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Impact of Disasters in Shaping the Vernacular Architecture of Coastal Area

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Abstract—Coastal regions are highly vulnerable to a range of disasters, such as hurricanes, storm surges, and tsunamis. Unfortunately, the increasing sea levels caused by climate change only serve to worsen these risks, resulting in more frequent flooding and erosion. These disasters not only pose a significant threat to human settlements, ecosystems, and infrastructure along the coastlines, but also highlight the urgent need for proactive measures to ensure resilience and adaptation. One approach that has shown promise in creating a climate-resilient built environment is vernacular architecture, which is the practice of local communities using locally sourced materials. Through years of experience and attempts to mitigate against disasters, vernacular architecture has evolved to incorporate specific construction techniques and architectural features that are better equipped to withstand such events. In this article, we explored how disasters have influenced the development of vernacular architecture in coastal settlements, focusing on three case studies from countries surrounding the western ring of the Bay of Bengal like Sinhalese jungle huts in Northern Sri Lanka, Odisha in India, and Bangladesh. To understand the impact of disasters on building design, we have selected five key features for investigation such as building form and shape, angle of the roof, roof materials, overhang length, and wall protection techniques. Through our research, we have observed that certain design elements are directly related to the intensity of disasters. For example, regions with lower rainfall, such as Odisha, exhibit shorter overhang lengths (0.35-0.4 meters) compared to areas like Sinhalese and coastal Bangladesh, where overhang lengths range from 0.45-0.6 meters [3–6]. Additionally, the choice of materials is influenced by both local availability and the impact of disasters. Thatch and bamboo, for instance, are commonly used as roofing materials in coastal areas of Bangladesh, while Sinhalese utilizes coconut thatch, dried coconut leaves, bamboo, or mud bindings. These interrelationships between design features and disasters in vernacular architecture have led us to examine the guidelines provided by the United Nations Development Programme (UNDP). Remarkably, Odisha has fully embraced these guidelines, resulting in a significant reduction in cyclone-related damages over the years. By conducting a comparative assessment of disaster intensity, design features and techniques, and the UNDP guidelines, our study provides valuable insights for future architects and policymakers working on built-environment projects in coastal areas. In conclusion, the vulnerability of coastal areas to disasters necessitates the adoption of proactive measures for resilience and adaptation. Vernacular architecture, with its focus on locally sourced materials and evolved construction techniques, has proven to be an effective approach. By understanding the interplay between design features, disasters, and international guidelines, architects and policymakers can create more resilient built environments in coastal regions.

Keywords: Natural disaster, Costal area, Cyclone, Resilient built environment, Vernacular architecture.

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INTRODUCTION

Coastal regions stand at the forefront of vulnerability when it comes to a diverse array of calamities, ranging from the ferocity of hurricanes to the relentless onslaught of storm surges and tsunamis. Regretfully, the inexorable rise in sea levels, attributable to the unwavering grip of climate change, only serves to amplify these risks, perpetuating a cycle of more frequent flooding and erosion. The devastating consequences of these disasters extend far beyond the mere threat they pose to human settlements, ecosystems, and the very infrastructure lining our coastlines. Rather, they serve as a rallying cry, demanding the immediate implementation of proactive measures that ensure unwavering resilience and adaptability in the face of adversity. In this pursuit, the concept of vernacular architecture emerges as a beacon of hope, a promising approach to forging a built environment that can withstand the test of time and nature's wrath. Through the utilization of locally sourced materials and the wisdom gained from countless experiences, vernacular architecture has metamorphosed into a formidable force, boasting construction techniques and architectural features specifically engineered to defy the ravages of disaster.

The existing body of literature addressing vernacular architecture in response to frequent rainfall, severe floods, and landslides has predominantly centred around analyses in Mediterranean cities (Aktürk and Fluck 2022; Fernandes *et al.,* 2014; Al Tawayha, Braganca, and Mateus 2019). However, these studies often present generalized findings or concentrate on broader geographical regions, thereby overlooking the nuanced architectural responses observed in coastal settlements within the specific area surrounding the western ring of the Bay of Bengal. Despite a wealth of literature on disaster-resilient vernacular architecture (Sehbasaleem 2019; UNO and HORIKOSHI 2000) and its connection to environmental factors in building design, there is a noticeable absence of comprehensive analyses specifically delving into the unique architectural developments found in Sinhalese jungle huts in Northern Sri Lanka, houses in Odisha, India, and coastal houses in Bangladesh. Our study, motivated by this research gap, seeks to provide a targeted exploration into how disasters have influenced the evolution of vernacular architecture in these specific coastal settlements.

