Rebuilding after Disaster: Towards a Resilient Community

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ABSTRACT

This thesis has been generated as a response to the humanitarian crisis in Port-au-Prince, Haiti as a result of a 7.0 magnitude earthquake on January 12, 2012. Events such as this highlight the fragility and vulnerability of the built environment to disasters. This research is focused on identifying the vulnerabilities that led to such widespread devastation in an effort to understand how built-in resilience can be achieved. The future development of Haiti needs to ensure the capability of the built environment to resist as well as recover quickly from future hazards. A series of case studies of community planning initiatives currently underway in Haiti will be used to explore the challenges and successes of the rebuilding effort in post-disaster Haiti. The field research conducted will inform the project about local customs, processes, and materials to ensure that the proposal is both a sensitive and realistic initiative.

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INTRODUCTION

“Over the years, disasters have had an increasingly heavy economic and social impact in many countries...Many authors predict that the trend will be more severe, owing to increasing urbanization, environmental degradation, and increasing vulnerability due to climate change and variability.”¹

The issue of disasters and the destruction of the built environment is a growing concern throughout the architectural industry. The risk of disaster is present in every community despite level of development. The level of development of a community can be closely correlated with the magnitude of vulnerability; but does not need to be the determining factor. Less developed communities have the ability to be resilient to the effects of natural hazards if they implement strategies that mitigate the risks and vulnerabilities of the environment.

In order for architecture to be used as an enlightened and intelligent process of response to disaster scenarios, a series of systems and processes need to be in place. In a developed country, building codes, planning strategies, and infrastructure development are implemented in a top-down approach and enforced by a governing body. In a less-developed country, these systems are often disorganized or non-existent, and at a time of disaster these processes are further strained.

Architecture can serve as an enlightened and intelligent process of response that can create an environment that is resilient to impending natural hazards. In order for an architectural project to be a viable, long-term solution, it must be developed with a clear understanding of the social, political, economic and cultural factors that influence development. These factors are specific to each affected community and require a distinct response to the particular issues of that community, eliminating the notion of a one-size-fits-all solution to rebuilding.

¹ Boshier, L. (2008). *Hazards and the built environment: Attaining a built-in resilience*. London: Taylor and Francis. Pg 39

This research intends to identify and analyze the factors that contributed to the vulnerability of Haiti in order to develop strategies that will increase the capability of the community to resist, and recover from future natural hazards. It will also survey the issues affecting the rebuilding program in Haiti, in order to guide the project developed as a response to the crisis. The Haiti earthquake disaster caused further destruction to one of the most marginalized communities in our world. Haitians deserve to be the recipients of and contributors to an intelligent, sensitive, and realistic project that integrates their traditions and cultural preferences while creating more resilient built environments. The aim of this thesis is to design a new resilient community development plan for Haiti which is built from local materials, integrates with cultural preferences, and contributes to the recovery of society through fostering economic and social growth.

SCOPE

This research is directly focused on the current rebuilding situation in Haiti and the future of community development. Although the major catastrophe of the 2010 earthquake is the catalyst for this rebuilding project, Haiti is susceptible to multiple natural hazards such as hurricanes, flooding, and mudslides, in addition to earthquakes. All hazard types must be accounted for in order to create true resiliency. The destruction of the majority of the urban building stock has generated much discussion and controversy regarding the proper course of action for rebuilding programs and solutions. It is the intent of this research to survey the current landscape of the rebuilding programs, policies, and intentions in order to navigate the complexities involved in of creating a long-term sustainable, resilience community for Haiti.

The scope of the project will be limited to a small Haitian community. As a result of the damage caused by the earthquake, nearly a million Haitians have been displaced and currently occupy tent-cities that were created four years ago as an immediate and temporary solution to the crisis. In an effort to avoid having these unsafe, vulnerable communities become a permanent solution for these people, the intention is to develop a resilient community plan that will not only

remove their vulnerability to these types of disasters but will assist in their economic and social recovery process.

RATIONALE

Much of the research about post-disaster architecture is formed around generalizations of theory and implementation, selecting case studies from across the globe in order to prove or disprove a variety of intended solutions. The accumulation of resources and knowledge of the contemporary research will provide a well-rounded base of knowledge about the rebuilding process in disaster scenarios and assist in the progression from generalities towards specific targeted solutions developed specifically for Haiti.

“Disasters are not ‘natural’. In reality, natural events such as earthquakes, floods, hurricanes, etc. become disasters because of the fragile relations that often exist between the natural, human, and built environments.” - Gonzalo Lizzaralde².

The devastation caused by a natural event is directly related to the susceptibility of a community to the effects of these events. Reconstruction programs in these affected areas continually fail to recover the affected communities from the destruction. Despite the vast resources and funds devoted to post-disaster reconstruction, there are seemingly few projects that result in sustainable development. The majority of these reconstruction projects fail to contribute to increasing the resilient capacity of the communities in which they are intended to assist.

In the case of Haiti, architecture has exponentially worsened with each disaster resulting in a very fragile building stock. Poor design, improper construction techniques, and inadequate construction materials were a major factor in the severity of the disaster. The failure of the built environment directly led to the deaths of innumerable Haitians as the buildings they believed were there to shelter them from the elements crumbled as a result of the earthquake. It is our

² Lizzaralde, G., Johnson, C., & Davidson, C. (2010). *Rebuilding After Disasters; From Emergency to Sustainability*. New York: Spon Press. Pg.1

social responsibility as the architectural profession to create sustainable rebuilding programs that drastically increase the resilient capacity of Haiti's communities. Architecture has the capability to limit the destruction of communities that are struck by these natural hazards such as earthquakes or hurricanes. In the case of Haiti it is now time to ensure that we assist in rebuilding their environment in a resilient manner so that the effects of these hazards will be mitigated or even eliminated.

CHAPTER 1: SITUATING THE PROJECT

HISTORY

The Island of Hispaniola is the second largest island in the Caribbean, and is home to the two sovereign nations of Haiti to the west and the Dominican Republic to the east. It has a tragic history of struggle caused by political instability, racial discord, natural hazards and poverty. The island was discovered by Christopher Columbus in 1492, and was inhabited by the indigenous Arawak people³. The arrival of the Europeans brought disease and brutal labour practices which nearly annihilated the indigenous population throughout the next century. Spain ceded the western third of the island (current day Haiti) to the French and the island is renamed Saint-Domingue.⁴ Saint-Domingue thrives economically as a colony for the French due to its forestry and sugar-based industries to which labour is supplied by the heavy importation of African slaves. The slave population of the Island outnumbered the free population four-to-one and due to the dire work conditions and poor treatment there was a complete turnover in the slave population every 20 years. By the middle of the eighteenth century the island had developed into a rigid hierarchically society based on skin colour, class and wealth⁵. Nearing the end of the eighteenth century there was increasing social disorder and rioting among the slaves and the plantation owners. The runaway slave communities that resided in remote areas of the colony began to revolt against the plantations and orchestrated mass escapes which increased the rumblings of revolution.

After a period of revolutions lasting nearly 25 years Haiti proclaimed its independence from France on January 1, 1804 and became the first black republic⁶. In order to purchase its liberty from France and eliminate a crippling trade imposed by France, Britain and the USA, Haiti

³ Library of Congress - Federal Research Division. (2006). *Country Profile: Haiti*. Washington: The Library of Congress. Pg 2

⁴ Ibid

⁵ Popkin, Jeremy (2010). *You Are All Free: The Haitian Revolution and the Abolition of Slavery*. Cambridge University Press.

⁶ Nesbitt, N. (2013). Haiti, the Monstrous Anomaly. In M. Poyne, *The Idea of Haiti: Rethinking Crisis and Development* (pp. 3-26). Minneapolis: University of Minnesota.

agreed to pay a fee of 150 million gold francs. This fee for the retribution of France's "lost property" crippled the economic development of Haiti. The early years of independence were still a time of turmoil. The hierarchical society still remained as the "mulatto freedmen" assumed their role as the nation's elite and the newly emancipated black population struggled with extreme poverty.⁷ Through much of the nineteenth century Haiti experienced chronic political instability and a struggle for unity which resulted in a lack of economic or social development. The violent political environment and increasing international indebtedness prompted the United States to occupy Haiti for a period of twenty years starting in 1915⁸.

The occupation of Haiti by the United States is a controversial issue within the Haitian population despite the United States creating better developed infrastructure, public services and implementing a democratic system. Many Haitians could only relate the experience to the period of slavery their ancestors had endured. During US occupation, the US Government imposed an 1864 Haitian law requiring peasants to perform labour on local roads in lieu of paying road taxes.⁹ This was forcibly enforced by the United States Marines and the newly trained Haitian National Guard through often brutal tactics. The United States allowed Haiti to resume free elections in 1930; however the incoming governments resumed Haiti's cycle of corrupt leadership who used their power to increase their own wealth at the expense of the country.

In 1957 Francois Duvalier won a controversial election on a platform of pro-black nationalism, strong military support, and national acceptance of the Vodou religion.¹⁰ Duvalier, known as "Papa Doc" declared himself "president for life" in 1961 and thus began the most brutal dictatorship in Haiti's history. He intimidated or murdered anyone who was a political threat to his position and desired to end the dominance of the mulatto elite over the political and economic development of the nation in the pursuit of nationalism. This violence and chaos caused the mass

⁷ Library of Congress - Federal Research Division. (2006). *Country Profile: Haiti*. Washington: The Library of Congress. Pg 3

⁸ Ibid. Pg 4

⁹ Heintz, R. D., & Heintz, N. G. (2005). *Written in Blood: The Story of the Haitian People, 1492-1995*. New York: University Press of America. Pg 430

¹⁰ Library of Congress - Federal Research Division. (2006). *Country Profile: Haiti*. Washington: The Library of Congress. Pg 5

emigration of the educated upper class. The entire governmental administration was stripped of all knowledge and experience by Duvalier and replaced with unqualified, inexperienced supporters and friends. This lack of expertise became a considerable obstacle to the development and governance of the country and resulted in the United States suspending aid to Haiti as part of their Alliance for Progress. Once Papa Doc died of natural causes in 1971 his 19 year old son (Baby Doc) assumed the leadership role.¹¹ He continued in his father's practice of oppressive rule, corruption, and violence. The political and economic condition of the country continued to decline as Baby Doc employed a system of kleptocracy to siphon international aid and revenue from the tobacco industry for his personal use. Finally in 1986 Baby Doc was forcibly removed from power by the army and forced into exile.

