

DESIGN DEVELOPMENT OF POST-DISASTER TRANSITIONAL SHELTER

A thesis submitted in partial fulfilment of the requirement for the degree of

Doctor of Philosophy

Submitted By

Kankana Narayan Dev

(176105005)

Under Supervision of

Prof. Amarendra Kumar Das



DEPARTMENT OF DESIGN

INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI

GUWAHATI – 781039, INDIA

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CERTIFICATE

This is to certify that the work contained in this thesis entitled '**Design Development of Post-Disaster Transitional Shelter**' submitted by Ms Kankana Narayan Dev to the Indian Institute of Technology Guwahati, Assam (India) for the award of the degree of Doctor of Philosophy has been carried out under my supervision. This work has not been submitted elsewhere for the award of any other degree or diploma.

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DECLARATION

I hereby declare that the work contained in this thesis entitled '**Design Development of Post-Disaster Transitional Shelter**' is my work done under the supervision of Prof. Amarendra Kumar Das at the Department of Design, Indian Institute of Technology Guwahati (IITG), Assam. I hereby declare that to the best of my knowledge; it contains no materials previously published or written by another person, or a substantial proportion of material which have been accepted for the award of any other degree or diploma at IITG or any other educational institute, except where due acknowledgment is made in this thesis. Any contribution made to the research made by others, with whom I have worked at IITG or elsewhere, is explicitly acknowledged in the thesis. I also hereby declare that the intellectual content of the thesis is the product of my work, and as per general norms of the reporting research findings, due acknowledgments have been made wherever the research findings of other researchers have been cited in the thesis

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Date: 11 October 2022

DEDICATION

I would like to dedicate this thesis to the many people that are displaced by disasters.



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This study would not have seen the light of the day without the guidance, encouragement and support of many people. Taking this opportunity, I extend my grateful acknowledgement to all of them.

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Date: 11 October 2022

Kankana Narayan Dev

Abstract

Transitional Housing is a crucial intermediate phase in the disaster recovery process, where the affected population resides for a temporary period until they can return to their habitats.

The built environment today is affected more and more by rapid and drastic changes due to human-made and natural disasters. Presently, Humanitarian Aid of disaster relief shelters functioning the role of transitional shelters is often in the form of plastic sheets, tents, prefabricated units, and public community buildings such as community centres, schools, hospitals, university halls of residence, places of worship, sports venues, and private rentals. The providence of such facilities is often carried out by the government administrations, NGOs, and Humanitarian Aid Agencies. The term of residence in such facility ranges from days to years, which disrupts the normal functioning of the public institution that is used to house the displaced population, especially schools and colleges. The study begins by studying the impact of disasters and Humanitarian Aid with a focus on Shelter Aid. The definition of transitional accommodation by several aid agencies is analysed with the help of case study of transitional shelters implemented in the aftermath of past disasters. We identified essential characteristics of transitional housing by making a comparative review of different solutions developed in the past in the global context by universities, architects, designers, engineers, manufacturers, NGOs, and governments.

The objective of this research is to develop the design guidelines for transitional shelter aftermath of a flood disaster, with a focus to create dignified living conditions which are both environmentally sustainable and economically feasible. The context of the study is the Flood Plains of the Brahmaputra Valley in the North Eastern state of Assam, India which gets flooded annually displacing thousands of people. The residents of the flood-plains and scattered river islands in the form of sandbars of the Brahmaputra basin reside there due to the available fertile land for agricultural activity. Evidence of architectural adaptation in the form of '*chang ghar*' or houses on stilts is observed in the indigenous tribal houses to address the floods. Most households had personal boats for transportation during floods.

A sequential mixed method approach is used in this research. The qualitative phase focused on selected study of three flood-prone settlements in the Brahmaputra Valley. This study documents the rural homesteads lifestyle in the valley by a selective survey of households from three locations which are annually affected by floods. Visual documentation supported by draft measured drawing and user interviews are used to study the homesteads, which are mostly non-

engineered. Salient building elements are identified and documented. Structural components, Comfort, Material Technology, Architectural Design, Sanitation and Waste Management are studied in detail to understand the lifestyle of the people and the cultural influences. Further, analysis is made to understand the housing response to the disaster profile of the context.

The genre of transportable, flexible and ephemeral architecture is rapidly expanding in the Humanitarian Shelter Aid sector. The research proceeds with the development of a full-scale prototype of a temporary shelter kit model made using the locally abundant material of Bamboo with community participation. The full-scale prototype underwent three iterations until March 2020. The design criteria are determined by the analysis of different aspects that could contribute to the optimization of the final product: life in relief shelter camps, essential qualities of a domestic environment, its spaces and functions, general requirements set by aid organizations and technical strength requirements. Bamboo is considered as a material for construction due to its availability in abundance, a renewable resource, and because many people in the region reside in houses made of Bamboo.

From the findings of the design exercise, we realize that Bamboo is the most appropriate material for use in transitional housing across the region of Assam. The structural stability with thermal comfort and privacy contribute to the cultural acceptance of the shelter type. The design development involved the community at every step of its conception to develop ownership over the project and also the construction of the same. However, the storage of the shelter kit of non-treated Bamboo was found to be a challenge.

We also explored the option of enterprise development of the shelter kit to establish the delivery of the shelter locally within the community as part of disaster preparedness.

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List of Abbreviations

IFRC	International Federation of Red Cross and Red Crescent Societies
USAID	United States Agency for International Development
SPHERE	Humanitarian Charter and Minimum Standards in Humanitarian Response
ASDMTP	Assam State Disaster Management Training Program
TISS	Tata Institute of Social Sciences
PiC	People in Centre
ASDMA	Assam State Disaster Management Authority
PWD	Public Works Department
PHE	Public Health and Engineering
NGO	Non Government Organization
OXFAM	Oxford Committee for Famine Relief
CARE	Cooperative for Assistance and Relief Everywhere
IGSSS	Indo-Global Social Service Society
TOCIC	TePP (Technopreneur Promotion Program) Outreach cum Cluster Innovation Center

CHAPTER 1: INTRODUCTION

1.1. Transitional Shelter

A disaster is a sudden, calamitous event that disrupts the functioning of a community causing human, material, economic and environmental losses that exceeds the coping capacity of the affected community with its existing resources. Disasters can be both natural and human-made. The recent natural disasters across the globe have proven that catastrophes, predictable or unpredictable and the resulting emergencies may occur all over the world, in developing as well as in developed countries. The Emergency Event Database (EM-DAT) listed 432 global natural hazard-related catastrophes in 2021. Overall, they led to 10,492 fatalities, affected 101.8 million people, and resulted in economic losses of over USD 252.1 billion. Asia suffered 40% of all disaster events, 49% of all fatalities, and 66% of all affected individuals as a continent, making it the most severely affected. While the number of fatalities and those affected was lower than their 20-year averages globally, 2021 was characterized by an increase in the number of disaster events and significant economic losses (CRED, n.d.). Unfortunately, the international aid community still seems insufficiently prepared for these incidents. Assistance in emergency situations, especially shelter intervention, is extremely complex (www.unhcr.org., n.d.).

In case of a disaster, a fast solution to resettle the victims is needed. The main options for settlements are dispersed settlements in host families in rural or urban contexts and grouped settlements in collective centres or camps. Due to a large number of people in need, it is often challenging to provide permanent housing solutions immediately at the first post-disaster stage (Oxfam, 2005). For families that have been displaced because of a natural disaster or man-made conflict, the process of constructing a more durable home may not be possible due to their temporary status, or it would require substantial time. Similarly, a disaster may be of significant magnitude resulting in a need of large-scale shelter provision. This cannot be met through the regular construction industry, which is typically geared to incremental construction over time (Kronenburg, 2008). In such situations, there is a need for pre-designed housing options to provide sufficient relief. The solutions need to be adaptable in terms of both materials and technologies used; to enable the affected population to transition back into more durable homes (Union, 2011).

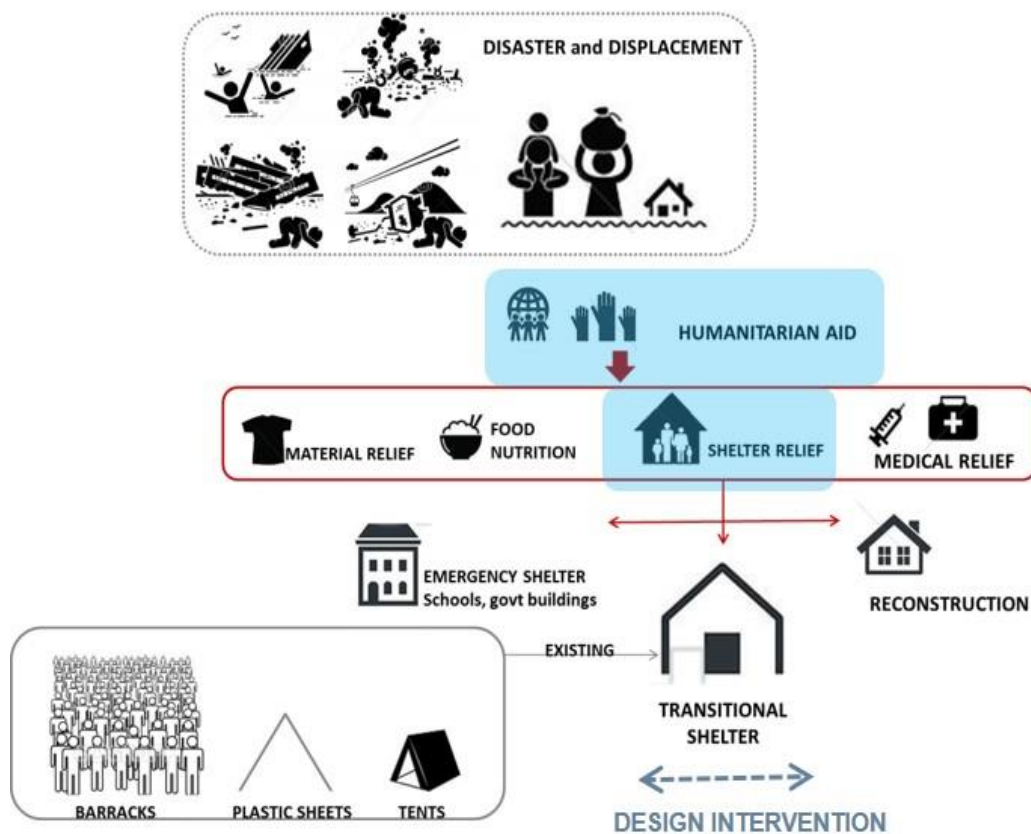


Figure 1.1: Transitional shelter in humanitarian aid (Source: author)

From the scientific-technological and logistical (packaging, stocking and shipment) point of view, the application of efficient shelter design, modular and lightweight construction systems need to be investigated. The logistics and setting up in the field form an important part of the intervention following post-occupancy studies on the internal comfort, functional efficiency and further iterations.

Transitional Shelter, a form of intermediate shelter in the housing reconstruction process, is the subject matter of this research. The general guidelines for transitional shelters are available, however; the same has not been considered for relief in the flood-affected areas of the Brahmaputra Valley. Transitional shelter aid is often in the form of plastic sheets, tents, schools, hospitals delivered ad hoc with improper sanitation, water and food. Till today in the Indian state of Assam, there is no authority addressing to shelter needs in specific. However, a few NGOs and disaster management authority provide the plastic sheets and tents as part of other necessary relief materials. The term of residence in a transition shelter ranges from days

to years, which disrupts the normal functioning of the public institution that is used to house the displaced population especially in government schools and colleges.

1.2. Definition: What is Transitional Shelter?

1.2.1. *There are three main approaches to transitional shelter:*

- **Shelter Centre, Transitional Shelter Guidelines.** Transitional shelter is an incremental process rather than a multi-phased approach, whereby the shelter is built using all the shelter materials distributed. Transitional shelters can be:
 - i) upgraded into part of a permanent house;
 - ii) reused for another purpose;
 - iii) relocated from a temporary site to a permanent location;
 - iv) resold; to generate income to aid with recovery; and
 - v) recycled for reconstruction.

Transitional shelter can be used to support both displaced and non-displaced populations in a variety of settlement options (Humanitarian Charter and minimum standards in humanitarian response, 2018). The process can last years and is only appropriate for tenants when land rights and safe shelter close to their sources of livelihood cannot be achieved immediately, and for owners only when repairs or reconstruction cannot start immediately (Humanitarian Charter and minimum standards in humanitarian response, 2018; IFRC, 2011)

- **IFRC: Post-disaster shelter.** The International Federation of Red Cross and Red Crescent Societies (IFRC) defines shelter after a disaster involves an overlapping process of emergency, temporary, transitional, progressive, core and permanent housing. In this case, transitional shelters are rapid, post-disaster shelters made from materials that can be upgraded or re-used in more permanent structures; or that can be relocated from temporary sites to permanent locations. Progressive shelters are non-movable rapid shelters designed to be later upgraded to more permanent status.
- **USAID Transitional shelter.** Transitional shelter addresses short to medium-term needs – up to three years – of disaster-affected households. It involves the provision of inputs, sometimes including salvaged materials, construction assistance, technical advice, and oversight needed to create shelters consistent with internationally recognised guidelines. (IFRC, 2011; Rohwerder, 2016)

All three approaches incorporate disaster situations both, natural and manmade.

Transitional shelter is an incremental process which supports the shelter of families affected by conflicts and disasters; as they seek to maintain alternative options for their recovery. Transitional shelter can be later converted into a permanent settlement for the affected families. It can also be utilized for a variety of other functions. The use of low-cost and reusable/recyclable construction materials for building transitional shelters provides the option for slashing prices, and they have the added benefit of being green and sustainable in most cases. Prefabrication has been a major trend in the construction industry lately; because it saves a lot of money on labour. Prefabrication doesn't replace a material per se; it's just a more efficient way of using materials.

1.2.2. Ten Principles of transitional Shelter

- **Access Situation:** The shelter response for transitional shelter need not be universal. Some different approaches exist for providing shelter in post-disaster or post-conflict situations. Comprehensive assessments should be undertaken to understand the potential strengths, weaknesses, opportunities, and threats of all shelter responses before selecting the most appropriate.
- **Involve Community:** the most significant effort in response is made by those affected. They are also aware of the most suitable, sustainable and rapid routes to recovery. Community participation has been identified as one of the most productive approaches to empowering the poorest and most vulnerable people with a mandate to provide opportunities for all people to housing that is safe and adequate with essential services.
- **Develop Strategy:** Programs should be used to support the appropriate groups within the affected population for a period of proper health and sanitation facility to support the entire population, both displaced and non-displaced; until durable shelter solutions are made.
- **Reduce Vulnerability:** Transitional shelter programs should reduce the vulnerability of the affected population and contribute to disaster risk reduction by using site selection, site preparation, shelter design and construction as a platform for communicating hazard resilient techniques and best practices and by building capacity within the affected population.
- **Agree Standards:** There is no standard transitional shelter design. Standards should be agreed upon, with participation from the affected population, which are appropriate for each beneficiary group.
- **Upgradeable:** While being inhabited, a transitional shelter may be improved over time to become a permanent shelter solution.

- Reusable: Transitional shelter is inhabited while parallel reconstruction activities are taking place.
- Re-locatable: Relocation distinguishes transitional shelter from other shelter approaches. A relocatable shelter can be built on land where tenure is insecure or temporary.
- Resalable: Transitional shelter is inhabited while parallel reconstruction activities occur. Once reconstruction is complete, the transitional shelter may be dismantled and its materials used as a resource to sell.
- Recyclable: Transitional shelter is inhabited while parallel reconstruction activities are taking place. The transitional shelter may be gradually dismantled during the reconstruction process and its materials used in the construction of a durable solution (S. Centre, 2011; IFRC/RCS, 2013).

1.2.3. Alternative approaches for Transitional Shelters

Temporary shelter usually involves a short stay in a tent or public shelter, providing a place where people can generally reside for six months to three years, enabling them to return to their normal daily activities before moving into permanent housing (Bologna, 2006). Temporary housing usually consists of a pre-fabricated house (ready-made units or houses to be assembled on site), rented accommodation or similar. They are used for a specific amount of time rather than being part of a process (Félix et al., 2013). It has been criticized due to problems of sustainability and cultural inadequacy (Bologna, 2006, 2007).

The temporary shelters provided to the earthquake victims of Nepal and Pakistan suggest that high-quality waterproof tents are viable temporary shelter options needed to prepare for the monsoon. They warn that temporary shelter is less straightforward in urban areas where open urban spaces such as parks, squares and sports areas are quickly occupied by homeless people and/or those afraid to re-enter buildings. Any temporary shelters in camps must be as short-term as possible as they are expensive to maintain and hard to close. For example, authorities closed the Pakistan earthquake camps after six months which avoided the risk of protracted relief (Rohwerder, 2016).

Semi-permanent shelter involves building parts of some elements of a house, such as the foundations and a roof, in order to offer shelter. In contrast, the remainder of the house is completed leaving scope for completion.

Sites and services refer to preparing the site for the permanent house and all wet services and utilities, such as the bathroom, sewage and electrical supply, to accelerate the process of reconstructing the rest of the house.

Core house or one-room shelter (ORS) involves building at least one complete room of a final house, to offer shelter while the household completes the remainder of the house, using their own means and resources (Rohwerder, 2016).

1.2.4. Ephemeral Architecture of Transitional Shelter and Settlements

Architecture is the science of building; often associated with the phenomenon of stability and permanence. For everlasting architecture, it is necessary to give importance to the aspect of durability and permanence (Store, Kate and Sinclair, 2006). Ephemeral architecture thus; contradicts permanence, which leads to the need to reevaluate the entire definition of architecture. The evidence of ephemeral architecture was seen in the ancient days in the form of yurts, tipis and caravan tents of the nomadic people who kept changing their habitat. The value of ephemeral architecture occurred during the last century when visionary architects such as Richard Buckminster Fuller, Cedric Price and Archigram group, managed to prove its importance and applicability on a large scale (Kronenburg, 2008).

Though contemporary ephemeral architecture is utopian in nature, they have definitely served as a source of inspiration for projects that address a diversity of context. The recent advancement in the development of science and technology has aided to the imagination and application of ephemeral architecture to the context of humanitarian relief and other similar social architecture needs.

An ephemeral architecture has the ability to mediate between aspired permanence and inevitable change, sustaining cultural meaning despite a short existence. Framing a moment in time through construction processes and lingering fragments, a building designed to disappear can foster a potent communal memory.

Ephemeral architecture has different roles today, most of them sharing common ground with everlasting architecture. As a result, many studies classify ephemeral architecture by various categories or use ephemeral architecture as research methodology for proving theoretical concepts (Balan, February 2016). There are three types of portable architecture, the third approach in which elements of modular parts are easily transported, and dry assembled on site has been considered to design and develop a portable bamboo transitional shelter. This is a

suitable type of shelter for use in humanitarian emergencies in northeast India where bamboo as a construction material is available in abundance.

From the various case studies and analyses, it can be said that ephemeral structures are:

- Quicker to build – Because they don't need foundations, and also since all the parts can be quickly made (if they are not already in stock), temporary structures are exceedingly quick to erect and dismantle.
- Much cheaper than a conventional building – Shorter lead times in the planning, designing and building stages, and the lower costs of components used in the construction will save you a great deal of money when compared to a conventional building whether you rent or buy outright.
- Versatility – It is very easy to change the configuration of the structure, or add to it at a later date. It is also very easy to relocate; or dismantle it.

1.2.5. Types of Ephemeral Architecture in the Context of Humanitarian Aid

The simplest strategy consists of buildings that are transported in one piece for instant use once they arrive at their location.

The second strategy enables the building constructed from factory-made elements transported as a partly complete package and then quickly assembled on site.

The third strategy is composed of a system of modular parts that are easily transportable and usually dry assembled on site (Debacker et al., 2006).

1.3. Comparative study of Transitional Shelters

1.3.1. Findings of the Comparative Study

The effectiveness of transitional shelters is expressed vividly by several humanitarian aid agencies. Some promote it as an effective participatory process that assists beneficiaries in rebuilding their homes, while others strongly oppose it as an expensive, damaging product that diverts funds away from permanent reconstruction efforts. The Shelter project suggests this opposition is based on a lack of understanding of the transitional shelter approach, its definition and how it differs from other reconstruction methods.







	Bamboo Frame (2009) Indonesia West Java 	Timber Frame (2009) Indonesia Sumatra, Padang 	Timber Frame (2010) Pakistan 	Timber Frame (2007) Peru 	Timber Frame (2007) Peru 	Bamboo Mat Shelter (2012) Bodoland 
Type of Disaster	Earthquake 2009	Earthquake 2009	Flood, July 2010	Earthquake 2007	Earthquake 2007	Ethnic Riot 2012
Materials	Bamboo, Concrete Terracotta tiles	Timber Frame, Palm Leaves and Palm Matting	Timber, Corrugated Steel Sheets and Plastic sheets	Timber Frame with timber cladding and corrugated metal sheet roofing	Eucalyptus tree poles, plastic sheet	Split Bamboo poles and Bamboo Mats
Source of Materials	Local	Local	Local and internationally procured	Locally sourced and prefabricated	timber sourced locally and sheets imported	Locally Sourced
Time to Build	3 to 4 days	2 days	1 day	1 day	2 days	1 day
Estimated Life Span	1 -3 years	1 -2 years	2 years	2years	12 months	1year to 18months
Construction Team	3-4 skilled people	5 skilled people	4 skilled people	4 skilled people 1 engineer and 1 project manager	4 skilled people	Local community
Cultural Relevance	Relevant	Relevant	Slightly	Relevant	Relevant	relevant
User Participation	No	None	No	Assembling the prefabricated members	No	yes

Table 1.1 A comparative study of 5 transitional shelters from various parts of the world and one from India is made with the findings tabulated in the following(IFRC/RCS, 2013)

Some lessons which have been learned from the comparative study of transitional shelter approaches implemented across a range of post-disaster scenarios can be summarized as follows:

Cost-effective over time

The transitional shelter approach is cost-effective over time if implemented correctly according to the SPHERE guidelines. While initial start-up costs may be high, the approach offers a ‘beneficiary-driven reconstruction process that quickly becomes self-supporting through direct investment into local economies’ and ‘often provides livelihood opportunities which are proven to speed up the recovery process and quickly reduces dependency on external assistance’ as materials and labour are procured from the local economy (S. Centre, 2011; Humanitarian Charter and minimum standards in humanitarian response, 2018; Migration, 2012), (Osman A and Sebake N, 2010).

Opportunities for scale-up

Large numbers of transitional shelters can be built incrementally after large disasters because they use common local and regional materials, unlike tents which have to be procured from elsewhere (S. Centre, 2011; Humanitarian Charter and minimum standards in humanitarian response, 2018; Migration, 2012).

Better living space and opportunities

Transitional shelters offer better living spaces than tents for activities such as childcare, cooking and home-based enterprises, and the recovery of livelihoods. In addition, they can provide a secure and healthy living environment that offers dignity and privacy further it can also be used later as, for example, a shop or livestock shelter (S. Centre, 2011; Humanitarian Charter and minimum standards in humanitarian response, 2018; Migration, 2012).

Materials

The use of local materials and local construction practices and designs appropriate to the context and local hazards improves acceptance, ownership and ability to maximize the value of shelters, and contributes significantly to effective disaster risk reduction as found in most of the studied models of transitional shelters (S. Centre, 2011; Humanitarian Charter and minimum standards in humanitarian response, 2018; Migration, 2012).

Flexibility of location

Transitional shelters may be relocated from a transitional settlement site to a transitional reconstruction site (S. Centre, 2011; Humanitarian Charter and minimum standards in humanitarian response, 2018; Migration, 2012).

Affected community/individual led

Transitional shelters should preferably be tailored to community/individual needs and circumstances and decisions about shelter type and location made in consultation with the affected population undertaken *by*, rather than *for* them. However, allowing affected families to construct their own shelter though it may be difficult in urban environments. Though in most of the models studied public participation was looked down upon it is very important to pay notice to this requirement (S. Centre, 2011; Humanitarian Charter and minimum standards in humanitarian response, 2018; Migration, 2012).

Human resources and technical knowledge

Significant human resources are often required to coordinate the acquisition of building materials, the required technical reconstruction skills and community input. If there is an insufficient skill, technical capacity or cross-sector coordination, transitional shelter approaches may be poorly implemented and result in unsafe practices. As affected people will often take on responsibility for building their new homes, they need knowledge of good, safe building practices to ensure houses do not repeat pre-disaster weaknesses. Expansion to gain much-needed space can weaken the structure of the transitional shelter if households do not understand what they are doing (S. Centre, 2011; Humanitarian Charter and minimum standards in humanitarian response, 2018; Migration, 2012).

Disaster risk reduction

The introduction of simple construction techniques such as cross-bracing and hurricane straps can mean shelters are more resilient to future disasters. Transitional shelters thus studied were found to be resilient, broadly understood to mean the development and application of policies, strategies and practices to reduce vulnerabilities and disaster risks throughout society. The design approaches were found to reduce short-term hazard risk and promote long-term livelihood security. (S. Centre, 2011; Humanitarian Charter and minimum standards in humanitarian response, 2018; Migration, 2012).

Land

Land-use issues are key for all types of shelter and need to be addressed from day one in order to prevent it from becoming a bottleneck in assisting those in need. It is highly preferred that preparatory identification of sites for transitional shelters be made close to the location of the damaged houses so that it can aid in fast reconstruction(S. Centre, 2011; Humanitarian Charter and minimum standards in humanitarian response, 2018; Migration, 2012).

1.4. Transitional Relief Settlements

Shelter needs vary depending on the nature of the disaster and the emergency situation created. When locating and planning emergency settlements, their long-term economic, social and environmental impacts on the surrounding areas should be carefully considered. The health conditions faced by people are largely affected by the location and organization of the site where they are obliged to live for days, weeks and several months after the disaster. Security, the presence of a suitable water supply and the conditions necessary for adequate sanitation are probably the three most essential factors to consider when designing a site for disaster-affected people (Humanitarian Charter and minimum standards in humanitarian response, 2018).

The requirements that ensure the healthy environment of post-disaster temporary settlements are as follows:

- The site should be free of major water-related hazards such as malaria, onchocerciasis (river blindness), schistosomiasis (bilharzia) and trypanosomiasis (sleeping sickness). If these diseases are endemic especially in a post-flood situation, care should be taken to avoid or control vector habitats and provide protection against mosquitos.
- The topography of the land should permit easy drainage and the site should be located above flood level. Land covered with grass is preferred however thick bushes and trees

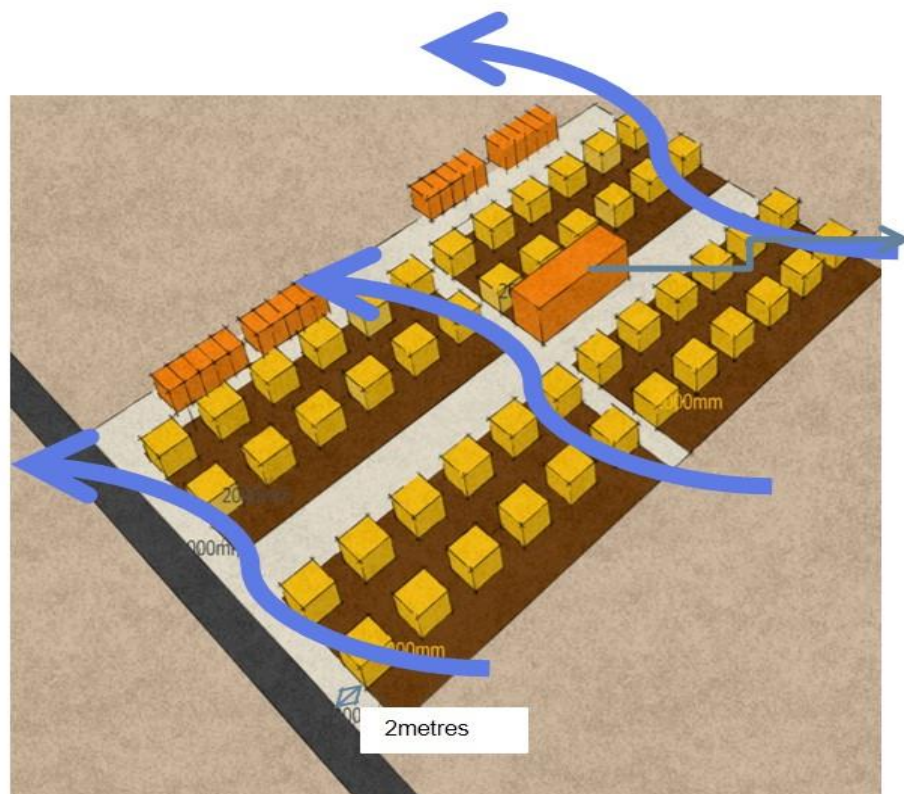


Figure 1.2: Schematic layout of relief settlements

should be voided for it may attract insects and reptiles. A slope of 2-4% should be considered for good drainage and should not be more than 10% for avoiding additional cost in earth moving for access and shelters.

- Wherever possible, the area should be naturally protected from adverse weather conditions and it should be located far from industrial zones, exposed to noise and air pollution.
- Areas sufficiently close to blocks or rows of shelter should be identified for sanitation and waste management. The residential areas should face the prevailing wind to avoid odour from latrines.
- There should be ample space for the people to be sheltered and for all social activities with a consideration of 3m² per person of open space for access, vegetation, play etc.
- Food distribution and food preparation areas should be organized to create safe environment for food distribution and food preparation.
- The maximum size of a settlement should not be more than 1000 people. If more it could be broken down to smaller settlements.
- Drain ditches should be dug around the shelters in flood prone areas. Persistent areas of stagnant water that are difficult to drain can be backfilled or covered with polystyrene or thin layer of oil to control breeding of insects.
- Shelters should be arranged in rows or in clusters of 10-12 and there should be a gap of 2 meters between the edge of the road and the tent pegs in case of tented shelter.
- Built up areas should be divided by 30 meters wide firebreaks every 300metres.
- Shelters should be spaced 8 meters apart so that people can pass freely between them. The spacing helps in preventing the spread of fire. Ideally distance between shelters should be twice the height of the shelter while keeping the minimum distance between shelters as 2 meters. If the space in between is more than 8 meters it may lead to open defecation and therefore needs to be avoided.
- There should be a minimum of 3.5 m² per person inside the shelter in warm climates where cooking is done outside, and 4.5-5.5 m² in cold climates where cooking is done inside the shelter.
- Small shelters with few occupants are preferred over large shelter with many occupants.
- Precaution should be taken to prevent fire.