The next section delves into the methodology adopted for this research. How architectural features of vernacular buildings in our study areas varies to cope with heavy rainfall and flooding is discussed in section 3. This section is concluded with comparative assessment and discussion. Next, we investigated the impact of cyclone and floods on the architectural features through the lens of standards and guidelines. Finally, this article is concluded with discussion of future research scope.

METHODOLOGY

This article aims to explore the impact of heavy rainfall and flood in shaping the vernacular architecture of coastal area. In this context, the coastal areas around Bay of Bengal is focused as this sub-basin is the most active and produces some of the deadliest cyclones of all time (Encyclopedia Britannica 2024; Wahiduzzaman *et al.* 2022). The most intense cyclone in the bay was the 1999 Odisha cyclone. The Bay of Bengal's coast is shared among India, Bangladesh, Mynamar, Sri Lanka and western coast of Thailand. This research is limited to investigation of three areas like Sinhalese jungle huts in Northern Sri Lanka, Odisha in India, and Bangladesh represented in Figure 1 (a).

Furthermore, in order to thoroughly examine the effects of heavy rainfall on architectural design, it is crucial to carefully select various architectural features. The impact of heavy rainfall, coupled with flooding, can greatly affect the exterior of buildings and the materials used for roofs. Therefore, it is imperative to focus on wall protection from heavy rainfall. Additionally, the shape of the roof plays a vital role in facilitating smooth waterflow. In certain regions, heavy rainfall can even lead to disastrous floods, making it essential to prevent water from entering the interior space of buildings. This is where the plinth height comes into play. Consequently, a comprehensive investigation will be conducted on roofing materials and angles, innovative wall protection methodologies, plinth protection, and other elements that contribute to the overall resilience of structures in the face of these specific natural calamities.

Finally, in order to gain a comprehensive understanding of the similarities and differences among existing standards, guidelines and vernacular buildings, a thorough review was conducted. By comparing these features with established standards and guidelines, it became possible to determine whether vernacular buildings adhering to these guidelines are better equipped to withstand disasters. Ultimately, the findings of this study will provide invaluable guidelines for future architects, informing them whether modifications to existing guidelines are necessary and what aspects should be prioritized for new designs in the western ring of the Bay of Bengal coastal region. The flow chart represented in Figure 1 (b) would help readers for process of this research.

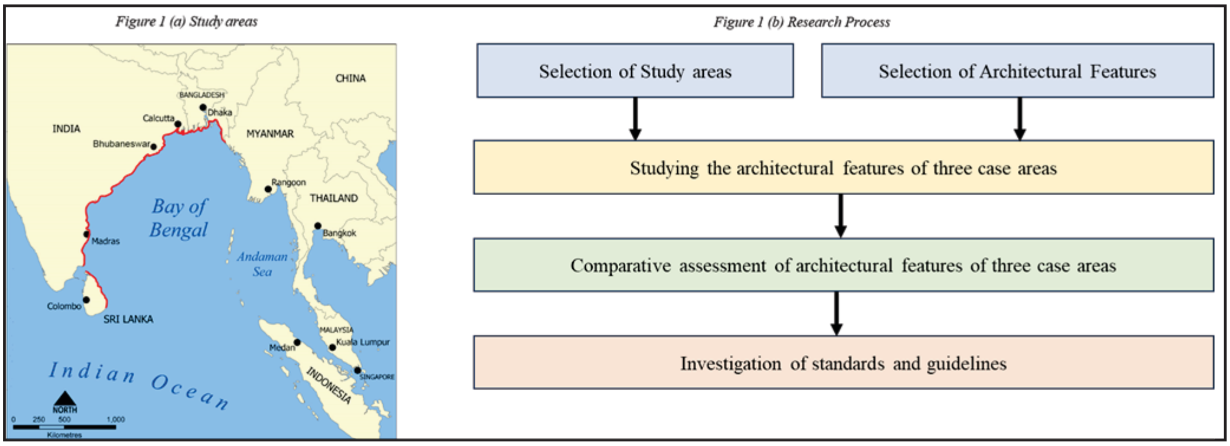

Fig. 1: Methodology

INVESTIGATION OF ARCHITECTURAL FEATURES IN RESPONSE TO CYCLONE AND FLOODS

This section is divided into two parts. The first sub-section delves into the detailed discussion on architectural features of three regions which is summarized in later sub-section.

