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# Communicating Sustainable Design through Visual Dynamics

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We have read this thesis and recommend its acceptance:

John McCrae, David Matthews

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Communicating Sustainable Design  
Through  
Visual Dynamics

A Thesis Presented for the  
Master of Science  
Degree in Landscape Architecture  
The University of Tennessee, Knoxville

Phillip Walter Zawarus  
August 2012

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## ABSTRACT

In this thesis I will explore dynamic visualizations and methods to effectively communicate sustainable design practices and design in Haiti. Every site consists of unique temporal aspects (climate, vegetation growth, hydrology, comfort, and aesthetics) that require dynamic representation of its progressive state. By understanding both the quantitative and qualitative measures of a site's content, designers can create guidelines and adaptive responses to changing conditions caused by new programs using digital tools. This can be achieved by first understanding the integrated relationship of those conditions, as each element has a direct or indirect impact on another. Design must evolve to address changing conditions to improve sustainable qualities.

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# CHAPTER I

## DYNAMIC VISUALIZATIONS

### INTRODUCTION

Process design requires consideration of complex temporal conditions, influenced by natural systems and development. The progressive state of a site cannot be properly represented or communicated through traditional graphic methods. Digital tools and dynamic visualizations can be utilized to solve the issues of process design. Natural systems change the conditions of a site at an hourly to yearly rate of scale, requiring dynamic visualizations to convey those changes quantitatively and qualitatively.

How do various visual dynamics and communication methods become effective and informative of high performance design in landscape architecture? Various visual dynamics and communication methods convey information, high performance design, and quality spaces clearly for various audiences. Can visual dynamics make the design ideas legible for allied professions? In addition, can they create a positive image of sustainable design and applications? Finally, can we determine if the new tools give the viewer an insight into design processes?

Sustainable measures need to be understood as more than just an application or afterthought for high performance design, and more as a building block to dictate (direct, inform, guide, suggest) the outcome of a design. If used as a template to inform planning a design, it can become integrated into a holistic design solution. Applying

these devices as only stand-alone components of infrastructure or systems will diminish the quality of a finished design. Understanding the role of high performance visualization as an inquiry within the design process and outcome will become more effective and desirable.

It is important to use visualization components into the design process effectively and appropriately. Photovoltaics, solar water heating, HVAC systems, and grey water harvesting will not be effective as individual components within a design. Accounting for a site's contents and context will play a vital role in how these elements perform together.

As an example, when using photovoltaics to collect energy, how is the energy and electricity used? This should be accounted for within a design. Is the energy collected used to sustain a high consumable lifestyle? Or is it limited to only provide necessities of clean water, food storage, hygiene, and moderate lighting? How these renewable sources are utilized is important for a successful outcome.

These visual tools and methods can be used to help understand the complex systems within sustainable design. For example, after finding out how much energy is needed to provide for adequate living, we then know the next series of variables for the design. Now that we know how many solar panels are necessary for them to be most effective, they need to be located and oriented properly to the sun. Next, how is

that energy used? What amount of energy is going towards other devices that need to function such as filtration devices, lighting, or other mechanical appliances? It is not about just knowing the necessary output of each component, but also its role within the entirety of the design.

## BACKGROUND

In landscape architecture, design issues are complex and dynamic, requiring process-based design to connect various levels of information into a comprehensive media for efficient communication. Quantitative and qualitative information can be integrated to understand design as a holistic process, which is upon elaborated by John T. Lyle. Initial practices of using alternative methods for envisioning information began in the early twentieth century with visions such as Hugh Ferriss' charcoal drawings. Kevin Lynch, Richard Saul Wurman, and Edward R. Tufte are other key theorists on the idea of dynamic visualization techniques, and more recently James Corner has continued to practice with modern technology and software programs. Various firms and design professions explore different methods for integrating information and aesthetics into a concise project narrative.

### ***Quantitative and Qualitative Information***

Before exploring the benefits of digital tools it is important to understand the significance of combining quantitative and qualitative information in design. John T. Lyle was an architect who focusses upon regenerative design, including the publication

“The Alternating Current of Design Process.” Lyle argued that “good design can be accomplished only through an appropriate sequence of thought development” (Lyle 7); described as a cyclical process proposing and disposing creative solutions with logical procedures. This design process can be understood as a foundation for digital tools, sequentially integrating creative intuition with rational thought for a holistic solution.

Dynamic visualizations were first utilized in the early twentieth century, demonstrated in the work of Hugh Ferriss, but implementation of the fundamentals within architecture and design did not occur until the mid-twentieth century. “Interest in processes of design has grown rapidly and drastically under the influence of a number of factors whose importance seems likely to increase in the future” (Lyle 7). In the first attempts of describing design process, rational thought was a dominant motive that could lead to misguided design. Although the role of rational thought provides order and parameters to design process, neither the human mind nor the design process work in the same linear arrangement. Dynamic and complex issues may exist in many landscape architecture projects that can be organized and arranged through rational procedures, but it requires intuitive measures to proceed forward (Lyle 8).

The alternating current within a design process involves three stages: the Stage of Romance, the Stage of Precision, and the Stage of Generalization (Lyle 12). The Stage of Romance, utilizing the right side of the brain, is a time of freedom and exploration within a design, discounting any limitations or parameters, seeking

opportunities in the design narrative. “Possibilities and connections are there to be explored and sorted out, and among them are hints and suggestions of a new order that we might eventually be able to shape” (Lyle 12). In the Stage of Precision, thinking shifts to the left side of the brain, where logical thinking evaluates the accuracy of initial concepts by organizing the ideas for opportunities in the design. Refinement is the main objective of this stage, creating concise parameters supported by the analytical information gathered. With the combination of creative thoughts with analytical knowledge, a realistic outcome can be derived for implementation in the Stage of Generalization (Lyle 12). “By understanding how intuition and rational thinking interact, we can develop design processes that provide for both inspiration and analytical validity” (Lyle 7).

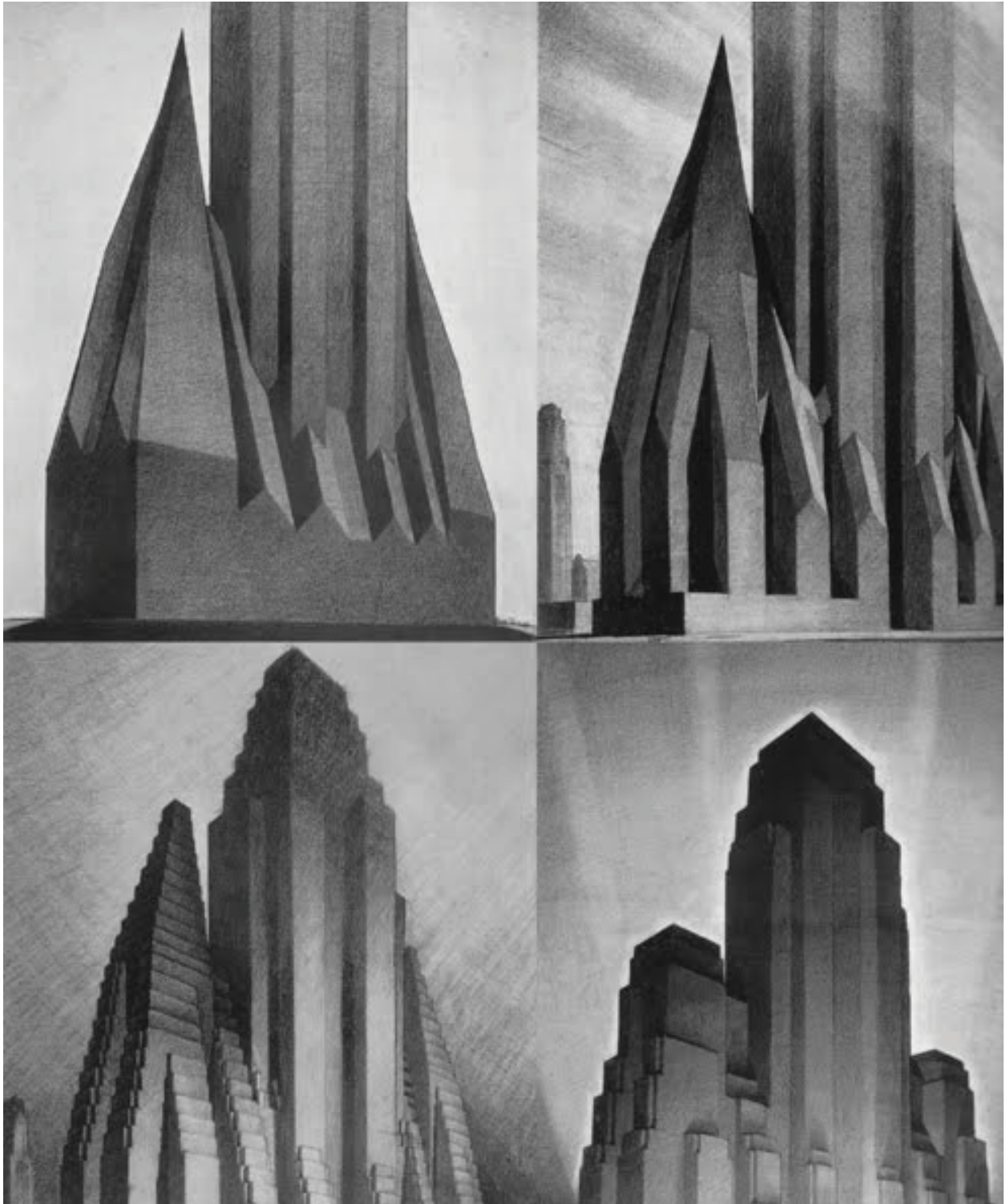
Lyle’s concept of connecting quantitative and qualitative information for a final outcome can be a foundation for landscape architecture design thinking. It is an innovative approach to allow analytical information assist in the refinement of creative and inspiring ideas. The acknowledgement and balance of the two levels of information is key to an effective outcome, so as one does not dominate the other for a misleading comprehension. This design process is utilized in the thesis as an effective mechanism to change from the logistical analysis section to the creative ideology for a holistic design outcome, integrating information and composition. That is the argument for using dynamic visualizations as a tool to effectively communicate a process-based design.

## ***Digital Representations***

In her book “The Exposed City” Nadia Amoroso explores different visualization techniques used by key theorists and practitioners in the profession of landscape architecture and other related fields. These techniques build upon the theory of Lyle through the use physical or digital representations integrating information and art. This section showcases a progressive advancement using graphical representation ranging from city zoning codes to large natural systems in an attempt to explain the complexities of design.

Hugh Ferris was one of the leading pioneers on using graphic representation for understanding extensive information or intangible qualities. His charcoal drawing “Evolution of the Set-back Building” portrayed the 1916 Zone Code Ordinance of New York shown in *Figure 1. Evolution of the Set-back Building*. This visualization dissected the zoning code of form based design into an abstract representation of what the parameters permitted. By providing viewers with a multitude of options in building form permitted by the new ordinance, decisions and collaboration could happen effectively between different entities from the city. Although the method of charcoal drawings was simple, the representation of how the city could develop was clear and legible for a diverse audience to understand (Amoroso 4-8).

Other key role players in the advancement of graphic representations are Kevin Lynch, Richard Saul Wurman and Edward Tufte. They were focussed on peoples’



*Figure 1. Evolution of the Set-back Building*

Source: King



perception and experience of an area through cognitive mapping and information graphics. Diagrams and maps were the working media to simplify complex change in the built and natural environment. It was important to these professionals to visually communicate graphics in a truthful manner without distorting the graphic to achieve a desirable outcome (Amoroso 41-42).

Lynch's work focussed on cognitive mapping, a technique using a mental image or map of an area generated by how people organize and visually identify their surroundings. Common symbols would indicate landmarks, nodes, edges, paths, and districts (Amoroso 46-48). Wurman initiated the practice of communicating visual information referred to as information graphics. These representations visually help users understand components of an area. Most of his work compiles data sets, of varying degree, into stimulating computer graphics. Wurman intends for his work to empower the users by creating effective instructions through graphic representations (Amoroso 52-54). Tufte intends to represent complex ideas with clarity by using precision and efficiency without distorting the data. "Tufte regards graphical excellence, which is a matter of substance, statistics and design, as the well-designed presentation of interesting data" (Amoroso 60). His work presents data at various levels of detail, starting at the broad overview of an area to the fine detail.

The last graphic representations examined are from landscape architect James Corner. Before going into his work, it is important to note landscape architect

Ian McHarg influenced Corner's work, and must first be understood. McHarg was interested in capturing natural and social aspects, including: vegetation, hydrology, soil structure, geology, morphology, sun and shade, erosion, and areas of sensitivity. Most of which are categories of physical characteristics analyzed in this thesis. These categories were layered to form a master composition, often by overlaying transparent sheets for each category. "McHarg used this scientific, analytical and drawing process to 'capture' the site before he attempted to design for it" (Amoroso 93). At the time this was a breakthrough technique in landscape architecture, and now a common effort to understand the context of a site. This method can be perceived as lacking appeal to today's standards, but provides a foundation of conveying site information in layered categories that can be enhanced through modern technology. The method behind this layered process is key for representation techniques. Corner took these fundamentals for mapping and visually communicating an idea through a map-drawing hybrid, shown in *Figure 2. Planting Calendar*. The hybrid is an altered diagram of fragments resembling a collage to tell a story. These are considered non-traditional diagrams because they are not standard line drawings or bubble diagrams overlaid on a map (Amoroso 93-95).

### ***Exploring the Visual Landscape***

"Landscape representations contain a space of perception, and do not reproduce only appearances and information, but also a world of experiences that enlarges the knowledge of reality" (Nijhuis 64). This section of the book goes over the dynamic

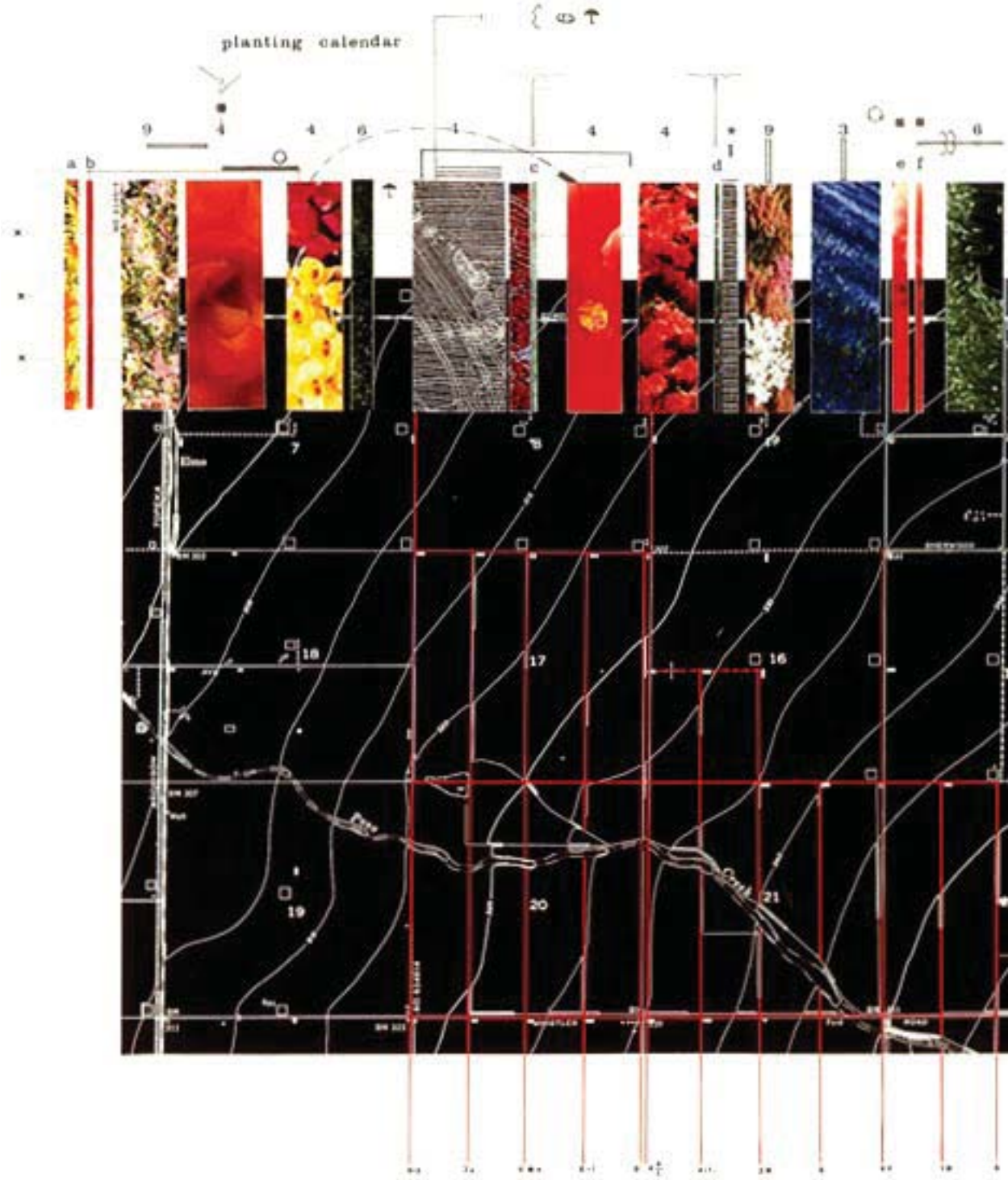


Figure 2. Planting Calender

Source: King

capability that geographic information systems (GIS) offers in taking the geo-referencing information, or spatial data, and combining it with perception and appreciation of the landscape, or non-spatial data. This combination of quantitative and qualitative data becomes a guide for understanding the change and process in the natural or built environment.

The world is composed of a complex layering of information constantly changing and adapting based on the physical context of reality and the perception of culture and regional values. This dynamic layering system must be understood for appropriate modification through design interventions. In order to fragment these layers and decode the information within each system appropriate technologies must be used to catalog the quantitative and qualitative values (Nijhuis 64-66).

GIS is adequate for collecting information regarding physical attributes but lacks the ability to collect qualitative attributes. To collect those sensory surveys, polls and questionnaires need to be carried out. One of the more common tools for that is Scales for Perception and Evaluation of Landscapes (SPEL). This survey has categories that different users fill out and return to an agency to input into their database. The results, however, were vague because there was no consistency in the collection and composition of qualitative information. There needs to be a repetition of surveys completed by specific user groups with precise locations. Using GIS technology can allow for a comprehensive database containing these results with precise locations for a

reliable outcome (Nijhuis 66). Digital tools, such as GIS, have the capability to comprise surveys into an organized database, permitting comparison and evaluation of the given results collected.

The conclusion that the authors derived, is that questionnaires are only a basic tool for the collection of qualitative measures and should expand more thoroughly. This can be achieved through the integration of social digital networks and devices that interfaces with GIS. Collecting data through this means a diverse user group can be achieved along with a vast number of surveys provided. This can be a simple integration through community participation and involvement of the project to establish a comprehensible template of values that relates directly with potential green infrastructure and sustainable systems. Using the values of a culture and unique user group can establish an appropriate and successful design intervention.

### ***Digital Land***

This compares using digital tools in architecture and land planning. The profession of architecture used the integration of digital technology and design before land planning. Architects have their own toolbox of programs and software to share information digitally throughout the design process and mechanical systems within. The author states that this same integrated process is needed for land planning as well. The book explores the possible tools to achieve this that include: Geographical Information Systems (GIS), Computer-aided Design (CAD), Three-dimensional modeling, rendering,

and animation (3D), Image Processing, and Multimedia, Web Technology, and digital video. GIS allows planners and designers to analyze a large range of information at any scale. CAD is an effective tool for communicating construction documents. Three-dimensional tools expand the capacity to view the impacts of design before construction. Image processing allows for designers to integrate real images with design applications within the context of a site. Multimedia devices provide interesting and dynamic presentations of projects to the general public and clients (Sipes 13).

These new technologies are not replacements for current design process practices, as the process of design development is a critical component to design. “Digital Land” explores conventional design processes is integrated effectively through the digital tools available to designers and landscape architects.