- In absence of electricity wind proof kerosene or battery operated lanterns should be considered for lighting the shelters and the access.
- The site should be located close to source of ample water point. No one should have to walk more than 500meters to a water point. At least one water point per 250 people.
- Latrines or other facilities for excreta disposal should be provided at least one per 20 people.
- Bathing, laundry and sanitation facility should be provided.
- Special accommodation for unaccompanied children should be considered (S. Centre, 2011; Humanitarian Charter and minimum standards in humanitarian response, 2018; Migration, 2012).

1.5. Motivation and prior study

In the year 2012, I was appointed as a project Officer in the Assam State Disaster Management Training Program (ASDMTP) by Tata Institute of Social Sciences (TISS), where my role was documenting the building typology across the State of Assam and preparation of guidelines in liaison with a Gujrat based organization called People in the Centre (PIC) to make the built environment across the state disaster resilient. The appointment gave me the opportunity to travel across the state of Assam, documenting the built environment by a selective study of buildings and houses by visual survey, measured drawing and user interviews. Towards the end of the documentation assignment I was deputed as the Project Architect for the design implementation of relief shelters of the then affected 4,00,000 people during the ethnic riots at Bodoland July-November 2012. The assignment that was put up as a challenge to me was the rapid delivery of 30,000 shelters for affected families.

During the first two weeks of my deputation around second week of August 2012, the specific objectives of my work were not in place which gave me the opportunity to join the social work team of TISS on field. I tried to understand and access the damage of housing caused by the riots which we would cross each day to reach the schools giving shelter to the displaced people. The half and sometimes completely burnt down houses of the villages expressed a lot of narratives about the built typology and the lifestyle of the people residing in the houses who then were forced to stay in the government schools. The inhuman condition in which the people were forced to stay during the months of August to September being the most uncomfortable due to extreme temperature and humidity levels of the weather. Following this, I was placed in a team of engineers from the Public Works Department (PWD) and Public Health and

Engineering (PHE) of Kokrajhar District in Bodoland. As an initial assignment I was involved in the design and implementation of over 30 community shelter shed for the Bodo Tribal victims of the ethnic riot. The shelters shed had an area of 30 meters x 12 meters which was planned to house 40 families with spaces internally partitioned by scavenged sheets of metal from burnt down houses in the neighborhood. Support services of water and sanitation was managed by the PHE along with two lamp posts for lighting at night by the Electricity department. For the security of the victims, regular police patrolling was mandatory. The community shelters were made primarily using Bamboo and Profile Sheets as the building material where Bamboo (non-treated, non-standard, non-engineered) was sourced locally and Profile sheets were brought in externally by train and delivered to Gossaigaon Railway Station and from there it was transported by mini vans to the sites. The community shelters thus created were made by contracted labors who were employed by scheduled contractors who had managed to get the job on tender. The construction quality of the camp shelter was extremely fragile where the walls were transparent due to the shrinkage of use of immature bamboo and the heat radiated from the metal sheets almost made impossible to be indoors during the day. This initial study of human hazards showed me the fragility of the human being especially when sheltered in the wrong way.

Around first week of September 2012, the administration faced an urgent need to reopen schools and colleges and therefore the millions of victims in the schools and colleges had to be housed immediately. The District Administrator called for an urgent need to design and deliver 'makeshift shelter' for the victims. Having spent almost a month in the region and assisting in the already made community shelters, I was expected to come up with a solution by the next day. Since, PIC was not able to reach the site we had to make an immediate move based on the study of local materials and traditions which had given me a useful input to mix tradition with innovation and new building technologies.

A humble shelter was developed using the locally sourced Bamboo material along with a walling of Bamboo mat which not only gave privacy but also thermal comfort during the hot and humid weather. The implementation of the makeshift housing was made with the affected community participation where they were engaged as labors. The shelter was appreciated by the users. However, due to political and administrative reasons the shelter was not implemented at the scale at which it was planned and the victims continued to reside in the schools and colleges almost till the end of the year of 2012.

The design exercise made me realize that there are several processes linked in the development of sheltering in the aftermath of a disaster. The socio-political, and cultural background of any particular location on the globe is very specific and no single solution works for all. Though a number of standardized technologies and products are accepted in the humanitarian Aid, the sheltering aspect of Aid is unique with its own set of determinants encompassing view of the political, economic, and social situation in the affected region.

The deputation assignment of the makeshift shelter for the victims of the Bodoland riots led me to the conclusion that though we have international standards for humanitarian Aid, the implementation of the same in the local context is of great challenge. I was unable to get any help from any national guideline that did not exist during the event of the Bodoland Riot (we do have recent national guidelines for temporary shelters developed during December 2019). In the following years, I tried making extensive research on the humanitarian shelter aid. During my study, I realized about 'Transitional Shelters', which perhaps is an interesting form of temporary housing in the post-disaster situation. As an architect, when I had the opportunity to propose my doctoral research, the rationale for research on Humanitarian Shelter Aid was compelling, and thus, the study was proposed.

It took me several years to focus my research in the direction of transitional shelters. As architects, we are used to certain design briefs by clients and a set of byelaws to help us in design. However, the field of Humanitarian Aid is quite uncertain with most of the decisions taken on an emergency. From the success of the implemented Shelter in Bodoland, I assumed that the shelter solution could be efficient in addressing the housing need after disasters in the region and therefore, the first thing I focused on during my research was the development of a Shelter Kit using the similar technology implemented in Bodoland in a Kit form. The shelter kit had its own set of constraints regarding stocking, transporting and enterprise development. Once again, I realized that no single solution could be implemented for all even if the area of implementation is the same. It was during this phase of my research that I tried to concentrate on the development of a guidelines for transitional living in the flood prone areas of the Brahmaputra Valley. The people in the Brahmaputra valley suffer temporary displacement due to the annual floods. This research, therefore, has two integral parts: one which tries to develop a guideline for transitional living during the annual flood of the Brahmaputra Valley and the other that continuously tries to amend the Bamboo Shelter Model to suit to the given context.

1.6. Problem statement

The focus of this study is transitional shelter. International Humanitarian Aid's shelter cluster aims to offer shelter to millions of individuals from all nations and cultures. These victims have been appealing for their well-being, security, dignity, and the chance to swiftly resume everyday life. The goal of this research is to help millions of disaster victims realize their dreams.

Although there are broad criteria for temporary shelters, the Brahmaputra Valley's flood-affected communities have not received any consideration for these rules. Setting goals throughout the relief, transitional and recovery process is essential for maintaining momentum and ensuring progress, but in an ever-changing environment, these must be dynamic and incorporate flexibility. While expectations regarding the pace and quality of shelter provision and housing reconstruction can play a crucial role in post-disaster evaluation, they can be set too high as delays and complications often arise. Unrealistic recovery timelines can be set for various reasons, including demonstrating to both national and global audiences that the situation is under control and manageable. Still it can have an adverse effect on perceptions and satisfaction with recovery when these timelines invariably slip. Crucial for timely recovery success is a clear and accepted strategy, accurate data and consistent communication, buy-in and support for participation among those directly affected, close collaboration between critical actors embedded in communities, alignment of national and local government priorities with those of the international NGO community, weaving disaster risk reduction principles into everyday life, sufficient overall resources and expertise, and equality in access to economic resources such as aid and government loans. The findings of this study are pertinent to the fields of social and scientific design (Ahmed, 2008). This study intends to assist victim communities and volunteers in using and improving of a better sheltering procedure from a social standpoint.

1.7. Research Gap

Researchers have explored transitional shelters in the context of humanitarian aid. A few researchers have studied best practices of transitional shelter and explored the concepts of modularity and choice of material (Bashawri et al., 2014; Batchelor, 2011; Boen, 2004). Transitional Shelter contribute to the concept of *Build Back Better* and evidence of innovation in shelter design is observed. It was found that no earlier researchers have studied the

importance of transitional shelter specially in the context of Northeast India. Hence, there arises the importance of exploring transitional shelter with participatory approach of design.

1.8. Aim and Objectives

The research aims to explore Post-Disaster Shelter design development for the flood-prone areas of the Brahmaputra Valley, Assam. A set of research objectives have been identified from two main areas, one being the transitional housing process and the second of a transitional shelter solution to highlight possible areas for improvement:

- To investigate the theoretical and practical ramifications of a transitional shelter design intervention.
- To identify spatial design components and understand user requirements particular to recurring floods through community consultation.
- To determine the best materials, building methods, and design for a quick transitional shelter model.

1.9. Research Questions

1. What type of transitional shelter is appropriate in the context of Assam?
2. Who should be implementing these transitional shelters?
3. What type of methodology and strategy is required?
4. What is the social impact of Transitional shelter?

1.10. Expected outcome

The results of this research are relevant for both the social and scientific design communities, according to the different goals considered. From the social point of view, this research aims to support victim communities and volunteers in the application and development of a better sheltering process. Every year over hundreds of thousands of people get displaced by the annual flooding of the Brahmaputra valley. Further, there is a steep increase in the number of victims globally in natural and human-made disasters. The sheltering process plays a vital role during disasters, especially in the context of developing Asia. Studies show that an effective sheltering method would enormously benefit local economies and, consequently, the whole community affected by the crisis.

The shelter cluster of International Humanitarian Aid promises to provide shelter to millions of people worldwide from different countries and cultures. These victims have been pleading

for health, safety, dignity, and the hope of returning as soon as possible to everyday life. This research ambitiously seeks to contribute to the dreams of the millions affected by disasters.

From the design science perspective, a systematic episodic approach of design has been explored where the logistical (industrial, mass scale manufacturing, packaging, stocking and delivery), technological, scientific, socio-cultural and application of local resources of material (Bamboo in the specific context of post-disaster flood in the Brahmaputra Valley) along with community participation have been investigated in detail. Post Occupancy Evaluations have been part of the prototyping phase where aspects of user comfort, assembly time, strength and durability of the structure have been analyzed in detail.

The second part of the study is the development of a set of guidelines specific to the post-flood situation in the Brahmaputra Valley is essential because the preparatory measures and early preparedness measures can contribute to the resilience in the built environment of the affected communities. The processes and products developed as part of the research focus on support for humanitarian aid organizations, be it the local community, NGOs, village or block level administration, as a strategic process that aims to save time and energy, thus contributing to a superior resilience plan for affected areas.

1.11. Structure of the thesis

The thesis consists of seven chapters,

1. The first chapter introduces the topic of the research with a brief background on Humanitarian Aid and Shelter relief. This chapter introduces explicitly the importance of Transitional Shelter, and its various qualities and features through a comparative study. The chapter also discusses the research gap, aims and objectives and the pertinent research questions involved.
2. The second chapter elaborates on the previous literature in the field of study. Humanitarian Shelter Aid design evolution has been discussed in this chapter followed by analysis of transitional shelters in flood-affected areas worldwide. Guidelines for shelter Aid are briefly discussed in this chapter.
3. The third chapter discusses the research methodology, a mixed method involving both qualitative and quantitative approaches.

4. The fourth chapter discusses the research context, the geographical location, hazard profile and building typology. A study of a flood-prone settlement and its salient features is made with a situation study of a displaced community.
5. The fifth chapter discusses the design development of transitional accommodation. Three scenarios for design intervention is explored of which the transitional shelter kit design is discussed in detail.
6. The sixth chapter discusses and concludes the findings of the research.



CHAPTER 2: LITERATURE REVIEW

2.1. Sheltering and Housing Recovery Aftermath a disaster

The phenomenon of housing recovery aftermath of a disaster is a very critical process involving a household and the community as a whole. Several dimensions of recovery have been explored by researchers which can be utilized to indicate the psychological and perceptual indicators of recovery related to either stress or a sense of loss. Regaining income, livelihood opportunities, employment, household amenities and household assets mark the primary objectives of the recovery process. While these indicators may seem to work fine at the household level, the problem at the community level is quite complex with its significant attributes to infrastructure and lifelines supported by transportation and accessibility, electricity, water and waste disposal. If a particular community lacks housing, the economic aspect of livelihood is lost as to where people would go for livelihood, and how they will continue the essential everyday services. The loss of housing after a disaster can impact all strata of the society, be it the high-income group or the low-income. Thus, the housing recovery is a highly critical process and all forms of housing, be it HIG (high-income group housing) or affordable LIG (Low-income group housing), are equally important (Havidan Rodriguez, 2006). It was in the year 1977 that the first research work focusing on post-disaster housing was published, titled “Reconstruction following Disaster” by Haas, Kates and Bowden. The research work was based on four case studies namely the San Francisco Earthquake of 1916, Anchorage Alaska Earthquake, Managua Earthquake and Rapid City flood. The study suggests that the housing recovery aftermath of a disaster takes place in four stages termed the “recovery response, restoration of the restorable, reconstruction of the destroyed for functional replacement and reconstruction for commemoration, betterment, and development with each period incrementally.” To date, there is no structured formulation of an ordered process of the successive stages and many a times, there is overlap among the stages of recovery (Haas et al., 1977; Rodríguez et al., 2007).

Sheltering the aftermath of a disaster is a significant challenge for governments, humanitarian agencies and the displaced community. Disaster relief shelters play an important role in reviving the life of the displaced community while ensuring personal safety, climate protection and giving a sense of security and protection from illness (Saunders, 2013). Post-disaster relief

shelters are often in the form of plastic sheets, tents, modular prefabricated shelters and or community spaces such as sports stadiums, schools, colleges and other places of worship. The duration of stay in this shelter ranges from weeks to years. Disaster Relief Housing is a multi-stakeholder issue, and therefore, it needs to take account of the physical location and the wants and needs of the likely users. Post-Disaster Shelters are widely accepted as a necessary means of relief and response following the aftermath of disasters such as earthquakes, floods and the like. However, it is not clear which type of shelter is the most appropriate to a particular context. As a result, the shelter solution is inappropriate climatically and socially not acceptable and expensive both in time and money (Barakat, 2003).

In addition, the design of shelters often overlooks the local technology of building and the available material (Hadafi and Fallahi, 2010; Johnson, 2007), and the standard of living in such shelters may not be acceptable while in some cases, it was difficult to relocate or re-use the shelter provided (Arslan, 2007).

Adequate shelter has a significant impact on human survival in the initial stages of a disaster (Humanitarian Charter and minimum standards in humanitarian response, 2018). Post-Disaster relief shelters are commonly roofed, secure, hygienic, and livable locations for the displaced people till they can go back to their permanent dwellings. Such shelters are lightweight which can be erected, dismantled and stored for future use (Arslan, 2007). A shelter and a dwelling serve different functions. While shelters provide a safe and secure environment to live in immediately after a disaster, homes involve everyday household chores and job routines (Félix et al., 2013; Johnson et al., 2006).

In 1982, Quarantelli offered a typology of distinctive forms of sheltering and housing: emergency sheltering, temporary sheltering, temporary housing and permanent housing. Emergency sheltering refers to the immediate need of sheltering aftermath a disaster usually for a few hours or an overnight in some cases (Rodríguez et al., 2007). Temporary shelters refer to a shortly displacement which is temporary in nature. Temporary housing is an improvement over temporary shelter which not only provides housing but also an opportunity to reestablish the day to day household routines and activities to a great extent. Finally, the permanent housing is the housing evolved or upgraded when the family can go back to their rebuilt sites or entirely shift to a new location occupying permanent residential facilities. Quarantelli further remarks that the housing phases are expected to develop in a phase wise manner with often overlaps and repetitive steps and jumps in the process with not very clear distinction between

each phase. In several instances, the temporary shelter transitions to temporary housing which again transitions to the permanent housing. At a community level often all the phases are seen to be existing at the same time. But in the humanitarian aid research perspective, the phases are often used to denote each stage of housing in the literature on Housing and Sheltering After Disasters (Johnson, 2007; Johnson et al., 2006; Quarantelli, 1991). However, the International Federation of Red Cross and Red Crescent Societies (2013) has added new categories such as transitional shelters, progressive shelters, and core shelters/one-room shelters to these.

2.1.1. Emergency Shelter

This type of shelter is the most basic kind of shelter support where the displaced population resides for a brief period of time, often a day or two. This shelter facility does not allow for preparation of food or prolonged medical aid (Félix et al., 2013; Johnson, 2007; Johnson et al., 2006; Quarantelli, 1991).

2.1.2. Temporary Shelters

This type of shelter is meant for short-term use. Temporary shelter includes a simple tent or a public mass shelter that is used for a few weeks after a disaster (Félix et al., 2013; Johnson, 2007; Johnson et al., 2006; Quarantelli, 1991). According to the (Saunders, 2013), the time that people spend in these shelters may be limited, so while building this form of shelter, timeliness should be prioritized, and expenses should be kept to a minimum.

2.1.3. Temporary Housing

This kind of shelter is frequently provided for lengthy durations, ranging from six months to three years. People affected by a disaster can resume their regular daily activities with the help of temporary housing, including rental homes and prefabricated units (Félix et al., 2013; Johnson, 2007; Johnson et al., 2006; Quarantelli, 1991).

2.1.4. Transitional Shelters

Displaced people create this kind of shelter after a disaster, and such ingenuity and self-sufficiency should be encouraged (Saunders, 2013). Transitional housing is frequently moved from a temporary location to a permanent one, improved into a portion of a permanent home, resold to generate cash to aid in recovery, recycled for reconstruction, and utilized for various purposes (Migration, 2012). Such transitional shelters are expected to serve for months or years (Yoshimitsu et al., 2013)

2.1.5. Progressive Shelters

This type of shelter is intended and built to be more permanent and upgradeable in the future through interchangeable structural components (Saunders, 2013).

2.1.6. Core Shelters/One-Room Shelters

This form of shelter is designed and built with the intention of becoming a permanent dwelling in the future, and it includes a foundation as well as all or some of the essential amenities, such as plumbing and various utilities (Migration, 2012). The purpose of this sort of shelter is to construct at least one or two rooms that meet permanent housing criteria and allow for future growth. However, these shelters are not intended to be full-time residences (Saunders, 2013).

2.1.7. Permanent Housing

A transitional shelter, a progressive shelter, a core shelter, or even a new house can be upgraded to permanent Housing (Félix et al., 2013; Johnson, 2007; Johnson et al., 2006; Quarantelli, 1991). Such dwellings should be designed in such a way that they are resistant and resilient to future hazards and disasters.

It is not yet known which style of shelter is best suited to various real-life crisis scenarios. As a result, when survivors' shelters are poorly planned, they may face a number of environmental, economic, technological, and societal challenges. Environmental concerns develop when designers fail to account for variations in climatic conditions, such as when simple tents are offered to survivors during the winter season (Félix et al., 2013; Johnson, 2007; Johnson et al., 2006), or when local materials and resources are overlooked (Arslan, 2007), such as a lack of hygienic water and air (Humanitarian Charter and minimum standards in humanitarian response, 2018), which leads to a significant amount of pollution (Johnson, 2007).

Economic concerns arise when the cost of a temporary housing unit exceeds the cost of rebuilding a permanent home. According to experts, such devices can cost up to three times as much (Hadafi and Fallahi, 2010; Johnson, 2007). The longevity of a shelter is another economic concern. Temporary homes are one example of a sort of shelter that is often only built up for a short time. However, these shelters frequently need amenities, services, and utilities like electricity, sewage, roads, and sanitation. As a result, the construction of such shelters is quite expensive, especially in less developed and developing nations, due to the high cost of the infrastructure required. Furthermore, shipping units has been a significant problem

because many shelters are produced in various regions or nations and need to be transported to the affected areas (Félix et al., 2013).

Technical issues include lack of room, poor design for storing units and materials, and unauthorized use of shelters following a crisis (Johnson, 2007). Additionally, certain types of units have more intricate designs than others and call for highly qualified personnel and equipment (Hadafi and Fallahi, 2010; Migration, 2012). When shelters are small, unpleasant, challenging to update, and made of isolationist materials, their performance typically suffers (Arslan, 2007).

Emergency sheltering is a spontaneous mode of housing solution that is often used to house a family for particular event in time. It is usually used in the event of an early warning of wind events often a tornado or a hurricane, in the form of organized shelter locations, which again, in the aftermath of an earthquake or a flood, could be places which did not get affected by the disaster (Rathi, 2010). In the literature, we often come across confusion as to if the emergency shelter is a spontaneous step in the recovery process there is a role for planning in the process or should they be preplanned like in case of wind events, and the same has been an issue among researchers, primarily Quarantelli. Usually planned areas of emergency shelters are often public facility such as stadiums, government schools and colleges (Bennett and Oxfam, 2008).

Often people are safe to go back to their habitats after the disaster has subsided and people are fine with going back to their daily routine. However, many times the effects of the disaster are felt for a longer duration with people not able to go to their houses immediately after disaster this is when the emergency shelter transitions to a temporary shelter. Temporary shelters are places where the victims of a disaster can be housed for a longer duration of time, thus resuming their daily activities of work, food, water and sanitation. To a great extent, security is an essential feature of this sheltering. But, many researchers criticize this form of housing because people don't tend to resume their life activities which were usually planned. In the regional context of Assam, we often see situations when the displaced community is provided with public sheltering, the community tends to continue residing in the facility way longer than intended, evidences of such settlement are still observed in parts of Kokrajhar District in Assam where sheltering for a tribal community provided way back in the 1991 are still functioning as camp near Gossaigaon due to the continuation of Aid and political reasons for not permanently housing them by providing land for housing, people continue to reside in such facility till today. We observe a housing situation here where people have been residing in transitional

accommodation way beyond the acceptable duration of such occasion. Bolin and Stanford states in their research that it is usually the weaker section of the society that take resort to the emergency shelter options. In contrast, others move with their friends and relative for support. The economically weaker section often don't have own land, and therefore to build back their houses is a complex issue with land being scarce, sometimes private and many times is lost in the erosion during flood and landslide. In several instance, these displaced people are observed to have migrated to urban areas where they are again challenged and compete with the already homeless people struggling for a living, and the sheltering needs take the form of squatters. In a study of squatters in the Udupi District of Karnataka in the year 2016, we found that over 80% of the population living in the squatters had moved to Udupi in the 1984-85 from the Belgaum region of North Karnataka when a Draught Disaster had greatly affected the livelihood of the people. Since then, people have been residing in temporary shelters on governments/ private land for rent building basic shelters using locally available sheltering material in clusters of 100-120 shelters per cluster (Bolin, R., and Stanford, 1991).

We realize that temporary shelter and housing in transition is a sensitive event that often leads to the squatting of the displaced population in the public facility site, which is planned for a very short period.

From the international example of the Pre and immediate post-impact of Hurricane Katrina in the New Orleans area in 2005, we observe a tenuous difference between emergency sheltering and temporary sheltering. For the economically weaker people often, emergency sheltering can extend in time to temporary sheltering, thus extending the duration of housing in transition. For instance, as a precautionary measure before the event of Hurricane Katrina many residents took refuge in locations outside of the city. Still, a significant group of people for whom leaving their location was not feasible took shelter in the Superdome, disaster relief community shelter. The Superdome was planned to give emergency relief while the storm and strong wind subsided, it was intended that people could go back to their homes (Peacock et al., 2007).

However, several people could not reach up to the facility due to lack of transportation, or personal inability due to physical disability, emotional awkwardness and other personal reasons. Though their houses survived the minor damage due to the hurricane, the subsequent flood that followed the event required people to shift to safe places. While rescue team managed to move people from stranded locations to the Superdome emergency housing facility soon, the emergency shelter facility, which was planned for a brief duration, transformed in to a

temporary shelter providing shelter to a vast number of populations in a congested environment. The people who resided in the Superdome had very little resource to rebuild or seek housing on their own and thus this group of economically poor group of people were completely at the disposal of the external Aid for their shelter need in safer location (Havidan Rodriguez, 2006).

Emergency Sheltering, and temporary sheltering is a social process, and it is never static. Much research on the changing behavior of sheltering needs after disasters have been made by researchers with examples mainly in the western context or in the context of the developed. Even in such literature, the duration of a particular type of shelter is not defined. The recent guidelines for temporary housing after disasters by the People in Centre (PiC) throws some idea into the Indian context. But from the findings of the literature review it is clear from the studies that most people who are affluent move in paid accommodation option or reside with their friends and family for sheltering and it is the problem of the economically weaker section of the society who need support with shelter. From the review of literature, we find that time plays a significant role in the sheltering process, while one form of emergency shelter transitions to a temporary shelter, till people can resume their daily activities (Osman A and Sebake N, 2010). The factor of time is a variable which is very difficult to define and changes from context to context.

The key distinction between sheltering and housing is the resumption of household activities and responsibility (Quarantelli 1982). With temporary housing, routine day-to-day household activities are reestablished, and those in temporary housing wait for permanent housing, either return to their pre-disaster homes or some type of alternative housing solution (Tierney, Lindell and Perry 2001). For those with the most extensive damage, temporary may be anywhere from weeks to months to years. According to some research the journey from temporary to permanent housing still remains an area less explored. In the United States the process is pretty organized where housing is funded by FEMA or the Department of Housing and Urban Development unlike in Asia where a number of funding agencies and donors aid in the shelter response in support of the local administration and the non-government organizations.

Financing of Post Disaster Housing: Though insurance policies are available to cover catastrophes but financing post disaster housing needs of the entire community is not a feasible concept and these needs are usually catered by humanitarian agencies which work in

participation of the government and the public. Moreover, no policy covers damages occurring due to recurrent annual floods in the prone areas.

A brief study of transitional shelter and its characteristics have been discussed in Chapter 1.1, where a humanitarian perspective of transitional shelter has been discussed. From a humanitarian perspective Shelter is seen as a housing process, and transitional shelter is an intermediate stage of this process that contributes to reconstruction. Many times, temporary and transitional shelters are simultaneously used to address the need. Terms like a makeshift, temporary and transitional are used to indicate a similar process where the duration of accommodation is considered temporary, ranging from a few days to a couple of months. “Emergency Shelter is temporary and intended to provide shelter for survival. Transitional Shelter implies something that is longer –term and gives space to carry out livelihood activities rather than just surviving,” as mentioned by Elizabeth Babister, Shelter Cluster Advisor.

2.2. Evolution of Humanitarian Shelter Aid Design

The origins of Humanitarian Design trace back to the late 1800s and the early 1900s, when social reformers focused their attention on the social housing conditions of the poor, which led to the development of building codes. The earliest evidence of organized Shelter Aid design was of the 5610 cottages designed by the Army Engineers to house the victims of the 1906 San Francisco Earthquake and Fires, which had then claimed the lives of over 3000 (Humanity, 2006). Housing itself has evolved as a continuous emergency in the past century, from the cycle of wars, natural disasters and poverty. Slums and squatters sprout as a result of displacement and forced migration induced by either urbanization or natural catastrophes (Store, Kate and Sinclair, 2006).

After the devastations of the first world war, to meet the demand of the acute housing shortage, there was the need to meet the new machine age and mass production. Famous Architect Le Corbusier expressed the latest thinking by expressing the house as “a machine for living in”. Maison Dom-ino is a basic, universal housing unit developed by a Swiss Architect around 1914-15, the walls of the unit were non-loadbearing thus, the internal spaces could be arranged in any way suitable to the users, therefore trying to achieve a universal housing design. Famous Architects explored this concept then to address the rapid housing needs in the post-war era of the early 1920s and 1930s. During this time, the first evidence of prefabricated housing was explored by Architect Walter Gropius who was heading the Bauhaus movement, and Bauhaus emerged as the centre for socially responsive architecture. The prefabricated housing

components were organized as “superblocks” to achieve community housing needs with an abundance of light in their context, which can be interpreted as for also ventilation in the tropical or Indian context. Several master architects have contributed to the need for the social housing, including the works of Buckminster Fuller who firmly believed that the future of housing was in mass manufacturing. He revolutionised the concept of the housing structure based on the strength of the gravity versus the use of suspended structures which will require limited materials. He developed the “Dymaxian House” embracing the principle of tension and trying to achieve more with less use of material and a “package toilet” that composted waste and converted it to methane. His explorations of tensile structures form the basis of modern-day humanitarian tents which work in the principle of tensegrity and contribute even to the tents used today.

During this time around the 1930s, we observe the shift from the conventional practice of Architecture design which happened with a brief from the client, to making architectural projects without clients. Around this time, we see the rise in mass housing in the form of apartment culture emerging.

2.3. Housing as a Manufactured Entity

Due to the rise of the automobile industry in the west, which had embraced industrial manufacturing during the 1930s, the next thing to be sought after was the mobile homes. In 1936 Wally Byam built the first Air streamed trailer, an aerodynamic embodiment of home on the road, which soon became an American icon with models very famously known as the Durham Portable homes. The concept of mobile homes was highly accepted by the masses, and today it contributes to about 25% of the total housing in North America, and in the United States to the number of such is projected to be over 8.8 million. The success of the mobile homes has been under debate for a long time but in terms of its application, despite the arguments have been able to make a breakthrough in the prefabricated housing industry. Just before the Second World War, American company Sears Roebuck and Co pioneered the sales of mobile homes out from a catalogue where the homes were sold in kit form with complete assembly instructions, which even came with a set of planters. The cost of kit homes was 40% less in price compared to conventional homes. The home kits by Sears used the conventional wood-frame type of construction in the beginning, and later they tried to explore the Glass and Steel, frame models. But due to the crash of the economy after the second world war, the kit home industry was left unexplored.

Social Act of Housing

The Social Housing Act of 1930 in England initiated the delivery of subsidized social housing for the one that was displaced by the First World War. This act triggered mortgage lending and a stimulated a building boom. One of the other aspects of the Act was the redlining of areas that were vulnerable and needed housing intervention.

