DWELLING, COMMUNITY, AND RESILIENCE:
Reimagining Tomorrow in Port-Au-Prince

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A THESIS

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ABSTRACT

DWELLING, COMMUNITY, AND RESILIENCE

Reimagining Tomorrow in Port-au-Prince

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People throughout the world have a need and right to housing that is both comfortable and durable. Within a country, there is also a need for a strong architectural built infrastructure of services and support, but many underserved populations lack these essentials, resulting in thousands of families living in inadequate housing conditions. Haiti, an underprivileged nation in the Caribbean, is faced with this kind of housing crisis.

This housing crisis reveals people's right to basic shelter and strong and durable structures that are able to respond to the local environmental conditions. The proposed design for are resilient and sustainable approach to architecture in Port-au-Prince will address this housing crisis. Current proposals to address this situation often focus on temporary solutions. While architecture alone cannot solve all living conditions, a more holistic and sustainable approach to the design seeks to tackle and address those within its scope.

DWELLING, COMMUNITY, AND RESILIENCE

Fig. 0.1:
Source: Huffington Post, https://www.huffingtonpost.com/entry/haiti-earthquake-anniversary_us_5875108de4b02b5f858b3f9c

ACKNOWLEDGEMENTS

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Many thanks to Louisa Larocci for all of the assistance early on. Thank you for the patience, love, commitment, and dedication you provided throughout the entire thesis process. I would like to thank Gisele J. Altea for all the comments and critiques throughout the thesis process, and for taking the time to assist me with such a vast thesis topic. And finally, I would like to acknowledge the entire staff at SHKS Architects, with special thanks to its principals David Strauss, Kevin Kane, and Jonathan Hartung. I truly appreciate you all allowing me to present my thesis during its infancy, and I thank you all for the outstanding comments and critiques which allowed me to push my thesis to its fullest potential.

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INTRODUCTION

Problem Statement

Shelter is an essential aspect of living that provides a sense of safety, security, and comfort. Everyone needs a strong, well-built home that provides both usability and durability. Haiti, among the most disadvantaged nations in the western hemisphere, is currently experiencing a housing crisis. By definition, a housing crisis is a lack of affordable housing. Haiti, however, is suffering from another type of housing crisis which involves thousands of individuals living in houses that do not meet living standards in terms structure, durability and resilience.

In the midst of the housing crisis, Haiti was hit with devastation caused by a 7.3 magnitude earthquake on Jan 12th, 2010. Port-au-Prince was among the most affected cities due to its location relative to the earthquake's epicenter. In 2017, Jesselyn Cook, Huffington Post news reporter and journalist, noted that about 55,000 Haitians remained without homes, residing in "makeshift camps"[1]. In the aftermath of this natural disaster, thousands of families continue to reside in partially damaged homes as they have continued their daily life. Haiti's housing crisis sheds light on the need for new resilient housing to ensure shelter capable of sustaining the life of the community. Efforts are being made to reconstruct the demolished and/or damaged settlements, in hope of providing adequate shelter to displaced individuals.

This project seeks to implement a resilient housing typology that provides adequate and sustainable shelter for displaced Haitian families. The thesis will investigate building methods that respond to the local environment while implementing design strategies which take the potential threat of natural disasters into consideration.

Fig. 1.1: World Map
Source: M. Thelusma

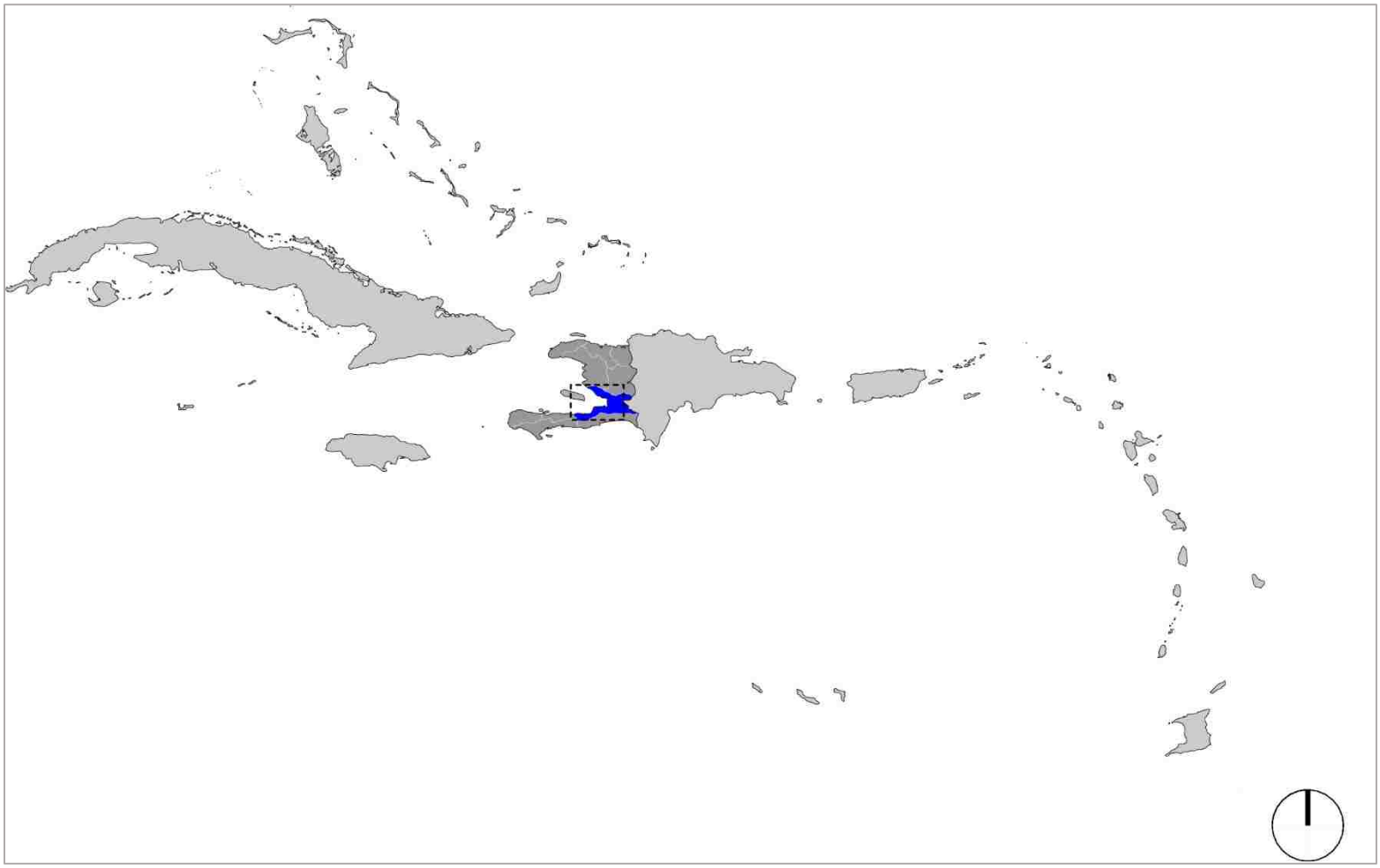


Fig. 1.2: Caribbean Islands Map
Source: M. Thelusma

The proposed project also seeks to provide simple resources, such as water and electricity, that may not be present in every home. By providing simple amenities to an underserved community, this project aims to improve their everyday life. This thesis argues for an environmental and socially sustainable approach to architecture as a means of addressing the housing crisis within Port-au-Prince, Haiti.

Thesis Statement

While architecture alone cannot solve all the issues that exist within Port-au-Prince, there are opportunities to implement strategies that not only address the housing crisis, but also other environmental issues the nation faces to foster a better and brighter future for this community of underserved individuals (Fig. 1.1,1.2). This thesis argues for a proposed housing infrastructure that attempts to respond to the local issues, addresses the permanent needs, and attempts to tackle the future needs of a community. By integrating sustainable strategies into the site and infrastructure, this thesis seeks to provide longevity while offering simple amenities to those directly affected by the housing situation in Port-au-Prince.

Project

The project addresses the topic of the present housing crisis using resilience and sustainability as a rebuilding strategy. With over 300,000 buildings destroyed in the wake of the 2010 earthquake, millions of individuals were displaced from their homes, and 7 years later, thousands remain without a stable shelter [1]. Haiti is in dire need of an architectural intervention to assist those underserved individuals. This project is centered around single-family housing as a catalyst to foster growth, community, and identity within the urban fabric of Port-au-Prince.

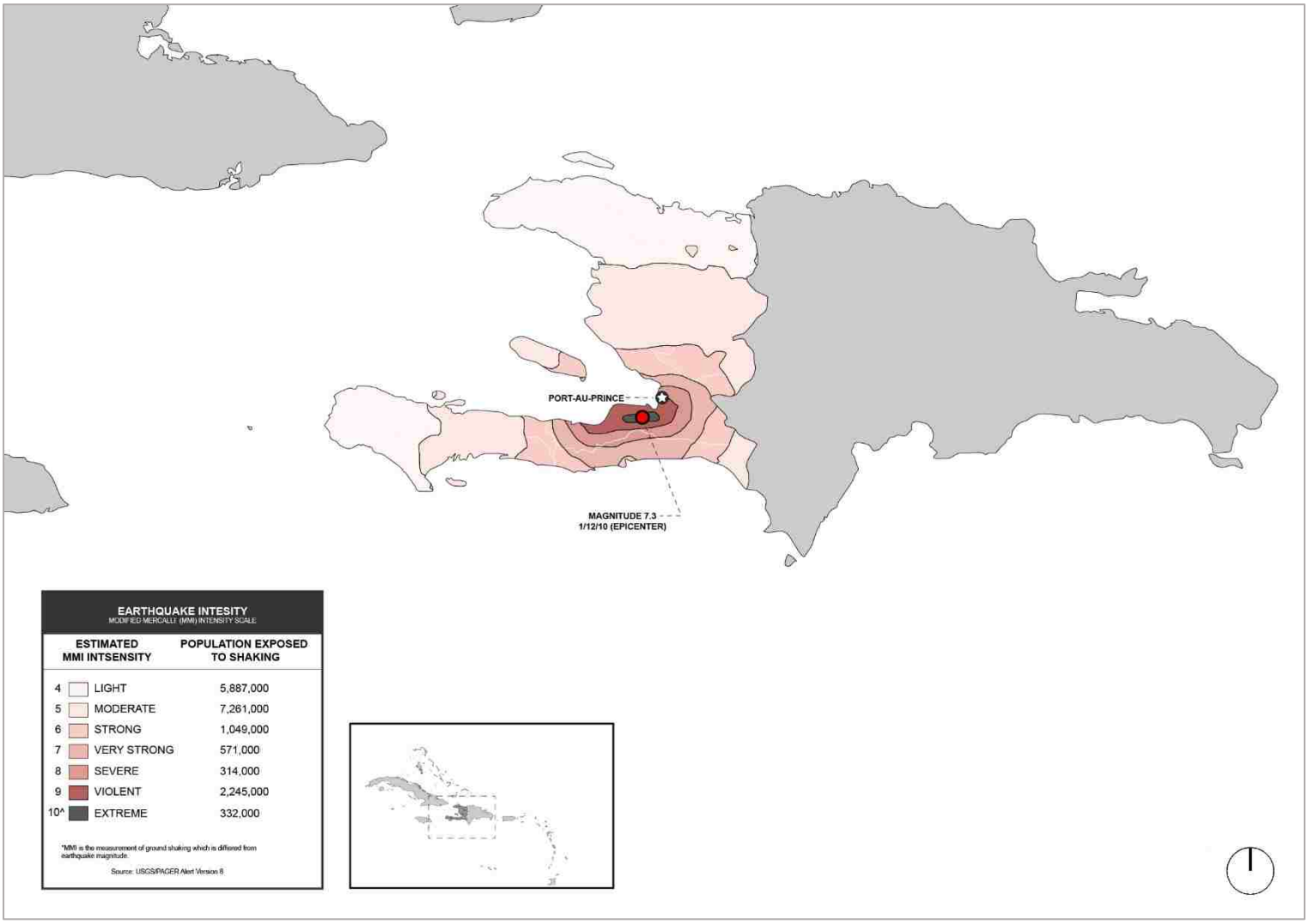


Fig. 1.3: Earthquake (MMI) Intensity Map
Source: M. Thelusma
Data: Ohio State University, Origins: Current Events in Historical Perspective, *http://origins.osu.edu/article/pact-devil-united-states-and-fate-modern-haiti*

The focus on single-family housing in this thesis responds to the existing housing typology in Haiti that is predominately this type. Looking to provide an architecture that responds to the local environment, while implementing design strategies which take the potential threat of natural disasters into consideration, this project will utilize sites that are located in areas that have experienced moderate to extensive damage (Fig 1.3). The proposed project

offers an appropriate building typology that seeks to interlock directly with the building fabric of Port-au-Prince with the intention of fostering community engagement in and around the site.

Methodology

This thesis seeks to reimagine the future tomorrow in Port-au-Prince through the integration of resilience and sustainability into the architecture while utilizing local materials which emerge from the existing architectural language and texture present in Haiti. The projected sites are situated within the city of Port-au-Prince, and seek to provide homes for individuals who lack such essentials, while encouraging community, social engagement, and public interaction. The proposed project seeks to provide amenities that benefit the occupants, their neighbors, and the general public. These amenities range from water pumps and filtration systems, to central electrical sources, and social community gathering platforms. These amenities are supported by sustainable building methods, such as rainwater harvesting, photovoltaic panels, natural cooling techniques, and community composting integrated through the interior and exterior. The project looks to address the issues present in Port-au-Prince as the city strives to move forward socially and economically while being mindful of its culture. This architectural reformation seeks to tackle problems which scientifically affect Haitian's quality of life, as well as address issues which may arise in the future.

Fig. 2.1: Haiti Reconstruction

Source: UNOPS, Building a More Resilient Haiti, *https://www.unops.org/news-and-stories/news/building-a-more-resilient-haiti*

LITERARY FRAMEWORK

Key Issues

Introduction/Overview

This thesis argues for the approach of reconstruction and reformation through an environmental and socially sustainable architecture as a means of addressing the current housing crisis within Port-au-Prince. Numerous social and political issues, as well as the constant threat of natural disasters have placed the people of Haiti in their current state. By implementing sustainable strategies in housing development and site infrastructure, this project attempts to provide potential solutions to the architectural needs of the Haitian community of Port-au-Prince. The project focuses on the families who were directly and indirectly affected by the 2010 earthquake and establishes solutions to improve the current situation within the city of Port-au-Prince.

This section reviews the literature covering the issues addressed in this thesis. This section will illustrate the historic significance of the country of Haiti, outlining its origins, statistical factors, and its current situation. Furthermore, this section will analyze specific precedent examples that implement sustainable techniques in housing and informal publics spaces, as well as examples that address disaster resiliency. The chosen precedent examples, however, are all intentionally located in Haiti. The use of case studies in Haiti is intended to illustrate the feasibility of the thesis proposal. Additionally, this will further reveal how resilient architecture is addressed, as well as address some of the challenges the designers may have faced. This section hopes to address the research, literature, and case on studies which this thesis project rests and provide a foundation for the argument it makes

Haiti: Country and Architecture

Haiti was established as a country on January 1st, 1804 when it gained its independence from France. Today, Haiti is the only nation in the western hemisphere that originated through slave revolt. Haiti is situated in the Caribbean just off the southern coast of Florida, and sits among the neighboring islands of Jamaica, Cuba, and Puerto Rico. The nation is located on the island of Hispaniola, sharing its border with the Dominican Republic, originally a Spanish settlement. Although similar, the two countries are differentiated with distinct developmental experiences. With its troubled internal infrastructure and economic disposition, Haiti is often regarded as the "dark side"[2] of the region.

Today, Haiti is home to 9 million people who largely speak Haitian Creole, although its official language is French. The capitol of the country is Port-au-Prince, which is located in the cove of Port-au-Prince Bay. Over the years, Haiti has experienced a slew of political and economic disparities which have resulted in it becoming one of the most impoverished nations in the western hemisphere. In addition to being an impoverished nation, its people have minimal access to "vital public services such as water, sanitation, education and health care"[3].

With 310 inhabitants per square kilometer, Haiti is one of the most densely populated countries in Latin America[4]. The level of urbanization in the country is far below that of its neighboring countries; in 2007, only 40% of its population lived in urban areas (Forsman). This problem is a result of its housing crisis, meaning a lack of housing that meets the standards of living. UNHabitat's *The State of Latin American and Caribbean* describes the current housing condition in the country as described by three aspects:

> the number of existing houses (housing stock), the shortfall in the number of units needed (quantitative deficiency), and the number of units that do not offer a minimum standard of habitability for an adequate and decent quality of life (qualitative deficiency)[5].

