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Assessing the Vulnerability of Post-Disaster Housing Expansion: A Case Study in Tsunami-Affected Thailand

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Executive Summary

Introduction

The tsunami on December 26, 2004 devastated the coasts of seven countries, including Thailand. During the immediate relief effort, tsunami victims in Thailand were provided with inadequate replacement units that were unsafe, did not suit the needs of the residents and were not culturally appropriate. The replacement units increased the residents' vulnerability to natural hazards they were exposed to regularly like sun, rain and wind. The residents added on to these units to attempt to solve these problems, but the modifications actually further increased their vulnerability to natural hazards. This situation exemplifies the problems the relief effort causes in any disaster-affected area when there is a lack of community involvement; this is a global problem. The goal of our project was to assess the vulnerability created by replacement unit expansions in two villages in the Ranong Province of Thailand and identify ways to mitigate the vulnerabilities through disaster resilient construction and education.

Long-term factors that make a community susceptible to disasters or change its ability to cope with events are vulnerabilities (Cannon, Rowell & Twigg, 2003). One way to reduce vulnerability is with mitigation, implementing long-term actions to reduce the effects of potential hazards (Cuny, 1983). The mitigation approaches that were most effective in this situation are education and awareness of disaster preparedness techniques, and the implementation of disaster resilient construction.

Four research questions were developed to accomplish our goal:

- What are Thai villagers' perceptions of vulnerability towards natural disasters' effects on unit expansion?
- What changes are Thai villagers are making to their units and the building methods, styles and materials they are using?
- What are the reasons and needs for the expansion of replacement units?
- Where do Thai villagers get information about construction and building styles?

We performed semi-structured interviews and focus groups with a Thai translator in two tsunami-affected villages in Ranong Province, Thailand to obtain answers to our research questions. In the two villages, we conducted semi-structured interviews with the villagers to determine what additions they were making, how they were constructed, the reasons why additions were built, and where villagers were getting information. The focus groups conducted were to determine the perception of potential hazards in the community and what villagers had done to protect themselves from them.

We also applied a Vulnerability Assessment and a Rapid Assessment to compare the villagers' perception of vulnerability to their assessed physical vulnerability. The Vulnerability Assessment was a series of interview questions used to determine the villagers' perception of natural disasters and how they perceive a natural disaster would affect their unit and additions. The Vulnerability Assessment framework was adapted from the Capacities and Vulnerabilities Analysis to incorporate questions to determine perceptions of risks (Cannon, Rowell & Twigg, 2003). These questions were asked through semi-structured interviews and focus groups conducted in both villages. The Rapid Assessment was adapted from the US Federal Emergency Management Agency's (FEMA) Rapid Visual Screening process (Rojahn & Poland, 1988a). We modified this

process to help us determine the physical vulnerability of the additions being built onto replacement units. The perceptions of vulnerability that we identified from the Vulnerability Assessment were compared to the Rapid Assessments of the physical vulnerability. We used the assessment of physical vulnerability as a standard to compare the perceptions of vulnerability to. If the perception of vulnerability is high, it is more likely that they will take actions to reduce their vulnerability (Coburn, Sspence, Pomonis, 1994).

Findings

We found that the relief effort increased the vulnerability of the communities we studied by making them susceptible to hazards. The relief effort also created a dependency on outside help in the villages we studied because in many cases the hazards the villagers are now exposed are new problems that villagers do not know how to fix. The relief effort directly affected the villagers' vulnerability through the following ways:

- *The relief effort did not eliminate the studied villagers' exposure to sun, rain and wind.* Every villager interviewed mentioned at least one of the following problems with the replacement unit: it did not provide enough space for their families, protection from the sun and rain, and/or wind.
- *The relief effort increased the community's susceptibility to wind storms*. The current community layout, straight parallel rows of houses, is not recommended in disaster-prone areas because wind may gain momentum when it is forced between houses during a storm (Seraj & Ahmed, 2004). This is a permanent problem that villagers cannot fix.
- *The relief effort also caused flooding problems for the villagers we studied.* Their previous homes were built on sand, one to two feet off of the ground. The replacement units were built on the ground on clay based fill, which does not absorb water as well as sand. Water collects on the surface causing flooding problems during the rainy season. The villagers are now dependant on outside help to solve this drainage problem.
- *One organization reduced the exposure to hazards in one of the villages we studied.* This organization built additions, strengthened the floor and replaced wall boards in one of the villages studied. This organization tried to help villagers studied, but they increased the villagers' dependency on outside help by not providing them with information on how they can solve the problems themselves.

We found that the relief effort increased the vulnerability of the villagers we studied by not providing them with sufficient information and skills to cope with the problems the relief effort has caused.

- *The villagers were not involved in the design and construction process of their replacement house.* The villagers had no input into what their new home was going to include, the way it was built or where it was located. The difference in the design between old and replacement housing and lack of community involvement left villagers without an understanding of how to properly maintain or change their home.
- *The villagers we studied have little or no information and skills on developing homes and additions that are disaster resilient.* Six of the eight households

interviewed built their own addition. The other two households hired contractors to build their additions, and both households said they still had problems with flooding. No villagers interviewed had received any information on disaster resilient construction, and the lack of disaster resilience in the additions built by contractors leads us to believe that professional builders are not being provided this information either.

- *Current methods of disseminating information to villagers we studied are not adequate.* The local government and non-governmental organizations (NGOs) working in the area used volunteers in each village to spread information. Our results showed that residents in one village did not know who their volunteer was. It is uncertain whether the volunteer did not fulfill his duties of disseminating information or if he was not given any information to distribute to villagers. Further research should be done to identify the cause of the lack of communication.

We found that the villagers we studied increased their own vulnerability. The villagers we studied are adding on to their additions to provide protection from the rain and sun, to add more space and to stabilize the unit. They have built two types of additions: closed additions and open additions. Closed additions were enclosed with walls and a roof and open additions were not enclosed by walls.

- *Villagers are admittedly not using disaster resilient building techniques in their designs for the additions*. When we asked villagers in our study if they thought their addition could harm themselves or their neighbors during a natural disaster, two village interviewees stated yes. They told us that the need for space was more important to them and they were willing to take that risk.
- *The process villagers are using to build additions is also increasing their vulnerability.* Villagers are building additions in phases depending on how much money they have. An unfinished addition increases vulnerability to natural disaster.

We found that the villagers we studied have done little to protect themselves against catastrophic events, but they are protecting themselves from other more common hazards. Villagers realized that their additions were unsafe and may increase their vulnerability to catastrophic events, but have done little to fix this because they do not have the resources or knowledge to do so.

- *Villagers perceive themselves as capable of protecting themselves from their house shaking in the wind (lack of stability), rain, and sun.* They are solving these problems respectively by expanding the bottom of the unit to provide more stability, covering windows with plastic sheeting and installing awnings onto the sides of the house.
- *Villagers perceive themselves as capable of protecting their community by replanting mangrove trees.* During the focus groups, villagers were asked if they had done anything to protect themselves against natural disasters. They mentioned that they planted mangroves because they noticed the majority of mangroves in the area survived the tsunami. An NGO in the area, USAID, provided the resources needed to complete this project, so villagers had the capacity to do this.

- *Villagers want a direct evacuation route built, but do not perceive they are capable of building one.* The residents of Ban Tub Nua did not have a direct evacuation route. The only road out of the village runs parallel to the coast for about half of a mile before turning away towards higher ground. The villagers mentioned that they wanted a new road that is a direct exit from the community, but they had no plans to construct this road

Based on these findings we make the following recommendations on how to prevent future vulnerabilities and reduce current vulnerabilities.

Recommendations

1. **To Prevent Future Vulnerabilities from Replacement Unit Modifications in Communities Impacted by Natural Disasters**

The following recommendations are directed towards NGOs to prevent future vulnerabilities in disaster-affected areas that can be caused by replacement unit modifications. We separated our recommendations into two categories: involve the disaster-affected community, and solutions for when the community cannot be involved.

- ***Involve the Disaster-Affected Community***
  - **We recommend that in the event of a future disaster, affected communities be included in the design process of replacement units so they are suitable to the villagers' needs.** Community participation is crucial when trying to design a home for another person, especially if the prevalent building styles and materials in the area are unfamiliar. Involving the community will increase the chance of satisfying the future residents with the initial replacement units and prevent the need for an addition to be built. Residents should be provided housing that can withstand everyday hazards present in the area. NGOs should directly ask the disaster-affected future residents what they need to live comfortably in a home, research the previous styles of house that existed before the disaster occurred and identify hazards that are prevalent in the area. This will provide a house that is both culturally appropriate and suitable to residents' needs and wants. Further research may be needed to find the most appropriate community participation process for the area.
  - **We recommend that disaster-affected people be involved in the safe construction of replacement units.** By observing and participating in the construction of new homes, residents can learn the safe building methods used. This knowledge can give residents the resources to safely build additions to their homes if the desire exists. This will provide residents the capability to solve problems themselves, will not create a dependency on outside help and therefore will not increase their vulnerability.
- ***Solutions for When the Community Cannot Be Involved***
  - **We recommend plans for safe culturally appropriate additions are distributed to villagers in a timely manner (less than three months after construction).** If research cannot be done before replacement units are built,

NGOs should inform residents that they are returning with safe designs and suggest that they wait to build additions until then. This would prevent residents from building unsafe additions that increase their vulnerability to natural disasters.

- **We recommend a simple and structurally safe shelter be provided to residents as a 'starter' unit that can be added to safely by the resident when appropriate.** The 'starter' unit should be a safe enclosed shelter that can provide protection from common hazards in the area. Residents will be able to make safe additions to complete their houses when their budget allows. There should be resources easily available to residents, whether it is building materials or a loan program, to aid them in building additional phases to their house. This process will empower residents to make changes and fix problems alone, and will steer away from the dependency and vulnerability that the relief effort typically causes.

2. To Reduce Current Vulnerabilities in the Two Villages Studied

NGOs should design solutions that will improve the original replacement unit and design safe additions that are culturally appropriate. This information should be disseminated to residents as soon as possible to prevent further unsafe additions from being built and increasing the vulnerability to natural disasters. We separated our recommendations into three categories so these types of recommendations may be applied to other disaster-affected areas. The categories are: identify problems with the replacement unit and ways to disseminate information, design safe culturally appropriate additions, and implement safe designs.

- **Identify Problems with the Replacement Unit and Ways to Disseminate Information**
  - **We recommend that a plan to stabilize the replacement units be developed and disseminated to villagers.** Villagers were concerned about the stability of their replacement unit and indicated that in moderate wind, their replacement units shake. Developing a plan to stabilize the replacement units will prevent villagers from building unsafe additions onto their units and decrease their vulnerability.
  - **We recommend that methods of flood proofing be provided to villagers and a drainage system be installed in the community.** Flooding is a problem for villagers because the replacement units were built on clay based fill instead of sand. This factor along with the lack of a drainage system for the villages created frequent problems during the rainy season. Flood proofing replacement units and the implementation of a drainage system will allow the space on the first floor to be used more effectively and reduce the villagers' vulnerability to flooding.
  - **We recommend that methods of rain proofing the replacement units be provided to villagers.** During the rainy season, precipitation and strong winds caused rain to enter the replacement structure horizontally. The wooden ventilation slits along the side of the replacement structures allowed adequate ventilation but also allowed rain to enter. Rain coming into the

second floor formed puddles and caused the floor to quickly rot and mold. Providing villagers with methods of rain proofing will address the problem of rain coming into the house, prevent further damage to the floor and decrease their vulnerability.

- **We recommend that a plan to strengthen the floor be developed.** The structural integrity of the original replacement unit floors was a concern, but the extra variable of rain compounded the problem. Developing a plan to strengthen the floor will allow for the space to be used efficiently and will decrease the unit's vulnerability.
- **We recommend that information on disaster resilient construction be disseminated directly to villagers.** Our results showed that villagers had little or no information on disaster resilient construction available to them and the means of spreading this information was not effective. By directly providing villagers with information, NGOs can be assured that the information that will reduce vulnerabilities through disaster resilient construction is reaching their audience.

- ***Design Safe Culturally Appropriate Additions***
  - **We recommend that safe building techniques for open additions be developed and provided to villagers.** Open additions were usually used for protection from sun and rain. Providing safe building techniques for open additions will reduce the vulnerability of unit additions to natural disasters. Further research should be done on the most common size and location of open additions to better suit the community's needs and be incorporated into the design.
  - **We recommend that a design for a safe closed addition be developed and provided to villagers.** Closed additions were usually added to provide more space. Providing a design for a safe closed addition will reduce the vulnerability of unit expansions to natural disasters. Further research should be done on the most common size and location of closed additions to better suit the community's needs and be incorporated into the design.
- ***Implement Safe Designs***
  - **We recommend that a safe addition be built onto a community facility as a model for villagers to replicate.** Building a full scale model addition to a community facility in each village will serve two purposes: 1) villagers will be able see and learn the safe building techniques used in the construction; and 2) villagers will have this model available to replicate whenever they have time or the budget to do so. To avoid jealousy in the community, the addition should be built onto a community facility, not a villager's house. This recommendation combines the mitigation methods of education and disaster resilient construction in a medium that will be well received in the community.
  - **We recommend that a loan program be established so disaster resilient additions can be completed in one phase.** Villagers were building their permanent additions in phases depending on how much money they had.

Leaving the addition partially finished increases its vulnerability to natural disasters. A loan program would allow villagers to borrow enough money to build their addition in one phase.

Summary

Our recommendations are intended to decrease the vulnerability being created in disaster-affected areas around the world by relief organizations who do not involve the community in their processes. It is important that organizations trying to help do not inadvertently weaken communities because of an inadequate process. If the community is not informed of how to help themselves after a disaster strikes, the community will become dependant on relief organizations for help and increase their vulnerability to natural disasters. Integrating mitigation approaches into long-term plans will effectively reduce the vulnerability of a disaster-affected area to another disaster.

Abstract

In Thailand, the relief effort from the 2004 tsunami provided replacement housing to affected people that lacked enough space and protection from natural hazards. To solve these problems, residents have been building additions that further increase their vulnerability to natural hazards. Our project assessed the vulnerability created by replacement housing expansions in two coastal villages and identified ways to mitigate the vulnerabilities through disaster resilient construction and education. Recommendations were made to reduce current vulnerabilities and improve future relief efforts.

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I. INTRODUCTION

Each year, natural disasters cause significant social and physical trauma. Between 1980 and 2000, seventy-five percent of the world's population lived in areas that were affected by natural disasters (United Nations Development Program, 2004). Natural disasters cause extensive damage to personal property and claim the lives of many. In 2004 alone, natural disasters caused an estimated US$ 99.3 billion worth of damage and took the lives of 249,896 people (Hoyois, Below & Guha-Sapir, 2005). While this year was exceptional because of the tsunami, the average annual death toll due to natural disasters is still significant – during the decade prior to the tsunami the average death toll per year was 67,000 people. Natural disasters affect everyone regardless of economic status or religion, but a person's ability to respond to them is a social problem (Kasperson and Kaspereson, 2001).

The way people respond to the varying impacts of natural disasters is different because some people are more vulnerable than others (Kasperson and Kasperson, 2001). Residents of third world countries are particularly at risk due to lack of money, resources, technology, and preparedness. For example, an earthquake of magnitude 6.5 (Richter scale) struck Los Angeles, USA, in 1993 killing 60 people; an earthquake of the same magnitude in the same year killed 8,240 people in Latur, India (Seraj & Ahmed, 2004). Anderson (1991) states that "poverty increases vulnerability to disasters," and also makes full recovery difficult (p. 18).

Long-term factors that make a community susceptible to disaster or change its ability to cope with events are vulnerabilities (Cannon, Rowell & Twigg, 2003). A person can be physically, socially, and motivationally vulnerable. Physical vulnerability deals with infrastructure, finances, environment and technologies. Social vulnerability is related to social and political structures. Motivational vulnerability is how people view themselves and their contributions to their environment. Disaster mitigation is intended to reduce vulnerability because it seeks to reduce the factors that expose people to disasters and lessens effects from hazardous events (National Research Council, 1999).

The mission and role of many non-governmental organizations (NGOs) is to improve quality of life and to mitigate vulnerability through longer-term development

projects (Hagman, 1984).The Asian Disaster Preparedness Center (ADPC), our sponsor, is a non-profit NGO focused on improving risk management systems in vulnerable communities in Asia (An Overview, 2005). The ADPC focuses particularly on preventative measures, including mitigation, over recovery methods. They have worked on projects such as the *Design and Construction of Housing for Flood-Prone Rural Areas of Bangladesh* and *Demonstration Housing Construction for Landslide and Flood Prone Areas*. The goal of these projects was to provide information to organizations on post-disaster reconstruction and retrofitting housing that will help to empower people who need new low cost, safe housing in vulnerable areas (Ahmed, 2005). There is currently a lack of information on safe building techniques in tsunami affected areas. Our project worked to identify and provide the information needed for tsunami-affected people to adapt their houses.

During the tsunami relief effort, replacement unit structures were provided to many affected families. The replacement units did not protect against catastrophic events or regularly occurring hazards. Future residents were not included in the design process, so the replacement units did not meet their needs and wants. During the year since the tsunami, these replacement houses were expanded and additions were placed on or around the houses for various reasons. These additions, constructed without disaster resilient construction, increase the vulnerability of the entire structure to natural hazards (Kessler, 2006). An emerging understanding that these additions create additional vulnerability alerted NGOs to the lack of guidelines available to the community on safe building techniques. Continual education and training on safe unit expansion is necessary to reduce the vulnerability of these tsunami-affected communities.

The goal of our project was to assess the vulnerability created by unit expansions and identify possible ways to mitigate the vulnerabilities through disaster resilient construction and education. We conducted our study in two villages on the Andaman coast in Thailand. Our project was achieved by identifying the changes villagers in the Ranong Province made to their units, their perceptions of vulnerability, their reasons or needs for expansion of the replacement houses, where they got information on construction techniques and by performing vulnerability assessments. By determining the current perceptions of vulnerability and process for building additions in the two villages,

we identified the types of information the villagers needed to reduce their own vulnerability. Our project developed recommendations for NGOS to improve future relief efforts as well as recommendations for information residents of the two villages currently need to reduce the vulnerability created by the replacement houses and new additions.