World War II

Emergency Shelters became a priority just after the second world war, in which the number of civilians had outnumbered the military. Finnish Architect Alvar Aalto developed a temporary shelter system that could be trucked to the site and house four families with a central courtyard space. He also developed the model of '*ecoles volentis*' a form of flying schools to address the urgent housing need.

The aftermath of the second world war marked the rise of the non-governmental organizations (NGOs). However, the International Committee of the Red Cross was founded by Henru Dunant in the year 1860. Most of the Aid Agencies today functioning in providing Housing Aid were initiated during the aftermath of the second world war, namely Oxfam, United Nations, International Rescue Committee, CARE and religious organisations such as the Catholic Relief Services. The postwar period shows a significant increase of NGO work in development works, starting from providing sanitation, development projects and construction of low-cost housing. NGOs worked with the government to draw expertise in the specialized field, and sometimes an architect was employed, and most of the time an engineer was commissioned to design and manage the construction.

Though architects were called upon to address the design challenge of managing the housing need on several occasions, but due to the idealism and the often-utopian solutions proposed by the designer community, there was hardly any similarity between the objectives of the Aid workers who struggled to provide the basic amenities of a roof, water, hygiene and sanitation. What Architects considered a design challenge was considered an issue of planning and policy by the Aid workers.

Levittowns

William Levit constructed the first Levittown in 1947-51; during this post-war time most of the prefab building models had failed, yet there was a boom in the construction industry due to

the support of housing loans. Levittown became the most significant housing development of the time then. The project was significant in the humanitarian Aid Design due to the fact that it had been able to transfer the concept of assembly-line production from the factory to the building site. The Levittown consisted of 17,447 homes in a building site with workers building one after the other with supplies dropping in order.

2.4. Study of transitional shelter in disaster-affected areas across the world.

A focused study of Transitional Shelter in disaster-affected areas was made, which helped in identifying issues that were specific to flood disasters. We realized that the shelter design is a very specific situation and thus generic disaster guidelines may not be sufficient to address the housing need in the flood affected areas. A list of projects from contextually relevant locations of South East Asia have been studied from the various sources of literature, which help us identify specific issues.

2.4.1. Design for Temporary Shelters to Groups Affected by Disasters Related to Rainfall in the city of Eldorado, Brazil.

The research discusses a model project in the city of Eldorado which can be later replicated to similar context in Brazil. In the case of Eldorado displacement lasts about 7 to 14 days and the cycle repeats with annual frequency. The shelter project takes a collaborative approach in which the community is engaged in the design process. The primary objectives of the community workshops are:

- Preventing the subsequent disaster through preparedness
- Understanding Community activity during disasters
- Increasing awareness of community
- Generate a database of community resource
- Raising awareness about the potential qualities of a community to address to disaster preparedness and developing partnerships.

From the continuous engagement with the community while they were displaced and temporarily residing in community shelter we find that affected population knows ways to prevent and remediate the problems of temporary shelters but they need help to implement the solutions. From the participatory approach, the measures that were suggested by the community to deal with future floods can be listed as follows:

- Commitment to building shelters on high platforms with spaces for cooking and sanitation.
- Providing an early flood warning system so that they can plan their shelter needs.
- Considering holistic measures of constructing dams or embankments at specific locations.
- Capacity building on shelter management with proper distribution of relief material.
- Installing a large water reservoir and cleaning a public facility (Barbosa, 2013).

2.4.2. Shelter for Flood Relief in Pakistan

The year 2010 saw the worst flood disaster in Pakistan. Almost every province in the country was damaged, with 1.8 million homes destroyed. For the first few months, the government, supported by other funding organizations distributed tarpaulins, tents and other non-food items. The surveys indicated that 9% of flood-affected individuals stayed with host families, 13% in collective centres, 19% in planned camps, 10% in spontaneous settlements and 40% returned to, or remained in, their place of origin. Many schools were used as collective centres. Following an emergency response, a “one room shelter” approach was adopted after this disaster. This model was an incremental housing model in which beneficiary could built upon the shelter to suitable needs over time. The primary focus of the total housing was the construction of single rooms for those who could return to their homeland and the other was to make a transitional shelter for those whose land remained submerged in water. The One room shelter was made using locally sourced materials and engaging the local labour. The life span of the shelter, which were rebuild on the site where the family could return back, was 3to 5 years and while for the transitional shelter, it was for a few months till they were in transition. For the transitional shelter, the design allowed should be such that encourages reuse of material. However, the scale of the requirement for such housing was so massive that only 10% of the affected population had access to the shelter project (Corsellis et al., 2014; Sayed and González, 2014).

The implementing organization selected beneficiaries on the basis of the following

- Poor families with three or more children.
- Women headed households.
- Households supporting orphans or disabled families and chronically ill family members.

The design of the One Room Shelter was based upon brick and cement mortar columns. Each column was built on an individual foundation. These columns were aligned to support three steel girders and a traditional style flat roof of bamboo, reeds (Khick), plastic sheet and mud plaster. In terms of Land Tenure, the region has a feudal system of land ownership and the houses were encouraged to be of *kaccha* in nature.

2.4.3. Shelter for Typhoon Victims in the Philippines (Ravina and Shih, 2017)

Super typhoon Haiyan wreaked havoc on the Philippines in November 2013. Leyte, Samar, Bohol, and northern Cebu islands were destroyed by its 300 km/h average wind speed (Mori et al., 2014). The typhoon killed at least 7,000 people, severely damaged the economy, and made thousands of others homeless. Since then, a deliberate effort has been made to provide more durable homes. But in this endeavour, as the UN acknowledged, the needs of the victims were overlooked as they were never consulted (Davis, 2015). The humanitarian agencies, which are usually not native, are unaware of the local needs and available resources. To mitigate this issue and keep community participation as the motive, Ravina et al. designed the climate-resilient transitional shelter and named it 'I-Siguro Da-an'. The key features of the shelter should be:

- (i) easily movable and portable
- (ii) Readily improvable
- (iii) made of regionally-sourced and recyclable materials.

In order to provide a design solution for the shelter, the "reverse-engineering" process was



Figure 2.1-Siguro Da-an Shelter design (a) Lipak Version (b) Amakan applied, which entails starting with the shelter's structural component and using the architectural design principles later. The design was based on the 'Bent method' of construction, where the bents may be prefabricated or constructed in situ. A housing unit for five members was made using bamboo and coco lumbar as the building material due to their easy availability and familiarity with the community. There are currently two versions:

- (i) The Lipak version, of which consists of bamboo slits (Fig. 1.1a)
- (ii) The Amakan version, which consists of the native material called Amakan (Fig. 1.1b)

With the help of agencies, around 500 housing units were constructed. This shelter received increased acceptance from the families as these were built based on direct suggestions from the victim parties. The shelter's architecture allows for expansion by the demands of the families. The area below the shelter may be utilised to store various small farm animals because it was elevated above the ground. The family is able to expand their areas for a variety of uses because to the roof's slope and slanted walls (Ravina and Shih, 2017).

Using this design approach, shelters can be made quickly using locally available products using local labour and promoting local manufacturers and make these shelters an integral part of the recovery process as they have been built keeping in view the desires of the community at stake, thus avoiding the, often expensive and out of context housing solutions by the international aid agencies.

2.4.4. Post-Earthquake Responses in Indonesia (Drain et al., 2019)

A series of earthquakes rocked West Sumatra on September 30, 2009. 13 out of 19 districts were impacted, and over 250,000 homes were destroyed. Though experienced with handling disasters and building codes established, there was low quality of general construction for "Permanent" (masonry) buildings, "Semi-Permanent" (part masonry), and "Non-permanent" (timber or bamboo) dwellings due to restricted certification (15 per cent), poor compliance, and tax enforcement. NGOs provided emergency shelter in the form of tarpaulins, but Within the first two and a half months, only 170,000 households received emergency shelter. A transition shelter design was worked upon, with Timber frames being a prominent feature. Mostly, they were covered in tarpaulins, plywood, or lumber for the walls and palm roofing. Technical advice was frequently included in shelter packages. This allowed a shelter span of around 12 months and required only five labours for construction. The cost per household for the transitory shelter kits ranged from 350 to 500 USD. This shelter provides an effective short-term design option suitable in regions susceptible to significant seismic and wind loads. One

major drawback of the shelter design was that it did not have lateral stability. The foundations and frame will need to be reinforced, and the wood should be treated, if the shelter is updated, for example, by replacing the matting with roof sheeting or ply.



Figure 2.2: Temporary shelters build during 2009 earthquake in West Sumatra, Indonesia

After a later review revealed a lack of support for metropolitan regions, several organisations started operating cleanly there. Transitional shelter projects continued for more than nine months following the earthquake due to delays in material supply and limited capacity, which notably overlapped with the receipt of permanent restoration funds(IFRC/RCS, 2013).

2.4.5. Post Cyclone Shelter Responses in Bangladesh

On November 15, 2007, a cyclone named Sidr hit Bangladesh, wreaking damage on the towns and cities it swept through. There were significant losses in terms of human lives, goods, and means of subsistence. Housing harms were the most obvious, and Government of Bangladesh claimed nearly 1.5 million homes were destroyed in total. Various organizations stood by the people and the DER shelter working group undertook activities related to shelter reconstruction, repair and renovation. As of the end of 2008, several agencies were responsible for roughly 78,519 core and transitional shelters, with other shelter programs still under progress. This will cover around 5% of the 1.5 million damaged and destroyed homes' shelter needs. Coordination with the implementing agencies and the assignment of specific work areas were crucial parts of the local government's responsibility. There were, however, grievances concerning the government's and certain agency-assisted shelter providers on the standard of the materials received. Adding to the woes, building shelters for victims residing outside the tidal surge protection embankment and victims without their own land was difficult for the local implementing partner agencies with limited time and budget, which facilitated more relocations. The solution from the government side was providing barrack style, combined row

houses. However, in doing so, environmental factors, such as the protection of the green belt and embankments or the availability of water sanitation services, were frequently disregarded. Donor-driven shelter design did not always cater for the desires of the victims, and receiving assistance becomes cumbersome in most cases. Most agencies provided the contractor-built traditional shelter solutions as were prevalent in the areas inspired by previous incidents, and no new solutions were explored. The government of Bangladesh formed a committee involving the Engineering cell of the Directorate of Relief and Rehabilitation (DRR) to produce a prototype shelter design, but there was no clarity on the purpose as to what type of shelter, whether transitional or temporary or permanent. Another aspect of the problem was where to build the shelters. For victims with own land constructing a permanent resilient shelter was cost-effective but for victims, without any land, any type of shelter, temporary, transitional or permanent, was difficult as providing ownership to the shelter would have legal implications and needed further government intervention. One agency took up the challenge and coordinated with the government to allocate government-owned *khas* land for 140 families but only 33 shelters could be built. Most agencies preferred a transitional shelter as it would meet the immediate needs and would be inexpensive. A timber frame and CGI (Corrugated Galvanised Iron) sheet were enforced, owner built shelter was constructed, as shown in figure 2.3 (Flinn and Beresford, 2009).



Figure 2.3: Family shelter funded by the Kingdom of Saudi



Figure 2.4: Transitional core shelter built of timber frame structure with bamboo mat walls, CGI sheet roof and earthen/bricked plinth.

2.5. Flood in the Brahmaputra flood plain recurrence, siltation/ sand casting.

Flash floods, floods and siltation are annual water-induced hazards in the Brahmaputra basin in Assam. These catastrophic events leave people homeless and displaced, destroying crops and damaging public amenities. The local people residing in the flood plains have developed several mechanisms to cope with the annual flooding. These mechanisms are obvious in how they build their houses, and plan their agriculture, livestock rearing and food storage. From the study, adjusting to Floods on Brahmaputra plains, Assam, India, we find that vulnerable community build thatched, stilt houses and granaries on stilts. In contrast, some others build homes with high plinths with granaries on stilts. People store food in a three-layered smoked shelved and save money for flooding season. They keep informed about flood situations and warnings as preparatory measures as imparted from the disaster management authority and sometimes using their folk beliefs and observational experiences.

During floods, displaced families take shelter on high platforms close by or on the road, or on embankments with their cattle and other livestock. Transportation during floods is usually on rafts made from the trunk of the banana plant and they help each other in rescue and evacuation operations. Most of the villagers know how to swim, and they are also efficient in using boats and rafts. The community affected by floods are usually agrarian, and over the years, they have identified ways to do multiple cropping and also growing vegetables on the fertile soil left after the flooding season. Communities living beside the flooding are also engaged in daily waged labour, with a few involved in fishing, fish drying and making and selling of country liquor (often a cultural taboo) especially for tribal community people living on houses on stilts. In

their study, they found that a good number of male members of the community had migrated in search of jobs to several locations in the country.

2.6. Study of SPHERE Guidelines

In 1997, a group of NGOs and the Red Cross and Red Crescent Movement took the initiative to develop ‘The Sphere project Handbook’; a set of minimum standards to improve the quality of humanitarian response during disaster and conflict and enhance the accountability of the humanitarian system to disaster affected people. It was based on two core philosophies: “first, that those affected by disaster or conflict have a right to life with dignity and, therefore, a right to assistance; and second, that all possible steps should be taken to alleviate human suffering arising out of disaster or conflict” (Humanitarian Charter and minimum standards in humanitarian response, 2018).

In a strive to implement these beliefs into action, the Humanitarian Charter was framed, and a set of internationally recognized minimum standards was published as a handbook for the four life-saving sectors, namely: 1) Water supply and sanitation; 2) Food; 3) Shelter and settlement; and 4) Healthcare. Each of these key lifesaving sectors has been reflected in the Handbook’s four technical chapters. Though each chapter covers a specific industry but often there is an overlap within the chapters which has the ability to influence the outcome. Thus the success of the response lies in the correct coordination among all the sectors.

Noteworthy, although the handbook has laid down the minimum standards, it is not a law and does not imply meeting one and all the requirements. In nature, these standards are qualitative and are intended to set the goals, monitor progress and assess outcomes. It should be used as a tool to realize the gap between the sphere indicators and reality, understand its reasons, and assess its fallibility, to be able to take congruous actions to assuage outcome.

The Universal Declaration of Human Rights has stated “ all human beings are born free and are equal in dignity and rights; have the right to a standard of adequate living, which includes food, clothing, housing and medical care; as well as the right to security” [(UN, 1948)] However dignity goes beyond physical well-being. It encompasses the respect for psychosocial well-being as well. To accomplish this and fill the gaps, Humanitarian responses must abide by these basic principles, namely:

1. Avoid exposure to further harm;
2. Impartial assistance
3. Protection from violence and

4. Assistance for rehabilitation.

To aid this goal, the Sphere handbook acknowledges that the affected population should be an integral part in decision making which is possible when affected population has access to safe shelter/community places during disaster or conflict.

2.6.1. Shelter, settlement and non-food items (NFI), one of the key life-saving chapters in the Sphere handbook. Shelter ensures personal safety, assures refuge from the external environment, resist diseases and assist recovery. It offers privacy, which is vital for human dignity, and serves as the springboard for self-sufficiency. The “Minimum standards in shelter, settlement and non-food items” is one of the technical chapters covered in the Sphere handbook that, for the purpose of this specific work, will be deeply discussed.

NFIs, include clothing, bedding, household, and shelter support items. From the architectural planning point of view, disaster-affected population will need access to safe, fuel-efficient cooking facilities. Nevertheless, for safety purposes, it might be easy to manage adequate ventilation and fire safety in communal cooking facilities than in individual arrangement for each household. Thus, depending on the shelter solution, shelter support items, such as construction materials, tools and fixings as well as technical guidance, whenever required, should be part of the relief assistance packages. According to the Sphere, basic standard adequate living can be translated into:

- Ample space
- Protection from environmental and health hazards
- Readily available, affordable and accessible services, facilities, materials alongwith habitable location which is culturally appropriate.
- Sustainable access to natural and common resources, including safe drinking water and energy for cooking, heating and lighting; sanitation and washing facilities; means of food storage; refuse disposal; site drainage; and emergency services
- Suitable arrangement of settlements and housing to allow safe access to healthcare services, schools, childcare centers and other social provisions with relevant opportunities to earn a livelihood

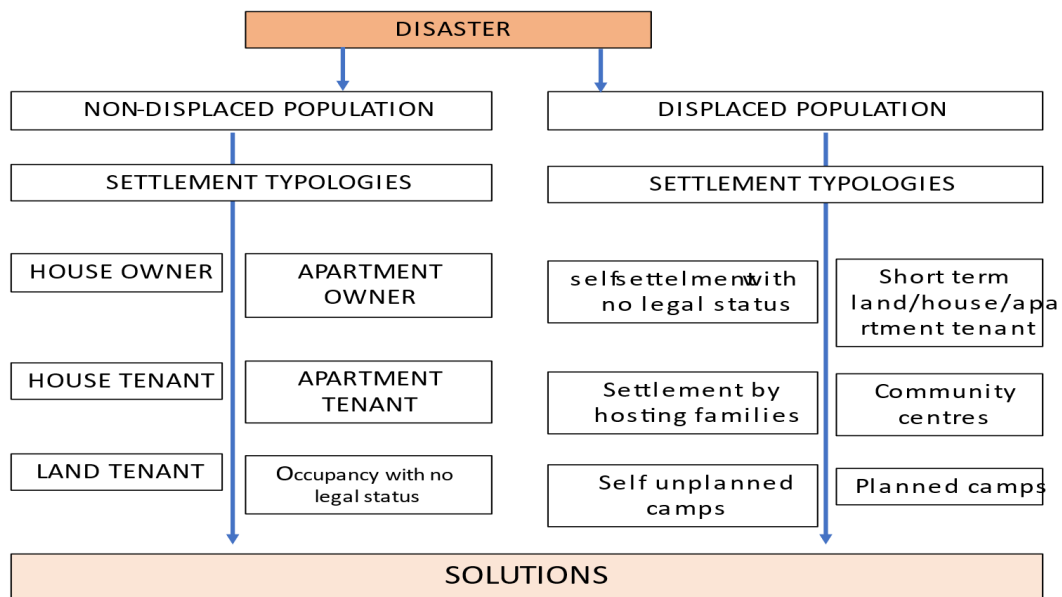


Figure 2.5: Settlement typology post disaster

As a part of a rapid response during times of disaster or emergency, it becomes imperative to arrange for quick shelter solutions. In such circumstances and depending on other factors (logistical support) they could either be settled in public buildings used as community centers, be hosted by families or be accommodated in existing planned camps. However, wherever feasible, the disaster-affected population should be assisted with transitional shelter near their original homes as possible. It will enable them to reconstruct and repair their homes and maintain their livelihoods and social connections.

2.6.2. *Water supply, sanitation and hygiene promotion (WASH)*

Water is one of the essential basic necessities to sustain human life. During times of disaster, easy access to clean and potable water can make a dramatic difference. Besides providing life support to prevent dehydration and an important commodity for activities of daily living, it may be a source of many communicable diseases which can lead to significant public health hazards during times of an emergency/disaster. Though the amount of water required depends on many factors like the weather, type of activities undertaken, individual habits etc., the following table illustrates the basic survival water needs per the Sphere handbook.

Survival needs: water intake(drinking and food)	2.5 to 3 litres /day
Basic hygiene practice	2 to 6 litres/day
Basic cooking needs	3- 6 litres/day
Total basic water needs	7.5 to 15 litres/day

Figure 2.6: Water requirement in post disaster settlements

From a planning perspective, the idea should be that each water access point should be nearby (no more than 500m from each household), and the queue time can be restricted to 30 minutes. The following table illustrates the recommendation by the Sphere.

Another aspect of planning a transitional shelter is the prompt availability of public toilets and an effective faeces disposal system. This helps not only in maintaining personal privacy but also restores cultural dignity and helps prevent faecal contamination and disease transmission. It has been suggested that one toilet should be made available for 20 people, and this should be organized based on gender. Further, all faeces disposal and containment arrangements should be at least 30 meters away from the ground water source and 1.5 meters above the water table (Humanitarian Charter and minimum standards in humanitarian response, 2018).

While designing a solution, it is also essential to provide the provision of correct solid waste disposal and water drainage to prevent vector-borne diseases. From a planning point this should include:

- 100 litres refuse container per 10 household
- Appropriate marking and fencing of refuse pits or bins in a specific area
- Less than 100 metres distance of the household refuse pit/area to the area of burial or incineration (Ginjeira do Nascimento, 2015).

2.6.3. Food security and nutrition

Adequate food and nutrition are a pre-requisite for a healthy community and can prevent morbidity and mortality indirectly. During disaster, food security becomes a humanitarian duty. However, from a planning point of view, the provided food should be -quick to cook, and require less fuel, commodities (water, grocery etc.) and accessories (utensils etc.). Storehouses should also be a part of the planning. In case community cooking is practised, distribution points are provided in locations near to other facilities like hand wash areas, toilets and shade.

2.6.4. Health action

A medical emergency response, along with other health care facilities, should be present at times of disaster not only to mitigate direct consequences of a catastrophe like death or injury but also to alleviate suffering from infectious diseases and malnutrition. Proper health care can prevent indirect impacts of overcrowding, inadequate ventilation, and poor quality and quantity of water and sanitation (Ginjeira do Nascimento, 2015). These can lead to better living conditions and survival rates among disaster-affected population.

The post-disaster response should be able to provide for (Humanitarian Charter and minimum standards in humanitarian response, 2018):

- one essential health unit/10,000 population (basic health units are primary healthcare facilities where general health services are offered)
- one health centre/50,000 people
- one district or rural hospital/250,000 people
- more than ten inpatient and maternity beds/10,000 people

2.7. Available guidelines from National Disaster Management Authority

In the Year 2019, the national guidelines for temporary shelters aftermath of a disaster were published by National Disaster Management Authority. According to this guideline, temporary shelter is considered equivalent to transitional shelter, where the concept of the durability of the top is for a brief period. Though this form of shelter housing is for a short period of time, care should be taken to build these shelters such that people can reside comfortably for a brief period till they can return or rebuild their homes. These guidelines use the term *temporary shelter* across the document to have consistency with the National Disaster Response Force and State Disaster Response Force (NDRF/SDRF) guidelines and the National Disaster Management Plan (NDMP).

The guiding principles according to this document can be listed as follows:

1. Recovery from a disaster is an entitlement of the affected people. All stakeholders, including the affected community, should have transparency in the providence of shelter aid, amongst other relief.
2. It is found that affected families are often left out in the housing process as they go through the trauma of losing a home and are treated as victims over being a human resource. It is the need of the hour to consider affected families as resources and involve them in the housing

process. There is a need to understand the capabilities of the affected families as they are highly resourceful in how they build their homes, the local wisdom and other resources. Involvement of the community in the rebuilding process gives a sense of ownership which has been also found to be therapeutic.

3. The shelter facilitation process needs to be inclusive so that no one is left behind. Especially vulnerable communities, mainly physically disabled, women households and other marginalised groups from different lower cast backgrounds.

4. The nature of temporary shelters should be such that there is no further damage from natural forces.

5. Use of materials and technologies that are local needs to be encouraged. The local materials include the retrieved, recycled and repurposed from the damaged houses. When people are involved in the building process using local techniques, the housing process is faster, more efficient and has a sense of ownership.

6. The guideline mentions that we cannot have one universal design but several good and suitable designs that may apply to specific scenarios.

7. Temporary shelters should be durable enough till the affected families can rebuild their houses. Every scale of the disaster is different. Some may need complete reconstruction and while others may involve a few repairs. Shelter options should cater to the scale of the disaster.

8. Socio-technical facilitation of the shelter process is not just a matter of specific tools and techniques but requires a mindset and perspective of enabling the community. Facilitators – social or technical – should work with an attitude of serving the entitlement of people and allowing them to make their own decisions on a sound and rational basis, establish mechanisms to support their access to materials, skills, land, finance and knowledge. If the process is facilitated well, it makes the community to take up the responsibility and ownership of their disaster-resistant intermediate shelters, making it a stepping stone for permanent housing reconstruction.

9. If collective community efforts are facilitated well, and in a timely manner, the early recovery shelter process can become an active precursor to an effective owner-driven housing reconstruction program later. In the immediate aftermath of a disaster, collective synergy amongst the affected communities is high, which, if not used positively for recovery, dissipates quickly. Therefore, the shelter process must promote and involves self-help and community support.

2.8. Findings from the literature survey

From the study of literature starting from the evolution of post-disaster shelters and settlements and government guidelines for temporary shelters, and national guidelines from relief camps. We find that a great number of design options have already been developed and guidelines have also been made. However, shelter design is often a post-disaster phenomenon where execution happens after the catastrophe has already occurred, irrespective of preparedness of agencies.

The main aim of a transitional shelter is to provide relief for a short duration of time, providing the post-disaster victims adequate personal space, hygiene, dignity and a sense of home, but not converting into a permanent settlement. The previous designs, though ambitious failed to address the needs of the community, which can be ascertained by active participation of the public, which infuses in them a sense of responsibility.



CHAPTER 3: RESEARCH METHODOLOGY

The term Research Methodology depicts the Systematic approach used to determine the established scientific techniques used to investigate research problems. It is necessary to select the most suitable methods for solving a research problem in order to obtain reliable results.

3.1. Choice of Research Method:

Research in the area of design is often multidisciplinary and involves the consideration of many different factors, including social, psychological and economic aspects, along with engineering and technology. A design research which looks at the reconstruction and recovery phase of disaster management, as in the case of the current research, can be classified as social science-based research (Rohrmann, 1998). Therefore, it is necessary to choose one or several research methods that are best suited to involving both qualitative and quantitative methods. Quantitative methods can cover a broader range of situations, which are fast and economical, and they provide statistical results which can be helpful to and more precise when interpreting results. However, quantitative methods require inflexible research methods and do not assist in understanding processes and variable human responses. Qualitative methods allow flexibility in data collection and provide the ability to observe situations over time and understand human aspects more deeply.

A mixed approach of 'episodic' research has been considered for this study. The findings from the prior study was followed by casual observation, which was then developed into a formal research proposal. The main focus of this research is Transitional Shelter, wherein the initial stage field study was made to observe and document how the physical environment affected the behaviour of the disaster-affected people. Focus group interviews involving multiple stakeholders were done, where users were asked to share their ideas for the design of transitional accommodation. The structured exercises of group design were continued for a long duration of time to discover the outcomes in the form of models which helped us derive a set of strengths, concerns, issues, constraints and their resolutions.

Consideration of Research Questions and objectives while choosing the appropriate research methods it is essential to understand the nature of the research questions and the research objectives (Aberdeen, 2013). Classified research questions based on whether they are why,

how or what questions in order to decide upon the use of qualitative or quantitative methods. Why and how questions are best answered through qualitative approaches.

The research questions addressing the research problem being investigated in this study are

1. What type of transitional shelter is appropriate in the context of Assam?
2. Who should be implementing these transitional shelters?
3. What type of methodology and strategy is required?
4. What is the social impact of Transitional Shelter?

Table 3.1: Shows the research questions with the research objectives

<i>Research Question</i>	<i>Research Objectives</i>
What type of transitional shelter is appropriate in the context of Assam?	To investigate the theoretical and practical ramifications of a transitional shelter design intervention.
Who should be implementing these transitional shelters?	To identify spatial design components and understand user requirements particular to recurring floods through community consultation.
What type of methodology and strategy is required?	To determine the best materials, building methods, and design for a quick transitional shelter model.
What is the social impact of Transitional Shelter?	To investigate the theoretical and practical ramifications of a transitional shelter design intervention.

Adopting a mixed method approach for the study since the research questions comprise of what and how questions, both qualitative and quantitative approach seem appropriate.

Mixed method research uses a combination of qualitative and quantitative approaches to perform research (Tashakkori and Creswell, 2007). Tashakkori describes mixed method

research as having the ability to answer research questions in more depth than could be answered using a single form. Mixed method research is also helpful as a method of triangulation of data to confirm and verify data gathered in different ways, as well as for reliability and validity of the findings.

3.2. Research Design

Based on the rationale described in the previous section, a mixed method approach consisting of both qualitative and quantitative approach is used to answer the research questions and meet the research objectives of the research. The data sources and actions taken to meet the research objectives of this study are shown in Table 3.2. As defined by Creswell, the mixed method strategy is used in this research as a sequential exploratory strategy where the first phase of research involves qualitative data collection and analysis followed by a second phase where quantitative data is collected and analyzed to build on the results of the first phase. The complete research process used for this study is depicted in Figure 3.1.