This housing situation can be attributed to a number of factors, that are economic, social, technical. Haiti stands as one of the poorest nations in the western hemisphere, and the most notable factor related to its current housing crisis is the lack of expertise, regulations, and planning. Although practical building methods are utilized, the homes are built by unqualified or low skilled laborers with minimal supervision to ensure the structural integrity of the building. The most common practice is to construct dense housing settlements within mountainous hillsides (Fig. 2.1). Housing construction has no set guidelines in addition to a lack of accountability. This amplified the destruction caused by the 2010 earthquake, leaving 220,000 dead, 300,000 injured, 1.3 million homeless [1]. In addition, just over 300,000 buildings were directly affected, 105,000 were permanently destroyed, and 208,000 severely damaged [6]. After the devastation, 891 camps were established to house 1.3 million displaced individuals, the majority of which included 262, 851 families [7]. Many individuals attempted to reconstruct their homes, while others opted to stay within a partially demolished home. (Fig. 2.2)

This crisis in housing is not simply one that affects physical need, as Asa Forsman observed:

> Housing is not only a roof to shelter under, it is also a place to live in and raise a family. For many, it is their most important asset in monetary and, sometimes, emotional terms; the biggest investment of a lifetime and often the place where resources are generated to support the household. Housing is also the basic unit of urban growth. It defines neighborhoods, demands on mobility, services and, in a large part, our relationship with the city and the environment [8].

Fig. 2.2: Earthquake Destruction

Source:

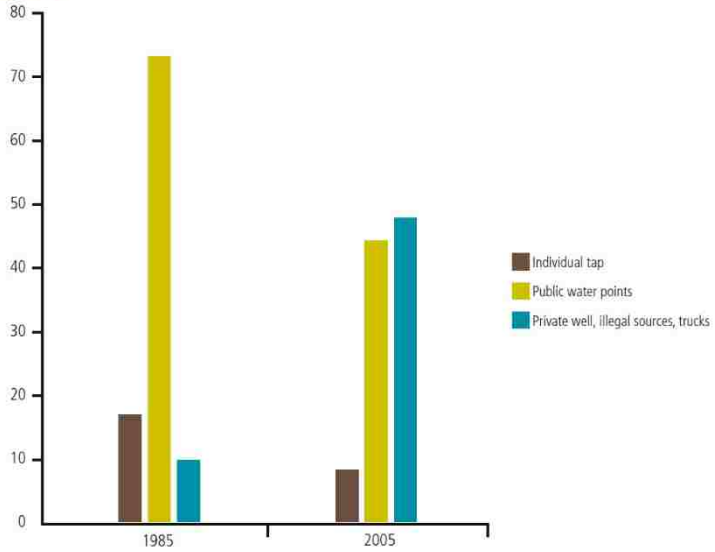
1. Flickr, Haiti Earthquake, *https://www.flickr.com/photos/37913760@N03/4274632760*
2. The Dathan Project, Fountain of Hope, *http://www.thedathanproject.org/hurricane-matthew-haiti/*
3. *Público, El Gobierno británico exige explicaciones a Oxfam por el escándalo de las 'orgías', http://www.publico.es/internacional/escandalo-sexual-gobierno-britanico-exige-explicaciones-oxfam-escandalo-orgias.html*

Owning a home or having a place for one to call their own evokes a sense of pride and accomplishment. A house is more than four walls and a roof overhead; it is an extension of an individual's identity and a family's kinship. The housing crisis exemplifies the lack of basic public necessities and shelter in the country, and calls for an investigation into sustainable housing in the capitol city of Port-au-Prince.

In addition to the housing crisis, the city of Port-au-Prince and the country of Haiti itself is faced with a number of additional challenges such as a lack of clean water sources, and a lack of clean energy sources (Fig. 2.3). Within the metropolitan area of Port-a-Prince, two entities (Centrale Auto-nome Métropolitaine d' Eau Potable, CAMEP, and Service National d' Eau Potable, SNEP.) are charged with providing drink waster [9]. Throughout the city, water kiosks were placed to provide clean potable water to the general public. However, public water is becoming scarcer and more privatized, and illegal watering sources have become more prominent [9]. The rise of private water is due to the inconsistency of the public water supply its often poor quality, making it unsafe for consumption. (Table 2.1). With a lack of water waste drainage and a lacking water purification systems, a number of impoverished individuals have consumer polluted water, leading to disease outbreaks..

For the country of Haiti, fossil fuels ~~a~~ are currently a necessity for day to day use as 85% of energy is derrived from imported types of this energy source [10]. The majority of cities' populations depend on charcoal and wood biomass for their energy source (Table 2.2). The need for biomass energy had led to a rapid deforestation issue, thus resulting in the increased use of imported goods. With the use of sustainable strategies, it is possible to tackle these two issues to provide a clean source of energy, and a viable option for potable water.

Water provision in metropolitan Port-au-Prince. The difference between 1985 and 2005 in type of service provider is striking. In 1985 the state was the main provider. In 2005 private providers are almost as important.



Source: CAMEP (undated).

Table 2.1: Water Provision

Source: UN-HABITAT, Strategic Citywide Spatial Planning: A Situational Analysis of Metropolitan Port-au-Prince, Haiti: Summary Report, 2010

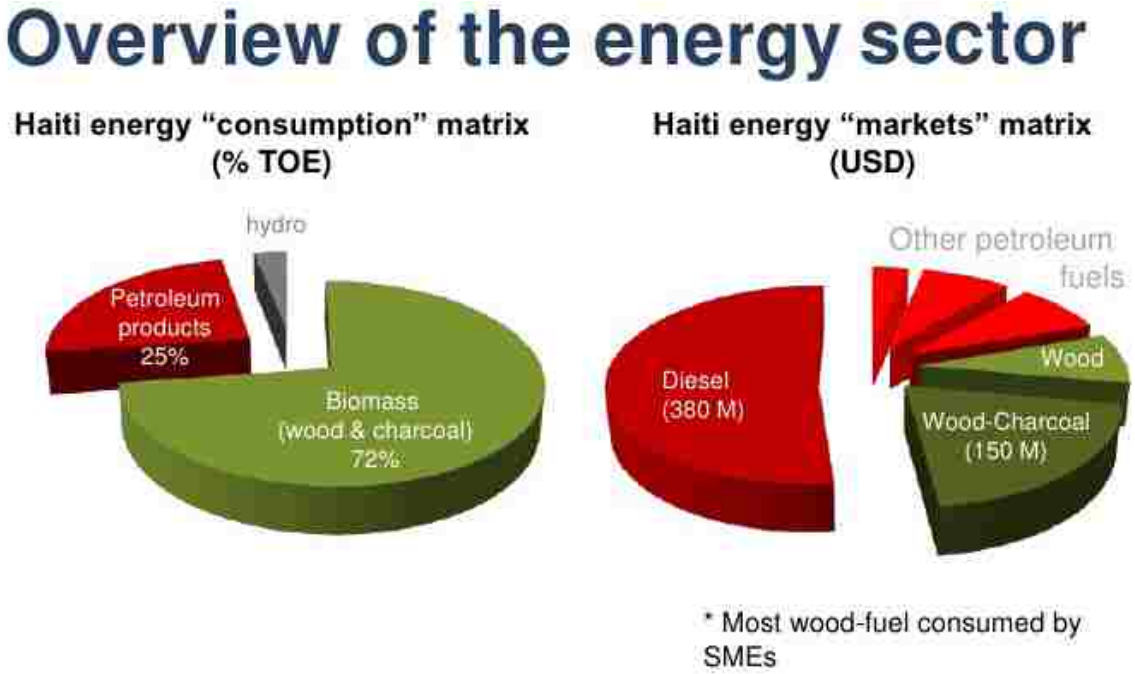


Table. 2.2: Energy Sector Overview

Source: P. Mellissa, Haiti Pawar; Energy Assignment Part 2, *http:///haitipawar.blogspot.com/2015/06/energy-assignment-part-2.html*

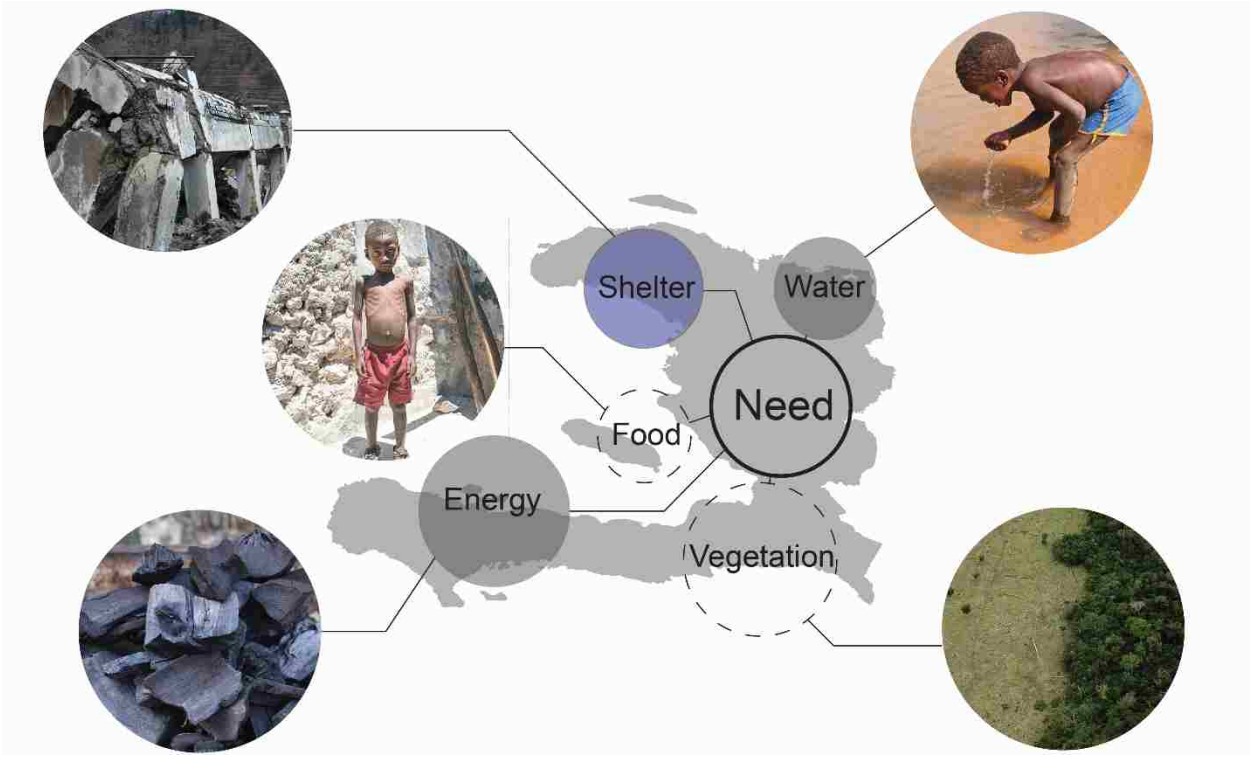


Fig. 2.3: Haiti Needs Diagram
Source: M. Thelusma

Sustainability: Housing Implementation

The term "sustainability" is used in many fields ranging from environmental, economic, and social. It describes the endurance, productivity, and longevity of biological systems and their ability to move forward. The current framework that revolves around sustainability began in the 1980s. The World Commission on Environment and Development 1987 defined sustainability as an economic development activity that, "meets the needs of the present without compromising the ability of future generations to meet their own needs" [11]. The word sustainability is derived from two words, sustain and ability, in reference to sustaining the environment today, while passing onto the future generations the ability to prosper and continue on this earth.

The main focus of sustainability is the biophysical nature of the earth's environment, typically relating to the conservation and preservation of its natural resources. In Haiti, this aspect can be seen in the deforestation of its forest ecology through the use of wood for fossil fuels. This issue presents issues for humans, animals and other plant life that rely on this particular ecology for survival. The altering or depletion of one ecology may negatively affect neighboring ecologies thus initiating a negative cycle of cause and effect. Another example is the depletion or pollution of water sources, ;this also affects the livelihood of the beings that depend on it for survival.

According to Kent Portney, the idea of sustainability can be broken down into three overlapping concentric circles; environment, economy, and equity, or the "three E's" of sustainability [12]. These "three E's" of sustainability depicted in (Fig. 2.4) are the base principles of environmental protection and preservation, sustaining economic growth and development, and the promotion of equity. The three concepts go hand in hand and are

completely reliant on one another, so the essence of sustainability is achieved through the accomplishment of all three [12].

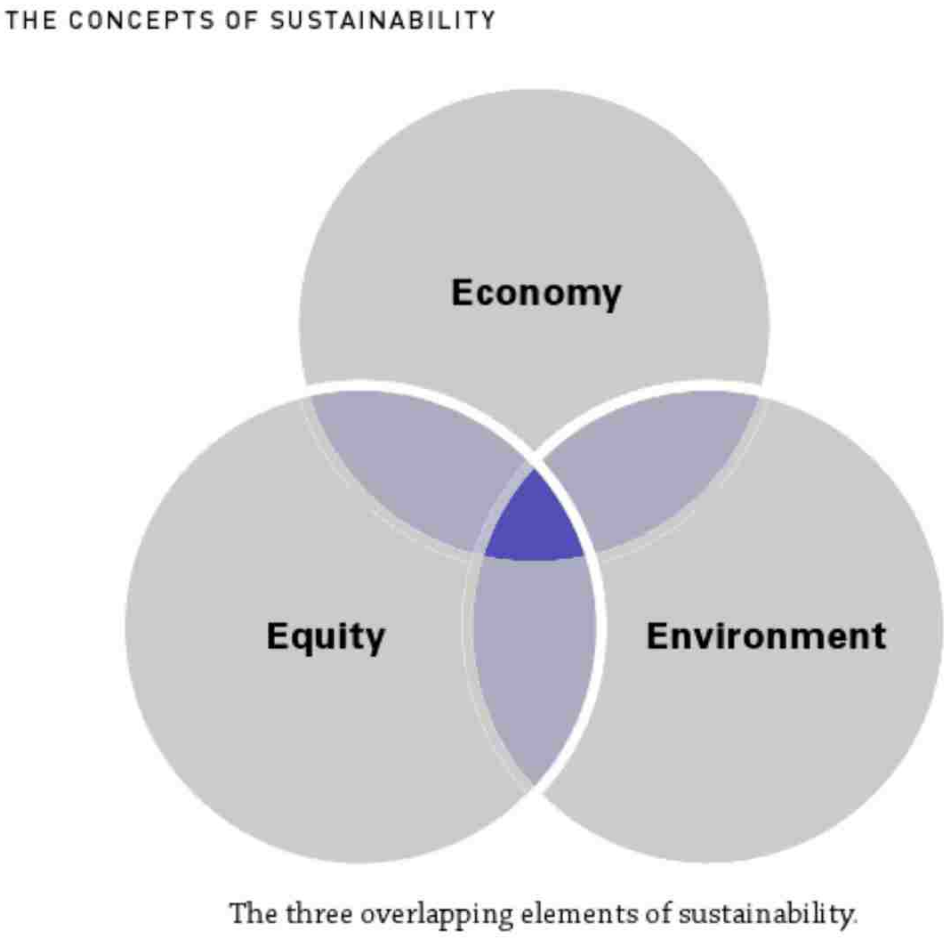


Fig. 2.4: Three E's of Sustainability

Source: M. Thelusma

Data: Portney, Kent E., "Sustainability." The MIT Press., *https://ebookcentral-proquest-com.offcampus.lib.washington.edu/lib/washington/reader.action?docID=4397950&query=*

One should not reject or undermine the other in order to move forward towards a brighter future for the generations to come.

Sustainability in the context of the built environment is often seen as a call for awareness about the effects of human activity. Sustainable architecture takes the approach of being green, which looks to reduce fossil fuel reliance within the building envelope. In addition to this, sustainable architecture also looks to reduce the amount of environmental pollution, while improving the overall building performances to reduce energy consumption.

According to Helen Benetts:

> To be green in more than a token fashion is to have some commitment to containing or reducing the environmental impact of humans on the Earth or regions of it... [That] means commitment in the immediate future term to either:
>
> - Human population reduction, or
> - Less impacting lifestyles for many humans, or
> - Improvements in technology to reduce overall impact [13].

In the realm of architecture, the improvement of technology is one of the largest factors in the pursuit of sustainability. These technological advancements aims to advance sustainability from theoretical to practical. At the 1992 Earth Summit in Rio de Janiero, Brazil, a large number of organizations and countries met to discuss environmental and development issues. This marked the first time in which developed and developing nations came to an agreement on difficult environmental topics [14]. From that meeting, came the Earth Summit: Agenda 21, one of several international agreements, that outlines eight objectives aimed towards sustainable building:

- Providing adequate shelter,
- Improving management of urban settlements,
- Promoting sustainable land-use planning and management,
- Providing environmentally sound infrastructure facilities,
- Promoting energy-efficient technology, alternative and renewable energy sources, and sustainable transport systems,

- Enabling disaster-prone countries to plan for and recover from natural disasters,
- Promoting sustainable construction industry activities,
- Human resource development [14].