Studying the Architectural Features

The analysis of disaster resistance concerning cyclonic storms, storm surges, and excessive rainfall and their impact on the vernacular architecture in the Bay of Bengal region is explored. The study investigates the integrated application of traditional and modern techniques to effectively mitigate and avert structural collapse. Particular attention is given to distinctive features, including the selection of roofing materials and angles, innovative wall protection methodologies, plinth protection, and other elements contributing to the overall resilience of structures in the face of such specific natural calamities.

Roof Geometry

Roof angle is a very important feature when it comes to deterrence of cyclonic storms and excess rainfall in coastal areas. A heightened roof slope promotes effective water drainage, preventing the accumulation of excess rainfall and minimizing the impact of storms. This slanted design reduces the risk of structural damage and leaks by preventing water pooling, thereby enhancing overall building resilience in the face of challenges posed by heavy rainfall and storms. The angle of roof steeps more as the annual rainfall of any area changes as it helps them to drain the excess rainfall away from the walls and house premises. The coasts of Bengal are prone to excessive rainfall and therefore the angle of the gabled roof in Bangladesh are around 42 degrees (88% grade of the roof, 10/12) as represented in Figure 2(a) and Figure 2(b) (Chowdhury 2020; Reza 2021). While as we move more towards down south, we find the angle of the roof changes, as in the houses of Odisha which is subjected to lesser rainfall the angle of the roof reduced to 34 degrees (75% grade of the roof, 8 / 12) as in Figure 2(d), however such angle also deter excess storm surges by holding them together with the roof structure (Hardy 1999). The Sinhalese jungle huts of Sri Lanka are subjected to further less annual rainfall and therefore their angle gets further reduced to 30 degrees (58% grade of the roof, 7/12) as shown in Figure 2(c) (Tucker, Gamage, and Wijeyesekera 2014).

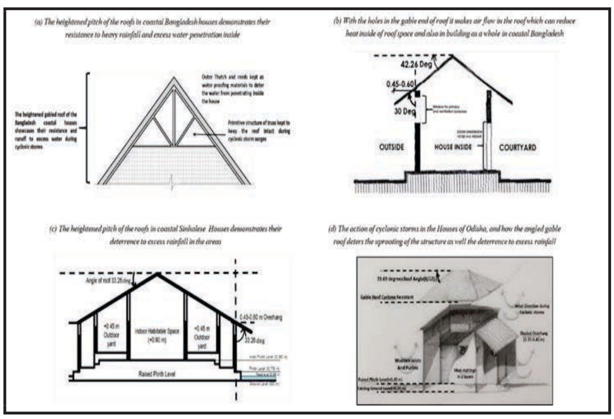

Fig. 2: Roof Geometry

Photoluminescence Study

In Bangladesh, local residents independently gather and process roofing materials like bamboo and thatch. The wisdom of construction techniques is passed down through generations, emphasizing the cost-effectiveness of employing native materials such as wood, bamboo, and thatch. Specifically, an interlocking system is utilized for materials like thatch and bamboo, forming a mesh of interconnected components. In the traditional houses of Odisha, wooden joists and purlins are paired with tin sheets using dried thatch strips. This not only strengthens the roofing, providing resilience against swift storm surges but also seamlessly incorporates contemporary materials. The tin sheets play a pivotal role in redirecting excess rainfall, averting structural damage and potential collapse. The architectural style in coastal Sri Lanka is exceptionally attuned to the tropical climate of the region. Structures are carefully designed to withstand heavy monsoon rains, strong winds, and elevated humidity, ensuring a comfortable living environment. Coastal residences often feature thatched roofs made from materials like coconut palm leaves or straw, offering natural insulation and contributing to a cool interior atmosphere amid the warm and humid coastal conditions. In some cases, the Palmyra thatch which are abundantly available in the eastern coast of Sri Lanka, dried Palmyra leaves, and mud are employed for binding in the construction process.