There is no digital tool or software program capable of integrating all levels of information and data for designers. A wide range of tools is necessary to convey ideas effectively and clearly to clients and the public for positive feedback and collaboration. The need to understand diverse programs becomes complex and difficult to transfer from one program to another as each has its own performance purposes. Another issue with the integration between each is that most of the programs were not designed or intended strictly for land planning and landscape architecture. Their initial purposes were for graphic designers, publishers, mechanical engineers, photographers, and game designers (Sipes 139).

This trend continues as new software is developed at a fast pace and designers struggle to keep up. There is no standard for communicating the design process. It is necessary to use digital tools effectively for clarity and understanding of complex systems. Designers need to be creative and intuitive with digital tools to dissect and create thorough examinations of design fundamentals. This is crucial for designing in Haiti, as traditional and conventional methods of design may not convey a clear message. Using programs for unique user groups should be emphasized for effective design communication.

### ***Mixed Messages: Communication in Education and Practice***

“Research findings pointed to a startling dichotomy in academic and professional perceptions of the importance of communication training in undergraduate architecture education. While only 13.8 percent of academic programs require communication coursework directly related to architectural practice, 94 percent of architects surveyed indicated communication skills are very important to their practice, and 73 percent indicated their undergraduate architecture education did not adequately prepare them for professional practice” (Weko).

This article from Design Intelligence emphasizes the importance of architectural based communication within a design studio. In a profession that hinges on architectural ability and communication as leading factors of success there is no curriculum within the program studies that provides that. A majority of the accredited programs throughout

the country require a certain number of credit hours in English courses, but that may not reflect communication of design projects. The writer suggested that design studios need to find a balance between design and communication. Within the research by the author surveys were taken between licensed professionals and academic faculty at professionally accredited programs. Both groups found presentation and communication skills very important, receiving a 5 out of 5 rating in the survey. Average ratings for specific communication skills on the same scale included writing (4.6), public speaking (4.9), graphic design (4.8), and interpersonal skills (4.6) (Weko).

### ***The Value of Green Infrastructure***

For the purposes of this thesis topic, the focus will be primarily on reduction of stormwater runoff, reduction in energy use, improved air quality, and public education opportunities. These green infrastructure benefits will have a direct and appropriate outcome on the issues that surround the Haitians and their community.

Stormwater runoff is a concern in most places in the world, but is considerably more so where water resources are scarce and often contaminated to a state of being unusable. Controlling runoff and having a passive treatment of that stormwater will provide a collection of water for uses in sanitation, agriculture, and human consumption purposes. By utilizing vegetation as a filtration mechanism, the green roof component becomes a natural system of treatment, as well as vegetation for evapotranspiration, agriculture production, and insulation. The use of a low impact development strategy,



verses a mechanized engineered system, provides cost benefits and less maintenance.

With green roofs providing insulation through the growing media there is a reduction in energy use. Some of these benefits include:

- Additional insulation provided by the growing media of a green roof can reduce a building's energy consumption by providing superior insulation compared to conventional roofing materials.
- The presence of plants and growing media reduces the amount of solar radiation reaching the roof's surface, decreasing roof surface temperatures and heat influx during warm-weather months.
- Evaporative cooling from water retained in the growing media reduces roof surface temperatures (The Value 4)

Air quality is another reason for green roof infrastructure in a community that lacks healthy living. The vegetation planted will capture pollutants and also intercept particulates. As mentioned previously, with the reduction of energy use there is also less reliance on electric generators that contribute to the pollutants in the air (The Value 4).

Lastly, the education opportunities through green roof application are vital within a community that lacks understanding of sustainable systems and the benefits that come from them. Through participation of the community in developing these passive systems there is an increase in community awareness and interest through the functioning capacities and aesthetic qualities that become revealed (The Value 4).

This green infrastructure application involves the redirection and productive use of that stormwater for purposes such as irrigation, toilet flushing, sanitation, and also potability. Within the practice of water harvesting, stormwater becomes a usable resource rather than a waste product. Diverting and collecting stormwater is simple and can be achieved by disconnecting downspouts from city inlets and collecting the water in rain barrels or cisterns (The Value 12).

Diverting runoff from the city sewer system can make runoff for production and irrigation. This can reduce the size of sewer systems as well as reduce the mixing of sewage and stormwater. For the purpose of the Haitians, potential agricultural plots will be a first priority for water reuse along with reforestation for erosion control, and lastly rain gardens. Collecting the runoff in barrels and cisterns will put less reliance on city water use and become less dependent on that source. This is extremely important for the Haitians as there is no city water system or infrastructure. Green infrastructure can reduce runoff and erosion (The Value 12).

#### Water: Benefit Measurement and Valuation

- Design a green roof requires knowledge of different variables that influence its retention and success rate. These variables include:
  - Average annual precipitation data (in inches) for the site
  - Square footage of the green infrastructure feature
  - Percentage of precipitation that the feature can retain (The Value 17)

For the use of water harvesting, calculations and information of stormwater volume to be stored on site are required and include:

- Average annual precipitation data (in inches)
- Rainfall intensity
- Size of the water-collecting surface (in square feet)
- Capacity for temporary water storage and release
- Frequency of harvested water use for building needs, irrigation or evaporative cooling (e.g. whether the captured rainwater is used before a subsequent rain event) (The Value 20)

This article focused upon the retrofit of green infrastructure applications within an urbanized setting. That raises two issues within my thesis topic in Haiti. Applications in Haiti will not be retrofitted to existing buildings but as an integral component of a new design. Therefore the building structures should be designed to have the carrying capacity based on the appropriate growing media chosen for that system. Extensive green roofs will have a shallower soil and root depth thus requiring less loading capacity on the roof. Most retrofit green roofs placed on large office buildings already require a high loading capacity due to air-conditioning units in place. The consideration of variables for green roofs in Haiti will include retention capacity, insulation needs, potentially productivity through agricultural function, and also economically viable.

The other issue is that Fond-des-Blancs is not an urbanized area. This small community is situated in an area lacking access to electricity and water; two vital components for survival. Application of green infrastructure, low impact development,

and sustainable systems is essential for communities detached from major infrastructure. Being aware and sensitive to these conditions will allow for appropriate and successful design decisions.

## CHAPTER II INTRODUCTION AND GENERAL INFORMATION BACKGROUND

On January 12, 2010 an earthquake registering a magnitude 7.0 occurred near Port-au-Prince, the capital of Haiti. This event devastated infrastructure, houses, roads, and peoples' ways of life. Over half a million residents were affected, prompting a policy response of relocation from metro Port-au-Prince to cities and towns throughout the country. Population displacement to the different regions in Haiti was determined through the tracking of Digicel mobile phones (Bengtsson), as illustrated in *Figure 3. Displacement*.

These towns, already lacking in adequate water supplies, are stressed further by population increases. Bacteria, disease, and sewage increasingly affect water infrastructure. At water sources, residents bathe, wash clothes and dishes, and clean machinery such as motorcycles. Farm animals stand and cool off in these drinking water sources; defecating and releasing bacteria. As potable water quality diminishes, people increasingly suffer and die from cholera and malnutrition. Malnutrition is also an issue due to the lack of a variety of affordable, nutritional foods in these smaller towns and villages. Diets of predominantly high sugar foods are a reality for most Haitians, due to cheap price for imported, processed foods.

With the living conditions continuing to diminish throughout these outlying villages, initiatives to inform, educate, and communicate the importance of improved

# DISPLACEMENT

After the January 12, 2010 earthquake, Port-au-Prince was left devastated in the aftermath with families broken, living conditions unbearable, and disconnected service. This prompted over half a million displaced residents to leave the metropolitan area for a better life. This rapid increase in population outside the capital requires appropriate planning to improve the natural and built environment in an integrated and holistic solution.

## Port-au-Prince Earthquake Exodus

January 12, 2010

**22% DECREASE**

January 31, 2010

**570k**  
Port-au-Prince

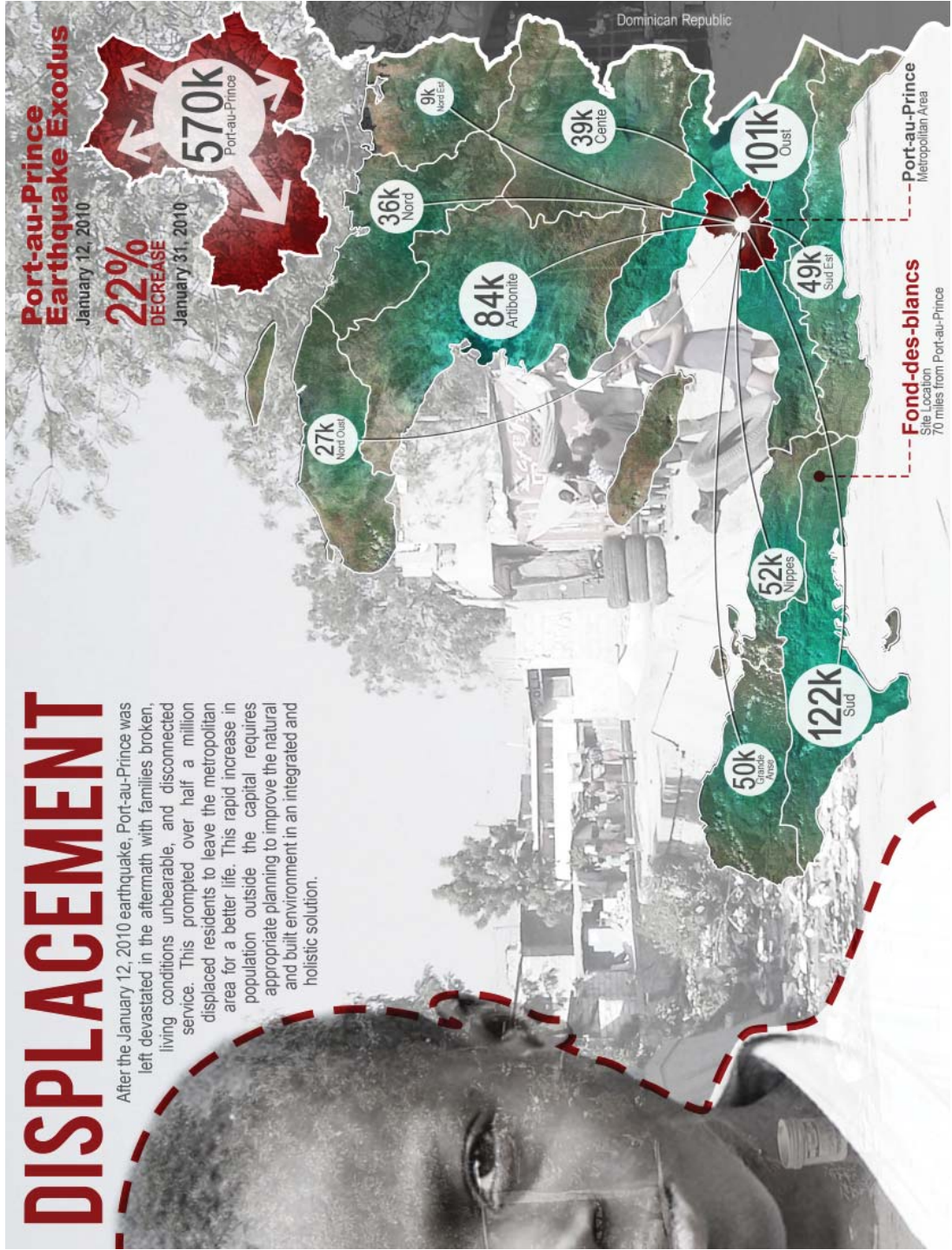


Figure 3. Displacement

water resources and a nutritional diet becomes vital. It is necessary to acknowledging the communication barrier, either verbal or visual, in Haiti. With the use of visual dynamics and alternative design methods, collaboration with other cultures and communities can improve to effectively communicate the intentions of sustainable design.

Haiti is a unique opportunity to explore alternative communication methods due to the lack of visualization resources such as: maps, floor plans, sections, and other conventional methods used in the design profession. Most individuals cannot comprehend the information portrayed through professional methods. It can be difficult to convey ideas or explain the process within a design in a manner for all parties to understand. The community in Fond-des-Blancs is familiar with photographs as cognitive perception of space. By taking the visual medium of what a particular community is familiar with, a design can be projected as an effective communication of an idea towards improving their living conditions. As designers, it is important to become aware of not only the physical context of a site, but also the cultural perception. Today design scenarios are complex, as they must address numerable variables affecting a site. These variables range from global to local environmental, social, and economic opportunities. With this complexity, alternative methods should be explored to make appropriate decisions based on the variables pertinent to the design initiative.

## RAPID ASSESSMENT

Before choosing appropriate visualization tools it was important, as with any other form of site analysis, to become grounded in the site of Haiti from a global, regional, and local context. Both direct and indirect factors will influence a site differently at each scale, ranging in levels of significance. Site analysis involves taking an inventory of information discovered at each scale, then rationalizing the possible positive or negative influence it may have. Information of a site should not be a stand-alone product, rather a tool or media for synthesizing appropriate decisions and guidelines. Once this database of information has been formulated, the next step is to connect specific elements of the analysis to the project objective. In the case of this thesis project, it was an association of variables pertinent for a sustainable housing development in Haiti, considering opportunities in water resource management and agricultural production for a nutritional diet.

A visit to Fond-des-Blancs in December provided an initial survey of the site's conditions, quality, concerns, and additional opportunities than those of just water. This established an analysis matrix of primary and secondary variables. The variables included: climate, vegetation, hydrology, soils, topography, wildlife, and aesthetic quality. These variables were established through a joint investigation with undergraduate architect and interior design students in early February for another visit to Fond-des-Blancs. The process of collecting this data will be further explained in Chapter III.



Once the inventory was finished, it was discovered that there was an integral relationship between the different variables researched. Because of this unique relationship, the analysis required dynamic modeling tools for a comprehensive communication of the site's condition. Utilizing these dynamic tools allowed for a seamless integration of data between the different variables, specifically vegetation, hydrology, soil texture, and slope conditions. Not only did the various data integrate easily, but changes in one component of the data set could be made while effectively adjusting the outcome of the combined variables.

This led to a comparison of conventional and alternative methods of understanding site analysis, shown in *Figure 4. Traditional Representations* and *Figure 5. New Opportunities*. Through the comparison, an evaluation of effectiveness could be determined for future investigation of site analysis, or which scenarios are appropriate for different visualization methods.

## SITE ANALYSIS: GLOBAL CONTEXT

For a successful design outcome, it was important to become grounded in the context of Haiti through a comprehensive analysis and synthesis at varying scales, starting global and trickling down to the site location. Haiti is one of many small island developing states (SIDS), as well as a least developed country (LDC), vulnerable to climate change, with high risk of increasing temperature, decreasing precipitation, and inadequate water resources and arable land due to the climate of the area. "These

## Fond-des-blancs Site Analysis

### Climate

- Wind Direction + Speed
- Precipitation
- Temperature

### Vegetation

- Canopy Cover and Major Trees
- Understory/Plant Communities

### Hydrology

- Drainage: Major and Minor
- Stormwater Runoff

### Soils

- Topsoil Texture
- Subsoil Infiltration

### Topography

- Contour Lines + Terrain

### Wildlife

- Aviary + Amphibious Wildlife
- Domesticated and Livestock

### Spatial Quality

- Unique Spaces and Conditions

## Traditional Representation Used

Representing the inventory often neglects to create connections between the data sets to form correlating relationships of integrated systems.

- Wind** - Wind rose displaying the direction and speed fluctuation throughout the **month, day, or hour**.
- Precipitation** - Charts and graphs informing **yearly** and **monthly** precipitation amounts along with **wet** and **dry** seasons throughout the year.
- Temperature** - Charts and graphs displaying air temperature by **month, day, hour, or** any other designated time frame. Determining the **daily high** and **low** hours.

- Canopy** - Identifying various established and **matured vegetation**, specifically **canopy trees** through photographs while referencing their location on a base map.
- Understory** - Identifying the **plant communities** within the understory and groundcover to emphasize the **symbiotic relationship** that exists in vegetation. Noting the **ecological value** of various communities and referencing them as **regions** relative to unique site conditions.

- Drainage** - Identifying the different drainage types as **primary, secondary, or tertiary**. Making each distinct in appearance, including the **direction of flow**.
- Runoff** - Site runoff contains both **quantitative** and **qualitative** values, being volume and velocity as well as pollution and sediment.

- Topsoil** - During site visits taking hand fulls of topsoil to determine **soil texture**; which will be indicative of the storm water **surface flow**.
- Subsoil** - Observing the **infiltration rate** of water levels at designated points on a site will indicate the **subsoil type** for proper programming of areas.

- Contour Lines** - Using provided contour lines from **regional maps** or **surveys** to use as base map. Ability to generate either **physical** or **digital models** of the terrain and context.

- Wildlife** - Identification of different **wildlife presence** and evaluating **sensitive habitats** to preserve and prevent development.
- Parasitic** - Documenting any potential **parasites, pests, or invasive species** that may be harmful to the natural conditions of a habitat.
- Livestock** - Acknowledging the presence of **domesticated wildlife** or **livestock** as potential intrusions of the natural environment as well as **pollution sources**.
- Intangibles** - The combination of various **site conditions** at a specific instance provides **qualitative values** that may include **light quality, lush vegetation, comfort**. Thorough investigation of a site quality can be carried out through **photographs**, including panoramas, **videos**, and **sketches**.

Figure 4. Traditional Representations

## Issues + Opportunities

Discrepancies in the compiling of different data prevents consistency in matching of various layers and information.

The analysis of climate is often left as an **independent component** of **generalized data**. The relationship between **climate data** and other **site variables** is not considered or recognized for a complete analysis.

Integrating the different climate data (temperature, precipitation, wind, sky conditions) with other conditions (vegetation zones and surface types) can create **visually unique** and **descriptive conditions** not seen otherwise through the span of months, days, and even hours, specifically from day to night.

These codependent data layers can be specifically used to determine both **human comfort zones** in the outdoor environment and **thermal heat gain** of the built environment.

Vegetation cover is crucial in understanding the surface conditions of the site for both runoff volume and erodibility. Preserving existing vegetation as well re-vegetating an area can be determined according to the site conditions.

Visualization of **vegetative succession** over time spans along with the **plant growth** of various canopy trees will emphasize the **environmental benefits** related to increased shade cover, diverse ecosystems, soil nutrition, and runoff infiltration.

Drainage systems rarely account for **soil properties** that control saturation levels; which will influence the volume of **sheet flow** and **erosion issues**.

Indicate a stronger connection between hydrology and soil and erodibility conditions. Calculating the storage capacity of basins to prevent flooding. Correlating the water quality with pollution sources from other site conditions: vegetation, wildlife, and soil types.

Through the location of different soil types throughout the site, you will be able to determine and assess **risk potential** for **flooding**, **erosion**, and **foundation suitability**. These risks are highly influenced by other components separate from soil analysis that include: **vegetation** and **hydrology**.

Vegetation can be correlated with **soil stabilization** and **flow control**. **Infiltration rates** of different soil types will be indicative on how hydrology functions on the site.

**Land survey's** and **contour maps** cannot capture detail of **micro conditions** of contours, thus resulting in less accurate drainage patterns and interpolation of the terrain.

Further investigation and collection of **concise elevation points** will provided further detail where **drainage** and **specific conditions** are not prevalent on maps.

Wildlife habitats are influenced significantly by **vegetation type** and **climate conditions**. Connecting these variables will aid in maintaining **sensitive ecosystems** as well as expand or **create additional ecosystems**.

Need to determine what conditions promote **invasive parasitic communities**.

This is a major opportunity to connect the **quantitative** and **qualitative inventory** and analysis to compose a complete story.

Compiling site analysis into a **collective media** will communicate clearly the **relationship between layers of information** for an analysis driven design proposal.

## New Opportunities

Exploring the potential of different programs (Rhino + Grasshopper + Ecotect) to integrate systems of information and data sets for dynamic representation of temporal site conditions

Potential to take data sets of the various climate conditions to illustrate changing qualities over different time intervals previously stated, **capturing the temporal conditions** of a site for **adaptive design proposals**.