Agenda 21 looks to improve the overall quality of human settlement, while aiming to reduce the ever-present effects of climate change. The built environment contributes greatly to climate change with its production of carbon emissions and additional greenhouse gasses [14]. As the push towards sustainable building seeks to reduce the negative impact on the natural environment, this thesis attempts to do the same. The implementations of sustainable architecture within this project attempts to provide adequate and efficient shelters for the individuals who reside in Port Au Prince, as well as pave the way to a better future for the generations to come. At a certain point, one must not ask what nature can do for them, but what can one do for nature [15].

Precedent Studies

Ti Kay Là | Anse-à-Pitres, Haiti

Ti Kay Là is a resource housing complex located in the western region of Anse-à-Pitres, Haiti. Completed in 2015 by architects of Bonaventura Visconti di Modrone, Ti Kay Là is an orphanage housing project that provides shelter and resources for orphaned children in the commune of Anse-à-Pitres. The project is a series of three housing units covered by overhead aluminum sheathing supported by wood framing. The project provides a series of interior and exterior spaces, giving maximum flexibility to the residents. The spacings provide shared space for playing and enjoyment, while facilitating space to perform more intimate tasks like homework and leisure hangouts.

Fig. 2.5: Ti Kay Là

Source: Ti Kay Là, Bonaventura Visconti di Modrone, *https://www.tikayla.com/*

The architects make an important point to include two factors that would allow the project to fit with the local environment. One factor was the adoption of the Haitian rural house. With the integration of the brick texture and color, as well as the architectural language of the Haitian archetype, the architects were successful in the project's implementation. The second factor was the adoption of the lakou. Lakou is a Haitain-Creole term that translates to yard or open exterior space which can be an extention of one's home. A prime example of a lakou can be the front/rear yard or a front porch (Fig. 2.6).

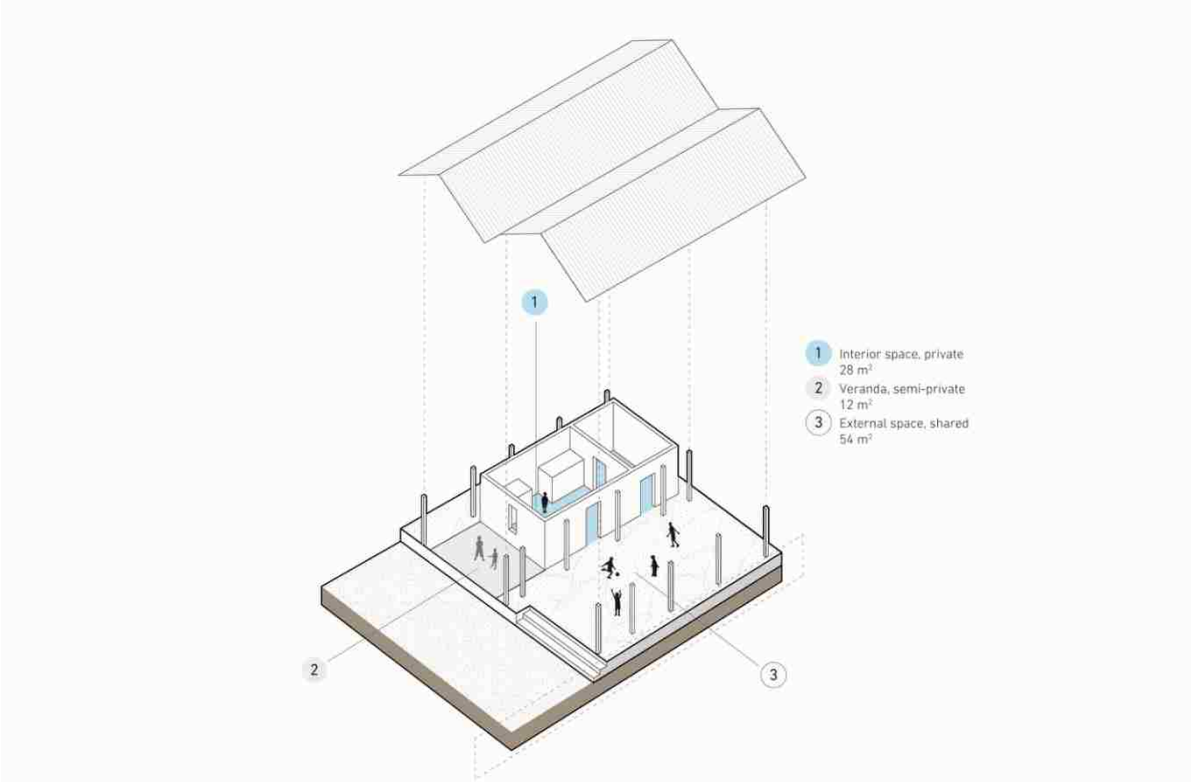


Fig. 2.6: Lakou – Ti Kay Là

Source: Arch Daily, Bonaventura Visconti di Modrone, *https://www.archdaily.com/787059/ti-kay-la-bonaventura-visconti-di-modrone*

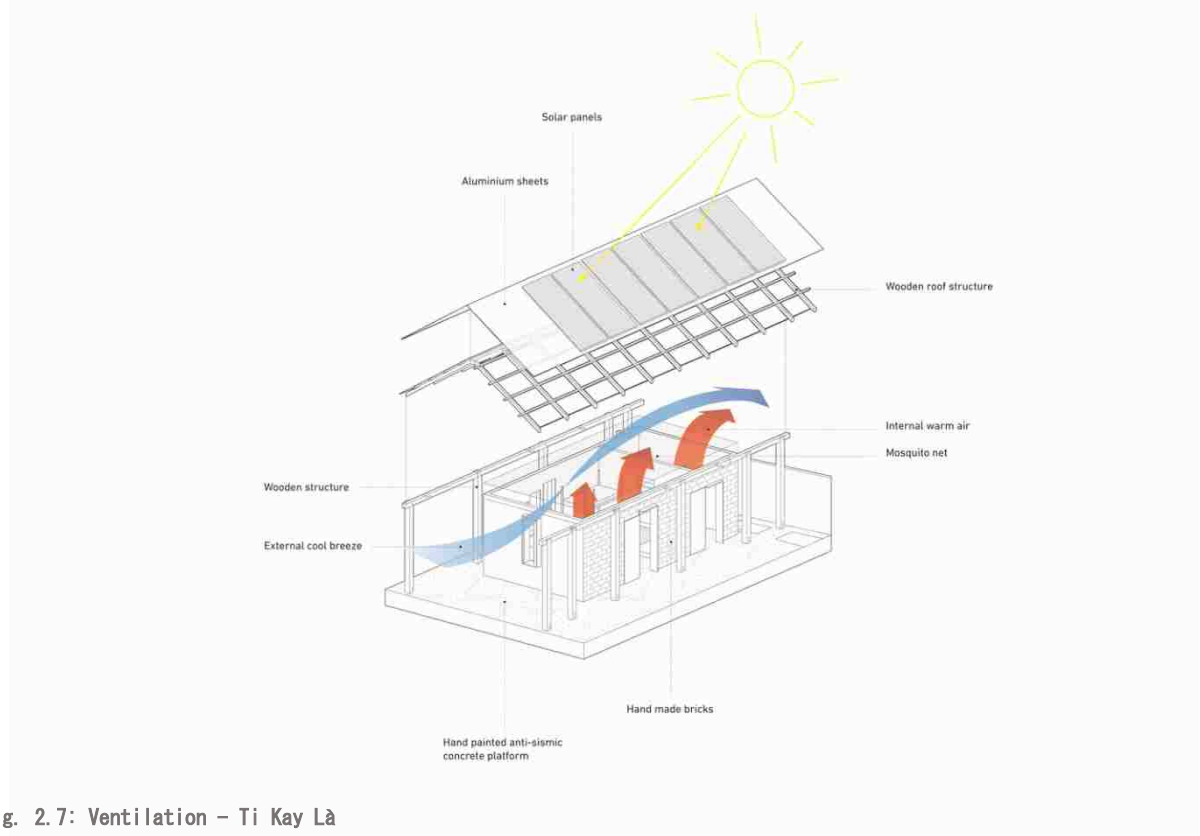


Fig. 2.7: Ventilation – Ti Kay Là

Source: Arch Daily, Bonaventura Visconti di Modrone, *https://www.archdaily.com/787059/ti-kay-la-bonaventura-visconti-di-modrone*

Due to the hot and humid climate in Haiti, some consideration was made for natural ventilation. The designers utilized a detached roof system that allowed fresh air flow through the housing units. Each housing unit is comprised of walls without an overhead ceiling plane, so the rooms are open to the wood frame structure up above and make great use of cross-ventilation (Fig. 2.7). This makes for makes for an efficient use of the natural resources available. In addition to wind, the architects took advantage of solar orientation through the installation of photovoltaic panels (solar panels) on the rooftops. The use of solar panels enables electricity in a remote location, while providing an alternative energy source (Fig. 2.7).

The architects were successful in providing a resilient earth-quake proof housing structure with the use of light frame wood construction. However, many challenges were faced in acquiring the building material. Haiti has very limited resources available to achieve adequate resilience to natural forces, so a bulk of the building materials like concrete, wood and sand were purchased in the Dominican Republic. Once purchased, the material had to be transported to the site, but difficulties arose as laws prohibit vehicles from crossing the border. The materials had to be loaded and unloaded at the border, then transported to the site for construction in Haiti.

This project was a successful attempt at designing an effective housing complex that addresses the needs and issues present in Haiti. Although successful in its resilience to earthquakes, it is not clear how the project combats the destructive capabilities of hurricanes, and how residents would be able to use the homes during this kind of disaster. Although different in project scope, this thesis also aims to develop sustainable and resilient housing that provides shelter and longevity to its occupants during most natural

occurrences. Furthermore, my thesis seeks to provide public spaces capable of delivering amenities for the the public and the community it serves

Tapis Rouge | Carrefour-Feuilles, Haiti

Tapis Rouge is a formalized public space in the neighborhood community of Carrefour-Feuilles, Haiti. Completed in 2016 by Emergent Vernacular Architecture (EVA Studio), Tapis Rouge is a community space that promotes social interaction and community engagement. Initially used as a tent encampment location for displaced individuals in the 2010 earthquake, the site of Tapis Rouge sits atop a hillside overlooking the community of homes on either side. Although the site can mainly be accessed through narrow corridors and tight alleyways, Tapis Rouge is the cornerstone of this community and aims to give a sense of belonging and ownership to the residents of Carrefour-Feuilles.

Fig. 2.8: Tapis Rouge

Source: Arch Daily, EVA Studio, *https://www.archdaily.com/802993/tapis-rouge-emergent-vernacular-architecture?ad_medium=gallery*

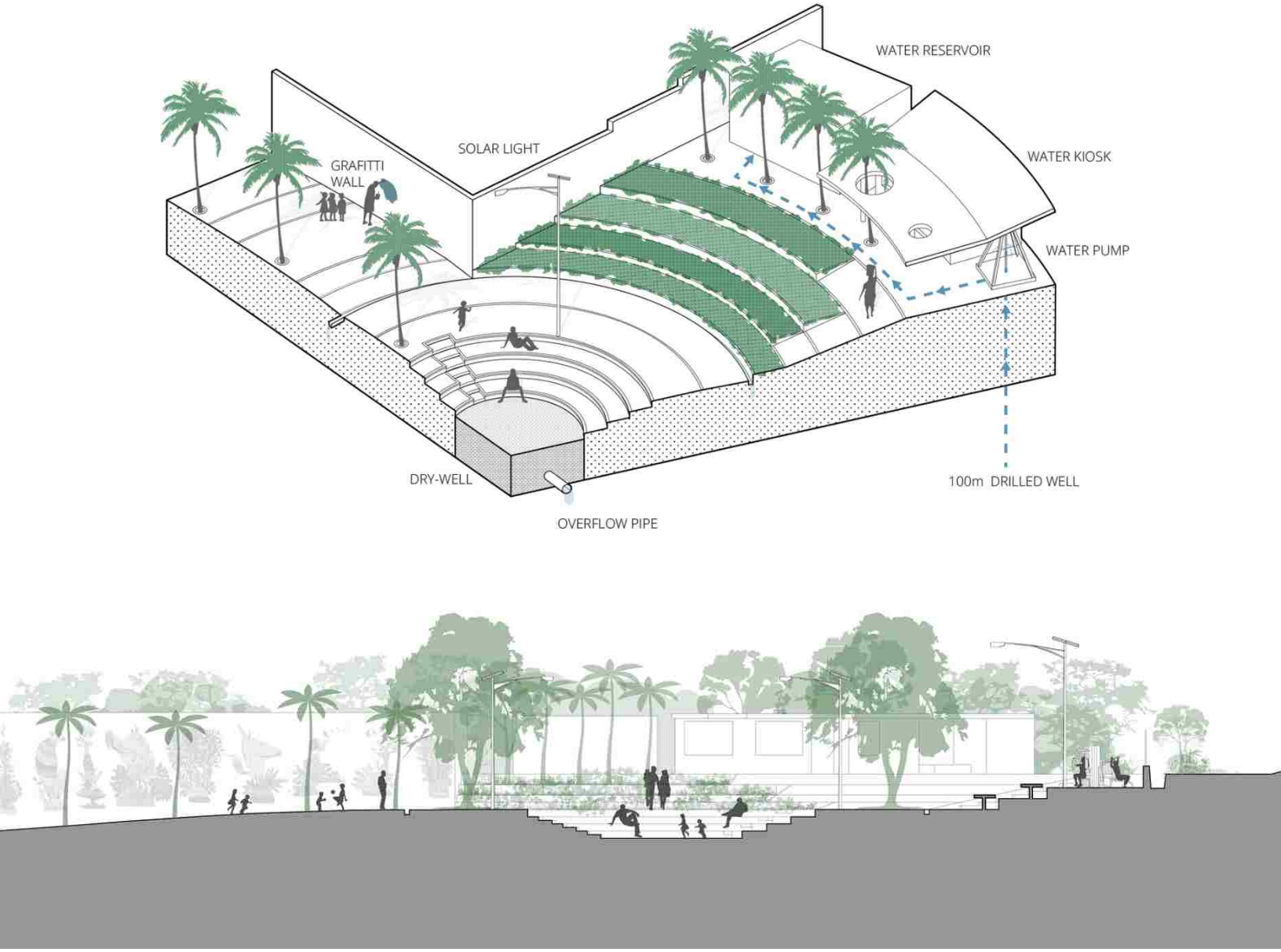


Fig. 2.9: Amenities - Tapis Rouge

Source: Arch Daily, EVA Studio, *https://www.archdaily.com/802993/tapis-rouge-emergent-vernacular-architecture?ad_medium=gallery*

Tapis Rouge incorporates simplistic designed infrastructures to achieve a dynamic social interaction. With the use of centralized Amphitheatre seating, the project is surrounded by public amenities (Fig. 2.8). These include a graffiti wall for local artists, low impact outdoor gym equipment, and green garden space. The simplicity and accessibility of the project give the users the freedom and flexibility to utilize the space as desired. Due to the lack of accessibility to potable water in the area, the project also incorporates a water pump and water reservoir for water collection. The project also aimed to provide a cleaner and safer environment with the inclusion of solar lights in a region riddled with poverty and crime.

This project is a successful example of how a public space can facilitate social interaction while catering to the needs of a community. The inclusion of water, sanitation, and electricity becomes a significant aspect of improving quality of life, particularly when incorporated in an environment where around only 20-30% of the population have access to fresh water and electricity. This thesis approaches social engagement and community in a similar manner. Although different in scope, the aim is to provide public amenities such as water, electricity, and public space to a community of underserved individuals.