II. BACKGROUND

This goal of our project was to assess the vulnerability created by replacement unit expansions in two villages in the Ranong Province of Thailand, and identify possible ways to mitigate the vulnerabilities through disaster resilient construction and education. To address these topics we needed to have a clear understanding of vulnerability to natural hazards. In this chapter, we identify ways vulnerability can be decreased with preventative measures. Through addressing the current relief and recovery effort, the importance of community involvement and culturally appropriate disaster resilient housing is emphasized.

2.1 Relief and Recovery after Natural Disasters: Temporary Solutions to a Long Term Problem

On December 26, 2004, an earthquake on the floor of the Indian Ocean created a tsunami that shot towards the coasts at 500 mph and devastated the shorelines of seven countries, including Thailand. The enormous death toll of about a quarter of a million people was due to lack of preparedness and inadequate warning; about 75% of lives lost could have been saved if people were educated about tsunamis and an early warning system was in place (Powers, 2005).

The devastation of the tsunami drew people from around the world to affected areas to help victims who had lost almost everything. Immediate relief efforts after large scale disasters are intended to fulfill urgent needs of affected people with water, food and means of shelter (Beck, 2005b). This effort focuses on restoring the people in devastated areas to a level where all individuals possess basic necessities of sustained living.

The subsequent step is the recovery effort which begins to provide rehabilitation to the people and reconstruction of homes, infrastructure and means for livelihoods. It is the intent of NGOs to provide efficient programs for long-term help, but they are limited by resource, budget and time constraints. The recovery process for disasters

> …is set within two timetables. The first is real-time, which can take five years or more. A second, shorter timetable is set by donors, partly because of pressure to disburse funds. Governments have to observe both timetables, balancing the

> political expediencies of short-term measures against the needs for longer-term recovery. (Beck, 2005b, p. 2)

The short-term relief effort immediately cleared debris, provided temporary shelter, food and basic necessities (Pongquan, Crawford, Saengkaew, & Tansakul, 2005). While short term help was plentiful and reached those affected within a week, few programs were initiated to provide long-term assistance (UNDP, 2005). The few programs included livelihood plans, support to recover small businesses, and support to recover tourism.

Problems emerged from a shortage of mid- and long-term rehabilitation efforts in the initial actions of the recovery effort. Mid- and long-term planning may seem irrelevant at a time when so much importance is placed on immediate aid "but unless local and international agencies think about recovery early on, their activities may contribute to recreating the same vulnerabilities that existed before the disaster" (Beck, 2005a, p. 9).

2.1.1 Relief and Recovery in Thailand: The Importance of Community Involvement

In Thailand, the government contracted non-governmental organizations (NGOs) to build replacement housing for tsunami-affected families (Gape, 2006). The government set limitations on the size of units built, forty-eight square meters maximum, and the materials used to try to make the housing provided as consistent as possible.

Habitat for Humanity was one NGO contracted by the Thai Government to provide replacement housing (Gape, 2006). This NGO was fortunate enough to have the resources and skills to design locally appropriate housing. Habitat for Humanity recognizes how important it is to include the future residents in decision making (Habitat's Response, 2006). With the help of the community this organization chose two or three appropriate designs for the area they were working in, and allowed each family to pick which style of house they preferred (Gape, 2006). Another aspect of Habitat for Humanity's process that worked successfully was to teach disaster-affected people to make the materials needed for construction. Habitat for Humanity would then buy those materials for use in the building of their homes. This organization hopes that the

increased capacity of tsunami-affected communities they have worked in will influence other communities that have been overlooked during the rebuilding process (Habitat's Response, 2006).

In areas where NGOs were not contracted, the Royal Thai Air Force constructed the replacement housing (Gape, 2006). The units they provided to villagers were two story structures with a kitchen and bathroom area on the first floor and two bedrooms on the second floor (see Figure 1). The units were set on a concrete foundation with walls constructed of a thin wooden material and concrete, and had a roof made from compressed asbestos shingles. This generic style of housing was provided to several communities. Future residents of these communities were not able to choose what style or type of housing they would prefer.

Figure 1: Replacement unit in Ranong Province, Thailand

Future residents also did not have input on the decision of the location of this type of replacement housing. The houses the Royal Thai Air Forces provided were constructed

in parallel rows, which may cause wind and surging water to gain momentum during a natural disaster (Seraj & Ahmed, 2004). Some communities were rebuilt in the same location they were in when the tsunami destroyed them, while others were relocated to areas unaffected by tsunami.

Because of the immediate need of replacement housing, there was a lack of community involvement in areas where the Royal Thai Air Force worked, which caused villagers to be unsatisfied with their new house and its layout. As a result, residents of these villages have made additions to these replacement units to satisfy their needs and wants which were not provided in the initial design. The additions being built are not being constructed with disaster resilient construction techniques (Kessler, 2006). The problems that the lack of community involvement and the unsafe additions may have caused have the potential to increase the vulnerability of the residents to future natural disasters. To comprehend how the relief and recovery effort truly affected these two villages, a better understanding of vulnerability must be established.

2.2 Vulnerability

Long-term factors that make a community susceptible to disaster or change its ability to cope with events are vulnerabilities (Cannon, Rowell & Twigg, 2003). The vulnerable are more easily wounded and recover slower (Kasperson & Kasperson, 2001; Cannon, Rowell & Twigg, 2003). James Lewis (1999) observes:

> The concept of vulnerability is a significant contribution to our understanding of natural disasters. The vulnerable state of populations and settlements is as much a contributor to the cause of natural disasters as are the physical phenomena with which they are associated. What are called 'earthquakes' and 'hurricanes' are the natural forces; what are seen afterwards are the results of the impact of those forces on human settlements. The degree of susceptibility to damage, destruction and death in those settlements is conditioned by the decisions and actions of society over time. This means that there exists a social, institutional and political responsibility for a major proportion of those causes, and for making efforts to remove, alleviate or to defend against them….There is much more however, to the understanding of the vulnerable conditions than their physical recognition and identification or, for that matter, than in physical resistance to natural forces in constructional and infrastructural technology. Social and political issues may have had a greater part to play (p. 4-5).

It is just as important to identify social vulnerability as to identify the likelihood of physical infrastructure damage (Cannon, Rowell & Twigg, 2003). Social vulnerability is the complex set of characteristics that include a person's or community's:

- *initial well-being* (nutritional status, physical and mental health, morale);
- *livelihood and resilience* (asset pattern and capitals, income and exchange options, qualifications);
- *self-protection* (the degree of protection afforded by capability and willingness to build safe home, use safe site)
- *social protection* (forms of hazard preparedness provided by society more generally, e.g. building codes, mitigation measures, shelters, preparedness);
- *social and political networks and institutions* (social capital, but also role of institutional environment in setting good conditions for hazard precautions, peoples' rights to express needs and of access to preparedness) (Cannon, Rowell & Twigg, 2003, p.5).

Vulnerability to natural disasters is complicated because "different classes in society are differentially at risk" (Kasperson & Kasperson, 2001. p. 206). A point that must be emphasized is that the most vulnerable people may not reside in the most vulnerable regions. People can live in a technologically advanced society and be vulnerable because they are poor or homeless. On the other hand, people can live in fragile and unproductive environments but live well because they are among the affluent, so they are not as vulnerable. These people may have the resources to include preventative measures in their lives and quickly recover from a disaster. Each community's vulnerability needs to be studied before a plan to reduce the vulnerability can be implemented. It must be understood that vulnerability is only found on a case-by-case basis and no generalized solution will effectively reduce it worldwide.

2.3 Decreasing Vulnerability

Our project focused on reducing the vulnerability of replacement units and additions to them. To decrease vulnerability we must change long-term factors that affect a community's ability to respond to disasters, such as unsafe housing. This can be done by involving the community and implementing preventative measures such as disaster resilient construction, and education and awareness of disaster preparedness. Disaster prevention, specifically mitigation, is crucial to reduce vulnerability to natural disasters.

2.3.1 Mitigation Approaches

Mitigation reduces vulnerability by implementing long-term actions to lessen or stop a hazardous effect from occurring (National Research Council, 1999). Cuny (1983) states, “Disaster mitigation efforts offer by far the best and most cost-effective method for dealing with disasters” (p. 205). Mitigation is effective because it prepares communities prior to natural disasters and minimizes the effects of future natural disasters.

However, many parts of mitigation cannot be dealt with in terms of a disaster only, since they are also related to development.

> Third world countries are so affected by disaster in part because of their inability or failure to address the root causes of poverty and underdevelopment….Progress toward development is required in order to mitigate, and mitigation is required in order to develop (Cuny, 1983, p. 206-207).

A common mistake in mitigation is failing to relate development plans to vulnerability reduction.

In the redevelopment of a disaster affected area, mitigation needs to be included in post-disaster construction as much as in the immediate relief and recovery effort (Cuny, 1983). Mitigation is not a short-term endeavor that is applied only during relief, it must be continually applied after the immediate help has ended and post-disaster construction occurs. Unless mitigation is incorporated into long-term development plans, it will not be effective. An absence of mitigation in redevelopment can allow for future vulnerabilities to natural disasters.

Two approaches to mitigate the effects of natural disasters through long-term development plans are disaster resilient construction and education and awareness. The teachings of safe building techniques and retrofitting can help protect houses against natural hazards. The application of these mitigation techniques reduce vulnerability since these changes affect how a community responds to a natural disaster and makes them less susceptible.

2.3.1.1 Disaster Resilient Construction

Correctly engineered disaster resilient construction is an effective mitigation approach because it greatly reduces the effects of natural disasters on structures (Slagter & Kerbo, 2000). Construction of this nature focuses on specific designs, materials used, and location of a structure so that it is much more resilient to the effects of disasters. It takes time to develop appropriate designs for disaster protection and determine the most suitable materials to be used in the area.

A problem with this type of mitigation in the third world is convincing a large community to use engineered designs. Most people in rural areas build their own homes with minimal supplies or knowledge of exactly what forces natural disasters have and how destructive they could be. Often, the styles of homes they build have been passed down from previous generations and have become part of their culture (Slagter & Kerbo, 2000; Phirom, 1995). Some aspects of their building practices have become lax or forgotten, which would add longevity and strength to the structures (Seraj & Ahmed, 2004). This style of home may have at one time been the best possible, but it is not necessarily so any longer.

The design of the redevelopment housing should take into consideration the members of the community in which it is aimed to help. "The recipient of aid will want a unit which is socially, culturally and climatically suitable, easy to maintain, and suitable also for other uses linked to this livelihood" (UNOCHA, 1982, p.27). Additionally, the former design of the house before it was destroyed should be taken into consideration:

> Rebuilding should be in situ wherever possible, as experience has shown that affected people usually want to stay close to their original homestead. Local customs – including the needs of extended families, the location of the kitchen, the building of verandas, privacy and weatherproofing – should be taken into account. (Beck, 2005a, p. 7)

Though the structure must be culturally appropriate it must also be stable enough to prevent against natural hazards which includes both uncommon large disasters and frequent natural occurrences. To make sure residents feel safe in their homes, the level of construction should at least protect them from the type of event they identify as a higher risk: catastrophic events or common natural hazards.

Disaster resilience is something that needs to be continually assessed. The disaster resilience of a home may be compromised by other exterior factors (Dalgliesh, 1995). It is important that regular maintenance and upkeep is performed to clear debris away from one's home. This can keep the house from deteriorating and prevents the debris from causing additional damage to the structure during a storm.

Disaster resilient construction in long-term planning is crucial to reducing vulnerability of disaster-affected areas to future natural disasters. In order for disaster resilient construction to be successful and useful, people need to be educated on the importance and implementation of it.

2.3.1.2 Education and Awareness

Education and awareness is a mitigation technique that provides people with information needed to reduce the effects of disasters. An approach to determining what information a region should be educated on is to examine current disaster prevention problems by identifying, "…country specific problems associated with the mitigation of disasters" (Erdik, 1991, p. 133). The information one learns about disaster preparedness has a large impact on how one reacts to and perceives disasters. When information from education is not applied, an understanding of disasters can come only from one's perceptions and experiences.

The more information known about a hazard and its effects can increase the perception of risk. If this perception of risk is increased, it may create the desire for protection and the application of a mitigation approach, such as disaster resilient construction. "How important the risk of natural disasters is compared with other risks in our lives will determine whether we do anything about it and how much we do. Awareness of the risk by the public in general and perception of how it compares to other

risks will determine society's attitudes about reducing it" (Coburn, Sspence, Pomonis, 1994, p.9).

Disaster-affected people may not be concerned with past disasters because, "the rate of occurrence and the nature of disaster influence how people perceive disaster risk. It is difficult to maintain a state of heightened disaster awareness when the majority of disasters occur infrequently. This is true even if the effects are devastating" (ADPC, 2005, p. 217). NGOs need proper education techniques to express the importance of long-term preparedness measures to mitigate the effects of future natural hazards. Developing clear, concise information that appropriately applies to a region through relevant methods and by working in areas "with recurring disasters or hazardous conditions, where there is some incentive for population to react favorably to the program," will result in a successful development of an educational awareness process (Thompson, 1995, p.2).

In the education of disaster preparedness, it is important to teach people the information relevant to their level of participation in the community (Erdik, 1991; Ward, 1991). Ward (1991), Director Emeritus of the ADPC, said in his report *Training in the Asian-Pacific Region*, "training must be appropriate to the level at which it is conducted. Potential victims need to be shown what they can do to help themselves, relief workers need to be trained to help others, community leaders must be shown how to prepare their communities and so on" (p. 136). These techniques help develop an effective education and awareness program that can mitigate the vulnerabilities to natural disasters in the area. The best way to disseminate this information is with community involvement techniques.

2.3.2 Community Involvement

Community involvement in redevelopment plans of disaster-affected areas decreases the vulnerability of the affected people. By involving the community, their input can be taken into consideration during the design of the redevelopment plans. Community participation in redevelopment plans empowers community members, and with education gives them the resources they need to be sustainable and less vulnerable to

natural disasters. We based the need for community involvement on the findings of the Pearl River Delta Charrette and Participatory Rural Appraisal.

2.3.2.1 Pearl River Delta Charrette

One way to redevelop a community is by holding a charrette. A charrette is defined as a process to develop a plan involving people from many different fields who work for at least four consecutive days (National Charrette Institute, 2005; Cody & Richardson, 2004).

In June of 2002, there was a charrette in Changdi, Guangzhou in China to redesign the waterfront of the Pearl River Delta (Cody, Richardson and Wallace, 2002). Six teams participated in this charrette that focused on sustainability, commercial development, community, historic preservation, cultural tourism, transportation and urban resources application. Each team developed their own design for the new waterfront. The one conclusion that all six teams drew was that they needed more community participation to better design the area. Cody et. al. (2002) states:

> Most participants concurred … community participation was too limited to gather insights and perceptions from the residents. A pervasive criticism was that the charrette relied too heavily on the opinions of 'external experts', without the community participation necessary for clarifying perceptions and misinterpretations. The charrette's sponsors and organizers agreed that future design events should include a series of workshops with residents and merchants. (p. 53)

This conclusion focuses on the fact that with greater community participation, the amount of gaps in perceptions and misinterpretations would decrease, allowing a better solution for redevelopment to emerge.

When redeveloping a community, it is important to place a high priority on the community's satisfaction, since they will remain in the area long after the developers leave. To do this, community members need to be involved in the process of redesign.

2.3.2.2 Participatory Rural Appraisal

Participatory Rural Appraisal (PRA) is "an approach (and family of methodologies) for shared learning between local people and outsiders to enable development practitioners, government officials, and local people to plan together

appropriate interventions" (Rietbergen-McCracken & Narayan, 1998, p. 123). The main focus of PRA is to empower the local people, to encourage education and improvement of standards of life, although the concepts of PRA can be applied to just about any aspect of improvement.

Open ended questions are used as the main application of PRA. They get locals to have more concern about their community and direct them into adapting improvements for their own techniques. This allows outside organizations to learn and assess communities' perceptions firsthand without imposing their own views. Imposing outsider's views is not allowed in PRA because it takes the focus off of the local people's empowerment and shifts a community towards dependence on outside help.

PRA is an efficient method for spreading information quickly because it spreads methods and information laterally instead of vertically, avoiding the obstructions of different class levels or structure (Chambers, 1994). Instead of spreading in a straight line from one organization or person, it spreads exponentially using local people as the main facilitators and trainers, which has produced positive results. The use of community involvement methods of PRA in disaster affected communities can empower community members and give them the knowledge and tools to fix their own problems, specifically in their houses, which can decrease their vulnerability.

2.4 The Assessment of Vulnerability

The assessment of the current state of vulnerability to natural disasters was important to the development of possible mitigation approaches to reduce this vulnerability. The assessment of the residents' perceptions of vulnerability was also important so we could understand why residents were making changes to their replacement housing. We researched two methods of vulnerability evaluation to determine how to accomplish the assessments needed. We researched Capacities and Vulnerabilities Analysis for techniques to determine perceptions of vulnerability and Rapid Visual Screening for methods of determining physical vulnerability.

2.4.1 Capacities and Vulnerabilities Analysis: Perceptions of Vulnerability

The purpose of a Capacities and Vulnerabilities Analysis is to educate givers of aid on how to provide help that will support the efforts of the affected people to attain social and economic development (Cannon, Rowell & Twigg, 2003). It was "designed principally for NGOs, to help them consider when and how to respond to a disaster by understanding what impact interventions will have on capacities and vulnerabilities" (p. 11).

CVA is based on a matrix which allows us to view people's perceptions on their capacities and vulnerabilities in three interconnected areas: physical/material, social/organizational and motivational/attitudinal (see Figure 2). Physical/material vulnerability deals with infrastructure, finances, environment and technologies. Social/organizational vulnerability examines social and political structures. The last section of vulnerability, motivational/attitudinal, deals with how people perceive themselves and their ability to change their environment.

=	**Vulnerabilities**	**Capacities**
Physical/material What productive resources, skills and hazards exist?		
Social/organizational What are the relations and organization among people?		
Motivational/attitudinal How does the community view its ability to create change?		

Figure 2: CVA Matrix

This method has been used often in disaster preparedness and mitigation developmental programs (Cannon, Rowell & Twigg, 2003). CVA should be used after a disaster has occurred to determine the best approach to reduce vulnerability and maintain the functions and abilities of the victims. This suggests that CVA can be helpful in accomplishing our goal.

