

ABSTRACT

Title of Thesis: REBUILDING A BETTER RESPONSE

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What is one thing in the world that we have little control over? Mother Nature. We as humans have tried to alter our natural environment countless times, and she has fought back twice as strong, leaving trails of devastation behind. The number of natural disasters has drastically increased, especially in the Southeast Asian region. The aftermath of a tsunami has left a large number of people homeless and lives forever changed. The current recovery process is chaotic and leaves affected individuals stranded without the means of rebuilding for long periods of time. This thesis aims to re-evaluate the recovery relief procedures and provide a better means of rebuilding their lives and community.

REBUILDING A BETTER RESPONSE

by

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List of Abbreviations

S.E.A – Southeast Asia

NOAA – National Oceanic and Atmospheric Administration

IFRC – International Federation Red Cross/Red Crescent

DRU – Disaster Relief Units

ERU – Emergency Response Units

RDRT – Regional Disaster Relief Team

RI – Relief International

FEMA – Federal Emergency Management Agency

NGO – Non-Governmental Organization

UN – United Nations

STAR – Study of the Tsunami Aftermath and Recovery

WHO – World Health Organization

Chapter 1: Understanding the Storm

In the ever-changing and ever-growing climate changes the world faces today, natural disasters have continued to occur at an increasing rate. These natural disasters come in many forms whether they be strong winds of a tornado, engulfing waves of a tsunami, shattering earthquakes, or combinations of both to create deadly catastrophes. No matter how different these phenomena may be in form, they all have the equally devastating destructive power to change the lives of many they hit. Many people hear about these disasters through the news, but how many actually understand the sheer power of what one natural disaster can do to gravely affect a population?

Understanding the storm, tornado, earthquake, and other natural disasters will help guide the research of figuring out possible solutions or successful methods to the recovery process. Many factors determine the damages of a disaster, such as the strength of the natural disaster itself but also the lack of preparedness. The limited knowledge of how to prepare for the impact of a natural disaster can multiply the damage done to a population. Educating and working with these natural disaster prone communities, towns, and cities will hopefully lessen the casualties and help shift the focus more on rebuilding the lives of the people.

This thesis will explore focus on natural disasters in the Southeast Asian region. Southeast Asia (S.E.A) has been the number one most natural disaster prone-area in the world and accounts for more than 60% of the world's hunger. From 1994-2013, S.E.A has increased in about 500,000 deaths due to these natural disasters hitting the region. Around 1.5 billion people are affected^{ed}, which calculates to be about 500,000 people

annually.

Components of a Disaster

Natural disasters are catastrophic events caused by nature or the natural processes of the earth. There are numerous disasters ranging from many extremes, such as drought to flooding or asteroids to earthquakes. In this thesis, my aim is to understand the elements of tsunamis.

What is a Tsunami?

A tsunami is a series of waves caused by sudden displacements in the sea floor, landslides, or undersea volcanic eruptions.¹ This force of nature is ranked high on the scale of natural disasters. Since 1850, tsunamis alone have been responsible for the loss of over 420,000 lives and billions of dollars of damages to coastal structures and communities.²

¹ <http://www.tsunami.noaa.gov/>

² http://www.tsunami.noaa.gov/tsunami_story.html

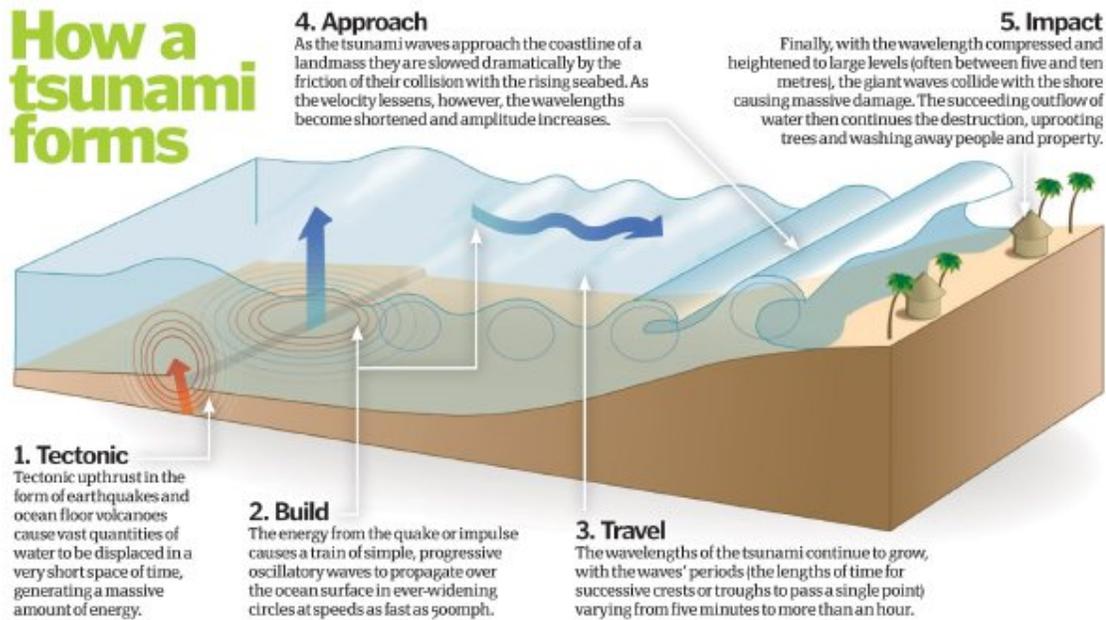


Figure 1 Illustration of How a Tsunami Forms³

Tsunamis are formed in a complex multi-stage process and spread from a massive energy release. Figure 1 is a breakdown of the tsunami formation in five stages. The first stage of the formation begins when Earth's tectonic plate up-thrusts, such as an earthquake or a large impulsive event, thus causing massive amounts of ocean water to be displaced instantaneously.⁴ The second step is the buildup of energy causing a train of simple, progressive waves on the surface at speeds as fast as 500mph. The third step is the growth of the wavelengths as it travels. It can grow from a few inches to several meters high. The fourth step is when the waves approach the coastline; the friction of the collision with the rising seabed slows them drastically. The velocity of the waves may sometimes lessen, but the wavelengths become shortened and the amplitude increases.

³ <http://www.howitworksdaily.com/how-a-tsunami-works/>

⁴ Ibid

The compressed waves may grow to a height of 30 feet or more.⁵ The height of a tsunami as it approaches a shoreline is referred to as the “run-up”. The final step is the impact of the waves. The wavelengths compressed and heightened to high levels collide with the land causing devastating damage to whatever it hits. The succeeding outflow of water then continues to destroy whatever is in its path, such as by uprooting trees, washing away properties and people.

As we start to understand the causes and formation of a tsunami, we should also start to understand the metrics of the storm. The energy and travel time of a tsunami forming to the impact to a coastline varies depending on several factors. One of the major factors is the measurement of the water depth. The depth of the ocean controls the overall wave speed. For example, a water of over 3.7 miles deep can travel at a speed of over 500 miles per hour, similar to the speed of a commercial jet plane.⁶ Tsunamis can also travel at a slower pace in shallower coastal waters, but it could still have the same intensity, if not more, as a normal paced one.

⁵ <http://abcnews.go.com/Technology/Weather/story?id=365979>

⁶ <http://ptwc.weather.gov/faq.php#6>

**Tsunami Wave Depth vs.
Speed of Travel**

Depth		Velocity	
feet	meters	mph	km/h
23,000	7,000	586	943
13,000	4,000	413	713
6,500	2,000	194	313
650	200	99	159
165	50	49	79
33	10	22	36

Figure 2 Wave Depth v. Speed of Travel Chart⁷

Figure 2 shows the estimated calculations of the wave depth to the tsunami's velocity. Other factors contributing to the arrival time to a landmass are the time the event that generated them occurred, the distances traveled by the waves, and the geological features that exist on the storm's path. As there are factors to increase the velocity of the tsunami, there are factors to decrease the speed and energy as well. Geological features such as reefs, bays, river entrances, and undersea formations may help dissipate the energy of a tsunami.

As we learned, through the factors that affect the velocity of a tsunami's path, we can [attempt to](#) calculate the travel time of the waves to a nearby coastal community. The location of the tsunami's epicenter affects the time of when it might reach a shoreline. It could be a matter of minutes to hours [of](#) when it [could reach](#) a population. The National Oceanic and Atmospheric Administration (NOAA)'s National Centers for Environmental Information has devised a map to display estimated tsunami travels to selected coastal

⁷ http://www.srh.noaa.gov/jetstream/tsunami/tsunami_faq.htm

locations from any point in the ocean. This tool uses maps generated by using Tsunami Travel Time (TTT) software developed by Paul Wessel, Geoware.⁸

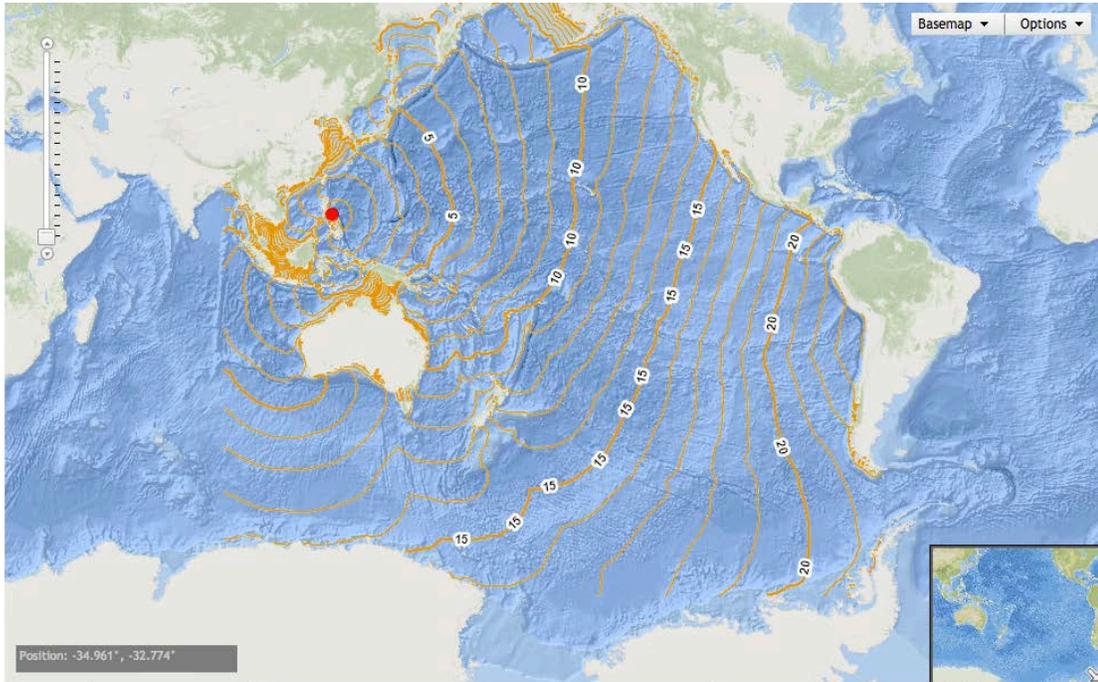


Figure 3 Estimated Travel Time from Philippines⁹

⁸ http://ngdc.noaa.gov/hazard/tsu_travel_time.shtml

⁹ Ibid

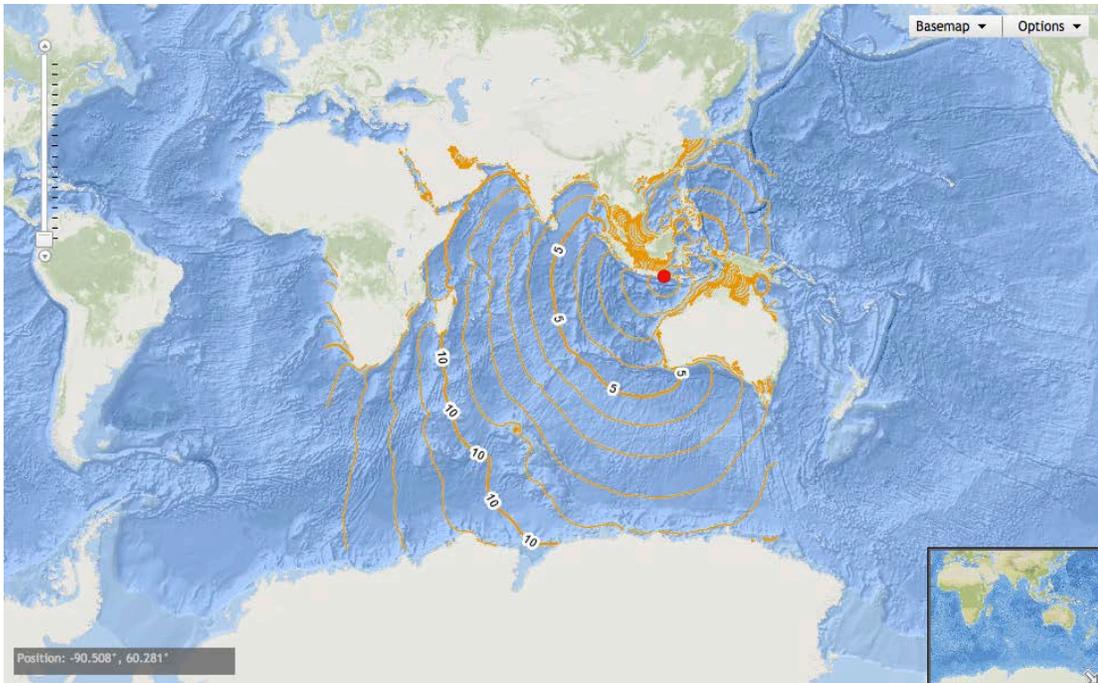


Figure 4 Estimated Travel Time from Indonesia¹⁰

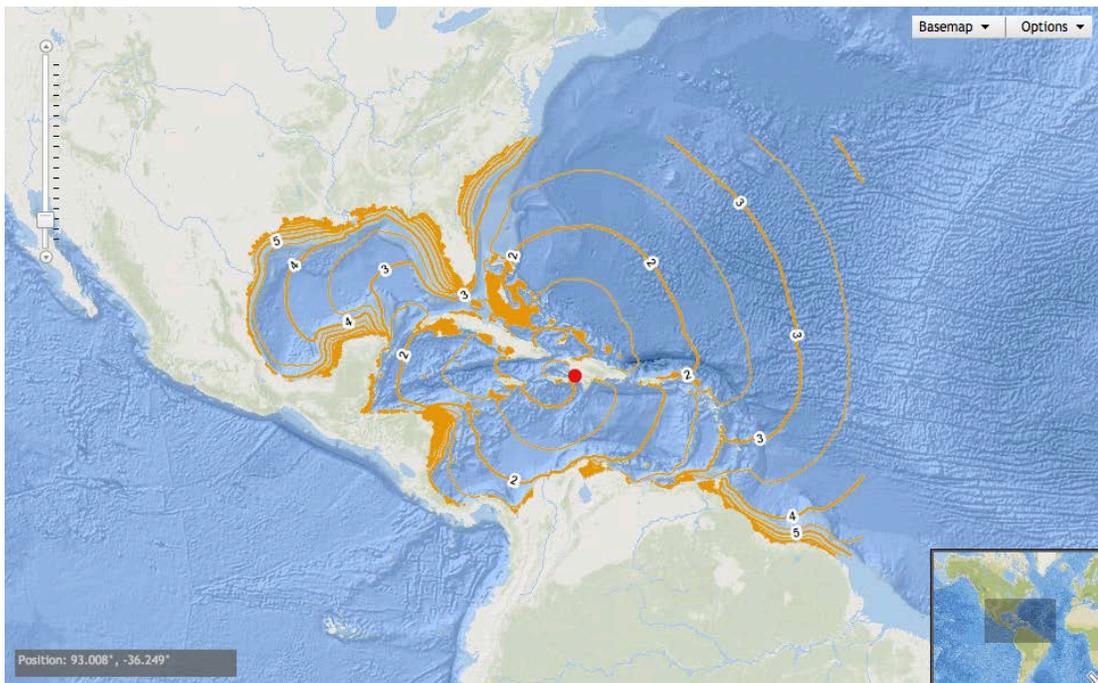


Figure 5 Estimated Travel Time from Haiti¹¹

¹⁰ http://ngdc.noaa.gov/hazard/tsu_travel_time.shtml

¹¹ Ibid

The series of figures above (Fig. 3, 4, and 5) demonstrate how the mapping tool travels in time (hours) of the selected countries would be affected from any point in the respecting ocean. So looking closer at Fig. 3, if the epicenter of a tsunami was located in the middle of the Pacific Ocean, it could take [approximately](#) 9-10 hours to reach the Philippines. [If](#) we look at Fig. 4, if the epicenter was located near the tip of India, it could arrive in Indonesia in about 5-6 hours. Even though this tool is just an estimated travel time of a potential tsunami, it could be used to plan community, town, and city safety evacuation procedures to minimize human casualties and damages [to property](#). The danger of a tsunami can last for many hours, [so](#) planning accordingly is essential to minimize the damages.

Tsunamis cannot be prevented; they are a force of nature that cannot be controlled or stopped. These inevitable forces have almost become [parts](#) of certain cultures. Tsunamis in the S.E.A countries are integrated into their lives. The [most](#) optimal [solution](#) we [have with our current technology and knowledge](#) is to effectively prepare and respond to these forces of nature. [Additionally, we can reduce](#) the recovery period as much as possible to help [populations rebuilt](#) their lives.

What is an earthquake?

An earthquake is an event when two portions of the earth slip past one another, [causing](#) a shaking and displacement of the ground. Many of the earthquake zones coincide with areas of high population density, and when large earthquakes erupt in such dense areas, [the](#) results can be catastrophic.

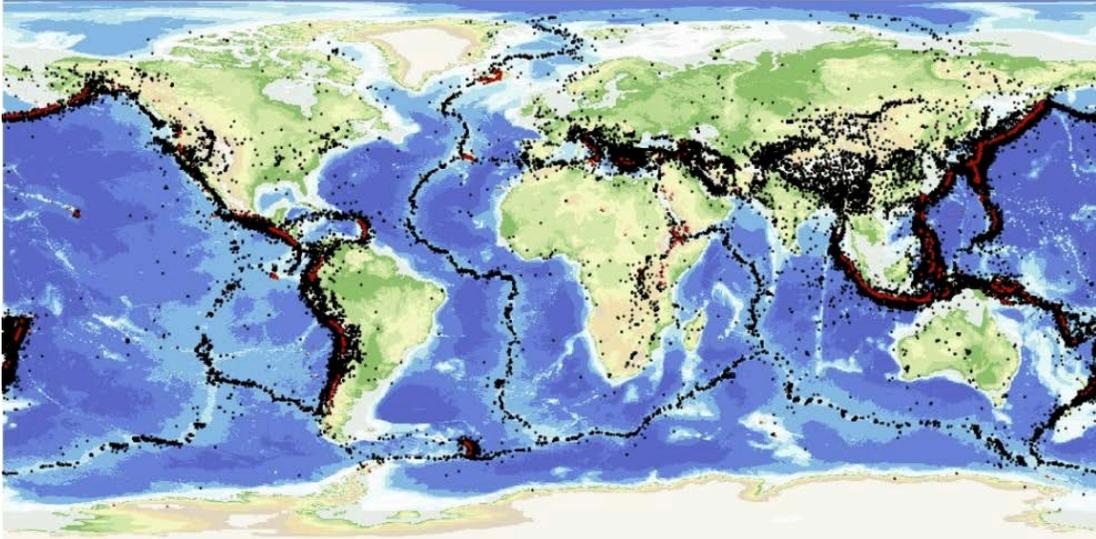


Figure 6 Map of the world showing the occurrences of earthquakes¹²

Taking a look at the [Figure 6](#), it is clear that most of the earthquake activity is concentrated around number of distinct earthquake belts throughout the world. The map shows that most of these quakes lie along the narrow edges of the continents, with some in the middle of the oceans.¹³ There is also a strong concentration of earthquakes along the Pacific Ocean and around the S.E.A region, which could be viewed as a strong factor to the increase of natural disasters, especially tsunamis, in that area.

Understanding the basics of earthquakes are [essential to](#) understanding the power of tsunamis; earthquakes and tsunamis have a strong correlation. Earthquakes are usually the precursor to many tsunamis, [and](#) some of the most destructive tsunamis are a result of a large, shallow earthquake epicenter occurring near or on the ocean floor.¹⁴ [N](#)ot all

¹² <http://www.bgs.ac.uk/discoveringGeology/hazards/earthquakes/whyWhere.html>

¹³ Ibid

¹⁴ <http://itic.ioc->

unesco.org/index.php?option=com_content&view=article&id=1158&Itemid=2026

earthquakes generate tsunamis; it usually takes an earthquake with a 7.5 magnitude or more to produce a tsunami.