Table 3.2: Research Methods Corresponding with Research Objectives

Research Objectives	Data Sources	Action taken
To investigate the theoretical and practical ramifications of a transitional shelter design and intervention.	<ul style="list-style-type: none"> ○ Literature ○ Books ○ Government Report ○ NGO publication ○ Conferences ○ Field Trips 	<ul style="list-style-type: none"> ○ Literature Review ○ Participation in Disaster Management conferences ○ Field visit to sites where people reside in disaster rehabilitation, specifically to Chirang District, Bodoland, Assam
To identify spatial design components and understanding user requirements particular to recurring floods through community consultation.	<ul style="list-style-type: none"> ○ Field Trips to Vulnerable Areas pre-disaster ○ Studying the built typology of vulnerable areas ○ Field Trip to places affected by the flood disaster in Assam 	<ul style="list-style-type: none"> ○ Semi-structured and open-ended interviews. ○ Observation. ○ Documentation
To determine the best materials, building methods, and design for a quick transitional shelter model.	<ul style="list-style-type: none"> ○ Case Study ○ Literature ○ Participation of Local Community 	<ul style="list-style-type: none"> ○ Literature Review ○ Co-Design with the community ○ Design of transition shelter

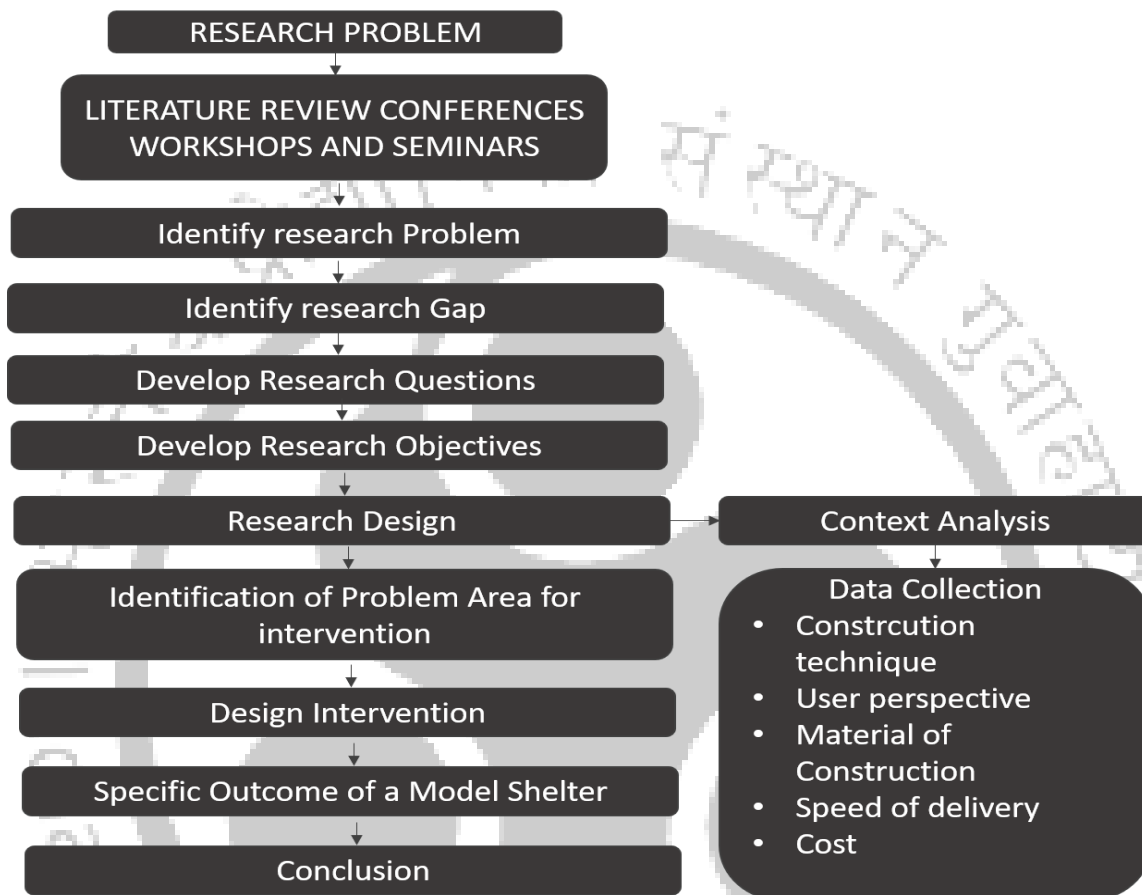


Figure 3.1: Research Process

The following section describe the qualitative and quantitative research used in this study in further detail:

3.3. Qualitative Research Phase

Data Collection:

Maykut et al. stated that valuable methods of data collection for qualitative studies include in-depth interviews, group interviews and document analysis (Maxwell, 2008; Maykut and

Morehouse, 2002), added that collecting information from a variety of sources serves as a method of triangulation adding validity and reliability to the results of the study.

Data Collection for the qualitative study of this research adopted two methods:

- Semi-Structured in-depth interviews
- Analysis of Documents

Semi-Structured in-depth interviews:

Interviews allow exploratory responses to be sought for research questions to obtain an exhaustive view of the subject. In-depth interviews also provide the researcher the ability to explore and uncover new directions based on the responses of the interviewer (Maykut and Morehouse, 2002).

Semi-structured in-depth interviews were conducted for the list of stakeholders who were listed based on importance and influence in the stakeholder analysis. The main objective of these interviews was to –

- Identify the key components which constitute successful relief in the post-flood scenario.
- Recognize the practical issues which arise in post-disaster reconstruction that prevent ideal situation of relief and reconstruction.
- Determine solutions on how these shortcomings can be improved.

The sampling of participants for data collection can be based on either formal or substantial criteria (Flick, 2014). Formal criteria are drawn by representatives of a sample for the population, while substantial criteria use theoretical or purposive sampling based on specific features of an individual or group and its relevance to the research being conducted. This research study employed theoretical sampling where individual and groups were selected according to their level of knowledge and experience for developing the findings for this study. A total of 15 stakeholders were interviewed. Participants for the study were obtained primarily through contacting different organizations who were critical stakeholders in reconstruction and recovery via email, telephone and physical visits. An explanation of the research project was provided during initial contact, and an invitation to take part throughout the study was made. Further participants were secured through helpful recommendations from the primary contacts initially acquainted with.

Although not all stakeholders contacted were able to participate, a representative range of stakeholders from key organizations involved in post-disaster reconstruction and recovery. Personal interviews were arranged with stakeholders who agreed to participate in the study. The stakeholder interviews were from a range of local, national and international level authority and organization who were directly or indirectly involved in disaster management activities. The NDMA (National Disaster Management Authority) and ASDMA (Assam State Disaster Management Authority) are national-level and state-level government regulatory authorities responsible for carrying out relief and reconstruction activities.

Interviews from NGOs and international organisations were chosen as they dealt with affected communities. Finally, participants from different sectors were interviewed to understand the prevailing disaster management practice in the state in response to the annual floods.

Table 3.3: List of stakeholders

No of Participants	Organization
2	ASDMA (Assam State Disaster Management Authority)
1	OXFAM (Oxford Committee for Famine Relief)
3	IGSSS (Indo-Global Social Service Society)
2	Habitat for Humanity
2	Aranyak
2	DASTR
1	Amrapari
1	UNICEF (United Nations Children's Fund)
1	Mother Shelter

Participants were interviewed using semi-structured questionnaire for the approximately one-hour duration. The semi-structured questionnaire was used to provide some structure for the interviews whilst still providing the freedom to proceed further and explore certain concepts as required.

3.4. Analysis of Documents

The analysis involved the evaluation of documents relevant to post-disaster reconstruction and recovery activities. Post-disaster reconstruction and recovery-related documents, including program reports, commissioned reports, government reports and guidelines, were examined as part of the analysis of documents. The list of characteristics for transitional shelter was also made based on this study.

3.5. Analysis of Data

A number of different ways to analyze data obtained from case studies, pattern matching, where patterns are established between collected data and predictions, and explanation building which is an iterative process where an explanation is built about the case study over time, starting with an initial theoretical statement; where changes in dependent and independent variable are studied over time and where data from different case studies are compared using a uniform framework.

The data analysis for this study was conducted using a combination of approaches- explanation building was used where theoretical principles for transitional shelter were generated in the second chapter, and recommendations from the literature were built on iteratively using data collected from the case studies. Cross-case synthesis was also used to perform comparison of findings between the case studies to determine universal principles and propositions for transitional shelter.

3.6. Design as Analysis and Evaluation

Following the concept of 'black box' by John Chris John, we realize that the design process is shielded from the eye of research. In order to reduce the mystery of the black box we need to know as much as we can going in to the project and then evaluate the outcomes of the project so that we can be more and more informed about the next (Groat and Wang, 2013). This we strongly agree as programming and, for the purpose of this study, 'architectural programming'.

The purpose of this scientific method is to create accurate and reproducible results. This model mostly discusses the pre and post-data analysis, and therefore the following approach has been considered for the venture into the design process (Figure 3.2). The questions of the model are procedures of scientific methods that give traction to the operation of identifying questions, collecting data, organizing experiments and documenting the findings.

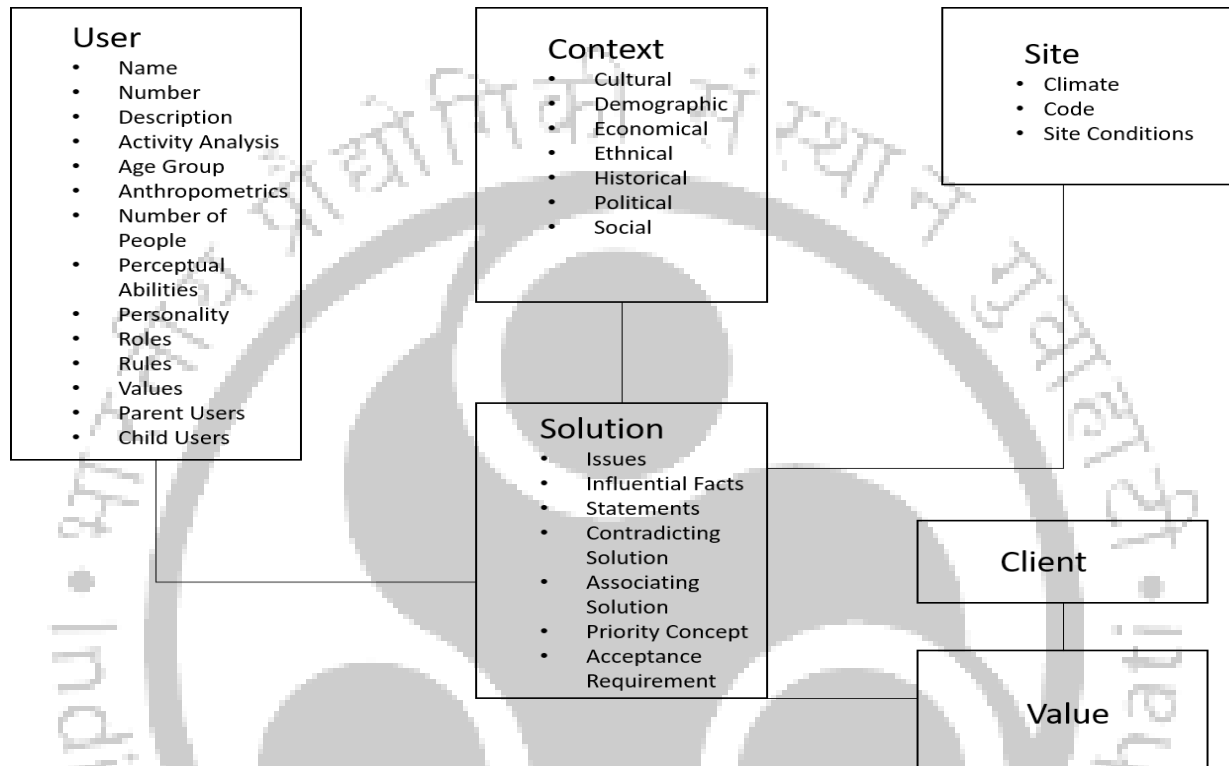


Figure 3.2: Duerk's Diagram

The other end of the design process is post-occupancy evaluation, mostly known as POEs. POEs lead to a great understanding of existing design with cost savings and user acceptance. POEs are divided into three levels of complexity:

- *Indicative*- Indicative POE is one that analyses as-built drawings, indexing them to such factors as safety and security records.
- *Investigative*-Investigative POE goes one step further by comparing an existing situation with comparable facilities as well as a summary of current literature.
- *Diagnostic*-Diagnostic POE involves multimethod tactics ranging from surveys, observations, physical measurements and user interviews (Preiser et al., 2015).

3.7. Design as Action Research

‘Action Research’ is a term given to studies that examine a concrete situation, particularly the logic of how factors within a particular situation relate to each other as the process moves towards an empirical goal. The emphasis is upon knowledge emerging from localized settings against abstract scenarios. Action research arises out of the social sciences having its roots in the work of sociologist Kurt Lewin’s notion of ‘field theory’, which primarily believes that theoretical knowledge and practical knowledge must inform each other in a concrete context for the establishment of a true endeavor. The emphasis is upon the establishment of a design venue, a kind of microculture, which is complete with ways of doing, implicit understandings, technical terms and other logistics that may arise in the midst of creating a design. A reproduced version of Duerk’s diagram is seen in Figure 3.3, Gerald Susman’s action-research diagram. We can overlay this model with Duerk’s model to fulfil more content.

In the context of the study of transitional shelters, it is helpful to consider the Susman’s cyclical process of diagnosing, action planning, action taking, evaluating and specifying.

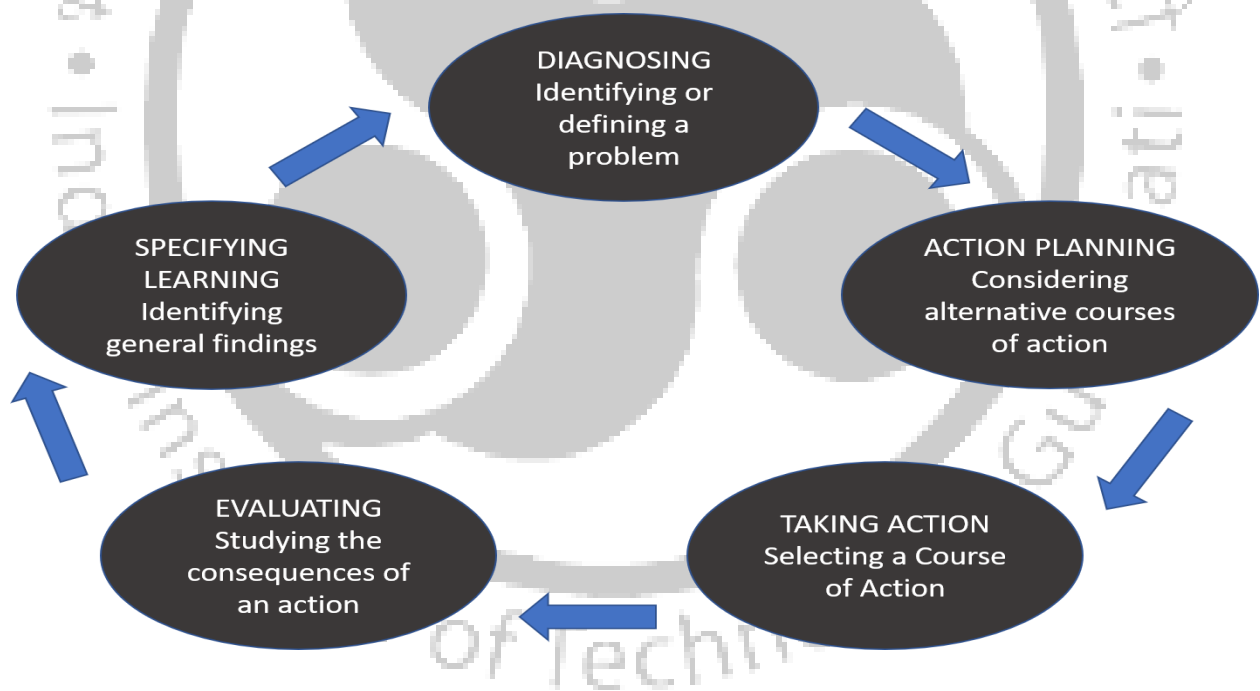


Figure 3.3: Gerald Susman’s action research diagram

Susman’s cycle describes what designers go through in the design process. If we try to refer to the Figure 5.8, where the initial drawings of a transitional shelter kit were made and to Figure 5.9 is the sketches of the kit transitional shelter which was developed into a model, we realize

that this transformation occurred because of some process of diagnosing, action planning, action taking, evaluation and specification had taken place? Action research can uncover these embedded stages in the iterative design process.

3.8. Design as a Learned Skill

Designers commonly rely not so much on precise theory as they do “on experience and rules of thumb”(Jones, 1992). Architects, when given design problems with very complex programmatic and social-cultural considerations, nevertheless tend to start by proposing very simple schemes. These schemes are then analyzed, tested, analyzed again and again until a more responsive scheme emerges as the process of integrating a cluster of requirements. Thus, the approach of conceptualizing the coexistence of design with research in order to establish design as a learned skill. The idea is rather than speculating on the abstract of a ‘black box’ of design, we should learn how to do it better by practice, by a more explicit awareness of the attributes that characterizes a design in general, followed by a reflective assessment of the process.

3.9. Design in Collaboration

In architectural design, design emerges as a result of a team effort as opposed to a single architect. Considering the problem of transitional shelter to be architectural in nature where multiple stakeholders having industrial expertise, technical expertise, material expertise, contractors and contributions of the community have been considered in the form of organized consultation. These bring up the issues of the role of the architect as the designer in the larger context of the design process. From several studies, it has been evident that we need to move away from the model of the architect as sole technician, the one that is sensitive to a larger communal mission of well-being.

Thus, going by the Groats model of architect-as-cultivator where an architect designer encourages:

- Emphasizes the process where the designer works in a spirit of collaboration and participation.

- Interdisciplinary design is encouraged, involving multiple stakeholder, precisely the community.
- Sensitive to the culture as the soul of the design, with the designer motivating the team to recognize that the thriving environment can only be realized by fully engaging the social and the cultural context in which the design is placed (Groat and Wang, 2013).

3.10. Episodic Ways of Relating Research to Design

Drawing the connections between the above models, we connected different models. Duerk's cyclic model of programming was informed by Susman's diagram of action research. The architect-as-cultivator was explored in the participatory design exercises held with community participation. Finally, to establish the design process as a framework for future iterations has been explored.

Table 3.4. Putting a timeline to the 'episodic' approach of Design Research

Months	Design Development of a Kit Transitional Shelter considering any post-disaster situation in northeast India
1-2	Literature Survey, Case-study
3-4	Design Brief Formation based on international humanitarian standards
5-6	Preliminary Design Development
7-8	Design Detailing and Prototype Development
	Revised Design Research focusing on Design of Transitional Shelters specific to the flood-prone areas of Brahmaputra Valley
9-12	Extensive field studies in specifically identified locations, literature studies, data collection, Surveys and interviews
13-16	Data analysis and exploring design exercises using user participation
17-20	Design iteration

CHAPTER 4: CONTEXT OF RESEARCH AND CONTEXTUAL STUDY

The hazard profile of the State of Assam is studied, followed by a brief building typology study by selecting five built forms from vulnerable districts of the region. A total of seven building typologies were identified in the typology study, of which three indigenous building typologies are discussed in detail to establish their potential towards disaster resilient development. Assam is situated in the northeastern part of the sub-continent India, at the foothills of the Himalayas. It is the largest state among the seven northeastern states. Commonly known as the gateway to the North East, the state is connected to the mainland by a narrow corridor in West Bengal that runs 56 km below the foothills of Bhutan and Sikkim. According to Census 2011, Assam has a population of 3.12 crores and an area of 78,438 sq. km (The Registrar General and Census Commissioner, 2011).

4.1. Geographical Location:

The state of Assam is an important geographic location in North East India which connects the other eastern States with the rest of India. It is situated between $89^{\circ}5'$ to $96^{\circ}1'$ East longitude and $24^{\circ}3'$ to $27^{\circ}58'$ North Latitude and is surrounded by hills on all three sides. The State shares international boundaries with the Kingdom of Bhutan in the North and Bangladesh to its west.

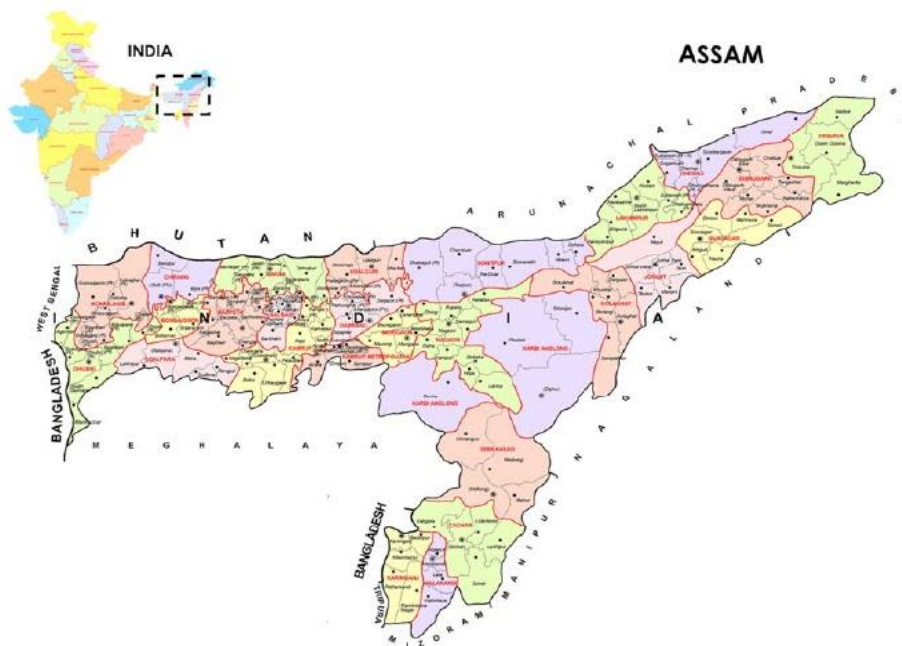


Figure 4.1: Location map of Assam (Source: Assam State Disaster Management Authority)

4.2. Demography: Assam is the 14th largest state in India. Assam is divided into 35 districts. As per the 2011 census Nagaon district is the highest populated district of Assam, and Dima Hasao is the least populated district. Kamrup Metropolitan district has highest urban population and Chirang district the least, Figure 4.2 shows the population density across the districts of Assam (Ministry of Environment and Forests, 2011).

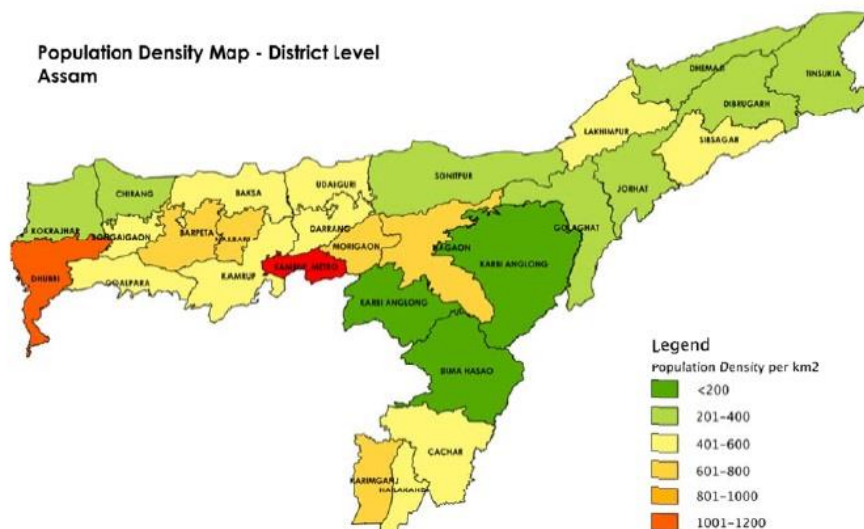


Figure 4.2: Population Density Map- District Level Assam (Source: Assam State Disaster Management Authority)

4.3. Topography:

Assam has uneven topography consisting of hills, plains and rivers shown in Fig. 4.3. The Brahmaputra basin covers an area of 70,634 sq. km out of 78,433 sq. km within Assam. About 7800 sq. km of Assam is surrounded by North Cachar Hills and Barak river Basin. A narrow corridor runs through the foothills of the Himalayas that connects the State with West Bengal. The topography has majorly three units, they are;

1. Karbi Plateau
2. North Cachar Hills and Barail Range

3. Brahmaputra Valley and Barak Valley

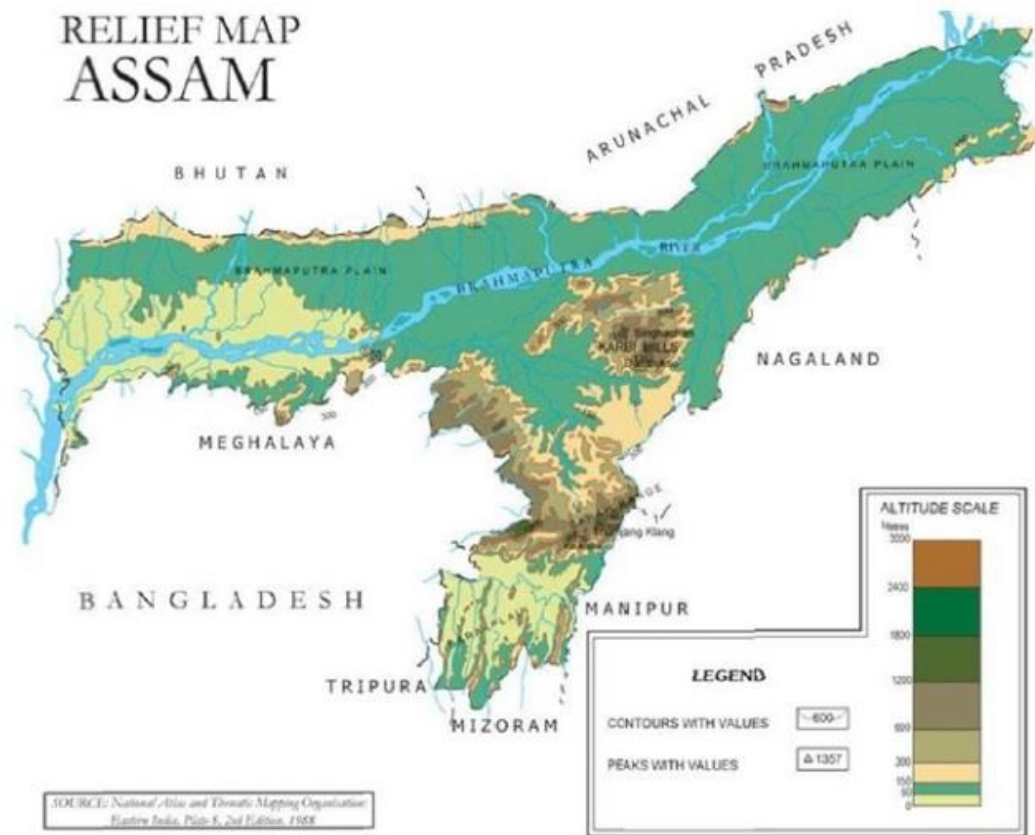


Figure 4.3: Topographic map of Assam

4.4. Geology, Major Rivers and Soil Type

Geomorphic Studies indicate that the river Brahmaputra is older than the Himalayas. The river with steep gorges and rapids in Arunachal Pradesh entering Assam it becomes a braided river 16km wide with tributaries. It further creates a flood plain known as the Brahmaputra Valley, about 80-100 km wide and 1000 km long. In the south, the Barak River flows through the Cachar District with a 40-50 km wide valley and enters Bangladesh with its river Surma.

Due to the complex geomorphology and topography, as seen in Fig.4.4, different types of soils are found across the State. The high fertility of Soil and good water resources make it suitable for agriculture. However, soil erosion is one of the major problems in Assam. Twenty districts of the Brahmaputra Valley and the Cachar district consist of younger alluvial Soil, especially on the banks of the river Brahmaputra and the Barak. Foothills of the Himalayas consist of Sandy Soil. In contrast, districts of Karbi Anglong, Dima Hasao and North Cachar consist of

red loamy and red sandy soil, which is less fertile compared to the fertile soil of the river basin (ASDMA. (2008) Disaster in Assam: Earthquakes, 2008).

4.5. Climate, Temperature and Rainfall:

Assam has four seasons in a year and is characterized by extreme humidity. The weather is hot and humid in summers (May-August) and dry and cold in winters (October-February). During winters, there are instances of rainfall, fog and cloudy weather due to the obstruction of the South west wind by the Himalayas. The average temperature is moderate, about 29°C in the hottest month of August, and the average winter temperature is 16°C. Though rainfall is an annual feature, the effect of the Monsoon is intensely felt from June to September. Rainfall in Assam is very heavy, with an average rainfall of 2262.95mm, close to places with the highest rainfall around the world. Rainfall often leads to destructive floods of the flood plains and raises the occurrence of urban floods.