2.4.2 Rapid Visual Screening: Physical Vulnerability

Rapid Visual Screening (RVS) is a method used to assess the seismic hazards of a building (Rojahn & Poland, 1988a). RVS is primarily used with commercial buildings, but can also be used with homes or smaller structures. It is inexpensive, requires little time and previous knowledge. RVS is based on visual observations of a building through "sidewalk surveys." It takes an average of 15-30 minutes to complete and does not require entering the building, doing a structural analysis or viewing building blueprints. RVS was developed to be used by everyone from professional engineers to emergency managers and interested citizens. "Due to the varied backgrounds of the members of this target audience, an effort has been made to define technical terms and, where possible, to provide rules that assist in making judgments where engineering experience would otherwise be required" (Rojahn & Poland, 1988a, p. 4).

RVS is comprised of a Data Collection Form designed to minimize writing (Rojahn & Poland, 1988a). Most information is circled or checked off. The Data Collection Form asks for information in the following areas: building location and identification, inspector identification, number of stories and total floor area, year built, occupancy, non-structural falling hazard, sketches, photo and comments.

It is obvious that a rapid visual examination cannot provide highly reliable or technical data:

> …the [RVS] method is simply intended to identify those buildings where reasonable doubts may exist… In some cases the [RVS] may miss buildings that in reality are seismically weak, so that if questions exist in the surveyor's mind regarding a particular building, the surveyor should err on the side of requiring the building to be investigated in further detail (Rojahn & Poland, 1988a, p. 53).

The confidence the inspector has in the data collected should be noted.

According to FEMA, “the data collection form is meant to be a model that may be adopted and used as it is…or it may be modified according to the needs of the community” (Rojahn & Poland, 1988a, p. 43). This suggests that with some modification RVS could help determine the amount of potential hazards a replacement unit had, and therefore the physical vulnerability to natural disasters.

2.5 Synthesis

Long-term factors that make a community susceptible to disasters or change its ability to cope with events are vulnerabilities (Cannon, Rowell & Twigg, 2003). The lack of community involvement in the relief effort caused several problems for tsunami-affected people, which had the potential to increase their vulnerability to future natural disasters. One effective way to reduce this vulnerability is with mitigation approaches, specifically disaster resilient construction and education and awareness.

Disaster resilient construction and education and awareness both work to implement long-term actions that lessen the effects of disasters. Disaster resilient construction strengthens buildings so they can physically survive a natural disaster. Education and awareness techniques provide people with information on disaster preparedness strategies they need so they can make appropriate decisions on how to respond and cope with disasters. An understanding of disasters can come only from one’s perceptions and experiences, unless people are educated otherwise.

One effective way to disseminate disaster preparedness information is with PRA and community involvement. PRA is an efficient method for spreading information quickly because it spreads information laterally instead of vertically, avoiding the obstructions of different class levels or structure (Chambers, 1994). Information spread laterally will reach a wider audience and more successfully reduce vulnerability.

Community involvement can also be applied in the redevelopment process. Community participation in the redevelopment process can help to avoid a disconnection between the intent of developers and the needs of the community members. When the community is involved and their ideas are taken into consideration during design, they become an active participant in the process, and will more likely be satisfied with the

outcome. Community members need to be satisfied with the redevelopment and feel empowered to change it if they desire.

Before vulnerability can be reduced, the type of vulnerability that exists needs to be assessed. The perceptions of vulnerability that exist in the area also need to be determined since that can enlighten us to why tsunami-affected people are changing their replacement units, the priority they place on protecting themselves from natural disasters, and the amount of information they have on disaster preparedness strategies. With some adaptation, the assessment tools of Capacities and Vulnerabilities Analysis and Rapid Visual Screening can help us accomplish our goal. The following chapter, Methodology, will explain how we used these assessment tools to accomplish our objectives.

III. METHODOLOGY

The goal of our project was to assess the vulnerability created by replacement unit expansions and identify ways to mitigate the vulnerabilities through disaster resilient construction and education. To accomplish this goal we studied two villages, Ban Tub Nua and Ban Hat Sai Khao, in the Ranong Province of Thailand that were devastated by the 2004 tsunami. In the course of our research, we answered the following research questions:

- What are Thai villagers' perceptions of vulnerability towards natural disasters' effect on unit expansion?
- What changes are Thai villagers making to their units and what building methods, styles, and materials are they using?
- What are the reasons or needs for expansion of the replacement units?
- Where do Thai villagers get information about construction and building styles?

We developed a vulnerability assessment of the villagers' perceived vulnerability, a Rapid Assessment of the vulnerability of the unit expansions, semi-structured interviews and focus group questions to use in our case study.

3.1 Case Study

Our goal was mostly obtained through on-site field work. We performed a case study of two coastal villages to assess the residents' vulnerability to natural disasters. The two villages we studied, Ban Tub Nua and Ban Hat Sai Khao, were in the Suk Samran District of Tambon Kam Phuan, in Ranong Province.We selected these villages with the guidance of our contact working in the area, Chris Dunbar, Field Supervisor of the USAID Post-Tsunami Sustainable Coastal Livelihoods Program. We explained the goals of our project and he suggested these two villages because of their differences. The villages were of different religions; Ban Tub Nua was Muslim and Ban Hat Sai Khao was of mixed religions, but was primarily Buddhist (Dunbar, 2006). Ban Tub Nua spoke a different dialect of Thai which required us to use a second translator, a volunteer from the

village. Ban Hat Sai Khao was working with another organization to retrofit their homes and had been relocated.

3.1.1 Ban Tub Nua

We specifically studied Hat Prapat, the redeveloped settlement on Prapat Beach. This area in Ban Tub Nua was comprised of 69 houses, all of which were completely destroyed by the 2004 tsunami (Pongquan, Crawford, Saengkaew, & Tansakul, 2005). The Royal Thai Air Force constructed 51 permanent houses and the Christian Foundation constructed 3 permanent houses after the disaster. This village has residents in both highland and lowland areas. Most of the area in the lowlands is located in the Lam Son National Park. Village residents in the park do not have land titles because of their location, but they do have the right for temporary land use. After the tsunami, villagers had no records to prove that they owned the land they used to live on (Kessler, 2006). Villagers had the option to take the replacement house provided to them by the Royal Thai Air Force in a designated location, or relocate to another village where it was uncertain if they would receive assistance from the Thai Government.

3.1.2 Ban Hat Sai Khao

This village was relocated to an unaffected cashew plantation about a half mile inland (Dunbar, 2006). Out of the original 120 houses in Ban Hat Sai Khao, there were 58 houses that were completely destroyed and 8 houses that were damaged by the tsunami (Pongquan, Crawford, Saengkaew, & Tansakul, 2005). The Royal Thai Air Force constructed 50 permanent houses and the Christian Foundation built 11 permanent houses at the new location during the immediate relief effort. There are currently 115 houses in this village that are located entirely in the Lam Son National Park. Like in Ban Tub Nua, village residents do not have land titles, and were faced with the same challenges.

3.1.3 On-site Data Collection

We used a purposive sample, "to ensure that certain types of individuals or persons displaying certain attributes [were] included in the study," in all of our individual interviews in each village (Berg, 2001, p. 32). We chose to interview homeowners that had expanded their replacement unit. There were no criteria for the people who participated in our focus groups because the purpose was to gain an understanding of the community's perception of risk.

We conducted a focus group in each village with about fifteen participants each (see Appendix D for Ranong Province Trip Itinerary). On our second and third days of research, we conducted interviews at four homes in each village. During interviews, neighbors would join the discussion to add their thoughts and concerns. There was an average of four people participating at each home we interviewed. We stopped interviewing when trends emerged in the responses we received from both the focus groups and interviews.

We recognized that the area of our study has been over-researched. To thank villagers for providing us with the information we needed, after each interview we gave them handouts on safe building techniques and flooding that they could use to improve their replacement houses (see Appendix H for Ranong Province Trip Handouts). We compiled the handouts on safe building techniques from other books on disaster resilient construction. They consisted of pictures and a small amount of instructional text that we had translated into Thai. The handbook on flooding, already in Thai, was provided to us by our sponsor, the Asian Disaster Preparedness Center.

Our translator was an ADPC employee with background knowledge on disaster preparedness. This helped potential validity issues because she was familiar with similar projects. We worked closely with our translator before and during the site visit to make sure the questions were asked in the way they were intended to be.

3.2 Assessment Tools

We performed archival research, observation, individual semi-structured interviews, focus groups, a Perceptions of Vulnerability Assessment and a Rapid Assessment of the physical vulnerability of unit expansions to obtain information related to our research questions. We developed the Perceptions of Vulnerability Assessment from the Capacities and Vulnerability Analysis (CVA) to use to determine the villagers' perceptions of vulnerability to natural disasters. The Rapid Assessment was developed from Rapid Visual Screening (RVS) and other Rapid Screening Procedures (RSP) to use as a data collection tool and to compare to the Perceptions of Vulnerability Assessment. While these assessment tools are intended to be widely applicable, the context and scope of our project required us to adapt them to satisfy our specific needs.

3.2.1 Perceptions of Vulnerability Assessment

The method we used to assess the perceptions of vulnerability in our two case study communities was Capacities and Vulnerabilities Analysis (CVA), which has been used often in disaster preparedness and mitigation developmental programs (Cannon, Rowell & Twigg, 2003). CVA was appropriate for us to use because in the case of natural disasters, it is used to help NGOs determine the impact their interventions can have on the capacities and vulnerabilities of victims. CVA does this by involving the community.

We adapted the CVA method to satisfy our project's need for a perceptions of vulnerability assessment and included questions on perceptions of risk. "In some cases, as in vulnerability/capacity assessment exercises, risk perception may be formally included in the assessment process, by incorporating people's own ideas and perceptions on the risks they are exposed to" (International Strategy for Disaster Reduction, 2002). The perceptions of risk questions allowed us to determine what types of disasters or other hazards villages perceived as a threat. Also, by determining the community's perception of risk and vulnerability, we identified ways to reduce and mitigate their vulnerabilities.

The CVA Matrix (Figure 2, Background Section 2.5.1) helped us to develop semi-structured interview and focus group questions to determine the perceived vulnerability to natural disasters in the area (see Appendix A for Semi-Structured Interview Questions and Appendix B for Focus Group Questions). To understand the perceptions of the physical/material area of vulnerability, we asked villagers if they thought their addition would harm their house or their neighbor's house during a natural disaster. The perceptions of social/organizational vulnerability were found by asking villagers if they had a planned evacuation route and if it incorporated a way to get elder villagers and infants out in the case of another natural disaster. To understand the perceptions of the motivational/attitudinal aspect of vulnerability we asked villagers if they had done anything to protect their houses against natural disasters.

We analyzed the results of our vulnerability assessment through reviewing our notes from interviews and focus groups. We compiled all of our notes and created a spreadsheet with common responses (see Appendix E for Ranong Province Trip Interview and Focus Group Responses and see Appendix F for Ranong Province Trip Response Chart). We paid close attention to the categories of *Hazards* and *Safety of Addition* in the spreadsheet to determine the villagers' perception of vulnerability.

The perceptions of vulnerability that we identify from this vulnerability assessment were compared to the Rapid Assessments of the physical vulnerability. We used the assessment of physical vulnerability as a standard to compare the perceptions of vulnerability to. If the perception of vulnerability is high, it is more likely that villagers will take actions to reduce their vulnerability (Coburn, Sspence, Pomonis, 1994).

3.2.2 Rapid Assessment

To assess the physical vulnerability of replacement unit additions, we developed a Rapid Assessment framework. We developed our Rapid Assessment from the Federal Emergency Management Agency's (FEMA) Rapid Visual Screening (RVS) method for determining potential seismic hazards and other Rapid Screening Procedures (RSP). RVS was not appropriate for our direct use because it dealt only with seismic hazards and an original structure, not additions.

RVS lists the following as potential inspectors: professional engineers, registered architects, local building officials, emergency managers, building owners, and interested citizens (Rojahn & Poland, 1988a). In our Rapid Assessment we collected the data and refer to ourselves as the inspectors.

We used the general format of RVS and some of the categories for our worksheet. We included the inspector's name, the date of the survey, the age of the unit, a sketch of the area, the occupancy, a comments section and the same data confidence symbol.

The elements we changed included the address of the unit, the use of the building, the non structural falling hazards, and the instant photo. The units in the two villages do not have an address that includes a street name, city, state and zip code. We modified our address to be the lot number and village name. We were not interested in the use of the unit, but rather the use of the additions to the unit. We also narrowed RVS's list of nine possible uses to two, residential and commercial. RVS asked the inspector to only check a box that non-structural falling hazards existed. We decided to include a list of possible hazards, not just non-structural falling hazards. We used the *City of Redlands Study* and the *Charleston Survey* to develop and define the list of possible hazards (Rojahn & Poland, 1988b). The *City of Redlands Study* identifies ornamentation and chimneys as possible hazards. The *Charleston Survey* identifies chimneys and overhanging walls. Our complete list of *Possible Hazards* was: not symmetrical, chimney, overhangs, poor maintenance, ornamentation, and other. Instead of using instant photos, we used digital photographs and allotted space on the form to record the photograph number. Using digital photographs saved money and allowed a more complete review of the pictures.

We added several sections to our Rapid Assessment that were specific to our project and not found in other assessments we researched. We added the following categories to provide specific information we needed to assess the vulnerability of unit expansions, the reasons and needs for expansion and the building materials used: *Addition, Age of Addition, Does the Addition Touch the Unit, Addition Height,* a *Vertical Location Sketch, Addition Material,* and *Changes to the Surrounding Area*. We also added other categories that we thought would help us classify our results. These categories were: *Unit Type, Religion* and a symbol to identify if the information was provided by the resident.

We wanted to include all additions to the unit and changes to the lot so we included the *Addition* category to identify if the modifications were attached to the unit. Changes to the unit are considered additions. Structures like fences or outdoor cooking areas are not considered to be additions if they are not within one foot of the unit.

To determine how severe the necessity of the addition was, we needed to determine the *Age of the Addition* for comparison to the age of the unit. This also helped us determine how well the addition weathered. This required the inspector to ask the homeowner for this information, unlike most of the other categories that rely on observation. To clarify whether information was gathered from the homeowner or from observation, we used the dollar symbol ($) as a marker for information obtained from the homeowner.

It was also important to determine if the addition touched the unit. During a storm, impact from the addition and the replacement unit colliding can cause extensive damage (Rojahn & Poland, 1989). The *Does the Addition Touch the Unit* category allows the reader to choose between the addition being in direct contact with the unit (yes), the addition within one foot of the unit, and the addition being further than one foot from the unit (no).

Our Rapid Assessment also requires the inspector to estimate the height of the addition and sketch the location where the addition touches the unit. This is important to determine where the addition touches the unit vertically. If the addition meets at a point other than the second floor which is designed to resist horizontal forces, there will be more damage during a storm (Rojahn & Poland, 1989). The floor is already reinforced to support the weight of the residents and the structure; therefore it can sustain more force than a section of wall that is not reinforced.

The stability and durability of the addition can be determined through the materials used. We reviewed pictures from a village with the same replacement units as the two in our study and made a list of the materials used in the additions. We included this list on the Rapid Assessment so the inspector could easily circle the materials used. We included “other” as one of the choices incase there were more materials than the ones we observed in the pictures.

To account for any changes the villagers made that were not within one foot of the unit, the Rapid Assessment asks the inspector to determine if there are any *Changes to the Surrounding Area*. Examples of changes in the surrounding area are picnic tables, outdoor cooking areas, bathing areas, or free standing temporary housing. These changes cannot be excluded from our study because they still fulfill a need the villagers have, even if they are not attached to the replacement unit.

It was important to determine the *Unit Type* so we could sort our results by the type of unit if there were any variations. The Royal Thai Air Force built the units in the two villages we were studying. In case we encountered any other type of unit, there was an option to select other. If there were any variations it would be helpful to compare the types of additions made on different replacement units.

The *Religion* of the homeowner and the residents was not relevant to the vulnerability of the addition, but provided insight into the style of the addition. From interviews with professors of architecture at Chulalongkorn University, described further in Section 3.4, we learned the differences in traditional styles of Buddhist and Muslim homes. Any information we could learn about the influence of traditional architecture on the replacement unit expansions would be helpful in recommending a design for future culturally specific replacement units and expansions to current units.

The final Rapid Assessment Form consisted of nine multiple choice questions, seven questions that required the inspector to write two words or less, three sketches, two categories that needed a description and one picture. It takes 10-20 minutes to complete (see Appendix C2 for Rapid Assessment).

The analysis of our Rapid Assessment to determine the vulnerability of the unit expansions is also easy enough for any interested individual to complete. If there are any possible hazards, the addition is considered to be vulnerable. We did not define a measure or scale of how vulnerable the additions were because we were not comparing the physical vulnerabilities. We compared each addition's physical vulnerability to that resident's perception of their vulnerability.

This assessment tool was applied to first two research questions to determine perceptions of vulnerability and the changes villagers were making.

3.3 What are Thai villagers' perceptions of vulnerability towards natural disasters' effects on unit expansion?

We needed to understand the villagers' perceptions of risk to natural disasters and if they realized that the changes they were making to their homes could be increasing their vulnerability. We also needed to understand why villagers were making changes to their homes. We were interested to know if villagers were making changes to their replacement units to protect themselves from natural disasters or if they disregarded natural disasters altogether when making the decision to expand. We created a series of semi-structured interview and focus group questions using Capacities and Vulnerabilities Analysis to answer this research question.

We designed a series of semi-structured interview questions to assess the villagers' perceived vulnerability. We chose semi-structured questions so we could probe villagers for the information we wanted to discover and to be able to expand on a particular topic if a villager had many ideas he wanted to share. Our open ended questions allowed us to assess the community's perceptions without imposing our views. The individual questions we created for villagers let us discuss if they had done anything to protect their house from natural disasters, if they thought their addition could harm them or an adjacent house, and how much damage they thought their house would incur if a natural disaster struck in the near future (see Appendix A for the complete list of Semi-Structured Interview Questions).

The focus group questions led into a discussion of what villagers considered to be hazards in their community. We asked if they had done anything to protect their homes from these hazards and if they were prepared to deal with a hazard if it happened in the near future (see Appendix B for the complete list of Focus Group Questions).

To draw better conclusions about their view of risks and perception of vulnerability, we conducted a Rapid Assessment to determine physical vulnerability at each home we interviewed. If any potential hazard was found, the addition was considered to be vulnerable to natural disasters. If this addition was attached to the original structure, it would also increase the entire home's vulnerability.