The effectiveness of roof overhangs in diverting excess runoff water from walls, preventing potential collapse, and occasionally facilitating groundwater recharge is pivotal in roofing. In regions with heavy rainfall, such as Bangladesh, overhang lengths typically vary from 0.45 to 0.60 meters, and some houses may feature lengths of 0.75 to 0.90 meters (usually 1.5-2.0 feet). This design is instrumental in shielding the outer walls from exposure to rainwater. Similarly, in Sri Lanka, where the climate resembles that of Bangladesh, Sinhalese jungle houses often have overhang lengths ranging from 0.45 to 0.60 meters, with some houses extending to 0.75 to 0.90 meters (usually 1.5-2.0 feet). This design strategy effectively safeguards walls against rainwater exposure and runoff, tailored to the climatic conditions of the region. In Odisha, where peak season rainfall is slightly lower, overhang lengths typically measure around 0.35 to 0.40 meters (usually 1.0-1.5 feet). Here, the incorporation of modern techniques like coal tar matting in walls allows for the potential reduction of overhang length.

Wall Protection Techniques

In Bangladesh, where houses are situated at lower elevations and in close proximity to potential flooding, dwellings in these regions are constructed using locally available materials such as bamboo matting and mud (Chowdhury 2020; Reza 2021). Mud mattings, often combined with reeds, serve as protective coverings for the walls, shielding them from the impact of heavy rainfall. To optimize construction costs, the spaces beneath the overhangs are intentionally left bare. This strategic approach not only leverages the accessibility of local resources but also minimizes expenses in vulnerable areas susceptible to flooding. In the construction of Sinhalese jungle huts in Sri Lanka, wall construction involves the daubing method (Clingen and Bavoso 2017). The cob wall technique is employed for daubing, where a mixture of mud, sand, and straw is utilized. Mud balls are closely arranged in a row to incrementally build the walls. The construction of house walls employs the cob wall technique, consisting of thoroughly mixing earth with water to achieve the desired consistency. Subsequently, mud balls are placed closely in a row to initiate and progress the wall-building process. The application of mud occurs in 2-3 layers over a span of 1-2 days. This mud matting serves the purpose of diverting excess rainwater away from the roofs. In coastal Odisha dwellings, wall coverings embrace indigenous materials tailored to the local environment. Traditional techniques involve applying mud plaster, a blend of mud, water, and occasionally additives like straw or natural fibres. This mud plaster is meticulously spread over the walls, ensuring both protection and insulation. Harvested locally, bamboo is intricately woven or affixed to walls, providing a robust and natural protective layer while contributing to the coastal aesthetic. In specific instances, houses in coastal Odisha may combine materials like mud plaster and bamboo matting to fortify walls against the region's challenging climate, marked by intense monsoons and high humidity(College of Engineering & Technology 2017). These traditional wall coverings exemplify local ingenuity in utilizing available resources to craft homes that seamlessly blend functionality with an environment suited to the coastal conditions. Figure 3 represents the wall protection techniques adopted for construction of costal houses in Bangladesh, Odisha and Sri Lanka.

Plinth Protection

The elevated plinth of Bangladesh coastal huts is designed primarily to counteract the impact of flooding and protect against rising water levels. Positioned above anticipated flood levels, this architectural approach minimizes water ingress during heavy rainfall, storm surges, or tidal activity common in coastal regions (Figure 4 (c) and Figure 4 (d)) (Chowdhury 2020; Reza 2021). The raised plinth serves as a defensive measure, shielding the interior of the huts from damage and ensuring a resilient living environment for inhabitants. This strategic elevation is a crucial adaptation to the challenges presented by the coastal environment, enhancing the overall adaptability and durability of the structures in the face of adverse weather conditions. The usual plinth is protected using mud matting over one or two layers and over the years many layers are further added to deter water intrusion into the structure. Meanwhile in Sinhalese jungle huts, the plinth is constructed using mud or a combination of mud and wattle. The house is elevated on this plinth, typically ranging from 0.75 to 0.90 meters as shown in Figure 4 (b)(Clingen and Bavoso 2017). The plinth is adorned with finger marks in white rice paste or vertical stripes of white and red ochre, serving as a water-resistant layer to safeguard the outer part of the plinth. This elevation is strategically implemented above annual flood levels, preventing and mitigating potential submersion of the structure. Additionally, in some instances, slits made of bamboo or locally sourced palmyra timber are incorporated, further raising the structure to 1.0-1.5 meters above ground level. In Odisha, houses are elevated significantly to prevent submersion during storm surges or high tides accompanying cyclones. The raising of the structures, typically at a height of 0.75-0.85 meters above the annual flood level, acts as a protective measure against the specific challenges presented by the coastal environment as represented in Figure 4 (a) (College of Engineering & Technology 2017). This strategic elevation contributes to the overall adaptability and durability of the houses, effectively mitigating the impact of adverse weather conditions. By positioning the houses above anticipated flood levels, this architectural practice ensures better resilience and mitigation against inundation during heavy rainfall, storm surges, or tidal activity.

