

Vernacular Architecture in Eastern-Terai of Nepal: Assessing Resilience in the Built-Environment of Taade Ghar

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Abstract.

Resilience and vernacular architecture are two concepts that show high correlation which is underexamined, yet promising. The existence of vernacular architecture experiences that the resilience capacity planning is involved as a strategic requirement for new established ecosystems of human settlement. Community life patterns shaped by customary networks, traditional law, social relations, myths, taboos, and religious ties produce physical forms that define the community's identity, known as vernacular architecture. Both concepts were based on a system, which is built environment that consists of four components (infrastructure, institutions, society, economy) and according to both concepts, they face and overcome problems, survive, and advance. This research aimed to assess the infrastructural resilience of the vernacular architecture of Eastern-Terai region of Nepal. Vernacular architecture in the Eastern Terai region of Nepal offers as important and rich resource in this respect. It has been home to many civilizations over the course of history. With a thorough literature review, the framework for assessment was shaped by investigating in 4 steps: Resilience of what, Resilience against what, characteristics of resilience and types of resilience. After investigating the formation, maintenance, disaster management, and the characters of the case study Taade ghar and the built environment of Rangeli, the events, actions that were taken before and after disasters were investigated. This data was analyzed by following 4 steps of framework. Results showed, three types of built environment resilience (infrastructural, physical and socio-ecological) and 5 characteristics of resilience (Redundancy& diversity, independence and interdependence, robustness, resourcefulness and adaptability & creativity) are evident in the built environment of Taade ghar. This study concludes that evolutionary resilience is evident in the vernacular built-environment of Taade ghar in the eastern terai region of Nepal. Furthermore, for eastern terai region of Nepal, built environment resilience is maintaining the vernacular character that consists of Taade Ghar's structure, infrastructural components and the natural elements, retaining the system throughout the stressors (mainly disasters like flood and earthquake), and continue functioning, maintaining, adapting, transforming, and advancing when/if necessary.

Keywords: Resilience, Assessment, Built-environment, Vernacular Architecture

1. Introduction

Human-caused climate change has already begun to transform human habitats in recent years. The most noticeable changes occur in cities as a result of the negative effects of rapid urbanization, natural resource consumption, and demographic changes (Dipasquale; et al., 2010). Mitigating the effects of changing environmental conditions is one of today's major urban challenges. In this context, resilience has been introduced in the field of urban planning and architecture as an integral concept for increasing human settlements' ability to adapt to changes. The ability of a system to withstand disturbance and reorganize while undergoing change, so that it retains essentially the same function, structure, identity, and feedbacks, is referred to as resilience (Walker et al., 2004). Direct experience with disasters has taught many communities the duration, location, time, frequency, intensity, predictability, onset and possible behavior of the hazard linked to these events.

Community life patterns shaped by customary networks, traditional law, social relations, myths, taboos, and religious ties produce physical forms that define the community's identity, known as vernacular architecture. It was unearthed that vernacular architecture has a high resilience capacity (Kennedy, 2004). The existence of vernacular architecture experiences that the resilience capacity planning is involved as a strategic requirement for new established ecosystems of human settlement. As global change, climate change, social and cultural change, natural and industrial disasters, and economic shocks affect local communities, resilience has become a strategic requirement for human settlements (Ripp, 2013).

Vernacular architecture in the Eastern Terai region of Nepal offers as important and rich resource in this respect. It has been home to many civilizations over the course of history (Caplan, 2000) and all of them developed by adding their expertise and knowledge to the total accumulation pool of the landscape they inherited.

Figure 1 Vernacular house in Eastern-terai Region of Nepal (Taade Ghar)



Source: Author

It is a suitable example of well adapted to climate and natural hazard i.e., floods, earthquakes, animal attacks where the region topography have lying at low land forest area with number of

rivers flowing from the hills poses an actively deforming area with high seismicity and flood prone zone. Over the years, this area was hit by series of earthquakes and floods causing physical, social, economic as well as psychological loss. Every civilization has developed its own building principles by drawing on previous knowledge and expanding on it. Learning from the past and from past expertise and the transfer of knowledge have been diminished today. With a very new interpretation of modernism, postmodernism, reinforced by globalization, are expressing the developing and underdeveloped countries with emerging replacement of vernacular architecture (Valverde, 2004). Though the region has experienced a lot of chaos, historically, administratively and culturally, its geographical importance has never changed and has always been a region of food bank. With different natural threats like flood, earthquake and fire, the region has experienced a resilient option of Architecture locally named as ‘Taade-ghar’.