4.6. Natural Hazard Profile of Assam

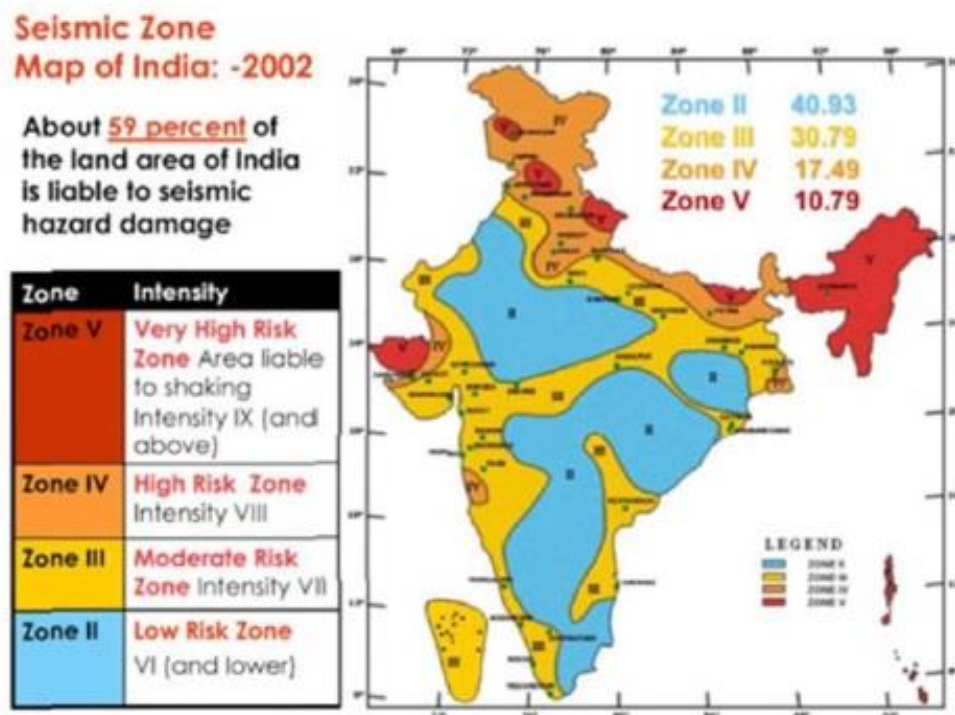


Fig 4.5 Seismic Vulnerability Zone Map of India 2002

The unique geo-climatic condition of the region makes Assam very prone to natural disasters like Earthquake, Flood and Landslide. Heavy rainfall often leads to flood, river bank erosion, landslide and other environmental catastrophes frequently. The effects of Natural disasters is

discussed in detail as follows: (ASDMA. (2008) Disaster in Assam: Earthquakes, 2008)(National Disaster Management Authority, 2011)

4.6.1. Earthquakes

Due to the collision of the Indian Plate with the Eurasian Plate, the Himalayan Region has emerged as one of the seismically active regions of the world, resulting in many disastrous earthquakes in the past and in recent times. Many active faults like the Himalayan Frontal Thrust, Main boundary thrust and the primary central thrust exist in the Region. The entire state falls under Seismic Zone 5, the most vulnerable Seismic Zone. Twelve significant earthquakes have occurred in the region in the last 100 years, and occasional quake on the 5 in Richter scale every four months. Figure 4.5 shows the Seismic Zone Map of India 2002. (National Disaster Management Authority, 2011)

4.6.2. Floods

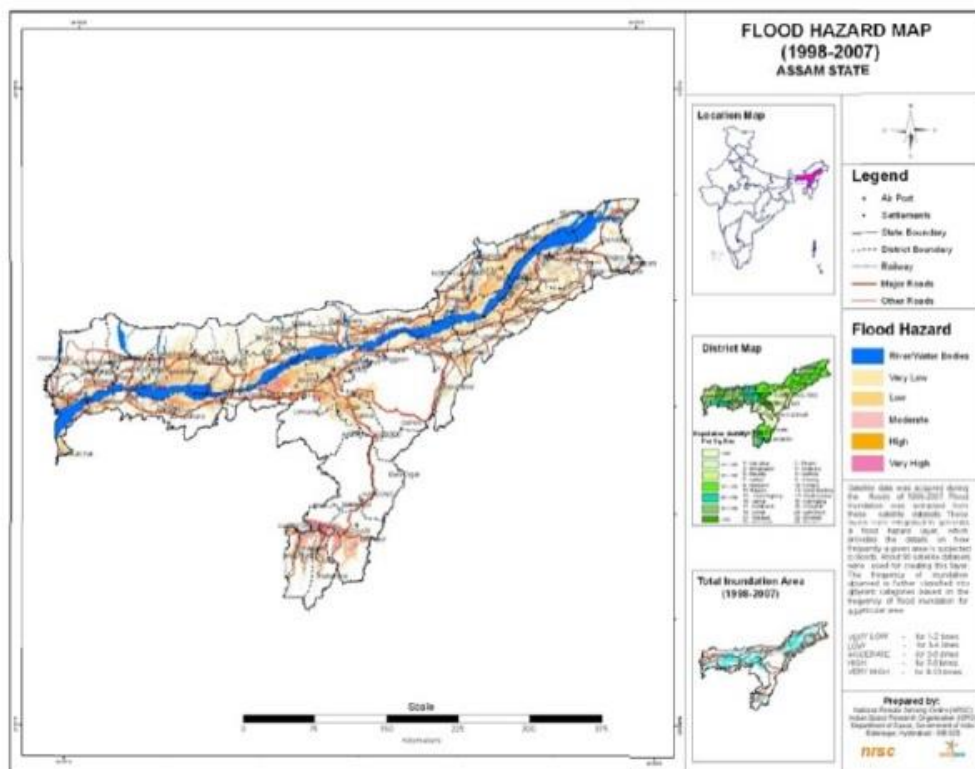


Figure 4.6 Flood Hazard Map of Assam (Source: Assam State Disaster Management Authority)

The Brahmaputra River is one of the largest rivers in the world. Every year the river Brahmaputra and its tributaries create significant destruction of resources by flood and soil erosion. Flood in the region occurs due to a variety of causes such as.

- Heavy Rainfall in a short space of time.
- Storm
- Aggravation of Riverbed
- Encroachment in the flood plains
- Degradation of catchment area in the form of deforestation
- Lack of Proper Control of Land use
- Illegal development on wetlands

From the Figure 4.6 it is clearly seen that except the *Dima Hasao* and *Karbi Anglong* Area, which are primarily Hilly, the rest of the districts in the plains and valleys are greatly affected by Flood. According to the flood damage data published by the Assam State Disaster Management Authority, the effects of Flood on damage to people and infrastructure is an annual feature which brings great economic loss to the State (ASDMA. (2008) Disaster in Assam: Earthquakes, 2008) (N. R. S. A. S. D. M. A. Centre, 2016).

4.6.3. Land Slide

Landslides in the recent years have been primarily induced by human activity. The urban areas, particularly the capital city of Guwahati, areas greatly affected by the occurrence of landslides. The hills of the City are coated with a thick layer of immature soil with low permeability, which naturally becomes prone to landslides during heavy rains during monsoons. Lack of proper land use development plan and unauthorized rapid growth of settlement on the hills are said to be the root cause of most of the landslides, and the effect of it is seen in the frequent instances of landslides in the city (Ministry of Environment and Forests, 2011).

4.7. Build Typology in the State of Assam

From the study of the Hazard Profile of the State, we realize that the state is highly vulnerable to natural disasters mostly floods and earthquake. The effects of floods and earthquakes



Figure 4.7. View of Diphu village, Karbi Anglong, Assam.

especially affect the human dwellings be it residential or of public use. A brief study of dwelling typology study is made by selecting five built forms from vulnerable districts of the region. A total of seven building typologies were identified in the typology study of which three typologies mostly indigenous to the region are found to be resilient in nature and therefore is studied in detail.

4.7.1. Dwelling Typology in Rural Areas

Traditional Rural Housing Typology generally consists of a homestead with a cluster of rooms arranged around an open courtyard and surrounded by betel-nut trees, plain tall trees, bamboos and vegetable gardens. The whole premise is surrounded by a Bamboo fencing. The several spaces in the dwelling consists of a front yard (chotal), the living room as a block with no shared wall, the bedroom, the kitchen block and the shed. A prayer room and a granary (bhoral) is observed in the homestead which is mostly constructed using Bamboo or ikra weed wattle and daub technique. Most of the dwellings doesn't have windows but jalis instead as openings

4.7.2. Dwelling Typology in Urban Areas

In Towns and Urban Areas houses of traditional style made with bamboo is often used by the economically weaker section of the people. Majority of the houses in the urban areas are either cement plastered burnt brick walls with profile sheets roofing and or RCC. Though small towns still have individual compound with the house, the flat culture is rapidly growing at a large scale. The buildings in urban areas have not kept any conformity to each other, the absence of local level zoning and building regulation has left the construction activity mostly at the disposal of individual with limited advice from any professional. Almost all major towns have multi-storied buildings in the town centre or the market areas which house shops on the ground floor and other commercial activity and sometimes residence on the upper floors.

4.8. Identified Building Typology

4.8.1. Typology 1 House on Bamboo Stilts with ikra/ woven bamboo wattle and daub walls thatched hipped roof with Wooden Frame Structure



Figure 4.8. Street View of silchar town of Cachar District

The house on stilts is a common feature among many places in North East. In Assam, *Mising* Community of the Dhemaji District in the Northern part of the State is known for this type of houses, majorly as a response to the regular floods. The structure is based on two grids of columns, occupying a rectangular shape in plan with a room and a verandah in front. One grid of Bamboo columns supports the floor, the other support the roof. The distance between the rows varies from 1.35m to 1.8m. The verandah in front is around 2.42m deep and 4.3m wide. The enclosed room is around 6.0m deep and 4.3 m wide. There are no windows and only one door through the verandah. The gap between the bamboo walls and the thatched roof provides

ventilation. The raised platform is accessed by a ladder which is often carved out of a single tree trunk, these trunk ladders are a peculiar feature of such dwellings observed across the similar houses.

The main structural system consists of bamboo frame structure with hipped roof. The roof under structure consists of wooden truss covered with local grass thatch. Bamboo beams and columns support the structure.

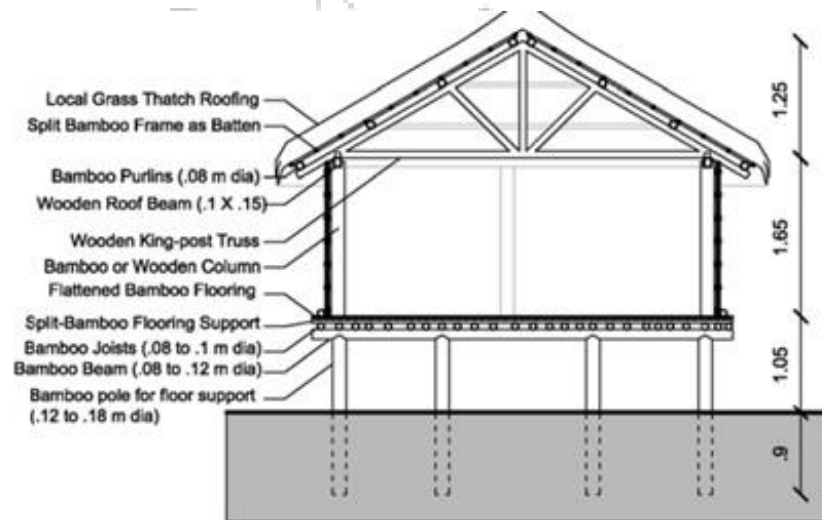


Figure 4.9 Measure drawing of a typical Bamboo House on stilts
 Source Assam State Disaster Management Training Program

Traditional way construction is not seen to have a strong foundation. The bamboo columns are directly inserted into the ground, not more than two feet deep. The floor is created by spanning a layer of Bamboo joists on top of the bamboo beams with a layer of thin bamboo made by opening out a pole of bamboo placed across the joists. Walls are usually made of woven bamboo or ikra weed mostly plastered with lime or, nowadays, with cement mortar. The locally available thatch is neatly tied to the purlins of the central support of the wooden kingpost.

Performance during Natural Hazard

Earthquake: The regular geometry in plan, lightweight structure and separate supports for floor and roof make these structures safe in earthquakes. Since the walls are independent of structure and tied at regular intervals with timber frame and built with lightweight materials like mud plater woven ikra/bamboo make, these walls are flexible during an earthquake. The solid and flexible wooden joinery also helps the structure to resist earthquake forces. Since the structure is built on independent stilts, the earthquake damage is minimal. Usually, the workmanship and joinery details are worked out well, minimizing the damage. Though the

structure shows good performance during earthquakes, there are possibilities of damage due to poor condition of natural material like the decay of bamboo poles due to direct connection to the soil, joinery of bamboo pole to beam.

Flood: The high plinth and thick thatch roof provide protection to the structure. However, flood waters can pose threat due to its flow, causing scouring and some horizontal thrust at the base of the system, if the bamboo stilts and columns supporting the structure are weakened due to decay, the structure may collapse. Shallow foundation and subsequent exposure of the foundation to the frequent floods is a possible threat.

4.8.2. Typology 2 Assam type Building –Wooden Frame with cement plastered Ikra/ Bamboo woven walls and CGI roof



Figure4.10 View of a Typical 'Assam Type House'

Commonly known as “Assam Type House”, these typologies are generally used in dwelling units. Performance of Assam Type houses has been very good in several past Earthquakes in the region. However, the houses are vulnerable to fire because of use of untreated wood-based materials. In this type of construction, walls are independent of the structural members resulting in variations with the infill wall material. These are found in both rural and urban areas but not in practice anymore in an urban area.

Buildings of these typology are geometrically regular in plan. These are rectangular in plan and verandah along its length on one side. Other variations in the plan are observed in the form of perpendicular extension of the spaces to form an L shaped or C shaped plan. Plan is divided

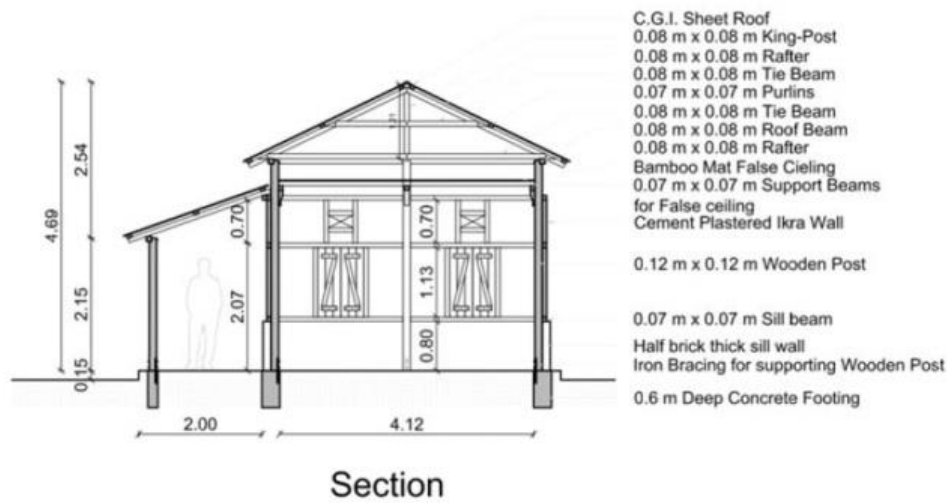


Figure 4.11 Typical Section of an Assam Type House

into a regular grid with position of columns along the grid and doors and windows placed centrally in between the columns. These houses are mostly single-storied without any provision for the location of overhead tank. The main structural systems consist of a wooden frame structure supporting a four-way slope wooden truss with a CGI roof. The load of roof is transferred to wooden beam (9cmx9cm) and then to wooden columns (12 cmx12 cm). The lightweight structure is often built on 60-90cm deep isolated concrete footings of size 16 cmx16 cm. The wooden column is anchored to the concrete footing by bolting it to 15-20 cm projected metal strip inserted while casting the foundation. Infill walls are half brick thick brick wall in cement mortar joint till sill level and timber frame woven bamboo/ ikra cement plastered wall above sill level. The structure of the roof is king post truss type made out of wood.

Performance during Natural Hazard

Earthquake:

The regular geometry in plan, light weight roof and walls make these very safe in earthquakes. Since the walls are independent of the structure and tied at regular intervals with timber frame and built with lightweight materials like mud/cement plastered woven ikra/bamboo, make these walls flexible during earthquake shaking. The burnt brick with cement mortar till sill level can develop some cracks, or fail in earthquake shaking, but as these are independent of the structure, there is not much damage to the structure, and it can be easily repaired.

Floods:

In the absence of cement plastered plinth, the flood water can cause damage to the plinth. In the absence of a brick wall above plinth level the flood water can damage the bamboo/ikra walls. However this can be repaired at nominal cost when the flood water gets receded.

4.8.3. Typology 3 House on RCC Stilts, RCC columns with RCC and burnt brick in cement mortar in fill walls and CGI sheet pitched roof with wooden understructure.

This house is a modern version of traditional stilt house very commonly built in the recent times. The Bamboo stilts for supporting the floor and the roof structure are replaced by RCC frame structure, kept in terms with use of new conventional materials. It is a new typology that is being implemented in the flood-prone areas of the State. It is observed that communities that were traditionally not building the stilt houses are also opting for this typology due to its flood resistant performance.

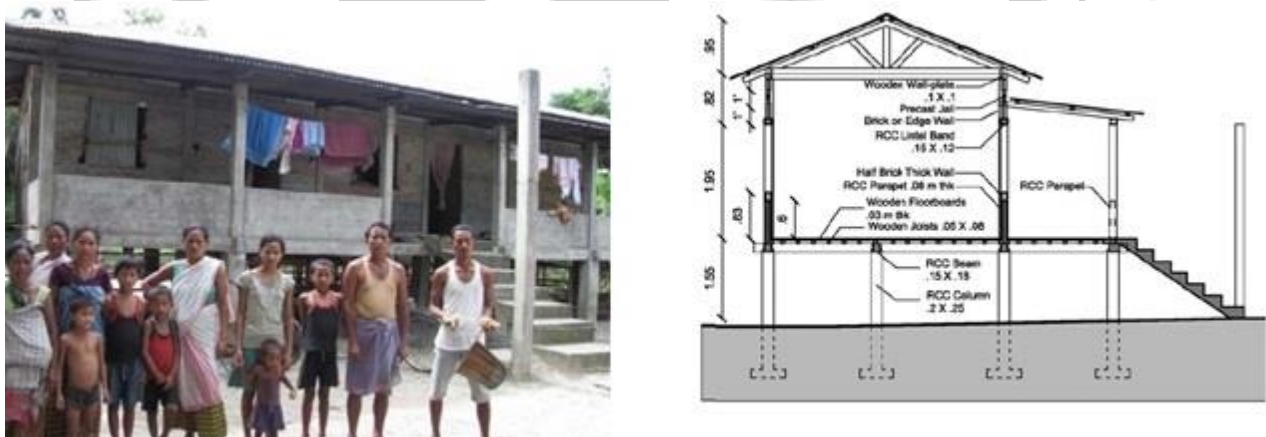


Figure 4.12 Typical RCC framed house on Stilts

The structure shows resemblance to the traditional construction, however at a little more significant scale. The grid of 6 x 4 RCC columns placed at regular distances supports the raised floor. The same columns continue to roof level to support the roofing. The main structural system consists of the RCC frame with hipped roof. The external walls are made of RCC till sill level. Continuous lintel band is present all across the rooms. The structural RCC columns are supported on 0.6x0.6m isolated RCC footing with 0.9m depth. The floor is created by spanning wooden joists on top of floor beams along the width of the structure. There is no engineering input in RCC design and detailing. The amount and placement of steel for RCC work pose some concern for construction quality. Very good quality joinery detail and finish in both wood and bamboo.

Performance during Natural Hazard

Earthquakes: The RCC frame provides enough support for the structure. The traditional flexibility of wood and bamboo is compromised due to heavy RCC use. The main problem is the amount and detail of reinforcement within RCC.

Floods: RCC footing of 1m depth withstands nominal flood and waterlogging. The high floor level provides enough protection for the superstructure.

4.9. The Physical Study of a Flood Prone Settlement

The village *dhansiri kash chapori* in the Darrang district has been chosen for the study on the prime consideration that it is a typical village having a multi-lingual characteristic of the population which gets affected by floods annually.

The village is located around 96 km away from Guwahati and is connected by National Highway No15. Dhansiri River, a tributary of Brahmaputra, flows through this village.

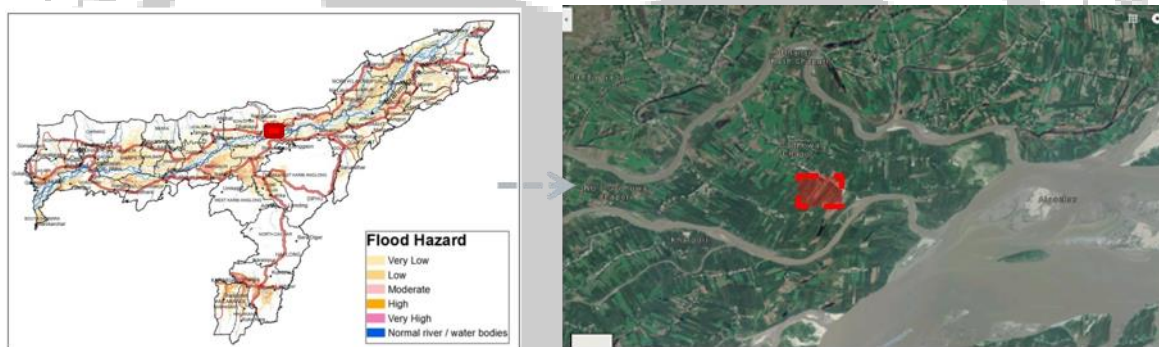


Figure 4.13: Location plan of Dhansiri Kash Chapori

A cluster of 36 households, “Chuburi (Hamlet)” in local language, was selected for the study. The clusters were placed in row housing, and the distance between one house to another was 3 m. The cluster was selected based on the criteria of a flooding river in the vicinity. The village households are connected by kaccha road. The toilets are placed outside the house at a distance of 1.5 m from the edge of the house. The average area of the house is 15.75sq.m (4.5 m X 3.5 m). The site boundary of such type of house is 9 m X 6 m and covers an area of 54sq.m. the open spaces are used for family gatherings, religious functions and get-togethers. They also house the cows. The house is surrounded by a verandah of 1m width in the front façade.

4.9.1. Identification of Spatial Elements and their vulnerability

The spatial elements identified in the neighbourhood setting are divided into three levels of study-

- Settlement level
- Neighbourhood level
- Building level

4.9.1a Settlement Level

At the settlement level, the streets act as the primary access paths to pedestrians as well as the vehicular access. The pathways follow a hierarchy characterized by the change in widths of the roads. The nodal points are characterized by the corner shops and evening bazaar (*godhuli bozar*). The *Tangni* river serves as a natural edge to the settlement. The bamboo bridge is a major access to the settlement during the winter months, and during the summer, people use boats (Rs 10 each way). The settlement is primarily agrarian, with winter crops cultivated in abundance. At the settlement level, the major vulnerability is the loss of connectivity made by the bamboo bridge, which is extremely fragile. Majority of the roads get submerged in water during the floods.



Figure 4.14 Bamboo Bridge a major connectivity to the settlement and mustard cultivation in the settlement

4.9.1b. Neighborhood Level

The characteristic feature of neighborhood level is the community pond where people gather for small festivities. Every house has an open space used for festivities and public gathering. It also houses the *maigi* for the cattle. Two to three families jointly own boats which they keep submerged under water for use during the flooding season. During floods the drinking water gets contaminated and livelihood dependent on the village pond gets impacted.

4.9.1c. Building Level

The characteristic feature of the neighborhood houses at the building level are the Ikra type walls, the different types of door used based on the construction technique. The vulnerability



Figure 4.15a Typical Household with a *maigi* and open space in the homestead

Figure 4.15b Boat submerged in water to be used during the flooding season

identified are the low mud plinth which are likely to be washed during the floods. The structural system without diagonal bracing gets damaged during the flood.

4.10. Introduction to Displacement Situation

From the brief Study of the Disaster Profile of the State and from the numerous discussions with the stakeholders and the stakeholder analysis, we identify three distinct displacement patterns across the Brahmaputra Valley. The first part being the north eastern part of the state mostly the districts of Dhemaji and Lakhimpur, where people reside in houses made of stilts and during the flooding they either continue to reside in their houses or move to a community flood shelter for a brief period. In the second scenario which is the central part of Assam, districts of Morigaon, Darrang and Barpeta the flood displacement is such that people shift to embankments in their boats or make shift Banana Plant rafts or shift with host families in the non-flood areas. affected community may quickly move from relief camps to permanent housing, requiring small repairs and retrofitting as per need. In the district of Dhubri and Chirang we find complete displacement of people where people just couldn't go back to their homes which are either completely washed out in the floods or submerged in siltation. Intermediate shelters are an active precursor to long-term housing recovery and set forth the perspective, expectations and processes for permanent house reconstruction.

4.11. Choice of Material

Locally available material is encouraged to be used wherever possible. The use of local materials allows local skills to be used, as these materials are a part of their construction vocabulary, and hence facilitate owners' involvement and participation in the construction of their houses. These factors also enable them to undertake repairs, maintenance and/or modifications on their own as and when necessary. Such direct involvement of owners in the recovery process, also contributes to their overall mental and emotional recovery from trauma after a disaster. Local materials are normally cheaper due to their availability, pose negligible transportation costs and are often best suited to the local climate. In cases where resources available locally are not durable, of poor quality, not available in required quantities; or likely to have a significantly adverse impact on the local ecology and environment, alternative materials may have to be considered. A good source of material resources that can be utilized in the intermediate shelter construction phase is the debris from collapsed or damaged houses. It is very important for local authorities or other government agencies to understand that these are only temporary shelters and they must ensure that these shelters are not allowed to become default permanent housing.

The research discusses ways to prevent and remediate the problems of transitional shelters, minimizing the negative consequences of floods. These studies are intended to result in possibilities for the deployment of transitional shelters and other necessary facilities for disaster assistance.

To achieve the desired results, this research is based on methodologies of design thinking to determine the main collection instruments that can generate inputs to the project.

4.12. The scale of the disaster and the duration of homelessness

According to international disaster database released by UNISDR- *The United Nations Office for Disaster Risk Reduction*, there are 2.7 billion people affected by natural disasters over the past 12 years. At least 1.1 million people were killed, considering the main disaster events between 2000 and 2011. The rising high-water levels that rivers are reaching during floods, as well as ferocious earthquakes, have more severe destructive consequence.

The definition of the problem is delimited by the intended solution. In the first paradigm, the disaster is defined as a threatening external agent: an extraordinary situation in which people's daily lives are suddenly interrupted, such that requirements for protection, nutrition, clothing,

shelter, medical and social care services are demanded. In the second paradigm, the disaster is seen as an expression of social vulnerability: the disaster is a situation involving damage and/or loss of life that surpasses a certain amount or number of deaths. In the third paradigm the disaster is perceived as a state of uncertainty generated by the Institutions. Here, the disaster represents a synonym for the loss of public order, causing public safety to be the highest priority, regardless of the assessment of the phenomena that caused the problems.

Therefore, one must consider not only the disaster circumscribed to the threat of rain, but it is configured by social relations that extend the time and requirements for monitoring the reconstruction process.

The second concern to be addressed is the duration of homelessness among evacuees. Experts in the area, such as Quarantelli (1982), understand that the recovery process after a disaster consists of four stages of shelter or possible housing types:

First stage - Emergency shelter, when schools, churches, armories or buildings which can temporarily house large numbers of people can be used; Second stage - Temporary shelter, with the provision of food and medical care; Third stage - Temporary or transitional housing, with the restoration of daily life; Fourth stage - Permanent housing after months of reconstruction.

A good deal of planning, preparation and knowledge of local factors are prerequisites for the success of the enterprise. However, without the knowledge of what people really need locally it is not possible to do an acceptable proposal for them. This brings the important message to different countries that considering the shelterless people testimonial is crucial to develop suitable temporary shelters.

4.13. Context of Research: The Brahmaputra Valley in the state of Assam, India.

This research presents the initial results of a study focused on Design of Transitional Shelters for people affected by Displacement aftermath a flood disaster. The research goal is to develop a model project for specific locations at the Brahmaputra valley as a case study. The results may be feasible to be replicated in other locations across the valley, which are constantly affected by flooding.

A study of 3 specific settlements which is affected by flood annually is made to determine the most appropriate type of intervention in the area. Affected populations were studied before the

flooding and aftermath the disaster in the community shelter. A CoDesign exercise was carried out in one of the disaster locations to develop a shelter model through community participation. A brief description of the exercise is discussed subsequently.

During the first and second years of research, we studied and surveyed the identified vulnerable location as indicated by the stakeholders and NGOs; from these initial studies, fundamental requirements of the preliminary design that involve the collaboration of groups of people made homeless by flooding were made. In the third and fourth years, the stages of design elaboration were made through community participation; design development in which design execution was out at specific locations and three-dimensional models were executed and technology was transferred to collaborative groups.

4.14. Shelter Design in the Context of Flood in Assam

The context of this study is Assam, a state in the northeastern part of India. According to Census 2011, Assam has a population of 31,69,272 and an area of 78,433 sq. Km is making it the largest state in the northeast. It is prone to natural disasters, namely floods, landslides and earthquakes, being in seismic zone 5 (a vulnerability index for extremely earthquake-prone Areas in India).

The state of Assam faces severe challenges to settlements, particularly housing, both urban and rural. According to the flood damage data published by the Assam State Disaster Management Authority, the effects of the flood on damage to people and infrastructure is an annual feature which brings great economic loss to the state. Six hundred villages have been submerged, and over 3 lakh people were affected in 2017, and similar accounts are occurring subsequently. The annual flooding of the River Brahmaputra also provides fertile siltation at the riverbanks, which supports the primarily agrarian society in the rural areas.

4.15. Rural built typology in the study area

From the Hazard Profile of the State, we realise that the state is highly vulnerable to natural disasters, mostly floods and earthquakes. The effects of floods and earthquakes especially affect human dwellings be they residential or public use. Traditional Rural Housing Typology



Figure 4.16: A typical plan of homestead of *Dhansiri kash chapori*

As shown in Figure 4.16, a rural homestead consists of a cluster of rooms arranged around an open courtyard and surrounded by betel-nut trees, plain tall trees, bamboos and vegetable gardens. A Bamboo fencing surrounds the homestead. The several spaces in the homestead consist of a front yard, the living room as a block with no shared wall, the bedroom, the kitchen block and the shed. A prayer room and a granary, and most of the time, a tower of hay (*maigi*) for the cow shed. The built elements are mostly constructed using Bamboo or *ikra*, a variety of weed wattle and daub technique. Most of the dwellings do not have windows but *jalis* instead as openings. The flooring is often mud and sometimes plastered with cement. The structural columns in the new houses are made of concrete pillars with bamboo infill walls. Profile corrugated galvanized iron sheets are used for the roofing. We observed from the field study that the flood-prone areas did consider houses on stilts as flood-resilient features in some of the rural areas. However, due to the difference in the effect of flood and cultural adaptation, houses on stilts are limited to a few tribal areas only.

4.16. Focused Group Discussions:

1. **Prevent the next disaster through preparation.** Take account of the community's principal complaints and make disaster preparedness a norm among the community so as to take preventive actions in the subsequent floods.
2. **Understand daily activities in disaster situations.** Observing the daily activities on a day to day basis of people residing in the flood emergency shelter where people are living in an environment they are not accustomed to.

3. **Increase awareness of citizenship / community.** Gain confidence among members of the community. Make them aware of the importance of their participation in flood mitigation activity. Awaken a sense of collectivism and cooperation, which is vital in a disaster situation.

4. **Generate knowledge: create a database from a specific case that is valid for other similar cases.** Record the findings of the study in the form of documents which can be further beneficial to the community.

5. **Raise awareness about the potential impact of the event and the importance of participants' own contribution, ideas and commitment during a disaster.** Make people aware of the size of the problem, its origins and indicators, and the need for collaboration.