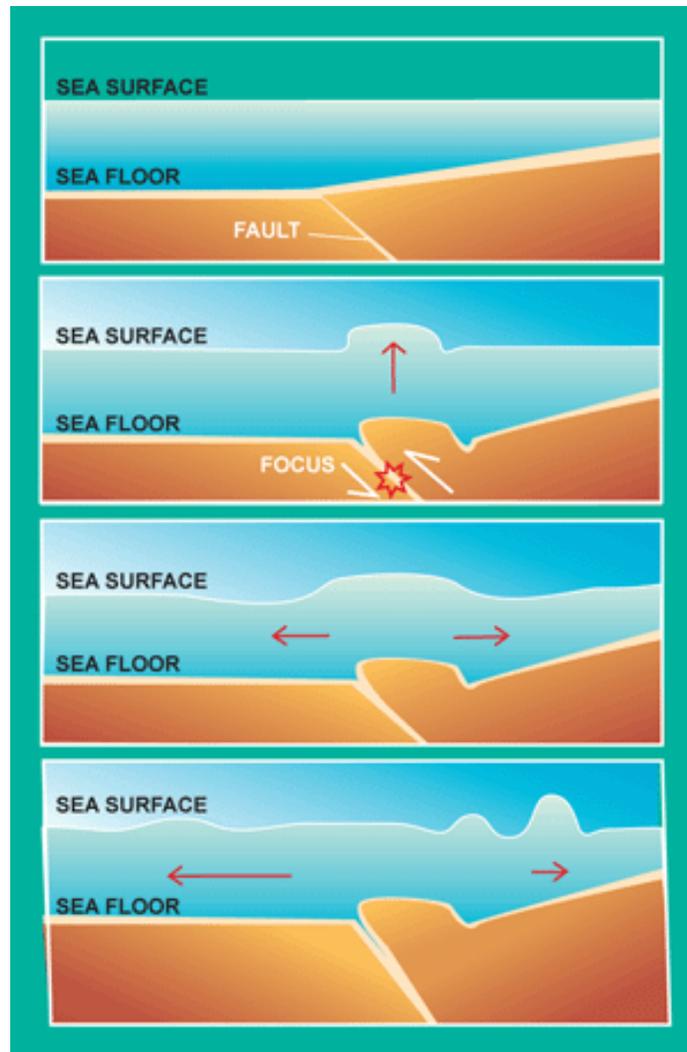


Figure 7 Illustration of how an earthquake generates a tsunami¹⁵

Figure 7 depicts the steps of how an earthquake plays a role in generating a tsunami. When a strong earthquake ruptures, the faulting (the surface where the two portions of the earth slip) could possibly cause a vertical slip large enough to disturb the waters, producing a tsunami that will travel outward in all directions.

¹⁵ Ibid

Further into this chapter are descriptions of case studies ranging in different scales of location. These case studies highlight different key points to illustrate the severity of the natural disasters. Some of these studies will be discussed and analyzed further in [this](#) thesis.

Chapter 2: Case Studies

Local Case Studies

2005 Hurricane Katrina

Hurricane Katrina was one of the most recognized natural disasters that impacted the United States. It was known to be one of the five deadliest hurricanes and [one of](#) the costliest natural disasters in the history of the United States. It has been estimated to [have caused approximately](#) 1,330 deaths and \$96 billion in damages in just New Orleans¹⁶. Hurricane Katrina's severe storm power was not the only thing that made it such a captivating headline but the responses to the aftermath of the storm as well.

The aftermath of Hurricane Katrina was not only viewed as a chaotic mess from the wreckage, but the emergency response was also seen as an unorganized mess. The national emergency response from Federal Emergency Management Agency (FEMA) suffered from severe communication issues. The preparation for the storm from FEMA was deployed and ready to [respond](#) to the storm when it would hit. [However](#), once the storm hit, the response period greatly suffered as the communication infrastructure was significantly destroyed¹⁷. It left many response teams very uncoordinated in the areas they were to aid in. This prolonged the rescue times for the survivors to days without help. On top of this issue, many of the roadways were blocked from either wreckage or

¹⁶ <http://library.stmarytx.edu/acadlib/edocs/katrinawh.pdf>

¹⁷ http://www.disastersrus.org/katrina/OIG_06-32_Mar06.pdf

[flooding](#). [This resulted in](#) the only travel methods [to be](#) through air or water to reach the survivors¹⁸.

In addition, the initial recovery also was not effectively implemented. Hurricane Katrina left around 770,000 people displaced; the largest since the Dust Bowl migration in the 1930s¹⁹. The housing options for the displaced arrived slowly for those who could not return to their ruined homes. Many were forced to relocate to other states and housed in [ill-equipped](#) large commercial buildings, such as stadiums and arenas. By the end of October, there were still more than 4,500 people staying in emergency shelters²⁰.

The [resulting effects on the survivors of the hurricane](#) became [calls](#) to action for many organizations, celebrities, and architects to start designing and creating permanent homes for [the](#) still displaced survivors. Make It Right was an organization founded by Brad Pitt as a response to the lack of governmental aid for the Lower Ninth Ward, one of the poorest districts in [New Orleans](#)^[OL1]. The idea of the charity [was](#) to rebuild the majority of the Lower Ninth Ward back, but [was executed](#) poorly. Make It Right had only completed 60 out of the planned 150 houses. Not only did [the organization fail to](#) finish the houses they promised to rebuild, some of the built houses were facing issues of rotting and damp wood²¹. Another issue that the charity [encountered](#) was that the new

¹⁸ Ibid

¹⁹ <http://library.stmarytx.edu/acadlib/edocs/katrinawh.pdf>

²⁰ Ibid

²¹ <http://news.nationalpost.com/news/brad-pitts-rotting-relief-homes-and-other-problems-facing-new-orleans-a-decade-after-hurricane-katrina>

homeowners could not afford to maintain the upkeep for the [homes](#); thus, they [often](#) had to relocate to more affordable homes.

Hurricane Katrina [exemplifies](#) how critical and careful steps [are](#) needed to [properly prepare for such](#) storms. [The disaster also shows](#) how important communication and alternative response plans are [crucial](#), since things can be changed at a moment's notice. In the recovery period, relief housing [can be provided](#) with the best intentions, but if it is not given careful thought, it could cause more problems than solutions.

2012 Hurricane Sandy

Hurricane Sandy was the second-costliest hurricane in the United States. This hurricane was not as deadly as Hurricane Katrina, but it did still leave a scar on the country. Hurricane Sandy was one of the most destructive hurricanes on the Atlantic; it was estimated to have caused \$71.4 billion dollars [in damage](#)²². This storm brought to light how little protection cities and communities had to their infrastructure and utility grid, as well as [how](#) little storm resilience the buildings had.

In preparation for Sandy, local and federal governments learned from the past storms on what worked and what did not. [This included](#) decisions to make earlier declaration of a major disaster and a significant increase of personnel before and after the impact of the storm²³. The response operations' priorities were more focused and organized; they were [focus](#)ed on people, power restoration, points of distribution for

²² <http://www.nws.noaa.gov/os/assessments/pdfs/Sandy13.pdf>

²³ https://www.fema.gov/media-library-data/20130726-1923-25045-7442/sandy_fema_aar.pdf

commodities, and pumping flooded tunnels²⁴. Once the response process became more stabilized, the recovery period came into full effective. Infrastructure restoration [became](#) an aggressive effort by the state, local, and tribal governments²⁵.

FEMA established an Energy Restoration Task Force to [coordinate](#) the restoring [of power to be executed](#) as quickly as possible. This [task force](#) was able to airlift 229 power-restoration vehicles and 487 personnel to help New York and New Jersey to restore power. Electric utility companies also deployed over 70,000 workers to affected areas; this was the largest dispatch of workers ever [in attempts to relieve a natural disaster in the U.S](#)²⁶. In terms of transportation recovery, New York City was able to restore 80 percent of the Metropolitan Transit Authority service. The [task force](#) was also able to provide 9.3 million gallons of fuel at the request of the states for the first responders²⁷.

[In addition to the](#) infrastructure damages, Hurricane Sandy caused nearly \$50 billion in property damages. Local and state officials were able to fund temporary housing for survivors as well as assisting survivors' stay in hotels or motels until suitable housing accommodations were available. FEMA approved more than \$1.2 billion in

²⁴ https://www.fema.gov/media-library-data/20130726-1923-25045-7442/sandy_fema_aar.pdf

²⁵ Ibid

²⁶ Ibid

²⁷ Ibid

housing assistance, such as house repairs, temporary housing and medical expenditures²⁸.

From Hurricane Sandy, it is evident that with careful and [well-coordinated](#) planning, an effective response and recovery can occur.

Regional Case Studies to Southeast Asia

2004 Indian Ocean Tsunami

The 2004 Indian Ocean Tsunami was a devastating and traumatic event [that](#) “left behind individual and social distress which will require long term attention”²⁹. Fourteen countries were gravely impacted by the tsunami, such as Indonesia, India, Sri Lanka, Thailand, Maldives, Bangladesh, and Malaysia. There has been an estimate of a total of 227,898 deaths, at least five million people affected, and [approximately](#) \$15 billion in damages³⁰³¹³². Millions of homes, shops, boats, schools, and places of worship disappeared into the powerful tsunami waves³³. [One](#) of the contributing factors as to why the death toll was incredibly high [was](#) due to the lack of [a](#) signal/warning system in the

²⁸ Ibid

²⁹ http://www.who.int/hac/crises/international/asia_tsunami/3months/report/en/

³⁰ Ibid

³¹ <http://earthquake.usgs.gov/earthquakes/eqinthenews/2004/us2004slav/>

³² <http://indianoceansunami.web.unc.edu/the-economical-impacts-and-aspects-of-the-2004-indian-ocean-tsunmai-on-indonesia/>

³³

http://www.redcross.org/images/MEDIA_CustomProductCatalog/m3140120_TsunamiRP5yearReport.pdf

Indian Ocean. There is a warning system in the Pacific Ocean, due to the fact that tsunamis were more frequent in the Pacific Ocean³⁴. Along with the lack of warning systems, it was difficult place for coordination and communications as the local and national officials [in these countries](#) lacked plans for these emergencies³⁵. In certain areas, it was difficult for relief organizations reach and [distribute](#) aid to the survivors.

National health professionals, supported by local and international NGOs, UN agencies, and other partners reacted immediately. Their primary immediate responses were to provide health support and protection of health to survivors. World Health Organization (WHO) provided immediate guidance of public health, disposal of the deceased, and [widely](#) disseminated information on the non-immediate risk³⁶. Throughout the course of five years, the Red Cross was able to support the construction and rehabilitation of 4,600 homes, benefitting about 23,000 people. The organization was also able to provide more than 88,500 people with livelihood assistance³⁷. [The Red Cross also](#)

³⁴ <http://www.australiangeographic.com.au/blogs/on-this-day/2014/12/on-this-day-in-history-boxing-day-tsunami>

³⁵ Ibid

³⁶ http://www.who.int/hac/crises/international/asia_tsunami/3months/report/en/

³⁷

http://www.redcross.org/images/MEDIA_CustomProductCatalog/m3140120_TsunamiRP5yearReport.pdf

[helped](#) prepare more than 580 communities and schools for future disasters by developing local disaster safety plans and forming disaster response teams³⁸.

The World Bank was able to establish a program called Study of the Tsunami Aftermath and Recovery (STAR) to help provide information for survivors in the short and medium term response³⁹. The STAR program was able to conduct a 98% survivor participant survey to gather information about the short to long-term recovery process. In this report, they were able to find out that it took about five years for individuals to be able to move back to the homes they owned with new schools and improved infrastructure⁴⁰. Ten years later, these communities received new residents as a result of births and in-migration. However there are some communities that have not been able to recover. The recovery process for the 2004 Indian Ocean tsunami is a long and continuous process.

2013 Typhoon Haiyan (Yolanda)

[The internationally known](#) Typhoon Haiyan, or [often recognized to by its Filipino name](#), Yolanda, was recorded to be one of the most powerful storms; it impacted multiple countries but [arguably most](#) gravely affected the Philippines. The storm has affected a total of 3,424,593 families (16,078,181 individuals) with 4.1 million of individuals

³⁸ Ibid

³⁹ <http://blogs.worldbank.org/impactevaluations/resilience-and-recovery-ten-years-after-2004-indian-ocean-tsunami-summary-results-star-project>

⁴⁰ Ibid

reportedly displaced⁴¹⁴². That is nearly four times as many left [homeless](#) by the 2004 Indian Ocean tsunami⁴³. It has also claimed more than 6,300 lives in the Tacloban City, Philippines alone⁴⁴. There were an estimated total of 1,084,762 houses damaged⁴⁵. The power of Typhoon Haiyan left a traumatic scar on the Filipino nation.

After Typhoon Haiyan made landfall, a large [number](#) of relief organizations, ranging from local to international and public to private [groups](#), sent their immediate aid response. The Red Cross network was able to quickly respond by delivering lifesaving supplies and services like food, medical care, water, and shelters⁴⁶. The rescue response was immediate to the reachable communities in the Philippines. Transportation of supplies became a large issue in certain areas due to severe flooding and blocking or

41

<https://web.archive.org/web/20141006091212/http://www.ndrrmc.gov.ph/attachments/article/1177/Update%20Effects%20TY%20YOLANDA%2017%20April%202014.pdf>

⁴² <http://www.care.org/sites/default/files/documents/Philippines%20ONE-YEAR%20HAIYAN%20REPORT%20final%2011-7-2014.pdf>

⁴³ Ibid

⁴⁴

<https://web.archive.org/web/20141006091212/http://www.ndrrmc.gov.ph/attachments/article/1177/Update%20Effects%20TY%20YOLANDA%2017%20April%202014.pdf>

⁴⁵ Ibid

⁴⁶ <http://www.redcross.org/what-we-do/international-services/haiyan>

destroyed roads⁴⁷. It took organizations, such as CARE to distribute food relief packages, eight days to [access](#) the [more difficult to reach](#) communities⁴⁸. Within a span of a month, many of the major roadways were cleared of the storm debris, allowing relief workers the full access to survivors and start the recovery and rebuilding⁴⁹.

The recovery period is a long and continuous development. Since 2014, about 25,000 people still live in transitional housing and about 475,000 people are estimated to be living in unsafe or inadequate makeshift shelters⁵⁰. Many organizations are still working closely with the affected individuals to rebuild their homes, communities, and [lives using](#) a mixture of local and imported materials to build a more resilient community⁵¹. As well as rebuilding, they are also working to prepare for future storms. Organizations such as the United Nations Development Programme (UNDP) work closely with the national and local government to develop evacuation routes, shelters, early warning systems, and hazard maps⁵².

⁴⁷ <http://www.care.org/sites/default/files/documents/Philippines%20ONE-YEAR%20HAIYAN%20REPORT%20final%2011-7-2014.pdf>

⁴⁸ Ibid

⁴⁹ <http://www.undp.org/content/undp/en/home/ourwork/our-projects-and-initiatives/Typhoon-Yolanda-Philippines.html>

⁵⁰ <http://reliefweb.int/disaster/tc-2013-000139-phl>

⁵¹ <http://www.undp.org/content/undp/en/home/ourwork/our-projects-and-initiatives/Typhoon-Yolanda-Philippines.html>

⁵² Ibid

Chapter 3: Emergency Relief Agencies

Typical Disaster Management Model

Control

The idea of having a typical/generalized disaster management model is to create a control component. The control component is then used for comparison to the other emergency response agencies discussed in this thesis. This control model is taken from the “Introduction to Emergency Management” textbook.

Disaster Management Model

The control disaster management model is a fairly linear process. It follows a series of steps of a small relief response to a larger response. Figure 8 depicts the process of the generalized disaster management model.



Figure 8 Typical Disaster Management Model

International Federation Red Cross/Red Crescent

History

The International Federation Red Cross/Red Crescent (IFRC) is the world's

largest humanitarian organization. It was founded in 1919 in Paris in the aftermath of World War I⁵³. The objective then was to improve the health of people in countries that had greatly suffered during the wars. Since then the goal of the organization has not changed too much, it still is to provide aid to those in need but without discrimination as to nationality, race, religious beliefs, class, or political opinions⁵⁴. It is a neutral organization providing all forms of humanitarian activities by National Societies⁵⁵. The IFRC focuses on multiple areas of humanitarian work, such as development work, migration, risk reduction, recovery, promoting principles and values, and disaster/crisis management⁵⁶.

IFRC covers the full spectrum in disaster/crisis management; from preparation to recovery. Their response to disasters focuses on three core goals for an effective management.

1. Provide leadership in disaster management in order to provide proper support of strengthening movement coordination and cooperation⁵⁷.
2. Promote IFRC-wide tools and resources to areas in need of disaster/crisis preparedness, response, and recovery planning. Such as disaster needs

⁵³ <http://www.ifrc.org/en/who-we-are/history/>

⁵⁴ <http://www.ifrc.org/en/who-we-are/vision-and-mission/>

⁵⁵ Ibid

⁵⁶ <http://www.ifrc.org/en/what-we-do/>

⁵⁷ <http://www.ifrc.org/en/what-we-do/disaster-management/>

assessments, relief to recovery planning, and use of cash in state of emergencies⁵⁸.

3. Improve the timeliness and quality of emergency response and Disaster Relief Emergency Fund (DREF) supported operations through plans of action and resource mobilization efforts⁵⁹.

Through these goals IFRC is able to effectively analyze and procedure with their response to many global disasters and crisis.

Disaster Management Model

IFRC's primarily aims to responds to disasters as quickly and effectively as possible, which means mobilizing its resources (specialized and trained people, money, supplies, and other assets)⁶⁰. Rescue responses to affected communities are to aid those in immediate danger and stabilize the physical and emotional conditions of survivors. The duration of IFRC's response and recovery depends on the scale, type and context of the disaster. It is divided in three sections; a short/immediate-term phase, medium-term phase, and a long-term phase⁶¹

In the analysis of the IFRC's disaster assessment guidelines, it is very evident that the organization is very meticulous and organized on their approaches towards disasters. The step they the IFRC will always begin with is the assessment to evaluate the extent

⁵⁸ Ibid

⁵⁹ Ibid

⁶⁰ <http://www.ifrc.org/en/what-we-do/disaster-management/responding/>

⁶¹ Ibid

and impact of the damage caused by the disaster. Essentially calculating the needs of the affect population, in terms of resources and time needed to be spent there. The assessments are performed in three steps. A rapid assessment to provide information on the immediate needs and course of action to be taken, this action takes normally a week to finish⁶². Following the rapid assessment is a detailed assessment, which takes about one month depending on the complexity of the situation⁶³. After the detailed assessment is a continual one, where the assessment is an ongoing gathering of information throughout the emergency phase⁶⁴.

From these assessment, the proper resources are deployed accordingly to the reports. The resources are divided into seven sectors, see Figure 9. These resource priority sectors are also divided into two branches, local/national and regional/global⁶⁵. The Local/National branch are typically given the activities of search and rescue, health responses, feeding and sheltering, warehousing, and monitoring⁶⁶. The Regional/Global branch has the tasks of deploying the DREF, dealing with the international media,

⁶² <http://www.ifrc.org/Global/Publications/disasters/guidelines/guidelines-for-emergency-en.pdf>

⁶³ Ibid

⁶⁴ Ibid

⁶⁵ Ibid

⁶⁶ Ibid

deploying specialized Disaster Relief Units (DRU)/ Emergency Response Units (ERU) and/or Regional Disaster Relief Team (RDRT), and telecommunications⁶⁷.



Figure 9 IFRC Priority Sectors⁶⁸

After the immediate relief response is completed, the full start of the recovery process begins and starts to regain the state of normalcy for the survivors. This recovery process in the disaster management cycle includes support for the people's effort to cope, recover, rebuild, and strengthen their resilience⁶⁹. An early recovery takes place along the

⁶⁷ Ibid

⁶⁸ <http://www.ifrc.org/Global/Publications/disasters/guidelines/guidelines-for-emergency-en.pdf>

⁶⁹ <http://www.ifrc.org/PageFiles/41104/IFRC%20Recovery%20programming%20guidance%202012%20-%20201232900.pdf>

relief response period to ensure faster rehabilitation and gains more active community participation⁷⁰. When the full recovery process begins the community and governments start to rebuild and rehabilitate. Reestablishing roads, hospitals, homes, schools, and other service buildings⁷¹. This step could potential turn into a long-term recovery development depending on the complexity of the disaster.

In understanding the IFRC's disaster management process, it has shown that the aid agency places a stronger focus on the relief and early recovery portion of the model. Their assessments done in the relief period has the ability to intensively evaluate the damages and allocate the correct number of resources to the proper channels. Their approach to early recovery is also effective due to the strong participation from the community to start rebuilding quicker. Figure 10 diagrams the IFRC disaster management process. It illustrates how the relief is split into three paths; the local, regional, and early recovery.