As mentioned by Pokharel, (1994), the eastern Terai region of Nepal has also experienced the trend of vernacular architecture from centuries emerged to advance the local and regional adaptation. Popularly known as “Taade ghar” in local language, this local vernacular has a distinct feature of tackling the disasters and co-operates with the local culture of the respective place. The eastern Terai of Nepal consists of an undeniable cultural, social and historical heritage that allows the gradual growth of a regional identity in which architecture must play a vigorous role. These regional architecture of Eastern terai has also started facing the modification as well as replacement with contemporary concert architecture because of globalization of modernism. Because of this, the region experiences the loss of traditional knowledge of smart and climate responsive design (Upadhyay et al., 2006).

As discussed by Browne, (1988) in his book “ Other Architecture in Latin America”, Contemporary architecture evolves with a permanent tension between its location in time and its location in space, the study aims to identify characteristics of Eastern-terai Vernacular through case study that contributes the resilience.

1.1 Vernacular Architecture

Vernacular architecture is based on climate, culture, social needs, economy, religion, available limited resources, affordable technology. Rudofsky emphasized the qualities of having no architect but being constructed in accordance with the natives' technology and culture. (Dabaieh, 2011; Rudofsky, 1964, cited in Susilo, 2005). Vernacular architecture, according to Oliver (2006)'s etymological definition, is the "native science of building," as vernacular is derived from the word native. The term "vernacular architecture" was coined by Oliver (2006), who went on to define it as "all the types of building made by people in tribal, folk, peasant, and popular societies where an architect, or specialist designer, is not employed." With its ethnic, regional, and local dialects, vernacular architecture may also be referred to as "the architectural language of the people," according to Oliver (2006), who also suggested an association between the term vernacular and its use in linguistics. Also, according to UNESCO publications, there are two key requirements for architecture to be referred to be vernacular: it must be constructed without an architect and must be traditional. (Ringbom, 1984, cited in Dabaieh, 2011).

According to the literature, social and cultural influences shape architecture, whereas physical conditions—particularly those that pushed boundaries—were what caused a change in vernacular forms. Different academic organizations looked into these two factors. While one

group of scholars studied materials, construction methods, spatial layouts, sites, etc. to better understand the physical and technical aspects of vernacular architecture, the other group was more interested in the social, cultural, religious, and economic aspects of the built environment.

The process of identifying, experimenting with, and changing forms, materials, and structures that are in line with the needs of the community, integrating with the natural environment, adjusting geographical conditions, potential disasters, and carried out over years results in the creation of architectural vernacular (Veldpaus et al., 2013). The study of vernacular architecture anticipates formula for determining both inputs and outputs of vernacular architecture (Karacali, 2020). Predictive inputs are climate, economy, and culture and are all external, intangible and somehow abstract factors for understanding the reasons behind the vernacular design. Predictive outputs are material, technique and form which are the internal, tangible and concrete evidences of the structure and all obviously observable.

Climate, culture, social needs, economics, religion, the availability of scarce resources, and accessible technology all influence vernacular architecture. According to the literature, social and cultural elements influence architecture, although physical conditions—which particularly pushed boundaries—were the catalyst for changes in vernacular forms.

1.2 Resilience

The word resilience was first used as a term in psychology in the 1950's to describe the tolerance abilities of children. The term was also used within a conglomerate of qualities that allow the people to remain psychologically balanced and mentally healthy in the presence of negative life circumstances and crisis. (Petzold et al., 2002). An ecosystem's "resilience" was initially described by Holling in 1973 as "the capacity of an ecosystem to tolerate disturbance without collapsing into a qualitatively different state that is controlled by a different set of processes" (Van et al., 2012). "Resilience" is the ability of a system to absorb disturbance and restructure itself while undergoing change, so as to still fundamentally maintain the same function, structure, identity, and feedbacks, according to Walker (2004). Furthermore, the evolutionary approach views resilience as a complex socio-ecological system's capacity to alter, adapt, and—most importantly—transform in response to stressors and strains rather than as a return to normal (Carpenter et al., 2005).

The close relationship between vernacular architecture and resilience was first noticed in the definition by Paul Oliver, (1997): “vernacular dwellings and buildings are related to their environmental context and available resources, they are customarily owner or community built, utilizing traditional technologies. All forms of vernacular architecture are built to meet specific needs, accommodating the values, economies and ways of living of the cultures that produce them”. Oliver’s description points out the existence of numerous parameters in the constitution of a local building culture, above all the role of the ‘micro-climate’ and various environmental conditions. Therefore, indigenous knowledge and vernacular culture become very specific and localized and can represent the specific responses given in the pre-industrialization age by human beings to environmental, socio-cultural and economic challenges by processing available natural resources for their survival. Vernacular Architecture is characterized by three specific factors that are relevant for resilience: Interaction with climate change and changing socio-cultural conditions, interaction with a certain environment after a certain time frame & being a socially shared knowledge

1.3 Resilience of What, against what, why and how

As explained previously resilience is a concept that has been applied to many areas of study. Some of the articles used questions of what, whom, why, how, and whose to position themselves in the scholarship for understanding resilience (White and O'Hare, 2014; Meerow and Newell, 2016). Due to this research is combining two concepts of resilience and vernacular architecture of Eastern-terai, where there is no clear precedent, this research follows similar footsteps of previous research investigations.