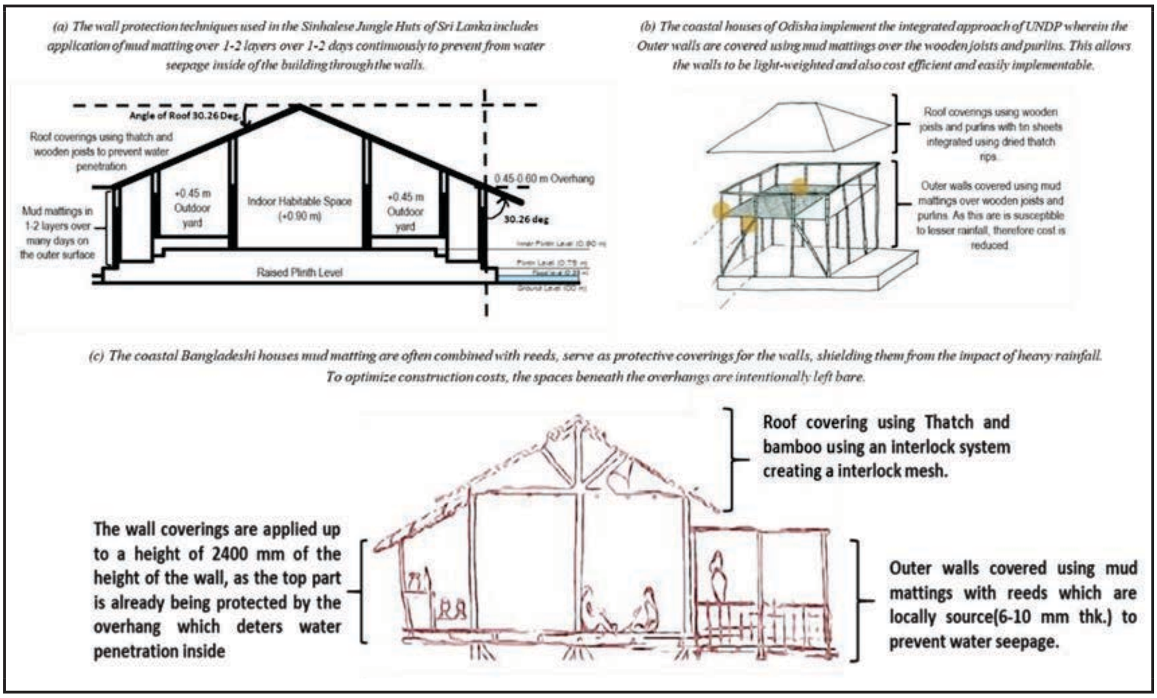

Fig. 3: Wall Protection Technique

Comparisons of the Features

The Sinhalese jungle huts in Northern Sri Lanka, houses in Odisha, India, and coastal houses in Bangladesh exhibit distinct architectural features shaped by their respective climatic conditions which is discussed in previous section. Coastal area of Bangladesh suffers from heavy rainfall and are susceptible to frequent flooding compared to Northern Sri Lanka and Odisha, India as discussed in Table 1. Northern Sri Lanka may experience floods, particularly during the monsoon seasons when heavy rainfall occurs. The region has faced challenges related to flooding rarely, especially during extreme weather events. Odisha is prone to floods, particularly during the monsoon season from June