The integrated data sets can create analysis "**contours**" or "**clouds**" for dynamic climate data representation over designated time frames.

The various "contour" and "cloud" maps can represent both the built and outdoor conditions: **thermal head gain** of buildings, and **human comfort zones** in outdoor spaces. With this information, you can apply passive design measures throughout the site to match desirable conditions already provided by natural conditions.

Canopy cover can be represented as a **progression** of diverse vegetated **massing** to reduce stormwater runoff as well as soil stabilization.

By combining the site analysis layers, regions can be prioritized regarding preservation of vegetation along with determining adequate vegetation needs to address shade, soil stabilization, and runoff infiltration.

Representing **velocity** of different drainage systems in relation to slope and watershed size, with risk of erosion and flooding through soil properties. Visualizations would include **time lapse of runoff** movement and catchment.

The use of stormwater calculations, specifically **time of concentration**, can create a progressive time lapse to represent storm intensity for infiltration and runoff volume.

Assessing water quality, based on location of **pollution sources**, and potential alternative use on site through calculated **runoff volume**.

Risk assessment of **erodible soil types** based on attributed values through intense runoff and lack of vegetation.

**Assigning values** to determine different infiltration rates and saturation levels.

Using a **global positioning system** (GPS) to record points for quick interpolation. Various software can take the **specific tracks** and **points** logged on the device to create a thorough evaluation of the terrain and landmarks on site.

These points make it simple to create **digital terrain** and accurate **contour lines** for base.

Using the site inventory of prevalent wildlife, creating data sets of wildlife properties for **temporal migration** and **habitat "clouds"** representative of daily situations.

Location of domesticated wildlife and livestock will be mapped and identified as having **different impacts**, positive and negative, on the site conditions.

The use of **flash platforms** and other **multi-media** to stitch the analysis layers will create a collective platform to represent various integrated systems related to high performance design.

An **immersive environment through 360 panoramas** become tangible and **legible for diverse user groups** (designers, contractors, general public, users, academia)

Figure 5. New Opportunities

climate characteristics, combined with their particular socio-economic situations make SIDS, among which are 12 LDCs, some of the most vulnerable countries in the world to climate change. This, added to the fact that SIDS produce such extremely low levels of greenhouse gas emissions, means that they will suffer disproportionately from the damaging impacts of climate change” (Sem 5).

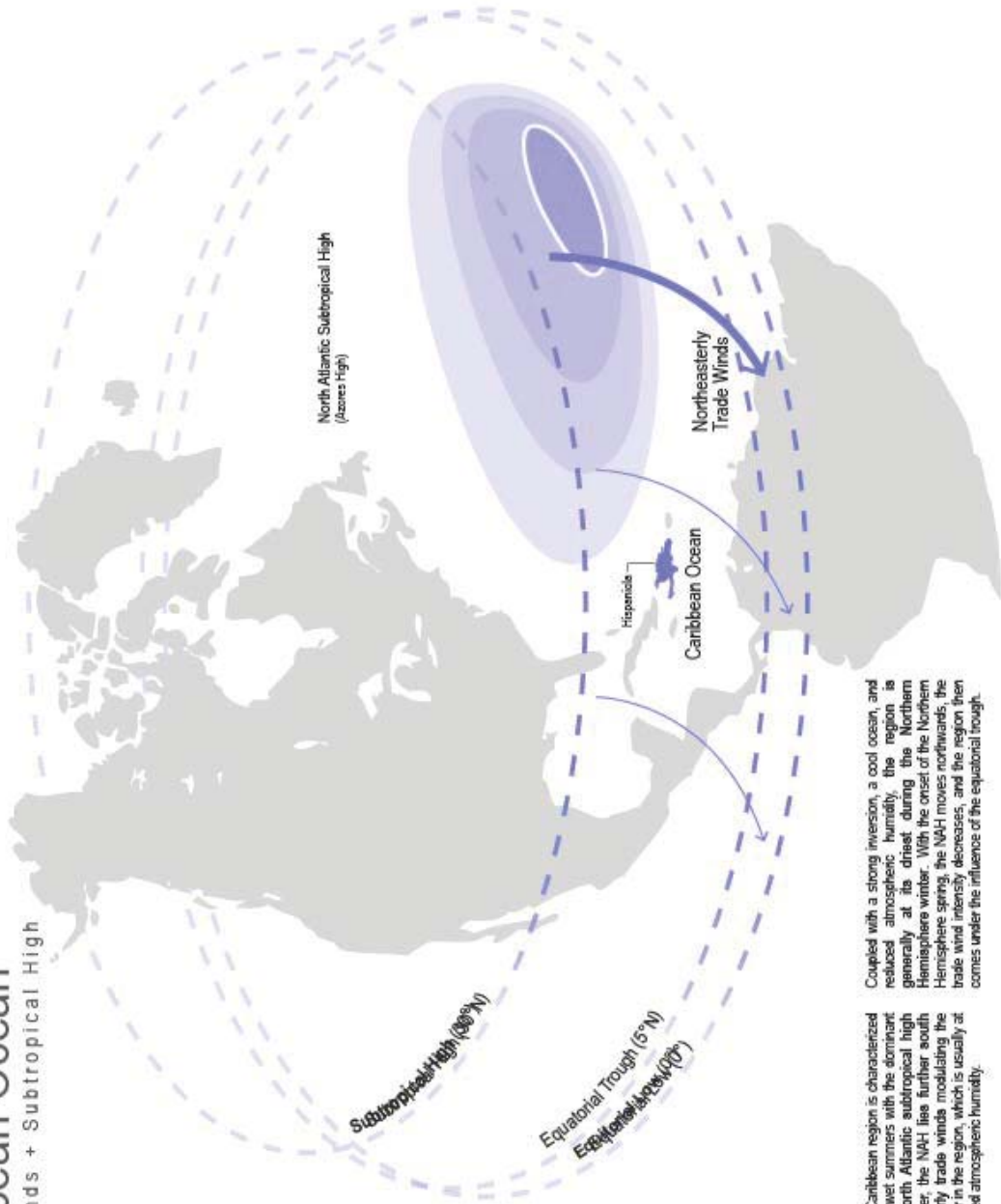
### ***Climate Conditions***

The climate is primarily influenced by the North Atlantic subtropical high (NAH) and trade winds, as seen in *Figure 6. Trade Winds Diagram*, resulting in dry winters and wet summers. During the northern hemisphere winter season, the NAH is closer to the equator with easterly trade winds, having speeds up to 21.5 knots, impacting the climate and precipitation levels. In this season, there is less atmospheric humidity distributed through the Caribbean island region resulting in low precipitation levels, which is responsible for 45.8% of all of the wind impacting Haiti. As the NAH adjusts northward, the cold dry air from the trade winds decrease, allowing the equatorial trough, having speeds up to 10.7 knots, to bring warm moist air to the region with increased atmospheric humidity, contributing 17.1% of the wind conditions (“Climate”; Sem 7).

Because the precipitation levels are affected by the trade winds at this global scale, climate change will have a dramatic and negative impact on the vulnerable state of these islands, in particular Haiti, where water resources are stressed from continual population growth, depletion of reserves, and a crumbling infrastructure. Many SIDS

# Caribbean Ocean

Trade Winds + Subtropical High



The climate in the Caribbean region is characterized by dry winters and wet summers with the dominant influence of the North Atlantic subtropical high (NAH). During winter, the NAH lies further south with strong easterly trade winds modulating the climate and weather in the region, which is usually at its driest with reduced atmospheric humidity.

Coupled with a strong inversion, a cool ocean, and reduced atmospheric humidity, the region is generally at its driest during the Northern Hemisphere winter. With the onset of the Northern Hemisphere spring, the NAH moves northwards, the trade wind intensity decreases, and the region then comes under the influence of the equatorial trough.

Figure 6. Trade Winds Diagram

are reliant on either rainfall or groundwater as their water resource. Not only is water inaccessible because of the already mentioned issues, but water pollution makes the water unhealthy for human consumption and susceptible to water-borne disease. “Owing to factors such as limited size, geology and topography, water resources in small islands are extremely vulnerable to changes and variations in climate, especially in rainfall, and with the rapid growth of tourism and service industries in many small islands, there is a need for both augmentation of the existing water resources and more efficient management of those resources that already exist” (Sem 15).

Natural water resources for SIDS are primarily surface water, rainwater and groundwater because of the underlying conditions such as weather patterns, geology, island size and topography. Therefore the reliability of water resources is vulnerable, sometimes limited, by these natural systems influenced at a global scale. Currently, the Caribbean islands are dependent upon surface water from rivers and ephemeral streams (Sem 15). A major concern influencing surface water availability is the deforestation of the island for the charcoal industry. The removal of mature vegetation and supporting root systems prevents precipitation from soaking into the ground to refill the aquifers. The issues of deforestation will be covered thoroughly in the next section of regional context. As these islands become attractive for tourism and service industries, an increase in demand, improved quality and management stress the existing water resources and infrastructure further.

Although Haiti relies primarily on surface water, rainwater significantly impacts the availability of their primary water resources through aquifer and reservoir recharge:

This dependency on rainfall increases the vulnerability of small islands to future changes and distribution of rainfall. Low rainfall can lead to a reduction in the amount of water that can be physically harvested, a reduction in river flow, and a slower rate of recharge of the freshwater lens, which can result in prolonged droughts. Since most of the islands are dependent upon surface water catchments for their water supply, it is likely that demand cannot be met during periods of low rainfall. On the other hand, during the rainy season, lack of suitable land areas for dams (e.g. in the Seychelles) and high runoff during storms (e.g. in Fiji) result in significant loss of surface and stream water to the sea (Sem 15).

Therefore, when approaching issues of a particular water resource management technique, there must be consideration of other indirect influences. In the case of Haiti, a decrease in rainfall or precipitation will negatively impact available surface water for consumption or other potable necessities.

Climate analysis is traditionally communicated as a stand-alone product, often lacking the correlation with temporal conditions such as seasonal changes or being impacted with other site conditions. Without understanding the connection between climate and global conditions, adapting to climate change becomes difficult to manage. There is typically no relationship between climate and other site variables in current site analysis projects. Static climate charts that are used do not effectively communicate when conditions change, but more importantly why conditions change.

Digital tools provide the opportunity to represent climate conditions as being dynamic and temporal. The conditions of a site are influenced by the global context, as they fluctuate throughout the year. Some of these specific fluctuations are wind patterns, precipitation, and temperature. Because these conditions influence each other, it is important to utilize dynamic visualization tools to communicate that relationship. This process starts with visualizing wind pattern speeds and direction changing between summer and winter, influencing the precipitation in Haiti. The information presented through the visualization is dynamic and comprehensive as the conditions change through the span of months, days, and even hours, specifically from day to night. Combinations of various climate data can be specifically used to determine important times to collect rainwater.

### ***Economic and Ecological Conditions***

In addition to issues of water resource availability through climate change, economic and ecological concerns are also prevalent. The sovereignty of many SIDS can be damaged by becoming uninhabitable as conditions diminish for adequate living. Potable drinking water is the primary concern for healthy living. Not only does the current infrastructures promote water-borne disease but also allows leaching of salt water into fresh water reservoirs. A rise in sea surface temperatures destroys aquatic ecosystems, specifically coral reefs surrounding the islands. Without healthy or living coral reef communities, there is no longer any protection of the mainland and development from storm surges. Another concern is an unstable commerce of trade



from the agriculture industry. As rain events decrease and droughts become more common, available water for irrigation and maintenance of crops dwindle (Sem 8).

The agriculture industry has a major role in the inhabitation and economic development of most SIDS. Healthy dietary options are a necessity for a country's people to flourish. Having cash crops for export provides financial support while maintaining a connection with the global market. Scarce and limited available land for adequate production is a major stress on the subsistence and commercial value of crops. Now the industry is vulnerable with climate change affecting arable land through salinization and sea levels rising. Increased temperatures, extended droughts, and loss of fertile soil will significantly decrease crop production, along with the loss of prime agricultural land due to sea levels rising. As suitable land for agricultural production decreases, Haiti will become reliant on outside resources and imports, putting a heightened burden on a fragile economy (Sem 14).

Lastly, temperature and exposure to increasingly warmer days will affect human comfort and health due to dehydration, putting a higher demand on the water supply. According to studies, "In the Caribbean, analysis of data from the late 1950s to 2000 has shown that the number of very warm days and nights is increasing dramatically and the number of very cool days and nights are decreasing, while the extreme inter-annual temperature range is decreasing" (Sem 12). Since the temperature range is decreasing with warmer temperatures, staying cool and shaded is a priority throughout the island.

Future development must be consider material use so that heat is not absorbed and extended into the cooler night. Ocean waters increased by 1.5 degrees Celsius during this period, negatively impacting aquatic life and ecosystems around the island. Although there has been a decrease in consecutive dry days and an increase in heavy rainfall events since the 1950s, an overall decrease in precipitation with more frequent droughts occurred recently (Sem 12).

Climate data is not only important for precipitation values, but also for improving human comfort zones in the outdoor environment and visualizing thermal heat gain of the built environment. In Fond-des-Blancs, it was important to communicate that temperatures were moderate to high 24 hours a day, as seen in *Figure 7. Haiti Temperature* (“Climate”). Because of that, issues of dehydration and fatigue were a factor, thus recommending re-vegetation of areas with high sun exposure. This would not be possible without overlaying vegetation cover with temperature change throughout the day. For the built environment, it was crucial to limit thermal heat gain of the buildings since temperatures were never low enough to require heating at night or during the cooler parts of the year.

### ***Sustainable Initiatives***

Issues of water resource management, vulnerable economic models, sovereignty, and others, are not new topics of concern to the inhabitants of these islands. Haiti, as well as most SIDS, is aware of the situation and the needed efforts

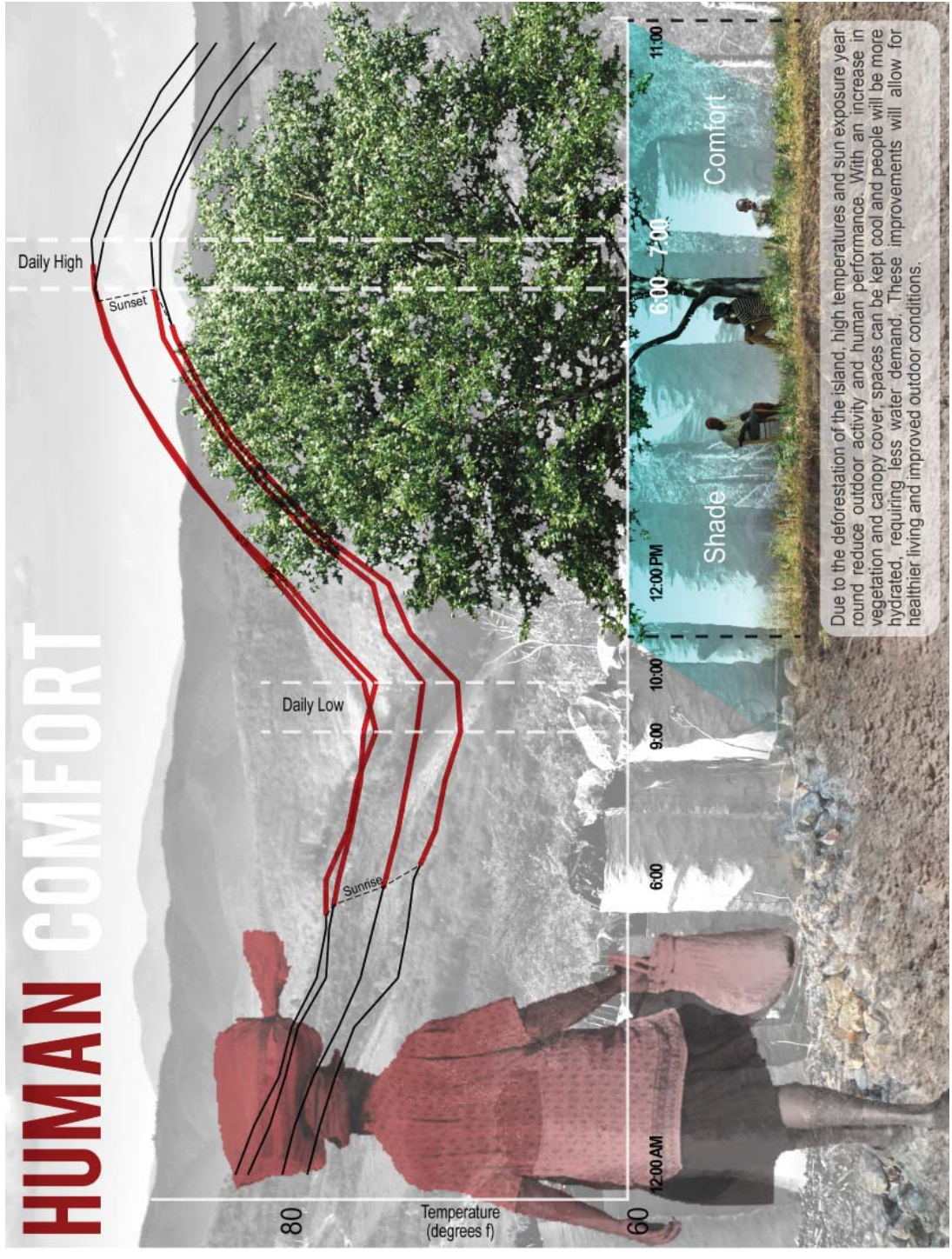


Figure 7. Haiti Temperature

to improve the living quality. Utilizing sustainable systems to combat the degrading conditions are being investigated and approached for long term renewal of the island. Although there are limitless options and opportunities for this country and village, the design will be primarily on sustainable water resources and agriculture initiatives in addition to infrastructure and community development.

Sustainable energy is a plausible option to initially complement and eventually replace existing fossil-fuel based energy sources with clean, renewable, and affordable energy resources. “In the climate change context, an important feature of SIDS is that, although they rely heavily on fossil-fuel based energy for their economic and social development, they account for less than one per cent of global greenhouse gasses” (Sem 8). By replacing technologies emitting greenhouse gasses (GHGs) with sustainable systems, there will be a reduction in the global contribution of GHGs along with awareness to environmental preservation. Haiti would have the opportunity at a small local scale in the village of study to become a case study for future development and growth demonstrating sensitive and regenerative design.

Initiatives to improve upon decreasing water resources range from household applications to national policies. Replacing existing appliances or integrating water saving devices will have an immediate impact on new homes along with retrofitting existing households with these devices. Household guidelines can be revised to take advantage of rainwater collection and storage systems for either individual or communal

consumption as an alternative to increasing the demand of the city water supply. At the next scale, implementing drought tolerant vegetation to reestablish the landscape and river buffer zones to enhance the restoration process of waterways and catchment areas. Lastly, enacting national water policies for “preparing water resource master plans for islands; and assessing and improving the water supply system” (Sem 18). These proposed water management initiatives are the start of incorporating natural systems of hydrology into a cohesive relationship with the built environment. Promoting the use of alternative, efficient, and appropriate systems will enhance the awareness to the sensitivity of natural systems.

Regarding the restoration and preservation of land from over development, erosion, and degradation there will be:

Measures to address the impacts of climate change on biodiversity and land degradation, include: creating land use plans and corresponding enforcement strategies; rainwater harvesting, water demand management, provision of water storage and water efficient household appliances; flood risk analysis with land zoning and flood mitigation actions; strengthening of institutional capacity to enforce land zoning restrictions (Sem 18).

As mentioned before, coastal lands are preferred for agriculture production rather than development. Policies will be enforced to create setbacks preventing alternative zoning and use of the land. Farming practices will also be improved for efficient and nondestructive use of provided agriculture zones (Sem 18).