Initial descriptions in the literature answer the question of the resilience of materials or systems. By attracting the interest of ecologists, the definition was used in ecological and then in social-ecological systems (Holling 1973; Davoudi et al., 2012). Resilience definitions explain resilience against a negative force or stressors, which pushes a system to break or change. 'Stressors are aversive circumstances that threaten the wellbeing or functioning of the individual, organization, neighborhood, community, or society' (Norris et al., 2008, p. 131). scholars addressed issues of the urban fabric of today and explained more expected issues for the future. Therefore, they found the concept of resilience a possible key for dealing with problems and adapting to them in the future for urban fabric.

There is not a universally accepted method of assessing resilience. In urban, architectural, or disaster studies, quantitative or qualitative methods were used. Different scholars have reviewed and set different indicators for respective stresses as mentioned. Jha et al. (2013) explained that 'by breaking urban resilience down into four components, infrastructural, institutional, economic, and social, underlying issues can be addressed, and capacity can be deepened. Several characteristics were used to describe the various forms of resilience that were examined in the literature. Overall, there are nine common characteristics: redundancy, diversity, interdependence, independence, robustness, resourcefulness, adaptability, creativity, Methods

With an approach to qualitative research, it involves the collection and analysis of expressions, such as interviews with people who live in vernacular architecture, observational studies, and historical research. Since the image of reality is an imperfect abstraction of the truth, the research strategy to be used in this investigation is correlational research. The theoretical and comparative assessments will be analyzed as independent variables. The first phase- evaluation of three theories (vernacularism, regionalism & critical regionalism) that demonstrates regional approaches. Second phase- analyze local dwelling models from material physical perspective.

As an interdisciplinary study, instead of adopting historical or qualitative theory, the research is driven by data. As adopting an inductive approach to analyze data, this research aimed to observe, find and analyze patterns and then theorize data. Based on the extensive review of resilience studies, definitions and methods of assessments, *a concise theoretical framework was created consisting of 4 steps to explore.*

In the first stage, a desk study was conducted in order to gather eclectic and extensive data from different study fields about the characteristics and architecture of Eastern-terai Vernacular as a case study.

- King Virata of Matshyadesha & Rajbanshis- Lokendra Kumar Malla
- *Land and Social Changes in East Nepal*- Lionel Caplan (Book)

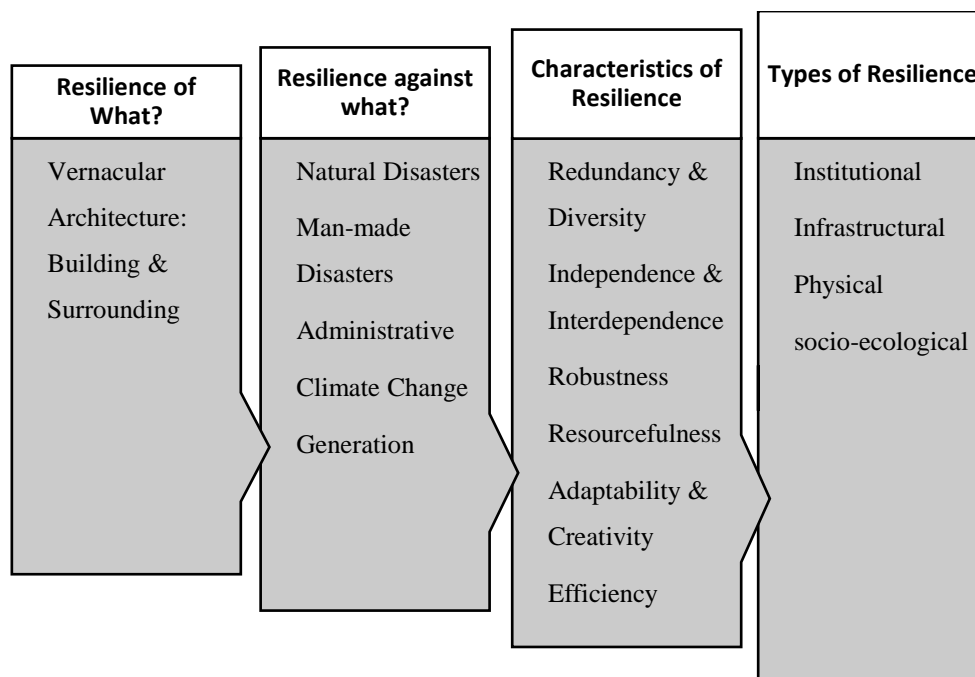
- *Vernacular Architecture of Nepal*- Jibaraj Pokharel (Ph.D. Thesis)
- *Disaster Resilient Vernacular Housing Technology in Nepal*- Dipendra Gautam (Gautam et al., 2016)(Research paper)