We compared the analysis of their perception of vulnerability, described earlier, to their assessed physical vulnerability. If the perceived level of risk was low, we could conclude that this community was vulnerable because they had no perceived need or desire to learn ways to protect themselves. If the perceived level of risk was high, we could conclude that this community perceived themselves as vulnerable which could help us determine what resources the villagers needed to help themselves.

To determine what information villagers needed to know more information about to reduce risk, we analyzed the data from the interviews. After our interviews we compiled all of our notes and created a spreadsheet of the responses on the following topics: *Hazards, Efforts to Protect and Prepare, Information about Disasters and Safe Building, Additions, Reasons and Needs for Addition, Safety of Addition, Addition Cost, Financing, Old Homes,* and *Other (*see Appendix E for Ranong Province Trip Interview and Focus Group Responses and Appendix F for Ranong Province Trip Response Chart). We used this to find the most common responses and concerns for each topic. We paid close attention to the *Hazards* section of our analysis to determine what hazards were perceived as risks. This information helped us recommend which hazards villagers were most concerned about and which hazards they needed more information about.

The analyzed data shows how the community perceived itself, if they had the ability or desire to protect themselves from natural disasters and the priority level of safe housing in this village. This assessment led to finding on villagers' efforts to protect themselves from natural hazards. After determining their perceptions on vulnerability, we needed to find out what villagers were adding to their replacement units.

3.4 What changes are Thai villagers' making to their units and what building methods, styles, and materials are they using?

We needed to determine the changes Thai villagers were making to their units and what building methods, materials and styles they were using. This information was used to find similarities in the changes they were making so we could determine what information would be beneficial in helping the Thai villagers make safe additions. We performed archival research, semi-structured interviews with experts and villagers, and

performed a Rapid Assessment on the replacement units to determine the methods, materials and styles the villagers were using.

We performed archival research before our field work in Ranong to gain an understanding of Southern Thai architecture. We interviewed three professors of architecture from Chulalongkorn University, Pinraj Khanjanusthiti, Phongsakorn Yimsawat and Pracha Sangsayan. We learned of the differences between traditional Muslim and Buddhist houses and the materials used in the construction of both. We used this information to get an idea of building styles that existed in the area before the tsunami. This background information was helpful to determine if the style of addition they were building was similar to the style of their homes before the tsunami.

Other archival research we completed before our study in Ranong included an analysis of pictures from a similar village and the development of our Rapid Assessment. We practiced using our Rapid Assessment on pictures of another village with similar replacement housing before our study in Ranong Province.

During our case study, we performed Rapid Assessments in the field on all homes that we interviewed. The Rapid Assessment served this research question as a data collection tool. Data collected from the Rapid Assessments helped us find similarities in the types of additions that were built.

We categorized the information we wanted to gather in our field study into three different areas: the building method, the building style and the materials used. The building method used was important to determine the stability of the structure and as a guide of the level of construction the villagers were capable of completing. The style of the changes the villagers were making was important to determine their preferred style and if there was a style of addition in their village they were copying. The materials helped determine what types of materials were readily available in the area. By breaking the information we needed into these three categories it was easier to find similarities in the changes they were making to their replacement units.

In order to determine what building methods, styles and materials the villagers were using, we developed semi-structured interview questions. We conducted semi-structured interviews with the villagers to determine who built the addition, where they got the materials, how much they paid for them, how long construction lasted and how

they decided upon the style (see Appendix A for complete list of Semi-Structured Interview questions). To analyze this research question, we looked for similarities in the *Addition* section of our Ranong Province Trip Response Chart (Appendix F and see Appendix G for the Rapid Assessment Results Chart).

The information found through this research question led us to conclusions about the additions villagers were making to their units and how they were making them. After determining if villagers perceived themselves as vulnerable to natural disasters and identifying the changes they were making to the replacement units, we needed to see why they were making those changes and if the reason was to protect themselves against natural disasters.

3.5 What are the reasons or needs for expansion of replacement units?

Exposing the reasons for constructing unit additions reveals the gaps between the design of the replacement units provided and villagers' actual needs. By determining common needs in the village, we can recommend that NGOs design an addition that satisfies these needs.

To answer this research question we needed to find similarities in usage of additions. We conducted semi-structured interviews with villagers to determine the reasons and needs of the expansion. To determine the reasons of expansions, we asked if the addition was constructed to protect against natural hazards, if the addition was created to mimic the style of the owner's previous home, and if additions were designed to improve residential or commercial circumstances. To determine the needs of expansion we asked what purpose the addition served (see Appendix A for complete set of Semi-Structured Interview questions).

These questions were included in every semi-structured interview session with the homeowners of replacement units with additions. We analyzed the information gained from this research question using the same method we used to determine building methods, styles and materials. We looked for similarities under the *Reasons and Needs* section of our Ranong Province Trip Response Chart (Appendix F).

The reasons and needs for unit expansion inform us on why they are making additions and what they are used for. To determine how to help villagers make safe additions that suit their needs, we needed to identify and evaluate their current sources of information on disaster preparedness.

3.6 Where do Thai villagers get information about construction and building styles?

To successfully complete our project it was important to determine how NGOs should provide information to reach the people in need. Determining where villagers get information about construction and building styles pointed out sources of information already in place in the village. From this research question, we also gained knowledge on the level of reliability of current sources of information in the village.

In order to adequately determine how the villagers were obtaining information on construction and building methods, semi-structured interviews were performed. We asked if villagers modeled their additions off another community member's and if they knew who to get information from about disaster preparedness (see Appendix A for complete set of Semi-Structured Interview questions).

We used the same analysis method as the previous sections to look for similarities in sources of information so we could recommend one that could reach the entire community (see Appendix F for Ranong Province Trip Response Chart). We specifically reviewed the *Information about Disasters* and *Safe Building* section to identify if the current sources of information were spreading correct information on disaster resilient construction techniques and if there were any other sources of information. The accomplishments of this research question helped us to recommend who NGOs should direct information to so it would successfully reach the villagers who needed it.

3.7 Summary

From the analysis of our research questions, we learned what villagers perceived to be hazards in their community and if they considered themselves vulnerable to these hazards. We learned what villagers were changing about their replacement unit and what

building techniques they were using. The reasons and needs for expansion of replacement units were identified along with the reliability of available sources of information. Responses to our four research questions helped us to determine our findings and what information NGOs need to provide villagers to empower them to develop disaster resilient structures that suit their needs and reduce their vulnerability to natural disasters.

IV. FINDINGS & DISCUSSION

In this chapter we present three major findings that the responses to our research questions have led us to:

- The relief effort increased vulnerability;
- The villagers increased their vulnerability to catastrophic events;
- Disaster-affected people have done little to protect themselves against catastrophic events, but they are protecting themselves from other more common hazards.

These three findings will be discussed in the following sections.

4.1 The Relief Effort Increased Vulnerability

As mentioned previously, long-term factors that make a community susceptible to disaster or change its ability to cope with events are vulnerabilities (Cannon, Rowell & Twigg, 2003). The relief effort had increased the vulnerability of the villagers we studied by making the community more susceptible to hazards and by not providing the villagers with information to help them cope with the hazards they were now exposed to. The relief effort had made villagers dependant on outside help because they did not have the resources to change the way they coped with situations. Villagers relied on outside help to provide these resources.

We found that the relief effort increased the vulnerability of the communities we studied by making them susceptible to hazards. The housing provided by the relief effort did not eliminate the villagers' exposure to hazards such as sunlight and rain. In some cases, the relief effort increased the villagers' exposure to flooding and wind.

After the 2004 tsunami, the villages of Ban Tub Nua and Ban Hat Sai Khao received basic two-story housing built by the Royal Thai Air Force (see Figure 1, Section 2.1.1). This new housing was very different from the previous style in the village. The houses that existed in this village before the tsunami were generally one-story units that were built on sand and raised on stilts one to two feet off the ground. The replacement houses are two-stories. The bottom floor includes a bathroom and a kitchen and the

second floor has two bedrooms. Everyone interviewed mentioned at least one of the following problems with the replacement unit: it did not provide enough space for their families, protection from the sun and rain, and/or stability. The replacement units did not eliminate the exposure to hazards such as sun and rain and in the case of some hazards, such as wind and flooding, their susceptibility was directly increased.

Villagers in Ban Tub Nua and Ban Hat Sai Khao did not feel safe in their homes because they felt their houses are very unstable and they were not confident in the strength of the second floor. In both villages, participants in the focus groups explained how their units shook in the wind. Individual interview responses further established this as a hazard in the community (see Appendix F for Ranong Province Trip Response Chart and Appendix E for Ranong Province Trip Interview and Focus Group Responses). Villagers also said they did not feel safe on the second floor and worried that it would collapse. One respondent attributed the lack of stability of the unit to its height off of the ground. Villagers' previous homes were only raised one to two feet off the ground. The height of the replacement unit and other factors that affect the stability of the structure, such as poor quality of materials and poor building techniques used in the villages studied, made the villagers more susceptible to the effects of wind storms.

The relief effort created another problem in the two studied villages: flooding. Ranong Province has an eight month long rainy season and receives more rain than any other province in Thailand (Dunbar, 2006). The housing that existed before the tsunami was built on sand, which allowed for permeation water and for natural drainage to occur. The replacement units are built on a clay-based fill, which is impermeable and does not absorb water like sand. Another factor that added to the flooding was the lack of a drainage system. This community now has problems with flooding that they never had before. Figure 3 illustrates a collection of water after a light rain (Kessler, 2006). During heavy rains, the amount of flooding is more severe and water collects in the first floor. One respondent in Ban Hat Sai Khao from lot 38 (see Appendix J1 for Ban Hat Sai Khao Village Map) described how water from the street flowed through her house to a canal behind it. If the entire unit was raised and a drainage system installed, this problem may not be so great. The relief effort had directly made these communities and homes susceptible to flooding.

Figure 3: Water collection after light rain

The locations and layout of the villages established by the Royal Thai Air Force also affected villagers' vulnerability. The village of Ban Tub Nua was reconstructed in the same location it was prior to the tsunami. The village of Ban Hat Sai Khao was relocated to an unaffected cashew plantation about a half mile inland. The houses in both villages were built in straight, parallel rows which are not recommended because wind may be forced between the houses during a storm, increasing its momentum and speed (Seraj & Ahmed, 2004; see Figure 4). Building in compounds and planting trees can lessen this problem. Similar to the problem with the clay ground, the relief effort directly increased their vulnerability because they used methods that are not recommended and cause adverse affects. The units are now permanent and the villagers do not have the ability to fix these problems.

Figure 4: A view of the parallel rows in Ban Tub Nua

An unidentified organization addressed some of the hazards the relief effort had exposed villagers to in Ban Hat Sai Khao. The organization strengthened the floors, replaced the wall boards and provided additions to almost every house in Ban Hat Sai Khao (see Figure 5). While this organization reduced the exposure to some hazards, it did not provide villagers with information to solve problems themselves. They increased the villagers' dependency on outside help by only providing a physical solution to the problem instead of providing information. Providing information would increase the villagers' ability to cope with these problems which in turn would reduce their vulnerability.

Figure 5: An example of a provided addition in Ban Hat Sai Khao (on right)

We found the villagers we studied did not have sufficient information and skills to cope with the problems the relief effort had caused. Villagers studied were building additions to their houses that satisfy basic living conditions and protect against hazards. The additions reduce their exposure to hazards like sun and rain but are increasing their susceptibility to catastrophic disasters. The villagers are reliant on outside help to cope with these problems because they do not have the information to solve these problems themselves. The relief effort has hindered the villagers' ability to cope with these hazards and therefore directly increased the villagers' vulnerability by not providing them with information on disaster resilient construction.

The villagers were not involved in the design process of their replacement houses. They had no input into what their new home was going to include, the way it was built or where it was built. The difference in the design between the housing that existed before the tsunami and the replacement housing, and lack of community involvement left villagers without an understanding of how to properly maintain, fix or change their home. From this, a dependency on outside help was created.

The organization that provided additions to houses in Ban Hat Sai Khao also did not include the villagers in the design process (see Figure 5). This will most likely cause

the same problems that the original replacement unit caused: a lack of knowledge to fix their houses and dependency on outside help.

The villagers we studied were building additions to their homes with little or no information and skills on disaster resilient construction. Six of the eight households interviewed had built their own addition. The other two households had hired contractors to build their additions, and both households said they still had problems with flooding. No villagers interviewed had received any information on disaster resilient construction, and the lack of disaster resilience in the additions built by contractors leads us to believe that professional builders are not being provided this information either.

The villagers we spoke with had a desire to make their additions safer. The focus group participants in Ban Tub Nua were interested in knowing more about safe building techniques (see Appendix F for Ranong Province Trip Response Chart). Also, the fact sheets we gave to villagers on safe building techniques and flooding were well received. Villagers passed them around and read them while we were still there. The villagers are eager to have the ability to cope with the frequent problems they have and protect against future hazards, but do not have the information to do so.

The methods of disseminating information on disaster preparedness in the villages were not working. The local government and NGOs working in the area have village representatives to spread information on disaster preparedness. The villagers in the focus group in Ban Tub Nua said they did not know who their village representative was and said that they learned about disasters from experience, not from another person (see Appendix F for Ranong Province Trip Response Chart). Any information on disaster preparedness techniques that this individual should have been relaying to the villagers was not occurring. It is uncertain whether this individual was not fulfilling his duties of disseminating information or if he does not have any information to give to villagers. Further research should be done to identify the cause of the lack of communication.

The relief effort caused the villagers to be dependant on outside help by creating circumstances that they could not fix and by not providing them with information that would empower them to fix their problems. It is impossible to change the layout of the village to reduce the wind problem. They also do not have the capacity fix their flooding problem and install a drainage system without the aid of outside experts. The relief effort

had directly increased the vulnerability of villagers by exposing them to hazards and not providing them with information and skills that could change their ability to cope with hazards. Providing this information will change their ability to respond to events and reduce their vulnerability.

4.2 The Villagers Increased Their Vulnerability to Catastrophic Events

The relief effort had indirectly increased the vulnerability of the villagers studied by not meeting their needs. The villagers then increased their own vulnerability by making unsafe additions.

We have found that villagers increased their vulnerability to catastrophic events by making additions to their units to suit their needs and provide protection against regularly occurring hazards. The replacement units the relief effort provided Ban Hat Sai Khao and Ban Tub Nua with did not give them enough space or protection against natural hazards. It was necessary for the villagers to make additions to suit their needs and wants.

Sixty-seven out of ninety-two houses we studied in Ban Tub Nua and Ban Hat Sai Khao had open and closed additions (see Appendix I2 for Ban Tub Nua Assessment and Appendix J2 for Ban Hat Sai Khao Assessment). Open additions had a roof and no enveloped walls and closed additions were completely enclosed by walls. Few villagers with enough money had hired external contractors to make the additions; out of the eight households interviewed, two had stated they had done this. The majority of additions were built by the homeowner themselves (see Appendix E for Ranong Province Trip Interview and Focus Group Responses and Appendix F for Ranong Province Trip Chart).

The additions homeowners had built increased their vulnerability to natural disasters. Of the eight households we completed Vulnerability Assessments and Rapid Assessments on, seven of the additions had obvious potential hazards which classify it as vulnerable.

In the focus group conducted at Ban Tub Nua, villagers explained how they had built additions in parts, depending on their current finances (see Appendix E Ranong Province Trip Interview & Focus Group Responses). Villagers built until they ran out of

money, leaving the additions partially finished (see Figure 6). While villagers saw no problem with this process, these unfinished additions have an even higher vulnerability than a completed one because unfinished walls do not bear loads properly (Dalgliesh, 1995).

Figure 6: A cement wall addition in the middle of construction

The villagers we studied knew that the additions they built were unsafe. When we asked villagers in our study if they thought their addition could harm themselves or their neighbors during a natural disaster, two village interviewees stated yes, but that the need for space was more important to them and the risk was worth taking (see Appendix E Ranong Province Trip Interview & Focus Group Responses).

From the data collected it is clear that these communities contributed to their vulnerability to natural disasters. They found their own ways to cope with problems the relief effort left behind. While the additions they made protected them from regular hazards, they also increased their vulnerability to catastrophic events.

4.3 Disaster-affected people have done little to protect themselves against catastrophic events, but they are protecting themselves from other more common hazards

The additions the villagers had made to their replacement units were intended to protect against rain, sun, or wind shaking their house. Villagers realized that these additions were unsafe and potentially increased their vulnerability to catastrophic events, but had done little to fix this because they did not have the resources or knowledge to do so.

We found villagers had done little to protect themselves against catastrophic events, but they were protecting themselves from other more common hazards. The villagers we studied were focused on dealing with daily and seasonal problems, like wind, rain and sun. This was perhaps because villagers felt they have the capacity to solve these problems.

Even though the villagers we studied were focused on regularly occurring hazards, they are concerned with all types of hazards. When asked to identify hazards in their communities during focus groups, the compiled list from both groups included: flooding from the lack of drainage, rain coming into their home, lack of stability of the replacement unit, storm surges, landslides, a shallow canal, shortage of water tanks, dust coming into their house, garbage disposal, less protection from the amount of sand lost from the tsunami, and another tsunami.

The villagers we studied were only protecting themselves against regularly occurring hazards because it may have been the only thing they felt they had the capacity to do. The hazards villagers were protecting themselves from were: lack of stability of their houses, rain coming into their houses, and sunlight. They were solving these problems respectively by expanding the bottom of the unit to provide more stability, covering windows with plastic sheeting and installing awnings onto the sides of the house.

When asked if they were doing anything to protect their homes from disasters, villagers in both focus groups said they did not know how to protect their homes. Protecting their homes from rain, sunlight and wind shaking their unstable homes were

actions the villagers had the capacity to do. Villages may not perceive themselves as capable of protecting their homes against catastrophic events.

The villagers have the capacity and desire to protect themselves if they are given directions and resources. During focus groups, we asked if villagers had done anything to protect their community against natural disasters. Focus group participants told us they planted mangrove trees, which are known to reduce wind and catch debris during a natural disaster. The villagers in the focus group in Ban Hat Sai Khao explained that this was the only thing they knew how to do to protect themselves. In Ban Tub Nua, villagers in the focus group thought this would help protect them because the majority of the mangrove trees in the area survived the tsunami (see Appendix E for Ranong Province Trip Interview and Focus Group Responses). USAID, an NGO working in the area, stated they initiated the mangrove project and provided the resources needed. Villagers may have planted mangroves because they were provided with resources and the goal seamed attainable. The villagers may have perceived this project as something they had the capacity to complete.