## SITE ANALYSIS: REGIONAL CONTEXT

### INTRODUCTION

Precipitation, vegetation, surface conditions, and hydrology are influenced by the collision of plate tectonics forming the island. To further understand the climate conditions of Haiti, specifically precipitation, the geomorphology of the island must be considered. Plate tectonics are responsible for the mountain formations, which affect precipitation values, as well as the surface conditions. Surface conditions affect vegetation and hydrology. "Mountains occupy 75% of the country and their orientation greatly influences local rainfall and insolation regimes" (Swartley 9). The capture of moisture on the mountains windward slope, the northeast in Haiti, with dry warm conditions on the leeward slope is referred to as a rain shadow. Rain shadows influence ecosystems in Haiti, with moist ecosystems existing on the windward slope and sub-humid ecosystems existing on the leeward slope (Swartley 9). Fond-des-Blancs, where the sustainable housing community is located, is in a valley on the leeward slopes on the southern peninsula.

#### ***Plate Tectonics and Precipitation***

Hispaniola has been created from the earth's crust shifting for over 90 million years. The North American plate is shifting downward and the South American plate is shifting upward cracking the Caribbean plate into fragments, creating the islands throughout the Caribbean Ocean as well as the mountain ranges in Central America. Haiti was originally detached from the rest of the island where a straight separated the

two islands, but over time the shifting plates converged the two islands, leaving the cul-de-sac plain in Haiti. Mountain ranges elevate along the convergent zones, while earthquakes occur along fault lines from plates strike-slipping (“Hispaniola” 35).

On the eastern part of the plate collision, the Caribbean plate runs perpendicular to the North American plate causing compression and subduction, or oceanic convergence. It is from this convergence of the two plates that the island arcs were formed throughout the Caribbean. “Convergence of two oceanic plates also creates chains of volcanic islands called island arcs. Island arcs are created by the friction of subduction which creates hot plumes of magma at the interface of the two plates. These hot plumes of magma then rise to the Earth’s surface to form volcanoes” (Pidwirny). To the north, the plates run parallel causing major friction along the strike-slip fault. It is this fault line that earthquakes occur, including the magnitude 7.0 earthquake that occurred on January 12, 2010 (Rowan).

The collision of these plates is responsible for the diverse ecosystems extending through the numerous mountain ranges, lush valleys, white sand beaches, and extensive coral reefs. The multitude of mountain ranges makes Haiti more mountainous than Switzerland (“Hispaniola” 35). The mountains cause a rain shadow, drastically shifting the lush environment into a hot dry sub-tropic landscape. It is within these rain shadow regions that towns become dependent upon surface water and aquifers as rainwater is no longer a sufficient water resource.

## ***Applied Digital Tools***

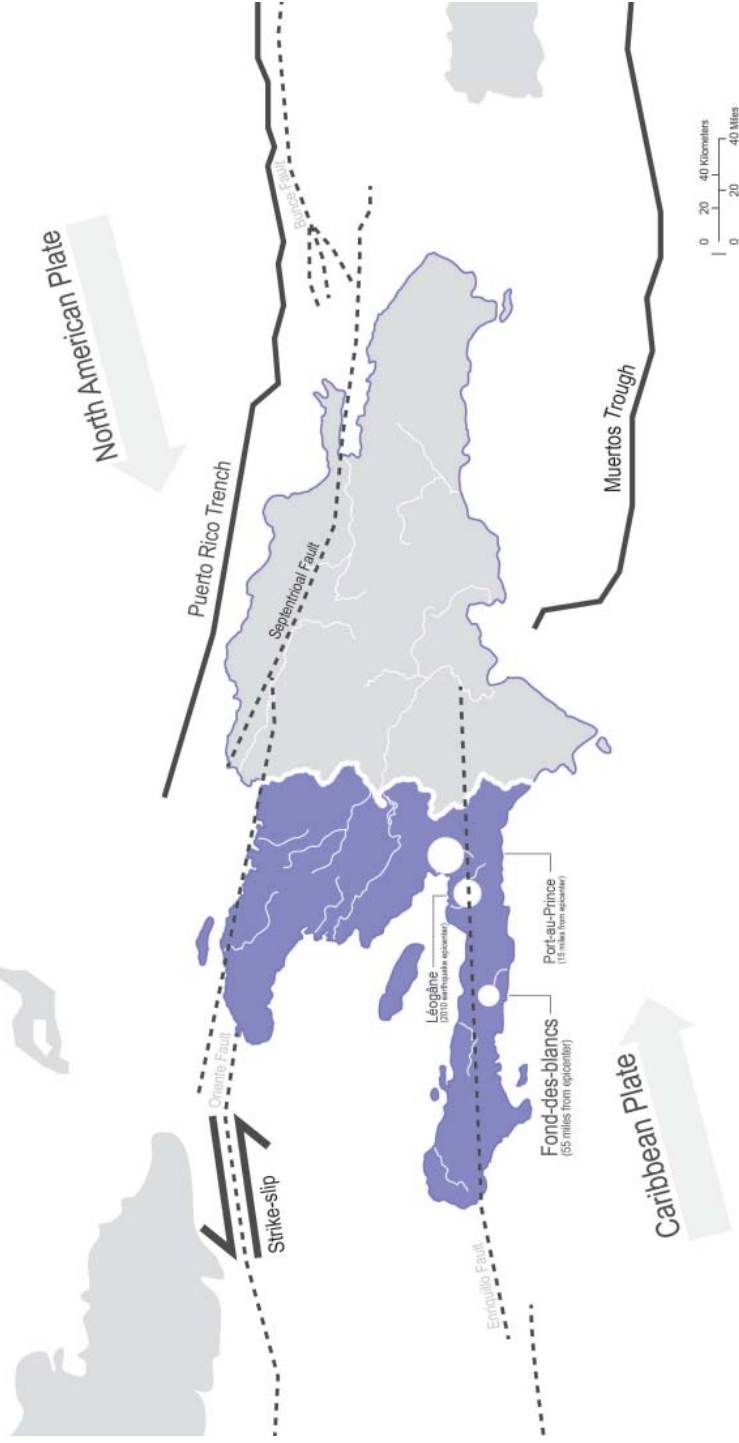
Demonstrating the collision of the plate tectonics, forming the island of Hispaniola, was made possible through animated diagrams. Both convergence, causing uplift of the island, and strike-slip, causing earthquakes, were represented as a process in the animation, as seen in *Figure 8. Hispaniola Plate Tectonic Map* and *Figure 9. Plate Collision Diagrams*. It was important to visualize the process of the plates colliding, creating the mountain ranges. This assisted in explaining how mountain ranges and wind patterns create a rain shadow, reinforcing their influence on precipitation values.

The rain shadow in Haiti is a result of the Northeast Trade Winds colliding with the high mountains throughout the country. Warm, moist air is pushed by the trade winds towards the mountains is forced to rise, where the air cools and compresses. The condensed air releases the moisture, precipitation, along the windward side, creating a lush environment. Once the moisture is released, the air expands into dry warm air with less precipitation occurring on the leeward side (Swartley 9; Rosenberg). Because of this, precipitation values are drastically influenced by the global trade wind patterns, especially in the winter when the air is predominantly cold air, lacking high amounts of moisture. It is also because of the diverse mountain ranges that precipitation values range differently throughout the island. The northwest region only receives about 15 inches of rain per year, whereas the mountains in the southwest receive up to 120 inches of rain per year (Swartly 9). Although the southwest portion of the island still receives a high amount of rainfall, the rain shadow still prohibits adequate use of



# Haiti : Tectonic Formation

Tectonic Plates + Geology



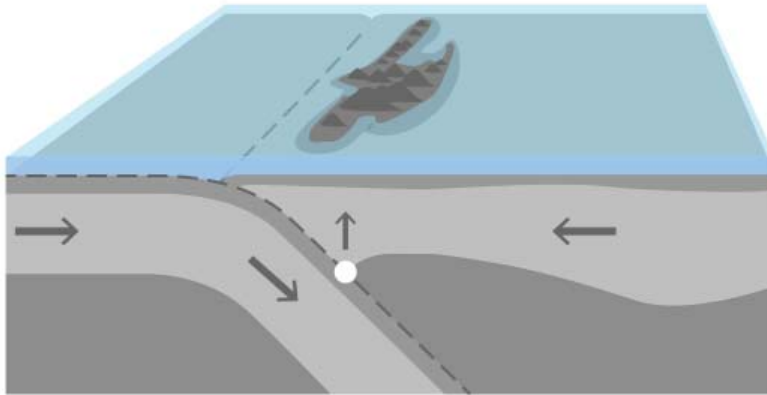
The North American plate comes down from the north, the South American plate pushes up from the south, and the Caribbean plate sits in between these two tectonic monsters, being broken up into the Gonave and Septentrional microplates. It is these microplates that are dealing the fault lines of Hispaniola its earth shattering blows.

In Haiti, exposed rock formations are igneous, metamorphic and sedimentary origin. The latter formations are the most abundant (80%) and are represented by limestone deposits from the middle and upper Eocene era. Accordingly, the parent material of soils in Haiti is primarily limestone. These soils are moderately young and fertile, exhibiting neutral to alkaline pH

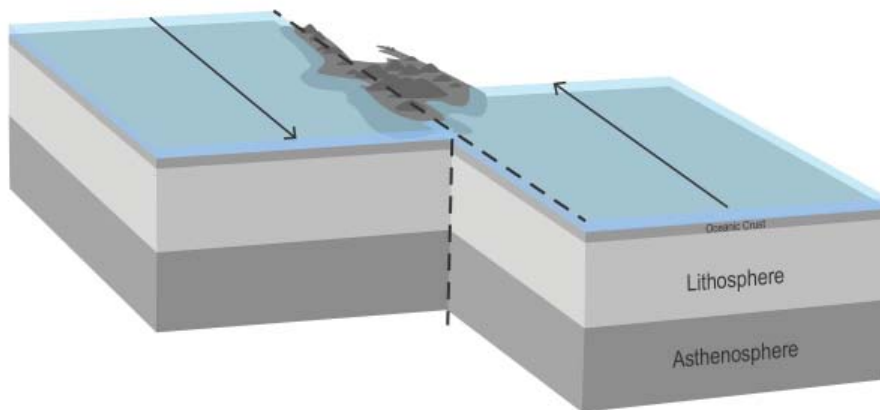
properties and with a tendency toward salinization where exposed to high evapotranspiration rates from irrigation or salt water intrusion. Pockets of basalt soils (mostly igneous rock) are found throughout the country, giving rise to soils that are less fertile and more highly eroded.

Figure 8. Hispaniola Plate Tectonic Map

## Oceanic Convergence



## Strike-slip



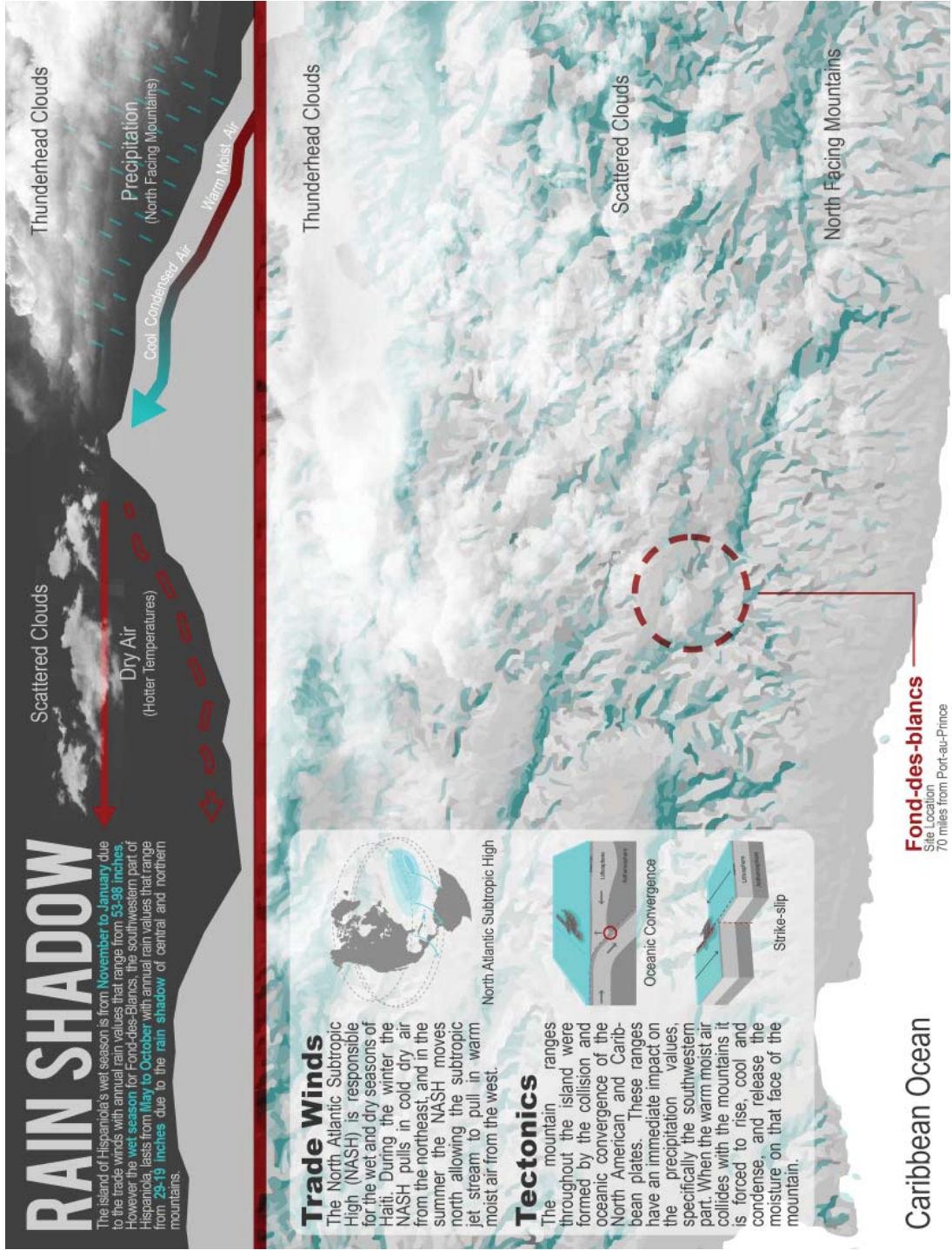
*Figure 9. Plate Collision Diagrams*

precipitation for drinking or potable use.

After investigating the significance of trade winds and mountain ranges from plates colliding through digital tools, the next step was to combine those factors to visualize the process of rain shadows, demonstrated in *Figure 10. Rain Shadow*. Combining the various climate data allowed for an effective visualization of Fond-des-Blancs precipitation, specifically showing why rain values fluctuate throughout the year. Visualizing precipitation occurring in the village provided a timetable for both the wet and dry season of the year. With that information known, appropriate measures could be determined for maximizing rainwater collection in preparation for the dry season, shown in *Figure 11. Water Collection (Tukiainen)*.

### ***Geology***

The collision and uplift of the three oceanic plates is believed to be the cause of landmasses throughout the Caribbean, including the island of Hispaniola. Rock formations composing the island are predominately sedimentary along with igneous and metamorphic rock. The sedimentary rock consists mostly of limestone deposits and is the parent material of most soils in Haiti. Although the soil is fertile, high alkaline pH properties cause salinization when exposed to high evaporation rates as vegetation is removed for agricultural production. Igneous rocks prevalent on the island are basalt based soils lacking in fertility and prone to erosion and weather as they become exposed to the elements. Fertility of the island is important for continuing the



# RAIN SHADOW

The island of Hispaniola's wet season is from November to January due to the trade winds with annual rain values that range from 53-98 inches. However the wet season for Fond-des-Blancs, the southwestern part of Hispaniola, lasts from May to October with annual rain values that range from 23-19 inches due to the rain shadow of central and northern mountains.

## Trade Winds

The North Atlantic Subtropical High (NASH) is responsible for the wet and dry seasons of Haiti. During the winter the NASH pulls in cold dry air from the northeast and in the summer the NASH moves north allowing the subtropical jet stream to pull in warm moist air from the west.

## Tectonics

The mountain ranges throughout the island were formed by the collision and oceanic convergence of the North American and Caribbean plates. These ranges have an immediate impact on the precipitation values, specifically the southwestern part. When the warm moist air collides with the mountains it is forced to rise, cool and condense, and release the moisture on that face of the mountain.

Caribbean Ocean

**Fond-des-blancs**  
 Site Location  
 70 miles from Port-au-Prince

Figure 10. Rain Shadow

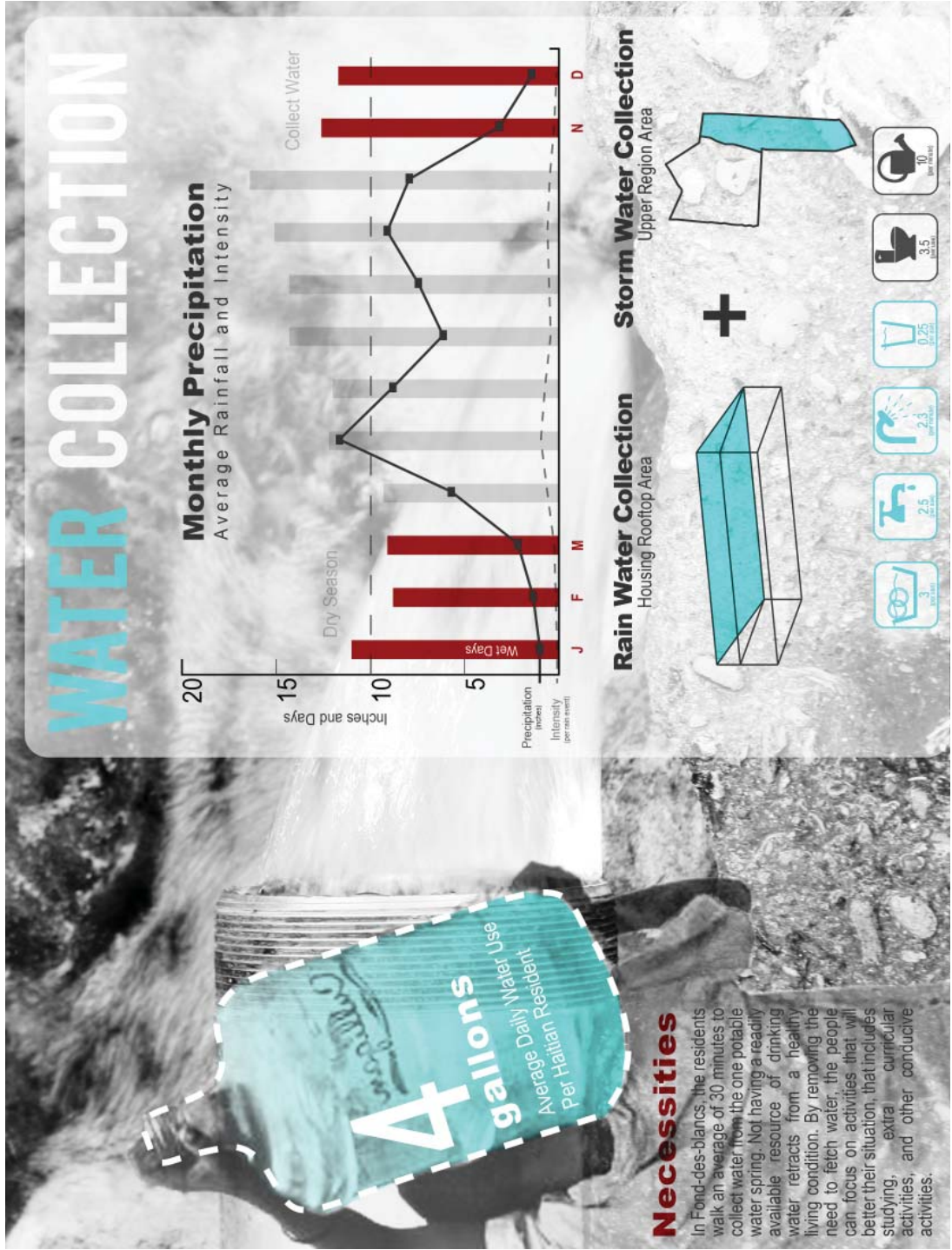


Figure 11. Water Collection

production and trade of crops, a major economic industry of the island. As vegetation cover is removed, surface conditions become exposed to varying elements reducing the productivity of the land (Swartly 9).