In the second stage, a field trip to Eastern-terai was planned in order to access archives as well as investigate the current state.

- Observation
- Interviews
- Document analysis
- Archival data from government offices

After the data collection phase ended, all written data was coded by themes and was put in chronological order. All types and characteristics of resilience that apply to vernacular architecture are listed as a result. Moreover, new characteristics that are detected through investigation were presented. Finally, what makes the case study resilient and resilience in the vernacular built-environment forms was defined.

Figure 2 Conceptual Framework for assessing resilience of Eastern-terai Vernacular Architecture



2. Case Area

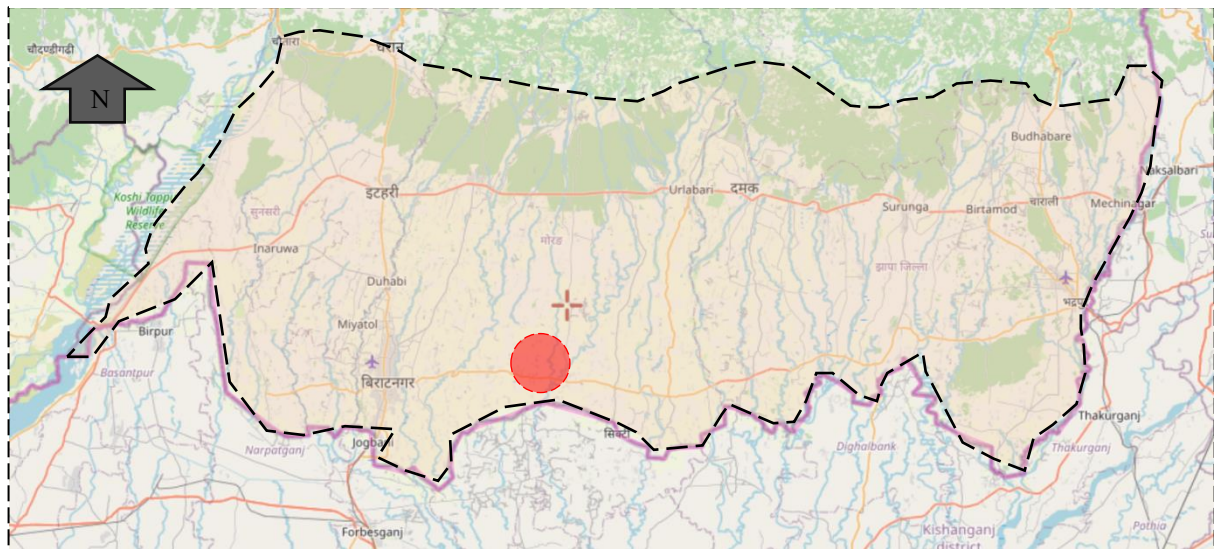
Eastern Terai region of Nepal is ruled by various civilizations over centuries and therefore architecturally consists of various architectural structures over time. The main focus of this study is vernacular *Taade Ghar* of Eastern-terai region specifically of rural area of Rangeli in Morang district.

Figure 3 Political Map of Nepal showing Eastern-Terai region



Rangeli is located in the southern part of Eastern Terai region in Morang district of Nepal. It is the southern border of Nepal to Bihar in India located at 26.4568° N longitude and 87.5099° E Latitude. It is one of the oldest cities of Eastern terai which was once the capital before Biratnagar. Enroute of one of the oldest trade roads namely Hulaki highway, it was once the prominent zone for agriculture, and a hub for agriculture industry. When Eastern-Terai was re-established as Morung by king Mung Mowrang Hang of Limbuwan, the current area where Rangeli lies was the Palace area of then King of Limbuwan. Also, after Gurkha Unification, Rangeli was the capital of the Eastern Development Region before Biratnagar.

Figure 4 Geographical map of Eastern Terai Region with the position of Rangeli



Source: Googlemap

According to Koppen Climatic Classification, the area is in the Cwa (Humid subtropical climate zone). However, with high altitude changes in short distances, Nepal is sub-divided into eight climate zones from tropical to perpetual snow (Lillesø et al., 2005). The study zone lies in the tropical zone with elevation below 1000m.

