areas.

Discourse will begin through a consideration of Lari’s flood resistant housing designs and their direct impact on rural communities’ climate vulnerability as the core basis of her grassroots model. Here, a bamboo frame, raised 0.5 metres off the ground on a compacted earth base is easily pre-produced in flat panels, rendered in earth and lime, and protected from above with traditionally thatched roofing. The ‘Women’s Centre’ in PONO Village similarly adapts local housing typologies through materiality, form, and roofing—raised on stilts for flood avoidance. An informal shaded open-air space is created on the raised ground floor in addition to an enclosed room and balcony space on the first floor. Macha structures—small scale, open-air, roofed platforms raised circa three metres from the ground—allow for continuation of daily tasks in dry safety regardless of flooding below. Importantly, developed as a

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response to the thirty-three million displaced persons from the 2022 flooding disasters, the structures aim to reduce immediate dislocation, allowing life to continue as normal during flooding. Through qualitative interviews with nearby villagers, it was established that residents had previously had to move onto the road where they lived for two months until the water receded. The inherent functional advantages of Lari’s adapted vernacular designs for increased flood resilience successfully reduce post-disaster recovery timescales by decreasing vulnerability to flooding effects in the first place.

Figure 1: Hand-Painted Houses in PONO Eco Village Following Dr Yasmeen Lari’s Vernacular-Based Flood Resistant Designs.

The achievement of a virtual ‘zero-cost’ rebound from natural disasters is a further key advantage of local material sourcing. At a period where we face external donor fatigue in parallel with intense climate breakdown, the ability to maintain substantial resilience despite minimal external funding is necessary in developing economies. Local material-use decreases transport and manufacturing labour time, emissions-related and economic costs, as well as contributing to the wider motion towards ceasing resource depletion. Importantly, longer term ‘zero-cost’ also extends to physical external aid, such that the Pakistani villages’ resilience is increased by local material sourcing due to the opportunities this proximity provides for the communities’ autonomy and self-education. During our stay, the ‘women’s centre’ acted as a central community hub within the urban fabric where the primary socialising, education, knowledge sharing and skill developing activities took place. Capitalising on its pioneering role, its industry specialty has now become one of education, where the residents of the eco-village are able to earn a living through teaching skills to other villages whose specialties may comprise fishing, agriculture, or bamboo. In aid of self-sufficiency, specialised construction techniques in Lari’s designs are used where there is already local familiarity, such as the fish mouth, hole, and angle bamboo joints. The
simplicity and vernacular outline increase efficiency and quality in production by maximising skills that can be readily taught. Locals’ empowerment consequently results in community’s added security in the knowledge that they can reconstruct their home with, ‘their own hands’ after potential future natural disasters, without substantial external aid implementing unfamiliar recovery measures.

Figure 2: Women’s Centre in PONO Eco Village as Seen from the Ground, Alongside a Prototype Floating Teahouse Structure.

Figure 3: Bamboo Structural System under the Women’s Centre in PONO Eco Village.
The importance of materiality as a resilience factor was further understood through the primary project we undertook as volunteers. An architectural brief was set to design and construct a floating public teahouse and home, both of bamboo. This signals towards a potential future direction for domestic flood resilience, where displacement at any flood severity could be avoided, without a water level limit for disaster relief as is currently present in static raised bases, for standstill water. The challenge in the case of PONO Colony was the duality of designing a base able to float stably with a dry pocket margin above the water level, without drifting with currents which would lead to potential damage when lowered onto uneven ground, whilst remaining practical in its un-floating state standing on dry land. Proposed structures constituted a ‘base’ floating mechanism based on recycled bottles, others made use of the naturally formed bamboo drums to increase surface area and exploit rising water buoyancy, whereas some focused on the form of the inhabited structure itself and mitigation through adaptations to its form during a flood disaster. Upon critical reflection, it could be argued that development of the design proposals prior to arrival and learning of local techniques or vernacular goes against core principles of designing to fit the context, instead introducing an external substance, and enforcing contextual adherence. However, I would argue that the undertaking of the process from conceptualisation to constructed completion revealed the practical onsite and experiential consequences of this same fact, serving as a valuable educational opportunity. As the initial challenge was added to by limitations in material availability and time, a combination of proposals was voted upon by locals, and consequently followed by live form experimentation and alterations to fit resource parameters and site context.