The Post-Duvalier era is categorized as a struggle for democracy. The substantial poor underclass struggles against the small but powerful upper class for power and control. Jean-Bertrand Aristide was democratically elected to succeed the transitional government put in place following the rule of Baby Doc. His presidency was short-lived as he was ousted by a military coup which was supported by the country's elite. The UN denounced the following military rule and imposed multilateral economic sanctions on Haiti, demanding that Aristide be returned to leadership¹². Aristide was restored to power and served till the end of his term in 1996.

Constitutionally barred from serving a second consecutive term, Aristide appointed Rene Preval as his successor. When Rene Preval won the election it signified the first ever transition between democratically elected presidents in Haiti's history. Aristide was elected to a second tenure of presidency following Preval's completion of his term, but his leadership was marred by an economic recession and allegations of corruption, political violence, and drug trafficking¹³. Anti-Aristide protests led to a coup d'etat which once again removed him from power. Rene Preval

¹¹ Library of Congress - Federal Research Division. (2006). *Country Profile: Haiti*. Washington: The Library of Congress. Pg 5

¹² Ibid Pg 6

¹³ Girard, Philippe (2010). *Haiti: The Tumultuous History*. New York: Palgrave.

was successful in his re-election campaign and resumed his presidency in 2006¹⁴. He was the reigning president during the catastrophic events of January 12, 2010.

DISASTER

At 16:53 local time the country of Haiti experienced a 7.0 magnitude earthquake with the epicenter near the town of Leogane, a suburb located 25 miles west of the capital city of Port-au-Prince. The shallow depth of the earthquake of only 10km allowed for little attenuation of the energy before it reached the surface¹⁵. The energy released by the earthquake coupled with the extreme vulnerability of the region created a severe crisis scenario. The statistics regarding the impact of the earthquake are widely disputed as the collection and verification of data in Haiti before the disaster was difficult, and in the post-disaster situation it is near impossible. According to official estimates released by the government, 222,570 people have died as a result of the earthquake and an additional 300,572 were injured. The earthquake directly affected nearly 3.5 million Haitians, over a third of the country's population. Damage and losses were estimated to be nearly 8 billion dollars, including 4.3 billion dollars worth of physical assets. Almost 300 000 homes were destroyed by the earthquakes force, causing a major housing crisis with nearly 1.5 million people being displaced and seeking shelter in emergency response camps. Many important social and cultural buildings were damaged or destroyed, including 80% of schools in Port-au-Prince and 60% of all schools in the two most affected regions.¹⁶ The result of this earthquake was catastrophic and generated a global humanitarian response. The immediate response from the global community was an outpouring of funds, pledged to the recovery of this tragedy. An unprecedented amount of aid, 13.34 billion dollars¹⁷, was pledged.

The response to crisis situations is a three step process of relief, recovery, and planning. Relief is the immediate, urgent response. It is the emergency state, where the most critical need

¹⁴ Ibid Pg 8

¹⁵ Styles, P. (2010, March-April). The Haiti Earthquake: a salutary lesson in (non) earthquake engineering. *Geology Today*, pp. 53-54.

¹⁶ UN Office of the Secretary-General's Special Advisor. (2012). *Key Statistics*. Retrieved from Lessons from Haiti: <http://lessonsfromhaiti.org/lessons-from-haiti/key-statistics/>

¹⁷ Ibid

is life-saving services, such as medical treatment, food and water provisions, and shelter for the displaced. In Haiti the earthquake crippled the existing infrastructure including transportation networks creating a critical situation in the distribution of aid. Recovery is the strategic strengthening of pre-existing local systems. It includes the rebuilding of vital infrastructure systems such as transportation, power, water, etc¹⁸. The recovery of the affected population is not only the physical needs of water, food and shelter, but also the physiological recovery. This stage of the response should be focused on restoring the dignity of the survivor. The final stage in the response is planning. Planning is organized around the long-term sustainable development of a community. It is focused on not only mitigating the risks and vulnerabilities of the past, but also on facilitating the continued social and economic growth of the affected region.

The current state of the response features all three phases (relief, recovery, planning) in process simultaneously. The response has been complicated and obstructed by numerous political, social, economic, and environmental issues. While the most urgent, critical aspect of the relief stage has concluded there is still a daily struggle of survival caused by extreme poverty. Food and water are still regularly distributed to makeshift tent cities that provide feeble shelter to usually the most vulnerable of the survivors. The recovery process has begun as roads are being rebuilt, rubble is being removed, services are being reconstructed and shelters are being upgraded. As the issues that are impeding the recovery process are slowly resolved the time for planning has arrived. The concepts of vulnerability and resiliency are guiding ideas in the development of a rebuilding program. In order to achieve a viable, long-term solution to community development, a project needs to take into account the pre-existing vulnerabilities that created the fragility of the pre-disaster area. These vulnerabilities need to be reduced and the resiliency of the community needs to be increased through the implementation of the recovery project. In order to create an environment of subsistence for the occupant, the development will need to contain provisions for numerous political, economic, social, and environmental issues.

¹⁸ Mayne, T. (2014, 03 07). *Haiti Now Studio Brief*. Retrieved from UCLAHaiti Architecture Studio: http://www.aud.ucla.edu/student_projects/advanced_topics_studios/401_advanced_topics_studio_thom_mayne_haiti_now_50.html

TYPES OF SHELTERS

The typical progression of housing in disaster relief projects follows three distinct stages. The first stage is the construction of emergency shelters. These shelters are intended to be temporary and often only provide the bare essentials for survival. They need to be assembled immediately after the disaster and often at a massive scale. One of the most challenging issues is finding safe, suitable land for these shelters. In Haiti the scale of the affected area was so large and the need for emergency shelter was so great, shelters were erected in any open plot of land in the city. When there were no open plots of land left, they had to build the shelters in the outskirts of the cities along the hillsides. The shelters were made up of plastic tarps, supported by whatever makeshift structure was available. They provided very little shelter from the elements, and almost no security from theft, or vandalism. The incredible need for emergency shelters created even more vulnerability to other hazards as shelters were hastily built, did not provide access to infrastructure, and were exposed to the elements. Shortly after the earthquake there was the potential of a hurricane headed toward the island, but thankfully it changed course and avoided the area. If the hurricane had headed toward Haiti than the increased vulnerability of the emergency shelters would have created even more devastation. The possibility of a second natural hazard so soon after the earthquake emphasized the limitations of emergency shelters and the need for improved architectural intervention.

The second stage in most rebuilding process is the construction of transitional housing. This stage is a direct response to the land ownership issue. Since the acquisition of suitable land is such a long process and the emergency shelters are only designed to be temporary, there is a period of time in which more dignified housing is built, but cannot be permanently fixed to the land. The housing units are often prefabricated optimized solutions that can be erected on public land, urban space, or even beside the debris of destroyed buildings. The term “transitional housing” refers to the move towards permanence, but often they are not designed to adapt to a more long-term housing option.

“Is it worth diverting long-term resources to alleviate short-term problems? If yes, what short-term problems shall get priority?” Marie J. Aquilino ¹⁹

Determining how much aid should be invested in transitional housing is a difficult decision because it does not lead to a permanent housing solution. Providing people with a more dignified shelter rather than the immediate emergency shelter will help restore some pride and self-worth within the community. However how much aid should be invested for this short-term solution and will it have adverse effects on the ability to provide long-term permanent housing solutions.

The final stage of rebuilding after disasters is the construction of permanent housing and communities. The focus on permanence is easily shadowed by the day-to-day chaos over post-disaster situations. Permanence should be the end goal of any rebuilding process, but it needs to be accomplished according to a plan for sustainable long-term viability. Rebuilding permanent communities includes providing all the necessities of life and commerce. This is a demanding task because it includes so many different components; from shelter, to education, to industry, etc. Permanent housing should also reduce the vulnerability of the population. Safe land use, environmental and community planning, resilient infrastructure and sustainable building practices are all measures that need to be taken to ensure disaster prevention and preparedness.

Figure 1.1– Typical Progression of Housing Types Post-Disaster in Haiti

¹⁹ Aquilino, M. J. (2011). *Beyond Shelter; Architecture and Human Dignity*. New York: Distributed Art Publishers.

Figure 1.2 – Urban Infill Emergency Shelter progression

CHAPTER 2: VULNERABILITY

WHAT IS VULNERABILITY?

Earthquakes, hurricanes, floods and other natural phenomena are not exclusively the cause of “disasters”. These natural events result in disaster scenarios because of the fragile balance between the natural, human, and built environment. The human and built environments create a level of “weakness” that determines the vulnerability of a society to the destruction that can result from the interaction with a natural event. The UNISDR defines a “disaster” as:

“A serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources”- UNISDR

*Terminology*²⁰

The second part of the definition alludes to the notion of vulnerability. Vulnerability characterizes the ability of a society to cope with or recover from a natural event without the need for external intervention. There is a limit to the amount of destruction that can be handled by a society before they need assistance from outside sources. This limit is determined by the vulnerability of the community. The UNISDR also defines “Vulnerability” as:

*“The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard” – UNISDR Terminology*²¹

The vulnerability of a society can vary based on its demographic composition. Some groups are more prone to damage, loss or suffering based on variables such as social status, age, gender, occupation, ethnicity, or health status. Therefore, the vulnerability of any group will involve varying magnitudes. For the purpose of this research vulnerability will be measured at the community level, rather than divulging into the specifics of personal vulnerabilities.