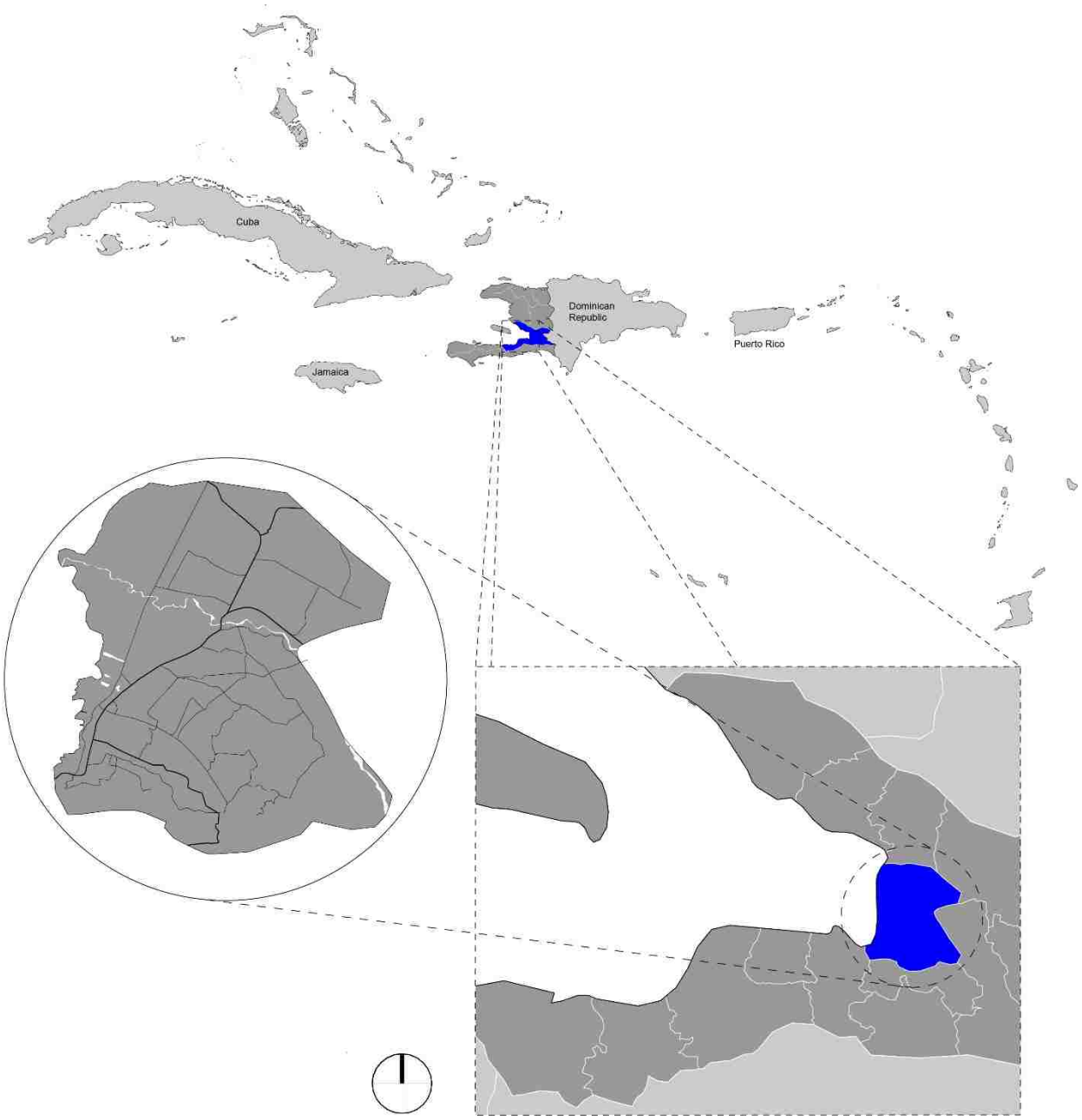


Fig. 3.1: Port-Au-Prince Metropolitan Region
Source: M. Thelusma

METHODOLGY

"... Architecture should have the capacity to endure... it should improve people's lives and their environment... it should reflect the place and the culture where it is created" [18].

Preliminary Studies

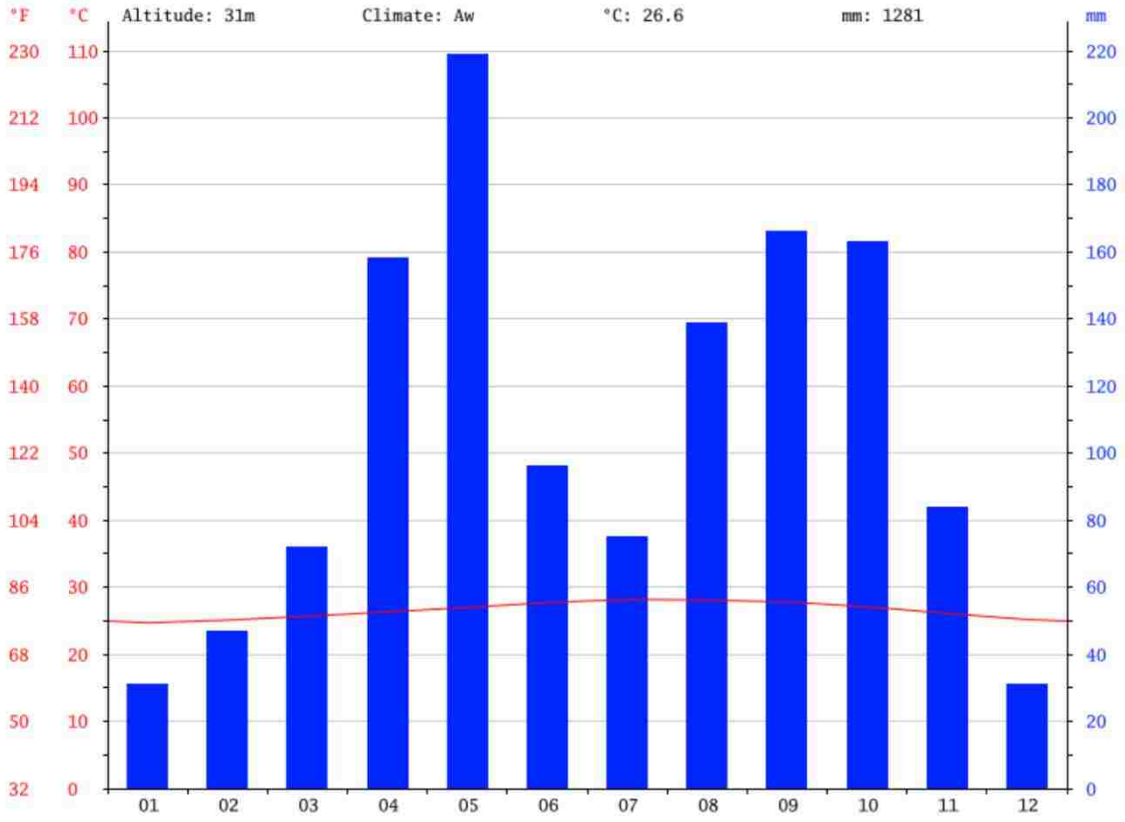
Project Goals

This project looks at architecture through the lens of sustainability and aims to provide housing for to the families directly affected by the 2010 earthquake. This project will be established in Port-au Prince (Fig. 2.5). Due to the internal struggles and issues faced within Port-au-Prince, this project looks to address those issues through the implementation of sustainable strategies. The proposed complex attempts to provide simple and necessary amenities to a community of people who have been displaced. This project also looks to embody the concept of shelter, community, and sustainability as a means of giving back to the families living within an impoverished region.

Climate.

Situated within the Ouest region of Haiti, Port-au-Prince is home to 980,000 people, home to 2.6 million living within metropolitan areas. Sitting on the bay of the Gulf of Gonave, the city houses the major seaport and airport in and out of the country. Like most cities, Port-au-Prince is divided into commercial and residential neighborhoods. The commercial zone is located at the mouth of the Gulf of Gonave serving as a great source of economic development. Residential neighborhoods are located inland within the hillsides. Port-au-Prince is situated in the warm tropical climate zone with its average climate being about 26.6 ° C (79.8 ° F) and its annual precipitation about 1281 mm (50.4 in.) (Fig. 3.1).

CLIMOGRAPH PORT-AU-PRINCE



	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature (°C)	24.7	25.1	25.7	26.3	27	27.7	28.2	28.1	27.8	27.1	26.1	25.2
Min. Temperature (°C)	18.8	19	19.8	20.9	21.7	22.2	22.4	22.4	22.4	21.8	20.9	19.6
Max. Temperature (°C)	30.6	31.2	31.7	31.8	32.3	33.3	34	33.9	33.2	32.5	31.4	30.8
Avg. Temperature (°F)	76.5	77.2	78.3	79.3	80.6	81.9	82.8	82.6	82.0	80.8	79.0	77.4
Min. Temperature (°F)	65.8	66.2	67.6	69.6	71.1	72.0	72.3	72.3	72.3	71.2	69.6	67.3
Max. Temperature (°F)	87.1	88.2	89.1	89.2	90.1	91.9	93.2	93.0	91.8	90.5	88.5	87.4
Precipitation / Rainfall (mm)	31	47	72	158	219	96	75	139	166	163	84	31

Table 3.1: Port-Au-Prince Climate Data

Source: Climate: Port-Au-Prince, *https://en.climate-data.org/location/3571/*

During the summer months, the temperature reaches its high at 33.8 ° C (93.0 ° F) and reaches lows of 18.78 ° C (65.8 ° F) in the winter months [19].

In addition to precipitation, Port-au-Prince receives an average of 3,115 hours of sunlight out of the 4,383 possible hours (Fig. 3.2). This means that for 71.1% of its day, Port-au-Prince receives constant sunlight while the remaining 28.9% of the day is spent under overcast, cloudy, or low sun-intensive conditions [20]. The annual average of daylighting ranges around 8.5 hours with its longest day being about 13 hours and its shortest being 11 hours [20].

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Sunlight Hours/ Day	08:58	08:59	09:00	09:04	08:05	07:56	09:01	09:05	08:12	08:05	07:58	07:54	08:31
Average Daylight Hours & Minutes/ Day	11:08	11:30	12:00	12:32	12:58	13:12	13:06	12:43	12:12	11:40	11:14	11:01	12:00
Sunny & (Cloudy) Daylight Hours (%)	81 (19)	79 (21)	76 (24)	73 (27)	63 (37)	61 (39)	70 (30)	72 (28)	68 (32)	70 (30)	72 (28)	72 (28)	71 (29)
Sun altitude at solar noon on the 21st day (°).	51.7	61	71.9	83.6	88	84.9	87.5	83.5	72.1	60.5	51.5	48.2	70.4

Table 3.2: Port-Au-Prince Daylighting

Source: Sunshine & Daylight Hours in Port-Au-Prince: Haiti, *http://www.haiti.climatemps.com/sunlight.php*

With its location, local climate, Port-Au-Prince provides unique opportunities to implement sustainable strategies. The potential exists to utilize its available sunlight as a means of an alternative energy source, and rain harvesting as a potential source of clean potable water. These strategies will be implemented into the project and into the site to provide basic necessities and amenities to the community of Port-au-Prince.

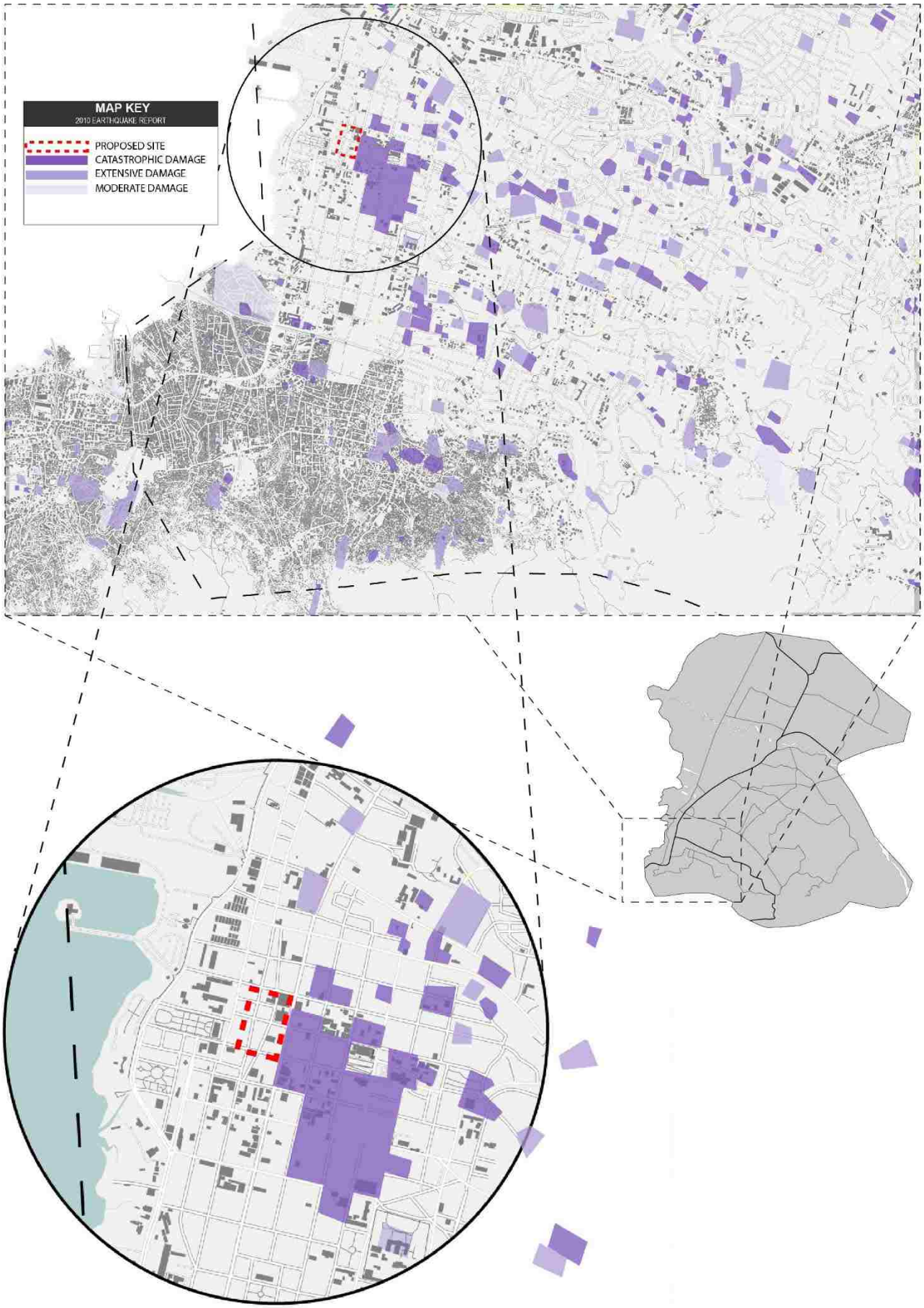


Fig 3.2: Port-Au-Prince Site Map

Source: M. Thelusma

Site Criteria

The city of Port-au- Prince is the most populated city within Haiti. Due to its proximity to the 2010 earthquake epicenter, the area has experienced considerable damage thus, affecting a large number of families. It is important to find a site that is located near neighborhoods that have experienced minimal to extensive amounts of damage (Fig. 3.2). This method presents the opportunity to provide housing, sustainability, and community to the displaced families affected by the natural disaster in 2010.

The proposed site options are located within the urban region of Port-au-Prince. The site selection aims to contribute to the urban infrastructure by utilizing the existing open space within the city. The proposed sites (Fig. 3.2) are two vacant plots of land that remained void due to underdevelopment. The site options are located on the south-eastern coast of the Port-au-Prince metropolitan region. Located within urban neighborhoods, the nearby surroundings consist of shops, low-rise apartments, and multilevel single-family homes. The sites are also located near a large section of development which have experienced catastrophic damage. This method of site selection aims to insert a designed solution with out disturbing existing settlements.

The selected sites are located on the south-eastern section of the block on the corner of Rue Bonne Foi and Rue Courbe. The site is also located along the path of Boulevard Harry Truman, a major road. located along the water. Additionally, the site is located near the major highway Boulevard Jean-Jacques Dessalines which leads to the Port-au-Prince International Marine Terminal and the Port-au-Prince International Airport. The proximity to these major roadways allows for more efficient construction process and the use of local and imported construction materials. Situating the site within the urban and commercial region of Port-au-Prince creates an appropriate addition of a large multi-family infrastructure.