⁷⁰ Ibid

⁷¹ Ibid

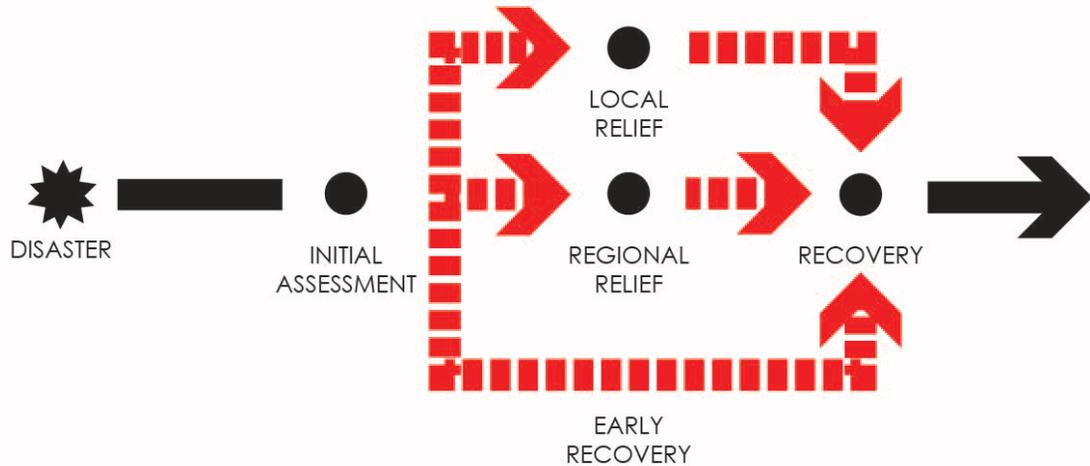


Figure 10 IFRC Disaster Management Model

Relief International

History

Relief International (RI) is a smaller humanitarian relief agency than the IFRC. RI is a humanitarian non-profit agency that provides emergency relief, rehabilitation development assistance, and program services to vulnerable communities worldwide⁷². This organization aims to reduce human suffering in a neutral manner⁷³. RI devotes their time seeking and addressing long-term developmental needs. Unlike larger relief agencies, like IFRC, RI focuses on serving people who typically do not receive as much aid due to lack of attention.

RI prides themselves in working closely with the local communities they help. RI work with the communities to ensure its program do not impose solutions from the outside.

⁷² http://www.ri.org/who_we_are/our-mission.php

⁷³ Ibid

But rather address the communities' needs and requirements for long term growth⁷⁴. This grassroots approach fosters an environment for self-help and sustainability⁷⁵.

Disaster Management Model

RI's disaster management approach is a very linear process. Since they work closely with the community they do not impose any large and major outside resources. Also due to the size of the organization, RI does not have a major global branch like the IFRC. The composition of RI is that they function in small groups to work with the targeted communities. Figure 11 depicts the linear movement of the RI disaster response process. The portion beyond the recovery phase is also highlighted red and elongated because the organization has stated that their goals is to provide long-term development.



Figure 11 RI Disaster Management Model.

⁷⁴ http://www.ri.org/who_we_are/our-approach.php

⁷⁵ Ibid

FEMA

History

FEMA was established in 1978 created by the United States of America's Presidential Reorganization Plan⁷⁶. It is an agency under the United States Department of Homeland Security. FEMA's primary purpose was to coordinate responses to a disaster that has occurred in the United States and that overwhelms the resources of the local and state authorities⁷⁷. Its mission is to also support all citizens and first responders to ensure the nation can improve the US's ability to prepare for, protect against, respond to, recover from, and mitigate all hazards⁷⁸.

Disaster Management Model

FEMA's disaster management model is similar to the control disaster management model. In terms of how the order of response model is constructed, moving from a local/state response to a federal response. FEMA's size and structure is also somewhat similar to IFRC's structure. They both have the relief response process divided into two branches, the local and regional/federal. They are, however, different in when the branches are utilized.

FEMA's immediate relief response is acted upon by the first responders, which are the local and community members. They provide the quick basic rescue services and supplies to the affected individuals, such as medical care, food and water, and monitoring

⁷⁶ <https://fas.org/irp/offdocs/eo/eo-12127.htm>

⁷⁷ <http://www.fema.gov/about-agency>

⁷⁸ Ibid

the situation⁷⁹. Depending on the size and complexity of the disaster, the local officials/authorities can request additional help from the state governor. If the state response is still not enough to provide aid to the damages, then the governor will ask for federal aid⁸⁰. The relief response is a fairly linear process, however it does require a series of steps in order to receive additional higher responses. Unlike the IFRC, where relief can be answered from two of the different branches at the same time.

FEMA's recovery process in the management model is also much more focused than IFRC's model. The recovery process is spread out in a more detailed response. It is divided in three types of recovery, short, intermediate, and long-term⁸¹. The short-term recovery occurs concurrently with the relief period. This recovery also lasts for several days; providing mass care/shelter, clearing debris on primary transportation routes, opening temporary businesses to help reestablish case flow, providing emotional/psychological support, and medical health care⁸². The intermediate recovery occurs for a duration of weeks to months. This stage of recovery builds upon the short-term recovery goals, however they also begin to provide accessible temporary housing

⁷⁹ <http://www.fema.gov/media-library-data/1405716454795-3abe60aec989ecce518c4cdba67722b8/July18FEMAStratPlanDigital508HiResFINALh.pdf>

⁸⁰ Ibid

⁸¹ <http://www.fema.gov/pdf/recoveryframework/ndrf.pdf>

⁸² Ibid

and repair/restoration to infrastructure⁸³. In the long-term recovery buildings upon the intermediate phase, in addition to providing permanent housing, implementing economic revitalization strategies, and reestablishing disrupted healthcare facilities⁸⁴

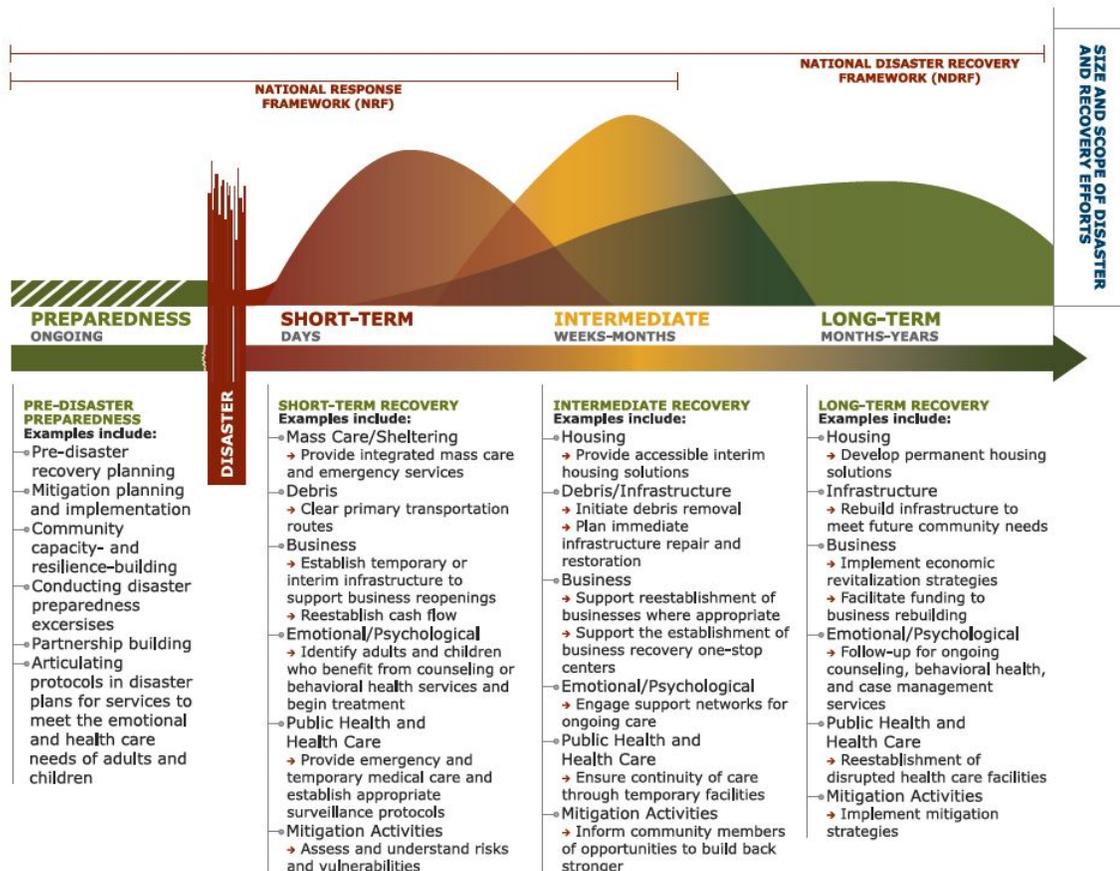


Figure 12 FEMA's Recovery Continuum of Phases⁸⁵

⁸³ Ibid

⁸⁴ Ibid

⁸⁵ Ibid

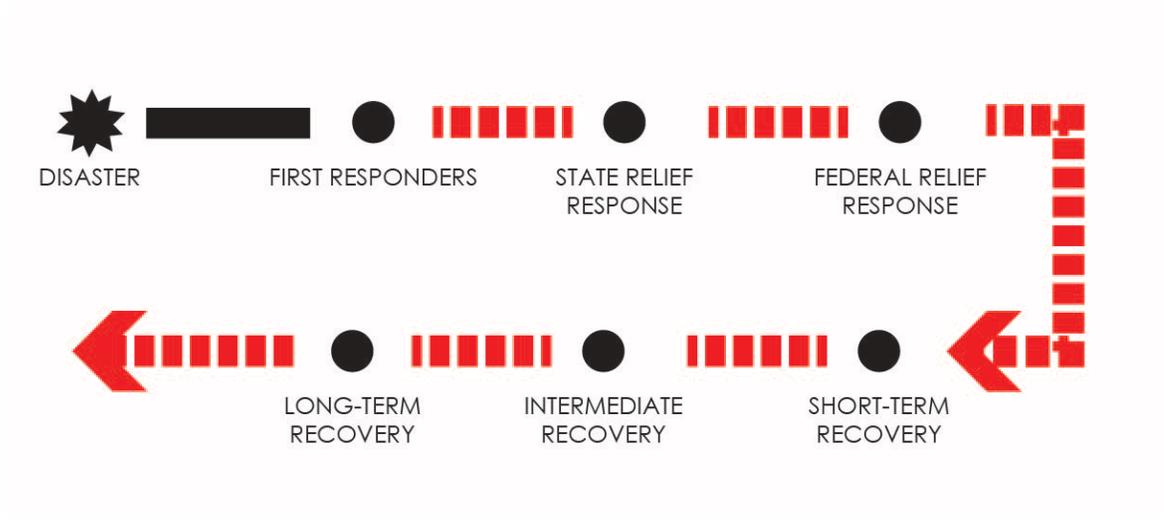


Figure 13 FEMA Disaster Management Model.

Synthesis

This section will showcase the different relief agency models together for better comparison. Analyzing the disaster management models, the IFRC’s model of relief process demonstrates a stronger method towards recovery. Since the relief splits in three ways working to a quicker recovery process. However in terms of the recovery process, the RI model illustrates a stronger system. The RI process does not contain multiple steps before reaching the recovery period, thus a more direct approach to revival for the community.

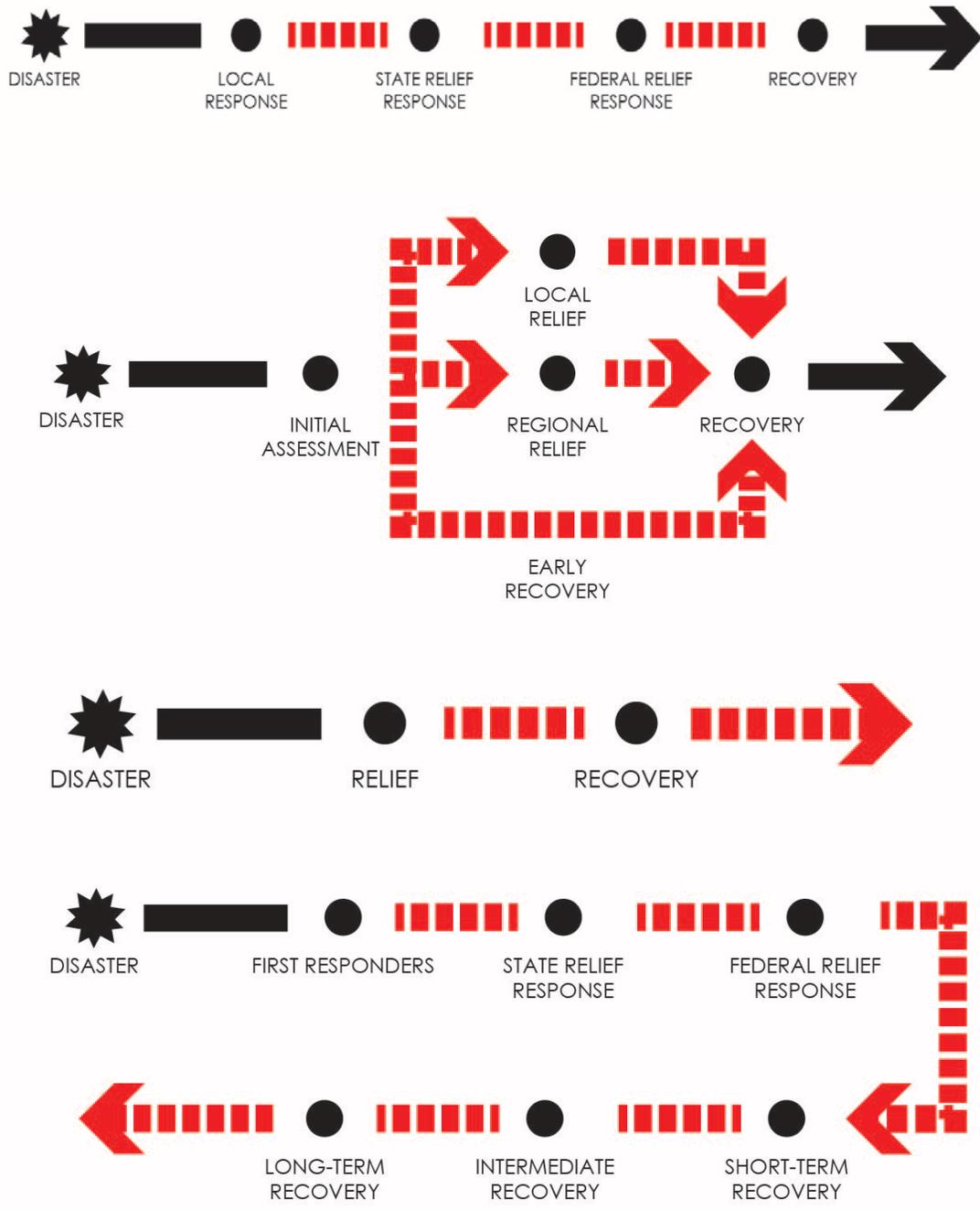


Figure 14 Disaster Management Models. From top to bottom, Control, IFRC, RI, and FEMA.

	LOCAL	REGIONAL/ GLOBAL	NEUTRALITY	CYCLE	SEPARATION OF RELIEF	RECOVERY DURATION	VAST RESOURCES	RELATIONS
CONTROL	●	●	N/A	●	●	N/A	●	
IFRC	●	●	●		●	VARIES	●	LEADERS, DIRECTS
RI	●		●	●		LONG	●	WORKS CLOSE WITH
FEMA	●	●		●	●	VARIES	●	LEADERS, DIRECTS

Figure 15 Relief Agency Matrix.

Chapter 4: Relief Shelter

Idea of the Shelter

Mobility

One of the current issues of relief housing is the lack of transportation of help to the affected individuals. A large number of communities lack aid from government and international organizations due to the poor conditions or non-existent roadways. They are not able to receive the supplies and services in a timely manner to effectively start rebuilding their lives and communities. The means of mobility in this proposal of relief housing is one of the key design goals. Designing a method for transporting the houses in packages with ease is one of the main proponents of this solution. The house should be able to withstand a possible air drop in hard to areas that are difficult to reach by land vehicles.

Designing the house with the ability to easily deconstruct and move to another location is another feature that will allow flexibility in terms of possible relocations. Throughout the recovery process, authorities deem certain zones dangerous, causing many residents to relocate to a safer area. This can sometimes again uproot survivors' lives after an already traumatic experience. Thusly, creating a mobile house could ease those families' worries of having to find another means of shelter.

User-Friendly

With the idea of mobility in the design of the shelter, comes the idea of user-

friendliness. The design should be easily built and replicable by others. For the families and individuals who lost their homes from the disaster to wait for relief agencies to rebuild could be a long wait. It could take days or weeks for proper help to arrive, so this relief housing design would allow for survivors to become self-starters and begin the process of their own recovery. A quick delivery of the shelter through an airdrop on the site will allow for survivors to then easily assemble the shelter with a small group of people, even with those lacking construction skills.

Self-Sufficient

Another design goal within the project is for the shelter to be able to sustain itself, not having to entirely rely on outside energy sources. Having the shelter provide energy for the unit itself is a must in areas where previous sources of energy have been rendered unusable. In addition to the necessity of fueling living essentials such as temperature control, applying this sustainability method will also provide a comfortable living for families within the shelter. The emergency fuel sources should utilize alternative energy sources where possible, such as solar, wind, and/or hydropower, rather than gasoline as that could be a limited and dangerous resource. In 2015, Nepal was impacted with a magnitude 7.8 earthquake and a 7.3 aftershock leaving hundreds of thousands Nepalese homeless and in need of dire aid⁸⁶. Gasoline is a limited and desired resource, So much so that people in Kathmandu were waiting in line for five days for it; diesel sold for \$19 a gallon on the black market. These survivors should not have to spend unnecessary money to survive.

⁸⁶ <http://www.bloomberg.com/features/2015-nepal-dzi-foundation/>

Ideal Performance of the Shelter

Going further into the program of the disaster relief house, it will be broken down into smaller sections of what amenities are needed for a daily life for affected families and individuals. It is divided in three sections that are thought to be essential in taking steps towards recovery and rebuilding: [sleeping](#), [eating](#), and [maintaining](#) hygiene.

Sleep

The idea of sleep, or a place to sleep, and recovery from a tragic disaster is essential in taking strong steps to rebuilding [a life](#). These natural disasters are extremely challenging for the people directly affected. The event itself is traumatic and disturbing but so are the events after it. The stress caused following a disaster can lead to physical, mental, and emotional exhaustion⁸⁷. Therefore, having a space to recover and heal is needed to continue on. [The shelter will be designed for a family of four. In this scenario, it would be ideal to have space for two beds.](#)

Eat

In addition to needing an area [to rest to recover strength](#), it is necessary to have a place to eat. This does not mean having an entire kitchen to [physically eat in](#), but more so [the availability of](#) essentials that [allow for meal preparation](#). Breaking down what a family needs from a kitchen, [it would be ideal to](#) include a stove, sink, and storage [space](#). A stove is important to cook [or](#) heat up food and to possibly boil drinking water [if clean](#)

⁸⁷ <https://www.lifeline.org.au/Get-Help/Facts---Information/Recovering-after-a-natural-disaster/Recovering-after-a-natural-disaster>

[water is unable to be provided by the relief aid](#). A sink is used for numerous purposes; it can be used for washing food in preparation of cooking, [for](#) washing oneself, and [for](#) washing clothes. Lastly, the essential of food storage [cannot be ignored](#). This [simply](#) means having a place to store food properly so it does not spoil. Incorporating these three core items of a kitchen is needed for a [strongly](#) performing shelter.

Hygiene

Lastly, hygiene is one of the core items to address in the shelter. In order to make sure that the families stay healthy, [it is key to maintain](#) good hygiene. After a disaster, a lot of the communities and city utilities are severely damaged, such as the sewage management. With disasters like tsunamis and typhoons where the majority of the land is covered in water, bacterial growth is seen everywhere and the water is not safe. [It is](#) necessary to stay as clean and [as](#) healthy as possible. [To maintain hygiene](#), a bathroom [should be present in the design of the shelter](#) with the [components](#) of a toilet, shower, and sink. [Included should be](#) a good plumbing system [for](#) the waste water [to be removed from the shelter](#).