²⁰ United Nations: International Strategy for Disaster Reduction. (2009). *UNISDR Terminology of Disaster Risk Reduction*. Geneva: United Nations. Pg 30

²¹ Ibid. Pg 9

Vulnerability affects the ability of a society to rebuild their livelihoods. Socio-economic status is the most closely correlated factor of the ability of an individual to rebuild or recover from this disruption. Those who have access to more resources will likely be less susceptible to damage than those who have very limited access to resources. The population of the Port-au-Prince region of Haiti includes numerous levels of socio-economic statuses, and therefore the level of vulnerability varies across the region.

MEASURING VULNERABILITY

The ability to measure vulnerability is a key step towards developing an effective strategy for the reduction of risk and increasing the resilience of a community. In their book “At Risk: Natural hazards, people’s vulnerability and disasters” Ben Wismer, Piers Blaikie, Terry Cannon, and Ian Davis explain a model they have developed to assist in the quantification of the vulnerability of societies. The “Pressure and Release” (PAR) Model (figure 2.1) is based off of the commonly used equation:

$$\text{Risk} = \text{Hazard} \times \text{Vulnerability}$$

This model is organized around the idea that a disaster is the intersection point between these two opposing forces. The risk of disaster is a compound function of these two forces, and increases exponentially as the level of vulnerability or the level of hazard increases. A disaster scenario cannot exist without a hazard event, just as it cannot exist if there is not a population to affect, or if the vulnerability of the population is (theoretically) nil.²²

²² Blaikie, P., Cannon, T., Davis, I., & Wismer, B. (2004). *At Risk; Natural hazards, people's vulnerabilities, and disasters*. New York: Routledge. P.49

Figure 2.1: Pressure and Release Model²³

²³ Blaikie, P., Cannon, T., Davis, I., & Wismer, B. (2004). *At Risk; Natural hazards, people's vulnerabilities, and disasters*. New York: Routledge.

Vulnerability is measured as a series of processes that generate an increasing level of susceptibility. The root causes reflect the exercise and distribution of power in a society. It examines the macro level of a community from the political and economic organization to the social structure and class hierarchy. The economically marginal members of society tend to be of less importance to those who have power and control over the political and economic development of a society. This creates an imbalance in access to resources or livelihoods which reflect the root cause of the level of vulnerability of these people. The root causes can be economic, demographic, and political processes, which determine access to and distribution of both power and various resources. The dynamic pressure category is a zone of transitional forces that transform and channel the effects of root causes into unsafe conditions. They reflect more contemporary or immediate forces contributing to unsafe conditions than the general overview of underlying political, economic, and social patterns outlined as root causes. Unsafe conditions are specific forms in which human vulnerability is revealed and expressed in a temporal and spatial dimension.²⁴ Unsafe conditions are dependent on the initial level of well-being of the community and the access of this group to tangible resources (cash, shelter, food and water) and intangible resources (social support networks, morale, and the ability to function in a state of crisis).

CONTRIBUTING ISSUES

The PAR Model creates the theoretical framework from which to begin historical and local research into the specificity of the issues impacting Haiti and the Port-au-Prince region. Much of the research contributing to this thesis can be organized into this qualitative vulnerability mapping model (Figure 2.2).

. A

Figure 2.2: Pressure and Release Model: Applied to Haiti (by author)

LITERACY AND POVERTY

The poor social and economic development of Haiti limits its access to resources and its ability to cope with damages caused by natural events. The literacy rate in Haiti is around 53% and the cost of education limits access to training for a large percentage of the population²⁵. The extreme poverty of Haiti is highlighted by the country's low GDP per capita of \$664 USD, which is comparatively about 13% of the GDP of the Dominican Republic (\$5,233) which shares the same land mass. It is less than 1.4% of the GDP per capita of a developed nation like Canada (\$47 367)²⁶.

ACCESS TO LIFELINES

The level of development of a country can often be revealed by the level of infrastructure that is provided to its inhabitants. In the more developed countries access to clean water, electricity, sanitation systems, telecommunication and transportation is considered as a basic need to achieve a comfortable state of living. Access to these same systems in a less developed country are often very limited and seen as an amenity that is often out of reach for the majority of the society. Haiti's economic and social development struggles are highlighted by their inability to provide their population with reliable access to lifelines. Lifelines are a system or network that provides for the circulation of people, goods, services, and information upon which health; safety, comfort, and economic activity depend²⁷.

²⁵ Central Intelligence Agency. (2014, April 16). *Haiti*. Retrieved from The World Factbook: <https://www.cia.gov/library/publications/the-world-factbook/geos/ha.html>

²⁶ International Monetary Fund. Report for Selected Countries and Subjects. October 2013. 31 Jan 2014 <<http://www.imf.org/external/pubs/ft/weo/2013/02/weodata/>>.

²⁷ Platt, R. (2007, December 18). Lifelines: An Emergency Management Priority for the United States in the 1990s. *Disasters*, pp. 172-176.

TRANSPORTATION NETWORKS: In 2009, only eighteen percent of Haiti's 4266 km of roadways were paved.²⁸ Only two of the 8 National Highway Routes are fully paved, but they receive little maintenance. The majority of the paved roads are in a state of disrepair due to years of maintenance neglect. Roads are littered with potholes, makeshift speed-bumps, and large sections washed away due to flooding or heavy rainfall. The poor conditions of the roads not only increase the difficulty of travelling, but also increase the maintenance costs of the vehicles that navigate them. Another issue that one will quickly notice in Haiti is the absence of any road signage, resulting in chaos at every large intersection. Even intersections of heavily travelled two lane roadways operate without any streetlights or stop signs, which lead to the creation of traffic jams and gridlock at almost all hours of the day. Accidents and damaged vehicles are commonplace in Haiti, as any car that is on the road without any sign of past damage or accident is considered an anomaly. Public transportation is facilitated by the use of modified brightly coloured pick-ups trucks called "tap-taps" This is the easiest and most affordable way of travel for Haitians. A typical trip will cost only 10-20 gourdes (\$0.20 to \$0.40 USD per trip), but the driver is only able to provide such reasonable rates because they fill the vehicle to the absolute maximum occupancy, sometimes fitting 20+ people into the modified bed of the truck. Moto-taxis are also used for transportation along roadways that are impossible to travel by four wheeled vehicles. Moto-taxis often service people who need transportation through alleyways and damaged gravel roads. These are more expensive because they can only accommodate 3 passengers at most, so those who cannot afford it may resort to walking many miles to travel between their homes and the main road.

WATER SUPPLY AND SANITATION: As of 2011 estimates, only 64% of the population had access to drinking water from improved water sources²⁹. Improved sources include any of the following sources: piped water into dwelling, yard, or plot; public tap or standpipe; tubewell or borehole; protected dug well; protected spring. The access to clean water is greater in urban

²⁸ Central Intelligence Agency. (2014, April 16). *Haiti*. Retrieved from The World Factbook: <https://www.cia.gov/library/publications/the-world-factbook/geos/ha.html>

²⁹ Ibid

areas (77.5%) compared to rural areas (48.5%). As of 2011 estimates, only 26% of the population had access to improved sanitation facilities³⁰. Improved facilities included any of the following sources: flush or pour-flush to a piped sewer system, septic tank or pit latrine; ventilated improved pit (VIP) latrine; pit latrine with slab; or a composting toilet. Sanitation facilities such as pit latrines, septic tanks, and composting toilets need regular maintenance in order to continue operation. If maintenance is ignored or avoided the system will quickly deteriorate and may need additional investments in order to resume activity. Both clean water and sanitation facilities are necessary for not only survival but also the health and well-being of a population. Failure to provide access to those systems leaves people with increased vulnerability to disease.

ELECTRICITY AND TELECOMMUNICATIONS: The Haitian electrical utility is a problematic industry that struggles to be able to provide regular electrical access to its customers. Suffering from underfunding from the government, rising energy generation costs, high inefficiencies, and chronic theft, the Electricite d'Haiti (National Electric Utility) only provides official access to 12.5% of the Haitian population. Upwards of 70% of the electrical generation in Haiti relies on thermal plants, which relies heavily on fossil fuels which are susceptible to rapid price increases³¹. The other 30% of Haiti's power is generated by a single hydroelectric plant which has experienced reduced efficiency due to the environmental impacts of deforestation. Those who have access to the power grid are subject to rotating blackouts and often only receive service for 4-10 hours a day. As a result, in order to have access to power throughout the day residents must rely on an inverter and battery system to store power during service times, coupled with a diesel or gas powered generator as a supplementary source. This increased reliance of inefficient power generating processes is expensive and increases the consumption of fossil fuels. Many Haitians who cannot afford the rising cost of electrical service resort to illegal connections to steal energy from the grid. This results in the inability of the national service provider to cover the costs of energy. It is estimated that 35% of the energy being produced by Electricite d'Haiti is lost due to theft, costing the government \$11 million USD/month. The telecommunications network is the

³⁰ Central Intelligence Agency. (2014, April 16). *Haiti*. Retrieved from The World Factbook: <https://www.cia.gov/library/publications/the-world-factbook/geos/ha.htm>

³¹ Ibid

least developed in the Caribbean area. Although in recent years it has experienced rapid growth of its mobile-cellular services due to the introduction of low-cost GSM (Global Systems for Mobile) phones. The coverage rate for mobile phones grew from 6% in May 2006, to 62% of the population having access in 2012. Internet access is still scarce in Haiti and only 11% of the population had access to the internet in 2012³². The scarcity of land line service has limited the increase of access to the internet and most of the population relies on mobile or wireless connections.