During the field visit to Rangeli, a number of typologies of old houses with vernacular technologies were collected. The typology of the *Taade-ghar* differed according to locality,

class, economy, caste & culture, and lifestyle of the family. Eight different typologies of *Taade-ghar* have been listed within this field visit to the place and one of the houses that was still in continuity to the traditional lifestyle of agriculture and ecological built environment has been studied in detail.

Figure 5 Typologies of *Taade Ghar* of Eastern-Terai Region of Nepal

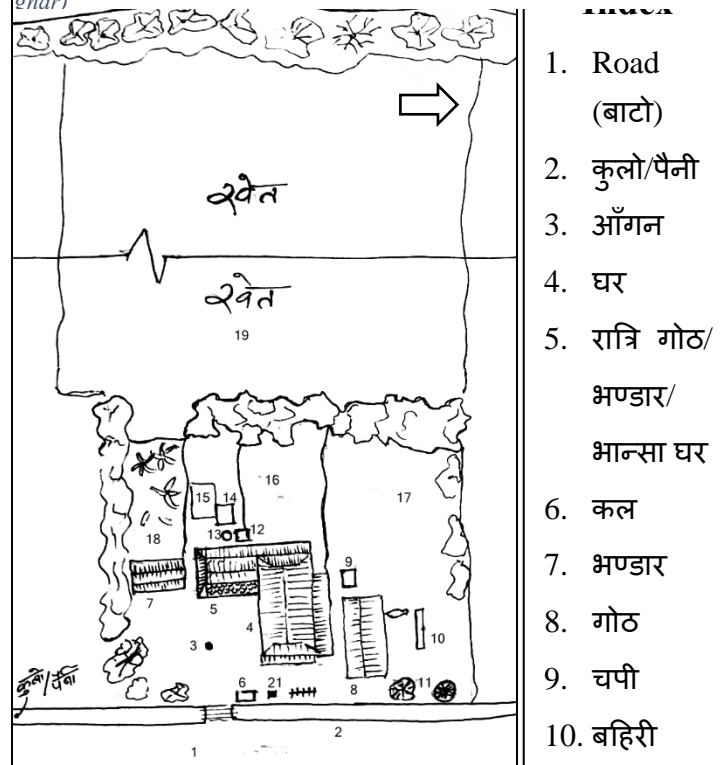


Source: Author

Typology 6 was selected as the base-case for the further study. As per the interview with the house owner, the origin of the land-ownership and house couldn't be estimated but witnessed that it was modified twice in 2015 B.S and 2040 B.S. respectively. This house was selected as a base case because of its originality, lifestyle of the family, adaption and modification due to different stresses, and its age. The house has also experienced generation of family. The house was built within the territory of the owned land to create their own built environment. With the threat of robbery and animal attack, the neighboring land owners built their house forming a cluster in the junction of their land boundary for security. Later, the same junction was used during the infrastructure development to cater every house.

the priority of planning would be to create an ecological built environment involving every element of an ecological system of a house. The element of the ecological system of the house involves the cycle of food of every living being to be lived there. The built environment to be created were equally important to be built for human as well as animals and birds to live there. Believing in the

Figure 6 Site Plan of the Built environment of the case-study house (*Taade-ghar*)



co-existence of human being with the collaborative living with other animals, the family, to whom the house was to be built, also includes the animals helping them in their lifestyle of farming. Every house consists of a large aagan (आँगन) in the front for the processing of the agricultural goods brought from the field. This aagan (आँगन) also caters as a multi-purpose space for social activities as well as sun space during winter.

Most of the houses originally built were in an earthquake resistant shape like, Linear, L-shaped, T-shaped and U-shaped. The case study house was also built in a linear shape previously and was modified to L-shaped after modification. The purpose of the modification of the house was to make the house more resilient to earthquake and also face the living space towards the south to gain more sun in the winter. The ground floor of the house was all dedicated to animals and stores because of the threat of the robbery and animal attacks. Some areas were also prevalent to flood and the entire ground floor was open. The structure of Taade-ghar is a regular rectangular grid colonnade pattern. The house is built based on the primary rectangular grid of spacing 6 feet, 10 feet or 12 feet (६ हात, १० हात, १२ हात). Long height columns of around 1 feet diameter are piled almost 8 to 10 feet (८ - १० हात) for structural stability. These columns are then bind by timber beams in the plinth for raised ground floor. For the additional support of the beams, a support column of Y-shaped at top are also added in the middle of the two columns. The connection of the column and beam is bolted in a lap joint.