Local community participation is crucial to the exchange of information; some selected methods include:

- Individuals follow some kind of interests while seeking the benefits of participation. They will learn how to respond to situations before, during or after an impending disaster, and they can also be encouraged to participate by the prospect of gaining some benefit from the situation.
- Participation gives an opportunity to express ideas and options which the community may have already explored in the past and through their previous experiences.
- Problem Identification, the community have already been through the effects of flooding and therefore, their experiences help in identifying the specific concerns.
- Political Advantage, the influential stakeholder may be interested in gaining publicity out of the situation and thus be part of the community participation.
- Traumatic experiences for some could be discussed so as to minimize their pain and also become a learning for others.

4.17. Situation Study in Flood Shelters implemented in the State of Assam

The process of housing is the fundamental aspect of dwelling in traditional cultures. Primitive cultures endowed individuals and households with the knowledge and materials required to coexist with the ecology of the area. The household led to the formation of the “place” of the individual and household in society. (Rapoport, 1969; UNHCR, 2010)The study of Maslow’s hierarchy of human needs introduces a brief reflection about human needs as a source of motivation in life. A careful shelter design addressed to the creation of a welcoming and

familiar environment could facilitate the recovery process of the users through its inhabitation. We find that when individuals are in control of the space, they live in, and have privacy needs met, feelings of comfort and freedom are possible. This freedom permits relaxation and the individual development of the self and the sense of a home (Smith, 1994) A list of humanitarian shelter designs was studied from literature as listed in Table 1.1 to develop design criteria which are crucial to meet the housing needs of people displaced by disasters as shown in Table 5.1.



Figure 4.18: A community flood shelter in the Chirang district

An initial field study of a relief camp which had 75 families residing together in a community hall post-2019 floods in *Chirang*, District Assam, was made to understand the effect on the daily lifestyle due to the displacement. The displaced community was homogenous in terms of their cultural and religious belief. Entirely agrarian, the community was dependent on the fertile soil on the banks of the River Brahmaputra. The makeshift camp in the community hall lacked the necessary human shelter need with the improper spatial distribution with over 300 people residing in a hall space of 180 m². Ventilation, sanitation and lighting were not adequate for the activities of reading and stitching as observed in Figure 4.18. Only women and children occupied the hall space, while the men slept in the outdoors, which impacted the family comfort and mutual support. From this study, we considered the design of unit shelter per family in clusters over community shelter.

4.18. Data survey about shelters in three stages

A qualitative research based on survey was conducted in three stages. The first stage is interviews to understand the flood situation from various perspectives of stakeholders. The

second stage is physical study of vulnerable communities. The third stage is studies into the living conditions and habits of the community during floods.

4.18.1. Stage One: Interviews

Interviews were guided by semi-structured questionnaire with a wide range of questions about residents' aspirations from the perspectives of Government officials, Housing Aid experts, Local level bodies here the panchayat, NGOs and the residents affected by floods in rural areas. The objective of these interviews was to determine the need for shelter aid and other specific requests for dealing with flood-related situations. Two types of questionnaire were prepared since two different groups were identified, with ones who were aid providers or contributors and the one who suffered and could give personal testimonials of their experiences during the flood.

The issue of preventive planning was discussed by several experts while working on field. The role of NDRF in disaster response and mitigation was briefly explained, where they were regularly engaged in capacity building by means of community based workshops. The aid agencies namely OXFAM and Habitat for Humanity were identified as influential and important stakeholder in the analysis. It was found that OXFAM was engaged in disaster preparedness through water and sanitation and Habitat for Humanity distributed necessary "stick and sheet" kind of relief amongst other food and material relief.

With regard to what is provided to the homeless, the Disaster Management Authority has four supply reserves for emergency response which are intended to serve the entire state. Included are mattresses, blankets, sheets, clothes, plastic sheeting, essential cleaning supplies and staple foods managed with a validity period of six months.

Many initiatives and donation drives became active during the flooding season; however, during our interview, we didn't find any drive for shelter intervention. Social Initiatives that receive donations are helpful when they conduct screenings to select only quality products and disregarding the junk donations. Some responses indicate improvisation and desperation on the part of aid workers.

For the interviews conducted with residents of flood-prone areas, we find that in tribal communities, people build their houses on stilts to co-habitat during the flooding period and store their food in a three-layer storage system over the family hearth. Some families often had arrangements to shift with relatives or host families for a brief period of the flood while others

had boats to take them to the embankments, where they made temporary arrangements till the flood water subsided. Residents, to some extent, in the flood-prone areas of Darrang where the settlement study was made were befuddled when faced the questions about the changes they made in their homes to prepare for the possibility of a new flood.

Regarding what will become of displaced persons in the event of flooding, according to the disaster management authority, residents said that they would go where they already knew to go. They complain that when floods occur, sometimes those who live far from the river don't receive the early warnings and so are the hardest hit.

4.18.2. Stage Two: Reports on living in shelters

These studies highlight the characteristics of shelters in order to assist in understanding how residents perform daily activities in a disaster situation. Both primary and secondary data were collected from three different situations of flood profiles across the state and from three different ethnic backgrounds. Namely, Mazgaon in Dhemaji District, Dhansiri Chapori, Darrang District and a Rajbongshi Village in Chirang District. The site was selected based on the flood disaster profile, where in the first case, people had already accustomed to floods by building houses on stilts and use of community flood shelter as temporary response. In Dhansiri Chapori, which is a minority settlement, people have a necessary arrangement to relocate during the flooding period and in the case of the Rajbongshi Village, the settlement was completely washed away and the community needed permanent shelter relief.

A brief questionnaire survey, as per Annexure 1 was made to understand the spatial needs of the community. Participants were assigned the following categories of spaces that simulated the shelter site plan and filled them with emotional descriptions of materials and memories: sleeping area, cooking area, gathering area, and areas for storing goods and belongings, bathing, defecating and urinating, washing clothes, treat injuries and illness, protect the family.

As a general rule, there are usually more displaced people than people without shelter because most can stay in the homes of acquaintances and family and do not need to stay in shelters. Others are isolated and, without means to leave when the water reaches their homes, they take refuge on the highest point, usually in the embankments that offer some protection. At the same time, a few continue to reside on their boats. However, the focus of this research is a model transitional shelter for displaced families.

In this activity, we outlined the plans of the buildings with notes drawn from the testimony of the participants. Two separate groups contributed to the formation of the following findings:

At the Community Center space was subdivided by sheets and by furniture brought by the residents, separating the household residing there. Theft of food items distributed as relief was reported. Regarding the "work" section, it was said that the men continued to work as daily waged labourers while women continued with the regular household cooking and cleaning activities of the relief camp. Regarding study and children's play area a makeshift school arrangement was made at a neighbouring community cultural platform while the schools continued to be used as relief centres. The Public Health and Engineering Department facilitated with the erection of hand pumps and temporary collective toilets to facilitate the stay in the community flood shelter. The problem was space constraints, and the stay as family was restricted as men continued to occupy the surrounding areas while women and children continued to sleep inside the community hall. Another issue of being in these community shelters is the lack of space for livestock while a few cattle were bought along the others had to give up the poultry stock.

With priority for families with children and seniors, relief agencies provided mattresses, blankets and other consumable goods. Due to a lack of hygienic supplies such as toiletries and sanitary napkins, flood victims relied on donations to fill the gap. Each shelter offered different conditions, such as the community flood shelter in Chirang, which provided cookware and a community cooking area. In some places, there was competition for space and food, and residents had to deal with the lack of privacy.

It must be noted that in the 2019 flood, there was no fresh water or energy between the second and fourth days of the disaster. Residents reported that it was necessary to use candles and lanterns at night. They received instructions to save as much fresh water as possible because it was used almost exclusively for food preparation. Bathing was reduced in frequency, less water was used in personal hygiene, and clothes went unwashed.

Through this activity, we were able to calculate the sizes of various spaces required according to utilization. Compared to previous events, the scale of those affected and the duration of the need for assistance and shelters varied little, marked by the repetition of these disasters.

4.18.3. Stage Three: Studies into the living conditions and habits of the community during floods

A visit to a temporary shelter is planned in order to have a brief period of contact with the displaced community. Because this can only occur during a flood and there has not yet been an opportunity to realize this stage of the survey, this interaction has been replaced by the workshop. In this, a sequence of normal and abnormal events was mapped on large boards. The objective was to simulate representations that could contribute to the survey of living conditions during the flood and at the same time, help the researchers to empathize with the participants. This was accomplished by studying the social interactions of a temporary community and seeking to understand its individuals, their behaviours, and their perceptions and needs in order to generate design requirements.

4.19. Exploring Participatory Design

The identification of the main problems that occur during sheltering shows a lot of elements that could be added in the design process. The results from the community participation activity provided evidence that people knew ways to prevent and remediate the problems of transitional shelters, but they needed help to implement the solutions. The participants suggested some measures which could be used to enhance the quality of the shelter from their prior experience of building with bamboo and housing themselves with mere sheets and poles at the embankment. The suggestions can further improve the quality of the shelter in the subsequent floods.

In the case of Floods in Assam, homelessness lasts about 7 to 14 days, and the cycle is repeated with increasing frequency. It has been observed that disasters cause damage that can be more or less temporary, causing the temporary removal of people from their homes or even preventing their return to their locales. This fact is often reinforced by relapse, i.e., the process of exit and return to these areas of risk becomes chronic. Just as in medicine, to treat and cure a chronic process, the course must be reversed, or in other words, healing mechanisms in the region must be reactivated. The diagnosis provides the transformation because when you feel the acute symptoms of the problem in the affected area, there will be reactions of warning and defence.

The participatory process of the workshop proved to be quite appropriate for the collection of information that will lead to the creation of more suitable spaces and equipment. The open

format, composed of participants from various institutions, and forms of collaboration that operate in the same context of the disaster showed themselves to be very rewarding. At the end of the testimonies, the theme expressed by participants was a question of solidarity. Because it is a small settlement where people know each other, even those whose homes were not affected by the flooding volunteered to help people that were left homeless. They portray the suffering as not only of those who are homeless but also of those who help. This interaction also brings with it a great deal of knowledge for participants whom themselves receive emergency care. They get to know whom to go to, where to get resources and transportation or assist in the restoration of infrastructure. Others contribute to simple everyday tasks that become quite complicated during floods, such as those related to cleaning. The disaster enforces a relationship of equality between people and can attract even more humanitarian assistance. Clearly, however, not only do good actions arise in this context; but opportunities for looters also present themselves. It is regrettable to finally note that, although the floods are recurrent, the population is not ready for the next possible event.



CHAPTER 5: DESIGN EXPLORATIONS IN THE CONTEXT OF SHELTERS AFTER FLOODS

5.1 Design Exercise

Based on the three profiles of displacement, we explored three design approaches. For the situation where people have already been co-existing with a flood, a community flood shelter capacity of 500 was made, as also floated as a design requirement by the Government of Assam, where about 50 community shelters were planned. For situations where people shift to live on embankments or on high land, we explored the design of a bamboo transitional shelter kit. For complete rebuilding in places where the houses are entirely washed out in the floods, we explored the design of a single room with a verandah module supporting a typical homestead.

Another critical area is providing proper sanitation facilities. Being in a flood situation, the EcoSan Dry Toilets could be an option that one can explore, as suggested in the guidelines for temporary shelters by NDMA.

Organising for reconstruction- a design problem

Organising a reconstruction design project requires a systems approach to establish the mandate required for the project. Questions like who should be considered for participation, on what basis, and who decides the participation. The challenge is to identify the participants and guide the relationships between the participants. The next thing that needs to be addressed is the type of reconstruction, whether it should be built and if so, where it should be built and how to initiate the project (UNHCR, 2008).

Temporary Shelter After Disaster – The type of reconstruction

A construction project has many participants ranging from professionals to enterprises and artisans from a particular context of the building industry within a given national location. Thus the selected project participants are called a project team which gets together to design and execute the project (Davidson, 2010).

Temporary shelter for the Flood-affected people of the Brahmaputra Valley

The annual flooding of the Brahmaputra Valley displaces over a million people destroying their houses either entirely or partially. The displaced people seek shelter in government institutions like schools and other academic institutions. Since the annual flooding takes place during the hottest and humid period of the year, exploration for a design solution for comfortable housing was required over the accommodation provided around government institutions in the form of tarpaulin/plastic sheet tents. From the study of a settlement which got eroded entirely during the 2019 Brahmaputra Valley flood in the Chirang District of Assam state in India, it was observed that displaced people were forced to reside in a dilapidated community hall where women would sleep inside the hall at night and men were forced to sleep outside in the open area. The sense of family and privacy was wholly overlooked in such accommodation, where the displaced people resided for over five months and more till they could build back their homes. In the context of flood disaster, three scenarios have been considered for design exploration:

First being the region affected by floods where people have adapted to houses on stilts and co-residing with the floods by moving to designated flood shelters in the form of multipurpose shelters on stilts, mostly in the tribal areas of Dhemaji and Lakhimpur Districts.








Second are the region where people are temporarily displaced for a few days to up to 2 months till the damaged houses can be repaired. These transitional shelters are the major focus of this research.

Third, are the regions where the homes are thoroughly washed in flood or are buried under the siltation. An option of relief housing is proposed for this category using an innovative prefabricated building material using the rich local resource of bamboo.

5.2. Design consideration and Area Programming for Proposed Multipurpose Flood Shelter in Assam

Community flood shelters are designed to be strong elevated structures that can be used by local residents for refuge during an extreme weather event. These flood shelters are usually desired to be made of concrete because they are easy to construct, strong and durable. They are elevated on strong pillars with a deep foundation designed to withstand high winds, water level

Table5.1. List of Design Criteria based on the essential qualities of human necessities

Sl No	Design Criteria	Objectives	Source
1	 Security	<ul style="list-style-type: none"> • feeling of safety and security • ensuring protection for the inhabitants and their belongings. • Protection from nature and other external anti-social factors. 	(Saunders G,2011.)
2	 Permanence	<ul style="list-style-type: none"> • experience of continuity that characterizes the home environment. • sense of belonging and connection with the place 	(Hayward, 1977)
3	 Personalisation	<ul style="list-style-type: none"> • exclusive control and use of the environment • self-expression and scope for customization 	(Sebba, R., Churchman, 1986)
4	 Privacy	<ul style="list-style-type: none"> • control of space in dense and crowded environments • sound insulation • internal partitions 	(Saunders G,2011)
5	 Social Relationships	<ul style="list-style-type: none"> • relationships with family • community meeting places • shared spaces for cooking, washing, cleaning etc. 	(Smith, 1994)
6	 Complexity	<ul style="list-style-type: none"> • visual perception • scope for customised assembly to avoid confusion due to repetition 	(Stamps, 2005)
7	 Identity (Form,Color,Lig ht)	<ul style="list-style-type: none"> • perception of physiological, environmental and cultural factors 	(United Nation Refugee agency, 2012)

and potentially scour in high flow environments. Flood shelters may also incorporate a bending thermodynamic façade and a protected entrance area. They often have metal shutters to protect

against strong wind, rain and debris. Possible design features include a separate floor for livestock, enhanced toilet facilities with soak pits and septic tanks, store rooms, an emergency water supply (tubewell), first aid facilities, separate rooms for pregnant women, solar lights and rainwater harvesting.

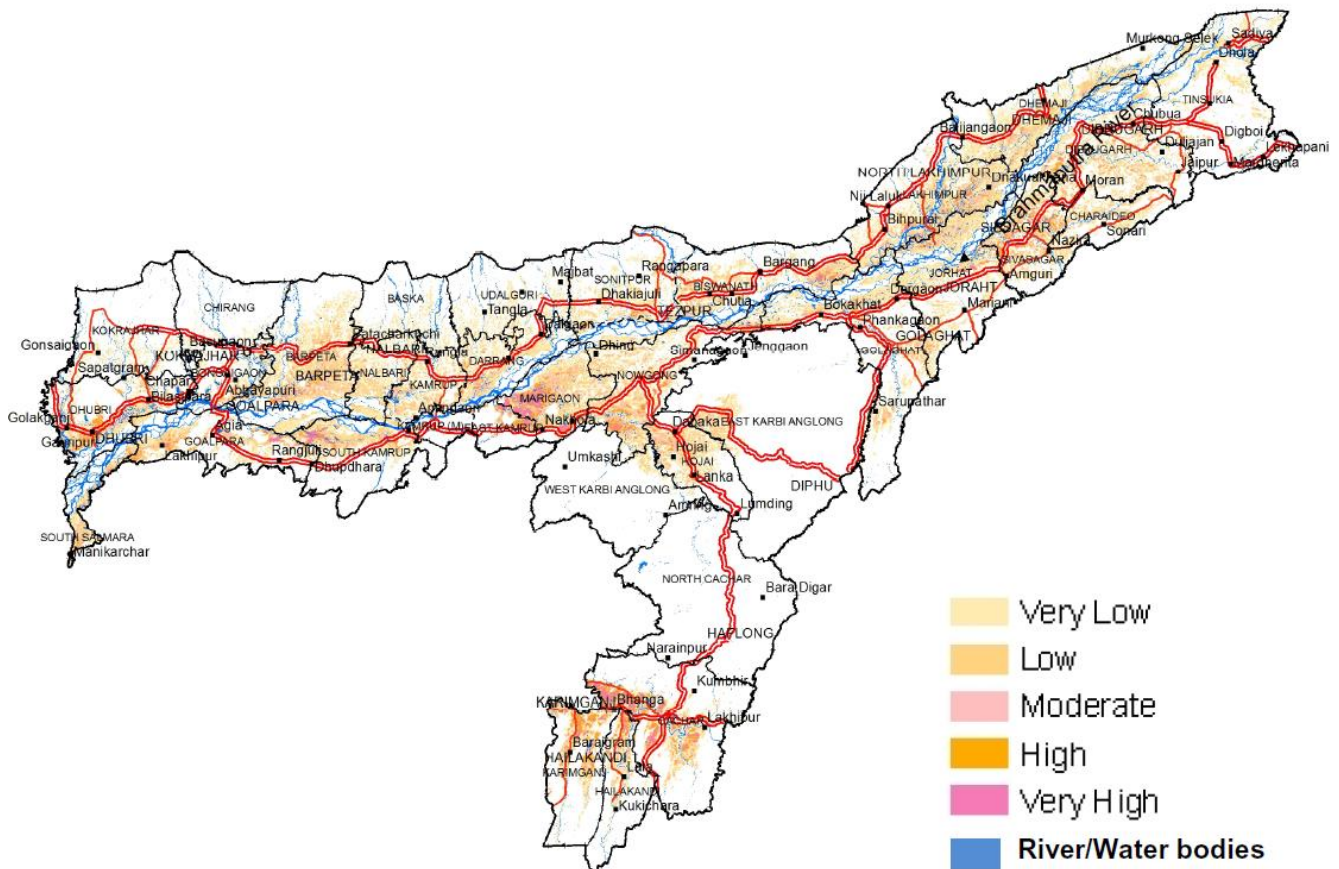


Figure 5.1 Map of Assam Showing the Flood Hazard Prone Areas

Source: Assam Flood Atlas by Assam State Disaster Management Authority

5.2.1. Site Considerations:

- Topography of the land should permit easy drainage, and the site should be located above flood level, preferably a raised platform. A slope of 2-4% and should not be more than 10%
- 3 m² per person of open space for access, vegetation, play etc.
- Food distribution and food preparation areas
- The maximum size of a settlement should not be more than 1000 people.
- Drain ditches should be dug around the shelter in flood-prone areas.

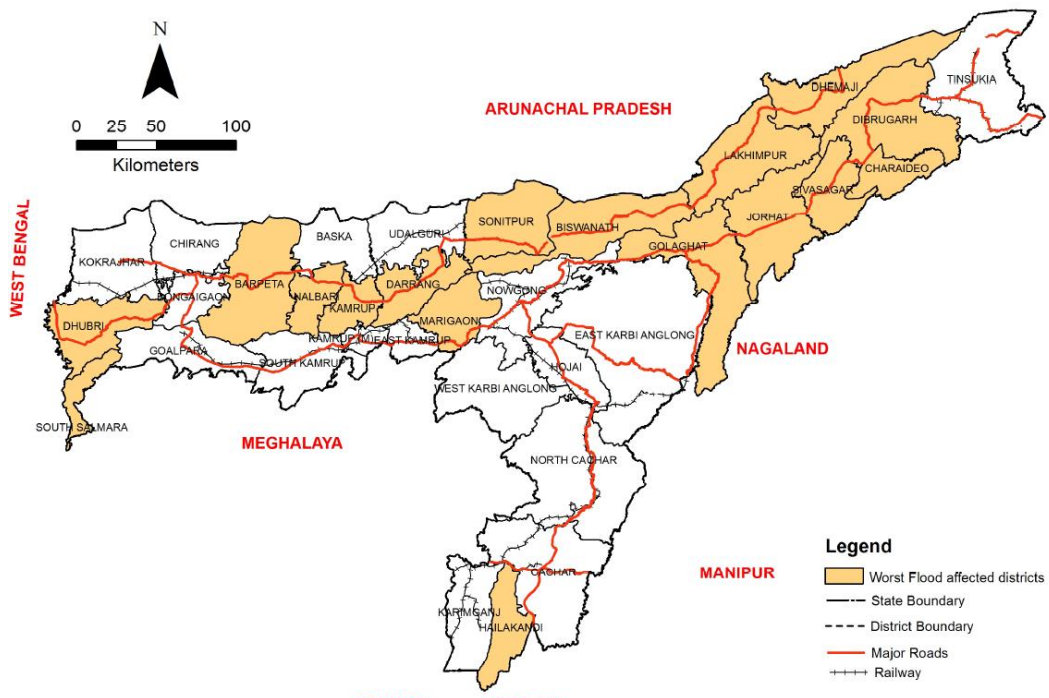
- Small shelters with few occupants are preferred over large refuges with many occupants.
- Consideration for lighting the shelter and the access.
- 500 m distance to a water point with one water point per 250 people.
- Special accommodation for unaccompanied children, elderly, expecting mothers and the specially abled.

5.2.2. Minimum Area Consideration as per the SPHERE Standards:

- Minimum 3.5 sq. m of living space per person, excluding cooking, bathing, and sanitation facilities.
- 4.5–5.5 sq. m of living space per person in cold climates or urban settings where internal cooking space and bathing and/or sanitation facilities are included
- Internal floor-to-ceiling height of at least 2 m (2.6 m in hot climates) at the highest point

5.2.3. Water and Sanitation Consideration:

- The Shelter should be positioned in such a way that the sleeping areas should face the prevailing wind to avoid odour from latrines
- Latrines one per 20 people. With bathing and laundry area.



Fig

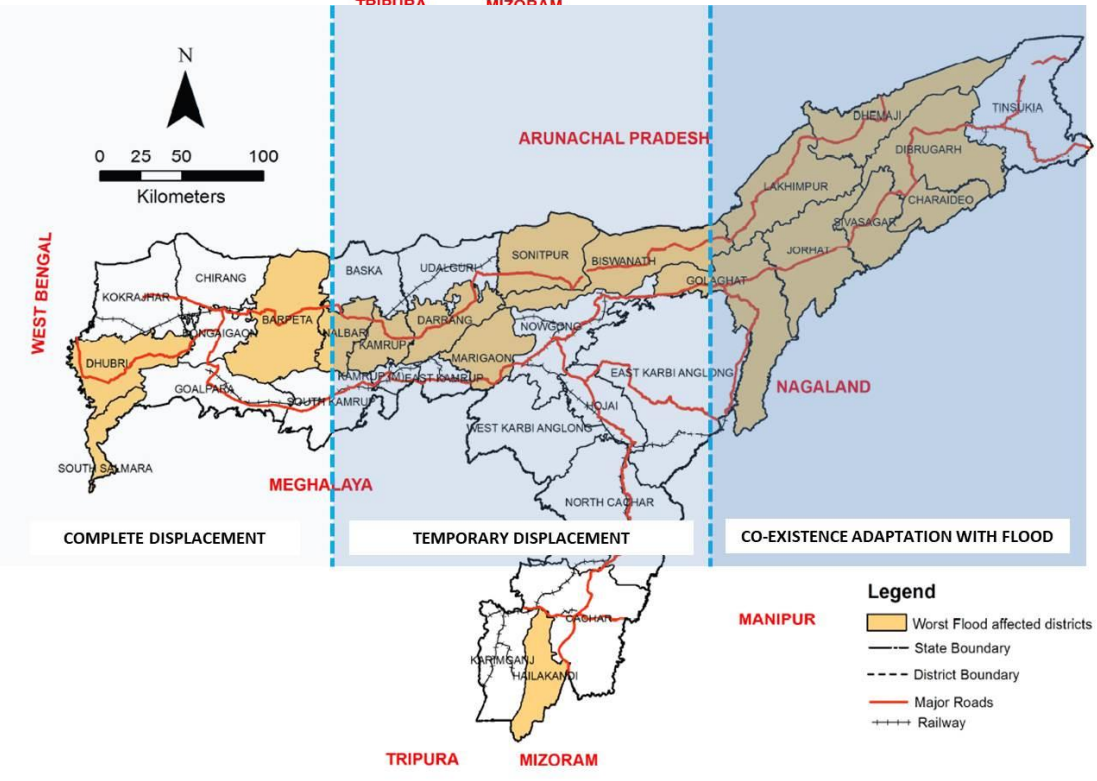


Figure: 5.2 Map showing worst flood affected districts of Assam and type of its Displacement

5.2.4 Area Programming

Considering a total area of 930 sq m per shelter. Approx. 465 sq m in the First and Second Floor and Ramp Facility till the First Floor of 400 capacity

Sl No	Specification	Area
1	Male Dormitory/ party hall/marriage hall/meeting hall with a locker Facility	232 sq. m (not column free and can be separated using temporary partitions)
2	Female Dormitory/ party hall/marriage hall/meeting hall with a locker Facility	232 sq. m (not column free and can be separated using temporary partitions)
3	5 no. of Classroom type rooms for makeshift schools/ livelihood centre/	278 sq. m (55 sq m each)
4	Inos Quarantine accommodation/ labour room	18.5 sq. m
5	1 no. hall for especially abled/ elderly and unaccompanied children	27.8 sq. m
6	Toilets with Bathing facility	19 no. (93 sq. m)
7	Universal toilet	1 no.
8	Kitchen with Store and Wash Area	1 no. (93 sq. m)
9	Circulation/ Services	46.5 sq. m
10	Air Drop	-
	Total	1000 sq. m approx.

5.2.5. Design Concept

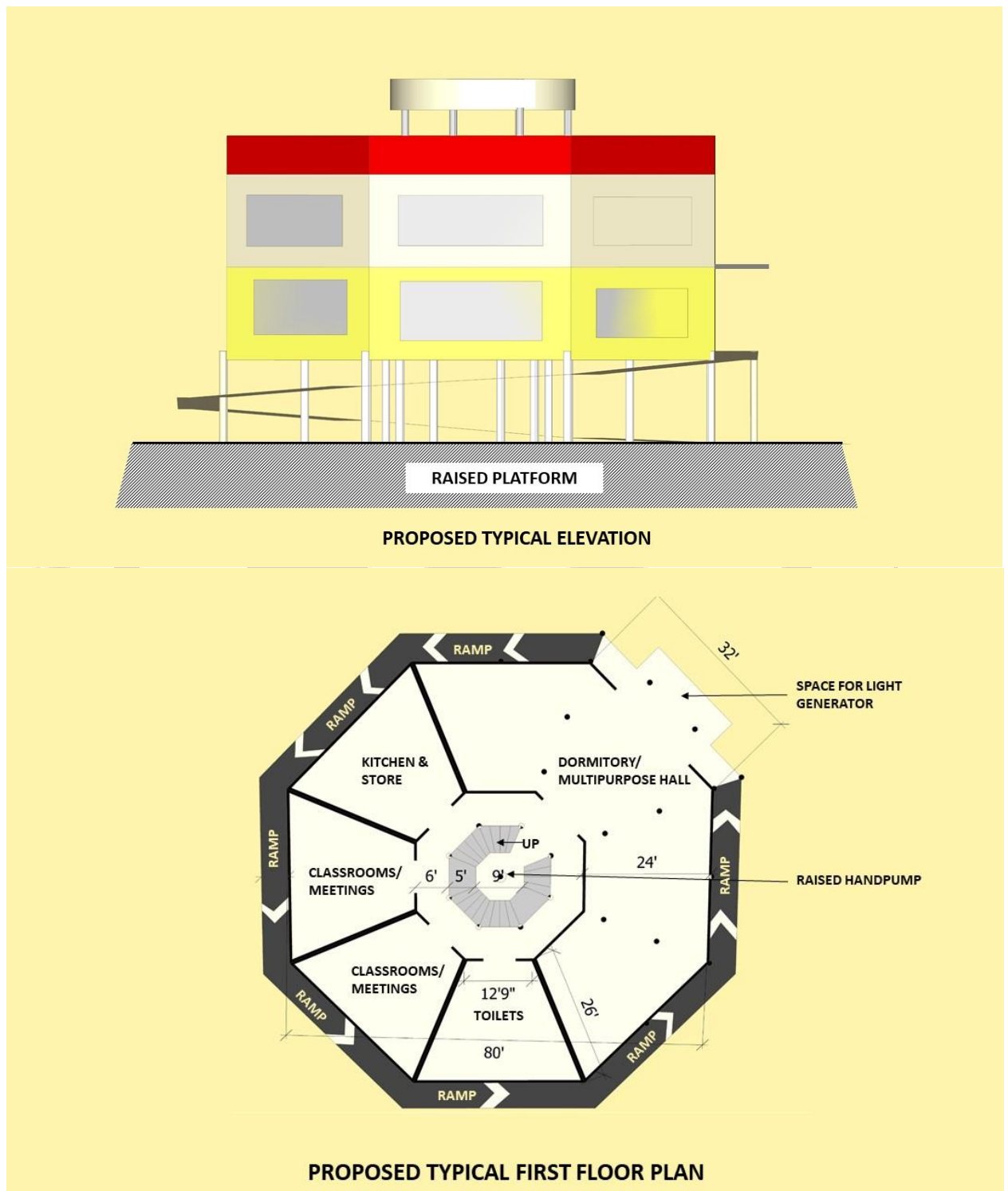


Figure 5.3 Schematic Design of a Community Flood Shelter

5.3. Design consideration and Area Programming for Reconstruction of individual Households

Shelter is a fundamental right that every Indian should have. An initiative to address this issue where more than 20 billion people are homeless in India needs a rigorous political attempt, and therefore, the PMAY; Housing for All by 2022 is a step of high regard. In this regard, a scholarship to explore a pucca housing typology was received by means of the competition organized by TOCIC, IIT Guwahati. The same technology is found to be appropriate for housing reconstruction in the regions completely washed away in floods. Traditionally houses in Assam were made of bamboo, available in abundance, which was locally built by skilled artisans, but lately the landscape of Assamese villages has undergone a drastic change with people shifting to non-engineered brick houses, which are vulnerable to earthquakes and floods. Though houses in Bamboo are the most appropriate solution for the context,

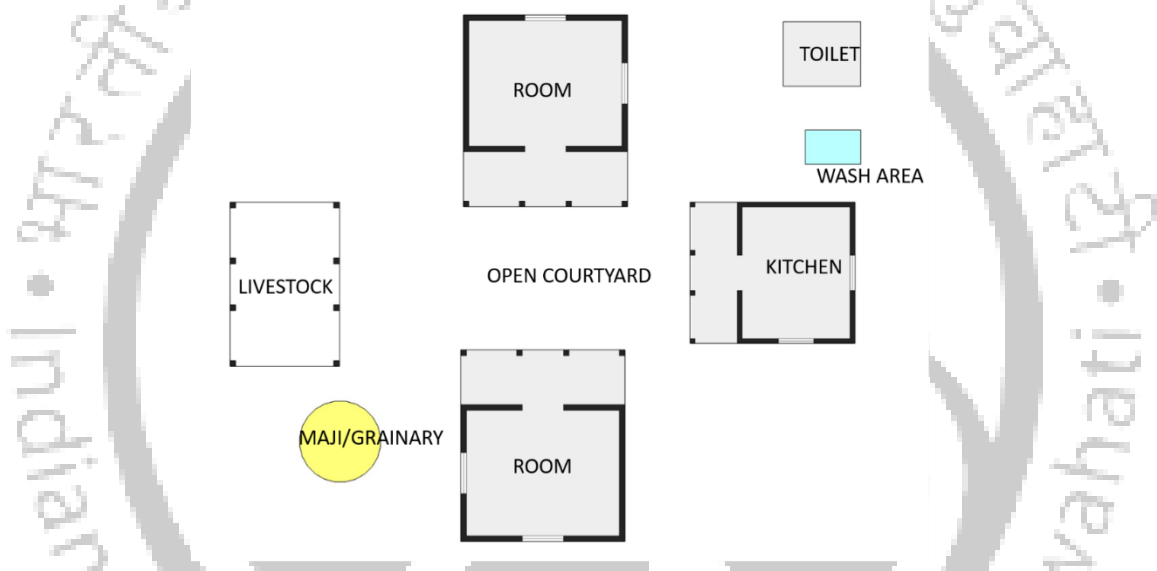


Figure 5.4 Typical Layout of a Rural Homestead

it is often associated with poverty and living in a Bamboo house becomes an economic taboo. This leads to the exploration for the innovation of a hybrid composite panelling system using Bamboo Fibre and ferrocement concrete technology to develop a panel of 1 m by 30 cm using steel of 2.4kg, sand 17kg, cement 5 kg and Bamboo Fibre 3kg. The composite panel thus developed has been found to be a suitable material and can be used in various ways to achieve sustainable *pucca* housing technology for the state of Assam. Development of the panels and wet assembly of the same is shown in Annexure 3. Using this technology, a part house of 15 sq. m is proposed in the context of a typical rural homestead.