Time

Construction Duration

Time will always be a looming factor in the process of response and recovery; the time it takes for aid to arrive, time it takes to start rebuilding, and time it takes to fully heal from the tragic event of a natural disaster. [Planning](#) out the time it takes to construct the relief housing is one of the steps towards designing an optimal shelter. Designing the

ideal [timeline](#) for construction was done through an investigation of current relief housing projects, such as the Better Shelter, Architecture for the Mass's prototype bamboo shelter, and some of Shigeru Ban's paper architecture shelters.

Better Shelter advertises their relief housing project [as assembly](#) between four to eight hours. This construction time period is greatly affected [by](#) how all the materials are pre-made and delivered with instructions in carefully designed packages⁸⁸. Architecture for the Mass's relief shelter for Nepal earthquake victims was to be built within three days. This idea was for the shelter to use salvaged local materials and [to be built](#) with a set of clear instructions⁸⁹. Shigeru Ban's paper architecture projects varied in construction time depending on the complexity of the shelter themselves. Most of his projects' completion times ranged [from](#) an average time of six hours to a day. Some of his projects were also based upon the usage of both pre-made and local materials. [If we ignore](#) those pieces of information and average [those proposed construction times](#), [about the result is approximately](#) half a day to a whole day's [work](#). This ideal timeframe of construction is also [dependent](#) on the complexity of the shelter and the materials used within it. One of the design goals for this project would be [to limit the construction time to approximately](#) eight hours to 24 hours.

⁸⁸ <http://www.bettershelter.org/product/>

⁸⁹ <http://www.dezeen.com/2015/07/11/prototype-bamboo-shelter-nepal-earthquake-victims-built-by-unskilled-workers-three-days/>

Temporary or Permanent?

With the idea of time [being very important](#) in the design process of the shelter, comes the decision of whether or not it will be a temporary or permanent solution. The aim for this disaster relief housing is for it to be a temporary shelter for the affected families and individuals. It will act as a transitional piece for people to use, lasting for about six to twelve month's maximum usage. [The shelter will](#) also provide the opportunity to re-use some of the components in the shelter for permanent use [in other projects and permanent home building efforts](#).

The idea for the shelter to [operate as a](#) mainly temporary solution comes from the thought of how [difficult it would be to provide](#) permanent housing to the families [in such a short time](#). Especially since the process of rescue and recovery is still happening. That this is a transitional piece for the more long-lasting shelter. The temporary shelter will allow for a more flexible development and possibilities to occur over time. That with these shelters will temporary uses flourish in the in-between spaces, such as cultural growth programs and activities.

Chapter 5: Site Selection

Idea of Site

The vision of site in this thesis is for it to be site-less. The proposed emergency relief shelter is designed to serve a large number of survivors in multiple areas of SEA. The mobility of the program would negate the shelter from being confined to a singular site. In the event that the user would need to move, they are able to without having to be tied down to their surroundings.

However in order to test the effectiveness of the proposed design a testing site will be used. The testing site is used to critically assess the core goals of the designed shelter, looking into the actual success of mobility, constructability, and self-sufficiency.

Testing Site 1: Tacloban, Philippines

Result of Typhoon Haiyan

On November 8, 2013, Typhoon Haiyan struck the City of Tacloban, gravely devastating the city with 195 mph sustained winds and 15 to 19 foot waves⁹⁰. While the typhoon affected a large majority of cities and communities in the Philippines, Tacloban City received the brute force of the storm in terms of damages and deaths. A report in April 17, 2014 stated that the city had about 6,300 deaths, 28,689 injured, and

⁹⁰ <http://microsites.digitalglobe.com/interactive/typhoon-haiyan/#secondPage/2>

1,061 missing⁹¹. One of the reasons why the city was so greatly affected by the typhoon was because of its high population density and the close proximity of the storm. Figure 16 shows the path of Typhoon Haiyan and the population density of the major cities along the path.

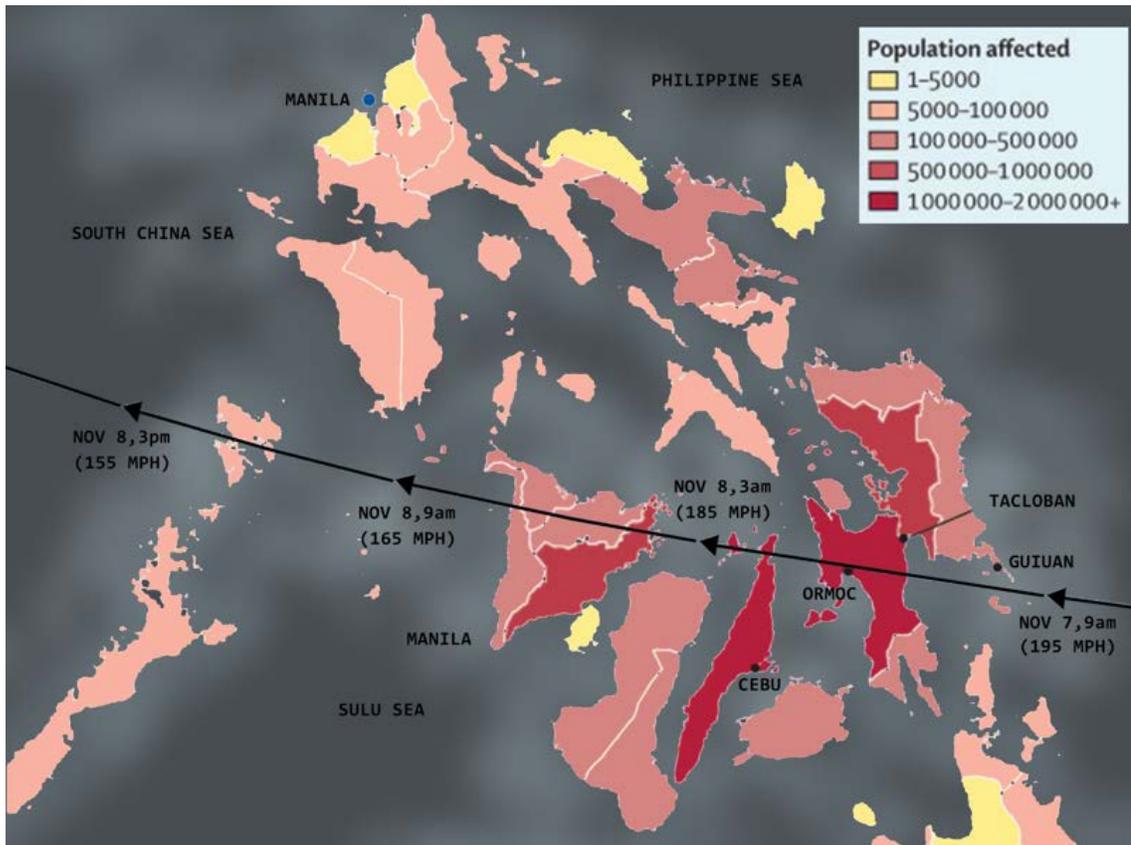


Figure 16 Typhoon Haiyan Path and Population Density.

The typhoon destroyed about 90 percent of the city, and a majority of the structures and infrastructure were either completely destroyed or significantly damaged⁹².

⁹¹<https://web.archive.org/web/20141006091212/http://www.ndrrmc.gov.ph/attachments/article/1177/Update%20Effects%20TY%20YOLANDA%2017%20April%202014.pdf>

⁹² <http://www.chicagotribune.com/news/chi-philippines-typhoon-haiyan-20131113-story.html>

Figure 17 and Figure 18 show maps of Tacloban one month before Typhoon Haiyan and a couple of days after the typhoon. From these images, the significant damages done to buildings and vegetation can be seen. Homes all along the coast have been destroyed, a majority of the vegetation has been stripped, and some areas were completely washed away.



Figure 17 Google Earth Maps of Tacloban. Top image taken on October 10, 2013; bottom image taken November 10, 2013

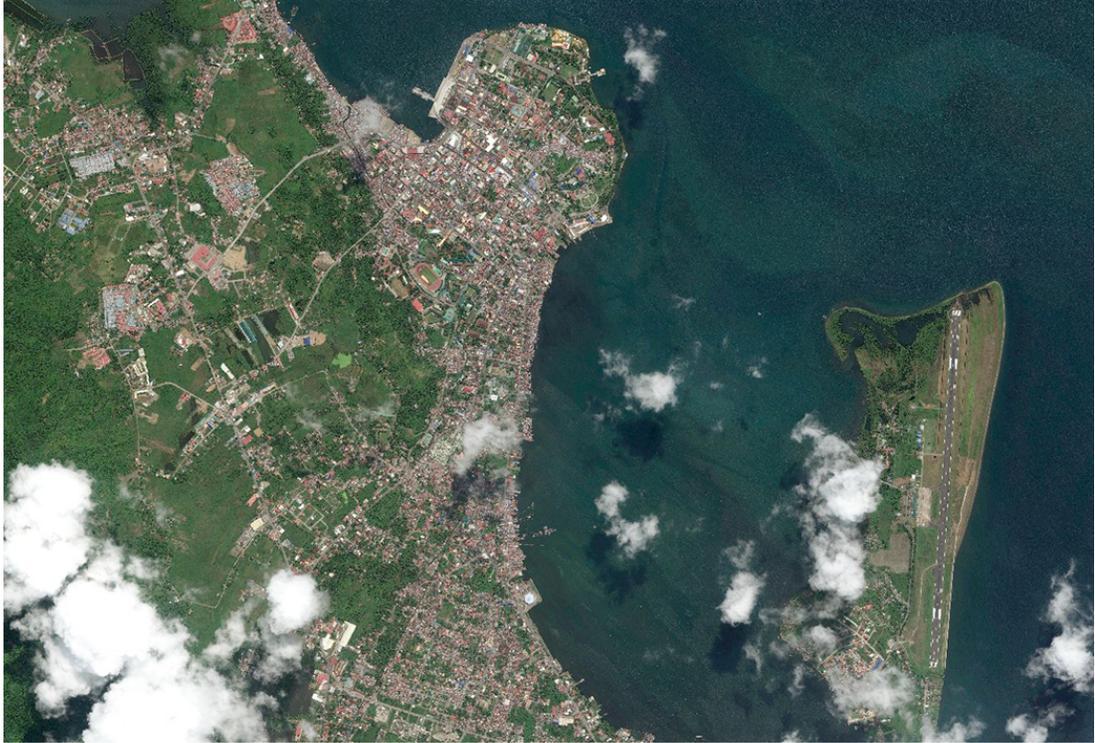


Figure 18 DigitalGlobe Maps of Tacloban. Top image take on June 24, 2012; bottom image taken on November 21, 2013⁹³

From multiple damage survey reports, an assessment can start to map out where the specific damages are in the city⁹⁴⁹⁵⁹⁶. Figure 19 maps out the structural damages to Tacloban in two categories; the red marked areas note buildings that are completely destroyed with no chances of repair and the orange marked areas are buildings that are heavily damaged with possible chances of repair. Taking a closer look at the figure, most of the destruction occurred on the coast and eastern side of the city. Notice the location of the airport and how the only land access to it is in the destroyed marked region. Figure 20 is a cross section of Tacloban City illustrating the height of the city with the height of the storm surge. Notice that the height of the storm surge is well over the land by 15 feet.

⁹³ <http://microsites.digitalglobe.com/interactive/typhoon-haiyan/#thirdPage>

⁹⁴ Ibid

⁹⁵ <http://www.bbc.com/news/world-asia-24917722>

⁹⁶ http://www.nytimes.com/interactive/2013/11/11/world/asia/typhoon-haiyan-map.html?_r=0

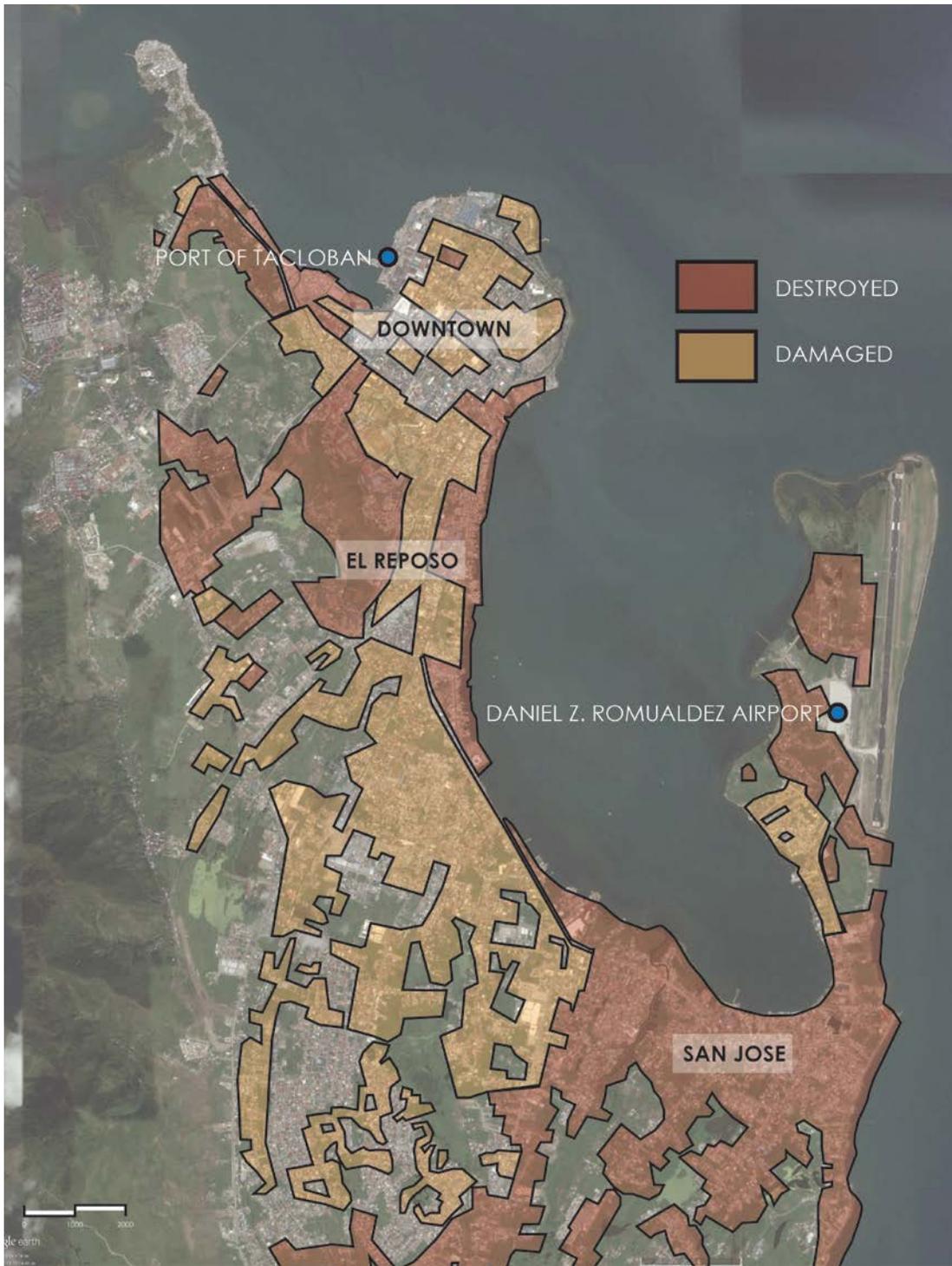


Figure 19 Tacloban City Damage Assessment.

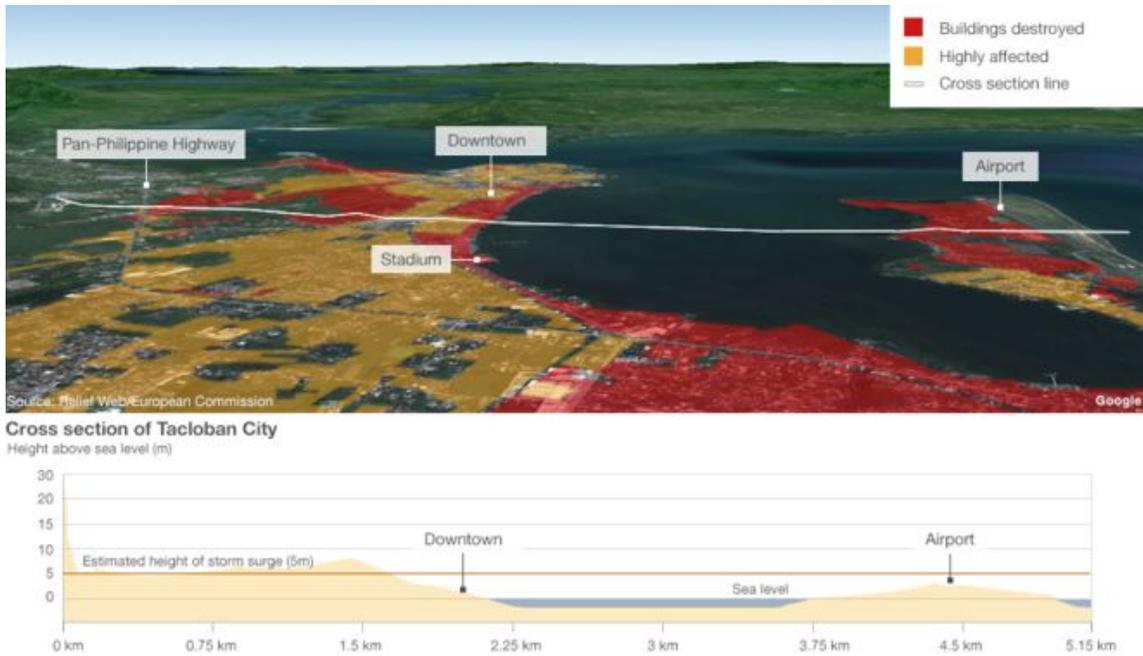


Figure 20 Tacloban Cross Section⁹⁷

Taking a closer look into the city, the proposed testing site is on the east side by the coastline of the downtown area; see Figure 21. The site measures to be about 150 feet by 220 feet. From Figure 23, it can be seen that the site is located in the destroyed area, so the majority of the buildings on the site and around it are either completely gone or have some debris. Figure 22 is a rendered site plan of the area of focus in Tacloban, where the red buildings indicate the destroyed buildings and the orange indicate the severely damaged buildings.

⁹⁷ <http://www.bbc.com/news/world-asia-24917722>



Figure 21 Google Earth Map of the Testing Site at 1000ft, 500ft, and 200ft



Figure 22 Rendered Tacloban Site Plan

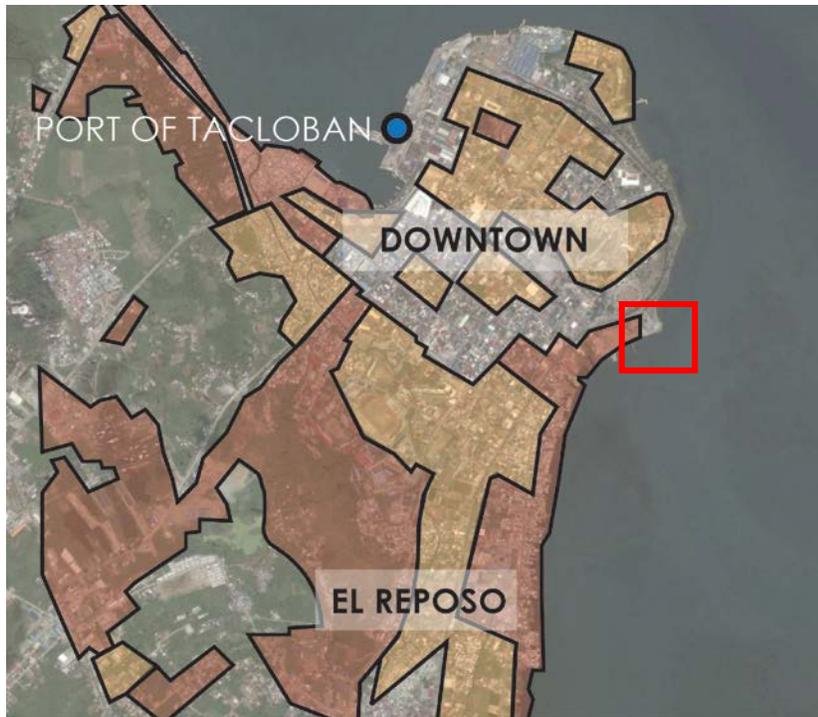


Figure 23 Tacloban City Damage Assessment with Testing Site

Access

Means of transportation is an important factor in an aftermath of a natural disaster. If access is damaged or obstructed by debris, then transportation of personnel help and relief supplies are delayed. This potentially increasing the death toll of the city caused storm. It could take days to months to clear the debris; thus, it is important to have alternative means of access to the site. Figure 24 and Figure 25 illustrate that the site is located along the major roadway with tertiary roads feeding towards the site as well. Also, locating the site by the water allows for a system of water transportation to bring in materials for relief. Allowing for water transportation near the site also brings in a quicker means of travel to and from the airport.