BUILDING CODES AND REGULATIONS / CONSTRUCTION METHODS

“Earthquakes don’t kill people, buildings do” is a commonly used phrase used by the humanitarian response industry in the wake of destruction caused earthquakes. This idea suggests that it is buildings themselves which contribute to the tragic loss of life we encounter in disaster scenarios. The built environment’s most primal function is to provide shelter to the inhabitant, however when unsafe building methods are used it creates a fragile structure that is extremely susceptible to damage from an earthquake. The structure which is supposed to provide shelter from the elements can actually cause the most danger to the health and well-being of the inhabitant. The earthquake on January 12, 2010 in Haiti was a clear example of this tragedy. Similar natural events have occurred in other areas of the world, with much less casualties. In Chile, an 8.8 magnitude earthquake hit the coastal region less than two months after the event in Haiti, yet the loss of life and damages were significantly less in Chile.³³ This discrepancy can be attributed to an unregulated and improper building industry that had created a system of unsafe construction practices.

There are currently no building code regulations in Haiti. Regulators often resort to ACI 318 (American Concrete Institution’s Building Code for Structural Concrete) EuroCode8 (Seismic

³² Central Intelligence Agency. (2014, April 16). *Haiti*. Retrieved from The World Factbook: <https://www.cia.gov/library/publications/the-world-factbook/geos/ha.htm>

³³ EM-DAT The International Disaster Database. (2014, 05 12). *Search Details Disaster List*. Retrieved from CRED - Centre for Research on the Epidemiology of Disasters: <http://www.emdat.be/search-details-disaster-list>

Design of Buildings) and the Canadian National Building Code³⁴. Which regulation is followed (if any) is dependent on the experience and expertise of the personnel involved in the project.

The problem lies within the culture and tradition of Haiti's building industry. The predominant building material in Haiti is concrete block masonry. There is a need for proper education and training; codes, standards and guidance; enforcement; and tangible examples of proper construction techniques.

Figure 2.3 – Improper Construction techniques and substandard building materials lead to the destruction of the majority of housing in the affected area

³⁴ Klarreich, K. (2012, 08 2). *Trouble Enforcing Building Codes Leads to Dangers in Haiti*. Retrieved from International Center for Journalists: <http://www.icfj.org/news/trouble-enforcing-building-codes-leads-dangers-haiti>

Figure 2.4 – Typical Masonry Infill Construction – Poor construction techniques allowed for separation of masonry panel from poured concrete column

Figure 2.5 – Example of handmade concrete blocks being used to construct a floor slab, highlighting the inexperience or lack of education of Haitian contractors

URBANIZATION AND RAPID POPULATION GROWTH

Urbanization and population growth are major factors in the increase of vulnerability of people in developing countries. The global population has increased to above 7 billion people with over 90 percent of the growth estimated to occur within the developing world. In developing countries additional children are seen as essential to provide labour, security, and additional sources of income for parents. The rise in population coupled with rapid urbanization towards the core cities creates an increase in land pressure. Unequal access to land due to economic factors creates increased vulnerability of the poor³⁵. This results in the increased use of hazardous land for housing, out of necessity and desperation for shelter.

Haiti experienced a collapse in their agricultural economy during the 1980's which forced the rural work force to migrate to Port-au-Prince and other smaller urban areas to increase their access to labour-intensive industries such as food processing, metal, and textiles. Haiti's population growth is 2.2% per year, with a 5% growth in urban areas. Urbanization has resulted in an increase from 1.2 million urban inhabitants in 1982 to over 3.2 million people living in urban areas in 2002, with two-thirds of that growth occurring in Port-au-Prince.³⁶ The area of Port-au-Prince is a densely populated region with an urban peasant culture. The population of the region is difficult to estimate because of large areas of slum development across the hills adjacent to the city. The increased demand of land caused by population growth and urbanization has caused an outward expansion of the city onto hazardous land such as steep hillsides which are prone to mudslides and valley bottoms which are susceptible to flooding. The use of hazardous land for residences or places of work create unsafe environments and increase the occupant's vulnerability to natural hazards.

³⁵ Blaikie, P., Cannon, T., Davis, I., & Wismer, B. (2004). *At Risk; Natural hazards, people's vulnerabilities, and disasters*. New York: Routledge. P.70

³⁶ Verner, D. (2006). *Social Resilience and State Fragility in Haiti*. World Bank

Figure 2.6 – Urban Density in Port-au-Prince, Haiti

NATURAL RESOURCE DEGRADATION

The state of the natural environment can have a significant impact on the level of vulnerability. Destruction of forests, soil, wetlands, and water sources create hazardous areas. There is often a connection of land degradation to national policies that favour export production. The natural resources of the area are traded for economic gains, but can negatively create a scenario where the short-term gain of finances creates a long-lasting adverse environmental condition. Deforestation of an area is a direct cause of soil erosion which lowers the capability of the land to produce a harvest. If the soil erosion is significant and uncontrolled it can lead to a process of desertification, where the land begins to lose its bodies of water and become increasingly arid. Land degradation is a significant dynamic pressure because it can increase the intensity and/or frequency of hazards. Deforestation has an impact on the stability of slope increasing the risk of landslides and erosion can increase the risk of drought. In areas of poor economic and social conditions the overdrafting of water sources, overgrazing, and land

exhaustion can significantly impede the productivity of the land. The economic situation of the inhabitants creates a struggle between immediate survival and long-term sustainability of the land.

The deforestation of the Haitian forest is influenced by two major factors. The first factor is the logging industry employed an unsustainable practice of clear-cutting forests and exporting the goods. This practice went generally uncontrolled by the industry throughout most of the twentieth century. Despite limited governmental control policies, which generally went unenforced, the practice stripped large areas of their protective layer of vegetation. The second major contributing factor is Haiti's reliance on wood and charcoal for energy and food preparation. The increasing demand of the growing population increased pressure on the production of charcoal and deforestation increased. In 1923 over 60% of Haiti was covered with forests, and as of 2006 less than 2% of the land was still forested³⁷. The most striking image of this complete natural resource degradation is aerial photos of the border between the Dominican Republic and Haiti (Figure 2.7). The physical border between the two nations is indicated by the stark contrast of green vegetation of the Dominican Republic and the brown arid landscape of Haiti, which is the result of generations of unsustainable forestry practices and unregulated environmental protection. Another major impact on the level of vulnerability in Haiti is the result of soil erosion and desertification. The city of Port-au-Prince is situated in a valley between two large mountain ranges. The effects of soil erosion have increased the risk of flooding and landslides contributing to the increase chance of the hazards occurring in this densely populated area. Large slum areas of Port-au-Prince are built directly on the steeply slope hillsides on the periphery of the city as a result of limited access to suitable land in urban areas. These slum settlements are poorly constructed and situated on extremely hazardous land which creates the environment for another disaster to occur if a landslide was to occur. The low-lying valley in which Port-au-Prince rests is susceptible to extreme flooding especially during the two rainy seasons. The degradation and

³⁷ Library of Congress - Federal Research Division. (2006). *Country Profile: Haiti*. Washington: The Library of Congress. Pg 10

mismanagement of natural resources have contributed to increased vulnerability in Haiti especially in the densely populated capital region.

Figure 2.7 – Aerial Photograph of Border between Haiti and Dominican Republic defined by the stark contrast in vegetation

CHAPTER 3: RESILIENCY

WHAT IS RESILIENCY?

The occurrence of these natural hazards cannot be completely eliminated. In order to provide safe environments for people in vulnerable communities there is a need to increase their resilience to the effects of these events. The UNISDR defines “resilience” as:

“The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions.” – UNISDR Terminology³⁸

Resilience is achieved through increasing the capability of the people in the community to withstand the effects of the natural event and their capacity to recover from any destruction that may have occurred. The key to creating resilience is ensuring the capability of the built environment to both resist and recover rapidly following a disaster event.³⁹ The damaging effects of these natural hazards can be decreased through some processes and strategies, but they cannot be eliminated, which leads to the notion of absorption, accommodation, and recovery. A system needs to create an environment where the level of destruction is such that it can be repaired without sacrificing an excessive amount social, economic, and environmental capital that would cause a serious disruption to the functioning of the community. A resilient built environment needs to maximize the ability of built assets, associated support systems (physical and institutional), and the people that reside or work within the built assets, in order to increase resiliency. Vulnerability and resilience act as the two opposite ends of the spectrum. The economic, social, and environmental factors that influence a community or society’s level of susceptibility or resistance to the effects of a natural hazard determine its place along that spectrum.

³⁸ United Nations: International Strategy for Disaster Reduction. (2009). *UNISDR Terminology of Disaster Risk Reduction*. Geneva: United Nations. Pg 30

³⁹ Boshier, L. (2008). *Hazards and the built environment: Attaining a built-in resilience*. London: Taylor and Francis. Pg 357

MEASURING RESILIENCE

Resilience is measured by the size of displacement a society or community can tolerate and yet return to a state where a given function can be maintained.⁴⁰ The Pressure and Release Model (Figure 2.1) that created the framework for defining and analyzing the level of vulnerability can be reversed to begin organizing a strategy for increasing the resilience (Figure 3.1). The root causes of Haiti's vulnerability outlined in the previous chapter are difficult for a rebuilding program to influence but they should not be regarded as immutable or unchangeable factors. Improved governance is the most influencing factor in creating resilience within a society. Good governance applies to more than just the entity of government. It incorporates social, economic, political, and environmental aspects to improve the exercise of formal power and authority within a society, from the national, provincial, and local level. Fair and intelligent organization is needed in order to understand the necessity of risk reduction and to coordinate the implementation of various strategies to increase resiliency. Strategies outlined in this model are intended to reduce the dynamic pressures in order to achieve safe conditions for the inhabitants of the community.

⁴⁰ Wilson, G. A. (2012). *Community Resilience and Environmental Transitions*. New York: Routledge.

Figure 3.1: Reversed pressure and Release Model⁴¹

⁴¹ Blaikie, P., Cannon, T., Davis, I., & Wismer, B. (2004). *At Risk; Natural hazards, people's vulnerabilities, and disasters*. New York: Routledge.

RESILIENT STRATEGIES

The reversal of the PAR Model creates the framework for outlining the progression to safety (Figure 3.2). The strategies defined in this model will begin to create an environment of resilience to improve the community's ability to resist, and recover from the opposing force of the possible natural hazards.