Villagers want to do more to protect themselves against catastrophic events, but may feel they do not have the capacity to do so. During focus groups, villagers were asked if they had an evacuation plan for a future tsunami or other natural disaster. The villagers had a general idea of how to evacuate but they did not have a set plan. The residents of Ban Tub Nua did not have a direct evacuation route. The only road out of the village runs parallel to the coast for about half of a mile before turning away towards higher ground (see Figure 7). The villagers mentioned that they wanted a new road that is a direct exit from the community, but they had no plans to construct this road. This is evidence that they were concerned with catastrophic events, but constructing a road is something they may have not felt they have the capacity to complete.

Figure 7: This is the only road out of Ban Hat Sai Khao. The ocean is located to the right of the road, approximately fifteen yards behind trees at high tide.

Those in charge of the villages did not see natural disasters as a current concern. The village chief of Ban Hat Sai Khao told the village disaster preparedness representative that a hazard map of the village did not need to be completed because, referring to natural disasters, “nothing has happened yet” (Ban Hat Sai Khao Livelihoods Program Village Representative, 2006). Hazard mapping is an activity to identify the locations of potential hazardous events or physical conditions (Noson, 2002). After the community becomes aware of potential hazards, plans can be made to protect themselves. It is difficult for the villagers of this community to protect against catastrophic events without the support of the village chief. It is this lack of concern and preparedness that increases the vulnerability of the village to natural disasters.

The changes villagers were making to their replacement units were not to protect against catastrophic events. The additions were to protect from frequent problems in Ranong Province: sun, wind and rain. These additions were made of readily available materials and were built with simple construction methods. There are two possible reasons that may explain why villagers were not protecting themselves against catastrophic events. The first is that villagers may not have felt they had the capacity to protect themselves against these events. The second is that villagers may not have cared

whether they were capable to protect themselves or not, rather they were unconcerned with catastrophic events in general and did not feel that it is necessary to implement preventative measure against them. More research needs to be done to identify why villagers were not protecting themselves against natural disasters, but it is clear that they had done little to protect themselves by this point.

4.4 Summary

The relief effort had directly and indirectly affected the vulnerability of the villagers we studied. It had directly increased their vulnerability by exposing them to hazards and by not providing them with sufficient information to cope with these hazards. As a result of this exposure and lack of information, villagers were adding on to their units. Their additions were protecting them from common hazards, something they may have felt they have the capacity to do, but were not protecting them against catastrophic events. Mitigation is necessary to raise the villagers' capacity and empower them to reduce their vulnerability. Our recommendations to reduce vulnerability through the mitigation approaches of disaster resilient construction and education are described in the following chapter.

V. SUMMARY

The goal of our project was to assess the vulnerability created by replacement unit expansions and identify ways to mitigate the vulnerabilities through disaster resilient construction and education. We identified the vulnerabilities created by replacement unit expansion in our findings. In this chapter we will present our recommendations on how to mitigate the vulnerabilities using disaster resilient construction and education.

Something that is apparent in all of our recommendations is the importance of education and implementation of disaster resilient construction. This is the mitigation approach we recommend to reduce the vulnerabilities of replacement units and their expansions. All of our recommendations are directed towards non-governmental organizations (NGOs).

The recommendations directed to NGOs on how to prevent future vulnerabilities can be applied to any disaster-affected area in the world. Though the wants and needs of the people affected by a disaster may be different in different locations, the problems they face are the same; if the relief effort does not include future residents in the design process of replacement houses, it can increase their vulnerability to potential natural disasters. This is a global problem. If the vulnerability is not decreased, it puts disaster-affected people worse off than they were before the disaster when they built their own homes. The recommendations we suggest are intended to reduce this vulnerability.

We organized our recommendations by time scale into two categories: to prevent future vulnerabilities and to reduce current vulnerabilities. Recommendations to prevent future vulnerabilities are directed to improve future relief efforts. If these recommendations are implemented, they can minimize the current problems exhibited in the villages studied. Recommendations to reduce current vulnerabilities address the immediate needs of the villagers in Ban Hat Sai Khao and Ban Tub Nua. The implementation of our recommendations to reduce current vulnerabilities can solve the need for space and the current problems with the replacement unit. These recommendations can also be applied in situations where our recommendations to prevent future vulnerabilities were not applied.

5.1 To Prevent Future Vulnerabilities from Replacement Unit Modifications in Communities Impacted by Natural Disasters

We found that the relief effort increased the vulnerability of the people it is trying to help by not involving the community in the design or construction of replacement units. It is preferable to involve the community in the design of the initial replacement unit, but if this cannot be done, the community needs to be provided with safe designs for appropriate additions in a timely manner. The recommendations provided in this section are ways to prevent future vulnerabilities from increasing as a result of the relief effort.

5.1.1 Involve the Disaster-Affected Community

It is crucial that the community is involved in the design and construction of replacement units to prevent future vulnerability. Involving the community will help to create designs that are suitable to residents' needs and will empower residents to be able to fix or change the replacement unit in a safe way if the desire exists.

We recommend that in the event of a future disaster, affected communities be included in the design process of replacement units so they are suitable to the villagers' needs. Our results showed that villagers felt alienated in their homes. The replacement units were not similar to the style of homes they had before the tsunami, and because of this, they do not know how to solve daily problems. The unit had made them vulnerable to problems like flooding, lack of stability and rain entering their houses. Involving the community in the design process will decrease their dependency on outside help to solve their problems because they will know how their house was built and how to fix it.

Replacement housing should be stable, provide a comfortable amount of space and protect from everyday hazards. It is important that disaster-affected residents feel safe and comfortable in their new home. The replacement unit should be structurally stable and be able to withstand and provide safety from natural hazards that are prevalent in the area. If the replacement housing provided these basic needs initially, it is less likely

additions would have been made for these reasons, and the villagers would not have increased their own vulnerability.

NGOs should also do research on the style of house that existed before the disaster occurred and identify components of previous houses that residents need or want incorporated into the new design. To research types of daily hazards that exist in the area, NGOs can adapt and apply our Focus Group questions and our *Perceptions of Vulnerability* questions in our Semi-Structured Interview questions (see Appendix A).

To apply this recommendation to other disaster-affected regions, NGOs should directly ask the disaster-affected future residents what they need to live comfortably in a home. Community participation is crucial when trying to design a home for another person, especially if the prevalent building styles and materials in the area are unfamiliar. To prevent unsafe additions from being built that may increase the vulnerability of the house, community participation should be included in the design process. We recommend the community involvement methods of Participatory Rural Appraisal be researched (see Background Section 2.4.2.2). Further research may be needed to find the most appropriate process for the area. This recommendation will help provide a house that is both culturally appropriate and suitable to residents' needs and wants.

We recommend that disaster-affected people be involved in the safe construction of replacement units. By observing and participating in the construction of new homes, residents will learn the safe building methods used. This knowledge will give residents the skills necessary to safely build additions to their homes if needed or wanted in the future. This will provide residents the capability to help themselves solve problems, will not create a dependency on outside help, and therefore will not increase their vulnerability.

5.1.2 Solutions for When the Community cannot be Involved

If the future residents of replacement units cannot be involved in the design process, **we recommend plans for safe culturally appropriate additions are distributed to villagers in a timely manner (less than three months after construction).** Our results showed that on average, the villagers we studied started to

build additions to the replacement units three months after they were provided. If research cannot be done before replacement units are built, NGOs should inform residents that they are returning with safe designs and suggest that they wait to build additions until then. This would prevent residents from building unsafe additions that increase their vulnerability to natural disasters.

NGOs should research the community using a participatory process, as described in the previous recommendation. NGOs should also do research to find a reliable source of information in the village to disperse safe designs to by adapting and applying our set of *Where they Get Information* Semi-Structured Interview questions (see Appendix A). If there is no reliable source of information found, the addition designs should be provided directly to the replacement unit residents to ensure that they reach their audience.

We recommend a simple and structurally safe shelter be provided to disaster-affected people as a 'starter' unit that can be safely added to by the resident when appropriate as another possible solution**.** This 'starter' unit will be the first phase of a multi-phase process that will result in a complete and structurally safe house in a few years (Kessler, 2006). The 'starter' unit should be a safe enclosed shelter that can provide protection from common hazards in the area. Residents will be able to make safe additions to complete their houses when their budget allows. There should be resources easily available to residents, whether it is building materials or a loan program, to aid them in building additional phases to their house.

This recommendation would allow relief organizations to spend the majority of the money supplied to them on ensuring the replacement units provided are structurally safe, instead of spending money on details that residents can easily add themselves or may not want. Though the replacement unit will technically be unfinished, it will be beneficial for residents to be able to personalize their house, and have the liberty to build what they want. This process will empower residents to make changes and fix problems alone, and will steer away from the dependency and vulnerability that the relief effort typically causes.

5.2 To Reduce Current Vulnerabilities in the Two Villages

We found that the relief effort had increased the exposure of the villages studied to flooding, effects of rain and sun, and wind. Information on how to reduce these vulnerabilities should be provided to residents as soon as possible. We also found that the replacement units provided to the villagers were not built to suit the residents' needs or built with disaster resilient construction techniques. NGOs should design solutions that will improve the original replacement unit and design safe additions that are culturally appropriate. This information should be disseminated to residents as soon as possible to prevent further unsafe additions from being built and increasing the vulnerability to natural disasters.

5.2.1 Identify Problems with the Replacement Unit and Ways to Disseminate Information

Before replacement unit expansions can be improved, the original replacement unit should be fixed. Problems with the replacement unit should be identified by NGOs through interviews with residents. With the input of residents, solutions for these problems should be developed incorporating disaster resilient construction techniques and disseminated to reliable sources. The following recommendations are applicable to the villages we have studied and their current problems.

We recommend that a plan to stabilize the replacement units be developed and disseminated to villagers. Villagers were concerned about the stability of their replacement unit and indicated that in moderate wind, their replacement units shook. Some interviewees said the reason they had added on to their replacement unit or would add on to their unit was to stabilize it. Developing a plan to stabilize the replacement units will prevent villagers from building unsafe additions onto their units to solve this problem and decrease their vulnerability.

We recommend that methods of flood proofing be provided to villagers and a drainage system be installed in the community. Our research showed that flooding was a common problem during the rainy season. Flooding was a new problem for villagers

because the replacement units were built on clay based fill instead of sand. This factor along with the lack of a current drainage system created frequent problems during the rainy season. Villagers said they used buckets to bail water out of the first floor of their homes. Flood proofing replacement units and the implementation of a drainage system will allow the space on the first floor to be used more effectively and reduce the villagers' vulnerability to flooding.

We recommend that methods of rain proofing the replacement units be provided to villagers. We found that villagers were concerned with rain coming into their homes. During the rainy season, precipitation and strong winds caused rain to enter the replacement structure horizontally. The wooden ventilation slits along the side of the replacement structures allowed adequate ventilation in the hot, dry season, but allowed rain to enter the unit during the rest of the year. Rain coming into the second floor formed puddles and was causing the floor to quickly rot and mold. Villagers attempted to solve these problems by placing tarps around the side of their house, but admitted that was not entirely effective. Providing villagers with methods of rain proofing will address the problem of rain coming into the house, prevent further damage to the floor and decrease their vulnerability.

We recommend that a plan to strengthen the floor be developed. We found that villagers were not using the second floor to its full potential because they were worried about the structural integrity of it. The integrity of the original replacement unit floors were a concern, but the extra variable of rain was compounding the problem. Large mold and water marks could be seen and were pointed out by residents during interviews. This problem will be helped by methods of rain proofing, but this only addresses one factor of the problem. The strength of the original floor still needs to be addressed. Developing a plan to strengthen the floor will allow for the space to be used efficiently and will decrease the unit's vulnerability. It is most important that this recommendation is implemented in Ban Tub Nua because Ban Hat Sai Khao has already strengthened their floors through an outside organization.

We recommend that information on disaster resilient construction be disseminated directly to villagers. Our results showed that villagers had little or no information on disaster resilient construction available to them. Villagers had a limited

understanding of disaster resilient construction and had not constructed their additions to protect against catastrophic events. One reason this was occurring was because information on disaster preparedness in general and disaster resilient construction in particular was not being provided. The process of using village representatives to spread information was inadequate. By directly providing villagers with information, NGOs can be assured that the information that will reduce vulnerabilities through disaster resilient construction is reaching their audience.

5.2.2 Design Safe Culturally Appropriate Additions

After problems with the original replacement unit have been solved, a design for a safe culturally appropriate addition should be disseminated as soon as possible. NGOs should research past building styles in the area or additions that have been made to replacement units to provide a safe design that will suit the needs and wants of the residents.

We recommend that safe building techniques for open additions be developed and provided to villagers. Our results showed that villagers had built open additions to block the sun and rain. Villagers designed and built the additions themselves and used their own money to buy the materials. Some were constructed out of organic materials that degrade quickly, while others were constructed with more permanent materials. Some of the open additions we observed were not properly secured in the soil or to the unit. Disaster resilient construction was not a factor in the design of the additions.

The materials used in the safe design for an open addition should be readily available and low cost. The design should be easy for villagers to understand and build. Further research should be done on the most common size and location of open additions to better suit the community's needs and wants. Providing safe building techniques for open additions will reduce the vulnerability of unit additions to natural disasters and reduce their exposure to common hazards.

We recommend that a design for a safe closed addition be developed and provided to villagers. Our research showed that villagers had built closed additions to

their units to get more space even though they knew the additions that were built were not safe. We also found that villagers were interested in learning about safe building techniques. Providing only a list of materials and building techniques may cause errors in interpretation. A specific design for a safe closed addition would be well received in the villages.

The materials used in the safe design should be readily available and low cost, and the design should be easy for villages to understand and build. Further research should be done on the most common size and location of closed additions to better suit the community's needs and wants. Providing a design for a safe closed addition will also reduce the vulnerability of unit additions to natural disasters and reduce their exposure to common hazards.

5.2.3 Implement Safe Designs

NGOs should research the best way for safe designs to be implemented in a community. The availability of resources should also be studied, to ensure that the safe addition can be afforded by the majority of the community.

We recommend that a safe addition be built onto a community facility as a model for villagers to replicate. Our results showed that many villagers replicated their neighbor's design for their own addition. Building a full scale model addition on to a community facility in each village will serve two purposes: 1) villagers will be able see and learn the safe building techniques used in the construction; and 2) villagers will have this model available to replicate whenever they have time or the budget to do so. To avoid jealousy in the community, the addition should be built onto a community facility, not a resident's house. This recommendation combines the mitigation methods of education and disaster resilient construction in a medium that will be well received in the community. A model of a disaster resilient unit will provide villagers with the resources they need to reduce their vulnerability.

We recommend that a loan program be established so disaster resilient additions can be completed in one phase. We found villagers were building their permanent additions in phases depending on how much money they had. Leaving

additions partially finished increases its vulnerability to natural disasters. A loan program would allow villagers to borrow enough money to build their addition in one phase.

5.3 Conclusion

The recommendations provided in this chapter are intended to decrease the vulnerability currently being created in disaster-affected areas around the world by relief organizations. It is important that organizations trying to help do not inadvertently weaken communities because of an inadequate process. Community involvement is essential to the success of long-term recovery from a natural disaster. Another crucial aspect to the sustainability of a recovering disaster-affected community is the education of disaster mitigation techniques, like disaster resilient construction. If the community is not informed of how to help themselves after a disaster strikes, the community will become dependant on relief organizations for help and increase their vulnerability to natural disasters. Integrating mitigation approaches into long-term plans will effectively reduce the vulnerability of a disaster-affected area to another disaster.

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VII. APPENDIXES

APPENDIX A: Semi-Structured Interview Questions

Types of Questions:
Building Methods
Perception of Vulnerability
Reasons or Needs for Unit Expansions
Where They Get Information

1. *Why did you add on to your house?*
    a. *What purpose does your addition serve?*
    b. Do you think your addition will harm you or your neighbor during a natural disaster?
    c. Have you done anything to protect your house and/or addition in case of a natural disaster (flooding, cyclones)?
        i. Are you concerned about flooding, typhoons, earthquakes or tsunamis?
            1. If answered more than one: can you rank these?
        ii. If a flood or cyclone occurred do you think your house would have no damage, some damage, or be destroyed?
            1. If some damage, what kind of damage do you think it would be?
            2. Do you think your would have to completely rebuild it?

2. Who built your addition?
    a. If you did not build the addition: Who did?
    b. If you did: Who taught you how to build an addition?
        i. Did you learn from a book or other material provided to you?
            1. Which ones?
        ii. Did you learn from a person?
            1. Who?
            2. Why were you influenced by this person or book?
        iii. Did anyone make suggestions about which kind of additions would be more appropriate for making your house more resistant to damage from natural disasters?
            1. What did they say to do?
            2. Did you take their advice?
                a. Why or why not?
    c. How long did it take you to complete construction on your addition?

3. Where did you get the building materials?
    a. Did you have to pay for these?

i. If so: how much?
ii. Would you pay more if it meant your addition would be resistant to typhoons, floods, earthquakes or tsunamis?
1. If yes, to more than one rank order of importance.

4. How did you choose the building style for the addition?
    a. Why does the addition have the form it does?
        i. Does it look like your old house?
        ii. Did you model this addition off another one you have seen in the community?

5. When did you start building the addition?
    a. How long did you live in this house before you built the addition?
    b. If changes were made recently, why did you wait until then to make changes?

6. What did you like about the house you had before it was destroyed by the tsunami?
    a. Did the new house have these features when it was built?
        i. If no: Is that what you added to your house?
    b. What did you not like about this house?
        i. Why?

7. What improvements would you like to make to the house in the future?
    a. If yes: why have you not done it yet?

8. <u>What do you know about the TAO community representatives for resilient communities?</u>
    a. <u>Have you participated in any of their programs</u>
    b. <u>Has anyone else given you information about natural disasters?</u>
        i. <u>Who was it?</u>
        ii. <u>What did they tell you?</u>

9. <u>Have you thought about what will happen if a natural disaster happens?</u>
    a. <u>Where will you go?</u>
    b. <u>How will you get there?</u>
    c. <u>Have you done anything to prepare for your evacuation?</u>

10. Would you like to show us around your house to see some of your additions we have talked about?
    a. If yes: Do you mind if we take pictures so we are able to refer back to them when we return?