Figure 24 Tacloban City Access



Figure 25 Testing Site Transportation Access

Resources

The proximity of the site to surrounding resources is another important factor to rescue and recovery. Resources of relief increase the potential of survival; resources such as hospitals/health facilities, evacuation centers, command posts, and vital infrastructures. Figure 26 displays all the relief resources that were available for survivors after the typhoon. The white dots mark the hospitals/health facilities, yellow dots mark the evacuation centers, and the orange dots mark the command posts and vital infrastructure. This information was available to relief aid personnel and survivors by Google's crisismap⁹⁸. Figure 27 illustrates the walkability distances from the site. Within the five minute radius from the testing site, a survivor is able to reach two evacuation centers and

⁹⁸<http://google.org/crisismap/a/gmail.com/TyphoonYolanda?hl=en&llbox=20.16%2C4.15%2C134.46%2C110.31&t=ROADMAP&layers=1%2Clayer4%2C2%2Clayer0%2Clayer3>

command centers for supplies and services. In the ten minute radius, a survivor is able to reach five more evacuation centers and one hospital for supplies and medical care.



Figure 26 Tacloban Resource Access



Figure 27 Tacloban Resource Walkability

Other Site Analysis Diagrams



Figure 28 Tacloban City Topography



Figure 29 Tacloban City Soil



Figure 30 Tacloban City Major Roadway and Water Access

Secondary Testing Sites

The intent of the thesis is for the proposed relief shelter be implemented throughout the SEA region. Thusly the research and exploration of two other testing sites were conducted. Exploring different countries that were affected by natural disasters, as well as different urban conditions. One of the secondary testing site was located outside of the dense city of Banda Aceh, Indonesia. Banda Aceh was one of the major cities greatly affected by the 2004 Indian Ocean Tsunami. In Figure 31, the red indicated the destroyed buildings and the orange indicates the severely destroyed buildings. The other secondary testing site is a village near Dacope, Bangladesh. This area was also largely affected by the 2004 Indian Ocean Tsunami. Figure 32 illustrates the destroyed buildings in red and the severely damaged in orange.

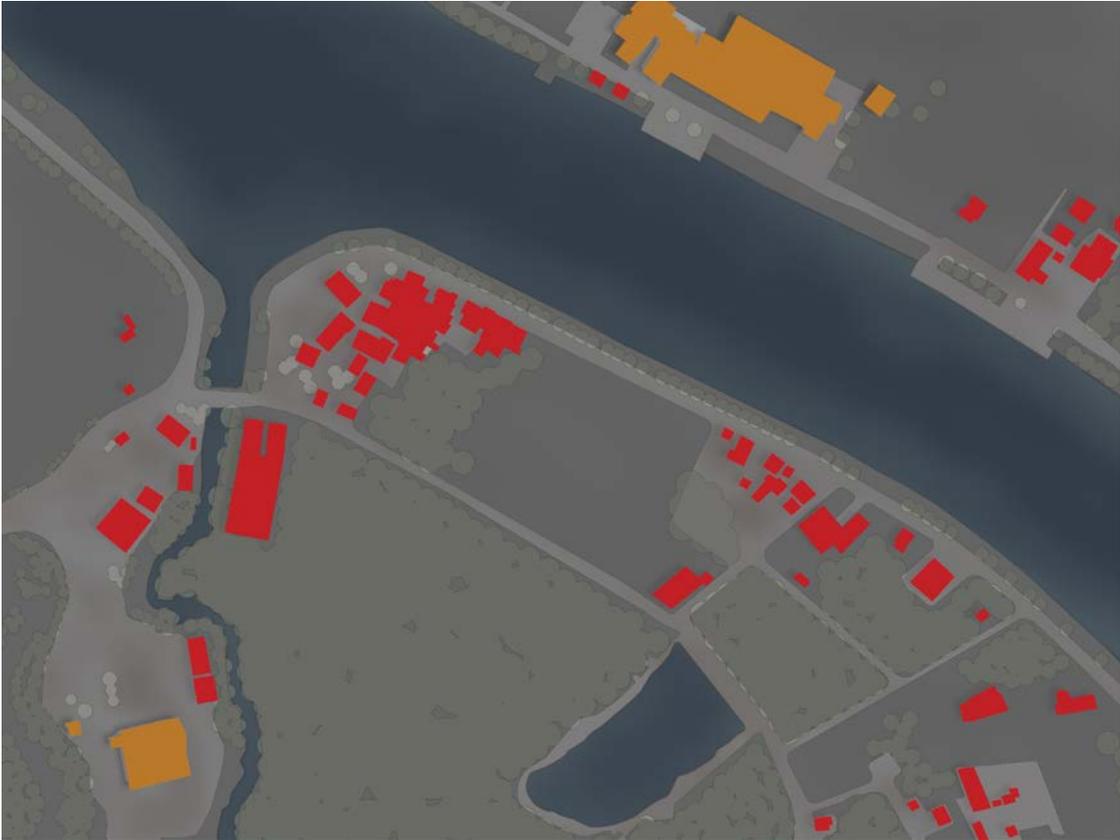


Figure 31 Rendered Banda Aceh Site Plan



Figure 32 Rendered Dacope Site Plan

Chapter 6: Precedents

Shigeru Ban: Paper Architecture

Shigeru Ban is one of the few high profile architects that has devoted his time and passion of architecture into designing for the displaced victims of natural disasters. He has currently done 24 design projects that deal with disaster relief all around the world⁹⁹. The design goal behind most of his projects was to use inexpensive materials, simple construction methods, satisfactory insulation, and be aesthetically pleasing. His primary material is paper, but he also tries to incorporate the usage of local materials from the different project locations. Some of his projects use the same construction methods of his earlier prototypes. The mixed use of the paper and local materials shorten the construction period¹⁰⁰. Not all of his projects are standalone shelters. Not all of his projects are standalone shelters. Some of his projects, such as the Paper Partitions Systems series, employ the use of large indoor spaces, like gymnasiums, to create small divisions of living quarters for families.

⁹⁹ <http://www.shigerubanarchitects.com/works.html>

¹⁰⁰ http://www.dma-ny.com/site_sba/?page_id=331



Figure 33 Shigeru Ban's Paper Log House in Philippines 2014¹⁰¹



Figure 34 Shigeru Ban's Paper Partition System 4¹⁰²

¹⁰¹ http://www.shigerubanarchitects.com/works/2014_PaperEmergencyShelter-Philippines/index.html

¹⁰² Ibid

Some takeaways from Shigeru Ban's works could be his core components of the design process. How he uses a primary inexpensive material, like paper, with a mixture of local material to create quick emergency shelters.

Better Shelter

Better Shelter is a social enterprise created by Ikea's non-profit foundation. This organization seeks to develop and provide innovative housing alternatives for people that have been displaced by military conflicts or natural disasters. Although a majority of their work has been towards helping the nations in militant conflicts, Better Shelter has sought to help those displaced by natural disasters. The main goal is to provide shelters that are safer, more durable, and bigger than typical relief tents at cost efficient prices. The shelter falls back on the idea of a simple house for five people; it features four walls, four windows and a singular door all under a pitched roof. It is 188 square feet of interior space and six feet tall¹⁰³.

¹⁰³ <http://www.bettershelter.org>



Figure 35 Better Shelter¹⁰⁴

The project's design goals are divided into five sections: safety, durability, adaptability, cost efficiency, and ease of assemble.

- Safety: The shelter provides a sense of safety and privacy by including a secure lockable door and windows, it allows them to have a “well-deserved privacy and calm in their temporary home”¹⁰⁵. Especially after many of the affected individuals have been forced to flee from armed conflicts, persecutions, or natural disasters¹⁰⁶.
- Durability: The frame of the shelter is made out of strong, lightweight stain-less steel and is anchored to the foundation¹⁰⁷. The form of the frame is designed to

¹⁰⁴ Ibid

¹⁰⁵ <http://www.bettershelter.org/product/>

¹⁰⁶ Ibid

¹⁰⁷ Ibid

withstand strong winds, rains, snows, and other heavy impact forces. It is also estimated to have a lifespan of three years. Which is a great improvement to the current UN tents that can only last about six months in harsh conditions¹⁰⁸.

- **Adaptability:** Due to the frame's modular design, most of the parts are interchangeable. The shelter is also designed to facilitate different environments and program uses. Positions of windows and doors are left up to the user. Sections of the shelter can also be easily fixed if damaged without dismantling the entire thing.
- **Cost Efficiency:** The cost of the Better Shelter is estimated to be about \$1,150, however the price is expected to drop below \$1,000 in the upcoming two years as orders volumes increase¹⁰⁹. As it is also compared to the current emergency relief tents, the shelter is over time more cost effective due to the fact that the life span is longer and would not need to be frequently replaced¹¹⁰.
- **Ease of Assembly:** The overall shelter arrives in two cardboard boxes, packaged in subsequent building order with instructions. Four people can lift the boxes individually. It is also estimated that it can be assembled by four people within four to eight hours. The shelter is constructed in three sub-sequential steps: 1) foundation, 2) roof with ventilation and solar panels and 3) walls with windows and door.

¹⁰⁸ <http://www.techinsider.io/ikea-better-shelter-for-refugees-photos-2015-11>

¹⁰⁹ <http://curbed.com/archives/2015/03/25/ikea-refugee-housing-production.php>

¹¹⁰ <http://www.bettershelter.org/product/>

The flexibility and building features that the Better Shelter provides allows it to be a more comfortable alternative to the current emergency tents. The flexibility and adaptability of being able to conform to the surroundings is ideal. In addition, the idea of integrating the photovoltaic systems into the shelter, providing a small amount of electricity, ensures that survivors are comfortable and secure. These design components are strong elements to integrate into the design process of this thesis.

Architecture for the Mass's Nepal Shelter

Architecture for the Mass is a relief organization founded by two Hong Kong based architects, Charles Lai and Takehiko Suzuki. Their emergency relief shelter was designed primarily for the earthquake in Nepal during 2013. The idea of the design was a response to not only [the needs for](#) a shelter for the victims of the earthquake, but as well as an answer for how transportation of relief agencies' aid to the people was obstructed due to damaged narrow pathways¹¹¹. As a result, the design team purposed an idea of using locally available materials such as bamboo and salvageable construction materials¹¹². [This was along](#) with the idea that the emergency shelter could be built with a manual by anyone, with or without construction skills. It is estimated to take between two to three days to build. Thusly there would not be the need of waiting for aid from relief agencies. Once erected the shelter would provide approximately 190 square feet of space.

¹¹¹ <http://www.archdaily.com/769890/temporary-shelter-in-nepal-charles-lai-plus-takehiko-suzuki>

¹¹² <http://www.dezeen.com/2015/07/11/prototype-bamboo-shelter-nepal-earthquake-victims-built-by-unskilled-workers-three-days/>



Figure 36 Emergency Temporary Shelter for the Earthquake in Nepal¹¹³

¹¹³ <http://www.archdaily.com/769890/temporary-shelter-in-nepal-charles-lai-plus-takehiko-suzuki>



Figure 37 Volunteers working on the Shelter¹¹⁴

This precedent brings up the idea of not having the dependent nature of waiting for emergency relief organization's aid to start rebuilding; it [allows](#) the drive of self-starters [to help fuel the recovery of the victims](#). Also, the idea of using locally found materials and simple construction techniques provided by a set of drawings easily found online [is revolutionary](#). This is a somewhat quick independent response for relief housing to natural disaster affected areas.

SURE HOUSE: 2015 Solar Decathlon Winner

The SURE HOUSE by Stevens Institute of Technology is the winning entry for the U.S Department of Energy Solar Decathlon 2015. Even though this precedent is not entirely an emergency relief house, it still holds some design components that this thesis will explore. The components being that the house were designed to be sustainable and

¹¹⁴ Emergency Temporary Shelter for the Earthquake in Nepal

resilient in a coastal region. The house merges the indoor and outdoor spaces to an open floor plan with the state of the art building science, and renewable energy technologies¹¹⁵. It uses 90% less energy, is 100% solar powered, and is a resilient energy hub¹¹⁶. [This design demonstrates the institute's understanding of](#) how a shelter can perform at the highest efficiency and being able to apply it into an emergency relief house.

The building is equipped with the highest efficient and performing technology and material to make sure that the house runs smoothly in a typical day and in an event of extreme weather conditions. Some of the technologies included in the house are solar powered hot water and power systems, solar panels integrated into the multiple areas of the house, and durable fiber-composite siding¹¹⁷. The house also features a designed high performing storm shutters to protect the SURE HOUSE against its typical loads as well as extreme loads during intense storms¹¹⁸. The storm shutters serve as a multi-functioning feature that provides storm protection, shading, and solar energy collectors¹¹⁹. Thusly, the home is able to adapt certain sustainable methods and through resilient ideas, such as the shutters' design. The ideas of the SURE HOUSE for the relief shelter could be useful for

¹¹⁵ <http://surehouse.org/the-house/>

¹¹⁶ <http://surehouse.org/core-principles/>

¹¹⁷ <http://surehouse.org/innovations/>

¹¹⁸ Ibid

¹¹⁹ Ibid

answering some potential questions of how relief shelters can resist intense environmental forces.



Figure 38 SURE HOUSE Section Perspective¹²⁰

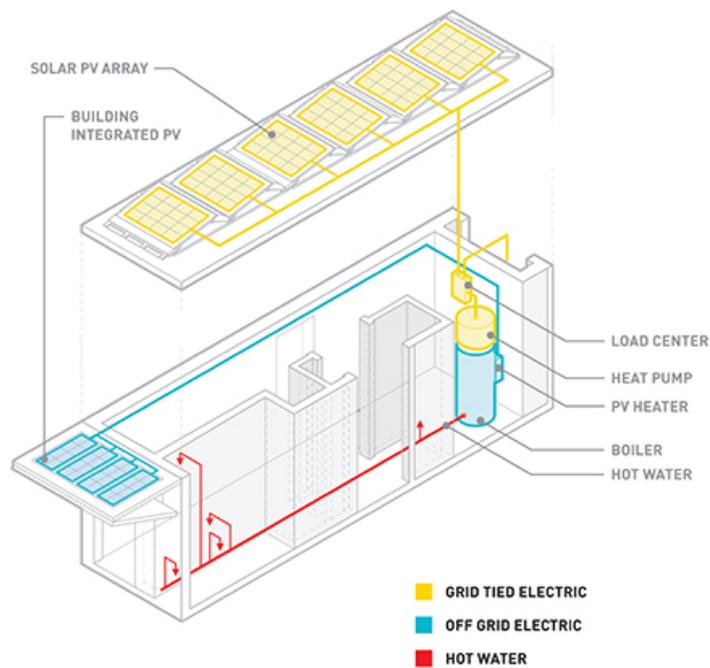


Figure 39 SURE HOUSE Solar Diagram¹²¹

¹²⁰ <http://surehouse.org/architectural-design/>

¹²¹ <http://surehouse.org/core-principles/>

Chapter 7: Timeline

In the design proposal response to the disasters, a devised timeline of relief and recovery is composed of a series of steps spanning a course of eight months. Within these 8 months, the survivors are able to receive aid, recover, and start to rebuild their lives. The timeline includes eight steps; The Event, Distribution & Arrival, Mapping & Surveying, Temporary Planning, Shelter, Establishment of Temporary Community, Planning Permanent Community, and Permanent Construction. Each of these steps will be further explained in the paper on how the design process of the shelter and community plays a role in rebuilding the lives of the affected survivors in natural disasters.

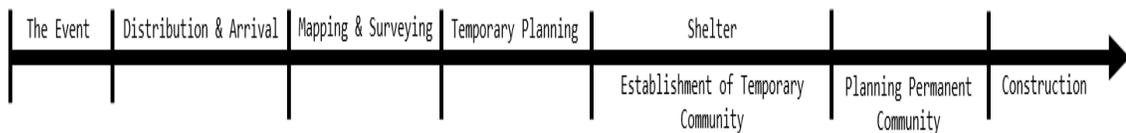


Figure 40 Timeline of Relief and Recovery

The first point on the timeline is “The Event”. The event being the actual disaster. Since it is difficult to predict the conditions of the future disasters, this thesis used two historical storms in the region as case studies. These two case studies are the Indian Ocean Tsunami and Typhoon Haiyan. Since those disasters have been mentioned before in the earlier chapters it is recommended to refer back to chapter two regional disasters if needed.

Chapter 8. Distribution & Arrival

The “Distribution & Arrival” is the first designed step towards rebuilding a better response. This point occurs during the immediate stages of response and relief, week 0 – 2. This phase of the timeline will introduce how the designed shelter will be distributed and the course of action when it arrives during the first two weeks of the aftermath.

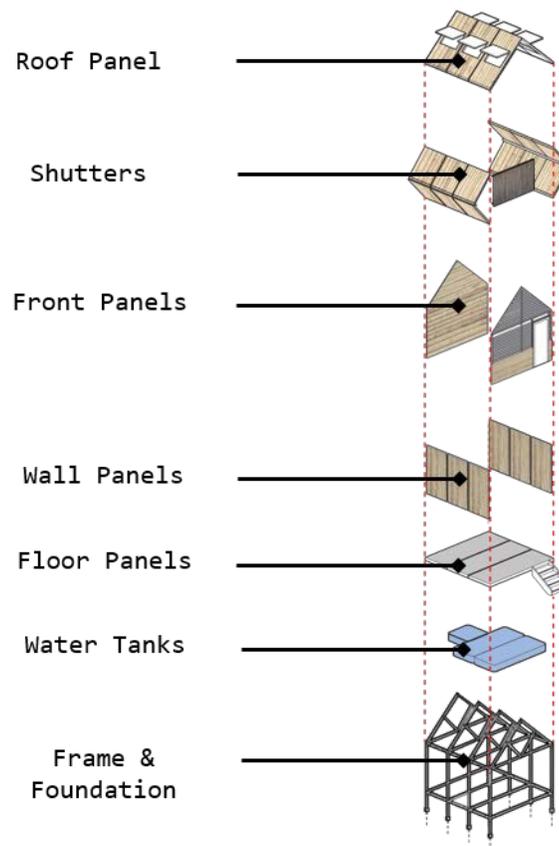


Figure 41 Shelter Kit of Parts

The distribution of the proposed relief shelter is packaged in five boxes. Due to the shelter’s modular design, it has the ability to be easily packaged and distributed. In the five boxes, it would hold one of the seven key elements needed to assemble the shelter. Figure 41 illustrates an exploded axonometric of the key kit of parts that

composes the shelter.

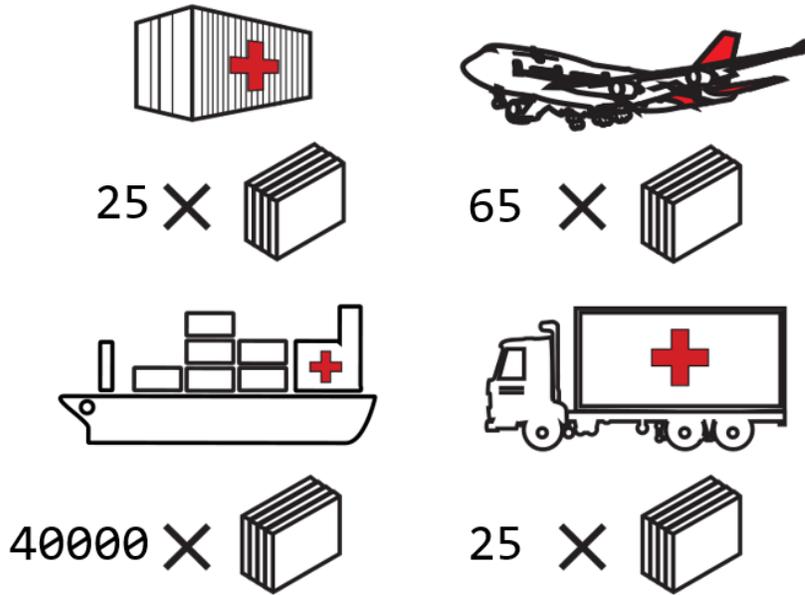


Figure 42 Distribution Metrics per Means of Transportation

Along with the shelter being packaged in five boxes, the calculations of how many of the shelter units can be fitted in to different means of transportation is shown in Figure 42. The distribution metrics were designed to have 25 of the shelter units be fitted into a shipment container, 65 units can be housed in a large cargo plane, 40000 units on a cargo ship, and 25 units in a cargo truck. On the arrival of a singular unit, the shelter is designed to be assembled within 24 hours by three to four people.