Figure 3.2: Reversed PAR Model – applied to Haiti (by author)

LAND USE PLANNING

The lack of an organized land usage is a result of an underfunded national planning department and enforcement strategy. This inefficiency has created land use patterns that increase the vulnerability of the inhabitant and squander the opportunity to maximize the production of the limited arable land remaining. Identifying and evaluating the different options for the use of land, and the economic, social, and environmental objectives and implications of the land use patterns is an important aspect of a viable community development.⁴²

Chronic deforestation has led to the erosion of most of the arable soil in the country. It is essential that all remaining arable land be protected from further degradation or development. The designation of all arable land for agricultural uses will not only increase the economic production of the agricultural industry, but it can also be used as a catalyst for reversing the trend of soil degradation and reclaim lost areas of production. Agriculture is an important industry in this culture because of its ability to provide sustenance to the community and potential exports.

The designation of no-build zones is also an important aspect of creating resilience within a community plan. In order to eliminate the use of hazardous areas such as steep hillsides and dried up river beds as building sites, no-build zones must be clearly outlined and strictly enforced. These areas are susceptible to frequent natural hazards and contribute to vulnerability, especially when occupied by temporary housing.

Areas for the development of the built environment need to be identified.. With flat arable land prioritized as agriculture, creative practices need to be employed to provide suitable land for the rebuilding effort. Shallow sloped hillsides can be made suitable for buildings if they are fortified against soil erosion, flooding, and water runoff. The main objective of this land use planning is to select and adopt the best land use options to meet the economic and social needs of the people⁴³, while eliminating the use of all hazardous land to reduce vulnerability.

⁴² Architecture for Humanity. (2010). *Rebuilding 101 Manual*. New York: Architecture for Humanity.

⁴³ Jha, A. K. (2010). *Safer Homes, Stronger Communities*. Washington: The World Bank.

PROTECTION AND GROWTH OF AGRICULTURAL OPPORTUNITIES

In an environment that has been destroyed by both human and natural influences, the recovery of the agricultural industry is essential to Haiti's future. The elimination of a large majority of the available arable land has led to increased pressure for production from the remaining parcels of land. It is important to not only protect these remaining parcels, but also to explore opportunities to recover some of the previously damaged agricultural land. As a result of decades of deforestation wood is currently not an economically viable building material in Haiti leading to the use of cementitious building materials which are much more vulnerable to earthquakes. Reforestation efforts would assist in making wood a more economically obtainable option for construction. Reversing the desertification of the soil through reforestation would also increase its productivity and availability. Agriculture is essential to the everyday life of Haiti through the production of food.

*Although more than half of Haiti's workers labor in agriculture, the country still imports most of its own food. Now, as hundreds of thousands of quake victims move to the provinces, restoring agriculture is key to helping Haiti feed itself and providing needed jobs.*⁴⁴

The inclusion of self-subsistence farming can increase the resiliency of a community. Agriculture not only provides sustenance for the Haitian population but it can also assist in protecting from future natural hazards such as flooding, landslides and droughts. The Food and Agriculture Organization (FAO) of the United Nations has been diligently working in Haiti to protect and restore the once profitable agricultural industry. One area of intervention was seed and material distribution to small-scale agriculture facilities and households to being to reinvigorate food production in the areas most disrupted by the earthquake⁴⁵. Investing in small scale agriculture and subsistence farming by households help the most vulnerable communities begin to rebuild

⁴⁴ Boodhoo, N. (2010, March 30). Restoring agriculture seen as key to helping Haiti. *Associated Press*

⁴⁵ Food and Agriculture Organization of the United Nations. (2011, October 04). *Helping Haiti's most vulnerable communities rebuild*. Retrieved from FAO in Emergencies: <http://www.fao.org/emergencies/fao-in-action/stories/stories-detail/en/c/152985/>

their livelihoods. The agricultural industry has the capability to solve the food crisis, provide valuable employment, and even assist in economic development through the exporting of goods. The regeneration of agricultural land is essential to increasing Haiti's resilience.

CONSTRUCTION REGULATIONS

In a society where poverty is so widespread, the regulation of constructing one's own home is very difficult. Haiti has numerous areas of slum development and shanty-towns. This is a byproduct of the poor economic and social development of the nation. In order to increase the ability of the structure to resist the effects of a natural hazard it is necessary to control what types of materials are suitable for building and what construction methods need to be used. However, the management and control of materials also needs to accommodate the incremental and gradual construction process of a family with limited resources. There are currently multiple ventures investigating ways to improve Haiti's construction industry. Architecture for Humanity has begun the Haiti Rebuilding Center, which includes a vocational school for contractors to receive hands on experience in proper construction of concrete block buildings⁴⁶. The thorough training of local workers is important for the ability of Haiti to improve construction practices. The majority of the trade industries operate on a master to intern training process. By educating masters on hurricane and earthquake resistant building methods the knowledge can be passed on by Haitians. Rebuilding manuals are being developed in the native Creole language to explain proper techniques and methods for building structurally sound buildings⁴⁷. In addition to education, it is also important for an ongoing review process in new community developments which can enforce building regulations and ensure that all guidelines for resilient construction are being followed.

⁴⁶ Architecture for Humanity. (2013, Feb). *The Haiti Rebuilding Centre*. Retrieved January 31, 2014, from <http://architectureforhumanity.org/haiti>

⁴⁷ Architecture for Humanity. (2010). *Rebuilding 101 Manual*. New York: Architecture for Humanity.

INTEGRATING CULTURE

The struggle of everyday life in Haiti is eclipsed by the rich and vibrant culture that provides colour, entertainment, and joy to the mundane. One of the most striking memories of Haitian life is the artwork, music, and colours that bring life into the streets of the communities. This life is most apparent during the most important social event within the community, which is the “market day”. This cultural hub of activity is the socio-economic fulcrum of everyday Haitian life. The urban development of communities in Haiti is centered on the marketplace. A community plan will not succeed if it ignores the importance of culture. Culture is integral to the social development of the inhabitants. Schools, churches, community centres, marketplaces, and recreation are essential parts of the community fabric. They provide the social and health services which will enrich the community.

"Everyone has practical, usually tacit knowledge of their social and physical environment, a competence reflected in 'knowing how to go on' in the routine activities of everyday life, and the capacity to improvise and innovate when necessary".⁴⁸

The marketplace is a place for purchasing goods, initiating commerce and interaction between the residents of the community. It is the most vibrant area of the community where culture is taught, practiced and put on display through the ritual of trade. In the post-disaster scenario this represents a return to everyday life after the disruption of the earthquake. The “Iron Market” in Port-au-Prince was an iconic symbol for Haitian aspirations for over 120 years. It suffered extensive damaged from a fire in 2008 and additional destruction as a result of the earthquake. The reconstruction of the market was a main priority of the early rebuilding efforts as it would be a symbol of the recovery from the disruption of the earthquake.⁴⁹ It was rebuilt in less than one year, and inaugurated on the one year anniversary of the disaster. The marketplace is integral to the strength and success of a community and needs to be integrated into every permanent rebuilding program for Haiti.

⁴⁸ Roy Ellen. (2010). *Indigenous Environmental Knowledge and its Transformations: Critical Anthropological Perspectives* New York: Routledge.

⁴⁹ Iron Market Reconstruction / John McAslan + Partners (2013, June 12). ArchDaily.
<http://www.archdaily.com/?p=392802>

CHAPTER 4: REBUILDING PROGRAM ISSUES

LAND TENURE AND ACQUISITION

The greatest obstacle in the rebuilding process is obtaining safe land for housing that has access to sufficient services and infrastructure⁵⁰. Land ownership is often unclear in post-disaster situations and there can be disputes among multiple parties over the ownership of a single parcel of land.

*When Nature challenges man's ingenuity, one tool that everyone, including the poorest of the poor, should be able to reach for is legal property, essential for the creation of harmonious towns and communities capable of standing up to the forces of nature – and rebuilding afterwards, quickly, efficiently, and fairly.*⁵¹

In Haiti there was a near non-existent land registry prior to the earthquake. Only approximately 5% of the land mass of Haiti had been registered with the underfunded and mismanaged land registry management office⁵². Unclear ownership stifles the progress of the rebuilding effort. It creates a problem not only in obtaining safe land for rebuilding, but also reduces the government's ability to expropriate land in order to provide new infrastructure. One of the problems this creates is forcing organizations to build new communities in northern, more remote areas of Haiti because it is less legally challenging. However these homes are being built prior to the development of services such as clean water, sanitation systems, proper roadways, and health or education services. As a result, there is a reduced chance these isolated communities, void of basic amenities, will be successful in the long-term. Planning for infrastructure and services should be the top priority of the rebuilding process, rather than

⁵⁰ Haiti Property Law Group. (2012, June 26). A how-to guide for the legal sale of property in Haiti. *Haiti Land Transaction Manual*.

⁵¹ Lizarralde, G., Johnson, C., & Davidson, C. (2010). *Rebuilding After Disasters; From Emergency to Sustainability*. New York: Spon Press.

⁵² Riddick, W. (2010). *Haitian Immovable Property Law Obstacle for Development*. Haitian Resource Development Foundation.

permanent homes for the affected population. The push for shelter first is yet another example of the way that the climate of urgency inhibits proper planning and development.

SPEED OF RESPONSE

In the immediate aftermath of a disaster market forces tend to establish pressures to reconstruct built assets (such as water supplies, transportation networks, healthcare facilities, and commercial buildings) as quickly as possible. Lee Bosher and Andrew Dainty suggest that this sense of urgency, albeit understandable, can actually hinder the ability to create resilience.