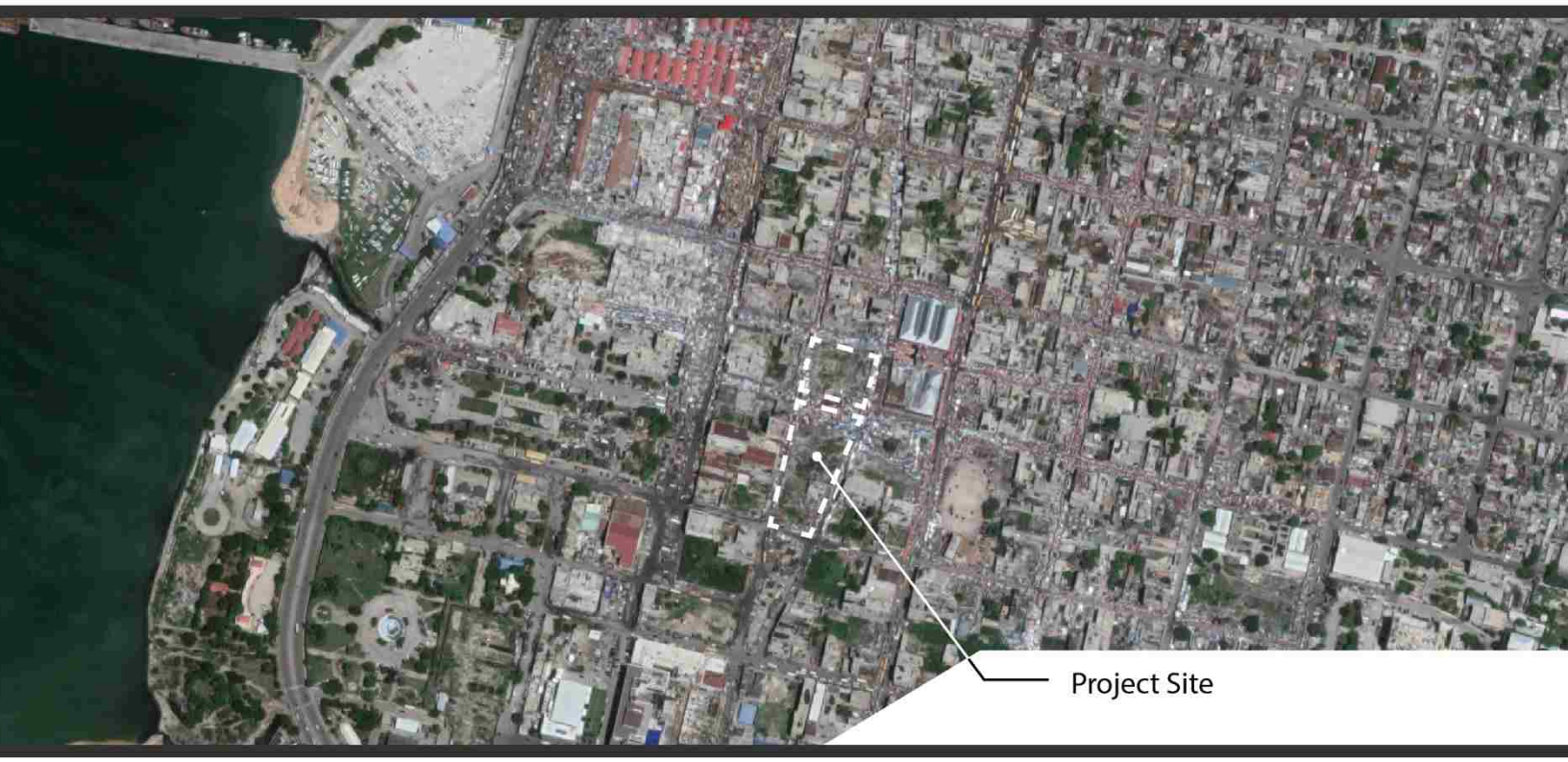


Fig. 4.1: Project Site

Source: Google Map, *https://www.google.com/maps/place/Port-au-Prince,+Haiti/@18.5511917,-72.3445785,832m/data=!3m1!1e3!4m5!3m4!1s0x8eb9dd57503eaa91:0x3cd5815df929aa08!8m2!3d18.594395!4d-72.3074326*

FINDINGS

Site Analysis

Prior to the design of the thesis project, an analysis of the sites, its surrounding context, and the city was performed. The location of the site in Port-au-Prince presents a large number of complexities that must be understood. In addition, having an understanding of the surrounding context supports the aim of an interconnection between the site and its neighbors. Buildings are not stagnant objects that are simply inserted onto a site; instead, this thesis aims to offer a dynamic architecture that can thrive in connection to its surroundings.

Zoning

The proposed sites are a part of the larger metropolitan area of Port-au-Prince. The city is comprised of various zoned regions dictated by land-use planning. The two proposed sites, currently unoccupied, are both zoned for residential land use, which allows for easy implementation without disturbing the existing urban plan dictated by the city of Port-au-Prince. The adjacent lots which surround the sites present a diverse typology of land use zones over a 1/2-mile radius. The current zones that are present are: residential, commercial/retail, land use industrial, parking, military, and academic(Fig. 4.2). Having an understanding of the zoning typologies allows for a better understanding of the context. The majority of the adjacent lots are dedicated to residential zoning, each of the other 5 zoning categories are present within a 1/2-mile radius relative to the site. The sites are centrally located and may present numerous resources to future occupants of the projects such as, market places, retail, schooling, and job opportunities.

Fig. 4.2: Zoning Report

Source: M. Thelusma

One of the most notable resources available to the future occupants is the Marche de Fer. Marche De Fer translates to the Iron Market, which is a large open market where individuals and families are able to purchase groceries, produce, and daily items. Its adjacency to the site allows interconnections between the two through social engagement in the public realm.

Fig. 4.3: Marche de Fer

Source:

1. Google Map, *https://www.google.com/maps/place/Port-au-Prince,+Haiti/@18.5511917,-72.3445785,832m/data=!3m1!1e3!4m5!3m4!1s0x8eb9dd57503eaa91:0x3cd5815df929aa08!8m2!3d18.59439!4d-72.3074326*
2. Loop Haiti, *http://www.loophaiti.com/content/haiti-dernier-pays-de-la-caraibe-ou-creer-son-entreprise*
3. Wild Junket, Travel Haiti, *https://www.wildjunket.com/travel-haiti-things-to-do-in-cap-haitien/*

Public Spaces/Plant Ecology and Access

Through further investigation of the surrounding environment, the public realm was better understood. There is a distinct disparity between built space and open public green space. In Port-au-Prince, the green spaces are dedicated to farmlands, woodlands and forests. The few public spaces that are available are designated as national monuments. Within the 1/2-mile

radius relative to the site there are currently 4 green spaces, three of which are soley dedicated to national monuments and the other containing farmland (Fig. 4.3). In a city with high poverty, providing an intervention with public space and public amenities may further bridge the interconnection between the intervention and its surroundings.

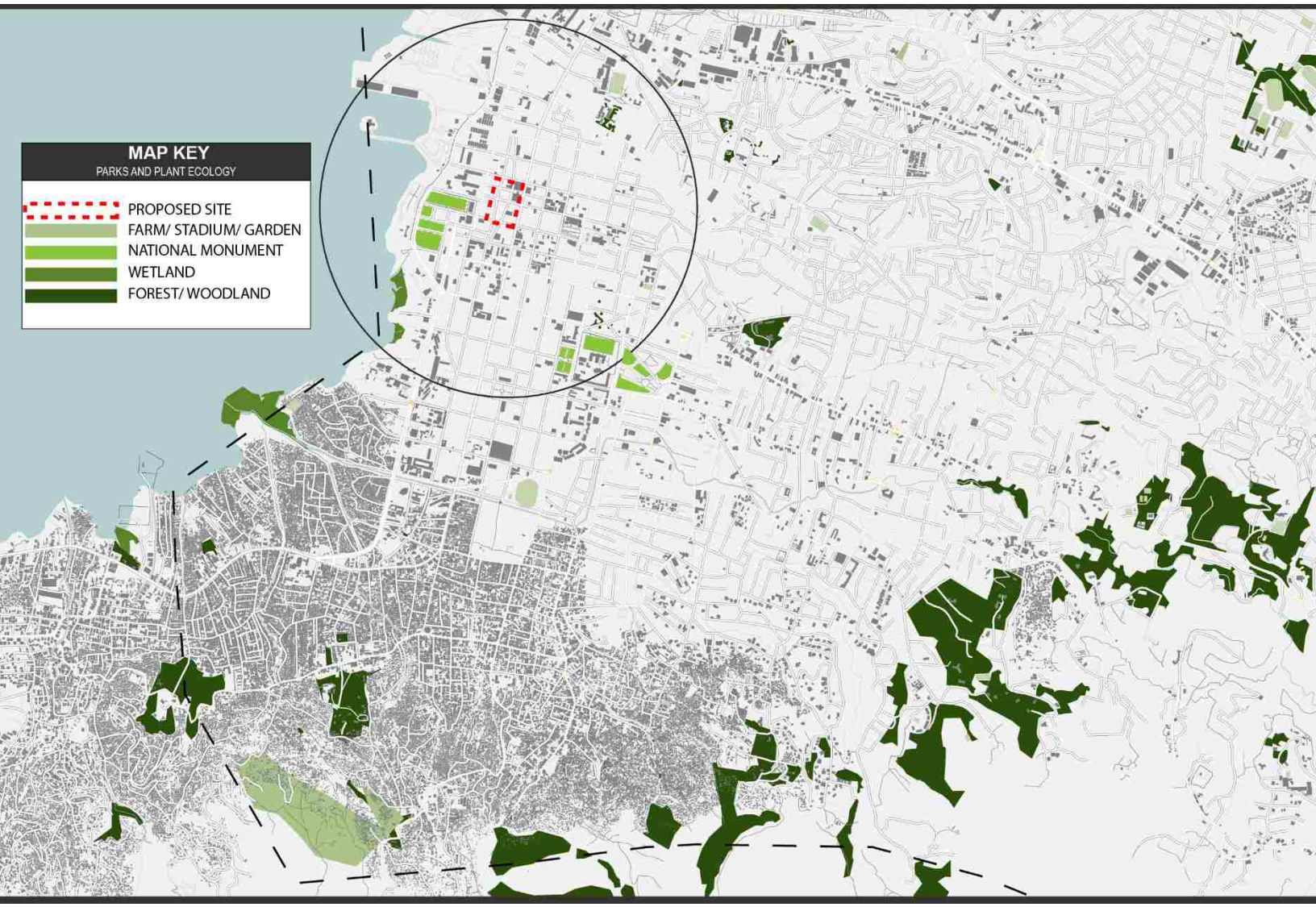


Fig. 4.4: Public Space and Plant Ecology

Source: M. Thelusma

Lastly, this contextual investigation helps to determine how building supplies and materials will arrive to the site. The investigation of major roadways and arteries must be referenced to determine the viability and scope of a potential intervention. The site is located near a major national road and a commune highway which is the equivalent to a state road. Furthermore, the site is located less than 2-miles from the major seaports (Fig. 4.4) The sites' connection to major transportation networks will benefit project development when considering material size and sources.

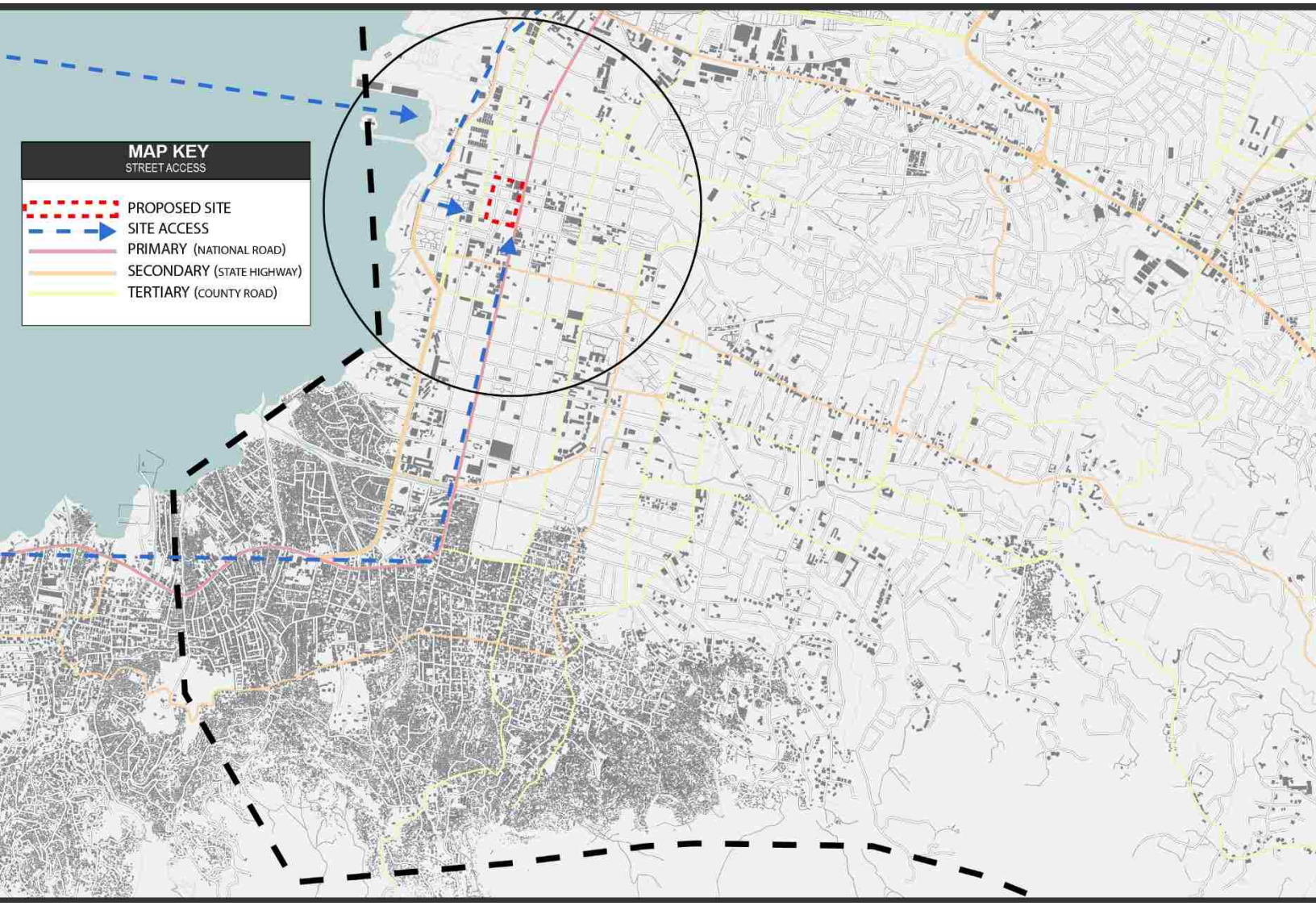


Fig. 4.5: Street Access

Source: M. Thelusma

Material Findings

The proposed housing project should not only have a connection to its surroundings through its context, but should also have a connection through its materiality. The materiality of an intervention should conform to its environment and the local culture. This thesis looks to implement the use of local materials as a means of addressing the current housing crisis. This section will illustrate material vernacular qualities that will be utilized within the intervention. Also, this section begins to illustrate material resources that are readily available for resilient construction within a country with limited resources available to.

Fig. 4.6: Concrete Block Construction
Source: Haiti UTK, Zack Smith, *http://haitiutk.squarespace.com/haiti_utk_public/tag/ventilation?currentPage=2*

Recycled CMU

Concrete masonry units (CMU) are standard construction units that are widely used in building construction. These concrete blocks are made from cast concrete comprised of cement, aggregate, sand, and water. The use of this building material is an essential part of the

architectural vernacular in Haiti. The use of CMU will be a quintessential element in the exploration of this thesis. However, in a seismic zone, the use of this material can be detrimental to the structural integrity of a building. in the event of a seismic tremor, the masonry units begin to move rapidly in multiple directions, eventually causing the units to crumble in extreme cases. In most cases, a large percentage of buildings in Haiti are not reinforced, which results in the destruction of the building material. This thesis looks to incorporate reinforcement in conjunction with CMU to provide an efficient and sustainable approach to building construction. Additionally, this thesis looks to re-use rubble as a means of fabricating new concrete masonry units.

In 2012, 2-years after the earthquake, one million cubic feet of ruble were removed across multiple sites throughout Haiti [21]. However, in 2015, there were still 25 million tons of debris remaining [22]. The mobile factory is a company established in 2007 by Gerard Steijn which specializes in the reuse of debris to create concrete masonry units [22]. Thousands of homes can be built with 25 million tons of debris, meaning the lives of millions can be changed with this manufacturing process.

The manufacturing process involves three phases of production which are preparation, sorting, and manufacturing (Fig. 4.6). The preparation phase starts with the identification of debris that is suitable for reuse, which is then collected and transported to the production site. The next step is the sorting, which involves the separation, crushing, and filtering of the debris. Finally, the manufacturing begins with the mixture preparation and mold assembly. Once in the mold, the units take an average of 12 hours to dry before they can be removed.