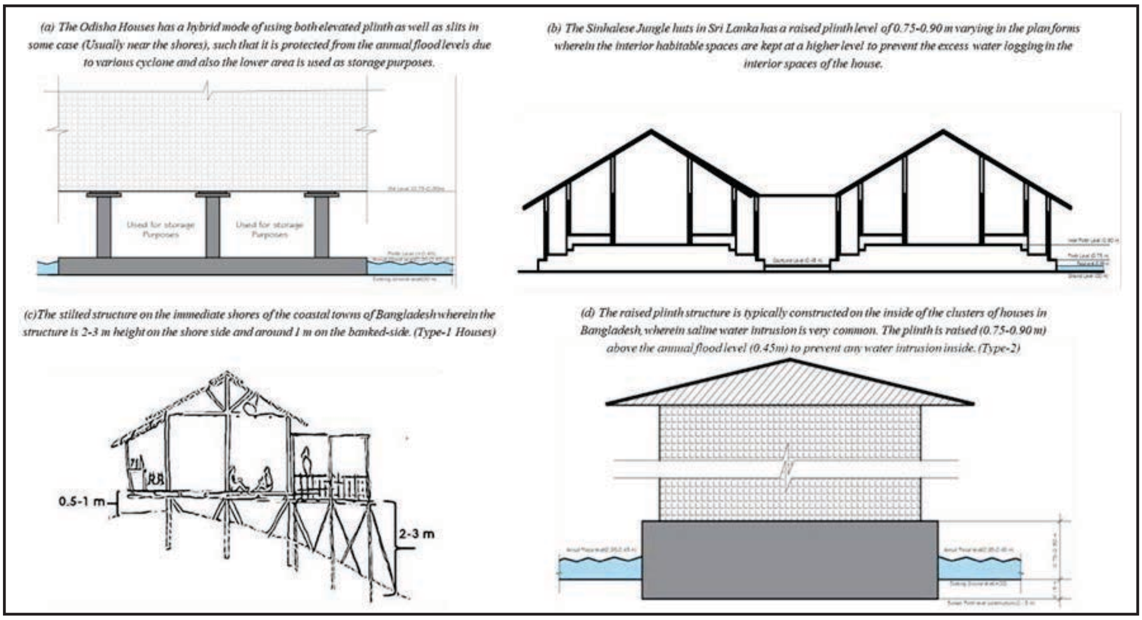

Fig. 4: Plinth Protection

to September. The state has a history of experiencing both riverine and coastal floods. Coastal areas of Bangladesh are susceptible to frequent flooding due to their low-lying topography and the influence of monsoons and cyclones. Riverine floods, storm surges, and tidal flooding are common occurrences. The frequency of floods in coastal Bangladesh is relatively high, and the region is prone to significant inundation during the monsoon and cyclone seasons.

The architectural differences, such as roof pitches, materials used, overhang lengths, wall protection techniques, and plinth protection, reflect the diverse approaches to housing influenced by the rate of rainfall and the frequency of flooding in each region. While Sinhalese jungle huts employ a roof with a 7/12 pitch and primarily use coconut thatch and bamboo for construction, Odisha houses showcase an 8/12 pitched roof integrated with wooden joists, purlins, and tin sheets. In contrast, coastal houses in Bangladesh feature a steeper 10/12 pitched roof with a unique interlock mesh of thatch and bamboo due to heavy rainfall in this region.

Overhang lengths vary, with the Sinhalese huts and Bangladesh houses ranging from 0.45-0.60 meters to 0.75-0.90 meters, while Odisha houses maintain a shorter overhang of 0.35-0.40 meters. Wall protection techniques also differ, with Sinhalese huts using layers of mud, Odisha houses employing mud matting over wooden structures, and Bangladesh houses incorporating mud matting with reeds. Plinth protection varies in terms of elevation and materials, reflecting the local preferences and environmental considerations of each region. These architectural disparities underscore the diverse approaches to housing influenced by rainfall rate and frequency of flooding.

Table 1: Comparative Assessment of Features Across Various Areas

Type of feature	Sinhalese jungle huts in Northern Sri Lanka	Odisha in India	Coastal Bangladesh Houses
Average annual rainfall*	1,000 to 2,500 millimetres	1,500 to 2,500 millimetres	1,500 to 3,000 millimetres or more
Angle of roof	7/12 , 30.26 degrees 58 % grade	8/12 , 33.69 degrees 66.67 % grade	10/12 , 42.26 degrees 88% grade
Roof materials	Predominantly using coconut thatch, dried coconut leaves and bamboo/mud for binding.	Wooden joists and purlins with tin sheets integrated using dried thatch rips.	Thatch and bamboo using an interlock system creating an interlock mesh.

(Table 1 Contd ....)