*“Post-disaster responses and reconstruction efforts that are overly influenced by a political and economic will to ‘reconstruct quickly’ are not conducive to the attainment of physical resilience. Therefore, hazard mitigation and preparedness activities need to be intertwined with response and reconstruction activities; it is through this holistic approach that physical resilience is more likely to be attained”*⁵³

By quickly rebuilding these assets the hope is to minimize the social impact and disruption the disaster has on the survivor. The pressure to build back quickly is often supported by policy makers to show that the work is being done, simply to improve one’s political rankings⁵⁴. However this urgency can actually handicap the successfulness of the rebuilding project because it limits the ability to develop a properly planned city structure that more adequately addresses the issue of vulnerability within the community. A long-term successful strategy needs to include the mitigation of hazards through numerous approaches such as local capacity building, sound urban/rural planning, and disaster-risk-reduction initiatives. This type of planning is governed and controlled by a series of socio-political factors such as land tenure, resource allocation, planning departments, etc. which can delay the process. In order for a large-scale development project such as this to be possible a top-down, authoritative process must be respected.

⁵³ Bosher, L. (2008). *Hazards and the built environment: Attaining a built-in resilience*. London: Taylor and Francis, Pg 364

⁵⁴ Lizarralde, G., Johnson, C., & Davidson, C. (2010). *Rebuilding After Disasters; From Emergency to Sustainability*. New York: Spon Press. Pg 9

MATERIALITY

The importance of using local materials and local labour can often be forgotten in the environment of urgency that follows these disaster scenarios. Prefabricated, drop-shipped shelter solutions are often perceived as an acceptable immediate response, but often they can be delayed by the logistics of production, shipping, and deployment. These types of shelters should be avoided for social and economic reasons as well. One of the major criticisms of the humanitarian organizations is the allocation of funds pledged towards the recovery program. Prefabricated units are seldom produced locally, and instead they create employment in a different (often developed) country, who become beneficiaries of aid funds rather than the country disrupted by the disaster. These types of solutions should only be utilized in the rare occasion that the affected nation is disrupted to such a degree that the local production of shelter is impossible. Local materials and labour not only stimulates the local economy, but the ability of the affected persons to contribute to their own rebuilding project can assist in the psychosocial recovery process.

CHAPTER 5: CASE STUDIES

CANAAN

The migration and settlement of the hillside of Canaan has been formed out of necessity. The elimination of a large portion of the housing stock has caused a rent increase across Port-au-Prince for the remaining suitable habitats. This increased cost leaves people financially unable to afford housing in the city. These people have migrated to the countryside because of the squatter settlement paradigm; land is essentially free, assuming you are able to “claim” it. The entire hillside has developed on a first come, first served basis⁵⁵. The most sought after land along the main highway intersection was the initial settlement location, but as more and more people moved to the area the community grew upwards and outwards, up the hillside and stretching all along the roadside. As the demand for building lots increased people and the housing availability decreased, people have resorted to living in hazardous areas, such as the bottom of a dried up river bed in order to live closer to the main road. The main road is the source point for both transportation and access to aid. Tap-taps (converted pickup trucks with bench seating and a canopy) are the cheapest option for commuting into Port-au-Prince, but they only typically travel along the paved highways. The treacherous rocky roads that stretch as veins up the hillside are only suitable for motorcycles which are more expensive. The closer proximity to the main road, allows residents to be more mobile through access to cheap transportation.

This area is already recognized as the “next slum settlement” by Haitians. They understand that this pattern of development is similar to the development of slum areas in poorer areas of Port-au-Prince. The lack of employment opportunities and the increased cost of transportation have only worsened the poverty level of the vulnerable population that resides in this area. The ad-hoc pattern of growth and the makeshift shelters are typical of slums. Unlike the planned communities which are almost autonomous in materiality, the settlement at Canaan is a mosaic of every type of building material in Haiti. As an expression of the resourcefulness of the

⁵⁵ Groupe URD (Urgence-Rehabilitation-Developpement). (2012, November). *Haiti Observatory Newsletter No.5*. Retrieved from Evolving through Evaluation: http://www.urd.org/IMG/pdf/Newsletter_no5_EN.pdf

people who have migrated to this area, they have accumulated various building materials. Buildings in this area are designed and constructed in an incremental manner. As a family accumulates the resources to further the investment in their home they will purchase additional building materials and components. This is a slow incremental process to rebuilding a permanent home for your family. The building materials range from concrete block and poured concrete, to bamboo poles, tarps and salvaged sheet metal. This creates an eccentric community of homes all at various stages of construction, from erecting foundation walls, to expressing ownership of a piece of land, to primitive piecemeal shelters.

Figure 5.1 – Aerial Photograph of Canaan Hillside area with detailed aerial photograph of the urban organization (inset)

Figure 5.2 – Typical ad-hoc, incremental development on the Canaan Hillside

CORAIL

The community at Corail is composed of people displaced from their homes who are now at the mercy of the recovery process. Most of them have been evicted from other tent city communities and have been accommodated for here in a planned transitional shelter community situated in the middle of the Canaan hillside. Over 2000 transitional shelters have been built in two separate settlement areas (two other planned settlements of 1000 units were cancelled). This is the prototypical transitional shelter camp. The transitional shelters constructed entirely out of wood are expected to provide a more dignified shelter than the tents, but are only designed to last up to a year. There are a few shared latrines, but they are poorly maintained and often avoided by the community. Commerce has begun as the main road has become a neighbourhood marketplace, where small businesses have started to service the needs of the community. There is limited vegetation on the site, taking advantage of whatever small amount of suitable top soil there is to grow a small few vegetable plants. The temporality of this place is clear as the occupants of the buildings have little sense of ownership and regular maintenance is non-existent. The future of this site is uncertain as the move to permanence is not always possible with these temporary sites. Despite providing for some of the immediate needs of the residents, it provides little stability which is important during times of recovery, little maintenance or further investment is apparent because of the instability and impermanence of the site.

Figure 5.3 – Aerial Photograph of Corail 3 and 4 transitional shelter camps

Figure 5.4 – Typical wood transitional shelters

MORNE A CABRIT

Located 10 miles outside of the urban area of Port-au-Prince is a sprawling subdivision of brightly coloured concrete houses lining newly paved roads and untouched curbs. The Community is organized as superblocks with four rows of single family housing per road with a pedestrian pathway servicing the inner rows. At the end of every two rows is a two-storey, four unit apartment building with the exact same unit layout and size as the single family homes. The intention of this community is to house the employees of the future industrial park that is in the planning stages of development. This community is in a prime location due to its proximity to multiple potential places of employment which are vital to the future of the community. The chance for economic growth and development is high. This planned community is currently about 90% constructed yet has a minimal occupancy rate. Only two of the sixteen blocks have any occupants in the building. There is a community centre, school, and church that have been constructed in a central block which will serve the social needs of the new community. It is unclear when the project will be finished and the community will begin to populate the area, but as of the time of my visit, the isolation of the entire development among the barren landscape was clear. This community is being prepared to not only provide for the immediate needs of the residents, but also providing amenities such as social areas and the possibility for employment. The integration of the site and the development of the area surrounding the community will be integral to the future success of this community plan.

Figure 5.5 – Aerial photograph of the community development at Morne a Cabrit

Figure 5.6 – Typical poured concrete housing unit

ZORANJE (VILLAGE DU RENAISSANCE)

This village was the site of an expo funded by the IHRC (Interim Haiti Recovery Commission) led by Bill Clinton. A study by the architecture schools of MIT and Harvard University provided insight into the planning and intentions of this development⁵⁶. The area was designed to be an “exemplar community” to the country of Haiti. Over 60 different architectural and engineering firms were invited to design and construct their prototype housing unit that could be used to assist with the housing crisis after the earthquake. The expo would be used to showcase these building prototypes to aid organizations and NGO's who would then have the ability to purchase these units for their housing projects. The critique of the expo was that it was used as a political show of progress, while in reality it was a waste of crucial aid funds. None of the houses that were built led to any further purchase and construction. And perhaps worst of all, they sat vacant for a period of almost two years while people affected by the earthquake were left to live in crowded tent-cities. Only recently has a local organization been given control of the 60 units and began to allow people to use the houses as residences. Some of these houses are more suitable for the Haitian climate and culture than others. The village is an interesting array of designs and building materials (none of which seem locally sourced). Houses range from modest two room houses to more elaborate multi-story, expansive layouts that seem out of place with the surrounding context. Village du Renaissance is a great example of the need to understand the social, economic, environmental, and political factors that influence the rebuilding program.

⁵⁶ Brickman-Raredon, A., Ergin, E., Thompson, P., Weissmann, C., & Weissmann, D. (2011). *Designing Process*. Lulu Publishers.

Figure 5.7 – Aerial photograph of the Village du Renaissance

Figure 5.8 – Examples of Disaster-Relief Housing Units designed by various Architects and Engineers and constructed in the Village du Renaissance

USAID-RED CROSS CABARET

This is a well serviced, planned development funded as a joint venture between US-AID and Red Cross. This controlled, secure community has a perimeter fence which directs all traffic through a security gate at the main entrance. The community in Cabaret is one of five projects across villages in Haiti that are built and managed by the same joint venture organization. The project includes one thousand single family housing units, a community water treatment facility, a community compost area and large septic field. The inhabitants are quickly planting the site with family vegetable gardens along the side and back of the house with flower beds along the street face. The community lacks any shade trees which causes the inhabitants to sit in the covered kitchen at the back of the unit throughout the majority of the day to escape the heat. The houses are provided exterior lighting by a series of photovoltaic powered streetlights, and are tied into the city power grid to provide interior lighting and electrical power. Potable water is provided by a filtration facility located in the south-east corner of the community and piped underground to a faucet located in the covered outdoor kitchen at the back of each unit. The cost of each of these units is \$40 000 USD, which includes the cost of constructing the infrastructure provided. The residents are required to pay only \$45 USD/month in rent and after 5 years of rent payments, they are promised ownership of the house. This system of rebuilding can be seen as winning the lottery for the occupants. For only \$2700 in capital they are receiving a property worth \$40 000. While this system works great for the inhabitants that have succeeded in their application for residency, it is an unsustainable system of development. The deficit of the buildings costs are covered by funds from international aid organizations. Once the aid resources are depleted the maintenance costs will be the responsibility of the residents, which may put increased strain on their limited resources. If this community is meant to showcase the possibilities of the rebuilding program in Haiti it lacks realistic, feasible, practicable strategies that are essential when dealing with a crisis of this magnitude.