Figure 8 structural system of a taade ghar

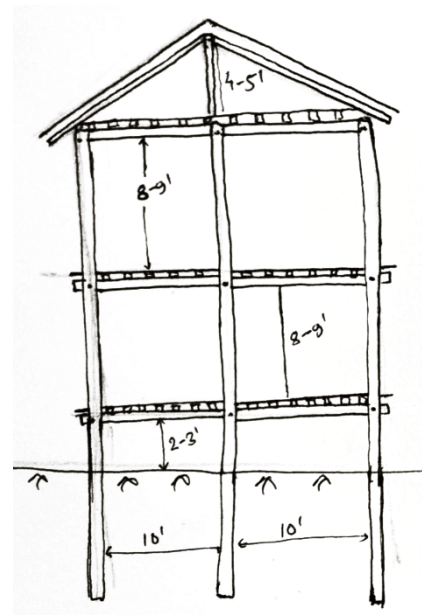


Figure 7 beams of the raised ground floor in plinth

As a vernacular architecture, the materials used in construction of the built environment is locally available. The use of material like timber (Sal/shorea Robusta) locally termed as सखुवाको काठ for structural elements is one of the heaviest/ denser timber that has high structural flexibility. This timber is also use for walls doors, windows, ladder and furniture. It is locally available in the nearby jungle named as char koshe jhadi. Some other timbers like sisau and uttis are also used for temporary structures because of its short life span. The Sal timber if treated well may last for hundreds of years with very less weathering effect. The other materials like bamboo, mud is also used in floors and walls.

The roofing material has been changing with response to time and different stresses faced by the structure. At the beginning, the straw bale (पाराल) was used in roofing. This roofing material later faced different stresses like fire, maintenance due to damage in few years. This roofing materials need to be changed in every 2-3 years of gap and had a huge risk of fire. Later after the production of clay times started in the region, it was almost replaced but still had hope that it provided a proper thermal comfort. The clay tiles too couldn't last for longer as it started falling due to strong wind in monsoon. This material though had bought no changes in thermal comfort need to be replaced because of its threat of falling. In present day, most of the houses use zinc sheet because of ease of installation, flexibility and long lasting. Though this material is not a vernacular material, people has been shifting to use it as a roofing. This material has degraded the thermal comfort of the rooms. Most prominently, the attic space used for vegetable storage is degrading its thermal comfort.

Figure 9 Roofing of the store house with clay tiles and straw bale



3. Result

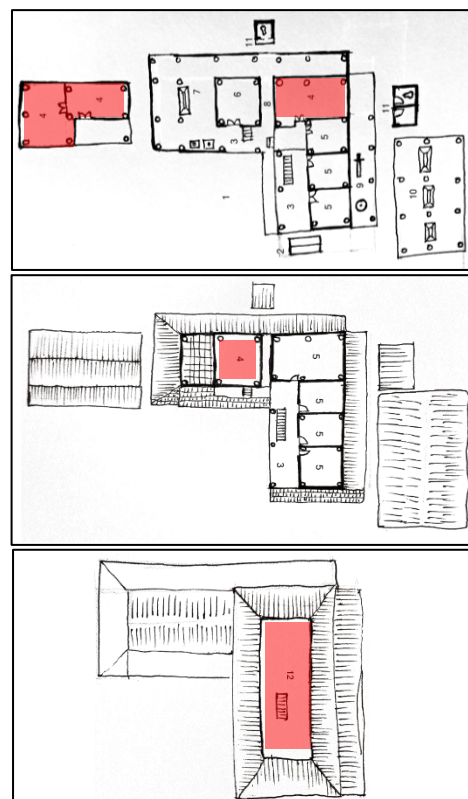
Even though vernacular architecture may contain layers of cultures and civilizations, this research is mainly focused on the vernacular architecture of Eastern terai evident after the unification of Nepal and fall of Limbuwan dynasty. Though after the unification of Nepal was done by Prithivi Narayan Shah in 18th century the modernization in this region started after the fall of Rana period. After the fall of Rana regime, democracy changed the lifestyle of the people

of Eastern terai region. Even after the change in lifestyle, number of earthquakes, fire and floods faced, the vernacular-built environment didn't change until the globalization of construction arrived in this region. There are tangible and intangible components in the built environment of Taade ghar. Physically the built environment of Taade-ghar consists of house to live for both animals and the people, infrastructures/ supportive elements like भण्डार, गोठ, गोबर ज़ास, खाद्यान्न मल, करेसा बारी, बारी, केरा बारी, खेत, and the natural elements like river, कुलो/पैनी, Plants and trees etc. managed to become a part of resilient system. Apart from the physical components, there were non-physical components that were a part of the neighborhood and had an impact on the built environment: festivals and the agriculture.