Soil conditions are a major factor on a site when determining suitability for program intensity, as erosion is a significant factor. Specific to this analysis, soil texture and slope conditions have the immediate impact on the suitability of a site. In most traditional methods, the extent of this site analysis is limited to soil texture and topography maps. Soil texture is determined through simple surveys of taking a handful of the topsoil and evaluating its composition of sand, silt and clay. Topography maps are under utilized for evaluating erosion through conventional methods, due to the labor required of mapping slope percentages. There are few effective methods to determine slope percentages without using dynamic tools. Because of the labor required to provide that information, evaluation of a sites soil conditions cannot be fully examined without incorporating modeling tools for visualizing slope conditions.

Combining both soil textures with slope percentages in modeling tools will provide an effective analysis for programming a site appropriately. This was extremely important on the site in Fond-des-Blancs since it needed to accommodate 20 housing units, and ultimately methods to prevent erosion. Using this modeling technique, areas were designated through slope percentages as being suitable for housing development, as seen in *Figure 12. Slope Conditions*. It was also noted which areas within the site

were at risk of erosion.

Although both soil texture and slope percentages are crucial for the locations of programming on the site, other site conditions impact the erodibility of the terrain. Vegetation cover and hydrology are also factors that must be considered for a complete evaluation of the site. Vegetation provides root structure and stability to the soil, significantly reducing its potential for erosion. Drainage patterns impact erosion, as some areas will have a higher volume and velocity of runoff in higher percentage slopes. This is another advantage of using digital tools and modeling for site analysis, as a comprehensive overview can be established by considering a multitude of variables impacting, but not directly related to soil conditions.

### ***Vegetation***

Haiti has an extensive ecology of ecoregions, which include coastal mangroves, dry forests, moist forests, pine forests, and wetlands supporting a vast diversity of wildlife. Unfortunately, the ecology of Haiti has been severely degraded over time as only 1.44% of the original forest cover remains due to deforestation. The removal of vegetation caused an increase in runoff, removing topsoil and fertility of potentially productive land. Major storms and hurricanes caused flooding as current vegetation cover and soils are no longer capable of retaining or infiltrating runoff. It is a difficult situation because deforestation supports the charcoal industry, a major service sector for employment, providing a means to cook meals for most Haitians (U.S.).

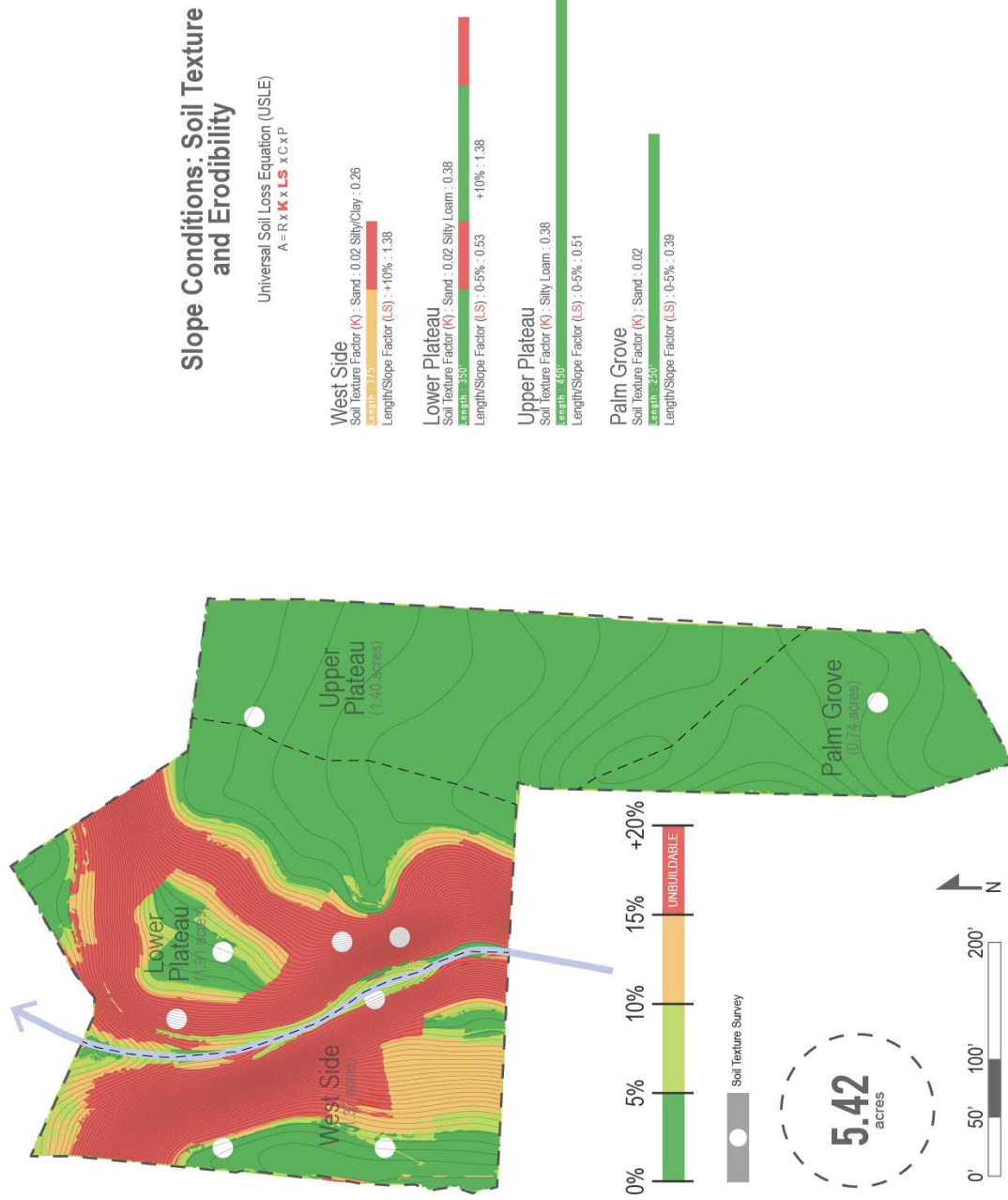


Figure 12. Slope Conditions



Fond-des-Blancs is located in a Hispaniolan Moist Forest on the southwestern peninsula of the island, as shown in *Figure 13. Haiti Ecoregions*. Moist forests originally occupied over half of Hispaniola, around 60%, “from the lowlands particularly on the eastern coast of the island (Haiti) to the valleys, plateaus, slopes and foothills of the many mountain ranges, up to an altitude of about 2,100 meters” (U.S.). Of the 46,000 km<sup>2</sup> that cover Hispaniola, less than 200 km<sup>2</sup> of unaltered forest remains in Haiti (U.S.; Swartly 11).

These wet forests support distinct flora and fauna, most of which are extinct in surrounding continents. Threats to this unique biodiversity include illegal forestry practices, farming expansion, charcoal burning, livestock grazing and hunting; turning the forest into an endangered ecoregion where less than 15% of the original vegetation remains. The ecological conditions of this region are influenced and reliant on the trade winds to bring moisture to support vegetation needs. Preservation of this ecoregion is important due to its location within the major catchment basins of the island, controlling runoff and soil erosion from rainfall.

Within the remaining moist forests, fragmentation is still prevalent, with the largest plot protected being only 500 km<sup>2</sup>, but not severe considering most fragments are grouped closely. “The annual rate of habitat conversion during the period 1990-95, from intact to altered, was about 2.5%” (World).

# Haiti Ecoregions

- 1. Hispaniolan Moist Forests
- 2. Hispaniolan Dry Forests
- 3. Hispaniolan Pine Forests
- 4. Enriquillo wetlands
- 5. Greater Antilles mangroves

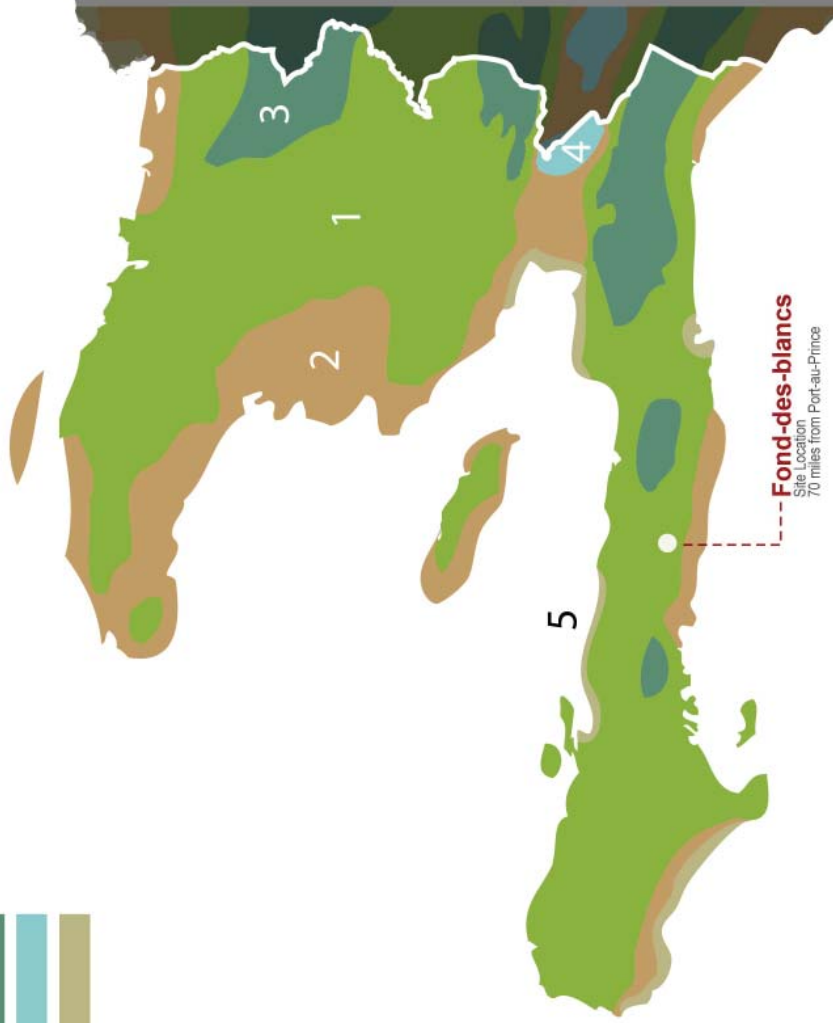


Figure 13. Haiti Ecoregions

## ***Applied Digital Tools***

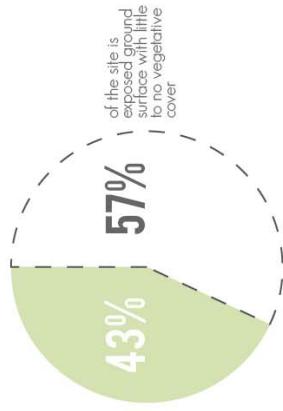
Vegetation analysis is usually conducted through tracing the existing canopy into a single mass, with an optional inventory of specific species by cataloging with photographs. Although the inventory collected is substantial for preservation purposes and aesthetic quality, the influence and benefits of the vegetation inventory is not explored thoroughly. As a independent analysis piece, vegetation cover does not provide compelling evidence for appropriate site design, thus requiring it to be incorporated with other variables of the site analysis. This new information will present parameters that serve as a foundation for program use and runoff volume made possible through digital modeling tools.

Similar to the analysis of soil conditions, exploring the potential of digital tools can provide opportunities to further evaluate the significance of vegetation cover, shown in *Figure 14. Vegetation Cover*. Stabilizing erodible soils was already determined in the previous section by overlaying the soil analysis with vegetation cover. Another significant role vegetation impacts is regulating runoff. Vegetation will capture rainfall and absorb runoff, drastically reducing the volume of stormwater and erosion. These variables are important because an assessment can be made as to which regions in the site require improved canopy cover and how that improvement will impact runoff volume and soil stability.



**Vegetation: Overall Canopy Cover**

**2.3 ACRES**



of the site is exposed ground surface with little to no vegetative cover

West Side



Lower Plateau



Upper Plateau



Palm Grove



Figure 14. Vegetation Cover

## ***Hydrology***

Major rivers and streams throughout Haiti are a result of the regional climate conditions stated earlier. The moist air is forced to rise along the windward slopes of mountains where the majority of precipitation occurs, becoming the origin of these hydrological systems. Surface water from these systems is the primary resource for Haitians, with groundwater from aquifers the secondary resource as the porous limestone allows for adequate infiltration into the subsurface (Swartly 9).

Surface water not only provides drinking water for the country, but also serves as irrigation to the major agriculture fields. The removal of vegetation for agricultural purposes and poorly managed development has severely altered the natural hydrology patterns in the country. As a result, erosion contributes major sediment to the rivers and streams, causing surface water to drain into the subsurface rather than deposit into easily accessible lakes and reservoirs (Swartly 10).

Water resources are extremely valuable in Haiti, requiring a thorough investigation of potential and proper management strategies. Drainage patterns and runoff volume are the two crucial components for this investigation. Through this analysis, potential catchment devices can be established to collect water for alternative use on site, versus contributing to runoff and erosion.

In traditional methods of mapping hydrologic patterns, topography maps are

used to locate drainage swales by the shape and proximity of contour lines. Mapping of these drainage patterns on a site can be difficult and inaccurate due to the subjective nature of not having either a physical or three-dimensional model of the topography. Through this process, crucial drainage locations may be missed or not account for other variables such as soil conditions and runoff volume. Drainage patterns vary in hierarchy of volume as well, which is also a difficult task to determine with only a two-dimensional map. Location of drainage patterns will provide an accurate location of ridgelines, which separate a site into watersheds, each containing a different volume of runoff and number of drainage systems.

Determining runoff volume has become a common practice within most analysis projects as various tools have become available for performing accurate calculations, which are included in Chapter III. Unfortunately most of the analysis ends there in regards to runoff calculations. In any project requiring appropriate stormwater management practices, further investigation must be pursued to visualize how runoff volumes fluctuate throughout the year between the dry and wet seasons. Alternative use of runoff can established now that there is a better understanding of the dynamic hydrology cycle. Once again, the study of a site's hydrology is not entirely accurate until variables of vegetation, surface conditions, and soil texture are included to the equation.

Digital modeling tools have the potential to accurately combine monthly precipitation values with drainage patterns for an effective communication of stormwater

runoff throughout the year, as shown in *Figure 15. Hydrology Patterns*. Runoff volume can also be adjusted accordingly with the addition of vegetation and soil conditions variables instantly. With the new runoff volume calculated, decisions can be made in regards alternative use as either potable or non-potable. Integrating drainage patterns, watershed regions, and runoff volume can be achieved effectively through these new digital tools.

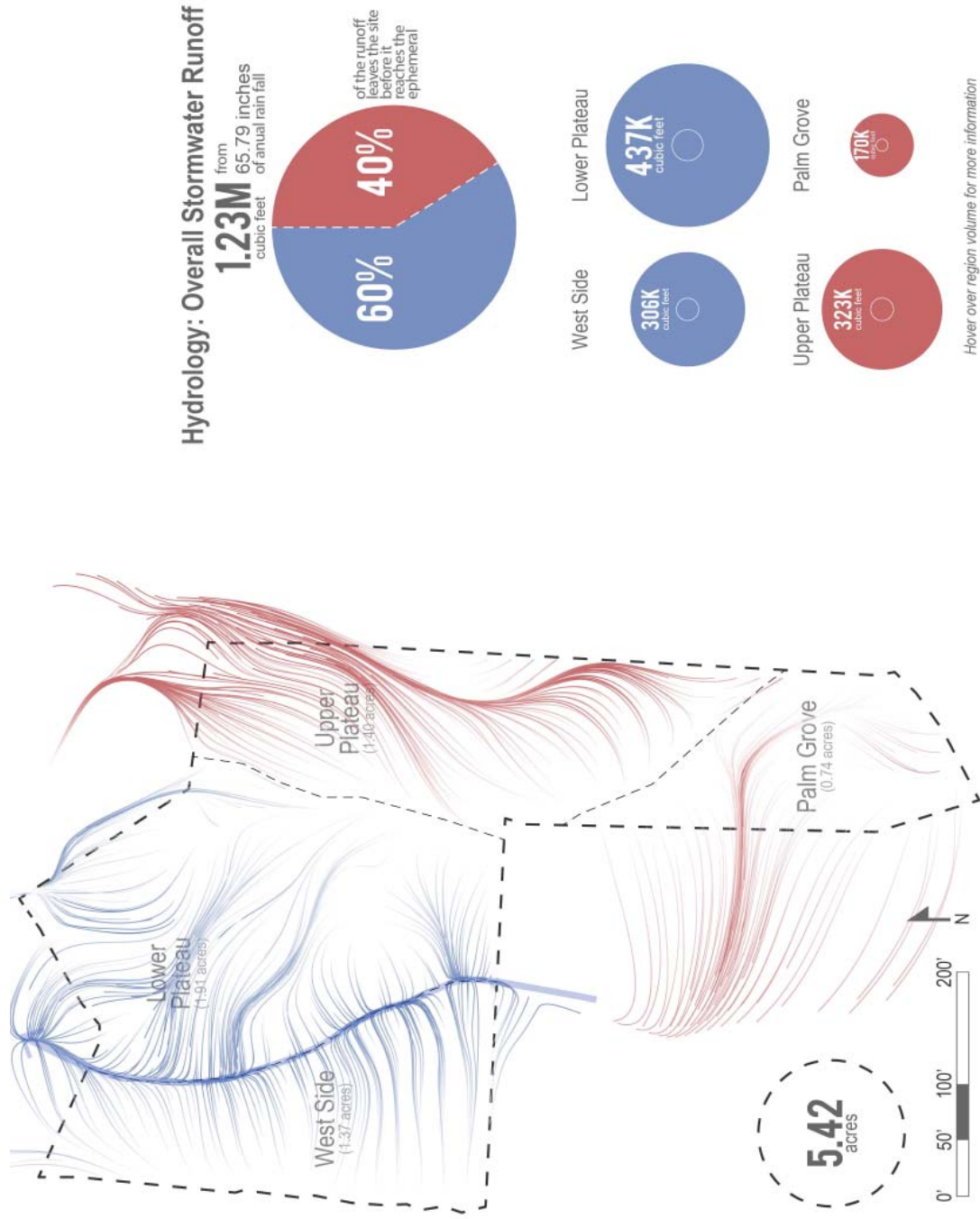


Figure 15. Hydrology Patterns



# CHAPTER III

## MATERIALS AND METHODS

### INVESTIGATION

In the previous chapter, digital tools were introduced to communicate different layers of information by compiling data into a dynamic visualization. Before that could be achieved, there was an investigation of different media techniques, visualization methods, and digital tools created by various sources. Many of the media techniques researched were influenced by Lynch's concept of cognitive mapping, emphasizing photographic compositions and multi-media as a platform to the various design outcomes. Visualization methods used in the thesis derived from different landscape architecture professionals and allied professions. The implementation of methods came from digital tools that include Adobe Flash Catalyst and Rhinoceros 3D. The application of green infrastructure and reinforcement of effective communication in the design process were also researched for their practicality in different situations. The following sections were researched based on their performance and effective communication of information within a dynamic visualization. Each provides advantages and benefits, however was adjusted to fit the context of Fond-des-Blancs.

#### ***Media Techniques***

After discovering the difficulty of communicating traditional plan drawings and other conventional illustrations, along with aerial maps, to the community from another student who studied in Haiti, it became apparent how necessary it is to project ideas through an alternative media explaining complex sustainable systems. The community's

spatial recognition is primarily cognitive, reliant on perceptual physical characteristics. To have an intimate connection that embraces the culture and heritage of an area, landscape architects should address design and spatial conditions from a 3D or first-person perspective.

Urban Earth is a studio that uses time lapse photography to document movement through an urban area. The group of designers goes to major urban cities such as Mumbai, Mexico City, and London and traverse a select route documenting the journey through still photographs every 10 feet (King). This creates a personal or intimate space capture similar to what Google does with their streetview cameras. Using this same principle, one can spend time with a community, in this case Fond-des-Blancs, and traverse their common routes in the area. That can then be documented with the photographs and utilized as a design medium or platform for design application. This is an important method, based on that previous research finding, to create a cognitive streetview for the people to understand how design interventions improve their lives. Producing this form of photographic documentation was not carried through in the thesis, but did use the fundamental principles of logging key features throughout the community noting their significance.