Figure 5.9 – Typical poured concrete housing

Figure 5.10 – Water treatment facility and solar-powered streetlights within the community

CHAPTER 6: ARCHITECTURAL INTERVENTION

SITE SELECTION

The site for this project is the hillside region of Canaan. The hillside is currently home to a large squatter settlement over 140 000 people and is still increasing in size and population from day to day. The site was expropriated by the Haitian government from a Haitian firm which was planning to develop the area into an “integrated economic zone” prior to the events of the earthquake in 2010. Article one of the expropriation declaration states:

“Lands retained in this order of declaration for public utility will be used for the redevelopment of the metropolitan area of Port-au-Prince and in part to the relocation of the victims of the 12 of January 2010 earthquake”⁵⁷

This once empty barren landscape is home to 10 000 people living in government sponsored relief camps and over 100 000 other squatters that have moved to the area and begun to construct makeshift or even “permanent” housing. The area was declared a “public utility” by the government three months after the earthquake in order to be able to begin constructing emergency shelters. This declaration prompted the settlement of the area by victims of the earthquake that saw an opportunity to “own” land. The lack of governmental control and organization created a situation where a network of property speculators and facilitators began to control the appropriation and distribution of land⁵⁸. They began to institute their own system and processes of dividing and selling land that they had no legal right of ownership. As people were evicted from tent-cities in the urban core, they were led to the Canaan hillside by facilitators or land speculators that were established in the area. The groups were led to believe that they were

⁵⁷ Zidor, K. (2012, August 2). *In Canaan, Haiti unsupervised building creates danger*. Retrieved from ICFJ - International Center for Journalists: <http://www.icfj.org/hu/news/canaan-haiti-unsupervised-building-creates-danger>

⁵⁸ Groupe URD (Urgence-Rehabilitation-Developpement). (2012, November). *Haiti Observatory Newsletter No.5*. Retrieved from Evolving through Evaluation: http://www.urd.org/IMG/pdf/Newsletter_no5_EN.pdf

legally purchasing (for a small amount) or obtaining lots and began to outline their plot of land with fencing and if possible a makeshift shelter. In this context where no land titles, deeds, or surveys existed, the only guarantee of possession of a plot of land was the acceptance by neighbouring people or an organized group made up of influential members of the community. In the case of land disputes, the organized group would either sever the land into two plots or provide the wronged party another plot of land in order to avoid violent conflict. The network of land speculators were only interested in accumulating wealth and neglected to use any of the income from land purchases to provide the infrastructure that was promised, such as roadways, water, sanitation, etc. As the most suitable locations for housing were becoming fully occupied the newcomers were offered plots of land in increasingly hazardous areas. The flow of new arrivals from Port-au-Prince has not stopped and is fuelled by the closure of other tent-cities in the urban core; these new arrivals are now beginning to settle the steep hillside areas or purchasing severed lots from previous settlements which increases the density of the area which already lacks sufficient services. This unsolicited and uncontrolled settlement has led to the development of a new shantytown that is referred to as a “savage urbanisation” with “no infrastructure, no water, no electricity, and no sanitation”⁵⁹. It is imperative that this area is assisted in their development to ensure that the mistakes of the past are not repeated leading to an increasingly vulnerable community of people. Planning and organization of the settlement of Canaan must incorporate resilient strategies in order to protect the people from future hazards and avoid another disaster scenario. Intervention into the ongoing settlement of this area is critical.

⁵⁹ Haiti Grassroots Watch. (2013, June 19). *Reconstruction of Haiti Slum to Cost Hundreds of Millions of Dollars*. Retrieved from Inter Press Service: News Agency: <http://www.ipsnews.net/2013/06/reconstruction-of-haiti-slum-to-cost-hundreds-of-millions-of-dollars/>

Figure 6.1 – Hillside region of Canaan

COMMUNITY PLAN

This project includes the development of a community plan for the resettlement of the hillside of Canaan. This exemplar community will intervene on the current settlement and begin to reorganize it based on land use planning principles and strategies to increase resiliency to future hazards. The community plan will highlight the social and economic zones as well as the transportation links to the existing network. The incorporation of schools, churches, and recreational areas are important to the long-term health and well-being of the community members. The economic zones will include the development of industry which is vital to the economic development of the country as well as the development of the market area, a rich and vibrant part of Haiti's culture. The market acts as a socio-commercial fulcrum for the community, it not only is an essential part of its economy, but it is an essential part of the social atmosphere of a Haitian community.

Figure 6.2 – Community Development Area

Figure 6.2(a)– Community Layout Plan

LEGEND

1. TRANSPORTATION LINK TO HIGHWAY
2. PEDESTRIAN PATHWAY
3. MARKET AREA
4. MOTOTAXI LANEWAY
5. BUILDING PLOT
6. MARKET SQUARE PARK
7. TIERED PUBLIC PROMENADE

Figure 6.2(b)– CommunityDetails

LAND USE PLANNING

AGRICULTURAL ZONES

The protection of arable land is imperative for Haiti's ability to provide domestic agriculture that will meet their food consumption needs. Haiti's ecological crisis has led to the reduction of arable land, topsoil erosion, deforestation, destruction of watersheds, floods, and droughts. Implementing a program to restore Haiti's once fruitful agricultural industry begins with the protection of remaining arable land as well as a system developed towards reversing the adverse effects that have eliminated previously arable land. Food security and creating employment are two goals of not only increasing the resiliency towards future hazards but also improving the economic and social development of the country. The United Nations estimated in 2006 that nearly 60% of the population of Haiti could be employed by the agricultural sector which is a significant growth from the current 38.1% agricultural employment.⁶⁰

There are two differing zones of agricultural areas in this community development plan. The first zone is comprised of flat arable land that is already suitable for agricultural use. In this area there will be no development or building permitted except if it services the agricultural industry. All arable land is protected from use for the built environment and will be used to employ Haitians within the community as they begin to resurrect the agricultural industry. This particular community has a significant area of arable land that is dissected by a water reservoir outlet from a natural lake up approximately 10 miles further inland. This waterway can be used to irrigate the adjacent fields as well as filling a reservoir that will contain freshwater to be used for irrigation during the dry season.

The second area to be purposed for agriculture is the steeply sloped hillsides. These areas are not inherently suitable for agriculture, but can begin to be reforested by employing a system of natural tiering by the use of vetiver grass. Vetiver grass is a locally grown plant that is characterized by a dense root structure. This dense root structure is able to naturally fortify steep slopes and over time begins to create a natural tiered area through erosion control. Vetiver grass

⁶⁰ Central Intelligence Agency. (2014, April 16). *Haiti*. Retrieved from The World Factbook: <https://www.cia.gov/library/publications/the-world-factbook/geos/ha.html>

is a rapidly renewable resource which can be harvested 4 to 5 times a year. It is an invaluable resource because it can be used for a variety of beneficial applications. In addition to fortifying slopes, it can also be used as forage for animals, assisting in the composting process, thatching roofs or walls, but most importantly it is an efficient producer of dry biomass which can be used as a charcoal substitute. Charcoal is the most frequently used fuel source for Haitian cooking. The extensive demand of charcoal in Haiti directly impacted the rapid deforestation of the forestry industry of Haiti. Through the use of vetiver grass as biomass energy the demand on charcoal will be eliminated and the demand on the limited forestry industry will be lessened. Vetiver grass also helps rejuvenate saline soils for future agricultural production. The tiered slopes of the hillside will be fertilized by biochar produced by the vetiver grass and made suitable for additional agricultural production.

Figure 6.3 – Vetiver Plant Details and Uses

Figure 6.3 – Agricultural Zones of Canaan Hillside

NO-BUILD ZONES

The hillside of Canaan is the primary resettlement area for all of the people who were displaced by the earthquake of 2010. Over 140 000 people have already moved to the area, with more people arriving daily as other camps are being shut down. For the majority of these people this is going to be there permanent resettlement area. The spontaneous settlement pattern and distribution of land have created an inefficient layout of irregular lots of various sizes. The prime area for rebuilding has already been settled leading to new arrivals beginning to settle in less suitable areas. The expected continual increase in population may lead to the settlement of hazardous areas such as dried up river bottoms and steep hillsides. The intention of the no-build zones is to eliminate the use these vulnerable areas for rebuilding. In this particular area of the site there are two no-build zones. There is a river bed that dissects the site which may seem like suitable land during the dry season when the flow is minimal, but in a strong rainy season or during a hurricane or coastal storm this river bed overflows with runoff from higher elevations of the mountain. A fortified river edge using gabion baskets will clearly demarcate this no-build zone. It will inherently establish that the area is hazardous for rebuilding and can be easily communicated and monitored by officials. The second hazardous area of the site is an unprotected quarry site that has been used to excavate building materials. The area around the ridge of this site is extremely susceptible to landslides. This part of the site will be fenced off with a 10 foot concrete block wall that is the typical structure used to secure areas in Haiti. By clearly outlining the areas that are impermissible for resettlement it will increase the resiliency to future hazards.

Figure 6.4 – No-Build Zones of Cannan Hillside

BUILDABLE ZONES

The community development will be limited to the buildable zones which will be areas of the site that are safe from future hazards. Buildable zones will be classified dependant on the steepness of their slope and proximity to vulnerable areas. These zones will become the site of all residential, industrial, and institutional development. Gabion baskets will be used to fortify the slope, protect the site from soil erosion, and create flat buildable plots of land. The shallow sloping hillside will be tiered in order to be suitable for this development. A series of interconnected roads will link the site to the main highway which is essential for the transportation needs of the community and creates opportunity for economic development.