Figure 43 Assemble Time

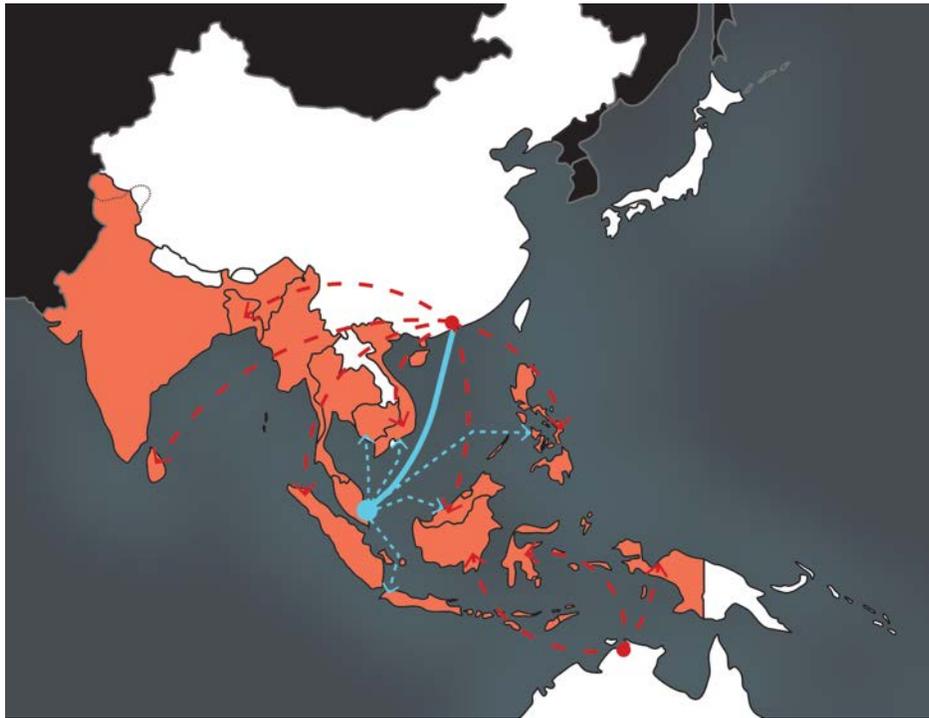


Figure 44 Southeast Asia Regional Distribution Sequence

The regional distribution sequence starts with the manufacturing and packaging. This manufacturing and packaging assembly headquarters is stationed in China and Australia. These two locations will also be the areas of major stockpile. The units will then be distributed to smaller disaster prone countries by cargo planes and ships for storage until they are needed. Figure 44 demonstrates the paths of how the shelter units

can be distributed. The red dashed paths depict the means of air travel, and blue paths show the means of travel by water.

Upon the arrival of the shelters and clearing the site, the first response would be for the units to be assembled into a large relief shelter hall to house a larger number of people for quick relief, aid and recovery to be administered. This space also allows for the survivors to come together and memorialize their lost loved ones during the tragic disaster. Figure 45 is an illustration of how the shelter relief hall can look, depending on how many shelter units are clipped together. In this image, there are eight shelter halls attached to each other.

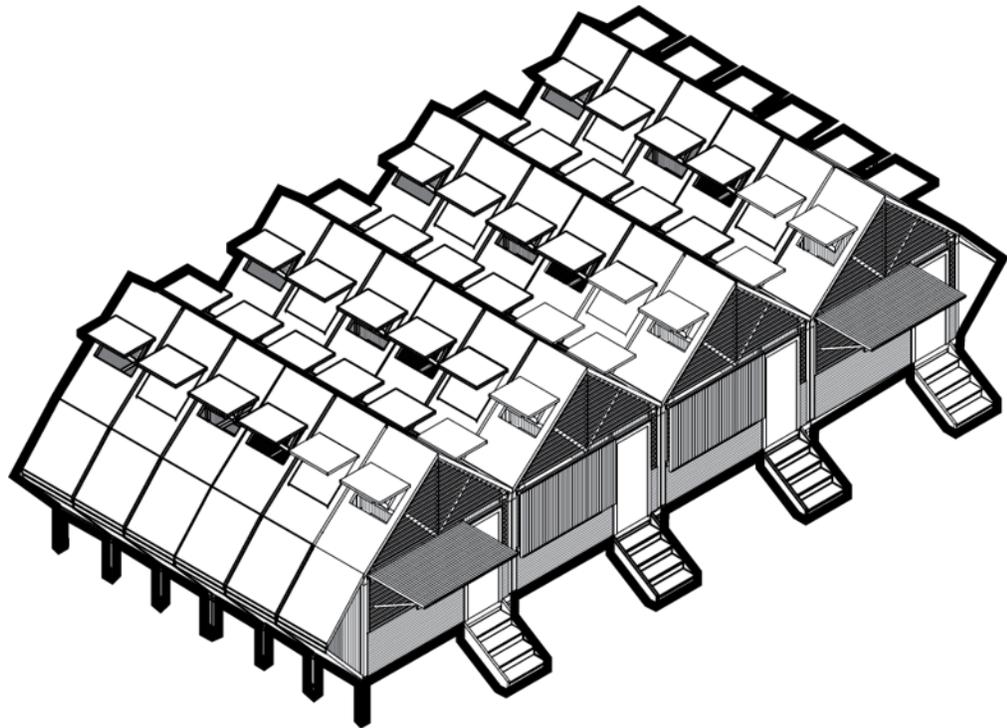


Figure 45 Shelter Relief Hall

Chapter 9. Mapping & Surveying

As things begin to slowly calm down and people are able to fully recover, the next step of the timeline is the “Community Mapping & Surveying”. This stage of the timeline lasts between week 4 – 5.5. One of the first step of the recover process is a community surveying¹²². This step allows for an accurate creation of a reliable mapping database for short and long term community planning. During this period, the abled community members forms small groups to survey and map their surrounding areas. Identifying the safe, deformed, and/or lost portions of lands. Community mapping and surveying also helps avoid future land disputes or unjust land distributions in the future. Along with gathering information about the nearby lands, the surveying also includes identifying all the residents of the area.

¹²² Beyond Shelter

Chapter 10. Temporary Community Planning

Within week 5 and 6, the survivor community should begin steps towards planning for a temporary community. Using the surveyed land database, the survivors begin to plan for a short and long term community. Following the proposed community framework to achieve the qualities of a successful growing community. Along with using the land database for planning the arrangement of shelters and other services, the sense of ownership for the individuals and families should be established.

The proposed framework for planning a community for the survivors is a simple loose three point guideline. The framework is intended to be open-ended to allow for cultural influences to impact the guidelines of planning and growth on the community.

The community framework:

1. A community should include an assembly hall/resource center and an open field, service core.
2. The service core should be located along an access corridor, or have a clear access to the corridor.
3. The surrounding units should have visible connection to the service core.

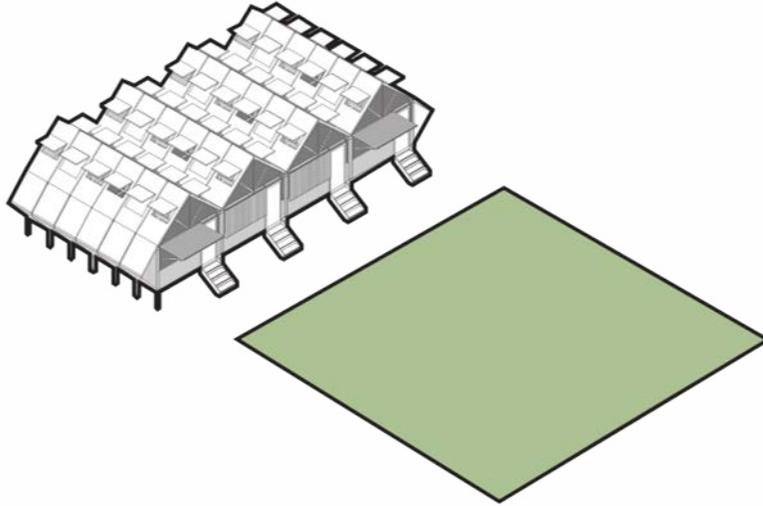


Figure 46 Framework Point One, Service Core

The service core provides a strong space for the community to engage with each other and with outside help. The assembly hall/resource center allows for large enclosed activities to occur, such as town meetings, place for worship, cafeteria, and/or community storage. The open field can also serve for multiple activities for the public, such as markets, community celebrations, playfields, and etc. The open space can also become an area for additional aid and supplies to be administered to the community throughout the recovery timeline. The need and use of the service core will help promote growth within the community.

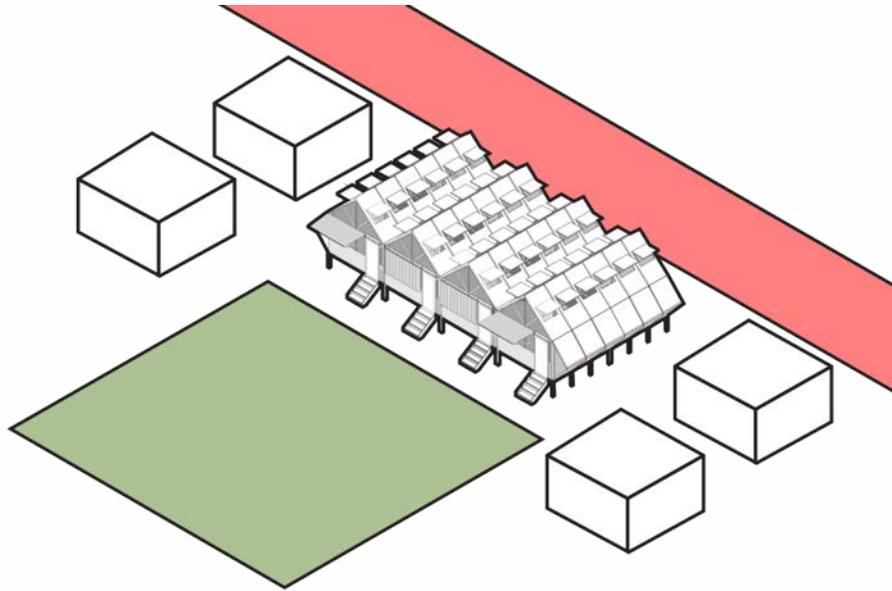


Figure 47 Framework Point Two, Access Corridor

Having a direct or clear passage to an access corridor allows for an easier means of going in and out the newly established community. This allows for additional aid and supplies from relief services to go in to the community without difficulty. As well as, allowing for the community to travel between the service core, shelter units, and outside areas.

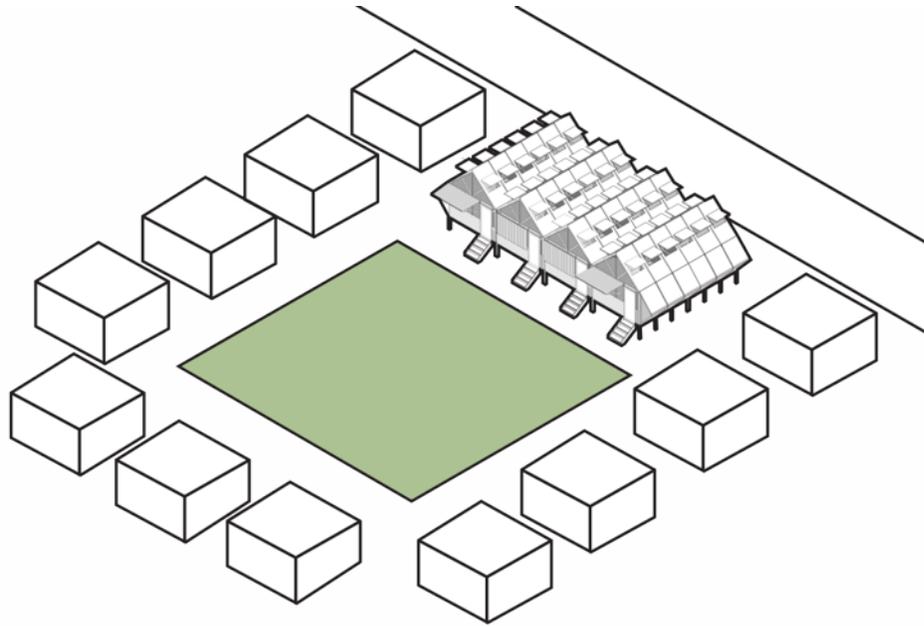


Figure 48 Framework Point Three, Visibility

Arranging the surrounding units of the community to have a visible connection, as well as a physical connection, gives the individuals and families a sense of security amongst each other. To be able to always see what is happening in the community core. Along with security, the visibility to each other gives the people a sense of their own established community.

So why communities? Communities provides a supportive environment, a sense of privacy and security, and public spaces which would ultimately promote growth through an establishment of a trusting relationships amongst each other. And the three-point framework is based on those ideas of what makes a strong community. As well as allowing for the culture of the survivors to impact the framework influencing and furthering the community planning.

Chapter 11. Bahay Shelter

After the temporary planning, the implementation of more individual shelters will arrive allowing for families and individuals to have their own home. This occurs between week 7 – 11. The design goals of the shelter are the same as explained in the chapter four; self-sufficiency, user-friendly, and mobility. As well as the ability to perform the actions of the three core functions of sleep, eat, and clean.

Assembly

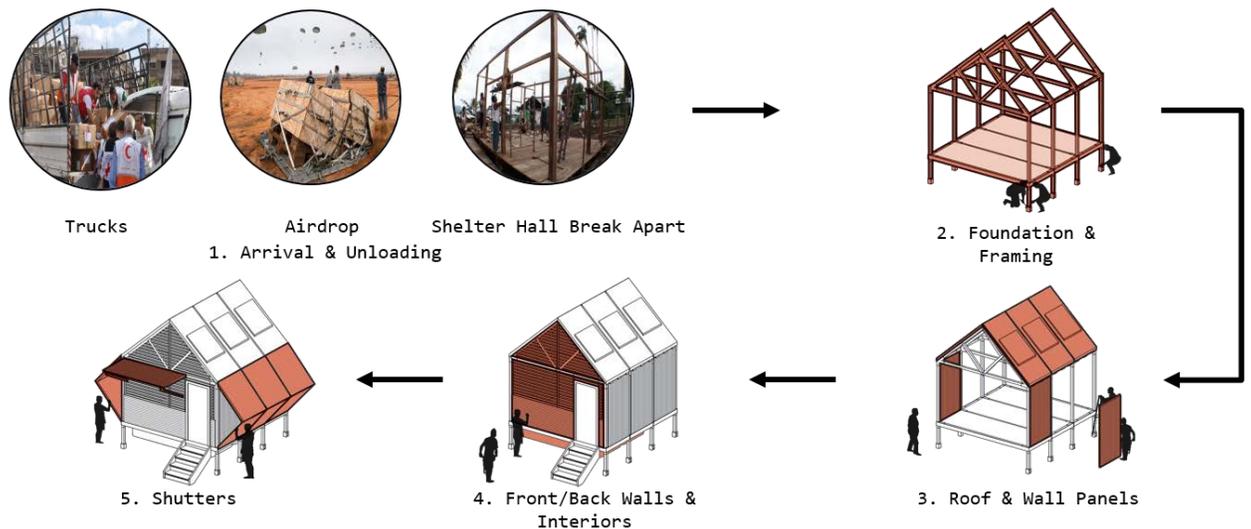


Figure 49 Bahay Shelter Assembly Sequence

Upon the arrival of the more individual shelters, whether it be by trucks, airdrop, or breaking apart some of the shelter hall modules, the survivors are able to unload the shelter materials out from the five boxes. Then they are able to begin laying down the foundation and framing of the shelter modules. In the third step, the survivors are able to clip on the roof and wall panels. On the fourth step, the assembly of the front and back

walls of the shelter. As well as, plugging in some of the simple systems integrated into the unit. Lastly, the users are able to snap on the side and front shutters. This assembly of a singular unit was designed to be constructed within the timeframe of 24 hours by three to four people of any skills. When designing the shelter, the thought was for the shelter to be easily assembled by anyone with a set of instructions included in the packaging of the shelter. The integrated modular system with clip-on panels would take away the complexities of regular construction.

Plans & Sections

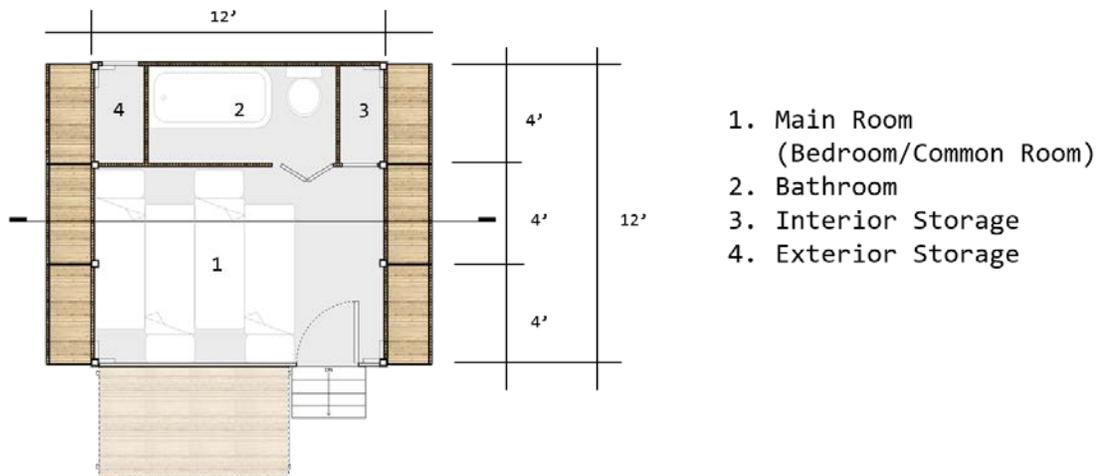


Figure 50 Shelter Interior Plan

The shelter consist of 3 12'x4' modular frames attached to each other. The overall dimensions of the unit being 12'x12'. The interior of the shelter consists of four spaces. The majority of the square footage belongs to the main room, which could change in programing throughout the day. The main room can become a bedroom, common room, or a dining room.

Behind the main room the bathroom, with a collapsible bathtub and a compost

toilet. When choosing what elements is to be composed for the bathroom, research was done to figure out what was most common in the Southeast Asian culture. As well as, looking into what would be the most ideal for a standalone self-sufficient shelter by looking into different relief shelters and traveling shelters. The idea of having a collapsible tub came from the idea that people in this cultural preferred a tub because it has a multi-use function. Such as the function of a sink, since the shelter does not include a sink. The reasoning for why the toilet is a compost one is because it does not require as much maintenance and power for it to function oppose to the other types of toilets.

Adjacent to the bathroom are the interior and exterior storage. The interior storage area consists of two drawers and a pull out table. The exterior storage is accessible through the back of the shelter by a small door.



Figure 51 Interior Perspective of the Main Room

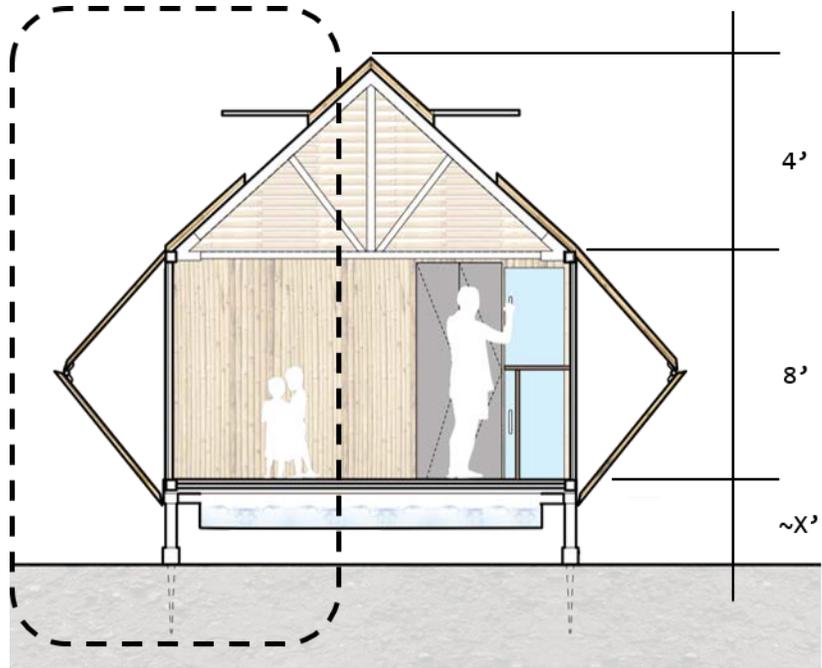


Figure 52 Building Section

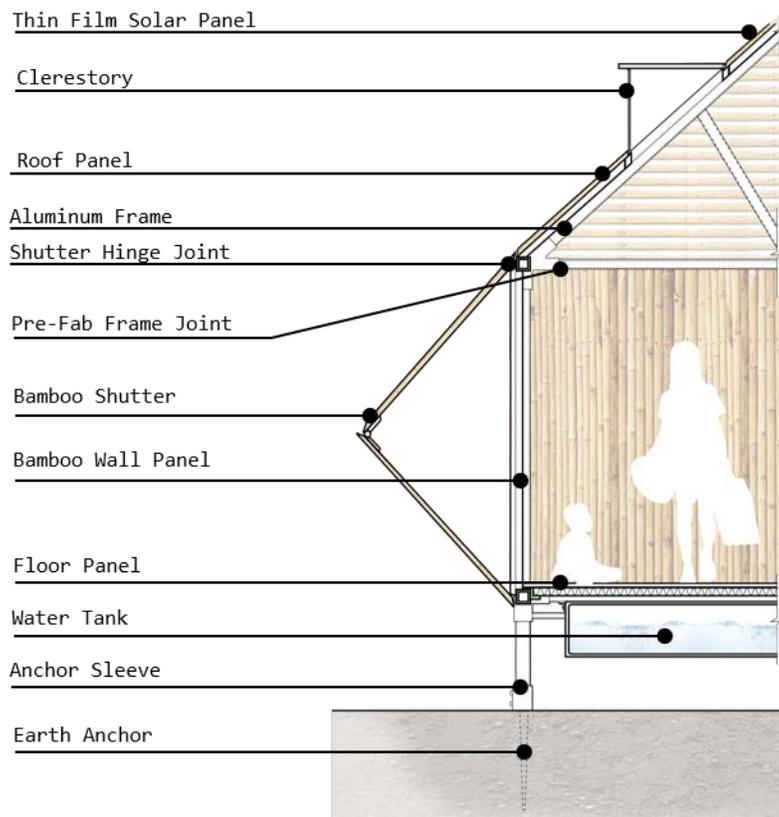


Figure 53 Shelter Wall Section

The shelter is lifted off the ground, it is ideally to have it lifted up by a minimum of three feet. However, the height can vary due to site conditions and/or the users' preference. The overall interior height of the shelter is 12'.