Interactive interfaces are the main qualities of a dynamic visualization by the National Film Board of Canada, using a collage of images to form an interactive 360 degree panorama with embedded video documentaries in their piece "Out my window".

As you select each person by either location, window facade, or portrait image, as seen in *Figure 16. Out My Window*, you are immersed into their living condition. You are able to scroll around like other 360 panoramas but they have included an interactive component embedded within the panorama. By scrolling over hotspots within the panorama, the piece becomes highlighted and prompts a video documentary from clicking it. Each person has 2-3 interactive components in their panorama (Cizek). Immersed environments within the design was a desired outcome to evoke a sense of place and emotional connection. The final perspective renderings contain similar hotspots of information embedded.

After discovering the previous technique of interactive panoramas, the next step was to explore potential methods to capture the same intention with limited time and equipment in Haiti. An application for smartphones allowed for convenient 360 panoramic capture of the site qualities in Fond-des-Blancs, seen in *Figure 17. Lower Plateau, Figure 18. Ephemeral Stream, Figure 19. Palm Grove, and Figure 20. Agriculture Field* as flat panoramas. The interface is easy and allows for instant upload to an online account to share on different social networks, including Facebook and Twitter. Having the ability to go on a field visit and instantly capture the spatial quality is extremely powerful as the conditions of a site constantly change. By uploading and sharing with your virtual community, there is an opportunity for quick feedback and input promoting efficient communication between different parties. This is a convenient tool to capture qualities of a site, not requiring additional photographic equipment.



*Figure 16. Out My Window*

Source: Cizek



Figure 17. Lower Plateau



Figure 18. Ephemeral Stream



Figure 19. Palm Grove



Figure 20. Agriculture Field

## ***Visualization Methods***

The media techniques were helpful to establish a foundation to produce effective design outcomes, but were not relevant to landscape architecture application and procedures within a design, accounting for the various layers of analysis and presentation attributes. Recognizing successful professionals for their work in exemplifying this strategy was the next key for advancing in the thesis.

Bradley Cantrell is a landscape architecture professor at Louisiana State University specializing in the relationship between ecological process and data visualization. His use of data representation attempts to deconstruct the landscape, revealing the underlying influences of its dynamic conditions. A combination of digital media and technology produce compelling visualizations that map ecological systems for responsive design implementation. The outcome is effective in communicating key concepts based on analytical investigation while retaining visual stimulation for the audience, showcased in *Figure 21. Ecolibrium 1* and *Figure 22. Ecolibrium 2* by students in his studio (Boutte).

Architect Bjarke Ingles and his firm B.I.G. successfully visualize the performance of their design through simple schematic diagrams for various systems impacting site. Some of the schematics are interactive, but all of them effectively communicate the process in which the design respects natural systems by taking appropriate measures to adjust the built environment. Ingles communicates that the structure and framework of

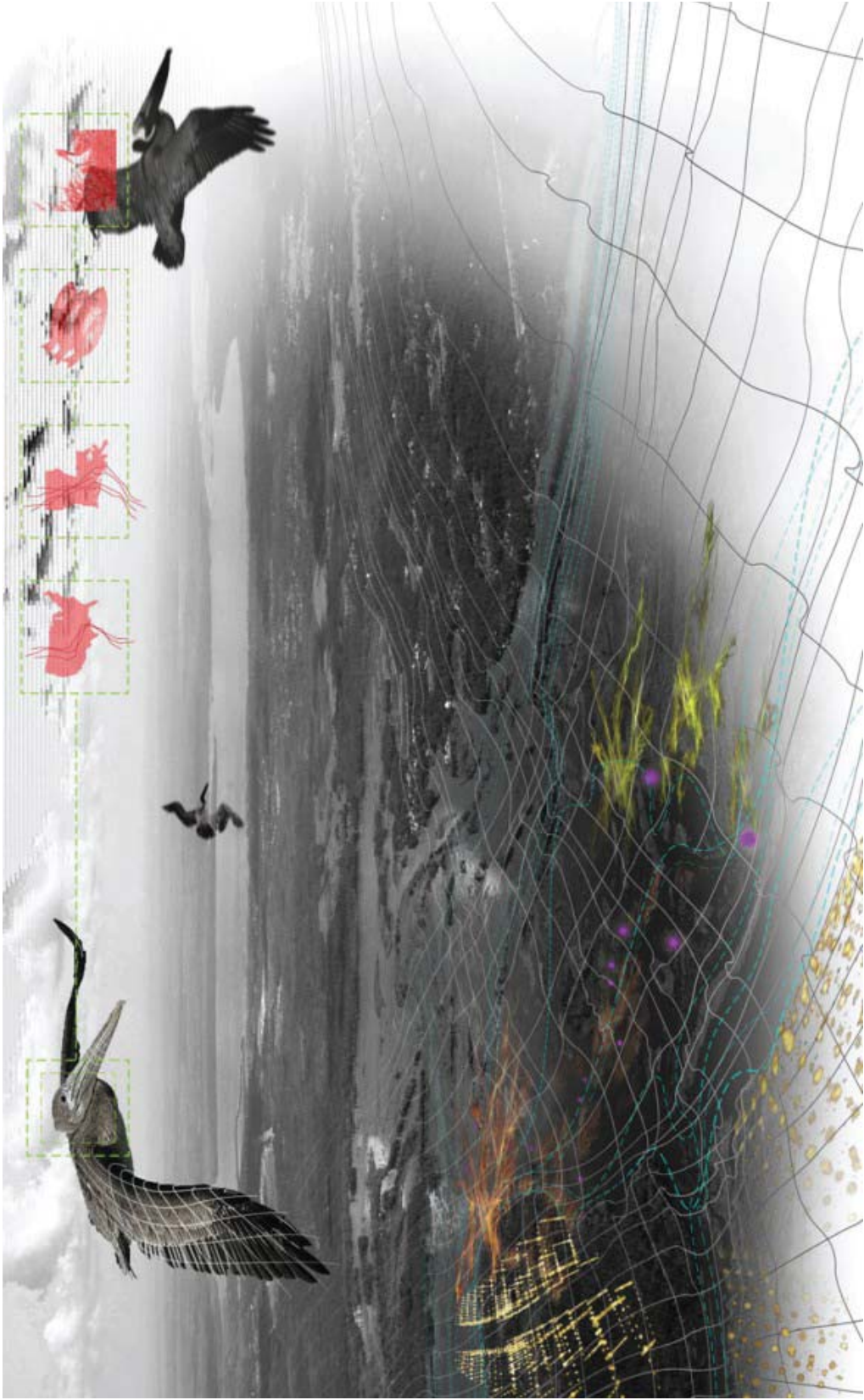


Figure 21. Ecolibrium 1

Source: Boutte



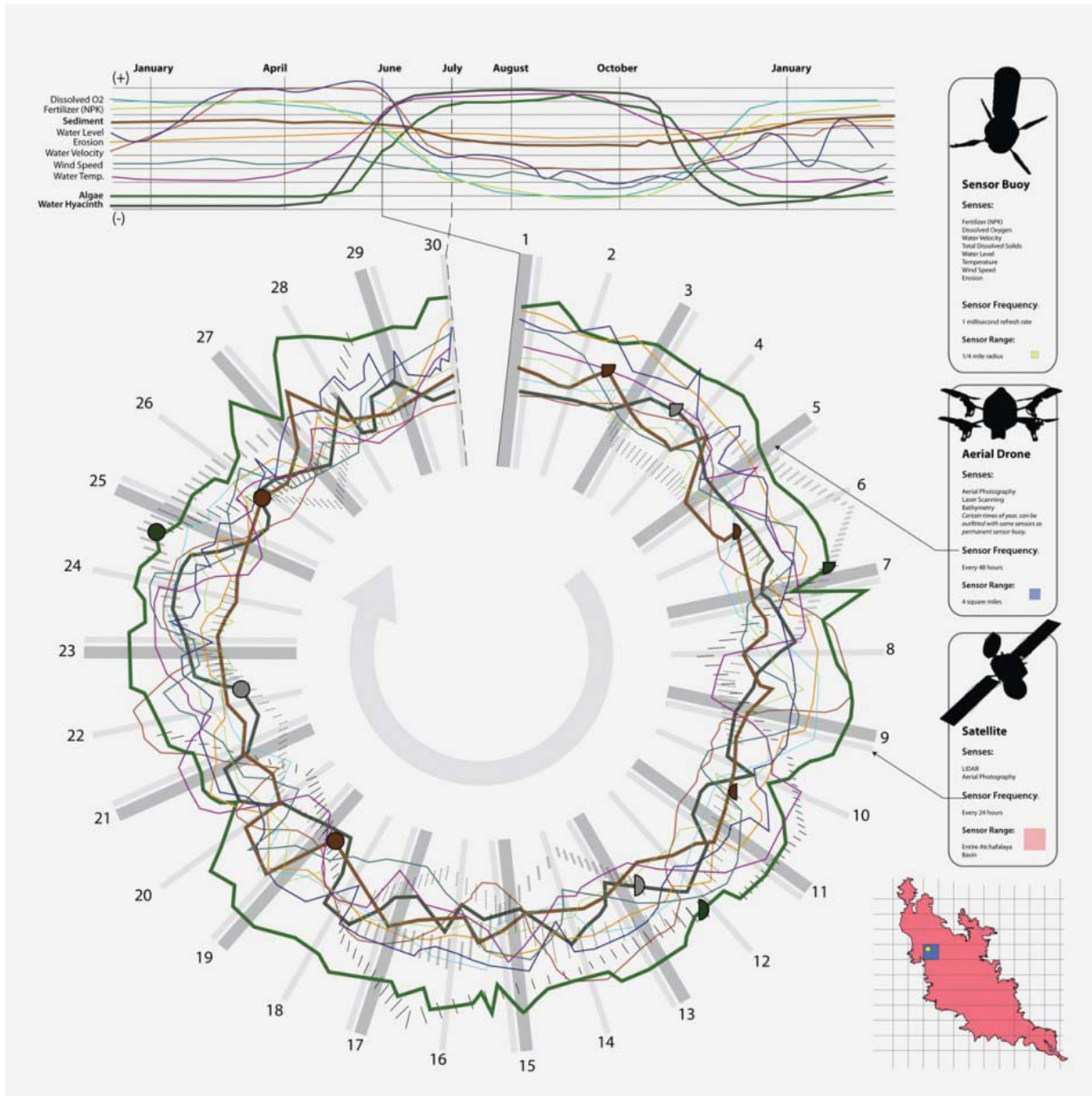


Figure 22. Ecolibrium 2

Source: Boutte

sustainability should not hold limitations or constraints to the quality of spaces. Holistic design lies within the integration of function and form for a seamless transition to the final outcome.

In the book “The Exposed City” by Nadia Amoroso, cited in the first chapter, has an article called “Data Appeal”. In this article, Amoroso asks an inspiring question, “If a city was able to be defined by these characteristics, what for would it take? How could it be mapped?” (King). Those characteristics are the complex and vast assortment of data and information that comprises in an urban setting. With complex urban settings there is a struggle to comprehend threads of information and, more importantly, the relationship that exists between those threads.

Data Appeal demonstrates a visual and dynamic representation of how GIS information links with Google Earth and is made tangible for different user groups. It is a great opportunity to explore the values within GIS and expand upon its generalized information. With this new program a user can assign different colors and shapes associated with the information being mapped. Not only is database of information being created, but also assigning them priority or value among the collection. It is important to distinguish the different values with a clear and legible hierarchy through color, shape, and size shown in Figure 23. Data Appeal 1 and Figure 24. Data Appeal 2 (King).

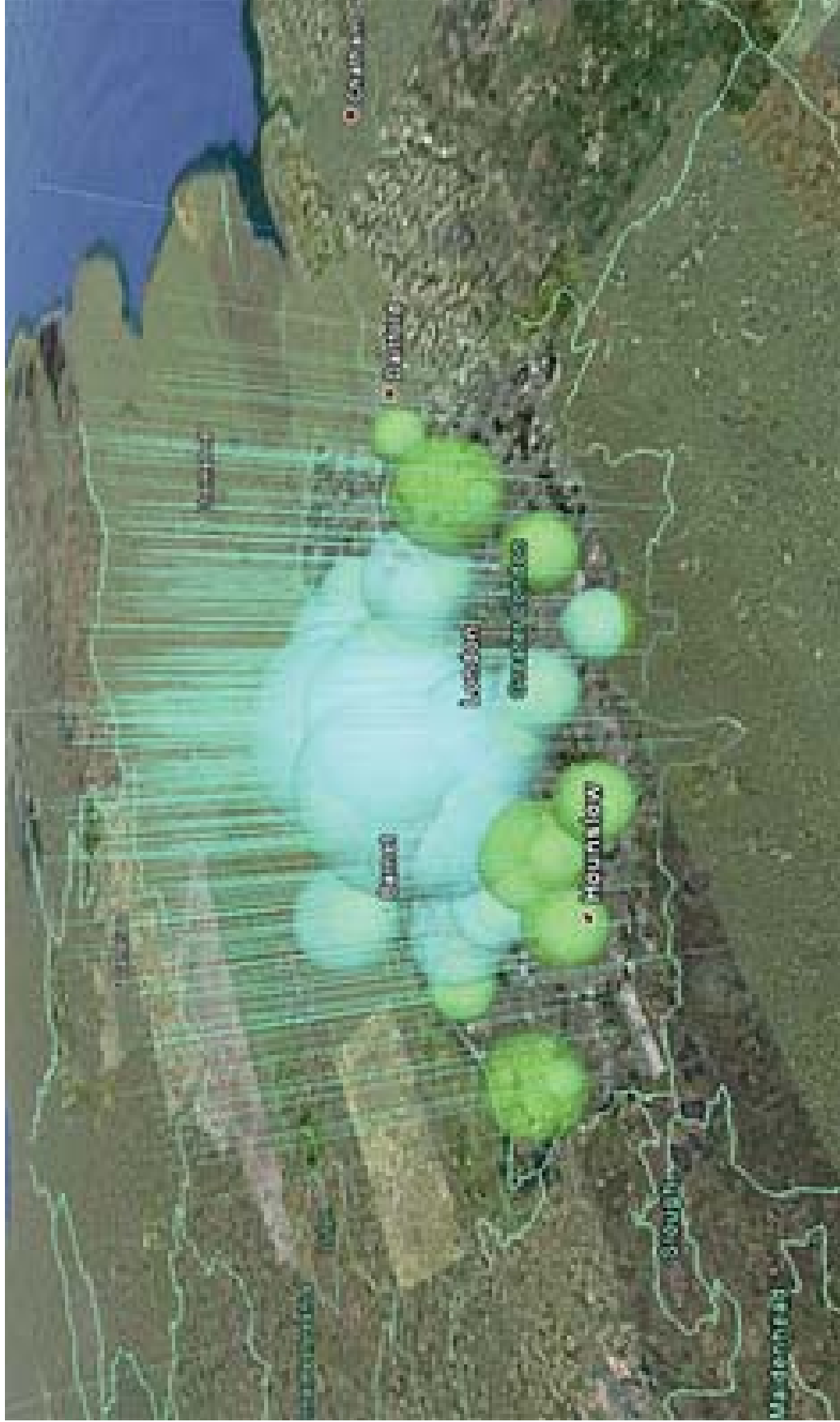


Figure 23. Data Appeal 1

Source: Amoroso



Figure 24. Data Appeal 2

Source: Amoroso

Investigating various visualization methods and tools develops a toolbox of resources and inspiration for communicating and educating peers and allied professions in the idea of process design. The complexity of the process needs to be legible for users to understand without any outside knowledge of the subject. Researching successful digital tools from other professionals assists with creating unique dynamic visualizations for the thesis.

### ***Education and Outreach***

The structure and, more importantly, the curriculum reflect the form and function of a nest. The object of the school is to instill within each student the ideals of “holism”. The student will grow as a whole person, and then demand a whole world to live on, by pioneering sustainability within the education, and creating “global green leaders” through the three simple rules of: being local, letting the environment lead, and considering for future generations, shown in *Figure 25. Green School* and *Figure 26. Green School Education (Green)*.

It is required that 20% of the student population is Balinese so that future leaders from the area may continue to educate community. Students learn and practice ancient Balinese arts, such as bamboo construction and mud wrestling for recreation. Part of the curriculum emphasizes agriculture where children plant, harvest and cook rice. Planting organic vegetable for native and ancient recipes used by the women for meals (Green).



*Figure 25. Green School*

Source: [Green](#)



*Figure 26. Green School Education*

Source: [Green](#)

Instilling this individualism with a collaboration to a larger community from the neighborhood to the world at an early age will inherently promote a proper lifestyle in all aspects of their life. Attachment with one's surrounding and knowledge of how life's necessities manifest themselves from a complex system is the fundamental principle of this project. Most people never realize where their substances originate from, but at Green school it becomes common understanding (Green).

## APPLIED DIGITAL TOOLS

This section will focus on the application and adjustments of digital tools, investigated in the previous section, as they pertain to the site in Fond-des-Blancs. Digital tools help model the analysis and quantitative information into a creative and aesthetic media. The intention of the project is to effectively communicate the design process as it relates to the natural environment and systems that impact the conditions of the area. It was important to create a design media applicable to the needs of Haitians and others unfamiliar with performative design. With the complexity of integrating data sets from the analysis, digital tools were needed to simplify the idea for users to comprehend. Surveys were completed by the undergraduate students evaluating the effectiveness of the digital tools, with the results provided in Chapter IV.

Various tools were explored and studied for their potential in creating an effective design media, with each recognized for advantages specific to this thesis project, as well as for future projects . Application of certain tools was based on their ability to

effectively communicate an idea, whereas some were not effective for this project, but may be used in other studies.

### ***Digital Tools***

This section will introduce the various tools that effectively communicated the analysis and design of the performative housing community in Fond-des-Blancs. The function of each digital tool was tested to determine potential outcomes along with being time efficient. Each digital tool was evaluated by having a desirable outcome, effective integration of information and aesthetic, and labor intensity. If the outcome was highly desirable and aesthetically appealing but extremely labor intensive requiring many man hours, it would arguably not be considered an effective digital tool. The same could be argued if the outcome had a quick time table but lacked clarity and legibility. These three categories were used to evaluate each digital tool as being an effective communication graphic.

Adobe Creative Suite was the primary digital media for many of the graphics. Composition, editing, animation, and publishing were where programs helped. Illustrator was used to create vector graphics for mapping and diagrams. These capabilities were integrated with Flash Catalyst to embed animation and interaction to the work from Illustrator. Flash Catalyst also allowed for the publication of the various graphics onto a website for web access to the thesis project. Photoshop was utilized for graphic rendering of the design portion of the thesis, further explained in Chapter IV. Renderings



from this program were then edited with either Flash Catalyst or Illustrator to overlay annotation, diagrams, and schematics for an informative graphic.

Rhinoceros 3D is a digital modeling tool used to create the site terrain and inventory components. The advantages of the program are its ability to take GPS location data from surveys and tools and accurately place them into a digital model. Specific components included the location of vegetation, streams, existing structures, and property lines. It is highly efficient in modeling that information into three-dimensional representations. The addition of the Grasshopper plug-in allowed for parametric, or responsive, modeling. Essentially, as parameters changed throughout the analysis, design adjustments could be made seamless within the digital model.

Google SketchUp is also a digital modeling tool to create an immersive environment within the site. Some of the immersion techniques included walkthroughs, section cuts, and also base points for rendering perspectives and sections. SketchUp and Rhino are compatible programs, allowing for efficient transfer of work from one program to the other.

### ***Climate Analysis***

Wind patterns and weather changes are seasonal characteristics impacting the community in Haiti. To effectively communicate this it was important to incorporate the wind pattern directions and speed throughout the year. Animation of wind patterns was

an appropriate tool through programs involving Adobe Illustrator and Flash Catalyst. Vector graphics were created to represent the cold and warm air, along with North Atlantic subtropical high. After these were accurately illustrated according to the analysis researched, the graphics were brought into Flash Catalyst for animating the location, direction, and speed associated with the two seasons. Buttons were included in the graphic for users to shift seasonal conditions to communicate the transitional changes that occur.