With the help of the interview with the resource persons and the residents of the case-study, the most affecting stressors to the built environment of taade-ghar were natural disasters like fire, earthquake and flood. Robbery and theft which were man-made are also the common reasons for the modification of the houses. Most of the natural disasters affected the material of the roof like fire intended to change that strawbale roof whereas the earthquake and wind intended to change the clay tiles. The main stressors investigated for the resilience of the built environment of taadey ghar for this research were mainly fire, earthquake, flood, theft and robbery which occurred due to various reasons and at different time period.

The infrastructural elements in the built-environment of Taade-ghar are taade-ghar, aagan, Bio-gas system, storage, animals and their shed

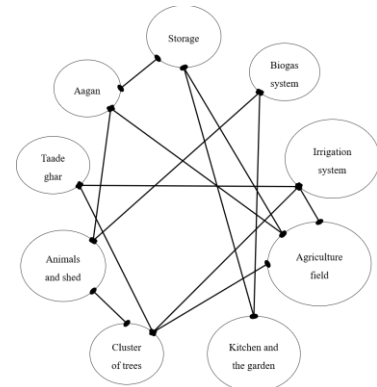
Figure 10 Storage spaces in all the floor spaces



(goth), kitchen and the kitchen garden, agriculture field, irrigation system cluster of trees. Infrastructural elements are responsible for serving the built environment and any disruption in the system may fail to function the built environment properly and may cause a cascading effect for the whole network of built environment to fail. For example, in the built environment of taade ghar due to geographical constraints, the disposal of kitchen waste and animal excreta and the production of fertilizer both are maintained by the bio gas system. If the bio-gas system blocked or disrupted by the flood, it would stop the production of fertilizer required for the production of crops of the season, excess of wastes and animal excreta may spread disease and also impact the ease of cooking in bio-gas. The ecological cycle of the built-environment would get a breakage. This may result in the no production of crops for the season. Therefore, the people managed to create the position of the bio-gas system in higher position of the land and also provided the water drainage system in-front of the house to prevent flooding. The system of infrastructural management like kulo, pokhari in the nearby area of the built environment is the key for infrastructural resilience in taadey ghar.

Redundancy in the built environment of taade ghar is observed as the storage spaces. Instead of relying on one central large storage spaces, multiple storage spaces are allocated in different levels from ground floor to attic space. Redundancy was a characteristic that was adapted after facing multiple floods and it increased the preparedness against stressors, helped the recovery process, mitigated the effect of disasters. Redundancy in functions helped in the cases of disaster by supporting the storage that lost a function by providing the same function from the immediate surrounding.

Figure 11 Components of the built environment of taade ghar and their interdependencies



Physically all the components of the built environment were independent units with various service structures they contain they are interdependent to each other where one stops functioning without the other. Due to being a rather small unit compared to the built environment and the neighborhood, individual components can assess the damage and make recovery. However, the dependency did not cause any cascading failure effect, but only supported each other.

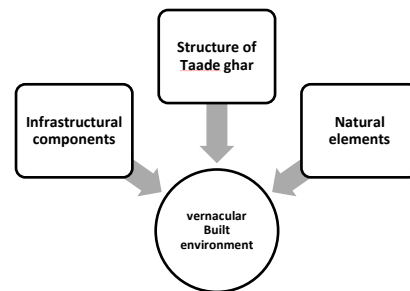
The structural system of taade ghar is a good example of the robustness. The structure of the house is actually built focusing the stresses like earthquake and floods. The open ground floor or the uplifted ground floor with a deep piling of the pillars (खम्बा) is a good defender against flood whereas the pin joint timber structure within a proportion is analyzed to defend the stress of earthquake. The structural proportion of 1:3 to define the shape has also impacted in stress relief of earthquake. There is also evidence of having the robustness of function where function resisted the change. The spaces like storage, and aagan are evident in the study.

Adaptability is observed in roofing material. When the fear of fire increased with the application of straw-bale, the material was shifted to clay tiles. Later the adaptability of clay tiles decreased and increased the fear during wind and earthquake. This made a shift of roofing material to zinc sheet which is not a vernacular material. Creativity was observed in the structural system of the building. In the early stages, during the threat of robbery and theft, the houses had no living rooms in the ground floor and the whole ground floor was open. Later after the region became more secured and the threat of robbery and theft diminished, people started to create an uplifted ground floor with addition of beam and floor without dismantling the structure to create more rooms in the house.