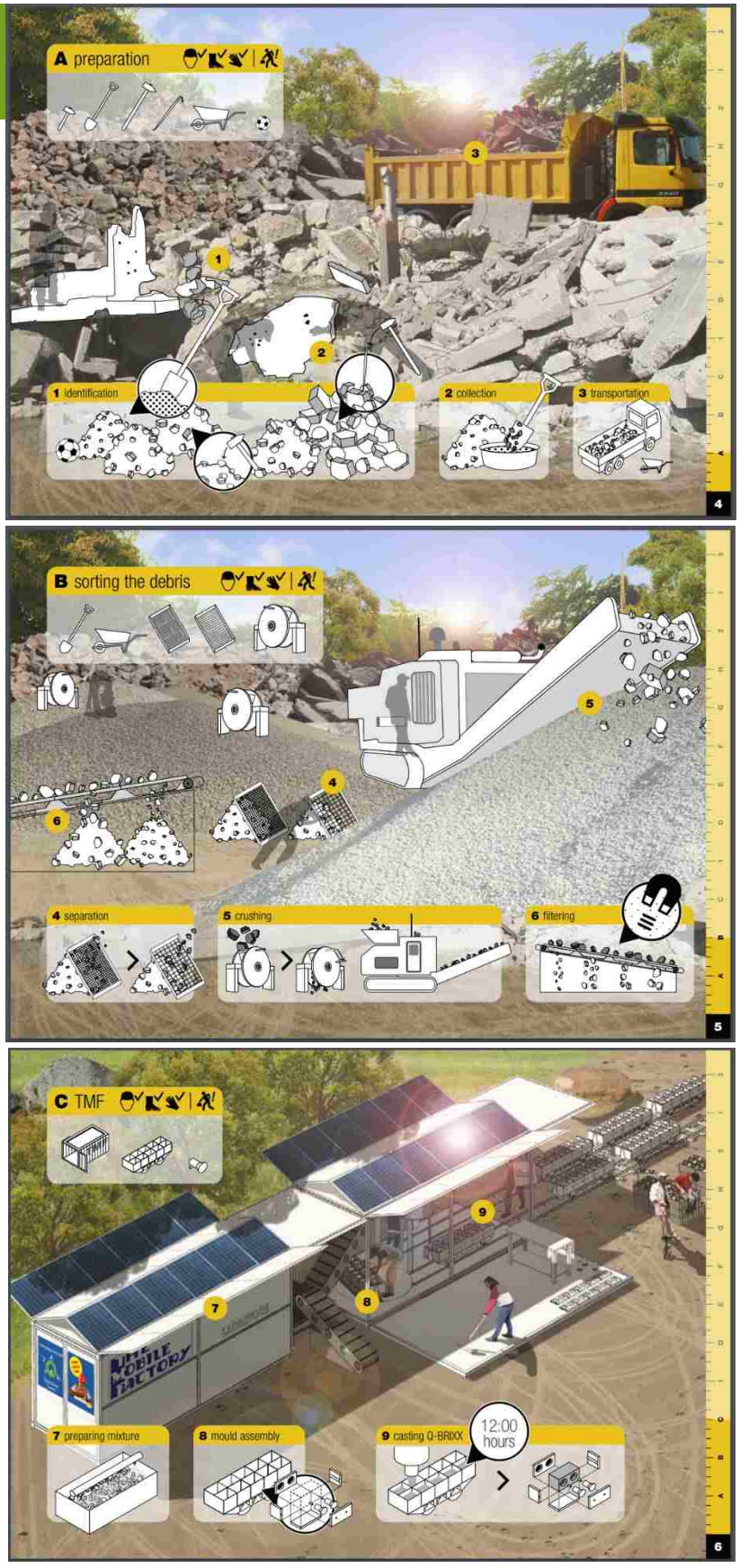


Fig. 4.7: The Mobile Factory

Source: The Mobile Factory, Gerard Steijn, *https://themobilefactory.org/wp-content/uploads/2015/04/150406-XCOOP-manualT-shelter-rubble72dpi.pdf*

The equipment needed to complete the manufacturing process must be sent from the Netherlands to the disaster area. The Mobile Factory company that makes CMU from reclaimed materials is still a pilot project. However, this method is a more sustainable and resilient approach to reconstruction rather than creating new concrete masonry. Instead, the reuse of the existing rubble provides a solution to utilize the excess amounts of debris while providing the building blocks to change the lives of thousands of individuals.

Bamboo & Corrugated Metal

The second material utilized in the proposed housing project is bamboo. due to its ease of access and availability in Haiti. Because Haiti is experiencing deforestation, the use of bamboo is viable for structural elements capable of spanning a certain distance. Because of its availability, bamboo is heavily used in building construction, and has added an additional layer to the vernacular language that is present in Haitian architecture. From wall framing and reinforcement, to vertical and horizontal framing, to decorative ornamentation, bamboo is integrated into the Haitian architecture in a variety of ways.

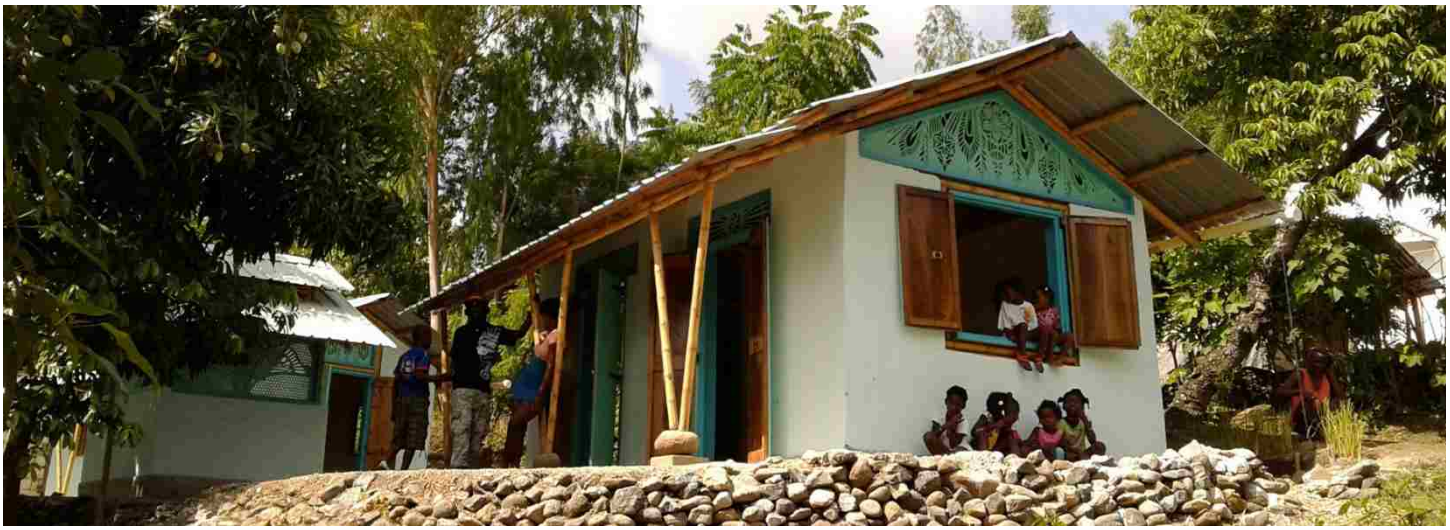


Fig. 4.8: Design Boom Bamboo House

Source: Design Boom, Sci Arc Master of Architecture, *https://www.designboom.com/architecture/oficina-house-louisana-haiti-06-14-2017/*

Fig. 4.9: Open Society Foundations Corrugated Metal Roof

Source: Open Society Foundations, **Chris Stone**, *https://www.opensocietyfoundations.org/voices/death-threats-haiti*

The final material utilized the thesis project is corrugated metal due to its availability throughout Haiti, and its multi-faceted utilization in building construction. From wall sheathing to roof paneling, corrugated metal is widely used as a barrier to shield the building occupants from the elements. With multiple distributors and an abundance of overstock, corrugated metal is readily available for projects at many scales. However, corrugated metal as a building material do present a few drawbacks. One drawback is the heat that is retained and transmitted throughout the day. Because it is metal, the corrugated material will require proper insulation to combat the heat gain. The second drawback is the potential for noise pollution during moderate rain. This may also be mitigated with the use of proper insulation. The use of these local materials aims to reflect the surrounding context, reinforcing the connection between the intervention and its neighbors. Also, the

material choices are an attempt to connect the intervention of the thesis to language of textures already present in Port-au-Prince.

IMPLEMENTATION

Within the scope of the thesis, the housing implementation does not conform to any singular site. The intent is to have a singular prototypical housing unit that can adapt to any site conditions. In order to have a better understanding of the project, this thesis takes a closer look at a particular site and its existing conditions. But the conditions on site are meant to provide guidelines on how housing should respond to these kind of conditions. The project provides housing while utilizing the site to provide public space and amenities to meet the community's needs.

Site Conditions

Design Process

The design process began with a study of the site's shape, dimension, solar orientation, wind direction, topography, and traffic circulation (Fig. 5.1). Due to the adjacency of the two sites, this project treats the two sites as one, to provide consistency in the project implementation and highlight connections between the two. The site studies provided an understanding of the physical environment to facilitate the design of interconnections between architecture and the environment.

Three of the five site conditions has had the largest impact on the project development. Due to a gradual slope, the topography was the first condition to affect the design (Fig. 5.1). Between the two sites, there is 12 feet of topographical change, with the southern end being the highest point and the northern end being the lowest. This condition necessitated consideration of how to distribute the program in a manner that allows for gradual shifts in elevation with the use of landings and platforms. It was also important to consider how an individual will access the site with multiple level changes.

SITE CONDITIONS

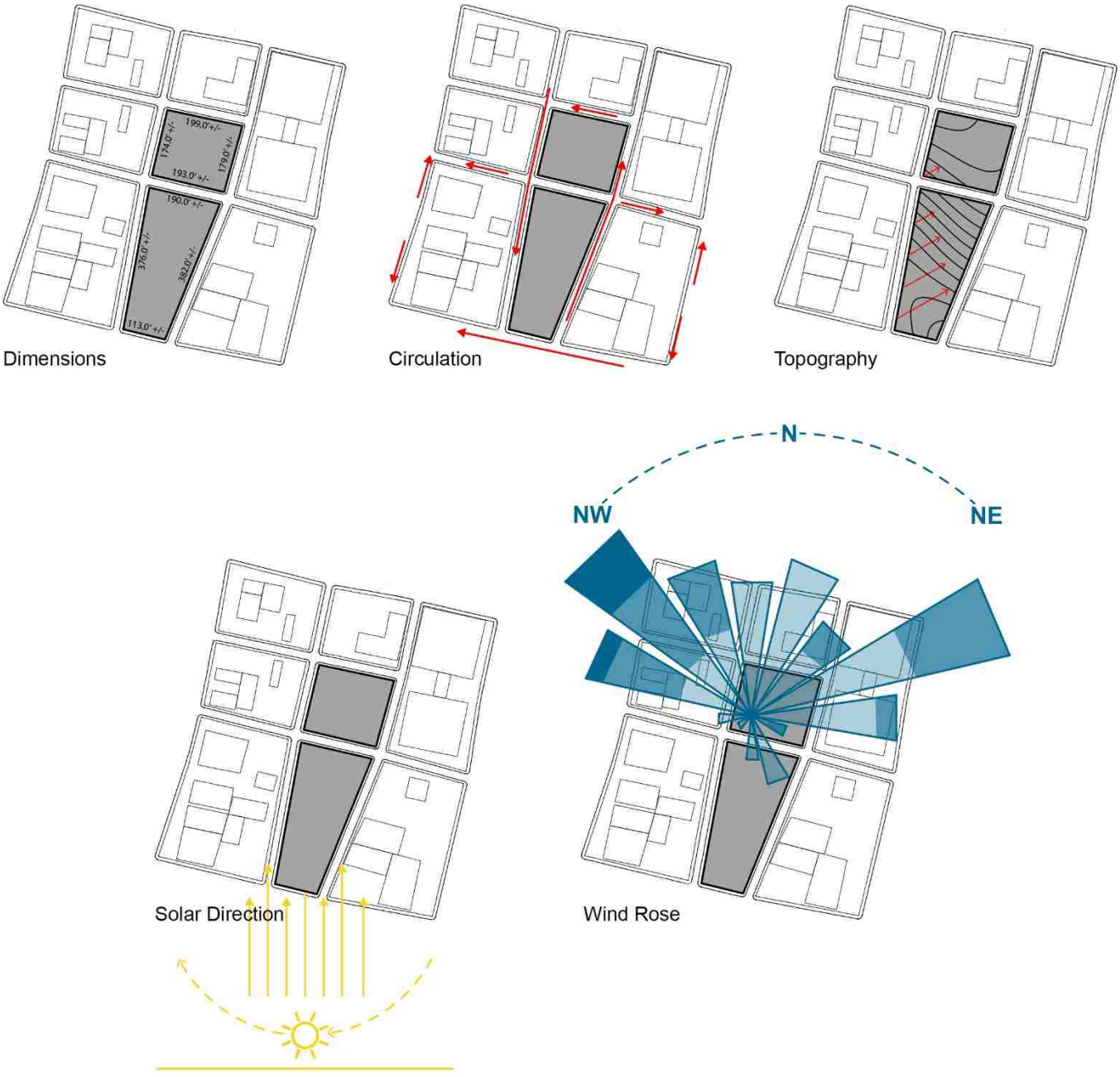


Fig. 5.1: Site Conditions

Source: M. Thelusma

The second condition taken into consideration was the solar orientation (Fig. 5.1). Due to latitude, the site experienced large amounts of solar exposure from the south. The southern solar exposure necessitated consideration to how sunlight would be collected, but also how to counter balance this with the sloping topography. This also involved being mindful not to obstruct solar exposure to the programmatic elements on the lower sections of the northern end of the site.

The last factor taken into consideration was the wind direction and how to effectively incorporate the natural ventilation. The wind in Port-au-Prince comes from the north, primarily directed from the west-northwest as well as the east-northeast with minimal ventilation opportunity coming from the south (Fig. 5.1). The direction opportunity presented by the wind direction allowed for the use of direct and indirect ventilation. Also, the wind direction correlates with the gradual increasing of the site topography, thus allowing the wind to rise from the north to the south providing ventilation opportunities through both sites.

After these conditions were taken into account, the next design consideration was the edge treatment of the site. This issue has a major impact on how an individual access and utilizes the site. Haiti however, has three types of edge conditions that are widely utilized: a hard edge, a gated edge, and a permeable edge (Fig. 5.2).

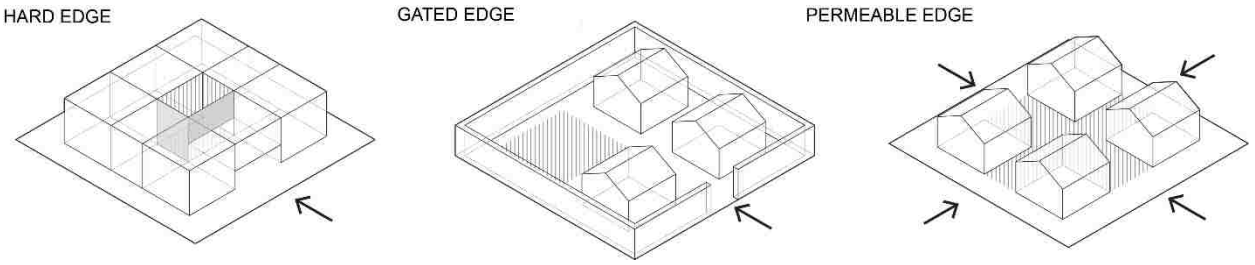


Fig. 5.2: Edge Conditions

Source: M. Thelusma

The hard edge utilizes street frontage to create a barrier which often leads to a singular entry to a site. Similar to the hard edge, a gated edge creates a frontage barrier with a singular entry, but this case the edge is achieved with a gate. A permeable edge makes use of a softer edge condition to allow multiple entry points.

While each edge condition presents unique qualities and benefits, this thesis primarily focuses on the use of the permeable edge. The use of the permeable edge stems from the desire to create a public space which seeks to facilitate social engagement. The permeable condition allows for the community to have access to the site without the feeling of being out of place. Lastly, the use of the permeable edge provides a a sense of connection by attracting pedestrian traffic without the use of ~~a~~ barriers.

Unit Configuration

The next step towards design development was the consideration of possible configurations of housing units. With the intent of having a prototypical unit, the units can be configured in a variety of ways. The configurations are a response to the site and the larger environmental conditions. The configuration response selected for this thesis attempts to provide relief, ventilate, shade, and in its orientation to capture sunlight (Fig. 5.3). This section looks at the effects and potential opportunities of the placement of the units on the site.

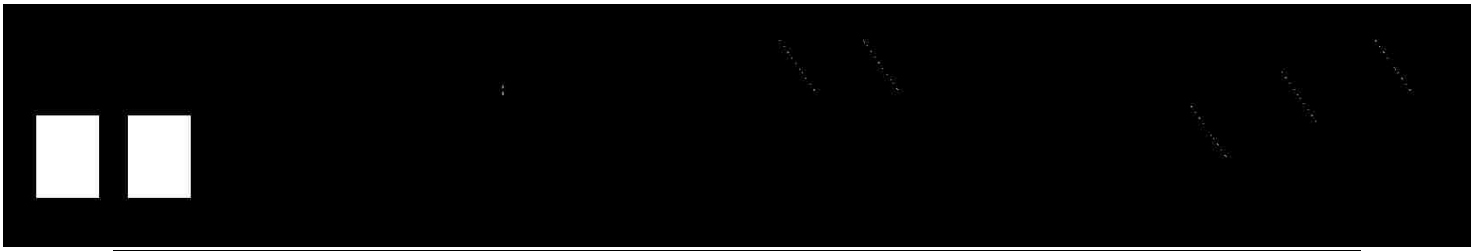


Fig. 5.3: Unit Configuration

Source: M. Thelusma

The separation of the units provides a point of relief that create an interstitial space that can be a place of pause or a transitional zone. Also with separation, the units are able to receive adequate light and ventilation. Additionally, this may also present opportunities to shade certain portions of the project, thus providing cooling zones for the occupants. Lastly, this provides the opportunity to capture adequate sunlight with unit orientation and separate without impeding the placement of the adjacent units.

The next step in the design looks at implementing a unit configuration on the site. The unit configuration utilized for this site is typical of row housing (Fig. 5.4). The units are organized in a manner that allows moments of relief allowing light and wind to percolate through the site. Furthermore, the units are organized to enable larger spaces which will serve as public relief space. Also, the relief spaces provide areas with green spaces and small garden patches. All units oriented due north-south to take full advantage of the solar orientation to the south, as well as the wind to the north.