(.... Contd Table 1)

Overhang length	0.45-0.60 m while in some houses it is found to be around 0.75-0.90 m also.(1.5-2.0 ft usually).	0.35-0.40 m as this region faces a slightly lesser hazard of rainfall(1.0-1.5 ft usually).	0.45-0.60 m while in some houses it is found to be around 0.75-0.90 m also.(1.5-2.0 ft usually).
Wall Protection techniques	Mud in 2-3 layers over 1-2 days are applied.	Mud mattings over wooden purlins and joists	Mud mattings with reeds.
Plinth Protection	The structures features a raised plinth ranging from 0.75 to 0.90 meters, with bamboo walls adorned with mud matting. In certain instances, slits measuring 1 to 1.5 meters are incorporated, enhancing ventilation and aesthetic appeal.	The structures showcases a raised plinth, varying between 0.75 and 0.85 meters, complemented by wooden walls adorned with a combination of mud and bamboo matting. Additionally, coal-tar has been applied to the walls, contributing to both protection and preservation.	The foundation is elevated with a plinth height of 0.95 meters, employing bamboo uprights for the uplifting of the ground floor. The structure features bamboo walls embellished with mud matting, and strategically placed slits for enhanced ventilation and lighting.
* It's important to note that these are general estimates, and specific locations within each region may experience variations in rainfall patterns. Additionally, climate conditions can change over time, so it's advisable to refer to more recent meteorological data for accurate and up-to-date information on annual rainfall in these areas.			

INVESTIGATING THE IMPACT OF CYCLONE AND FLOODS ON THE ARCHITECTURAL FEATURES THROUGH THE LENS OF STANDARDS AND GUIDELINES

The correlation between design features in vernacular architecture and disaster resilience has prompted an examination of the guidelines outlined by the United Nations Development Programme (UNDP) (Chakraborty *et al.* 2021; Management, Programme, and India 2006). Notably, Odisha has wholeheartedly embraced these guidelines, leading to a substantial decrease in cyclone-related damages over time. Through a comparative assessment of disaster intensity, design elements, and UNDP guidelines, our study offers valuable insights for future architects and policymakers engaged in coastal area projects. The construction of millions of new houses under Odisha's rural housing scheme has proven instrumental in safeguarding the lives and livelihoods of impoverished and vulnerable communities. The success can be attributed to the implementation of principles such as transparency, technology, teamwork, timeliness, and transformation. The rural housing mission in Odisha operates under two government schemes—the Central Government-sponsored Prime Minister Rural Housing Scheme and the State Government's rural housing scheme. The government has enlisted the Central Building Research Institute (CSIR-CBRI) as a technical partner to provide suitable, appropriate, and disaster-resilient housing designs. The integration of transparency, technology, teamwork, timeliness, and transformation has yielded groundbreaking results.

To bolster the state government's efforts, UNDP has provided technical support for expediting the implementation of the rural housing program, introducing various technological solutions. For instance, the mobile app "Mo Ghar" facilitates the monitoring and evaluation of construction progress. The app, linked to the rural housing website, ensures that each instalment of the four-tranche fund is released only after the verification of construction progress through shared photographs. UNDP has also played a role in establishing management units, enhancing oversight capacity, and ensuring proper documentation. From April 2020 to March 2021, Odisha successfully constructed 438,747 houses, contributing to a total of 7.2 million houses since the project's inception. The Odisha government has fully embraced and implemented various features recommended by the UNDP along the coastal region villages to effectively mitigate damages caused by frequent cyclones. These include the incorporation of cyclone-resistant structures, elevated plinth levels in coastal towns, robust and durable foundations, wind-resistant designs, roof tie-downs, impact-resistant doors and windows, early warning systems, mangrove plantations, and active community engagement. The successful adoption of these measures was evident during Cyclone Fani in 2019, where Odisha emerged as the least affected state in terms of casualties and damages incurred.