Following the smaller fishing village case study of Kewal Kohli expands the discourse on increased resilience from local materials and knowledge-sharing to the possibility of scaling up flood resistance and improving living standards on a provincial, even nationwide level through cross-community co-operation. The settlement, built following the 2022 floods and currently unseen on digital satellite imagery, was analysed in comparison to nearby villages. Primary quantitative and qualitative data collection constituted measuring infrastructural dimensions, urban spatial layout and land topography through photography and diagrams. Live translated interviews with the local population were also carried out regarding post-disaster recovery and perceived protection. With an established local understanding of water and drainage, Kewal Kohli’s settlement plan is uniquely structured around clusters of circa five homes placed on raised ‘compounds’, upon which shared, raised cooking, cleaning, and dining areas are also found—allowing for the continuation of daily life patterns where otherwise even comparatively minimal flood levels would devastate living spaces. The ground level in between, used only for cattle storage, acts as drainage pathways to further encourage the natural ground flow towards the lakes and out of the village. Additionally, a dug channel leads to a nearby canal to further drain water levels. In presentations to leaders of other villages, it is this specialised knowledge that was passed on to settlements with similar parameters but less specialised understanding of the same drainage principles. However, inter-settlement advice was multidirectional, as despite drainage efficiency, where this village made use of twig and reed barriers for mitigating violent flood penetration, another implements a more effective bamboo plastered with mud and lime boundary defence line. By combining the most effective features from multiple villages, we aided in realising steps towards larger scale regional urban resilience, through the sharing of knowledge and expertise between different communities themselves, rather than only drawing from one source for inspiration.
It is notable that sustainability, through using local zero-carbon materials is inbuilt into the rural village’s cultures, as can be seen through the practical applications of their crafts. As part of the volunteering programme in Pono village, locals, particularly the women, generously shared their expertise in local crafts: Ralli stitching—a handmade Sindhi quilt of scrap fabrics and bold patterns—local clay pottery, reed matting, natural paint mixing, and Chulah decorating. The revolutionary Chulah is an example of zero carbon design itself, constructed with compacted earth and decorated with natural dye paints mixed with lime. Introduced by Lari to replace dangerous open flames in homes, it is an open air stove whose introduction brought a major improvement for quality of life for women. Chulah decorating amongst locals revealed the importance placed on creating art as an expression of local pride. Locals shared their hand painted home interiors, custom technicolour exteriors and displayed an unrivalled generosity in gifts of their brightly patterned textiles, forming an additional case for the importance of community pride as a major driver in resilience from a sociological perspective, through morale, hope and mutual support. Thus, it was involvement in smaller scale elements of the village life which ultimately served to bring both sides of existing grassroots discourse: that of materiality and community involvement, together to understand the extent of the community’s natural disaster resilience and ensuring its future resilience.
Resource resilience is driven by local sourcing of vernacular materials—namely, bamboo—and by reducing transportation and production costs and emissions. Vernacular materials also allow for Lari’s ‘barefoot social architecture’ model to be established, as it is due to the familiar materiality that existing traditional expertise can be built upon, driving construction efficiency and innovation. The solution to maximising resilience is not designed in isolation, but rather finds its basis on increasing the safety and strength measures of adapted traditional techniques, often already familiar to locals. I briefly outlined wider implications of the village’s specific bamboo materiality, as an upcoming global zero-carbon material with great structural potential. Shifting attention towards communities where its use in the vernacular is successful and widespread could serve as a starting point in material investigation, potential or contextual knowledge. However, I would argue that the greatest impact this material has on overall resilience, albeit a more abstract observation, is the implications on the community’s social resilience. Community empowerment was evident in both Pono Village and Kewal Kohli at all scales of locals’ daily life. Within villages, widespread use of zero-carbon Chulah stoves establishes sustainability and materiality as central to their culture, but it is their decoration and expression of art which signals pride and drive to innovate and construct more. On a larger scale, data collection from neighbouring villages demonstrates the ‘regional’ stage ‘barefoot social architecture’ finds itself in, and its consequent accelerating pace in knowledge-sharing between communities. Hence, it is the community’s self-empowerment, self-education and knowledge-sharing encouraged by the Heritage Foundation and bamboo material familiarity which will be most important for these communities to establish greater resilience moving forwards.