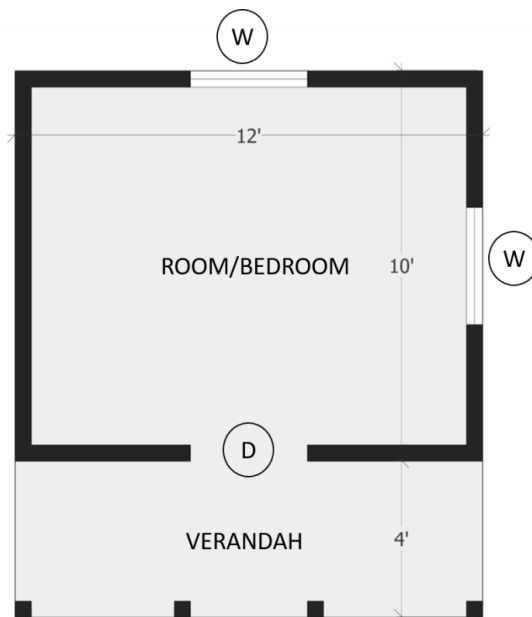


Figure 5.5a Plan of the single room House for Reconstruction

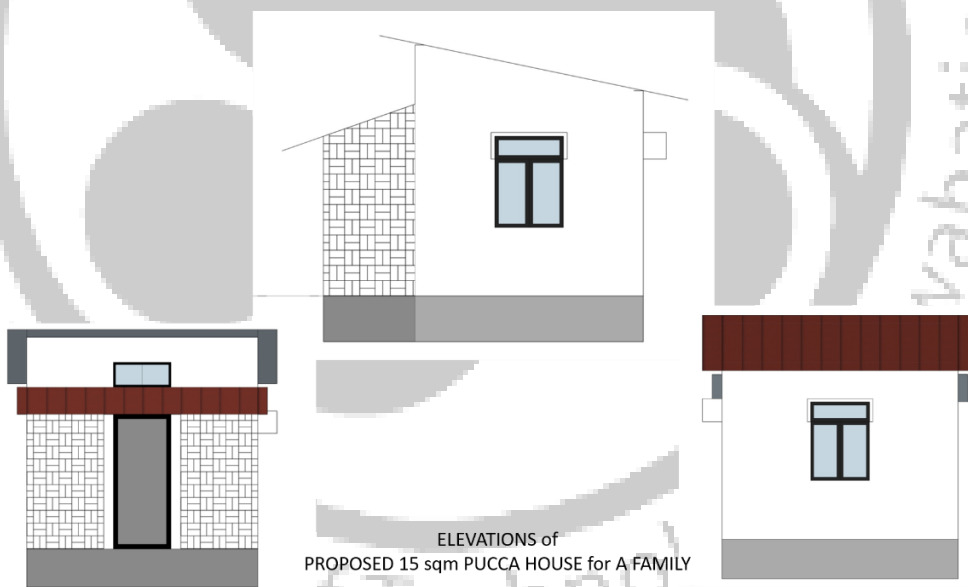


Figure 5.5b Elevations of the single room House for Reconstruction

5.4. Co-Design Process

The co-design process was a form of community participation to address the post-disaster reconstruction requirement. We carried out a community participation design exercise with representatives from the displaced population. The community shared a need for assistance in designing through a cumulative effort. A process of architectural facilitation was made through an intense method of drawing discussions, prototypes and modelling to engage the participants in the design process. We documented the process to develop a methodology for co-design. The act of enabling all members addressing the displaced population: young people and adult, men and women, authority and contractors to enter into the design dialogue is the key that reduces relief situation alienation.



Figure 5.6 Building of Transitional Shelter with Community Participation

Considering the SPHERE Humanitarian standards, Shelters were designed along with selective members of the affected community, which could meet the needs of the community and which could be delivered with the availability of land and other resources.

Assessment of relocation and resettlement issues

A preliminary assessment of displacement patterns and rehabilitation of a displaced community was made in community consultation. User interview was conducted to understand the effect on the daily lifestyle due to the displacement. A range of possible relocation options was explored in consultation with the community Figure 5.6 shows the community consultation activity of developing an early housing model. This model of housing is suitable for areas with



Figure 5.7 Transitional Housing for Flood victims of 2019

temporary displacement. The displaced community then resided in the embankment, building basic structures using the materials distributed as a relief. There was no provision of proper sanitation and drinking water facilities. Figure 5.7 shows the kind of existing transitional housing.

5.5. Design of the Bamboo shelter kit

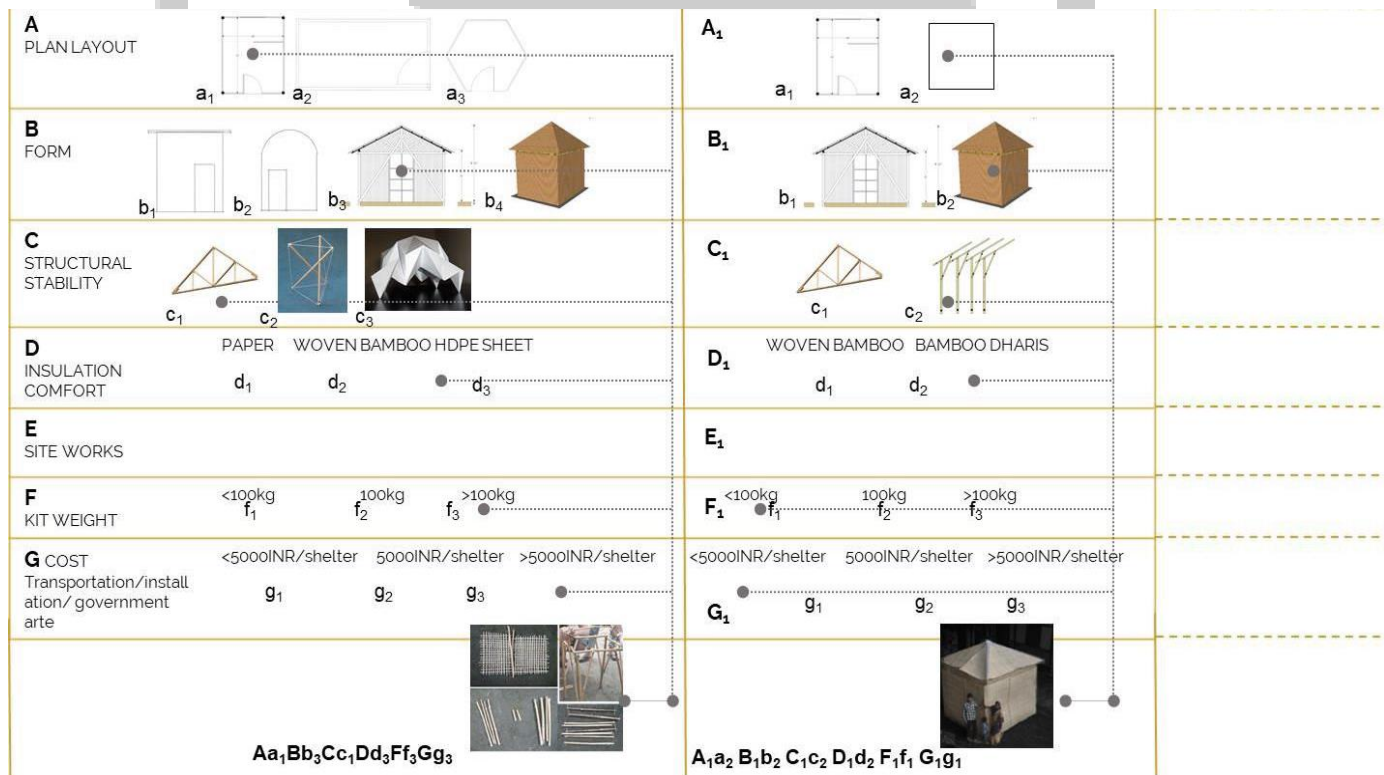


Figure 5.8 CASA Collaborative strategies for Adaptable Architecture and AIDA Analysis of Interconnected Design Area

The contemporary DIY, “do it yourself” culture, ethics, process and tips, and its creative incorporation in academic experiences of architectural self-construction seemed to be appropriate in the said context. CASA Collaborative strategies for Adaptable Architecture and AIDA Analysis of Interconnected design area, way of design method was explored to develop several options (John Chris Jones, 1992). Figure 5.7 shows the process of layout development and suitable design alternatives. The timing in the process of design is an ambiguous issue. The designer and the owner of architectural design decide together, and sometimes it is very time-consuming (Groat, L. N., and Wang, 2002). We considered a community consultation activity where we presented CAD drawings made using Autocad and Sketch Up mock-up models to a representative community from the study area. The feedback obtained was considered to improve the proposal. The layout plans were processed further for actual prototype development of the temporary shelter kit by user assembly.

5.5.1. Design Features of the Bamboo shelter kit

The spatial, functional, humanitarian and technical aspects of the shelter kit

- 9m² per unit shelter.
- Maintaining the privacy of the family unit by perforated walling over openings.
- Opening of the shelter into the access pathway.
- Community cooking corner with cleaning facility is considered in the commonplace.
- A shared toilet and washing facilities per every eight units.
- The lowest position of the roof inside the shelter unit is considered to be a minimum of 1.8m.
- A compressed roofing layer develops a sandwiched roof with HDPE Sheet and woven bamboo mats for the roofing.
- A 15cm perforated lattice bamboo between the roof and the top of the wall cladding act as ventilation to enable the release of hot air.
- All residents were involved in setting up the shelter kit.
- User assembly, thus giving scope for customization and a sense of ownership.
- The affected community were involved in the process of designing. They had the skills and experience of utilizing the local resources and which makes the process fast.

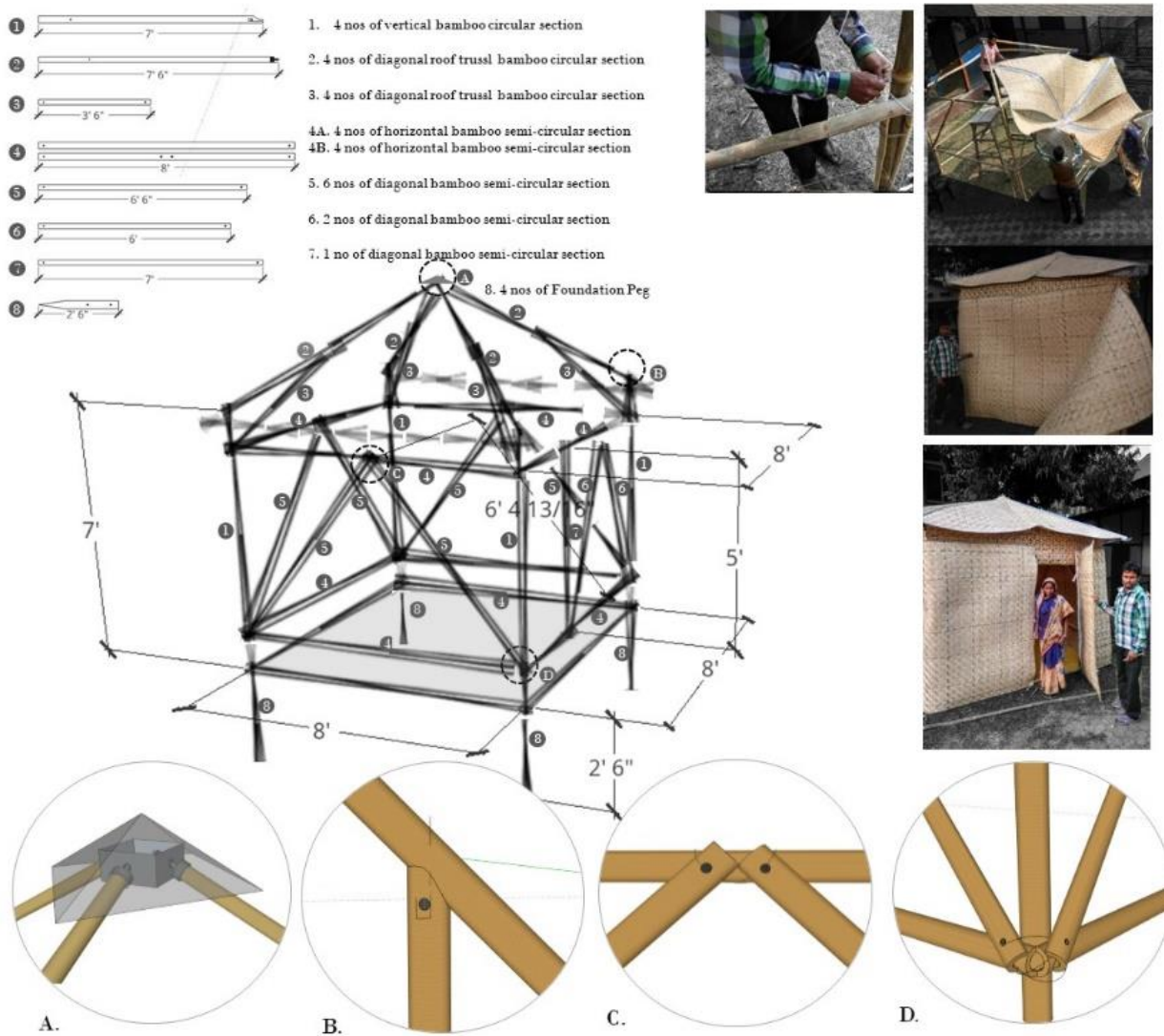


Figure 5.9 The Bamboo Shelter Kit: Isometric view showing the skeletal frame details and to scale prototype pictures of the assembled kit

5.5.2. Construction Process

The construction process, which involves the transportation of the shelter kit to the site and its assembly, takes just a day with only a few workmen, preferably users, for a single-family unit. The prefabricated details in the form of modular bamboo pole components with predefined positions in the way of drilled holes make it convenient for assembly using plastic tags/treated rods for bolts or bending wires to meet the desired strength. The weight of the Kit is optimized to be lightweight, using only half Bamboo splits instead of solid poles for ease in delivery without the use of any mechanical devices or cranes. The connections are kept simple for assembly by users so that if there is any shrinkage in the natural material, users can modify it to suit their needs. The delivered Kit comprises of Bamboo Poles precut to length in different

sizes and colour-coded for step-by-step assembly. The prefabricated and woven Bamboo Wall and Roof Panel are wrapped around the Poles for ease of delivery.

5.5.3. Protection and Maintenance

Ecological Protection: Bamboo is a renewable material which can be grown in three years. However, considering the annual need for temporary shelters, proper guidelines need to be in place to generate awareness among the local communities to find a sustainable harvest of Bamboo and encourage plantations to meet future needs.

Physical Protection: Temporary shelters, unlike reconstruction, should be encouraged to be used for a temporary short period until users can rebuild their habitats. Physical protection of the Shelter Kit is optimized to reduce cost.

Termite Treatment: The anti-termite treatment for Bamboo, if chemically made, is expensive. Thus, the consideration for mature culm harvest, natural water treatment and spraying of organic insecticide made using local herbs and smoking have been considered and also encouraged.

Fire Protection: Fire Protection is a significant concern in Bamboo Houses. During the field study, we observed that the Kitchen is detached from the homestead in the local houses to avoid a fire hazard. The Post-Disaster temporary Housing should consider centralized cooking or cooking area where a family can cook food and provisions for firewood, water, and light can be made available.

Waste Management: Temporary settlements in the post-disaster phase are expected to have a very short lifespan. The shelter kit having over 90% of the product as a natural material, contribute minimal to the environment degradation of the shelter site.

5.5.4. The spatial, functional, humanitarian and technical aspect of the shelter kit

Principles adopted in designing;

- Minimum of 9 sq. m per shelter unit.
- Maintaining the privacy of the family unit.
- Maintaining privacy within the family unit by internal partitioning.
- Maintaining the privacy between men and women by internal partitioning and by providing separate public and private spaces.

- Self-maintenance practices of toilets and other facilities.
- Providing an environment conducive to living and ordinary day-to-day family life by allowing for cooking facilities and maintaining privacy needs within the unit.

Height of the unit/Roofing:

- The lowest position of the roof inside the shelter unit should be a minimum of 1.8 m.
- Wall cladding. – woven bamboo mats (*dharis*) should be used to clad the structure of size 1.2 m X 1.8 m. Bamboo *dharis* have porous surface that keeps the structure cool through venturi effect in the hot and humid climate of Assam.
- If G.I. corrugated sheets are used for roofing, the heat and glare from all the housing units can cause health hazards. Thus, this needs to be avoided. In fact, a sandwiched roof is developed by a compressed roofing layer with HDPE (High density polyethylene) sheet and woven bamboo mats for the roofing.
- It is recommended to have a 0.15 m gap between the roof and the top of the wall cladding as an air gap to enable the release of hot air.

5.5.5. Social Aspects

- All intended residents should be involved in setting up and allocating the units. This will help restore some sense of normalcy among the displaced.
- Involve NGOs, CBOs and Social Networks in the process of designing, identification and categorization of the beneficiaries at all stages. They have the experience of undertaking similar work, the skills, capacity and experience in mobilizing people and have a network of human resources that can be utilized fast.

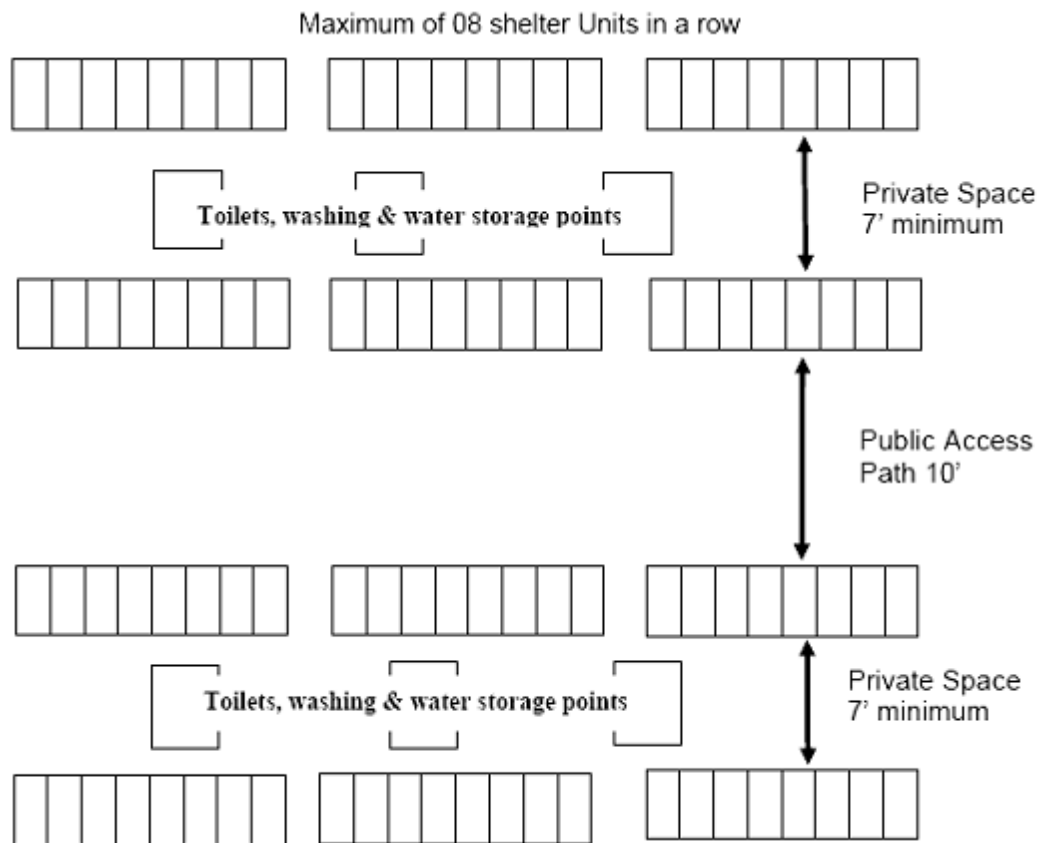


Figure 5.10. A schematic layout of relief settlement as per SPHERE

5.5.6. Bamboo as the Material for the Shelter Kit

Bamboo is the traditional building material of Assam. It is commonly used as a construction material due to its rigidity, strength and availability. In a disaster, the needs of families are often not met by tents and tarpaulins alone; moreover, the cultural and comfort levels of tents and tarpaulins cannot meet the comfort of a bamboo structure.

Bamboo is environmentally the greenest building material. The plant is abundant in north east India and culturally and socially the community is comfortable to bamboo houses.

The developed model can be in a kit form where in all the joinery can be assembled at site and thus can give rise to a green industry. The core idea of the structure is that the whole structure is pre-stressed. All bamboo used are splits which is better than using round bamboo poles reducing cost and weight and increasing the tensile stress.

The structure is designed keeping the climatic conditions of the state in mind. The lightness of the structure and the modular form makes it very convenient to assemble and dismounted to various convenient locations during emergency of flood (Mori T, 2002).

The following sketches shows the assembling of the structure.

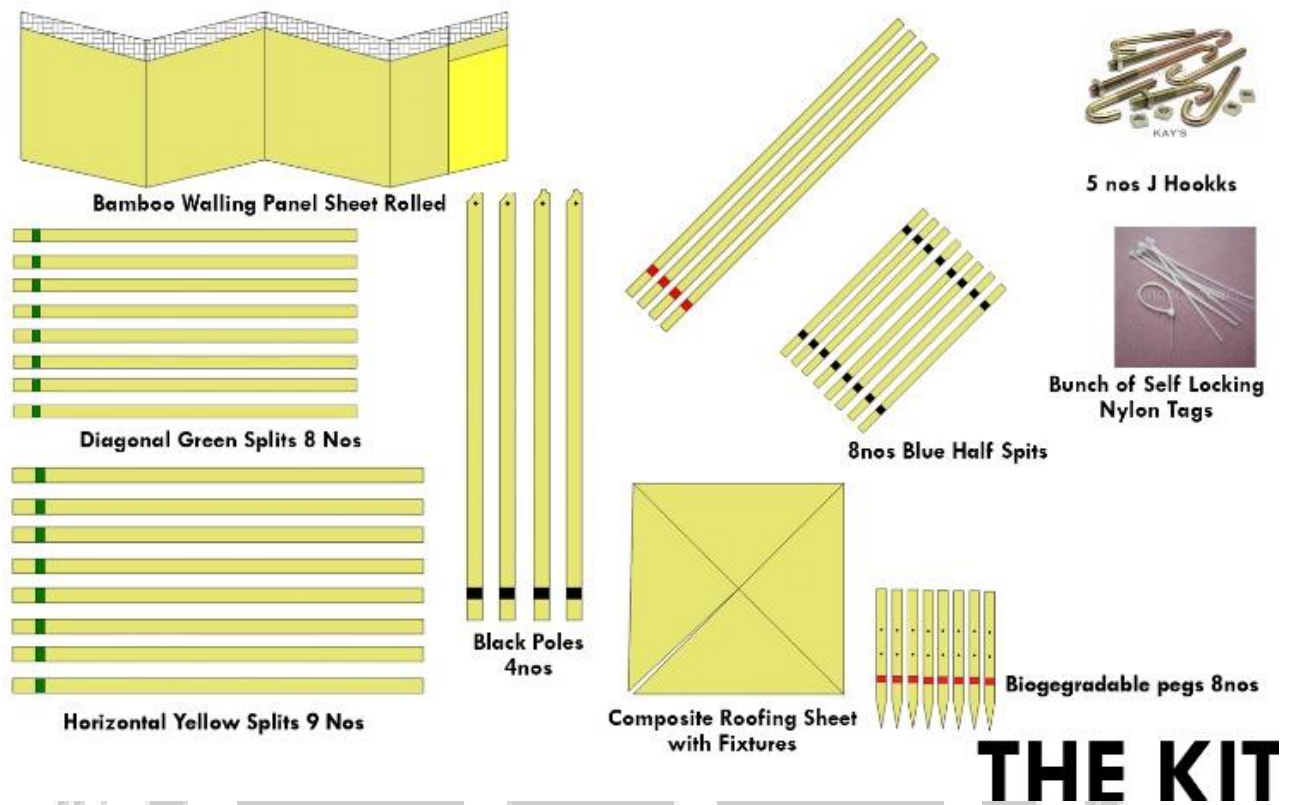
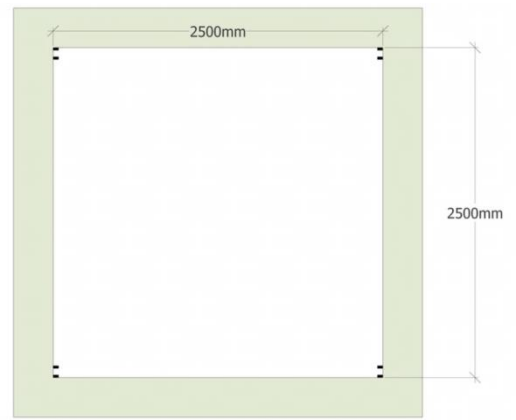


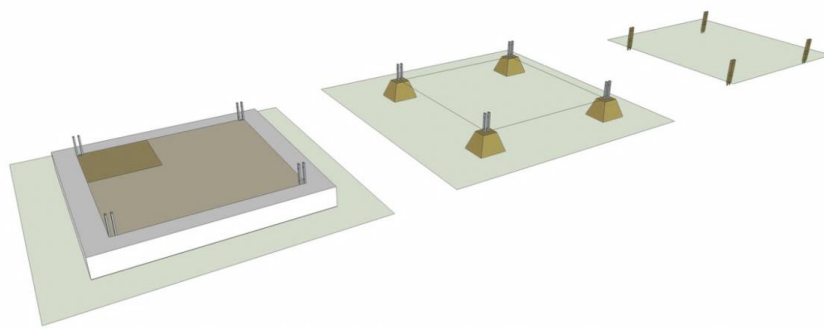
Figure 5.11. Components of the Bamboo Transitional Shelter Kit



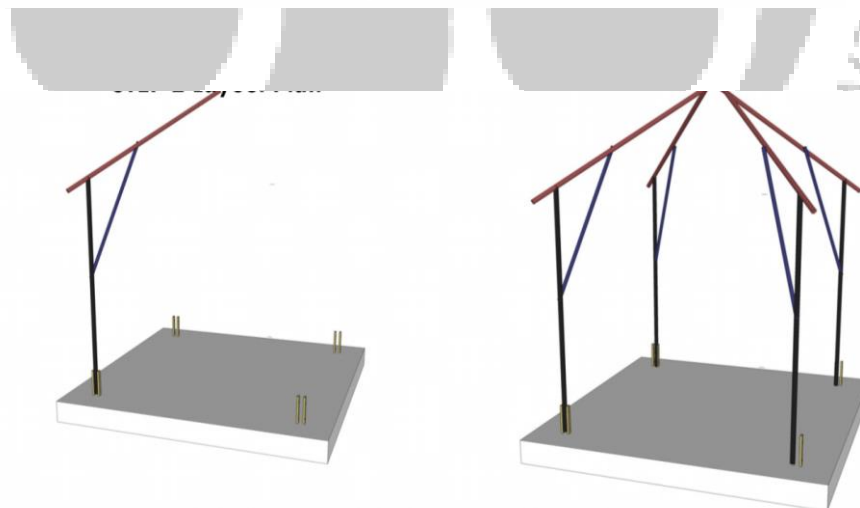
STEP 1 Making of the Frames 4 nos



STEP 2 Layout Plan

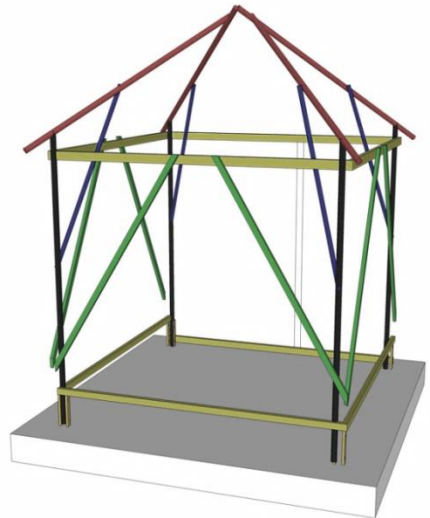


STEP 3 Foundation Options 1,2,3 with the connectors fixed

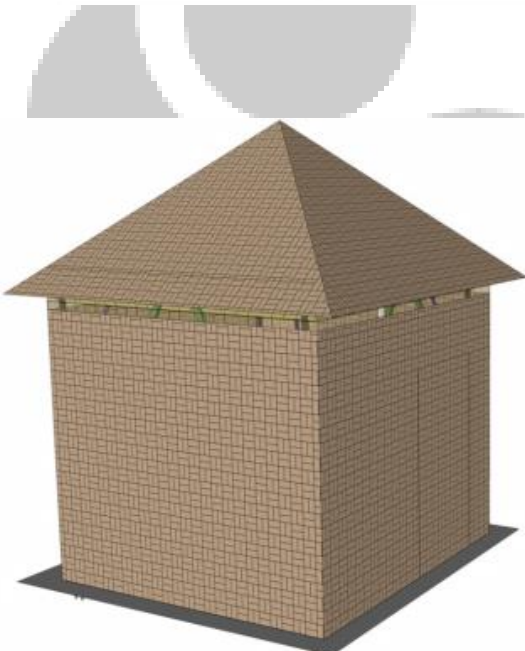


STEP 4 Fixing of the Frames with the Connectors

Figure 5.12a. Assembly of the Bamboo Transitional Shelter Kit



STEP 5 Fixing of the Diagonal Members



Complete Shelter

Figure 5.12b. Assembly of the Bamboo Transitional Shelter Kit



Figure 5.13. User led assembly of the Bamboo Transitional Shelter Kit

From the findings of the community-led design exercise, we found that the design discussions should be made open to all of those who might be affected in post-disaster displacement. The aspirations that originate within the community are architecturally developed into visions of accord so that they are applicable in post-disaster situations. Further, we iterated the shelter making exercise to develop a Shelter Kit which can be made available for the recurring flood disaster every year across the region.