In Sri Lanka, vernacular architecture, such as the Sinhalese jungle huts, has adapted over time to withstand natural disasters like cyclones and floods. While there is no singular national guideline specific to these huts, traditional construction practices align with broader disaster risk reduction frameworks supported by both national agencies and international bodies, such as the United Nations Development Programme (UNDP) and the Asian Disaster Preparedness Centre (ADPC) (Nissanka, Amaratunga, and

Haigh 2019; Patterns et al. 2006). The guidelines emphasize the use of locally sourced sustainable materials like coconut thatch, bamboo, and mud, which are readily available and effective in resisting wind and water damage. Furthermore, the Sri Lankan government has promoted Community-based Disaster Risk Management (CBDRM) programs that encourage the adoption of resilient construction techniques, such as elevated plinths and sloped roofs (Disaster Preparedness ECHO 2013). These practices are reinforced by traditional knowledge systems, which have been passed down through generations and adapted to the specific environmental conditions of the region. The integration of these community-driven guidelines into local construction practices has helped mitigate cyclone and flood impacts, as evidenced by reduced structural damage in recent cyclonic events. Such adaptations are supported by disaster management frameworks that prioritize decentralized and community-led approaches, aligning with global disaster risk reduction strategies such as the Sendai Framework for Disaster Risk Reduction.

In Bangladesh, where the frequency and intensity of cyclones and floods are among the highest in the world, there is a more structured approach to disaster-resilient construction, guided by the National Building Code of Bangladesh (BNBC) and supplemented by international recommendations, such as those from the UNDP and the World Bank (BNBC 2020; Management et al. 2006). The guidelines emphasize critical features like raised plinths, the use of light-weight materials (e.g., bamboo, thatch), and specific roof geometries to minimize wind-resistance. Additionally, the Comprehensive Disaster Management Programme (CDMP), a collaborative effort between the Government of Bangladesh and the UNDP, provides a framework for building cyclone-resistant houses (Luxbacher 2011). It promotes techniques such as reinforced walls, improved roofing materials, and elevated foundations, particularly in flood-prone areas. The CDMP also supports capacity-building initiatives at the community-level, ensuring that local populations are equipped with the knowledge and skills needed to construct and maintain disaster-resilient buildings. The success of these guidelines in reducing disaster impact is evident in the significant reduction of fatalities and property damage during recent cyclones like Cyclone Amphan in 2020. The coordinated efforts between local and international bodies have fostered a resilient architectural culture that integrates modern guidelines with traditional practices, ensuring sustainable and safe living environments.

According to the Government of India's notification on cyclone shelter management, cyclone shelters are structures designated for short-term use during natural hazard events such as cyclones, tsunamis, or floods. The sustainability of these shelters relies on their utilization and maintenance throughout the rest of the year when there are no ongoing natural hazards. Given the substantial investments in constructing cyclone shelters, it is considered wise to explore various other purposes that can contribute to maintaining these structures. There exists a difference of opinion among experts regarding the appropriate normal uses for these shelters. However, a consensus seems to favour uses that do not impede the primary function of the structure as a cyclone shelter. Design considerations should take into account local ethos and values to enhance the shelter's utility as lessons learned from Sri Lanka (Dayaratne 2018). Cyclone shelters are not just seen as a means of mitigation but also as agents of development, providing facilities for sustainable purposes like education and healthcare, thus contributing to local development. The guidelines emphasize features such as sustainable use, building specifications, accommodation capacity, location, shelter height, inner design, structural specifications, staircases, material selection, and their impact on structural considerations. It is acknowledged that heavy cyclones can inundate large areas, potentially requiring helicopters for access to affected regions. The terraces of cyclone shelters may serve as landing spaces for helicopters due to their elevated and sturdy nature. Design parameters must be determined, and cost implications need to be considered to address the dynamic forces generated during helicopter landing and take-off on the structural integrity of the shelter.

CONCLUSION

This study delved into the assessment of disaster impact on the shaping of vernacular architecture in coastal areas, focusing on three case regions along the western ring of the Bay of Bengal: Sinhalese jungle huts in Northern Sri Lanka, houses in Odisha, India, and coastal houses in Bangladesh. The research specifically examined the influence of rainfall and flooding on architectural design by conducting a comparative assessment of various features, including roof pitches, materials, overhang lengths, wall protection techniques, and plinth protection. The findings revealed that architectural design features vary across coastal regions based on the intensity of rainfall and the frequency of flooding. Vernacular architecture, characterized by the use of locally sourced materials and evolved construction techniques, has demonstrated its effectiveness in responding to environmental challenges. Recognizing the dynamic relationship between design features, disasters, and international guidelines, architects and policymakers can develop resilient built environments in coastal regions. This research serves as a foundation for further exploration in other coastal areas, contributing to a more holistic understanding of disaster-resilient architectural practices.

CONFLICTS OF INTEREST

No conflict of interest was declared by the authors.

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