Animation and interaction, in the same digital format as wind patterns, were also used to demonstrate the process of plates colliding in the formation of the island and mountain ranges explained in the previous chapter. Hispaniola was created over a long period of time, and continues to converge, so an animated visualization for that process was necessary. Convergence and strike-slipping were both affecting the island formation, yet had different impacts. Through the use of interactive media, each plate tectonic formation could be viewed as a distinct process.

Communicating the process of a rain shadow was the last component of the climate analysis, combining the information from wind patterns and mountain ranges to determine the cause of Fond-des-Blancs precipitation value. Through this interactive media, the user is able to visualize the process in which warm air releases moisture to the windward side of the mountain range, leaving little to no moisture for the leeward side. This is an effective communication tool for explaining the significance all three

global climate conditions of wind, mountain ranges and precipitation contribute to the available water resources throughout Haiti.

### ***Site Inventory***

Once the climate conditions were established, it was necessary to scale down to the site in Fond-des-Blancs. At this scale, collaborative efforts with the undergraduate studio provided a rapid assessment, during the February visit to Haiti, examining the following site conditions: vegetation (canopy and understory), soil conditions, hydrology, wildlife, and unique vistas. Students were organized into groups to inventory one of those site conditions. *Figures 27. - 32. Site Inventory and Investigation* provides more detail of that inventory. The data collected was then compiled into a comprehensive site analysis of detailed information. A land survey, conducted by one of the local residents in Fond-des-Blancs, provided GPS points that were taken into a digital modeling program, Rhinoceros 3D, to create a three dimensional computer model of the terrain and topography. The site inventory created four distinct site areas based on vegetation cover, slope conditions, and drainage patterns; labeled: Palm Grove, Upper Plateau, Lower Plateau, and West Side, illustrated in *Figure 33. Existing Site Conditions*. Not only was there a physical inventory established, but also an awareness for shade and comfort within the intense sun and temperatures of Haiti.

Through this process of working with other students a vast amount of information was collected to create an extensive description of the site. Since additional visits to the

## Site Inventory and Investigation

This is an overview of select topics and categories relevant to sustainable site planning and development addressing major issues of low impact development, preservation, solar energy, rain water harvesting, and agricultural production. Through the inventory and analysis we will be able to determine opportunities for comprehensive and creative design solutions. Utilizing the information gathered on site is crucial in directing unique and specific outcomes for sustainable living.

### Vegetation

Use the following three site conditions to assist and aid in determining the different vegetation types:

- **Elevation** (different elevations and locations have adverse effects on plant groups) **Slope** (determines infiltration and hydrology), **Aspect** (direction of slope determines moisture and microclimates based on solar angle)
- **Mature Trees** - use provided dimensions and measurements of tree caliper
- **Vegetation Clusters** - plants thrive in symbiotic relationship! Very important to note the group of vegetation that exists ranging from the canopy to the understory and groundcover. Refer to diagrams and plant groupings.

### Soil Conditions

Soil conditions are imperative for locating potential building foundations, rain water collection, and agricultural production:

- **Texture** - use the following diagrams to determine if soil is sand, silt, or clay
- **Infiltration** - time and observe the duration of water infiltrating into the group through the use of provided table

### Hydrology

The direction, velocity, and saturation of an area has a crucial impact on the different design solutions

- **Direction/Pattern** - observing where swales and ridges are located at a microscale
- **Velocity** - making note of where major erosion is occurring by physical distinction and sediment within ephemeral and major stream
- **Saturation** - changes in the slope topography may create standing water and wetland areas

### Wildlife

Photograph and noting obvious presence of different wildlife types (birds and amphibians)

### Major Views/Special Places

The previous categories focussed on quantitative values, but successful design includes balancing out with qualitative values

- **Framing** - where is the landscape and site conditions framing distinct or distant landmarks
- **Nodes** - how do the various environmental conditions create a unique microclimate through moisture, light, ventilation

*Figure 27. Site Inventory and Investigation 1*

# Vegetation

Use the following three site conditions to assist and aid in determining the different vegetation types:

- **Elevation** (different elevations and locations have adverse effects on plant groups) **Slope** (determines infiltration and saturation), **Aspect** (direction of slope determines moisture and microclimates based on solar angle)

Identify and record the following trees through photographing the leaves and bark. Use the initials provided next to each tree name to plot the location or region on the base map.

## CANOPY

**Oak Tree/Haitian Catalpa (*Catalpa longissima*) HC**

Well-drained areas (moderate slope, dry groundcover)



**Royal Palm (*Roystonea hispaniolana*) RP**

Calcareous rocks (alkaline soil)



**Mahogany (*Swietenia mahagoni*) MA**

Well-drained areas (moderate slope, dry groundcover, full to partial sun)



**"Juan Primero" (*Simaruba glauca*) JP**



## MIDDLE STORY

**"Jagua" (*Genipa americana*) JA**

**Black Olive (*Bucida buceras*) BO**

**West Indian Lancewood (*Oxandra lanceolata*) LA**



Figure 28. Site Inventory and Investigation 2

Source: Multiple See References

## Vegetation

Use the following three site conditions to assist and aid in determining the different vegetation types:

- **Elevation** (different elevations and locations have adverse effects on plant groups) **Slope** (determines infiltration and saturation), **Aspect** (direction of slope determines moisture and microclimates based on solar angle)

Identify and record the following trees through photographing the leaves and bark. Use the initials provided next to each tree name to plot the location or region on the base map.

### Others

Fustic (*Chlorophora tinctoria*) FU



Logwood (*Haematoxylon campechianum*) LW



Barbados Lilly (*Hippeastrum puniceum*) BL



West Indian elm (*Guazuma ulmifolia*) WIE



"palo de leche" (*Rauwolfia nitida*) PL



Fiddleword (*Citharexylum fruticosum*) LW



Figure 29. S  
Rich  
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Figure 29. Site Inventory and Investigation 3

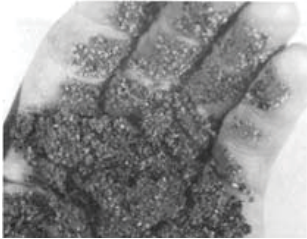
Source: Multiple See References

# Soil Conditions

Soil conditions are imperative for locating potential building foundations, rain water collection, and agricultural production:

**Texture** - use the following diagrams to determine if the top soil is sand, silt, or clay at the given locations. Identify and record the following soil textures through photographing the soil texture as shown in the diagrams. Use the initials provided next to each texture and record it on the base map where indicated.

**Sand (S)**



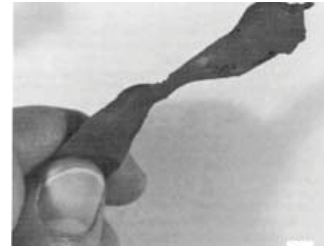
Sandy samples do not stick together enough to form a cast, or they form a weak cast that can be handled gently without falling apart. They cannot be formed into a ribbon, and rubbed surfaces are very grainy in appearance. They are not sticky.

**Silt Loam (SL)**



Silt loam samples form a good cast and a moderately weak ribbon. The clay content varies from 0% to 27%, so the strength of the ribbon varies. Many of these samples are silt loam in texture and have few sand grains on a rubbed surface; sand grains are more apparent in loam textures. Medium-textured soils are slightly sticky.

**Clay (C)**



Clayey soils contain more than 35% clay and form a long ribbon that can be squeezed very thinly and still support its weight. The appearance of a rubbed surface mainly appears to be very smooth and shiny or waxy, but it could have some graininess. They are very sticky.

**Infiltration** - Follow the instructions below and then time and observe the duration of water infiltrating into the hole through the use of provided table. Record process through photographs or video. The time of infiltration will determine the absorption rate of the subsoil.

1. Dig a hole 6 inches deep by 6 inches in diameter.
2. Fill hole with water and measure depth of water with a ruler.
3. Let stand 1 hour. Then measure the depth again.

	Hole 1	Hole 2	Hole 3	Hole 4	Hole 5	Hole 6
Depth 1 (inches)						
Depth 2 (inches)						
Difference (inches)						

Soil type	Sand	Silt	Clay
Rate	2.5 inches/hour or 4 hours total	1/2 inches/hour or 12 hours total	1/3 inches/hour or 18 hours total

Figure 30. Site Inventory and Investigation 4

Source: "Indiana"

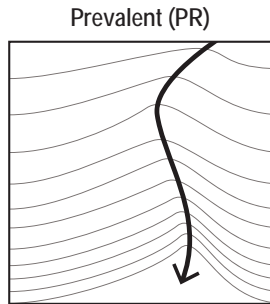
# Hydrology

The direction and velocity of sheet flow, along with the saturation of an area, has a crucial impact on programming a space for development.

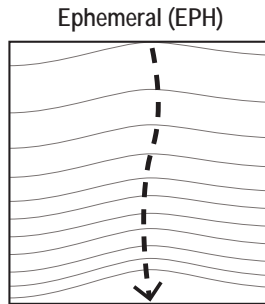
Use the following three site conditions to evaluate the various hydrology conditions

- **Elevation** (different elevations and locations have adverse effects on plant groups) **Slope** (determines infiltration and saturation), **Aspect** (direction of slope determines moisture and microclimates based on solar angle)

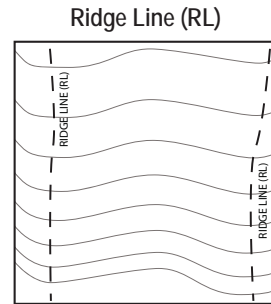
**Direction/Pattern** - observe and record where swales and ridges are located at a microscale within the regions marked on the base map. Using the diagrams below use the different symbols to identify the direction and moisture level of the swales (prevalent or ephemeral)



This symbol indicates that there is a prevalent and distinguishable swale in the region with high to moderate moisture within the topsoil.



This symbol indicates that there is an ephemeral and shallow swale in the region with low to no moisture within the topsoil.



Where swales are difficult to identify, use the dashed lines to indicate where ridges are apparent and little to no evidence of direction of water flow.

**Velocity and Erosion** - Make note on base map of where major erosion, with ER, is occurring by physical distinction and sediment within ephemeral and major stream with photographs and/or video.

**Saturation** - changes in the slope topography may create standing water and wetland areas. Mark on the base map with the different symbols if any are identified.

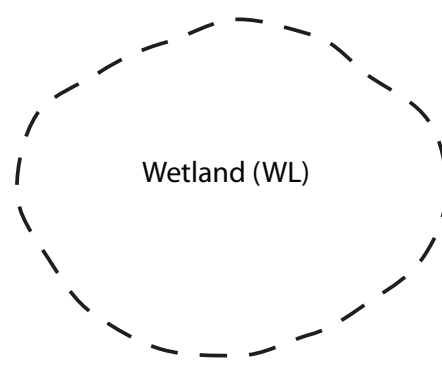
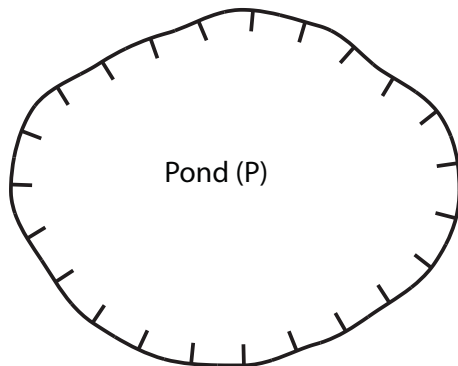


Figure 31. Site Inventory and Investigation 5



## **Wildlife**

Photograph and noting obvious presence of different wildlife types (birds and amphibians) as well as domesticated livestock. Due to the variety and number of different wildlife its important to be opportunistic and document through photographs and/or video the location of wildlife within the marked regions. Identification of wildlife presence can also be documented through tracks on the ground or bird sounds. Below is a selection of wildlife prevalent in the area but not limited to. If wildlife is unknown make sure to mark location with a number corresponding with the photograph or video.

Some of the domesticated animals present in the area may include cows, donkeys, goats, and chicken as well as others not observed previously.

### **Birds**

Hispaniolan parrot



Parakeet



Hispaniolan lizard cuckoo



Palm crow



American kestrel



Vervain hummingbird



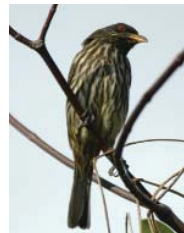
Hisp. Woodpecker



White Necked Raven



Palm Chat (DR national bird)



Red-tailed hawk



### **Mammals**

Haitian solenodon



Hutia or Agouti



*Figure 32. Site Inventory and Investigation 6*

*Source: Multiple See References*

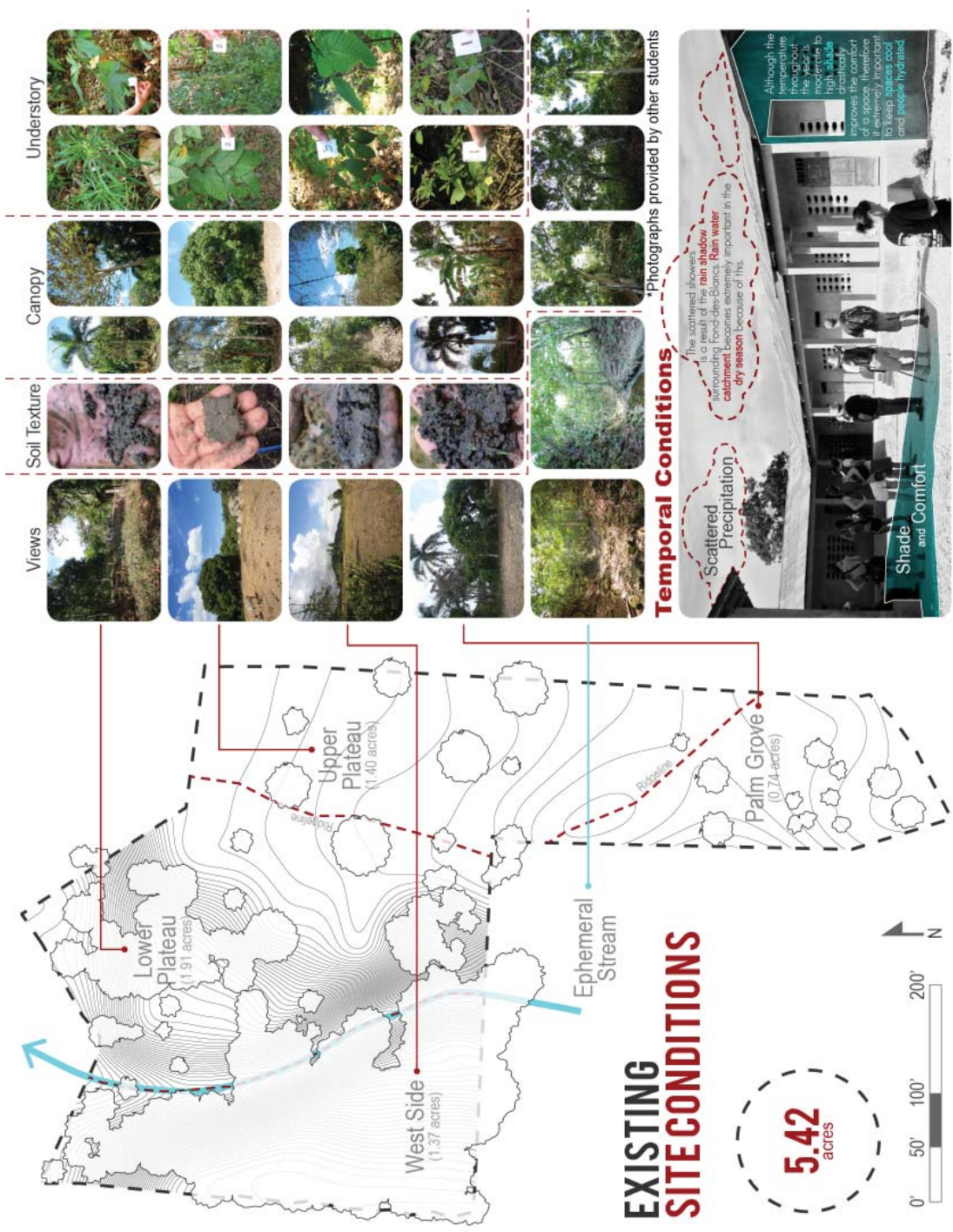


Figure 33. Existing Site Conditions

site were not probable, this comprehensive site inventory was able to keep an accurate foundation for continual analysis and design guidelines.

### **Site Analysis**

With the information collected in February, the site analysis could be started for integrating the various site conditions into a functioning model of unique qualities. Information from the soil survey provided soil texture and types throughout the site. This determined areas of potential high erosion and poor drainage and vice versa. Soil conditions were combined with slope conditions for a comprehensive diagram of erodibility. Mapping of the mature vegetation provided regions of established vegetation, indicating whether surface conditions were stable or vulnerable to erosion from stormwater runoff. The last step was using Rhinoceros 3D and the Grasshopper plug-in to script the drainage patterns on the site, shown in *Figure 34. Hydrology Script 1* and *Figure 35. Hydrology Script 2*, credited to WooJae Sung. Through this script, ridgelines and major drainage patterns are mapped. By animating the drainage it became more effective in visualizing water moving through the site as there was a start and end point of the drainage lines. A user could view the drainage pattern as the animation began at the start of a rain event, transitioning to the end point where stormwater collected or drained off-site.