From the user experience of the said shelter, we realize that the:

- Shelter meets the structural stability as desired by the user.
- Users responded positively to comfort in the shelter.
- We were able to meet the financial cost requirement.
- The minimum humanitarian standards have been met.
- Users feel secure, and there is a sense of home due to the use of bamboo as a material.
- Assembly time of the Kit is 1 hr. 15 min. by four people
- Weight of each shelter Kit is an average of 75 to 80 kg.
- 10 shelters per 3-Wheeler Van can be delivered
- There is an abundance of local resources precisely bamboo to deliver the required quantities

The field of post-disaster housing is very multi-disciplinary uniting the principles of social, environmental and technological sustainability together with economics, logistics and politics.

From the study, we realise that working with the community is an effective approach in the affected areas where victims are often seen to long for assistance externally. In a developing country with limited resources at our end, we must try to work with the existing resource and address its shortcomings. In the developed shelter kit, the use of bamboo was encouraged for it being a low carbon footprint product, socially relevant and economical to the context. However, the concern of termite infestation due to non-treatment of bamboo, ecological harvesting of bamboo followed by the waterproofing of the walls gives scope for further research of exploring the material and learning the traditional treatment practices which can not only contribute to the longevity of the shelter kit but also give an aesthetic visual character due to the stains of the use of plant-based insecticides.

5.5.7. Process of designing a unit transitional shelter

By combining the bamboo poles, split poles, walling and roofing panels one can create exactly the transitional housing unit that fits to the family's needs. Alternatively, one can choose different wall, roof, and floor systems scavenged from the destruction site and remove or add structural poles as required to suit the users need. Either way, the result is a transitional housing unit that is custom-designed to suit both site conditions and the space that is required. (UNOCHA, 2004)

There are three steps to follow either while assembling a transitional housing unit:

1. Shelter type: To be considered for those whose houses are partially damaged and need time and resource to rebuild their homes over a brief period of time up to 3 months
2. Shelter Size: The shelter kit is designed for a single unit and if the family size is more than one might have to go for 2 shelter units.
3. Choose panels: Bamboo woven panels have been considered for the wall and roofing with lamination. People can also opt for profile sheets wherever applicable and are available.

Transitional shelters can be understood in following three typologies.

Assembly based shelters such as shelter kits, tents, pre-fab units, shipping containers, etc.

Construction based shelters that are to be constructed in-situ or ex-situ with construction materials like bricks, stones, timber, bamboos, steel, cement, mud or other such materials.

Rental accommodation that the affected people can find in already existing undamaged houses that survive the disaster.

who are already working in the disaster relief operation for the identification of beneficiaries and delivery of the shelter kit. In early 2020 the shelter kit know-how was technology transferred to DASTr NGO in Darrang, District, where they accepted it as a suitable solution for the flood-prone areas.

During this exploration, we realized the potential application of the developed design in the context of seasonal tourism activities, which start post-monsoon till the late winter. We realized that the need for such shelters is in great numbers, thus, giving the opportunity for enterprise development and capacity building for local enterprises.



CHAPTER 6: FINDINGS, RECOMMENDATIONS and CONCLUSIONS

North East India, particularly the Brahmaputra Valley, is flood affected annually, leading to loss of human lives and the economy, putting a dent in the already perilous situation of this economically challenged region. With poor disaster preparedness, it becomes imperial to research for an appropriate transitional shelter model for the inhabitants of these regions to provide support to tide over the acute crisis. Floods and other natural/human-made calamities usually involve the displacement of a large number of people at once, making it challenging to provide permanent housing shelters on an urgent basis. Plastic tents offered via various organizations are not cost-effective, do not provide a durable solution, do not address sanitation issues, and add on to the waste disposal predicament. Transitional shelter is an incremental process rather than a multi-phased approach, ideally abiding by the ten principles, as discussed in Chapter 1. The time period is kept flexible, with a mean duration of 6 months to 3 years. Although the term is ‘transitional’, the question of durability and permanence also arises in cases when a prolonged stay is required, as in instances where extensive damage to property has occurred. The research gap in this context is that not much has been done in pertinence to the problems faced by people of North-East India. The purpose of this research was to address those issues by making a cost-effective, durable and culturally acceptable transitional shelter using locally available materials, keeping the option of relocation open, tailoring according to the needs of the population, and keeping in mind which kind of disasters are more familiar to those areas.

The research initiated with the exploration of a single design solution which could be implemented across the Brahmaputra Valley. From the situation study of displacement after floods and previous work experience of working in the relief housing sector, it was realized that no single solution could be suitable for the valley. Field studies on the flood-affected areas in Chirang and Dhemaji illustrate how the inhabitants have adjusted to the harsh natural calamities by building houses on stilts. In a minor settlement like Dhansiri Chapori, Darrang district people have necessary arrangements for relocation during the acute crisis. In the case of Rajbongshi village, Chirang district permanent shelter relief was required as the entire settlement was washed away. Accordingly, three distinct displacement scenarios have been identified, and design development of context-specific transitional shelter has been made.

Co-Design, a form of community participation activity to understand the spatial requirement of displaced people, was carried out in Darrang and Chirang districts. Community consultation helped understand the requirements and shortcomings of the proposed design solutions. We realized that enabling all stakeholders' involvement in the design process is the key that reduces relief situation alienation.

The research involved an extensive study of existing building typology in the flood-affected areas. It was found that Bamboo, a fast-growing grass-wood is the most suitable building material available in the valley, and people affected by floods in the rural areas primarily reside in houses made of Bamboo. Bamboo is the traditional building material of Assam. It is used commonly as a construction material due to its rigidity, strength and availability. With the backdrop of frequent floods in the state of Assam and the abundant natural availability of suitable Bamboo species for construction viz; *Bambusa tulda* and *Bambusa balcoa* makes, bamboo a suitable material to address the emergency housing need. During our study, we found that for the 2018 floods in Cachar District Assam, Habitat for Humanity, an international aid organization, distributed bamboo poles of 6metre length in a bundle of five with a tarpaulin sheet and a bucket of fasteners in the form of nails and bending wires to per affected family. The hot and humid weather following the floods in Assam makes it uncomfortable and prone to vector-borne diseases. The cultural and comfort levels of tents and tarpaulins cannot meet the comfort of a bamboo structure. Thus, we decided to explore design options using bamboo with wall cladding of woven bamboo mats of size 1.2 m X 2.5 m. Bamboo matting has a porous surface that keeps the structure cool in the hot and humid climate of Assam.

The research gave the opportunity to explore two variants of housing using the rich resource of bamboo. For the scenario which required a housing solution for completely displaced people of the valley design of a *pucca* housing prefabricated material is explored using bamboo in fibre form with ferrocement. A full-scale prototype using this material is also made as part of a TOCIC (TePP Outreach cum Cluster Innovation Center), IIT Guwahati-funded project completed during the period of the doctoral research; details of the same; are enclosed as Annexure 3. In the field experience of relief housing in the Bodoland riot as discussed in chapter 1, it was found that single-family transitional bamboo housing is suitable over community shelter. Therefore, in scenarios where there is temporary displacement, a kit bamboo transitional shelter is designed and detailing of the same is made into a full-scale demonstrative model as described in chapter 5. This model has been displayed in research conferences and to NGOs for feedback and suggestions.

A proposal for 50 multipurpose flood shelters was declared in 2019 to temporarily house 500 people together by ASDMA. With respect to this proposal and considering an extremely short duration of stay as in the case of successful cyclone shelters in Orissa, a concrete multipurpose flood shelter is proposed with a conceptual design as discussed in chapter 5.

To assimilate the findings of my study, we can conclude that the field of post-disaster housing is very multi-disciplinary uniting the principles of social, environmental and technological sustainability together with economic, logistics and politics. From the study, we realize that working with the community is an effective approach in the affected areas where victims are often seen to long for assistance externally. It is in the early, emergency phase that fast and effective aid can make the most difference, however further study is needed to assess the effect of aid during the emergency and transitional phases for long-term recovery and improvements in housing. Transitional housing policy should define the roles, responsibilities and coordination of government, NGO agencies, the private sector and individuals. In our country, a lack of this transitional housing policy has led to chaotic, diverse and often substandard relief housing, causing a politically tense environment with a breakdown in coordination between the central government, local government, and NGOs.

The Brahmaputra valley is blessed with natural resources, especially bamboo, which is cost-effective, culturally acceptable, durable, abundantly available and biodegradable. It works well both in areas affected by floods and earthquakes. Locally available bamboo bypasses transportation costs and facilitates the affected community to be involved in the participation of the making of their own shelter, facilitating them to overcome the trauma of their loss post-disaster. Also, involving the local populations makes us gain their trust, and overcomes issues of cultural acceptability. Houses on stilts, as have been part of the culture of tribal communities, can act as a good example for shelters during floods in other areas of North East. They have been in use by the local tribal population of Dhemaji, and can be implemented in other flood-affected areas. SPHERE standards should be preferably met while housing the affected. The proposal of individual households per family, which addresses privacy and eliminates overcrowding and the emergence of communicable diseases, is an effective housing solution for the affected population. An area of 3 sq. m per person to be precise, with a maximum of 1000 people per settlement is ideal. Topography should permit adequate drainage, and the shelter should be equipped with a raised platform. One water point per 250 people and one latrine per 20 people should be implemented. Cross-bracing and hurricane straps make these

shelters resilient to future disasters as well, and such design cues should be kept in mind while designing a transitional shelter.

Although the initial costs may seem high during the construction of transition shelters, which can seem daunting to policymakers and stakeholders, providing a hindrance to the project, the vision of a long-term outcome and permanency of these structures should always be considered. Political issues can be a setback to proper utilization of an already made transition shelter, the shelter might not rise to its full potential. The role of private organizations, NGOs and other social workers is pivotal for the provision of hygiene products, clothing, food and medication. The provision of electricity can be accessed from the affiliated electricity board. There is also a need to train key individuals on how to access and act upon current and future information on grants or other financial assistance so that efficient responses to new initiatives in the event of a disaster can be executed.

6.1. Limitations of the study include

- With Bamboo production declining, the prime raw material availability could hamper production and might require an equivalent substitute in the future, including procuring these from neighbouring NE states.
- Termite, borer infestation and other factors may deteriorate the quality of the bamboo-based kit if untreated.
- Regular maintenance of the shelters is a challenge and is beyond the scope of our study
- No technical experiments were conducted to test the resiliency of the shelter to tolerate vagaries like wind and weight, thus a factor of uncertainty remains as to the longevity of the shelter in terms of safety.
- This shelter kit needs to be evaluated in real-life disaster situations in significant numbers to further define its safety and utility and understand the scope for improvement.
- Acquisition of land for construction of these shelters can also be a hindrance, as government approvals for the same can be tedious and may be driven by individual interests.
- Though community participation leads to better implementation and utilization, finding a skilled set of hands at desperate times is not always readily available.
- Political affiliations are a practical prospect, as they ultimately lead to success/failure of usage of the shelter in the true sense.

- The urban settings define a different context for temporary shelter due to the complex land use, lack of open spaces, existing shelter stock and damages incurred to it, different occupational and lifestyle patterns, and infrastructure. Often there are challenges regarding a number of families that require immediate shelter support in an urban post-disaster situation. People are likely to be living in a variety of housing forms such as multi-occupancy dwellings, squatter settlements, tenancy etc. Special attention is needed for the affected squatters and rental population in the city, as eligibility criteria are mostly based on property or land ownership which may lead to their exclusion. Pre-disaster preparedness to identify accessible open land in times of disasters for temporary shelters can help meet some such exigencies. Less dense urban centres such as Tier 2 and 3 cities in India with considerable open space can consider setting up temporary shelters. The inclusion of neighbourhood-level resident associations and local civil society can be useful.

6.2. Research Validation

A questionnaire-based survey was done amongst the residents for feedback. The shelters were eco-friendly and gave protection from the hot and humid weather. However, termite infestations were a practical obstacle impinging on the quality of their daily living. Also, there were limitations in the provision of medicines, sanitary pads, and clothing as they required assistance and funding from other social organizations. Fresh water and electricity depletion were other issues which were not adequately met. It may be pertinent to mention here that the residents were satisfied with the housing pattern and spacing.

The research was also validated considering the fact that Design of the Transitional shelter won several competitions which are given below:

1. First Prize in Poster Presentation at the Research, Innovation and Enterprise Conference at Solent University, UK, 2018
2. First Prize at Redstart Start Up challenge 2019
3. First Prize NE Hackathon 2019
4. Project Awarded for housing typology exploration by TOCIC (TePP Outreach cum Cluster Innovation Center), IIT Guwahati 2018
5. Selected for iB Hubs Start-Up School for enterprise development of transitional shelter

6.3. Further Scope of study

- Design of Transitional shelters in pertinence to urban areas.
- Low-cost, pre-treatment for the bamboo used to avoid infestations/damage.
- Design of Transitional shelters for community to initially shelter people before individual family shelters can be erected.
- Regular maintenance of the shelters during times when people have been relocated to their permanent homes.

6.4. Recommendations

There is a paucity of study regarding transitional shelters in relevance to climate changes and disaster epidemiology, especially in North East India, which has been met through our study.

From our study of three different scenarios in the context of flood in the state of Assam, we can formulate three sets of guidelines applicable to shelter recovery.

- In the first scenario, where the community have adapted to living with the flood by residing on stilts. A community flood shelter is applicable where the community can reside for a few days till they can go back to their homes after the flood water level comes down.
- In the second scenario, where houses are partially damaged, the transitional shelter kit may be applicable provided other site conditions are met efficiently.
- In the third scenario, where the houses are completely damaged, an owner-led reconstruction is applicable.

6.5. Possible Economic impact of the research in Global terms

- The methodology of design of Transitional shelter is context specific. This can be used in different geographical locations of the globe considering local resources where bamboo is not available and can deliver appropriate Transitional shelters relevant to the location.
- The shelter is made of components which are easily available in the market and just need assembly into a kit as per specifications. Thus, from the beginning, SMEs could be involved and can serve to provide employment and entrepreneurial assistance.
- This shelter kit can be used not only during disasters but can be used in any conditions requiring temporary transitional shelters like campsites for soldiers, trekkers,

professionals at drill or research sites etc. and thus can be developed into a successful business model. Though readymade camps are commercially available, they are not structurally strong and do not support long-term habitats. This void may be filled with this DIY shelter kit which can house a greater number of residents and is more resilient.

- India slowly climbing the ladders of development and the world looking towards her for solutions at times of need like during the COVID pandemic, large-scale 'Make in India' solution of these kits may provide answers to the shelter need of the world during emergency.



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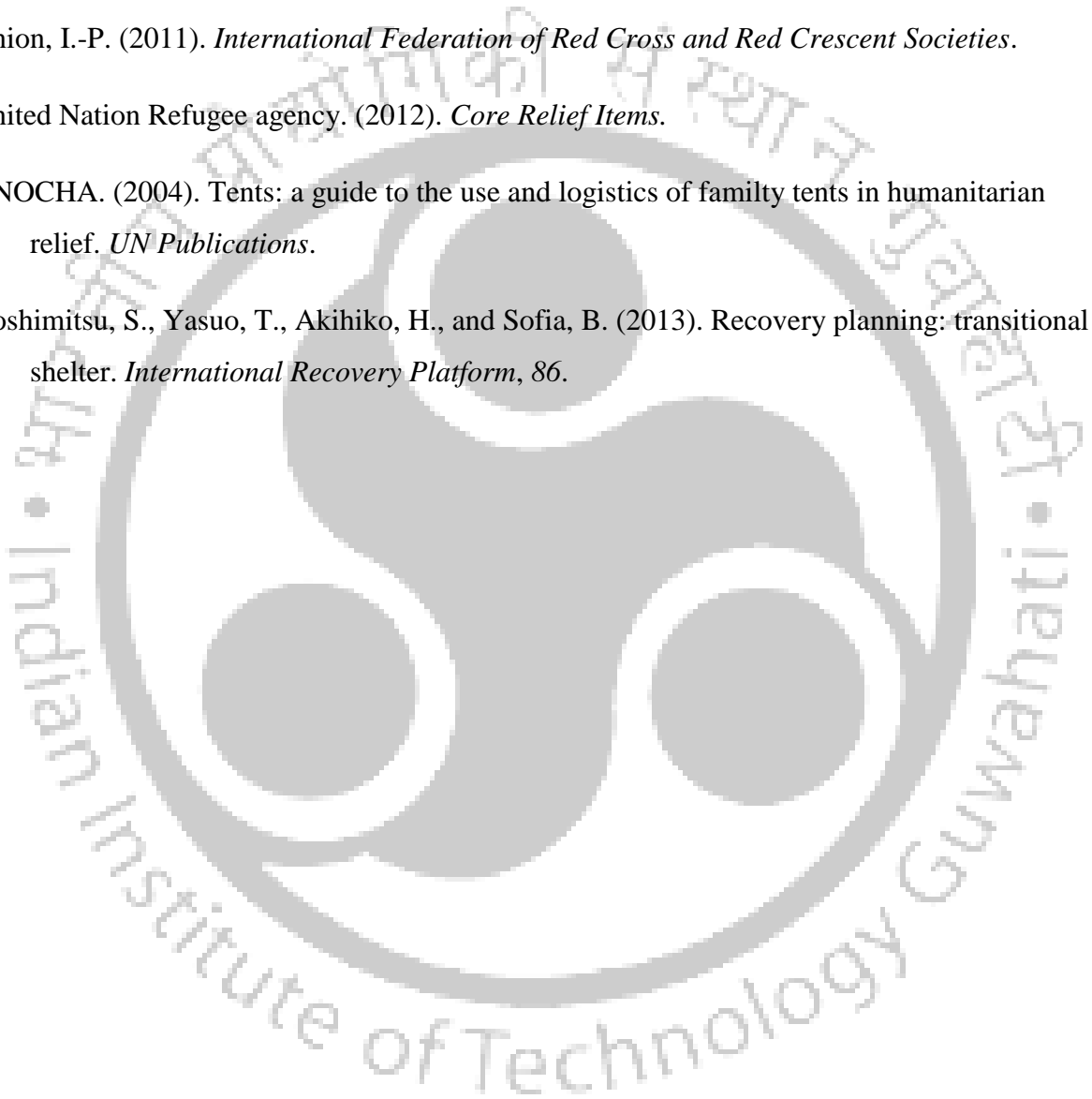
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APPENDIX 1- Questionnaire for Study in Flood affected area

District:

Town/Village:

Name:

Address:

Family Members:

Occupation:

Income status:

Livestock:

Situation

1. When and where did the floodwater enter your house?
2. When/How did you first know about the flood? Frequency of Flood?
3. Did anyone from the Government warn people about the dangers of the flood? Yes /No If yes, then how?
4. How high did the flood come?
5. How long did the floodwaters stay in your house and in your area? Is there still floodwater?
6. How many days were you without electricity?
7. Did sewage mix with drinking water, well water, or bore-well water in your house or area? Yes/ No
8. Did you leave your house as soon as the flood came? Yes No
9. Where did you go after leaving your house?
10. Did the government provide shelter for you? Or did someone else find you shelter? What help was available to you?
 - *Boat rescue Government or Private Cooked food provision for how many days?
 - *Government or Private Drinking water provision for how many days?
 - *Government or Private Basic goods provision Government or Private Mat, blanket Government or Private Medicines, medical camp Government or Private Sanitary needs
11. How was WASH facility at the relief camp?

List of Loss items:

- *
- *
- *
- *
- *

1. What kind of house do you live in? Thatch? Tiles? Concrete?

Land Area:

Ownership status:

2. What kind of damage was done to your house?
3. How much will it cost to clean and repair your house?
4. How many days will it take to repair your house?
4. How many days were you unable to go to work?
5. Did you suffer any health problems as a result of the flood and relief accommodation? Yes/
No
6. Did you go to a government hospital when you were ill? To a private hospital? Were you
admitted into hospital?
7. How much were your medical costs?
8. Did you spend extra on drinking water, milk, necessary medicines, or transportation costs
to escape the flood? How much did you spend?
9. What other expenses were incurred during the flood?

APPENDIX 2- Questionnaire for Study of Housing in Flood affected area

SL NO: GPS:

FAMILY MEMBERS:

FAMILY STRUCTURE:
TOTAL MEMBERS:
CASTE/ETHNICITY:
DURATION:

VULNERABILITY:

FLOOD:	
EARTHQUAKE:	
EROSION:	OTHERS:

SKETCH PLAN OF THE HOUSE / IMAGE:

ANNUAL INCOME:
SOURCE:
EMPLOYMENT STATUS:
AGRICULTURE DEPENDENT:

DISTANCE FROM:
SCHOOL:
MARKET:
HEALTH FACILITY:
DISTRICT HEAD:
POND/WATER:
POLICE:
Post Office:
River:

NOTES:

PLAN ORIENTATION:
 TOPOGRAPHY:
 DIRECTION OF WIND:
 Condition: 20% 40% over 60%
 BUILDING MAATERIAL:
 TOILET:
 WATER:
 COOKING FUEL:
 ELECTRICITY:
 SIZE OF PLOT:
 LAND HOLDING:
 LAND RECORDS:
 LIVESTOCK: COW GOAT POULTRY

REQUIREMENTS FOR REBUILDING:

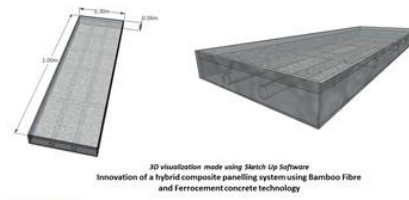
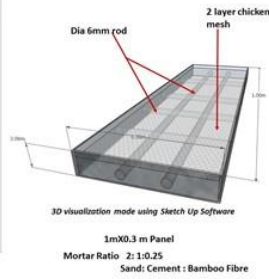
PREFERRED MODE: SELF/ CONTRACTOR/ CO OP

PREFERRED TECHNOLOGY:

ESTIMATED COST:
 FINANCE: GRANT/ MATERIAL/ LOAN

WILLING TO CONTRIBUTE THE PROCESS? How?

APPENDIX 3- Design Exploration using Bamboo Fibre Ferrocement Concrete



BACKGROUND

Single Occupancy Housing using the innovation of a hybrid composite prefabricated panelling system using Bamboo Fibre and Ferrocement concrete technology to develop a panel of 1 metre by 0.30 metre using steel of 2.4kg, sand 15kg, cement 7.5 kg and Bamboo Fibre 2kg.



Modular Prefabricated Panels development



Development of Prototype at Howli Village, Mangaldai, Darrang, Assam



Development of Prototype at Howli Village, Mangaldai, Darrang, Assam



APPENDIX 4 : Pros and Cons of the Bamboo Transitional Shelter Kit

Options	Pros	Cons
Bamboo structure with tarpaulin sheets	<ul style="list-style-type: none"> • Temporary in nature indicating that its only makeshift • Easy procurement in large quantities • Most economical • Possible to distribute the ready material kits and let people take responsibility to erect • Easy to erect 	<ul style="list-style-type: none"> • Not very comfortable climatically
Bamboo transitional shelter	<ul style="list-style-type: none"> • Temporary in nature indicating that its only makeshift • Possible to distribute the ready material kits and let people take responsibility to erect • Climatically more comfortable 	<ul style="list-style-type: none"> • Procurement may be more difficult as specifications, costs and available quantities may vary. • Not so quick to erect but quicker than third option. • Costlier than first option
Bamboo structure with CGI sheet roof	<ul style="list-style-type: none"> • Conventionally executed 	<ul style="list-style-type: none"> • Long lasting solution may encourage continuation in camp. • Possible to distribute but difficult to be erected by people themselves. • Will take more time to deliver if required in large quantities CGI sheets are difficult to be reused if once nailed. • Costly option
Bamboo structure with CGI sheet roof (community shed)	<ul style="list-style-type: none"> • Conventionally executed 	<ul style="list-style-type: none"> • lack of privacy for women, feeding mothers, old women • need to be built and delivered • Not so quick to be delivered • costlier than option 1 and 2 • Risk of longer continuation

APPENDIX 5: Sanction Letter of TOCIC, funding for the housing typology design.

No: DSIR/PRISM/02/2018
Government of India
Ministry of Science & Technology
Department of Scientific & Industrial Research

Technology Bhawan
New Mehrauli Road
New Delhi-110 016
June 11, 2019

To
The Pay & Accounts Officer,
Department of Scientific & Industrial Research,
New Delhi.

Subject: Project entitled “Development of Pucca Housing Topography using Bamboo fiber ferrocement concrete” – financial support under Promoting Innovations in Individuals, Start-ups and MSMEs (PRISM) of DSIR ; reg. release of 2nd instalment

Sir,

I am directed to refer to the Sanction Order of even number dated 05-10-2018 regarding sanction of **Rs.4.29 lakh** (Rupees Four lakh Twenty Nine thousand only) to Ms. Kankana Narayan Dev for PRISM project, “Development of Pucca Housing Topography using Bamboo fibre ferrocement concrete”. 1st instalment of Rs. 1,00,000/- was released to Ms. Kankana Narayan Dev for project work under PRISM scheme of DSIR.

2. I am also directed to convey the sanction of the President of India for the release of second installment of **Rs. 150,800/-** (Rupees One Lakh Fifty Thousand Eight Hundred only) out of the above mentioned support to Ms. Kankana Narayan Dev for second mile-stone: Fabrication of Fully functional prototype of 450 sq ft modular unit for single family.

3. The amount of **Rs.1,50,800/-** will be drawn by the Drawing and Disbursing Officer, Department of Scientific & Industrial Research (DSIR), New Delhi and will be disbursed through RTGS/NEFT to the following as per details given below:

Beneficiary Name & Full Address	Ms. Kankana Narayan Dev C/o Darrang Eco Works, Rajapam, Mangaldai, Assam 784125
Beneficiaries Bank	State Bank of India
with Full Address	IIT Guwahati Assam-781039
IFSC code of Bank	SBIN0014262
Account No.	00000037930091442
Amount(Rs.)	1,50,800. (One Lakh Fifty thousand Eight Hundred)

4. This DSIR support is subject to the terms & conditions as accepted by Ms. Kankana Narayan Dev. The next instalment of DSIR support would be considered for release based on the progress of the project and receipt of Statement of Expenditure (SE) and Utilization Certificate (UC) and compliance of EAT module from the innovator.

5. It is certified that the provision of GFR 238(3) of GFR 2017 relating to Utilization Certificate (UCs) has been fulfilled and copy of UC/SE is enclosed herewith. No other UC is pending from the innovator of any scheme of DSIR.