Integrated Systems

There several integrated systems designed into the shelter to provide a level of self-sufficiency and user-friendliness.

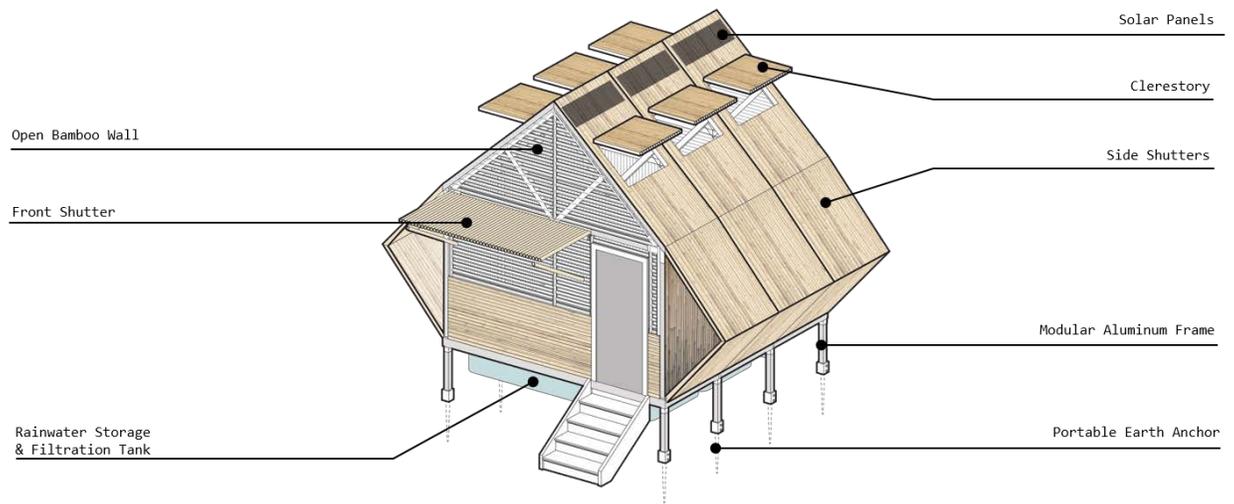


Figure 54 Shelter Systems

The alternating open bamboo wall design acts a window system for the shelter, it allows for sunlight and natural air into the home. The operable front shutter provides a shaded exterior space for the users, as well as providing a sense of privacy and security when closed. The rainwater tank is based below the shelter, collecting rainwater during storms. The simple filtration system allows for the reuse of water within the shelter, such as drinking water or tub water. In Figure 55, rainwater is directed down the roof and onto the side shutters, which also acts a gutter system, directing water into the tank.

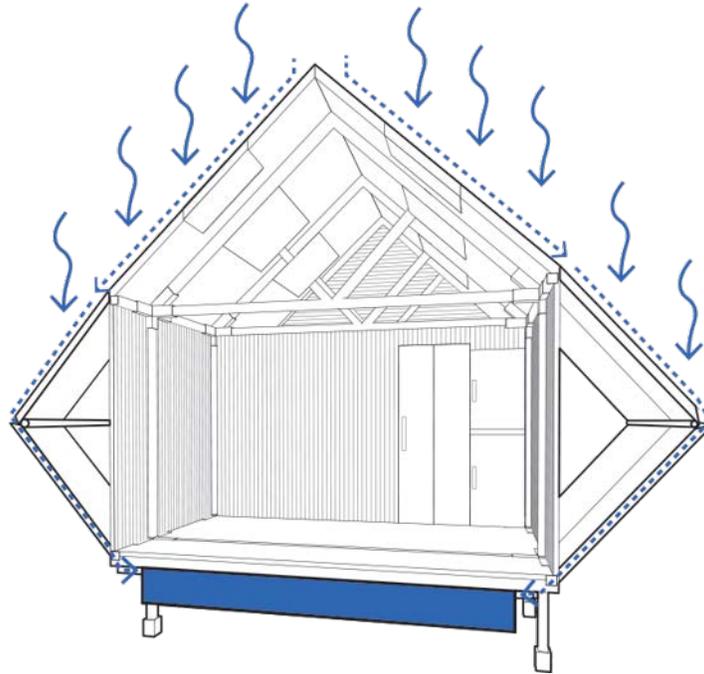


Figure 55 Rainwater Collection System Diagram



Figure 56 Solar Panel System Diagram

The shelter consists of 24 thin film solar panels. The panels are able to produce 74

watts of power. Which is more than enough power to light up two interior LEDs that need only about 34 watts. Any excess solar power is storage in a small battery within the shelter. Figure 56 depicts how connection of the solar panels to the LEDs and to the battery pack inside one of the interior storage rooms.

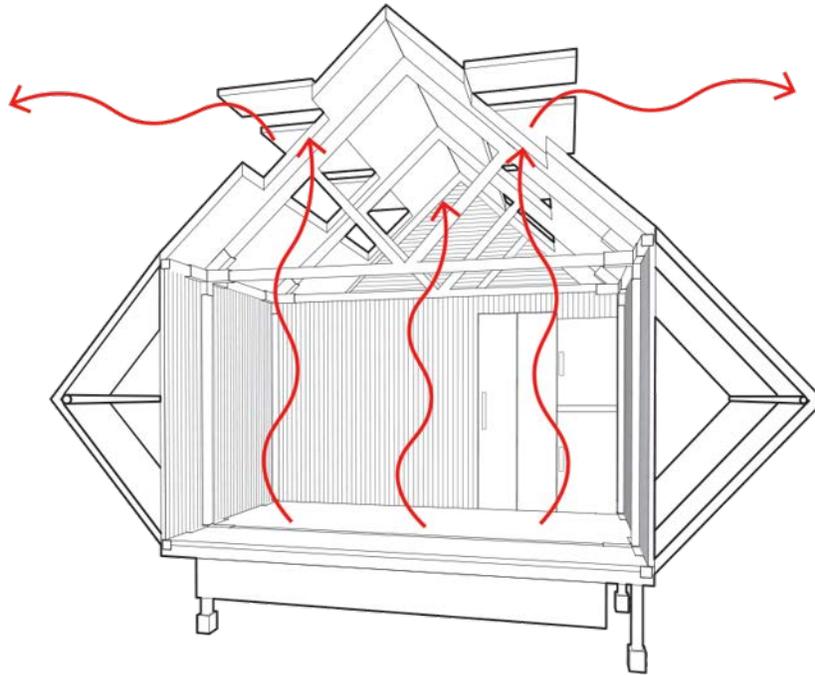


Figure 57 Air Ventilation Diagram

The operable clerestory allows for air ventilation through natural heat rising, as seen in Figure 57. Providing a level of comfort in this tropical climate. The side shutter's primary objective is to deflect strong winds to go above and below the home. Allowing the shelter to withstand strong storms, as seen in Figure 58. The shutters are also designed to be able to open up to provide additional outdoor space, this also helps display the sense of ownership between each neighboring units. Lastly the Earth Anchors provide an easy installation for a stable foundation.

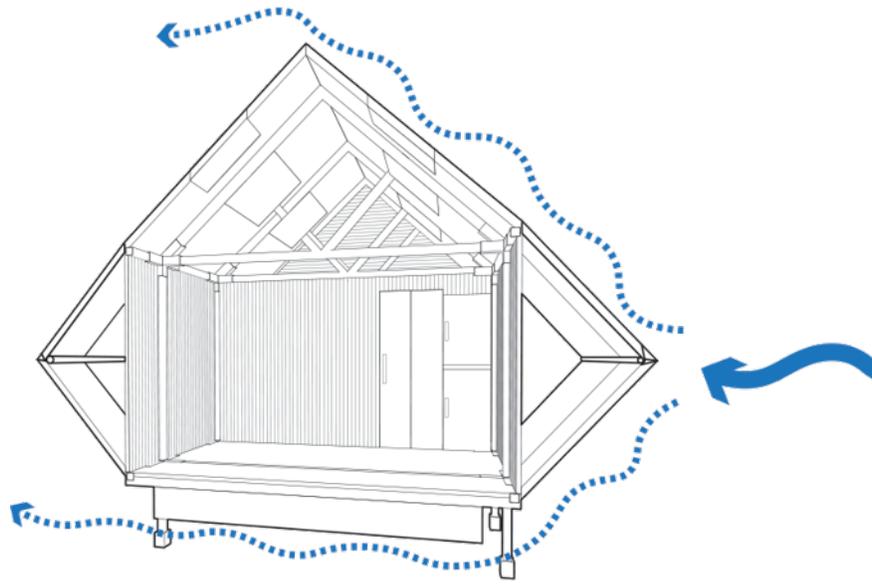


Figure 58 Wind Deflection Diagram



Figure 59 Exterior Perspective

Transformation

In addition to the integrated systems, the shelter is also designed to adapt to the changing timeline. The shelter is able to adjust into four forms of transformation depending on the surrounding conditions. The four stages are: Survival, Self-Growth, Community-Growth, and Expansion.



Figure 60 Transformation, Survival Mode

In the survival mode, as seen in Figure 60, the users are able to close down the shutters and clerestories in order to bunker down to wait out an incoming storm.



Figure 61 Transformation, Self-Growth

As the immediate mode of survival is no longer necessary, the shelter can start to open up and provide additional programming. Such as a space for gardening or a workshop for the shelter users.



Figure 62 Transformation, Community Growth

Further down the timeline, the shelter can completely open up and allow for more exterior space for the members of the community to exchange their goods and services amongst each other. Thusly, creating a stronger sense of community and relationship between the neighboring units.

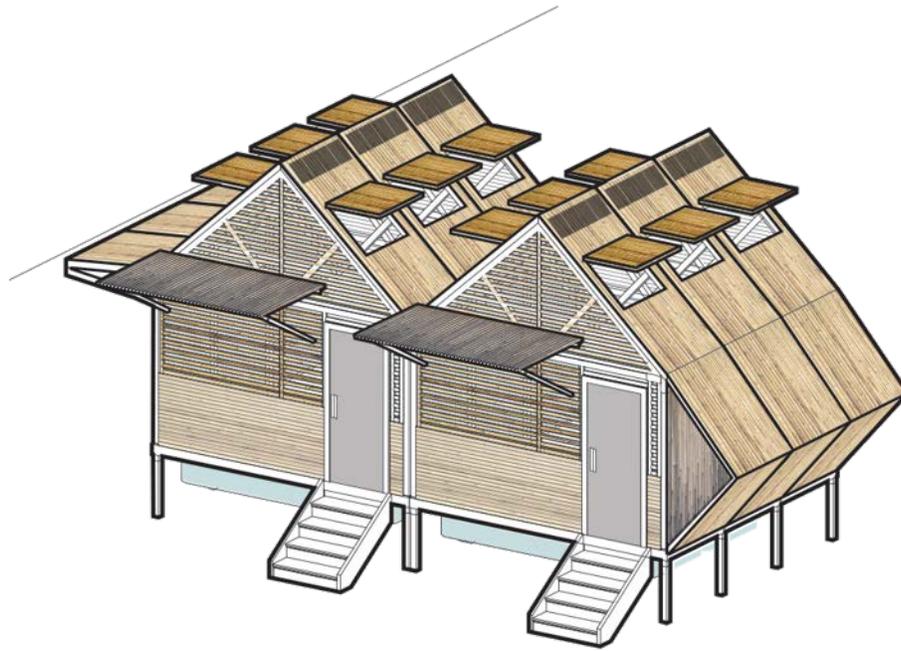


Figure 63 Transformation, Expansion

In addition to the community growth, the individual shelter can expand and attach to another unit if needed. For either a larger housing option or another program, such as a place of worship, enclosed shop, communal restroom, and etc.

Chapter 12. Establishment of Temporary Community

During the implementation of the shelters period, the establishment of temporary community is also occurring. As the shelter units were designed in mind to create a sense of community. Since the relationship of the individual unit and the whole of the community greatly influence each other. Using the planned temporary community arrangement from the previous step of the timeline to start establishing the units and service core. The framework of the communities can be achieved through four elements; Interconnection, Permeability, Micro Spaces, and Growth. Using the four design elements, there can be multiple ways of configurations of communities. This thesis explores three configuration concepts; Adjacent, Central, and Linear.

Adjacent

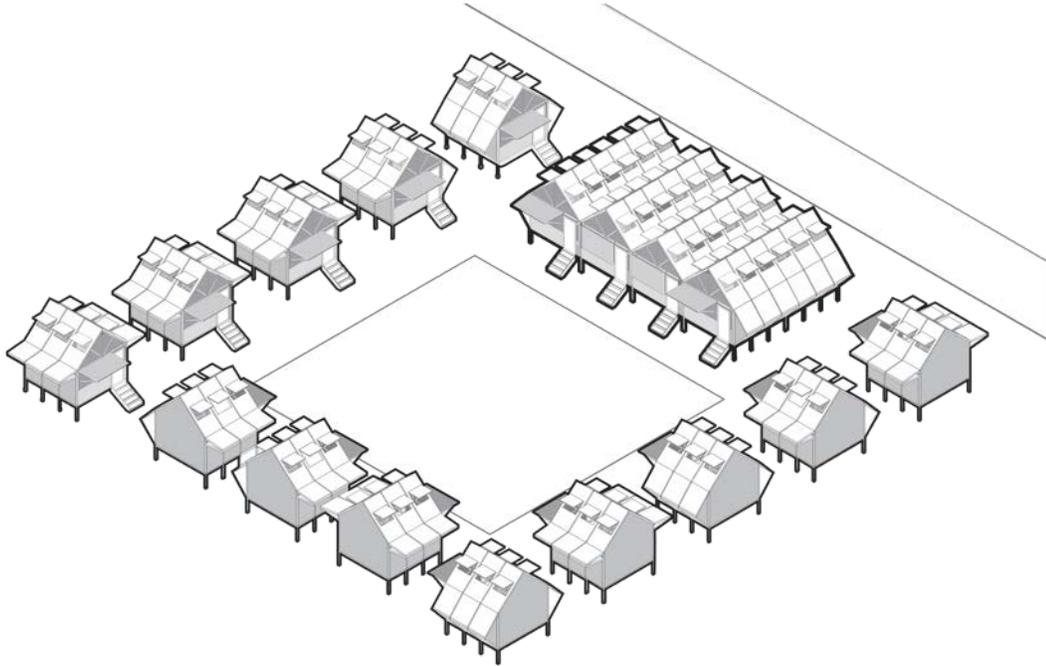


Figure 64 Adjacent Configuration

The first concept is where the assembly hall is located directly adjacent to an access corridor. The individual shelters are connected to the service core and vice versa (Figure 65). This setup also allows for permeability between the shelters and the service core. The spacing arrangement allows for relief trucks to come in and out safely to provide additional supplies and/or services to the community if needed (Figure 66). In addition to the spaces provided with the assembly hall and open field, the units create these social micro spaces for the community members to interact in different ways (Figure 67). The adjacent configuration also allows for outward modular growth for each shelter unit (Figure 68).