APPENDIX B: Focus Group Questions

What are some things you think are hazards in your community?

If they don't say anything about natural disasters: What about natural disasters?

Do you consider them hazards in your community?

Have you done anything in the community to protect yourselves against natural disasters?

Have you done anything to protect your homes?

Have you made an evacuation plan?

Have you thought about where you would go?

Have you thought about how you and other community members would get there?

What about your elders and children?

Is this place ready for your arrival?

Is there enough food and water?

Have you made any hazard maps?

Can we see them?

Can you explain them to us?

APPENDIX C: Rapid Assessment

APPENDIX C1: Rapid Assessment Directions

Fill out the form attached. If you are uncertain of something place an asterisk (*) next to the response. If more explanation is required, use the back of the form. It is assumed that all information was collected from observation. If you talked to the occupants to determine any of the information please mark that information with a dollar sign ($).

Lot Number: If no lot number is available, please identify the location of the home by street or draw a map on the back.

Village: Please circle the village the unit is located in.

Date: Record the date of the survey in MM/DD/YYYY style

Unit Type: Specify the type of unit surveyed. It not military, circle other and record the type on the back of the form.

Addition: We would like to consider all changes that increase vulnerability to the unit. These include both additions to the unit and changes to the lot. Changes to the unit are considered additions. Structures like fences or outdoor cooking areas are not considered to be additions if they are not within one foot of the unit.

Number of Occupants: If the occupancy can be determined fill in box.

Age of Unit: If the age of the unit can be determined please write in box. If it cannot, leave blank. The age of the unit may be determined from local facilitators or contacts. The houses may be built at the same time or the style of the home may determine what phase of reconstruction the unit was built in.

Age of Addition: If the age of the addition can be determined fill in box.

Addition usage: Please try to assess whether the addition is used for residential or commercial uses.

Does the Addition touch the Unit: Is there direct contact between the unit and the addition? If there is direct contact circle “yes.” If the addition does not touch the unit, but is within one (1) foot, circle “within 1.’” If there is no contact, and it is not within one foot of the unit, circle “no.”

Height of Addition: Estimate the height of the addition (English/Standard units).

Religion: If there are visible signs of the religion of the occupants, mark the region. If not, leave the box blank.

Photo Number: Please record the digital picture number.

Brief Description of Addition: List any observations about the addition like the materials, the style, the usage or any other relevant information.

> *Example:* The addition is made of wood posts with tarps hanging between them on 3 sides. It is partially on the cement foundation of the unit and partially on dirt. It appears to be a storage area.

Sketch of Unit & Addition: Please make two rough sketches of the addition. An aerial view should show what side of the unit the addition is on. The elevation view should show the specifics of the addition and if there are any additions under the house (on ground level).

Possible Hazards: Circle any of the hazards on this list that apply. If you observe others, note them on the back.

Addition type: Document the type of material used. If the material is not timber, bamboo, leaves, canvas, aluminum or concrete, write on the back.

Vertical Location: Please draw a more detailed elevation view of the area between the unit and the addition. Estimate the space between the addition and the building (in English/Standard units) if they are not in direct contact. Pay close attention to and mark the location of the floors of the unit and the addition.

Are there any changes to the surrounding property: Please identify any changes to the area around the unit.

> *Example:* There is a picnic table and outdoor cooking area on the left side of the house. The arrow (←) on the map identifies its location.

APPENDIX C2: Rapid Assessment

Lot Number:		**Village** (circle)**:** Tub Nua Sai Khao	**Date:**	**Inspector's Name:**	
Unit type: Military Other	**Addition:** Yes No	**No. of Occupants:**	**Age of Unit:**	**Age of Addition:**	
Addition use: Residential Commercial Other	**Does the addition touch the unit?** Yes within 1' No		**Addition Height:**	**Religion:** Buddhist Muslim Other	**Photo #:**
Brief Description of Addition (materials, usage, etc.):					
Sketch of Unit and Addition: Aerial: Elevation:				**Possible Hazards:** Not Symmetrical Chimney Overhangs Poor maintenance Ornamentation Other	
				Addition Material: Timber Bamboo Leaves Canvas Aluminum Concrete Other	
				Vertical Location:	
Are there any changes to the surrounding property? yes no If yes please explain: **Please record comments, observations, &explanations of "other" on the back of this form**					

Place an asterisk (*) next to information you (the inspector) are not certain of.
If the information is from the resident mark with a dollar sign ($)

APPENDIX D: Ranong Province Trip Itinerary

MONDAY, February 6, 2006

8:00 am – 3:00 pm: Travel to Ranong Province
3:00 pm – 5:00 pm: Check in to hotel and settle in
5:00 pm – 6:30 pm: Dinner at hotel restaurant
6:30 pm – 8:30 pm: Orientation with Chris Dunbar, TAO Field Supervisor, at hotel

TUESDAY, February 7, 2006

8:45 am – 9:15 am: Travel to Ban Hat Sai Khao
9:15am – 10:30 am: Tour Ban Hat Sai Khao
10:30 am – 11:30 am: Group Interview Session at Ban Hat Sai Khao
11:30 pm – 1:30 pm: Lunch and travel to Ban Tub Nua
1:30 pm – 2:30 pm: Group Interview Session at Ban Tub Nua
2:30 pm – 3:30 pm: Tour Ban Tub Nua

WEDNESDAY, February 8, 2006

8:30 am – 9:00 am: Travel to Ban Tub Nua
9:00 am – 12:00 pm: Individual Semi-Structured Interviews and Rapid Assessments in Ban Tub Nua
12:00 pm – 1:30 pm: Lunch
1:30 pm – 3:30 pm: Individual Semi-Structured Interviews and Rapid Assessments in Ban Hat Sai Khao
3:30 pm – 4:00 pm: Travel to hotel
4:00 pm – 6:00 pm: Discuss preliminary findings
6:00 pm: Dinner, Reflect on the day's activities. Discuss what information we needed to get on Thursday.

THURSDAY, February 9, 2006

9:45 am – 10:15 am: Travel to Ban Hat Sai Khao
10:15 am – 11:15 am: Individual Semi-Structured Interviews and Rapid Assessments in Ban Hat Sai Khao
11:15 am – 12:30 pm: Thank villagers in Ban Tub Nua for being honest and for their participation and provide with more handouts if needed.
12:30 pm -1:30 pm: Lunch
1:30 pm – 2:00 pm: Travel to hotel
2:00 pm – 3:00 pm: free time
3:00 pm – 6:00 pm: Work on report
6:00 pm – 8:00 pm: Dinner
8:00 pm – 10:00 pm: Work on report

FRIDAY, February 10, 2006

9:30 am – 11:30 am: Check out of hotel.

APPENDIX E: Ranong Province Trip Interview and Focus Group Responses

Ranong Province Trip February 6-10, 2006

Day 2: February 7, 2006 — Village 7: Ban Hat Sai Khao

Focus Group:
10-15 village women, 2 men

Hazards:

- Flooding: No Drainage
- Landslides: Erosion of banks, soil stability
- Hard rains: water comes in windows & under roof because roof is too short; hang tarps to block rain and sun
- Canal not deep enough for boats, 3 villages use same canal
    - Have to keep dredging canal because of bank erosion so boats can pass
    - Want jetty
- Not every house has water storage tanks; 50 house, 5 tanks
- Dust from streets enters house, have to continually clean
- Sometimes rain and wind causes house to shake
- Most worried about storm surge with new canal
- Afraid canal will erode towards houses

Do not know how to protect themselves

- Planting trees to block winds is the only thing they think they can do
- Will run away or go upstairs during a storm
- No plan for elders and young children, but they take care of the neighbors

No Hazard Maps yet

- One more month to do them
- Disaster person talked to village chief and he thinks its not necessary because nothing has happened yet

Day 2: February 7, 2006 — Village 2: Ban Tub Nua

Focus Group:
9 Women, 1 man, all Muslim
Translator from Thai to Southern Thai

Hazards

- No drainage, flooding
- Rain comes in windows; switch back and for between dry and wet rooms

- Garbage disposal a problem
- Flooding and storm surges
    - Do not know how to protect themselves
    - New road doesn't have drainage
    - Old houses built on sand, water would go in sand
    - Government paid for new soil, TAO dumped it
- House Sways in wind
- Sand gone on beach from tsunami, less protected now
- Nervous second floor will break
- House unstable

Protecting themselves
- Do not know who the village disaster volunteer appoint by TAO is
- Interested in knowing more
- Some afraid of another wave, moved away
- Want to build a road as a direct evacuation route
- Planting mangroves to protect themselves, saw that the mangroves survived
- Learned about disaster by experience
- Play music through Tsunami Evacuation system to test it

Additions
- Building additions on their own
- Want more space
- Make additions how they want
- Interested in learning safe building techniques and how to stabilize their home
- Bought materials with savings
- Build in parts by how much money they have at the time
- Previous houses were built differently to the extent of ones finances
- Think addition will make house more stable

Day 3: February 8, 2006 Village 2: Tub Nua

Semi-Structured Interviews

Interview 1: Lot 21
Live here for 1 year, 6 people

Floor is rotting from rain
- For past 6 months
- Molding
- Afraid floor will fall out in next rainy season
- Have to go in bathroom during rainy season
- Water collects on second floor during rainy season, comes through windows

Addition

- Use tarp for shade
- When they get money they will make addition like Lot 11
    - Didn't get a boat, no work, no money for addition
- Want it to get more space and to make house more stable
    - Stabilizing is more important than space
- Will move whole family back together if they get addition
- Knows that the design of 11 is dangerous

Interview 2: Lot 23

7 people live in this unit for 4 months, rent it for 500 baht/month

Addition

- Renter built addition
- Built temporary addition of bamboo and leaves because they are not allowed to build permanent one
- Addition is to protect from sun and rain
- Holes in it from wind, rain and sun, needs repair
    - Have to repair every couple of months
- Husband built it, Works as fisherman
- Chose the style because it saved money, no one told them how
- Took one day to build it with 5 people
- Wouldn't add this type of addition onto old house
    - Old house made of cement
- If they could expand the house, they would make a bedroom
- Have to get owners permission to build a Permanent Addition, wants one
- Put up tarps to keep out rain
- Think addition will come down and could harm them during a storm, but need it

Hazards

- Unit and addition shake a lot

Interview 3: Lot 34 (Store)

3 ppl live there, for one year; has been a store for 3 months, didn't have a store before tsunami

Hazards

- Storm
- Flooding
- Tsunami
- Rain
- Sun

- House unstable
- Spots on ceiling and floor from rain, stairs are the same

Addition
- Added awning 3 months ago
- On the side for rain – 1,500 baht
- In front for sun – Found
- Wants to make permanent additions like others, needs more space for herself
- Will make another addition if they have the money
- If they don't have money they will put up another permanent awning
- Want to make addition the same style as others because they think the village will look nice if all the same
- Know addition is dangerous, but need more space
- Interested in addition that is safer
- Thinks that the house is unstable because it is too high
- Knows the other village has additions
    - Wants them too
    - Village 7 sent representative to ask for Ban Hat Sai Khao Additions
- Think windows would be best if glass

Store
- Got loan from rotary club for store

Preparation:
- Listen to radio/news and warning system
- If anything happens they will run down a road or maybe climb pine trees

Old Houses
- Built 1-2' off of ground
    - Enough to keep flooding away
- Concrete with wood shutters
- Usually old houses were bigger than the units, but it depends on family and how much land they had

Interview 4: Lot 37*

7 people (two families), lived there for 1 year

Addition
- Always had DDPM temporary shelter attached
    - Were given it by DDPM
- Want permanent addition, but do not have money
- Would add 4m on side, 3m in front
- Would do by his own design, would hire someone to do it
- Elder couple cannot get upstairs, sleep in addition

- Children and family live upstairs, are fishermen
- In rainy season, stay in addition and get wet
- Want more space

Old Houses
- Former house looked similar, but only had one floor made of concrete
- If rebuilding themselves, would have made similar to old style

Preparedness
- Don't know what to do if another disaster comes

Day 3: February 8, 2006 Village 7: Sai Khao

Semi-Structured Interviews

Interview 5: Lot 43
1 year, 8 people live in unit; changed bathroom into bedroom, moved bathroom to back

Addition:
- All additions 1 year old
- Front
    - Materials came from Japanese Foundation
    - People in village helped build it
    - Helps with wind and rain
    - Took 5 days to build
- Side
    - Made of wood
    - Materials from World Vision
    - Husband built in 3 days
- Back
    - Used personal savings
    - Husband built in 3 days
    - 5,000 baht
- Ban Hat Sai Khao Addition
    - Getting addition
    - Will replace thatch and bamboo side addition
    - Think it will make whole house safer
    - Don't need to apply, they will make for anyone
    - Wasn't asked about what they wanted
    - Will use space for bedroom
- If she has enough money she will add more after Ban Hat Sai Khao Addition
    - Make permanent like Ban Hat Sai Khao Addition

Replacement Unit:

- Doesn't think unit is safe; shakes
- Wants water tank and cover from rain and sun
- Thinks it is impossible to make this house safe from disasters
- Government says house costs 120,000 baht, thinks that is too high of an estimate
- Problem with knees, can't go upstairs

Interview 6: (Store)

Interviewee not a resident, sister's store
4 people live there, 3 bedrooms, 2 upstairs, one downstairs

Addition:

- Used as a store
    - Used to sell fish in store before tsunami
- Borrowed money from relative for the store
- Built it right away when they got the unit
- Cost 100,000 baht
- Hired someone from outside the village
- Unidentified organization wont give them Ban Hat Sai Khao Addition because they already have one
    - Have to apply
    - Some houses don't get additions if they already have permanent additions
    - Every family must apply independently
- Will continue back addition for fish market

Replacement Unit

- No one uses the two upstairs bedrooms
- All sleep downstairs
    - Because second floor not sturdy – worried it will fall through
    - Kids are still young
- Rain comes in second floor

Hazards

- Flooding is a concern even though it is not much of a problem because ground around front is raised

Day 4: February 9, 2006 Village 7: Sai Khao

Semi-Structured Interviews

Interview 7: Lot 38

6 people live there, 1 year; one woman is pregnant with twins

Addition

- Left Side

    - Materials from Chinese foundation
        - Member of Chinese religion, asked for help
    - Kitchen
    - Play area for twins
    - 3 months old
    - Hired somebody in village to help

- Right Side: Ban Hat Sai Khao Addition
    - 2 months old
    - Bedroom
    - Thinks safer than unit
        - House used to shake more
        - Thinks its stronger than before
        - Not sure yet, haven't had rainy season
    - Replaced the floors on second floor
- Front
    - Grandmother can't go upstairs, going to add on to front when twins are born
    - Protects from sun and rain
    - Have to replace every three months depending on rain

Replacement Unit:

- Hasn't done anything to protect themselves
- Water runs through house to canal
- All additions are better than the original house for rain and sun

Other

- Red cross gave first aid kit

Interview 8: Lot 6

7 people live there, 1 year

Addition

- Left Side:
    - One half of side = Ban Hat Sai Khao Addition
        - Had to apply
            - Just send in address and say need help
        - Replaced floors, now it feels safer and more stable
    - Other half = Personal savings
    - Had for 1 month
    - Used same workers to construct whole addition
- Right Side:
    - 30,000 baht
    - Made right away
    - Hired someone from outside to do it

    - They designed it themselves
    - Not like old house
    - Do not think its safe, but needed space
- Future Plans
    - If they get more money move toilet and kitchen to the back
    - If they make addition in back, make more stable to protect against storms
    - If she has more money she will replace cinder block wall to make safer

Hazards

- Still have problem with flooding
    - Use bucket
    - Might remove brick from side wall so water from flooding will leak out

APPENDIX F: Ranong Province Trip Response Chart

			Ban Tub Nua				Ban Hat Sai Khao			
	Group 1: Ban Hat Sai Khao	Group 2: Ban Tub Nua	Interview 1	Interview 2	Interview 3	Interview 4	Interview 5	Interview 6	Interview 7	Interview 8
Number of residents			6	7	3	7	8	4	6	7
How long they have lived in unit			1 yr	4 mo[1]	1 yr	1 yr	1 yr	1 yr	1 yr	1 yr
Lot Number			21	23	34[2]	37	43	[3]		6
Rapid Assessment Results V= Vulnerable; NV= Not Vulnerable			V	V	V	V	V	NV	V	V
Hazards										
Flooding, No Drainage	x	x			x			x	x	X
Landslides	x									
Rain comes into house	x	x	x		x	X		x		
Canal not deep enough	x									
Shortage of water storage tanks	x						x			
Rain and wind shake house	x	x	x	x	x		x		x	
Storm Surges	x	x			x					
Canal will erode towards houses	x									
Garbage disposal		x								
Sand gone from beach, less protected		x								
Second floor not durable		x	x		x			x		
Second floor is rotting			x		x					
Tsunami		x			x					
Sun					x					
Dust	x	x								
New ground covering (clay) doesn't absorb water		x								
Efforts to Protect and Prepare										
Do not know how to protect themselves	x	x				x				
Planting Mangrove trees	x	x								
Will run away during storm	x				x					
Will go upstairs during a storm	x				x					
Will climb pine trees during a storm					x					
Want to build a direct road for evacuation		x								
No plan for elders or children	x									
Thinks it is impossible to make house safe							x			
Has not done anything to protect themselves									x	
Information about Disasters and Safe Building										
Do not know who TAO disaster volunteer is		x								
Interested in knowing more about safe building		x			x					
Learned about disasters from experience		x								
Want to build addition like neighbors			x		x					
Listens to radio/news for storms					x					

[1] Renter
[2] Store
[3] Store

			Ban Tub Nua				Ban Hat Sai Khao			
	Group 1: Ban Hat Sai Khao	Group 2: Ban Tub Nua	Interview 1	Interview 2	Interview 3	Interview 4	Interview 5	Interview 6	Interview 7	Interview 8
Additions										
Built on their own		x	x		x		x			
Built with help of other villagers				x			x			
Hired someone to build								x	x	x
Ban Hat Sai Khao addition							x		x	x
Make additions how they want		x		x						
Will build another addition once they get money			x	x[4]	x	x	x			x
Not built like previous homes		x								x
Reasons or Needs for Addition										
Want more space		x			x	x		x		x
Want to make more stable		x	x				x			x
Stabilizing is more important than space			x							
Want to protect from sun and rain			x	x	x		x		x	
Safety of Addition										
Thinks addition is safer than house									x	
Knows their addition is not safe							x			x
Knows the addition they want to build is not safe			x	x	x					
Addition Cost										
Cost 1,000-2,000 Baht					x					
Cost 5,000 Baht							x			
Cost 30,000 Baht										x
Cost 100,000 Baht								x		
Financing										
Built in parts depending on finances		x								
Loan from relative								x		
Loan from outside organization					x					
Addition was provided by foundation						x				
Addition was paid for from personal savings		x					x			x
Addition materials were provided by a foundation							x		x	
Old Homes										
Built 1-2 ft off of ground					x					
Old houses concrete					x	x				
Old houses usually bigger, but depends on money					x					
One floor						x				
If rebuilding themselves, would have built in old style						x				
Other										
Elderly, cannot get upstairs						x	x		x	