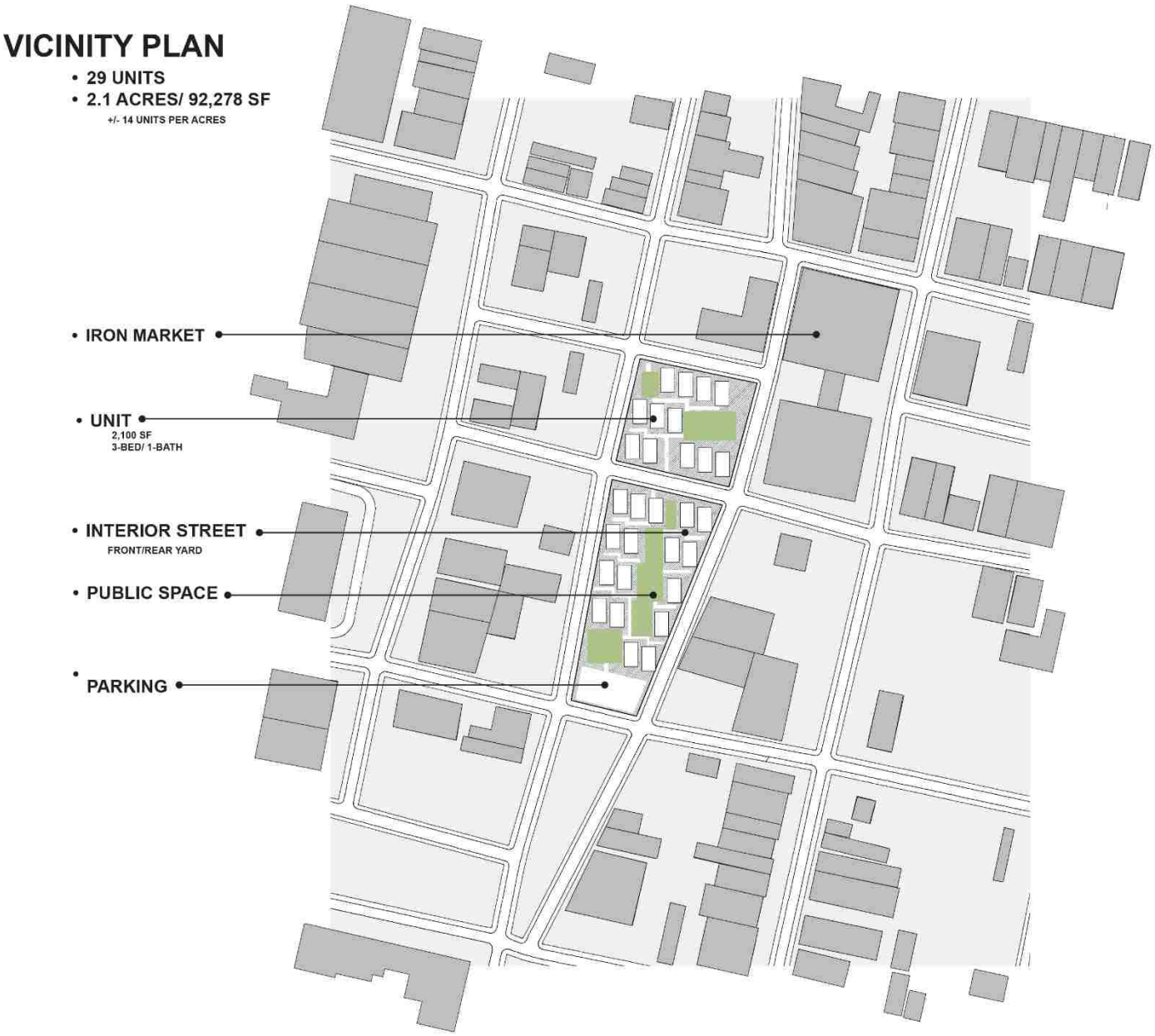


Fig. 5.4: Vicinity Plan

Source: M. Thelusma

Unit Development

The next step in the design development was developing the unit prototype. The design starts by considering how to facilitate ventilation within the unit. By implementing a more directional floor plan layout that has a ratio of 1:2 or greater, the unit is able to receive fresh air on one end and expel it through the other. Once this is established, the

floor plan is developed. The floor plan is arranged in a manner similar to that of shotgun housing (Fig. 5.5). Shotgun housing makes use of a narrow, rectilinear floor plan arranging one room after another on either side of a long corridor. This makes effective use of cross ventilation within a naturally ventilated space. Also, utilizing this technique would benefit the structure and resilience of the walls which can be constructed with the recycled concrete masonry units.

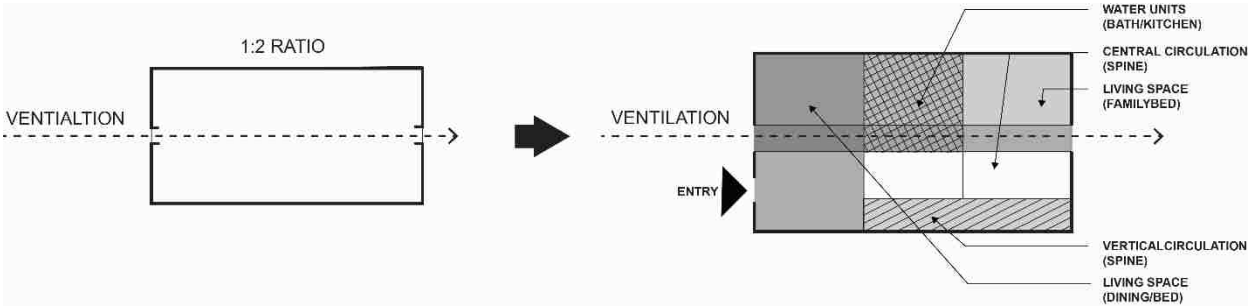


Fig. 5.5: Plan Matrix

Source: M. Thelusma

In plan, all programmatic spaces are placed to one side of the central corridor with the vertical circulation placed on the other side. Once the structural framework for the plan is established, the form of the units is addressed (Fig. 5.6). The form is manifested from the structural logic of CMU as well as response to the natural environment.

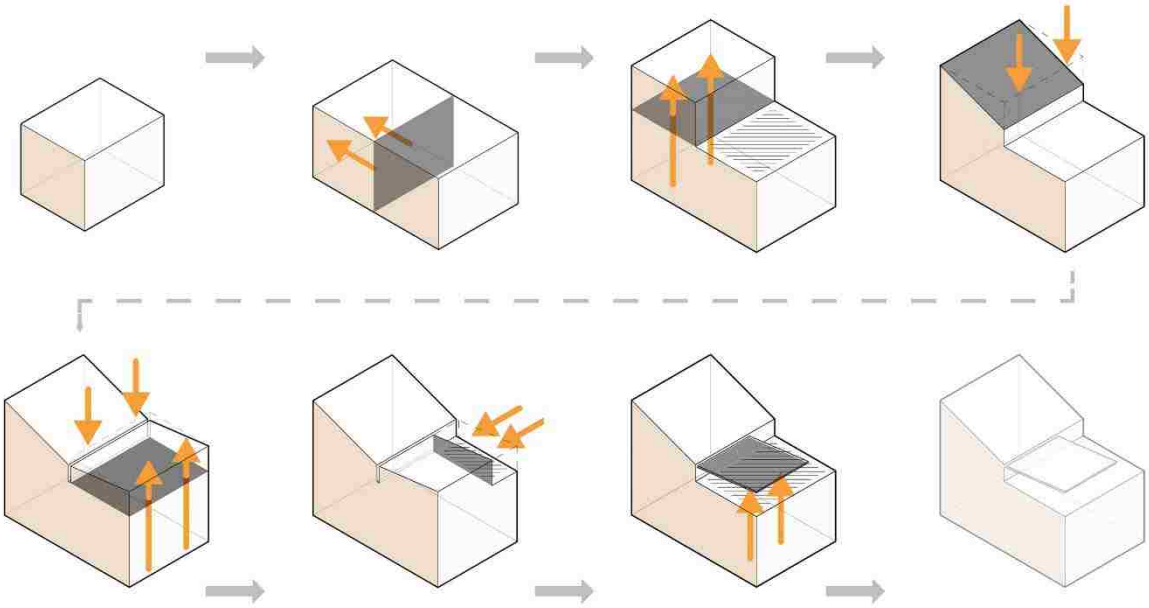


Fig. 5.6: Form Finding

Source: M. Thelusma

The process incorporates a series of pushing and pulling actions based on the interior programmatic spaces, in response to the natural elements (Fig. 5.6). Each unit is designed to collect sunlight, water, and provide a planted garden.

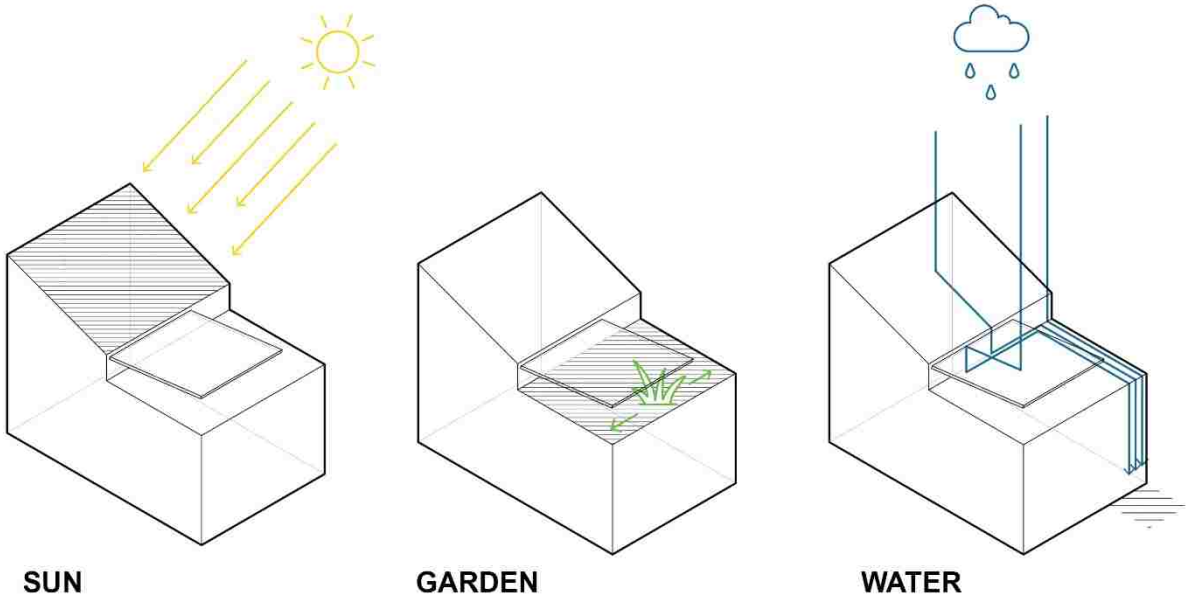


Fig. 5.7: Environmental Response

Source: M. Thelusma

The units are designed with self-sufficiency and resiliency at the forefront. With the collection of solar rays through the use of photovoltaic panels, the unit is able to produce an alternative energy with the intent of reducing the use of non-renewable fossil fuels. The roof angle is set to 18° which is the optimum angle for solar panel efficiency in Haiti. With the collection of rainwater, potable water is produced to provide running water within the unit. The roof angles are utilized to direct water to a cistern for storage and distribution.

The units are multi-leveled single family residences with 3 beds, 1 bath, one half-bath, and two living spaces. The units include three bedrooms to account for the standard family size of two parents and three children. However, in Haiti, most families also consist of extended families living under the same roof. This unit allows for flexibility of rooms in the event that a family will have extended family residing in the same home. The two living spaces on the first level are currently unprogrammed, thus giving the family the ability to utilize them as a living room, dining room, or even an additional bedroom. The ground floor allows for the greatest flexibility as it presents the most opportunity for different configurations. This method allows each family to make the interior spaces unique, thus provides a sense of pride and ownership of one's home.