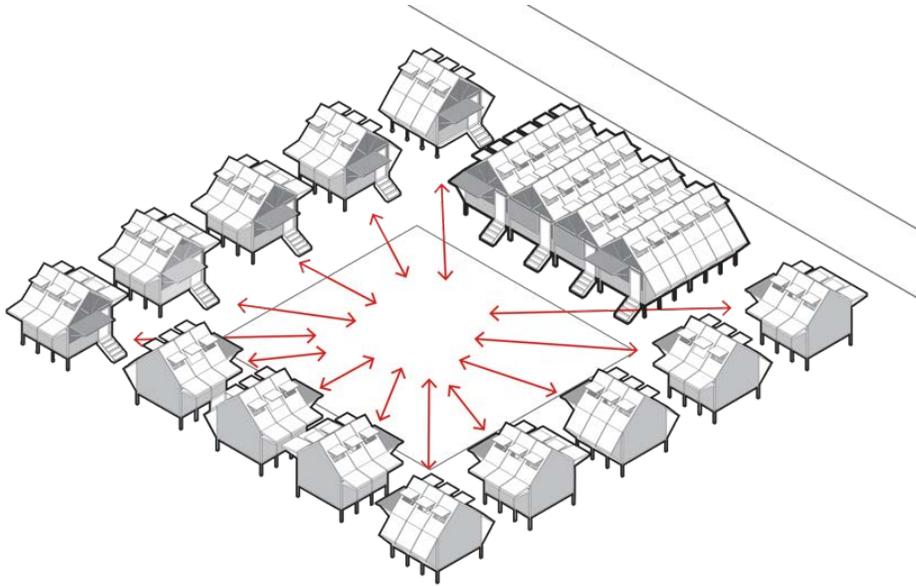


Figure 65 Adjacent Configuration, Interconnection

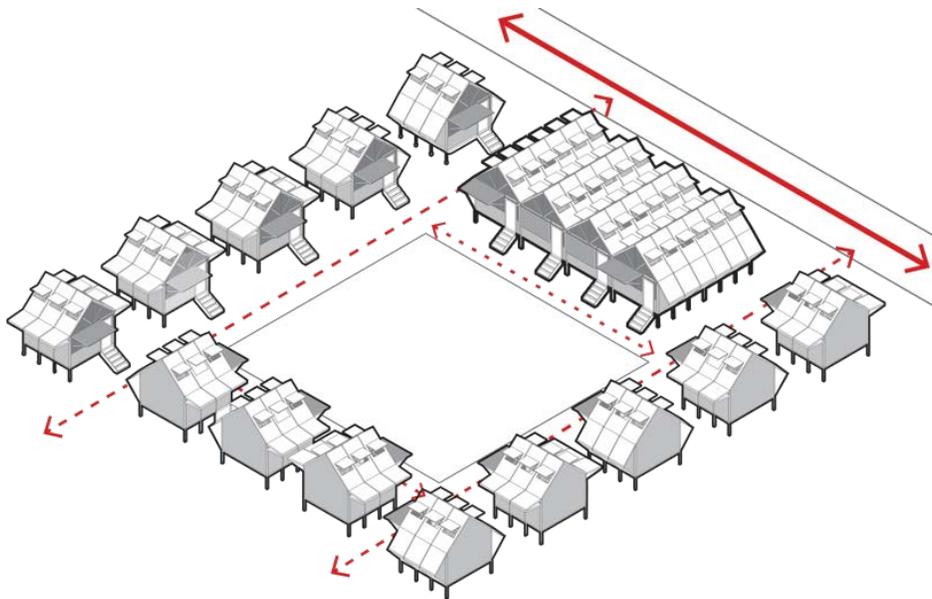


Figure 66 Adjacent Configuration, Permeability

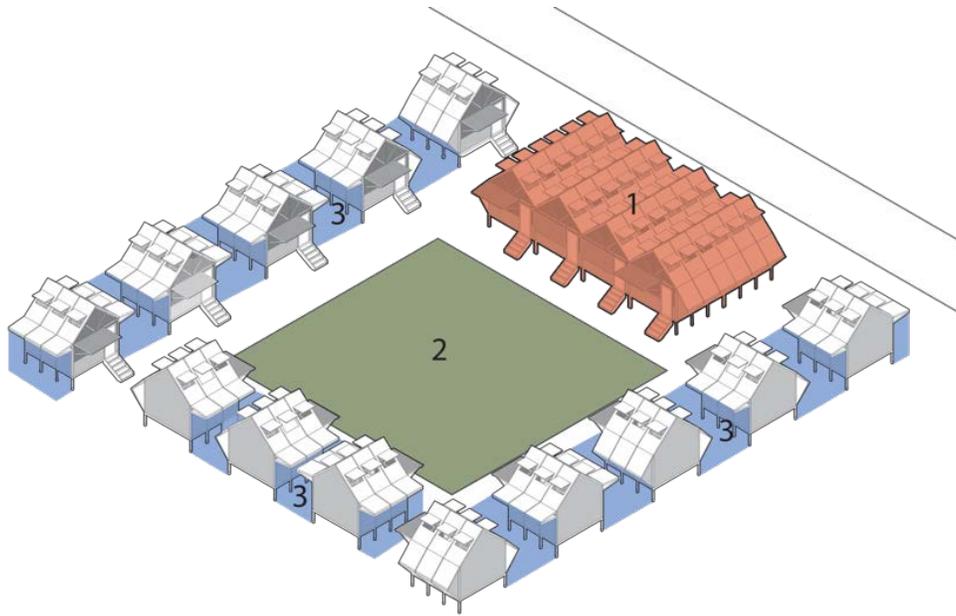


Figure 67 Adjacent Configuration, Micro Spaces

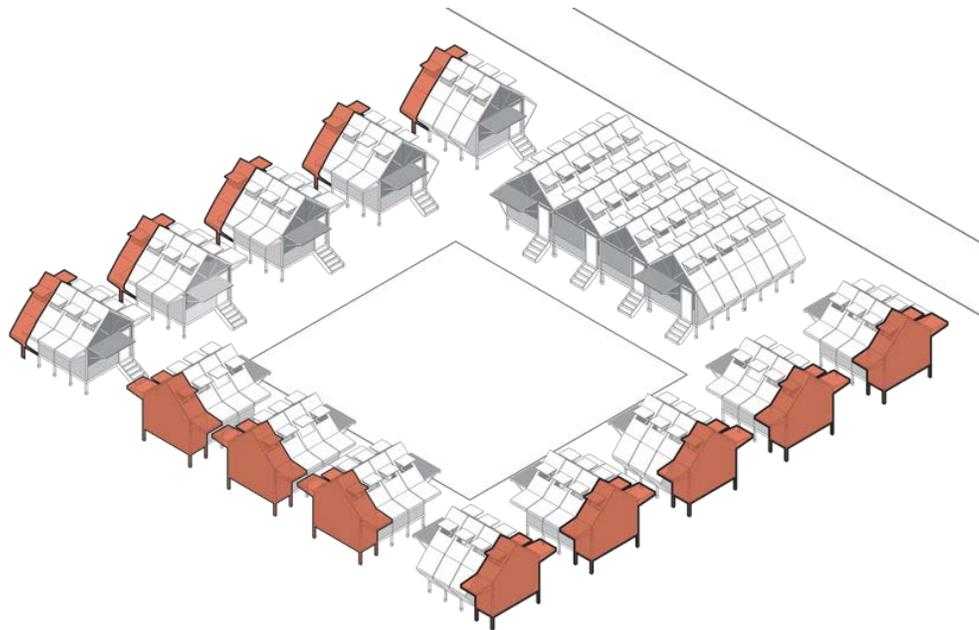


Figure 68 Adjacent Configuration, Growth

Central

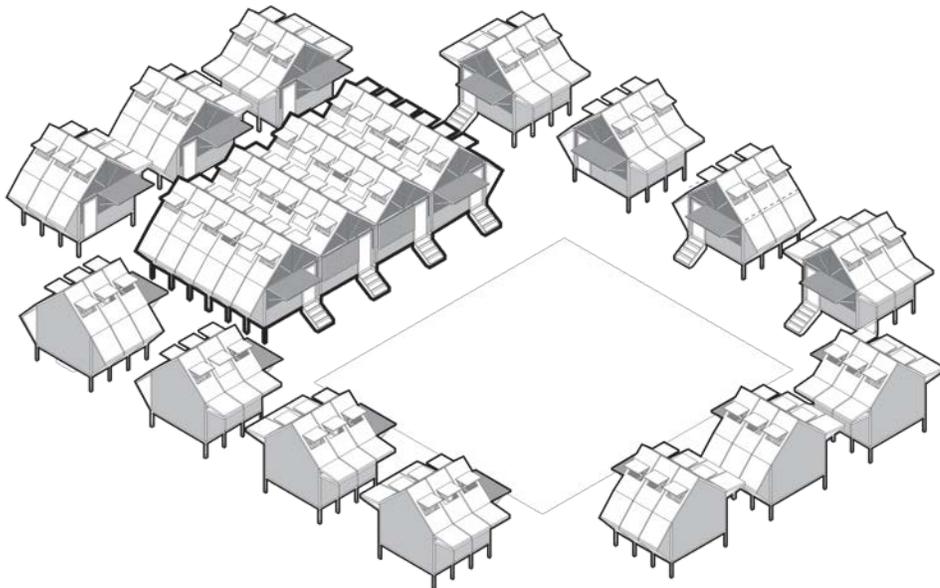


Figure 69 Central Configuration

The central configuration is very similar to the adjacent configuration, with the exception that there are units behind the service core. And that the service core does not have a direct connection to the access corridor. This concept allows for more growth of shelter units within the community.

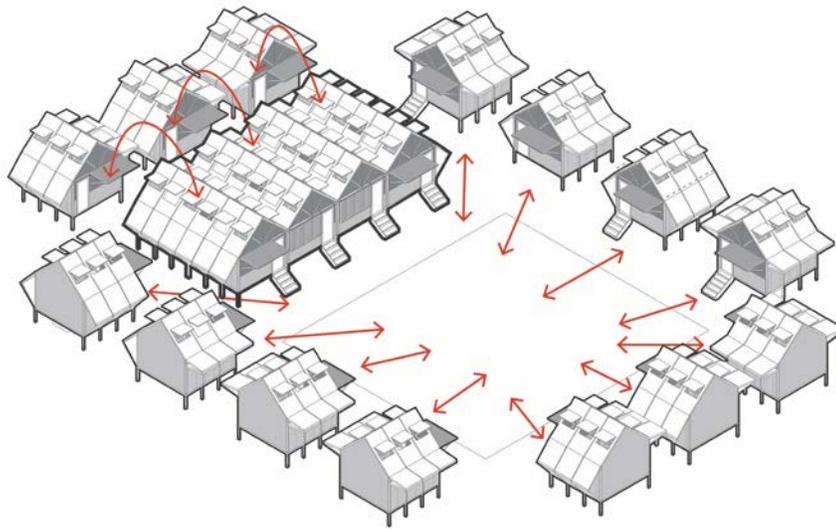


Figure 70 Central Configuration, Interconnection

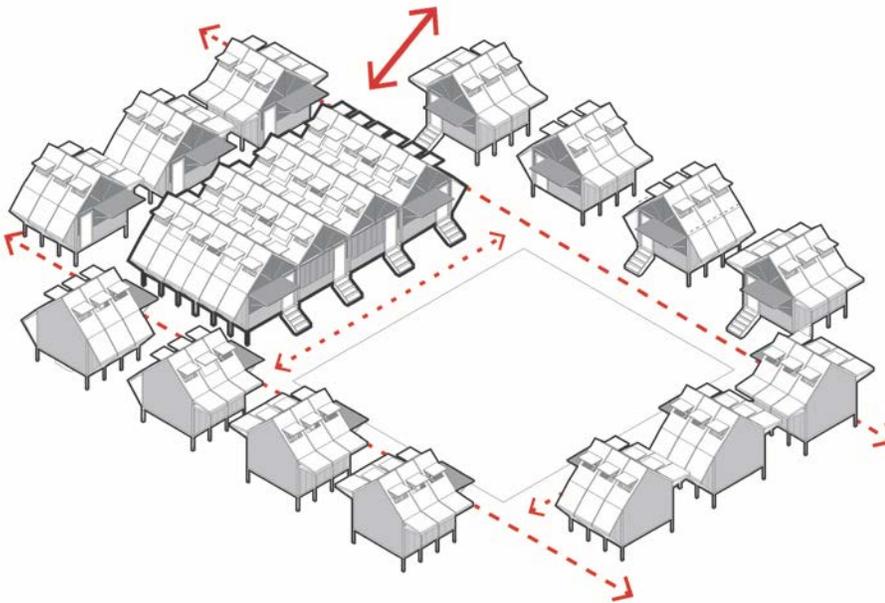


Figure 71 Central Configuration, Permeability

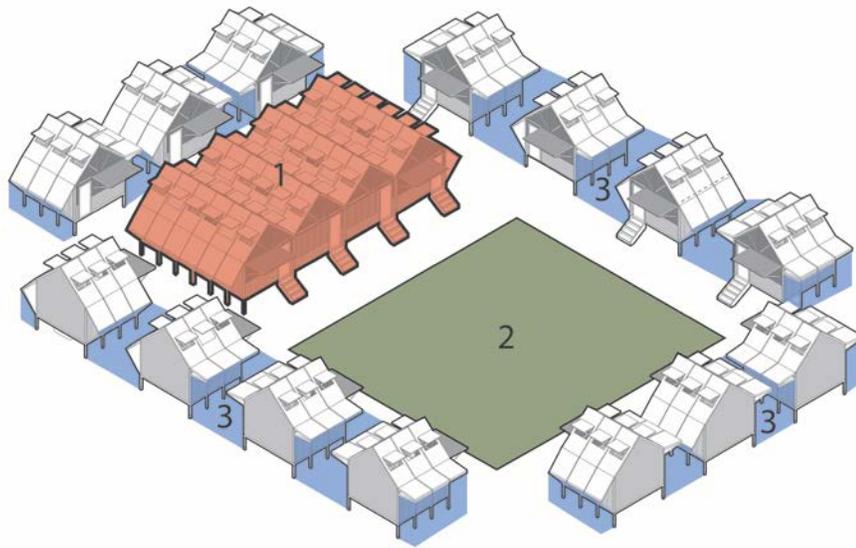


Figure 72 Central Configuration, Micro Spaces

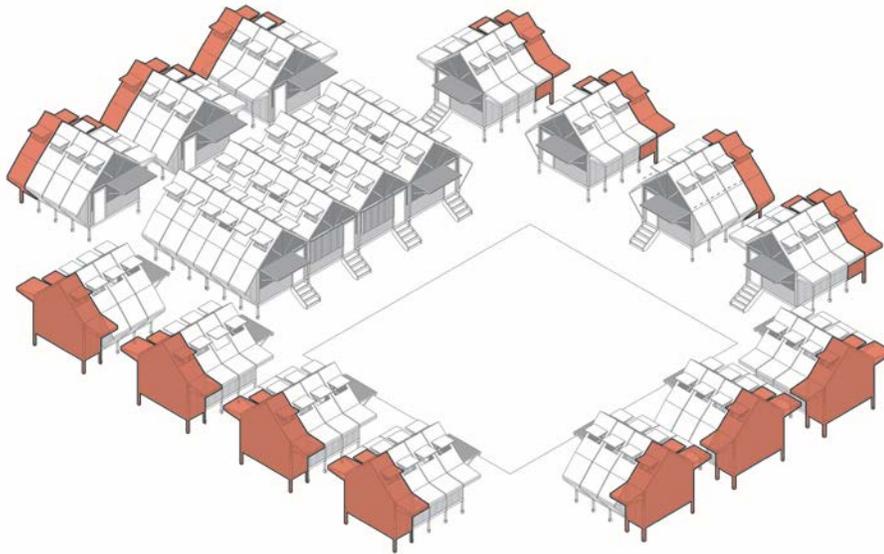


Figure 73 Central Configuration, Growth

Linear

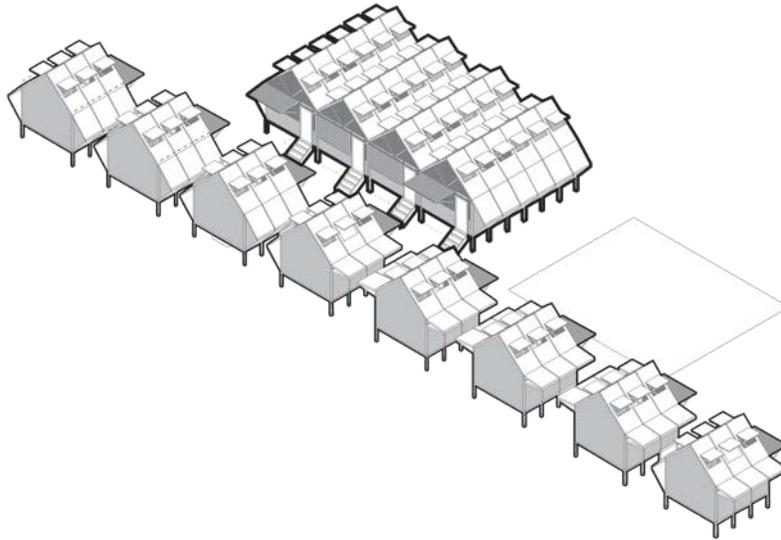


Figure 74 Linear Configuration

The linear configuration is of a tighter arrangement of the community due to restrictive site conditions, such as topography or large debris surrounding the site. However, due to the simple community framework the arrangement still allows for the design elements to still be visible. The shelter units still have a strong connection with the service core. The community has strong axial approaches inside and outside. There are still micro spaces in between the units. As well as the opportunity to have the shelters grow modularly.

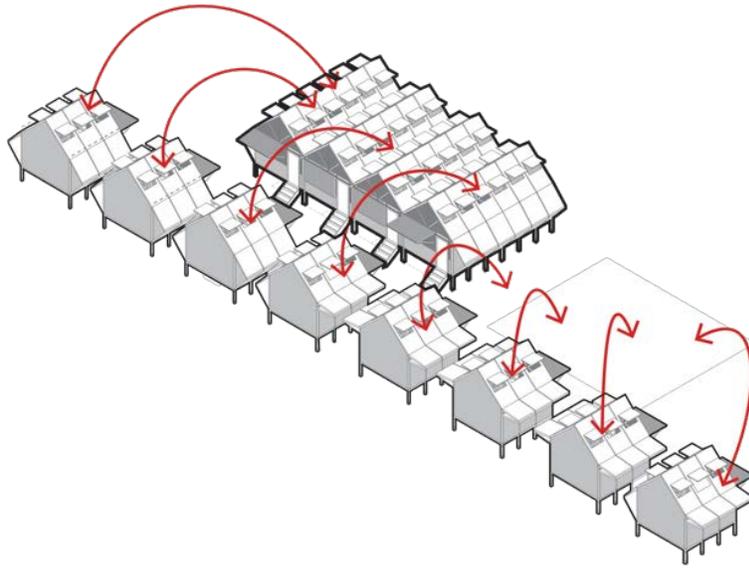


Figure 75 Linear Configuration, Interconnection

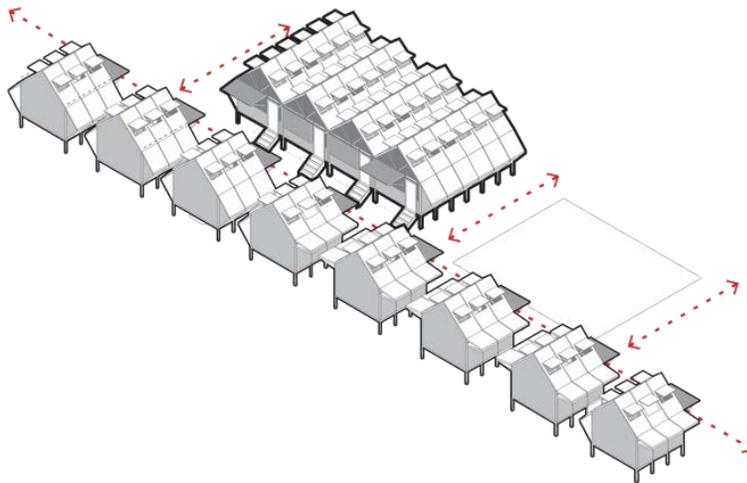


Figure 76 Linear Configuration, Permeability

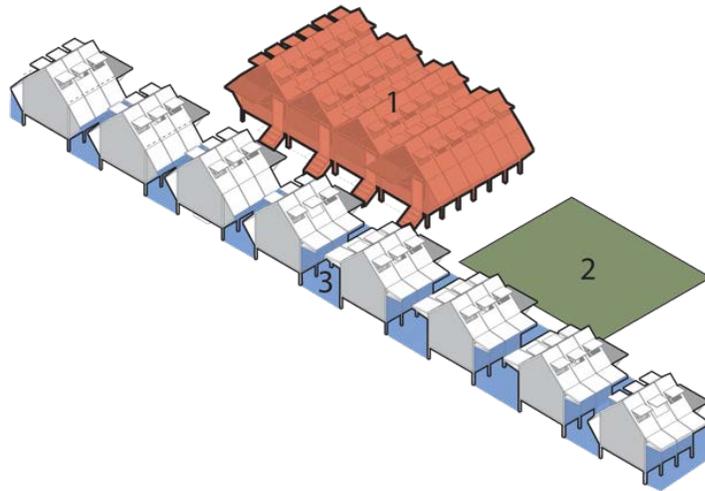


Figure 77 Linear Configuration, Micro Spaces

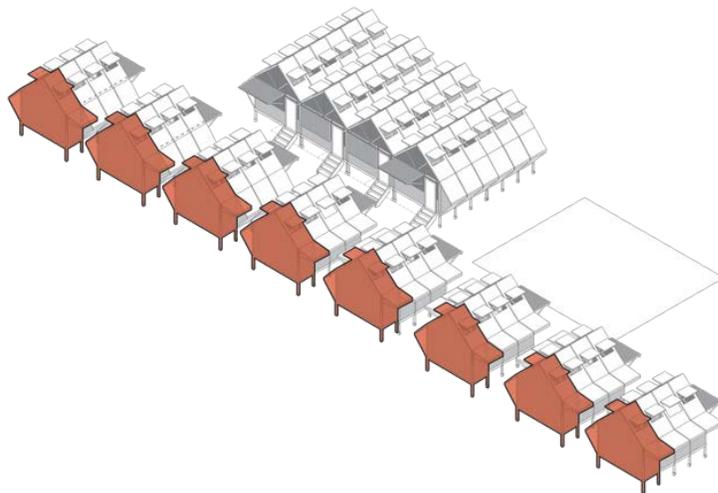


Figure 78 Linear Configuration, Growth



Figure 79 Service Core, Open Field as a Playground



Figure 80 Micro Spaces, Individual Markets

Chapter 13. Permanent Community Planning and Construction

Permanent Community Planning

After the “Establishment of Temporary Community” and the “Bahay Shelter” periods, movement towards planning a more permanent community occurs. This stage of the timeline happens during month 4 – 6. This is a continuation of the long-term community planning. Finalizing the details and steps towards a permanent livelihood. During this planning stage, the community can make the decision to either expand on the current temporary community or possible move to another locate.

This stage is necessary because the relief shelters are design to have a lifespan of eight months. And due shelter’s lifespan, the community members would need to plan on what would be the best option for the future. The design of the shelter to have a lifespan is because the shelter is intended to be a temporary shelter. It is a temporary solution to help buy time for a stronger permanent answer for the survivors. It is also due to some of the past relief shelters that have negatively affect the lives and health of many of the shelter recipients. Precedents such as the UN lightweight tents and Hurricane Katrina Shelters. These shelters had good intentions for the survivors of their disasters. However, the users became too dependent on the shelters and outlived the intended shelter life. The materials started to degrade and negatively affected the users.

Permanent Community Construction

The last step in the timeline of relief and recovery is the permanent construction of the community. This is the full implementation and construction of the permanent

community plans. With the usage of more resistant and local materials, as well as on a stable site. Along with the construction of the permanence the shelter's modular frame can be either reused and integrated into the community, or it can be recycled back towards the organization for a partial monetary refund.

Chapter 14. Conclusion

To summarize the design proposal of a relief response, the thesis has grown from a singular idea of designing a simple relief shelter for the Southeast Asian survivors of natural disasters to developing a large framework of community planning along with the shelter design. This thesis has evolved into more of a design process and a working idea of how to address this growing issue of environmental and social changes. That this topic will be even more relevant than it is now as the increase climate change throughout the world. And with the hope that this thesis sparks the conversation of how to rethink and redevelop the though process of relief and recovery response to natural disasters.

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