[4] Wants to build permanent addition, but is a renter

APPENDIX G: Rapid Assessment Results Chart

Village	Interview	Inspector's Name	Date	Lot Number	Unit Type	# of Occupants	Age of Unit	Age of Addition	Addition Use	Does Addition Touch Unit	Addition Height
Ban Tub Nua	Interview 1	Amy LeBlanc	2/8/2006	21	Military	6 $	1 year $	2 weeks $	Residential	Yes	7 feet
Ban Tub Nua	Interview 2	Amy LeBlanc	2/8/2006	23	Military	7 $	Rent for 4 Months	3 months	Residential	Yes	10 feet to 6 feet
Ban Tub Nua	Interview 3	Sean O'Dowd	2/8/2006	34	Military	3 $	1 year $	3 months $	Commercial	Yes	10 feet
Ban Tub Nua	Interview 4	Sean O'Dowd	2/8/2006	37*	Military	7 $	I year $	1 year $	Residential	No	9 feet
Ban Hat Sai Khao	Interview 5	Tom DeMasi	2/8/2006	43	Military	8 $	1 year $	1 year $	Residential	Yes	
Ban Hat Sai Khao	Interview 6	Tom DeMasi	2/8/2006	UK	Military	4 $	1 year $	1 year $	Commercial	Yes	
Ban Hat Sai Khao	Interview 7	Tom DeMasi	2/9/2006	UK	Military	6+ 2 (twins to be born soon) $	1 year	3 months	Residential	Yes	7', 8', Connected to roof
Ban Hat Sai Khao	Interview 8	Tom DeMasi	2/9/2006	UK	Military	7 ($)	1 year ($)	1 year ($)	Residential	Yes	

		Religion	Possible Hazards	Addition Material	Vertical Location	Brief Description of addition
Ban Tub Nua	**Interview 1**	Muslim	Not symmetrical, other: canvas	Canvas	Level with second floor	Piece of tarp tied to stairs with bamboo pitching one side up
	Interview 2	Muslim	Not Symmetrical, Overhangs	Bamboo, Timber, Leaves	Touches house at 13 feet	bamboo, wood and leaves awning
	Interview 3	Muslim	Overhangs, Poor Maintenance	Timber, Bamboo, Canvas		2 Awnings: 1) Is a black tarp supported by bamboo and wood used to block the sun 2) Is a thick canvas and metal attached to house, was produced by an external source
	Interview 4	Muslim	Other	Canvas, Aluminum		Addition is a temporary shelter given by DDPM approximately 12'x10' wooden platform raised one foot off the ground that has metal framing with canvas top and sides. Opens towards the house. Used as bedroom for old couple living there as they can't get upstairs. Their children live upstairs.
Ban Hat Sai Khao	**Interview 5**	UK	Not Symmetrical, Overhangs	Timber, Bamboo, Leaves, Concrete		front addition to protect from sun, made of timber, abspestos roof tiles, and concrete roof tiles. Side addition used to protect from sun, hang laundry, wash dishes and laundry. Back addition is bathroom with shower and storage
	Interview 6	UK		Timber, Concrete, Abspestos Roof tiles		money to build addition loaned from relative. Bottom floor converted into convenience store. 2 electric pepsi coolers, quite a bit of stock
	Interview 7	Other	Not Symmetrical, Overhangs	Timber, Bamboo, Leaves, Concrete, Abspestos roof tiles		Used addition given by foundation for bedroom. Addition on left side used for kitchen, to clean hang clothes.
	Interview 8	UK	Not Symmetrical	Timber, concrete		Used addition given by foundation for living area back room for kitchen area, backshed for storage area which only has three walls. Right side of house addition used for storage and to protect from rain constructed by owners out of concrete.

		Any Changes to Surrounding Property	If yes, please explain	Comments, Observations, & Explanations
Ban Tub Nua	Interview 1	No		
	Interview 2	No		
	Interview 3	Yes	There are 2 Tables, a water tank, and trash cans filled with water.	Converted bottom floor into convenience store with chairs and table
	Interview 4	Yes	Debris and garbage around house, cinderblocks loosely stacked up on one side of the house	
Ban Hat Sai Khao	Interview 5	Yes	Have water tank	Addition 1: made of bamboo, woven leaf rof, and timber. Leanto with no walls; Addition 2: Open air addition with no walls made; Addition 3: not visibly attached to house but touches, patch plywood walls, seems flimsy
	Interview 6	Yes	Tables outside for customers of wood and stone	Front and right part of house are walled with concrete with timber and abspestos ceiling. Have pilings for long cement walls. Back is to be used for fish market open aired with concrete pilings,timber and abspestos roof tiles
	Interview 7	yes	Filling in backyard with crushed gypsum board to level it for addition that is going to be put in back	Walls for additions 1 and 3 are of patched plywood
	Interview 8	yes	Garden in back, also store equipment for job behind house	Addition to the right side of the house not finished yet, windows framed not shuttered, wall not completed

APPENDIX H: Ranong Province Trip Handouts

FIGURE F8.19 OVERHANGS MUST BE AS SHORT AS IS NECESSARY

ชายคาบ้านไม่ควรมีความยาวเกินความจำเป็น

FIGURE F8.20 LONG OVERHANGS WILL CAUSE A ROOF TO BLOW OFF IN A CY

ชายคาบ้านที่มีความยาวมากเกินความจำเป็น

อาจเป็นสาเหตุให้หลังคาปลิวเมื่อเกิดพายุ

[5]

[5] (Ayer, 1990)

FIGURE F8.12 TIE YOUR HOUSE PROPERLY TO THE POSTS

ยึดบ้านไว้กับฐานให้แน่นหนา

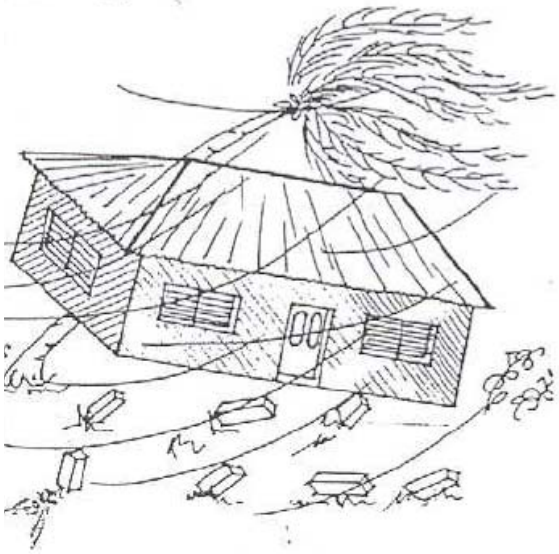


FIGURE F8.13 A HOUSE THAT IS NOT PROPERLY TIED DOWN WILL BLOW OFF THE POSTS

ตัวบ้านที่ตั้งอยู่บนฐานที่มีความมั่นคงเพื่อป้องกันหากเกิดพายุ

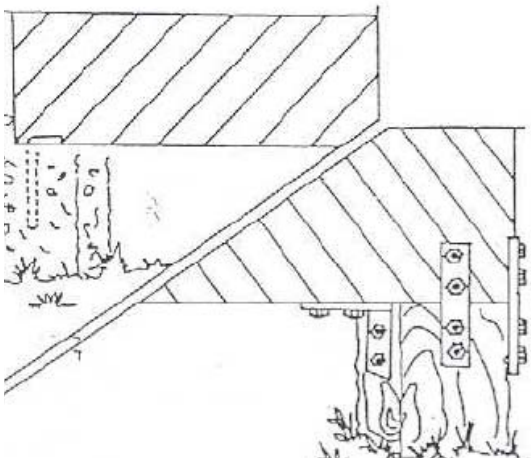


FIGURE F8.14 USE METAL STRAPS AND BOLTS TO TIE THE HOUSE TO THE POSTS

ใช้ตัวเชื่อมที่เป็นเหล็กหรือทำจากวัสดุที่มีความมั่นคง

ในการยึดตัวบ้านไว้กับฐาน

[6]

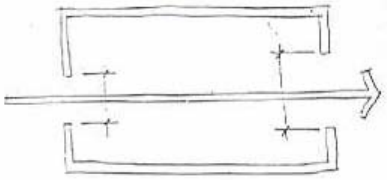
[6] (Ayer, 1990)

DESIGN INFORMATION

No. 3.22 - 6

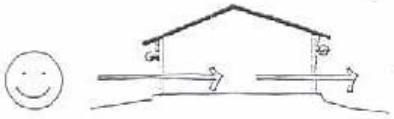
CLIMATIC CONSIDERATIONS & GUIDELINES - Hot Wet

9. If the wind usually blows from one direction, make the windows on the windward side smaller than those on the leeward side.



ถ้าลมพัดมาในทิศทางเดียวให้ทำหน้าต่างในทิศทางที่ลมพัด

4. Use a maximum of natural ventilation. (CAUTION - In areas with high winds, openings on the windward side can cause dangerouly high pressure if not properly vented. See Section 3.23)



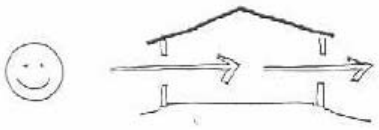
พยายามให้การระบายอากาศเป็นไปตามธรรมชาติ

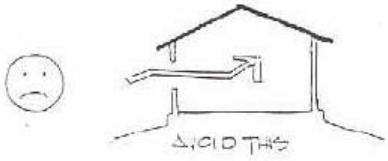
สมดุลกับทิศทางที่ลมพัด

คำเตือน: ในบริเวณที่ลมแรงให้เปิดหน้าต่าง

หรือ ทำหน้าต่างในทิศทางเดียวกับลม

เพื่อลดความรุนแรงและอันตราย





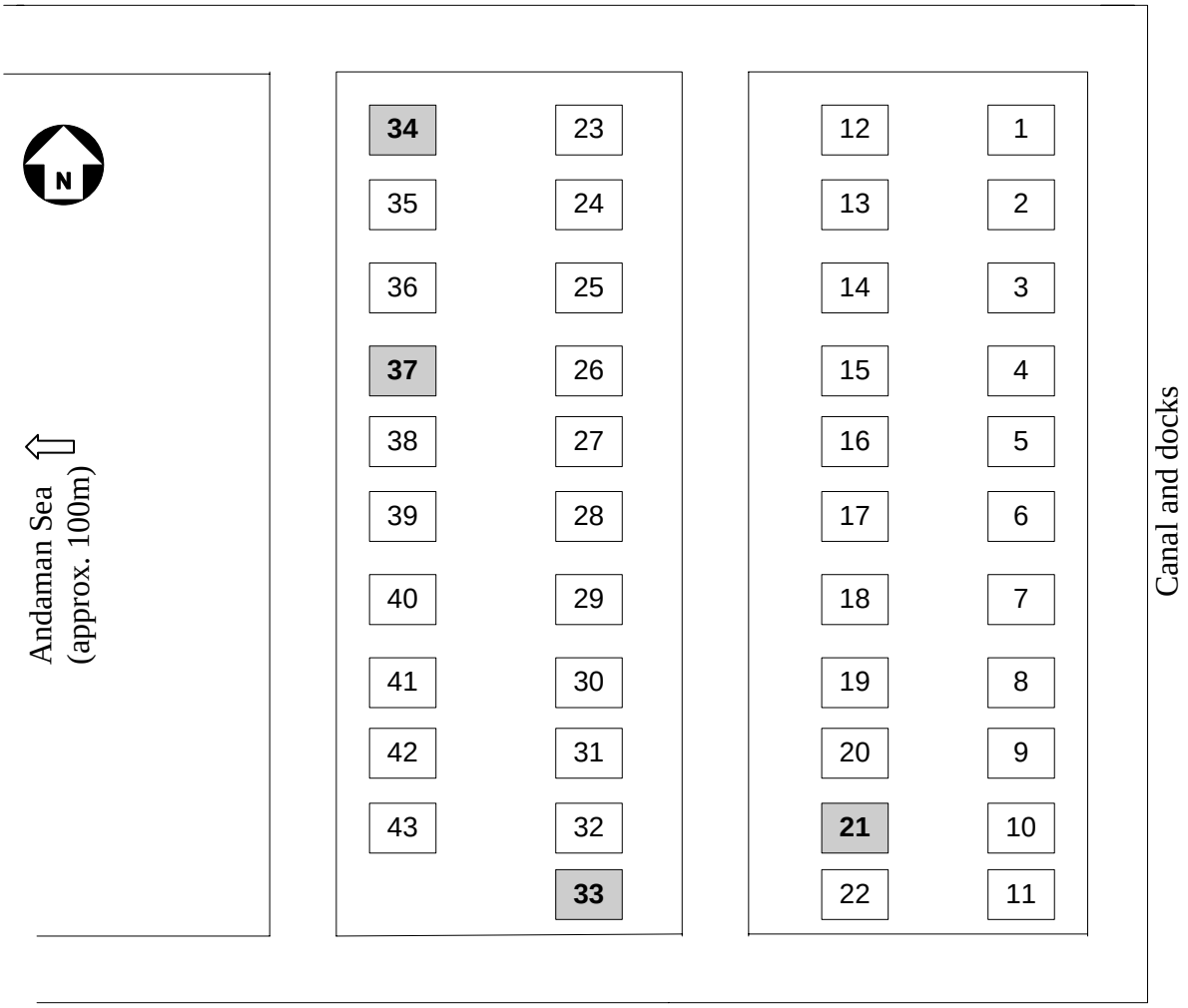
7

[7] (Final Report, 1982)

APPENDIX I: Ban Tub Nua
APPENDIX I1: Sitemap of Ban Tub Nua

Sitemap of Replacement Units and Lot Numbers

Semi-structured Interviews and Rapid Assessment conducted at shaded lots



NOTE: Map not drawn to scale

APPENDIX I2: Observations of Additions in Ban Tub Nua

Ban Tub Nua				
Lot Number	**Type**	**Orientation**	**Materials**	**Observations**
1	Closed	Front	Cinder Block, Concrete, Wood, Asbestos shingles	additional space, closed with large overhang
2	none			
3	Open	Front/Left	Canvas, Bamboo, Wood, Rope	Large over hang
3	Open	Left	Canvas, Bamboo, Wood, Rope	Not attached to house, "garage" to shade car from sun
4	none			
5	Open	Front	Canvas, Bamboo, Wood	Overhang, protect agaist sun/rain,
6	none			
7	Open	Left	Tarp, Wooden Plywood sheet	To protect against sun and rain
8	none			
9	Open	Front	Tarp, wood	Put up by owner to block sun
10	Closed	Left/Front/Right	Cinder Block, Concrete, Wood, Asbestos shingles	Constructed additional space, comeplete cinderblock walls around starter unit
11	Closed	Left/Front/Right	Cinder Block, Concrete, Wood, Asbestos shingles	Constructed additional space, comeplete cinderblock walls around starter unit
12	Open	Front/Right	Concrete, Wood, Asbestos shingles	cinderblock walls on right, open wall/not enclosed in front
13	Open	Front/Right	Wooden Plywood sheets, canvas	
14	Open	Front	Wooden Plywood sheet	Not attached, leaning on stairwell
15	none			
16	none			Lobster and fish traps stacked next to house
17	Closed	Front	Wooden Plywood sheets	adds no additional space, boards up open wall and window
18	none			
19	Open	Front	Canvas, Wood	
20	Open	Front	Canvas, Metal	Bought not made
21	Open	Front/Right	Tarp, Rope	Put up by owner to block sun

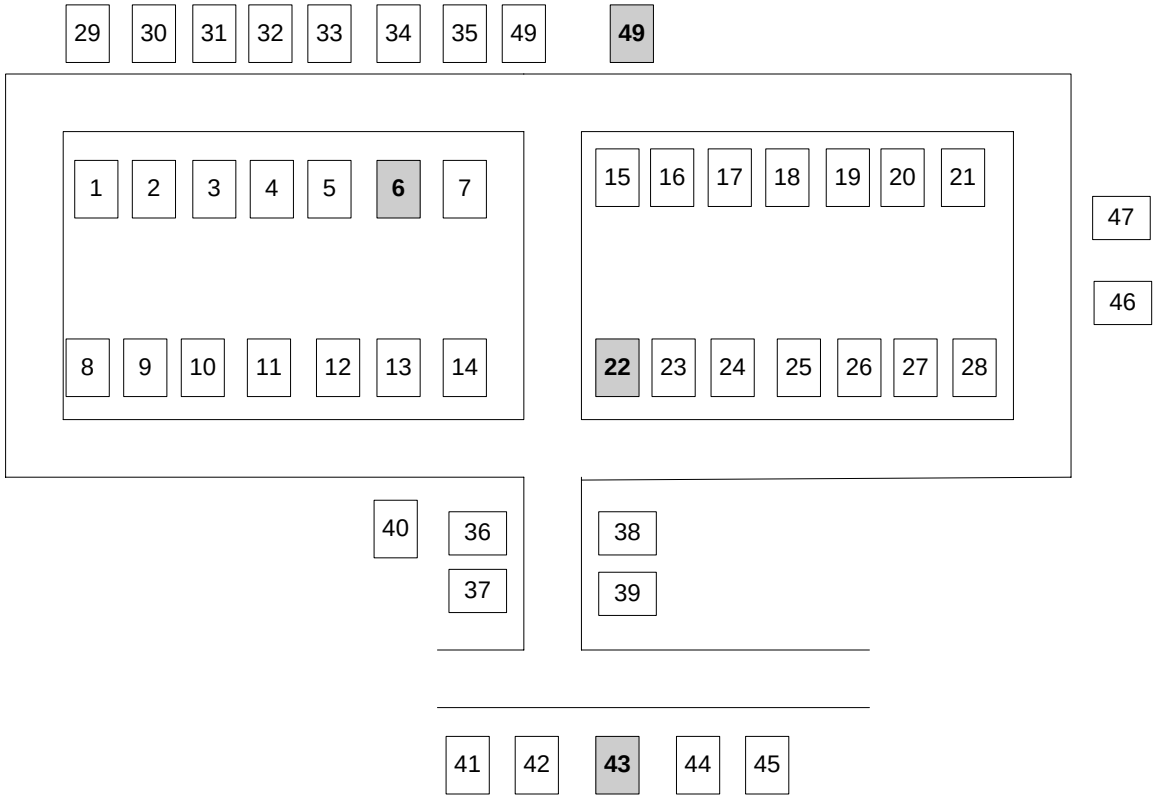
Ban Tub Nua				
Lot Number	**Type**	**Orientation**	**Materials**	**Observations**
22	none			scattered fisherman equipment
23	none			
24	Closed	Left	Sheets of Plywood	adds no additional space, boards up open wall and window
25	Open	Front	Canvas, Wood	
26	none			
27	none			
28	none			
29	none			
30	none			
31	none			
32	none			cinderblock stacked along side wall and front
33	Open	Front/Left	Bamboo, Wood,Thatch	Wraparound addition, open walls/ not enclosed
34	Open	Right	Canvas, Metal	Bought not made
34	Open	Front	Tarp, Bamboo, Rope	Put up by owner to block sun
35	Open	Right	Tarp,Rope	Put up by owner to block sun
36	Open	Right	Bamboo, Tarp, Rope, tables,chairs	Owner made to use as resteraunt
37	Closed	Front	Canvas, Metal, Wood	Owner given temporary DDPM home to keep
38	none			
39	none			
40	Open	Front	Canva, Metal	
41				
42	Temporary	Front/Right	Bamboo, Wood,Thatch	Wraparound addition, open walls/ not enclosed
43	none			