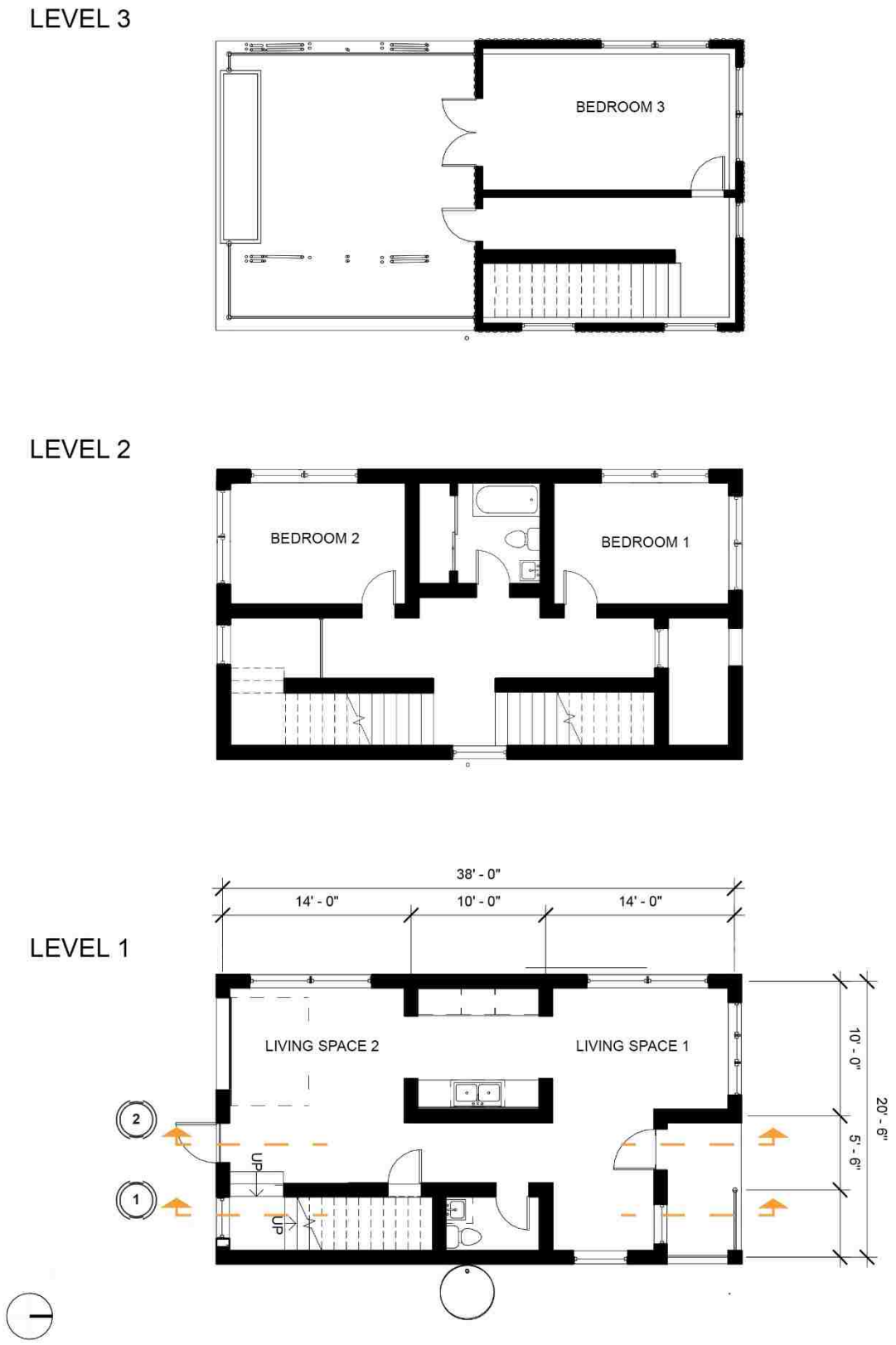


Fig. 5.8: Plans

Source: M. Thelusma

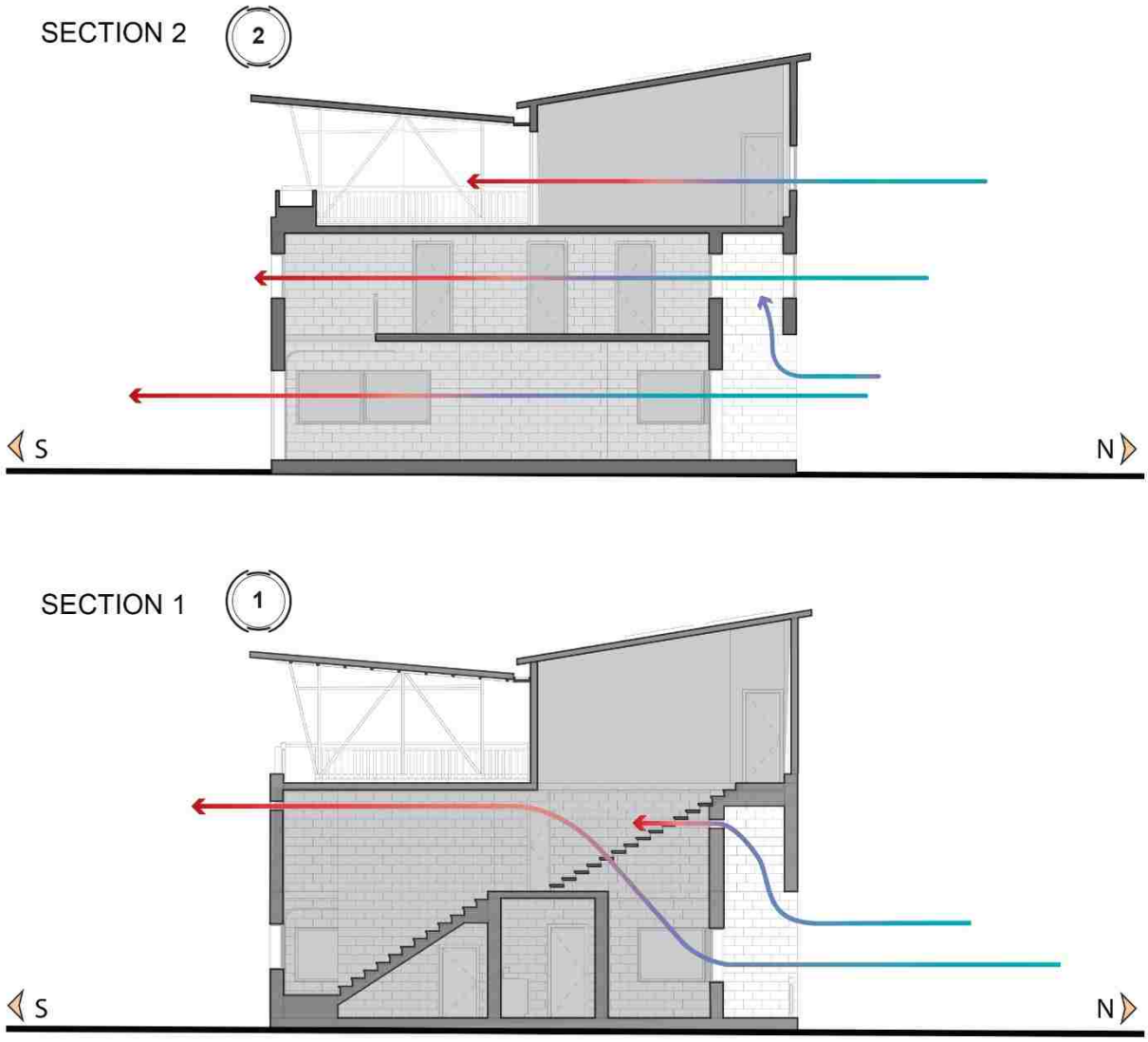


Fig. 5.9: Sections - Ventilation

Source: M. Thelusma

Because the interior has no mechanical ventilation, natural ventilation becomes an important aspect of this unit. This unit makes use of the front porch as a means of projecting the northern winds into the space, thus achieving stacked ventilation. The open risers of the second-floor stair allow for air to travel through and rise into the space. As the cool air enters the space, the warmer air is expelled at the southern end via window or vent. This cooling method aims to provide a pleasant interior space within a hot and humid environment.

Fig. 5.10: Unit Exterior View

Source: M. Thelusma

Fig. 5.11: Unit Relationship

Source: M. Thelusma

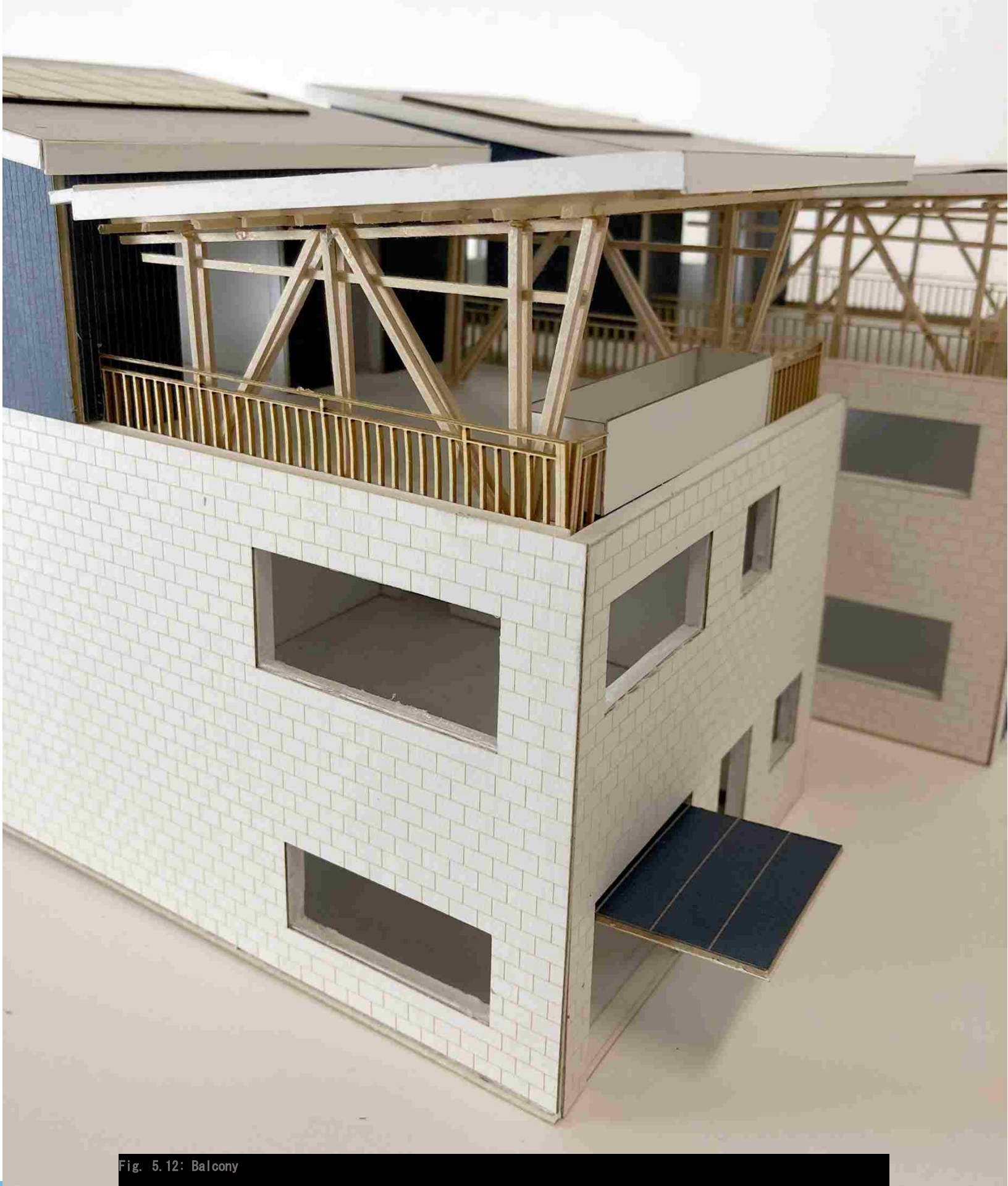


Fig. 5.12: Balcony

Source: M. Thelusma

Fig. 5.13: Site Plan

Source: M. Thelusma

Site Response - Public Amenities

This thesis project also provide public space and amenities to a community of people who have experienced a lack of such resources. The site utilizes a series of open spaces to provide an interconnected public experience. The public spaces are meant to facilitate public engagement and provide amenities such as water and electricity. The public spaces presented within this thesis utilize simple design implementation that give the community the freedom to program most areas. The public spaces also engage with the units, with the incorporation of large garage doors which front the public space, thus further facilitating the engagement between place and architecture, architecture and community, and ultimately people and community.

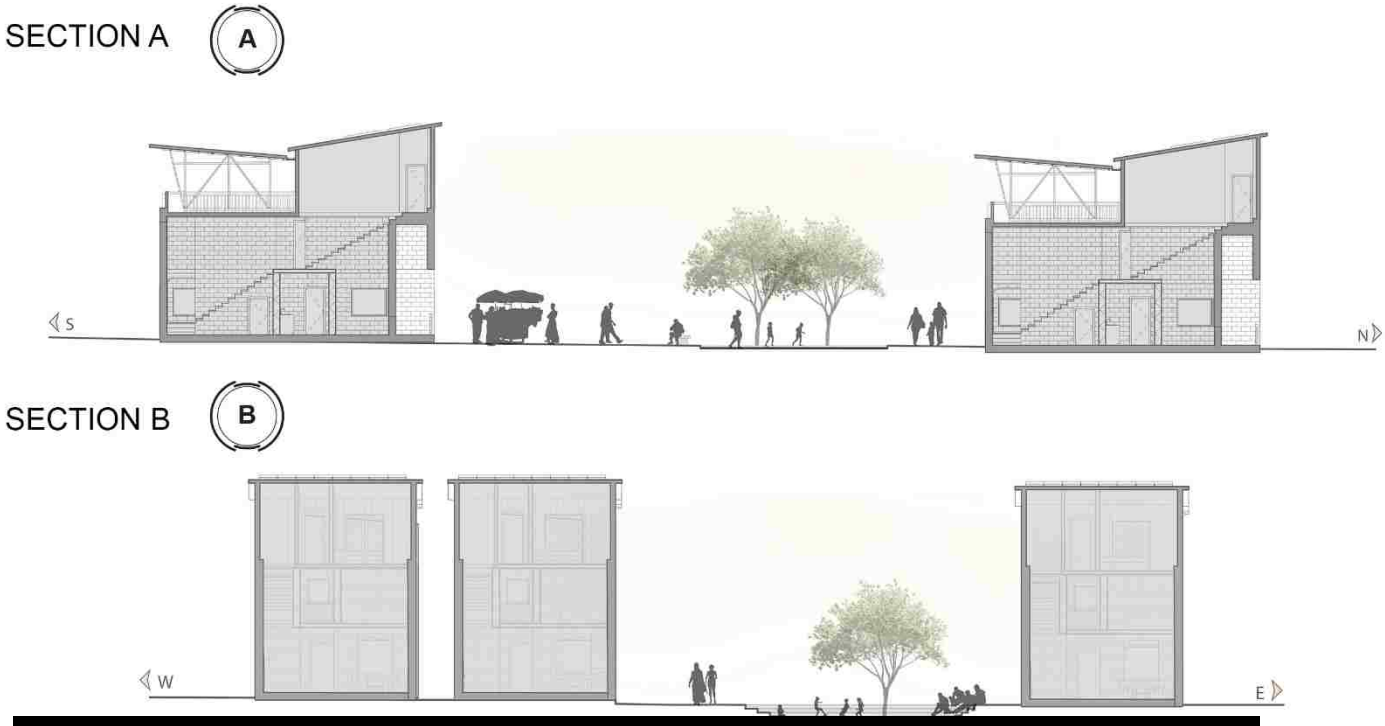


Fig. 5.14: Site Sections

Source: M. Thelusma

The first public space is located on the northern end of the site which is adjacent to the Marche de Fer (Iron Market). The proximity between the two spaces allows for their integration, thus enabling the site occupant to transverse between the two seamlessly. Also, the relationship between the site and the market allows for individuals to make use of the sites open space and utilize it as a secondary informal market space.

The public space also incorporates a water pump and water reservoir for public use. The water is completely self-sufficient and does not require large scale infrastructure monitoring as it utilizes a self-pumping system.

Fig. 5.15: North Community Space

Source: M. Thelusma

The second public space is located on the southern end located among the housing units. The space includes a playground for kids and a sunken platform with stepped seating. The public spaces provide a safe environment for people of all ages and provide multiple vantage points of visual safety and security. Children have the opportunity to play while having direct or indirect supervision.

Fig. 5.16: South Community Space

Source: M. Thelusma

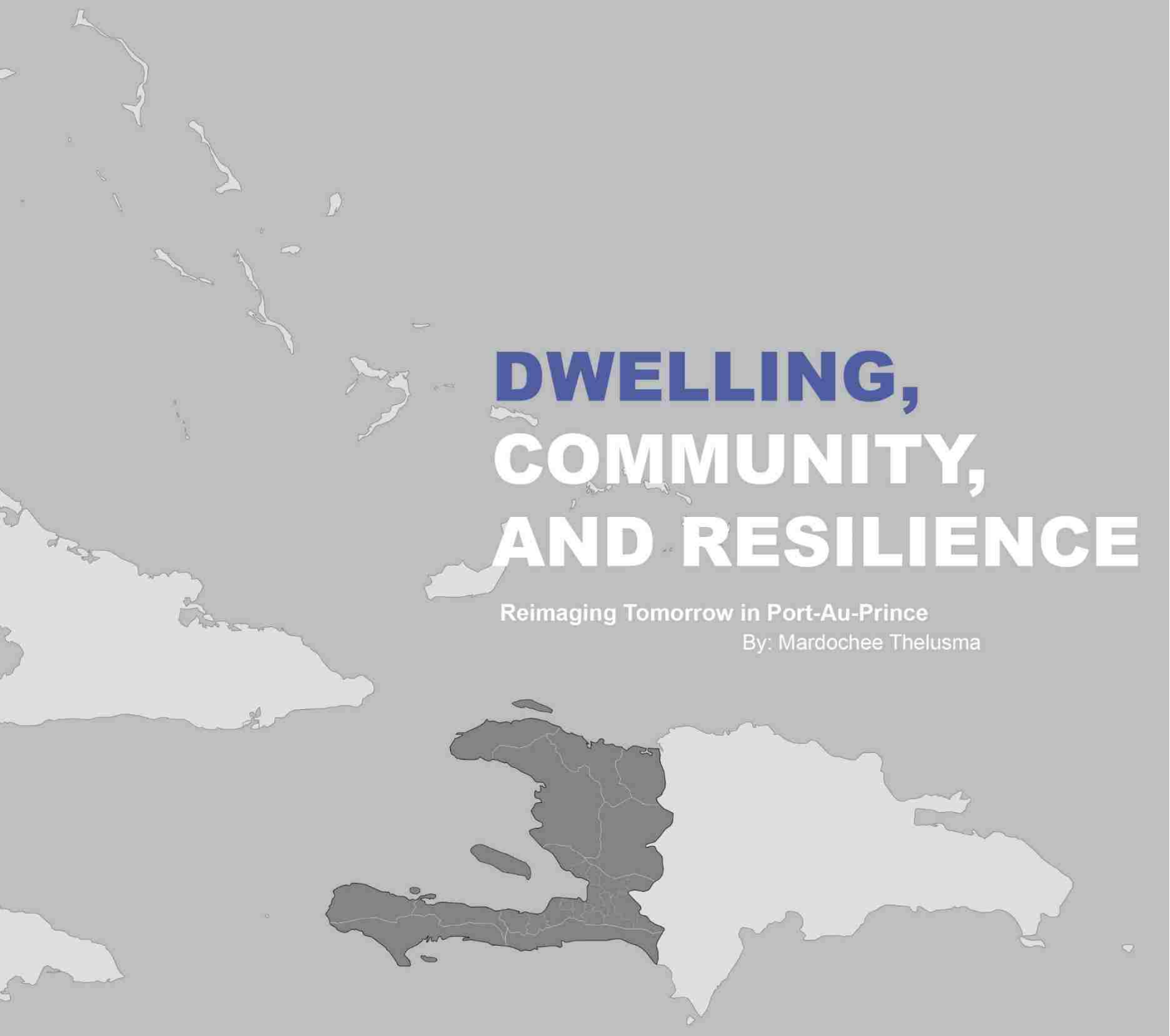
CONCLUSION

This thesis has argued for an environmental and socially sustainable approach to architecture as a means of addressing the housing issue within Haiti. Among the most disadvantaged nations in the western hemisphere, Haiti is currently experiencing a housing crisis. This thesis look to shed light on a present issue currently going on in a country filled with individuals and families who search for an opportunity.

This thesis approaches reimagining tomorrow in Port-au-Prince through the integration of resilience and sustainability into the architecture while utilizing local materials relating to the existing architectural language and texture present in the area. The project aims to provide homes to individuals who had been displaced for several years and living without safe and reliable shelter. Shelter is an essential aspect of living that provides a sense of safety, security, and comfort. Everyone needs a strong, well-built home that provides both usability and durability.

The thesis attempts to facilitate social engagement and public interaction through community gathering spaces that addresses the issues Haiti is facing. The proposed project sought to provide amenities that benefitted the occupants, their neighbors, and the general public. This involved providing simple resources, such as water and electricity, that may not be readily available in the community. This thesis argues for an environmental and socially sustainable approach to architecture and space as a means of addressing the multitude of issues faced in Port-au-Prince. Providing simple amenities to an underserved community, this project aims to bring awareness to issues currently affecting millions.

While architecture alone cannot solve all the issues that currently exists for underserved populations in Haiti, there are opportunities to implement strategies that may provide a better and brighter future for future generations in a way which effectively incorporates existing resources and environmental and cultural considerations.



DWELLING, COMMUNITY, AND RESILIENCE

Reimaging Tomorrow in Port-Au-Prince

By: Mardochee Thelusma

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