Resourcefulness was observed in building materials. The structure of taade ghar initially were made of timber only which is naturally available. Due to change in climate, construction materials of some of the portion of the structure became a combination of timber, bamboo and clay. Due to the climatic zone and landscape of the region, wood clay and bamboo are easily available. These local materials were cheap and readily available within the territory at any time helped the recovery process go faster and cheaper. However, in present day, due to strict laws in timber transportation, availability of timber has decreased and became expensive.

Three main elements created a resilient system for built environment of taade ghar that managed to overcome various stressors over centuries and not only continue existing but also advancing over time. These three elements are taade ghar to live for both animals and the people, infrastructures/ supportive elements like भण्डार, गोठ, गोबर ज़ास, खाद्यान्न मल, करेसा बारी, बारी, केरा बारी, खेत, and the natural elements like river, कुलो/पैनी, Plants and trees etc. At the various stages of forming and maintaining a built environment, these different elements played various roles and when their cycle is completed, they continued supporting each other for resilient built environment.

Figure 12 the built environment system of Taade ghar



4. Discussion

The purpose of this research was, in line with the context of Eastern-Terai region and the concept of resilience, to study with a framework of resilience to bring a new understanding of the historical formation, maintenance, and development of the Eastern-terai region. The resiliency of these 4 components creates a resilient built environment system. The results chapter conclude the dimension of infrastructure, physical components that created a built environment system in the environment of taade ghar: structure of Taade ghar, infrastructural components and the natural elements of a single case study was mentioned as a last contributor to the resilient built-environment of Taade ghar. Through this built-environment system, the people of Eastern-Terai region created their environment, maintained, and moreover, became resilient against disasters.

Figure 13 correlation between the components of built environment resilience and components of built environment system of taade-ghar

The first element of the built-environment system of Taade ghar is the structure of taade ghar. the studies of the present day-built environment point out the importance proportional grid and pin-joint structural system of the house due to their less complicated and more efficient system.

Components of built environment resilience	Component of built environment system of Taade-ghar
<ul style="list-style-type: none"> • Infrastructural • Physical • Socio-ecological 	<ul style="list-style-type: none"> • Structure of Taade ghar • Infrastructural components • Natural elements

The results of this study showed the vernacular-built environment of taade ghar's condition align with evolutionary resilience. The taade ghar and the built environment were constantly tested by stressors, they managed to retain continuous functioning, adapted, and transformed as stressor as demonstrated in the previous chapter. Moreover, when a stressor struck in the area, people used this as opportunity for advancing better by adding new functions. Also, because time itself is a constant internal stressor that is affecting the built environment constantly, through their lifestyle, the people of eastern terai region had been maintaining all the components regularly to provide a longer service period. Built environment resilience is maintaining their physical, infrastructural and socio-ecological functioning and retaining throughout the stressors and continue maintaining, adapting, transforming and advancing when/if necessary, through stressors.

Resilience, in the present day, is seen as a concept that should be applied to existing built-environments through actions and strategies while the Taade-ghar managed to have a resilient built-environment by containing 3 types and 5 resilience characteristics without prior planning and strategies. In Chapter 2, the expected correlation between vernacular architecture and resilience was presented. Unlike many resilience studies which are only interested in present-day and do not consider vernacular architecture as an example to learn from, the taade-ghar clearly are an example of the resilient built environment system. People of eastern terai region used an ecological approach of creating the built environment. The region and time let the people start building their own living environments. When the formation process is completed, the architecture unites the community that in return the community becomes responsible for the architecture, and as a result, this becomes a self-feeding cycle. People (a) used locally available resources and materials for their construction process, (b) considered natural and geographical conditions before the construction, (c) created continuous maintenance system, (d) followed a flexible and resilient structural system to create their houses, (e) created systems of multiple functions wherein the loss of one function the rest continued supporting the whole system.

5. Conclusion

While there is a clear connection with the concepts of resilience and vernacular architecture, this connection was under-examined, yet promising. Both concepts were based on a system, which is a built environment that consists of infrastructure, physical and socio-ecological components and according to both concepts they face and overcome problems, survive, and advance. This correlation between to concepts was a starting point of the research analysis. After selecting the built environment of taade-ghar, there was no previous study about the built environment, and their resilience was detected. A literature review was conducted on resilience studies and assessment methods. This approach shaped the framework in 4 steps: Resilience of what, Resilience against what, Characteristics of resilience and types of resilience.

This study concludes that evolutionary resilience is evident in the vernacular built-environment of taade ghar. Furthermore, for eastern terai region of Nepal, built environment resilience is maintaining the vernacular character that consists of taade ghar's structure, infrastructural components and the natural elements, retaining the system throughout the stressors (mainly disasters), and continue functioning, maintaining, adapting, transforming, and advancing when/if necessary.

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