APPENDIX J: Ban Hat Sai Khao

APPENDIX J1: Sitemap of Ban Hat Sai Khao

Sitemap of Replacement Units and Lot Numbers

Semi-structured Interviews and Rapid Assessment conducted at shaded lots



NOTE: Map not drawn to scale

APPENDIX J2: Observations of Addition in Ban Hat Sai Khao

Ban Hat Sai Khao				
Lot Number	**Type**	**Orientation**	**Materials**	**Observations**
1	Closed	Left	Wood, Asbestos shingles	raised approx. 1' - 1.5' on wood stilts
2	Closed	Left	Sai Khao Addition	
3	Closed	Left	Sai Khao Addition	
4	Closed	Left	Sai Khao Addition	
5	Closed	Left	Sai Khao Addition	
6	Closed	Front/Right	Concrete, Cinder block, Wood, Asbestos shingles	provides additional space
7	Closed	Front	Concrete, Cinder block, Wood, Asbestos shingles	eprovides additional space, loosely stacked cinderblocks in front
8	Open	Front/Right	Wood, Bamboo, Thatch	overhang, no enclosed walls
8	Closed	Back	Concrete, Cinder block, Wood, Asbestos shingles	
9	Closed	Right	Sai Khao Addition	storage for window frames
10	Closed	Right	Sai Khao Addition	
11	Open	Front	Wood, Bamboo, Thatch	
11	Closed	Right	Sai Khao Addition	
12	Closed	Right	Sai Khao Addition	
13	Closed	Right	Sai Khao Addition	
14	Closed	Right	Sai Khao Addition	
15	Open	Front	Tarp, Wood	Protect against sun
15	Closed	Left	Sai Khao Addition	
16	Closed	Left	Sai Khao Addition	
17	Closed	Left	Sai Khao Addition	
18	Open	Front	Tarp, Wood	overhang, open/no enclosed walls
18	Closed	Left	Sai Khao Addition	
19	none			
20	Closed	Left	Sai Khao Addition	
20	Open	Front	Tarp, Bamboo	attached to Princess addition, protect against sun
21	Closed	Left	Sai Khao Addition	
22	Closed	Right, Front, Left	concrete, wood, cinder block, Asbestos shingles	offers additional space, converted into a convience store
23	Closed	Right	Sai Khao Addition	
24	Closed	Right, Front, Left	concrete, wood, shingles	added pillars to front, ornate, satellite dish
25	Closed	Right	Sai Khao Addition	
26	Closed	Right	Sai Khao Addition	
27	Open	Front	Canvas, metal	Protect against sun and rain
27	Closed	Right	Sai Khao Addition	
28	Closed	Left	Sai Khao Addition	
29	Open	Front	Bamboo, Thatch, Wooden plywood sheets	not attached to house

Ban Hat Sai Khao				
Lot Number	**Type**	**Orientation**	**Materials**	**Observations**
30	Closed	Right	Sai Khao Addition	
31	Closed	Right	Sai Khao Addition	
32	Closed	Right	Sai Khao Addition	
33	Closed	Right	Sai Khao Addition	
34	none			
35	Closed	Right	Sai Khao Addition	
36	Closed	Right	Sai Khao Addition	
37	Open	Left	Tarp, wood	
38	Closed	Left	Sai Khao Addition	
39	Open	Right	Concrete, Wood, Asbestos shingles	large overhang, no enclosed walls
40	Closed	Right	Wood, concrete, cinder blocks	Incomplete, mid-construction so not enclosed yet
41	none			
42	Open	Front/Left	Tarp, Wood	Protect against sun
42	Open	Front	Bamboo, Thatch, Wood	not attached to house, separate room raised 2' above ground, open/no enclosing walls
43	Closed	Left/Back	Bamboo, Thatch	overhang, no enclosed walls
43	Open	Front	Concrete, Wood, Asbestos shingles	large overhang, no enclosed walls
44	Open	Front	Tarp, Rope	Protect against sun
44	Open	Left	Wood, Asbestos shingles	large overhang, no enclosed walls
45	Open	Front	Tarp, Bamboo	
46	Open	Front	Concrete, Wood, Asbestos shingles	overhang, no enclosed walls
47	none			
48	Closed	Left	Wood, Asbestos shingles, plywood sheets	Large overhang, enclosed with plywood sheets
48	Closed	Front	Wood, plywood sheets, Thatch	small enclosed overhang
48	Closed	Right	Sai Khao Addition	
49	Closed	Right	Sai Khao Addition	

APPENDIX K: Disaster Resilient Construction Techniques

A Californian building code book on seismic performance criteria states that homes should: resist minor earthquakes without damage, resist moderate earthquakes without structural damage but with some nonstructural damage, and resist major earthquakes of the intensity of several of the strongest experienced in California without collapse but with some structural as well as nonstructural damage (Green, 1987). To support a house to meet these standards there are different ways of bracing and building structures against the shear forces of quakes. Three special bracing techniques that can be used on a variety of buildings are:

1) Frame – action bracing, which consists of installing box shape frames of steel or other materials in the framework of the building (good for tall buildings).
2) Shear – wall bracing, which is a process where you tie all the walls together by overlapping plywood in a way which makes the structure much more resilient to lateral swinging and adds considerable support to the roof and floor. This particular technique is good for small wood structures and would be a useful application in Thailand.
3) Diagonal or cross bracing, which consists of taking steel or wood members and attaching them in an X fashion at a 45˚ angle across two of the previous frame members of the existing structure (Kovach, 1995).

The two factors that do the most damage during tropical storms are excessive wind forces and flooding (Dalgliesh, 1995). A house using shear wall bracing will not only resist earthquakes but help protect against wind forces as well. This is because a house is much more structurally sound when it is complete. If the roof of a house is taken off by the uplifting wind forces the remaining structure will not last much longer in a storm. A low angled roof will greatly reduce wind forces on a house, extending the life of the house. The easiest way to protect against wind however is to build above the specifications of code, which is based on forces of the strongest hypothetical natural disaster (Breyer, Fridley, Pollock & Cobeen, 2003). To protect against flooding, the Federal Emergency Management Agency (FEMA) has established five methods of flood

proofing: 1) Relocation from high risk area; 2) Elevation of structure; 3) Flood walls around house, which are not a structural part of the actual building; 4) Dry flood proofing, which seals off the foundation walls to make them watertight; 5) Wet flood proofing, which is to design the structure so that no or little damage will happen when basement/first floor is allowed to flood (Institution of Civil Engineers, 1995a).

APPENDIX L: ADPC Deliverable: Ways to Improve Your House

Special points of interest:

- Ways to strengthen your floor (page 1)
- Ways to stabilize your house (page 2)
- Ways to protect your house from rain (page 3)
- Ways to protect your house from flooding (page 4)

WORCESTER POLYTECHNIC INSTITUTE & ASIAN DISASTER PREPAREDNESS CENTER

Ways to Improve Your House

What's wrong with your houses?

From February 7-9, 2006, representatives from Worcester Polytechnic Institute visited Ban Hat Sai Khao and Ban Tub Nua. During our conversations with villagers, we learned about some problems you have with your homes.

We learned that you feel the houses are unstable because they shakes with the wind. We learned that you believe the second floor is not strong enough and you feel unsafe. We learned that rain comes into the house and collects on the second floor. We learned that flooding is a problem during the rainy season. We have found some techniques that may help you fix these problems. They are included in this pamphlet.

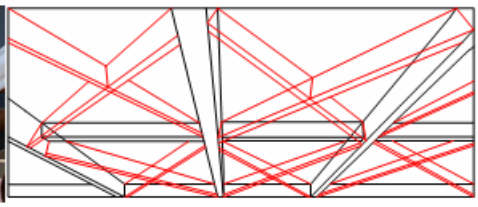
We would like to thank the villagers we spoke to for their help.

Water collection after a light rain

Water marks from rain on the second floor

Ways to Strengthen the Second Floor of your House

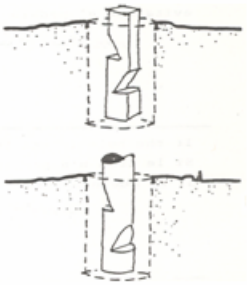
Frame of Second floor of house (painted blue)

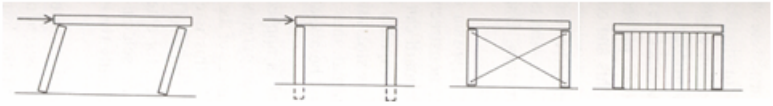


Black lines: Old framing; Red lines: Suggested additional bracing

One reason why your house shakes in the wind is because more bracing is needed between the wood frame of your floor. We suggest you add wood to cross brace the second floor (see picture above). The wood you are adding should be the same thickness as the wood of the old framing (black) and positioned like the red braces in the picture above. You should replace the floor with two layers of thicker plywood. The first layer should be put down with the long way towards the front and back of the house and the second layer laid from the right to the left of the house so that gaps of the two layers do not line up.

Ways to Stabilize your House



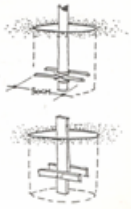


If your house shakes in this direction, these are ways to stabilize your house.

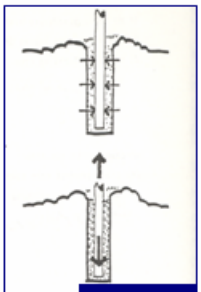
1) Bury the supports in the ground

2) Cross or Diagonal brace between supports

3) Build a rigid wall attached to the frame of the house

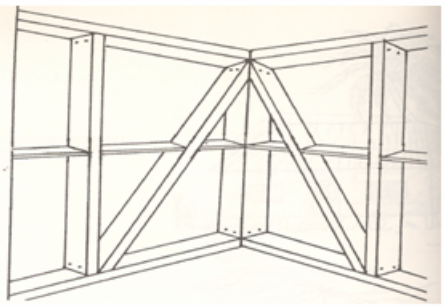


1) Bury the Supports in the Ground: When making an addition or rigid wall, you should dig holes to 100cm or more to protect your house from high winds and storms. If using timber or bamboo for supports, a cement footing will add more support and last longer. Bamboo and timber footings can be made stronger by tying boards to the bottom like the picture to the right. Thick timber will stay in the ground better if you carve pieces out like in the picture in the upper left corner.



If cement footings are too expensive when using wood or bamboo, dig the hole bigger than the bamboo or wood support. Compact the dirt that you put back in, to better secure your support (see picture above).

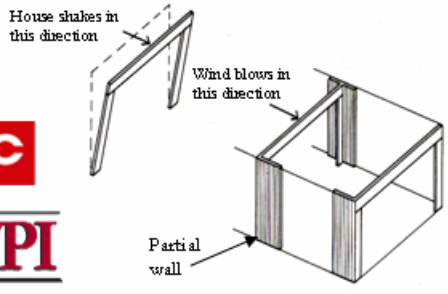
Upstairs bedroom in current unit



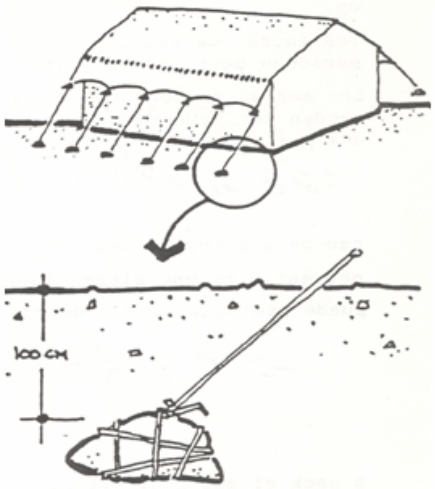
Brace interior walls in the corners

2) Cross or Diagonal Brace between supports: Diagonal or cross bracing consists of taking wood members and attaching them in an X shape at a 45° angle across two of the previous frame members of the original house (see picture 2 at top of page). To help keep your second floor from shaking, diagonally brace the inside walls (see picture above). Make sure to brace in the corners, it will help the most.

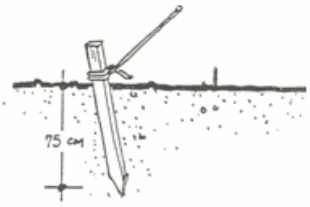
3) Build a Rigid Wall Attached to the Frame of the House: One way to stabilize your house would be to build a wall of concrete with re-bar or timber on the first floor. If walls are built of timber they should be cross-braced. This wall would have buried supports that attach to the frame of the house. Replacing the walls of rooms on the first floor, or adding full or partial rigid walls to the concrete supports at the front of the house, will help stabilize it. If building a partial wall, it should be built into or away from the direction wind most commonly blows (see picture to the left).



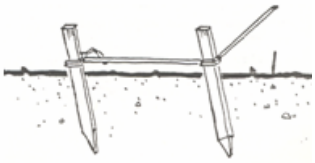
Ways to Protect your House from Rain



When using a tarp or awning to protect from rain or sun it is very important to tie it down tightly. Loosely tying a tarp down will damage the tarp in high wind and possibly cause damage to your home. When tying down your tarp, secure it first to your house, then use tie-downs (see pictures to the left and right). If using a rock, make sure to bury it at least 100cm deep. If using a wooden stake, bury at least 75cm. Use buried supports to hold up your tarp or bamboo addition for more stability (see page 2).



Stakes do not have to be buried as deep as rocks if put in the ground properly. When tying down a tarp or addition, ground the stake so it is perpendicular to the roof angle.



If one stake can not hold down your tarp or shelter, a second stake can be added in line with the first stake to provide more support.

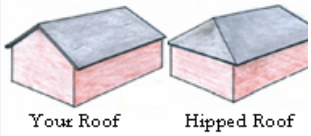
Tips for rain proofing your second floor:

- Put a plastic sheet down on the second floor to reduce mold
- If you have a tarp over your windows already, tie down the bottom of the tarp away from the house. It will help keep more rain out of your house.

After every major storm be sure to check your tarps and additions to make sure they are still tied down.

If you are going to lengthen the roof of your house in order to protect the second floor from rain, only add on enough to keep the rain out. With a longer roof it is necessary to brace the roof so it does not break. You can either place supports from the roof to the house (see picture on the left), or you can build buried supports connecting the ground to the edges of the roof.

If you are going to lengthen your roof it is very important that you also support your house. If supports are placed from the roof to the house, it is necessary to add bracing where these supports meet with the house. Not bracing may cause the roof and/or house to break. It should connect to the edge of the roof and below your windows. You should support your first and second floor with methods mentioned earlier, like diagonally bracing on the second floor and adding rigid walls on the first floor (see page 1).

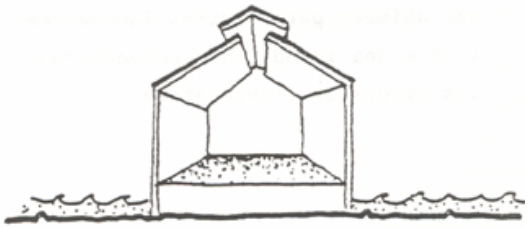


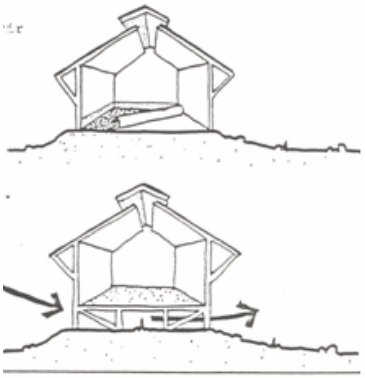
Your Roof Hipped Roof

To protect the front of your house from rain or sun, it is better to make your roof a hipped roof (see picture above).

Ways to Protect your House from Flooding

There are two ways that you can protect yourself against flooding. Dry flood proofing will prevent flooding in your house, but costs more money. Wet flood proofing only protects against water damage, but is cheaper.





Dry flood proofing: To avoid flooding you can build a raised floor of wood or bamboo above the flood line. Use diagonal bracing for a raised bamboo or timber floor for some support to prevent it from breaking. Another type of material you can use is concrete. Building a raised concrete floor above the flood line would stabilize your house and would not have to be replaced like the wood or bamboo floors (see pictures above and to the left).

Wet flood proofing: This is an easier method than dry flood proofing, but it does not prevent flooding, it is just a method to protect your house from damage. It is a good idea to flood proof at the same time you are stabilizing the first floor. While you are supporting your walls, also build shelves or raised bamboo platforms to store items that would normally get damaged from water. Make ways for water to flow through your house so that it does not stay in your house. Do not make large holes in your walls or take out supports because this will make your house shake more.

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Four Worcester Polytechnic Institute students talking to villagers in Ban Tub Nua

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