Figure 6.5 – Buildable Zones of Canaan Hillside

LAND TENURE

The need for land tenure for the inhabitants of the new community is critical. Without land tenure there is no long-term security of property and there will be limited incentive to further invest in the housing situation. Community members need to be enthusiastic about the self-development of their unit, and must first be assured in the permanent ownership and occupancy of their houses. Only when they feel secure will they invest their limited resources and energy into improving it. With the hillside of Canaan being declared a “public entity” there is significant confusion about the process and permanence of land ownership. The intention of the project is to propose a new building plot typology that can be used to organize the resettlement of the area while allowing for the ad-hoc development that is necessary in a self-generating rebuilding scenario. Land suitable for rebuilding is a limited resource near Port-au-Prince, which has led to the improvement and fortification of less desirable land in order to reduce the land pressure of the area. The hillside is in close proximity to the urban core, but is currently without most of the infrastructure required to make the area a suitable resettlement area. The fortification of the slope, the inclusion of infrastructure of both a communal and individual level, and the transportation links to the main highway converts the existing land into a much more desirable area for settlement. The opportunity to own a safe and secure parcel of land is rare for the majority of the Haitian community, but it is an essential start to the rebuilding of a safe and resilient community.

Figure 6.6 – Tiered building plots with initial building units

INCREMENTAL REBUILDING

The importance of allowing for the incremental development of housing cannot be overlooked. With a very limited access to resources most victims of the earthquake are unable to provide the initial investment needed for a suitable home. They are reliant on assistance from foreign or governmental aid processes to acquire shelter or building materials. The design of this project intends to provide the very basic essentials for resiliency which are clean drinking water, food, power, and shelter. In order for this project to be a successful long-term program the new homeowners will need to invest in the growth or adaptation of this initial building unit in order to meet their growing needs for a long-term sustainable house. The house plans are spontaneous, they will be developed based on the family's needs and reflect the taste and style of the inhabitants. All construction will be required to adhere to a set of standard guidelines for construction to ensure that structural resilience, but the building materials and layouts will be monitored only by the imagination of the residents. The result of this process will be a self-generated community with built-in resilience. It will result in a spontaneous architecture which will empower the residents to be creative and have control over their situation. Security and control are two elements of life that were disrupted by the hazard. This project intends to provide both of those elements to the individual in an effort to assist in the recovery process.

In many cases the new residents of this area are being transported from another relief shelter area. The initial stage of the concept of incremental rebuilding is to disassemble and reassemble the owner's existing shelter onto this new plot of land. If the new resident was granted a tent, sheet metal, tarps, or even a transitional shelter; the initial unit is designed to be closed in by repurposing these building materials. Not only will this reduce the initial investment of the unit, but it will reduce the waste of existing materials. Once the homeowner is able to further invest in their housing, either through their own accumulation of resources or other aid sources they will construct more permanent areas of their home. The tarps, scrap metal, and wood that is no longer needed can be reused to construct an outdoor Haitian kitchen, a market stall, or passed along to a neighbour who is in need.

The residents of this new community will be able to engage in the development of their own housing. The intention of this proposal is to facilitate a community of self-generation with built-in resilience.

“People who have homes built for them – without consultation, without information, and without - choice – will naturally adopt a fatalistic view of the product”⁶¹

The intention of the project is to transfer control of the development to the community members once the initial units are constructed. This will allow them to have communal access to essential infrastructure but allow for the housing units adaptation to respond to the varying needs of the individual. Communities are not homogeneous; therefore the rebuilding effort needs to allow for the individuality of the residents. These inhabitants will be able to rebuild according to their imagination and determination and will not be burdened by large mortgage payments that they are unable to sustain. The human need for diversity will be able to be accomplished as there is no prescribed layout or building type. Only a set of standard guidelines that will ensure structural stability and fire safety will control development, with community regulated inspections to ensure compliance.

⁶¹ Boshier, L. (2008). *Hazards and the built environment: Attaining a built-in resilience*. London: Taylor and Francis, Pg 191

Figure 6.7 – Incremental Development process throughout the progressive stages of investment

INITIAL BASE UNIT

The initial base unit will be equipped with essential pieces of infrastructure in order to satisfy the occupants physiological and safety needs. Using Maslow's hierarchy of needs as a guideline this unit is designed to ensure that the first two levels of the hierarchy are provided. It is important that these pieces of infrastructure be stand-alone processes in order to be resilient to future interruptions or hazards. They also need to be low maintenance or easily repaired as regular servicing is not a feasible option. The provision of water, sanitation, and food sources are the primary objective for the unit and are essential to providing for the health and safety of the community. The secondary objective is to ensure the security of body, employment, resources, family, health, property, and morality in order to increase the sense of safety that is often disturbed after the traumatic events that have led to the displacement.

The unit is designed to allow for further growth and adaptations to meet the changing needs of the resident. The initial unit (344 sq. ft.) is designed as a simple post and beam poured concrete construction with three rooms. The main room (194 sq. ft.) is enclosed on three sides, with the fourth side to be closed in temporarily with tarps or metal sheeting. It is expected to be used as a bedroom in the initial stage. The second room (123 sq. ft.) contains all of the water collection and treatment equipment as well as the battery storing excess power from the solar panel streetlight above. The third room is a small bathroom equipped with a composting toilet and a small wash basin. This small, contained unit is equipped with the essentials for clean water, power, and provides shelter and security for the resident. In the initial stage the rest of the building plot can be used for further construction as well as extensive area for the creation of the garden to provide fruits and vegetables. Resiliency is achieved not only through providing safe, suitable shelter that is protected from hazards, but it also facilitates the creation of clean drinking, sanitation, and the growth of food from the garden.

BUILDING PLOT (50'x30')	1515 SQ. FT.
STANDARD UNIT	360 SQ. FT.
FUTURE BUILDABLE AREA	560 SQ. FT.
AGRICULTURAL AREA	595 SQ. FT.

Figure 6.8 – Typical Base Unit

1. Building Plot

- Gabion walls are erected to protect building plot from erosion and create a flat area, suitable for residential rebuilding
- Transportation laneway to be used by service vehicles and mototaxis

Figure 6.9 - Tarpaulin Shelter Details

2. Initial Unit

- Construction of initial unit, including installation of rainwater collection/treatment equipment and composting toilet
- A low-cost Biosand Water Filtration system will filter collected rainwater to create potable water

Source: Center for Affordable Water and Sanitation Technology (CAWST). (2010). BioSand Filter Manual. Design, Construction, Installation, Operation and Maintenance. A CAWST Training Manual. May 2010 Edition. Alberta, Canada.

Figure 6.10 - Initial Unit Details

3. Tarpaulin Shelter

- Sheets of tarpaulin reclaimed from emergency shelters are used to enclose bedroom area of initial unit. Additional tents can be erected in yard

Figure 6.11 - Tarpaulin Shelter Details

4. Fortified Temporary Shelters

- Plywood sheathing and sheet metal are used to enclose areas of the initial unit

Figure 6.12 - Fortified Temporary Shelter Details

5. Transitional Shelter

- Transitional Shelter materials can be reassembled as an additional room of initial unit

Figure 6.13 - Transitional Shelter Details

6. Permanent Wood Home

- A permanent home is designed and constructed out of wood products as an addition to the initial unit.

Figure 6.14 - Permanent Wood Home Details

7. Concrete Block Home

- A permanent home is designed and constructed with concrete block and poured concrete columns. The home will adapt the existing initial unit into its overall layout.

Figure 6.15 - Concrete Block Home Details

7. Maximized Concrete Block Home
- A permanent home is designed to maximize allowable ground floor building area

Figure 6.16 - Maximized Concrete Block Home Details

Figure 6.17 – Unit Construction Details

Figure 6.18 – Community Section

Figure 6.19 –Community Arrangement

Figure 6.20 – Rainwater Collection Diagram

CONCLUSION

The recent growth (both in frequency and magnitude) of disasters caused by natural hazards has stimulated much research in the way which disasters can be avoided or managed. The built environment accounts for most of every nation's economic savings, yet years of development and investment can be disabled by a single natural event. The scale of the threats facing the built environment continues to grow as a result of global population change, urbanisation, and climate change. This is creating urgency in the research on disaster preparedness, hazard mitigation and vulnerability reduction rather than disaster management and relief. This research paper is part reactive, as it responds to the issues and challenges of a specific event, but also proactive, as it aims to create a reasonable solution to reducing the disruption by future hazards.

Throughout this research the scale of the challenge of developing a more resilient built environment following the earthquake disaster in Haiti has become very apparent. Examining the factors that lead to vulnerability has revealed the need for multiple, mutually reinforcing strategies to be integrated simultaneously in order for resilience to be enabled. Vulnerability can never be completely eliminated, but it is essential to understand the capacity of the human and physical systems to respond to extreme events. Resilience is created by ensuring and enhancing the capability of the built environment to both resist and rapidly recover following a disaster event. The ability to investigate current culturally specific rebuilding programs as part of a field research trip was invaluable for my understanding of the localized recovery process. Analyzing the successes and failures of these projects helped guide the development of this project. The implementation of proper land use practices and restoration of the agricultural industry will begin to reverse some of the long-standing vulnerabilities of the Haitian community. The provision of a simple housing unit that provides for the most basic of human needs ensures that the resiliency of the individual is increased, while being frugal with the finite amount of relief aid provided for a large-scale relief effort. The facilitation of incremental growth and investment of the family unit creates incentive for the community to be self-generative. The regulation and control of

development along the hillside of Canaan is crucial to ensuring that pre-existing vulnerabilities are not continued and that resiliency is the focus of the newly settled area. These strategies are integrated into a community rebuilding plan that will assist in the recovery from this catastrophic event and ensure that future natural hazards do not severely disrupt the community.

PostScript

In order to allow this project to fulfill its goal of becoming an independent, self-generating community it will need to engage the residents to participate in the development and further investment of the area. The initial construction of the infrastructure and initial units is only the first step or progression of this growth. The incremental development pattern is necessary to allow for further investment according to the accumulation of resources, both monetary and material. It is understood that this progression will vary according to each family or resident. The goal however is to reach the goal of a resilient dignified housing unit which is integrated into a strong community which has the ability to provide further economic and social development. The initial unit ensures that resilience is built-in to the community from the beginning and that it can be maintained during the growth period.

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