Although the information contained in these three categories was still isolated, section cuts through four major site areas compiled the data for an integrated

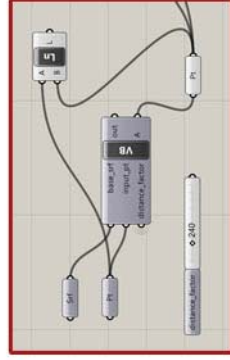
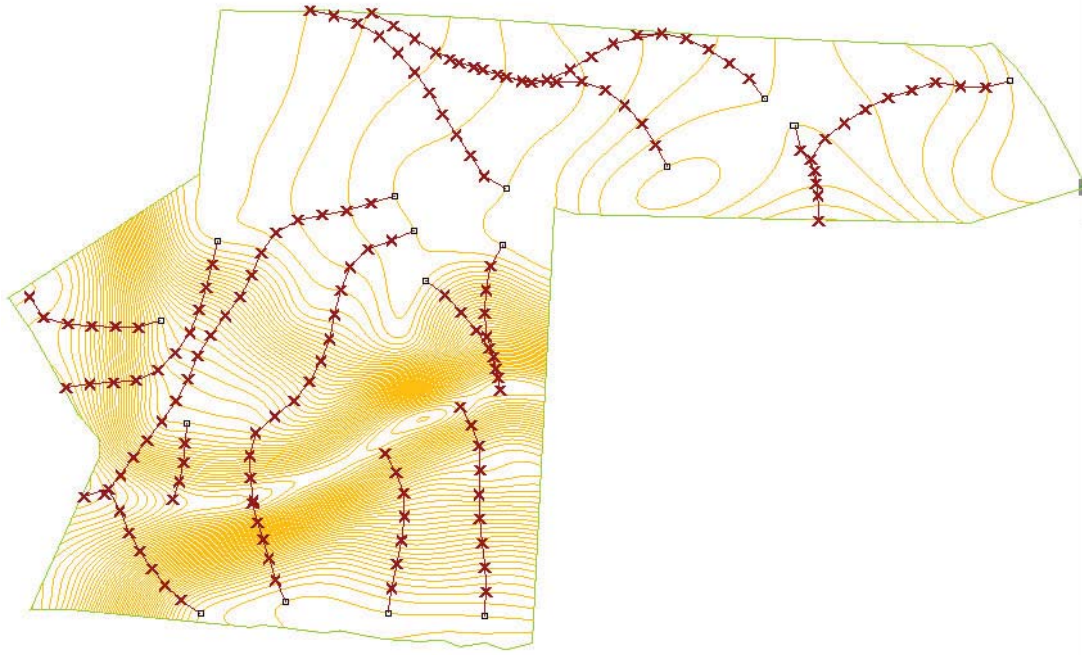


Figure 34. Hydrology Script 1

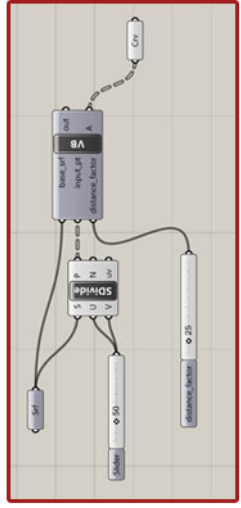
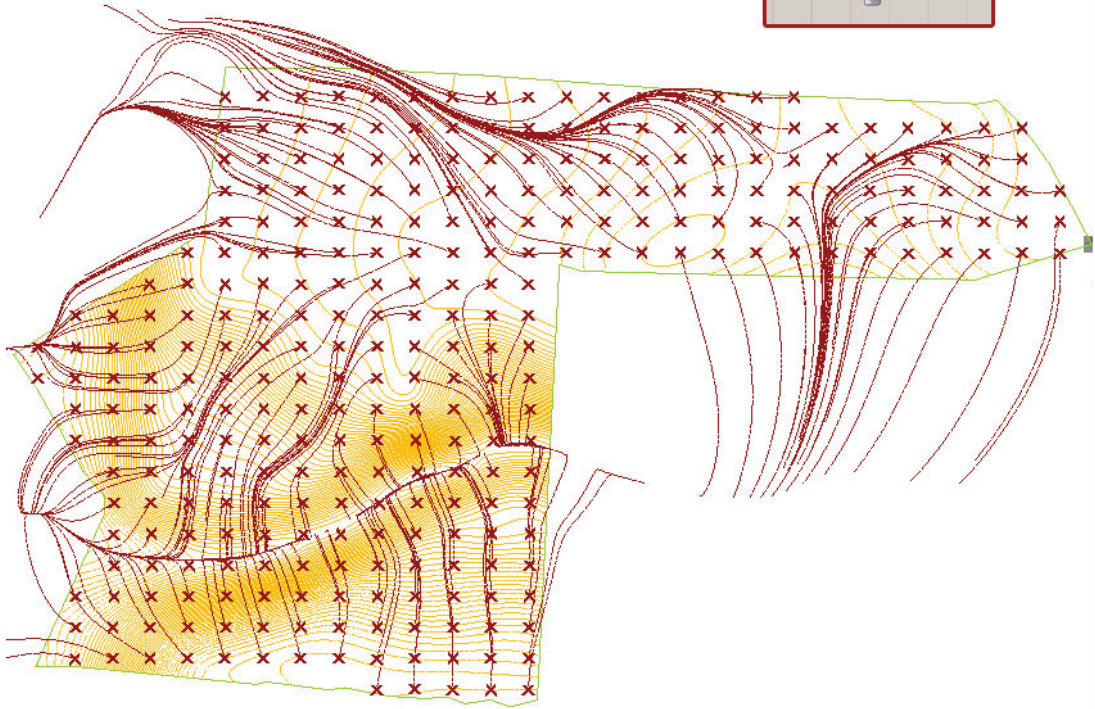


Figure 35. Hydrology Script 2

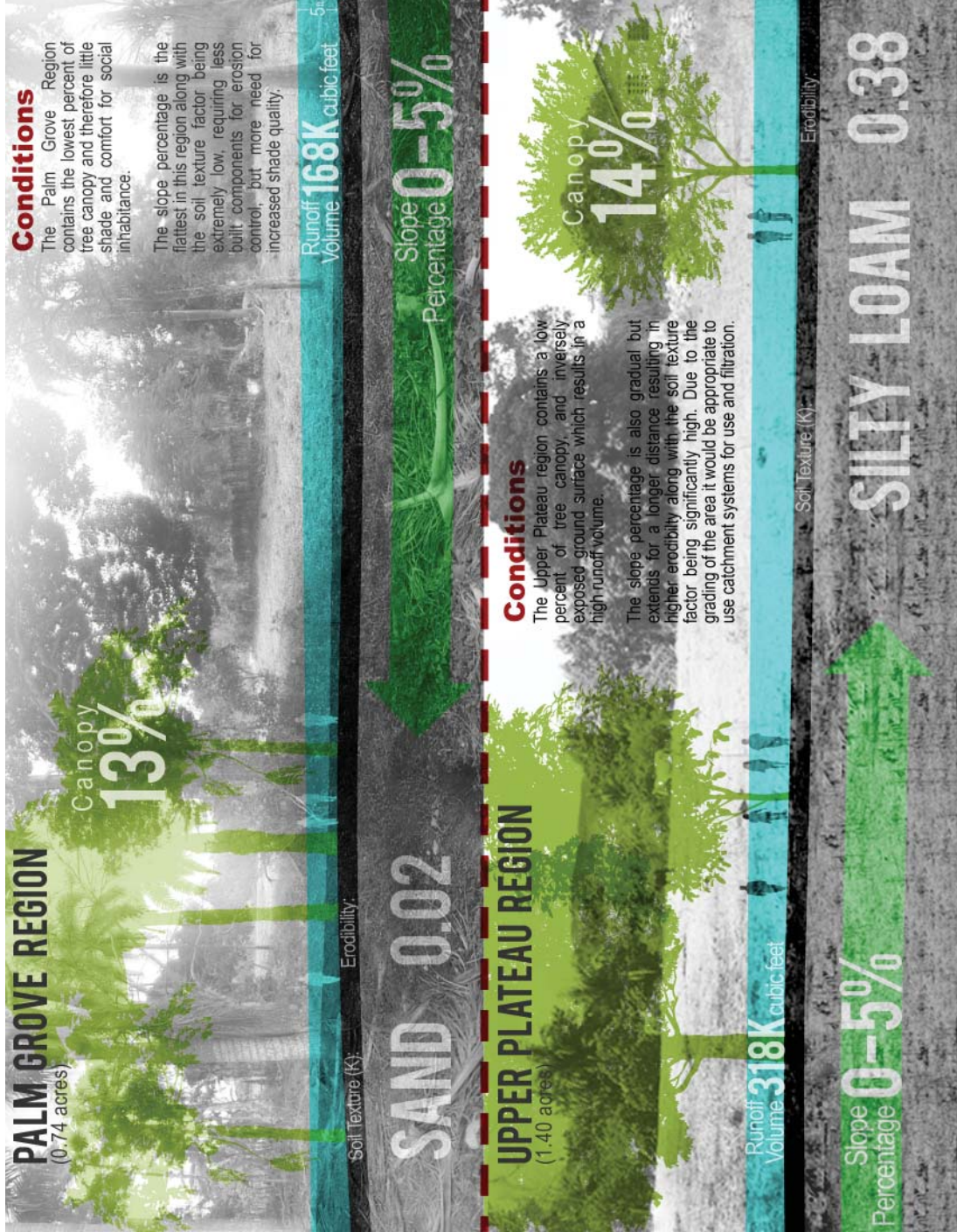


Figure 36. Section Cuts 1 and 2

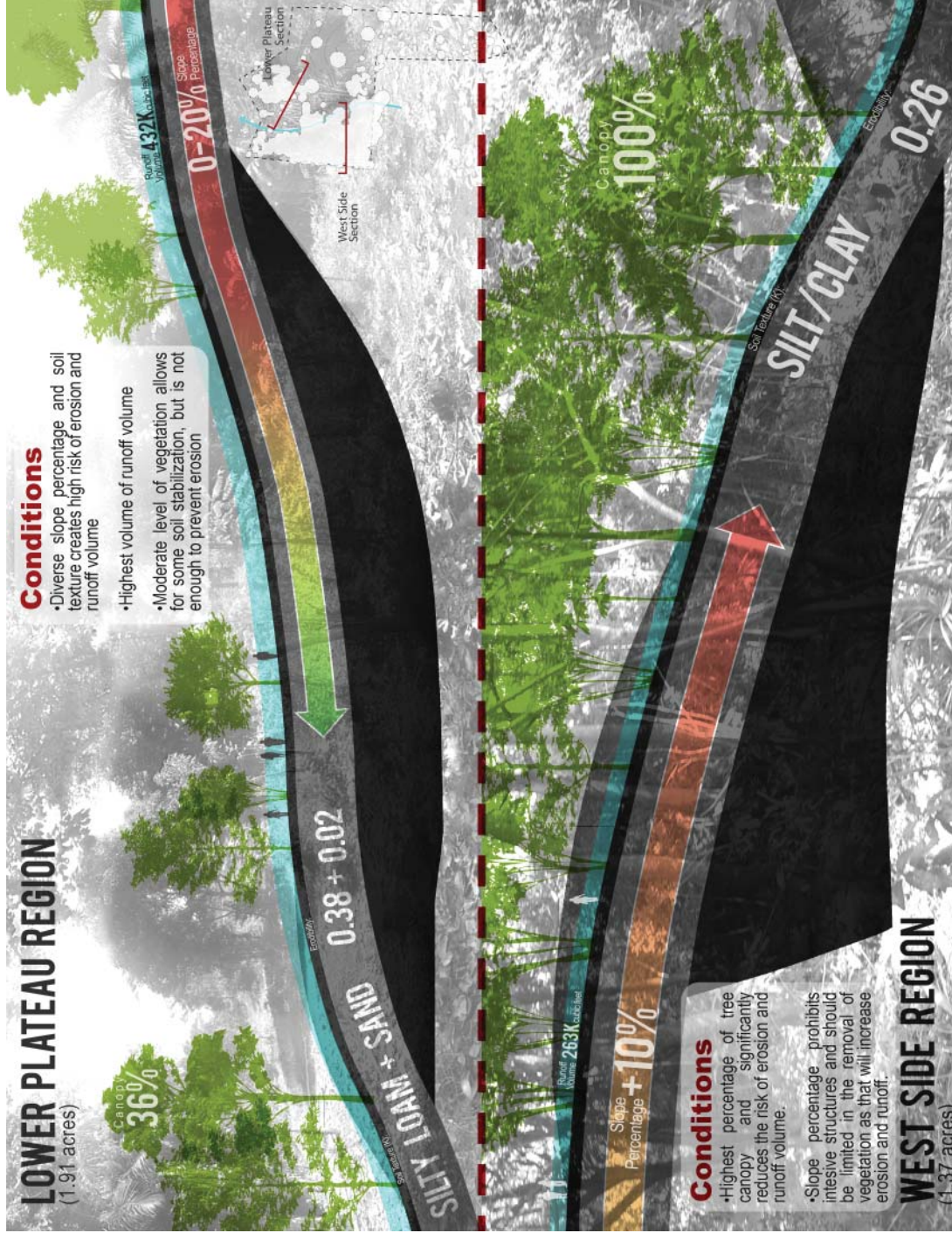


Figure 37. Section Cuts 3 and 4

walkthrough of the site as shown in Figure 36. Section Cuts 1 and 2 and Figure 37. Section Cuts 3 and 4. The four major site areas were labeled: Palm Grove, Upper Plateau, Lower Plateau, and West Side. Each section cut compiled the analysis from the site plan to create design guidelines for appropriate design implementation. Design applications fluctuated from low-impact pathways, for accessibility to the onsite stream, to housing units for ex-patrons, families, and teachers. The program of the four sections will be explained in Chapter IV.

### ***Housing Units***

The final scale of analysis involved the orientation and rainwater collection of the individual housing units. Rhino and Grasshopper were used to determine the appropriate orientation of the building by isolating the peak temperature to the western façade of the building, illustrated in *Figure 38. Building Orientation*. As stated before, thermal heat gain was not a desirable function of the building so with this new orientation addressed that concern. Passive solar water heating was proposed for that façade to take advantage of the heat gain throughout the day.

Rainwater harvesting from the individual units was proposed to provide substantial water resources to the individual housing units. It was important to design for a pitched roof to minimize litter and debris from collecting, thus contaminating the rainwater. Roof materials were evaluated for effective runoff from the roof, comparing metal and concrete for their coefficients in the equation:



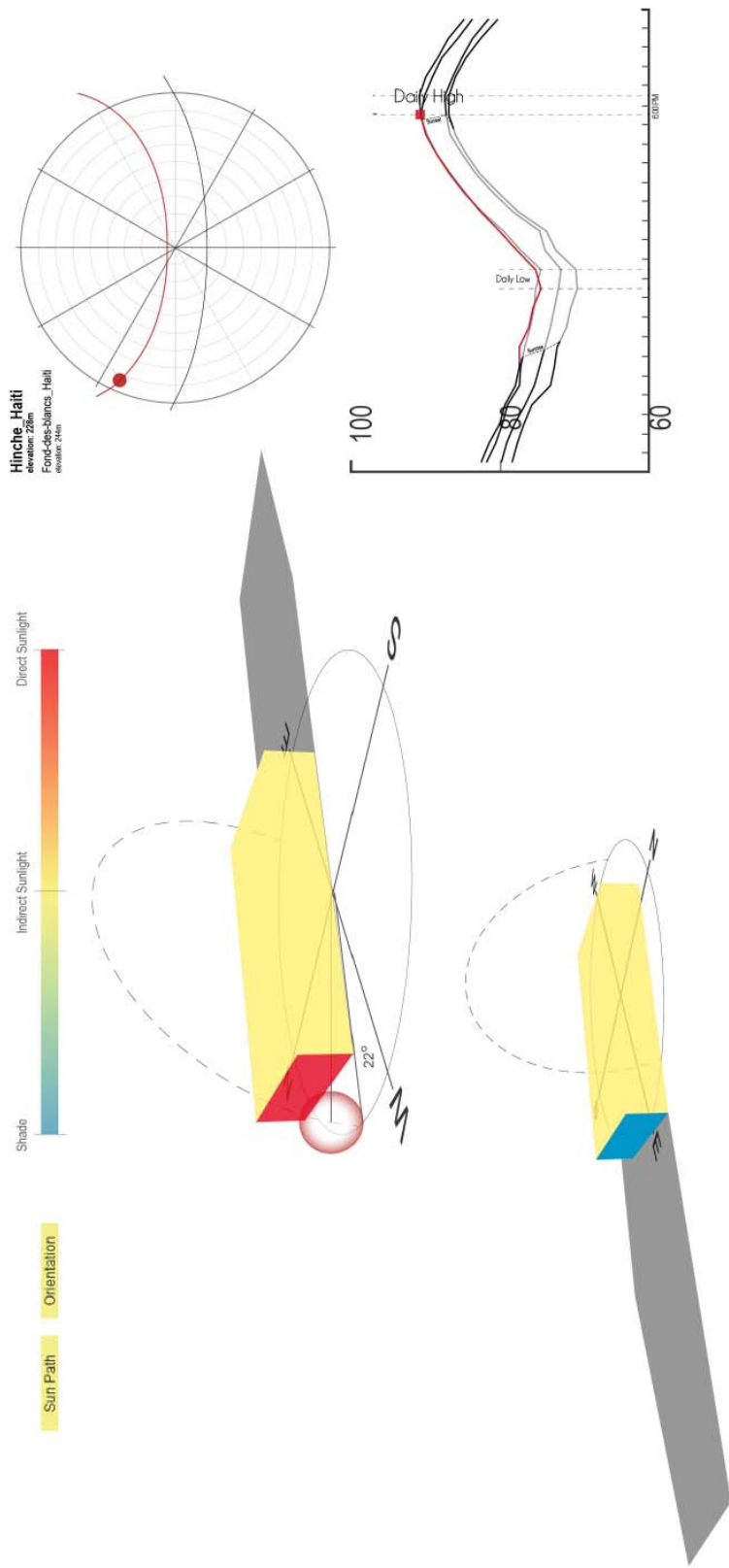
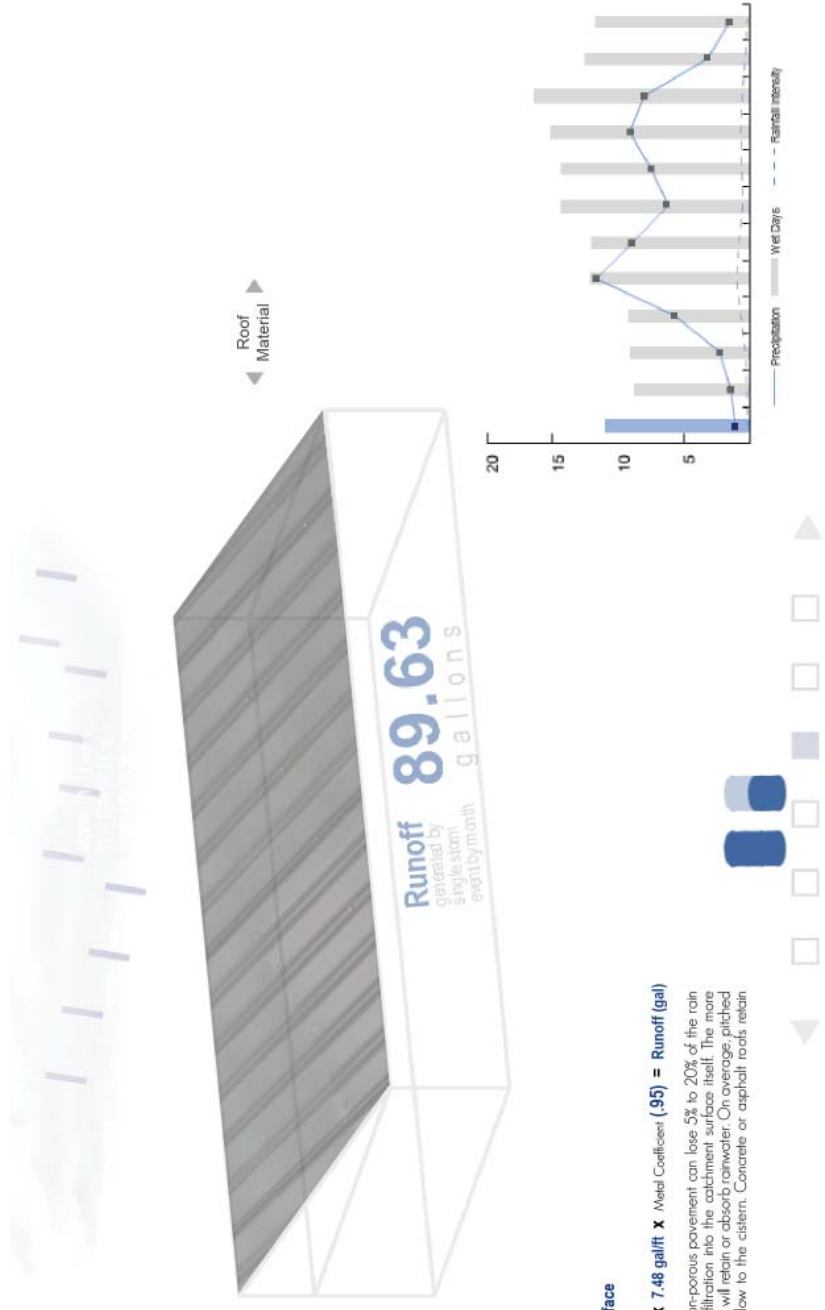


Figure 38. Building Orientation

catchment area (ft<sup>2</sup>) X rainfall (ft) X 7.48 gal/ft X runoff coefficient = net runoff (gal)  
(Lancaster 129)

The next step was demonstrating the varying values of rainwater collected by different roof materials throughout the year, shown in *Figure 39. Rainwater Collection*. This visualization connected rain events with roof materials for a collection value of reusable water. Once the quantities of rainwater collected by an individual home, the process of storing and function of water was demonstrated. Rainwater would drain off the roof into a gutter, channeling it to a cistern for reuse in the individual home, illustrated in *Figure 40. Rainwater Reuse*.

Now that both a collection and reuse value were established, graph comparisons were created to visualize time frames of surplus and demand in water consumption. This occurs in the dry season where rain events are less frequent and intense. Because enough rainwater cannot be collected from rooftops during the dry season to meet water needs over the year, additional measures to collect stormwater from the site were considered. The hydrology analysis, which provided runoff volumes during the dry season, supported the use of collecting stormwater to be reused as irrigation and other non-potable use, the highest demands in household consumption, illustrated in *Figure 41. Household Water Use*.



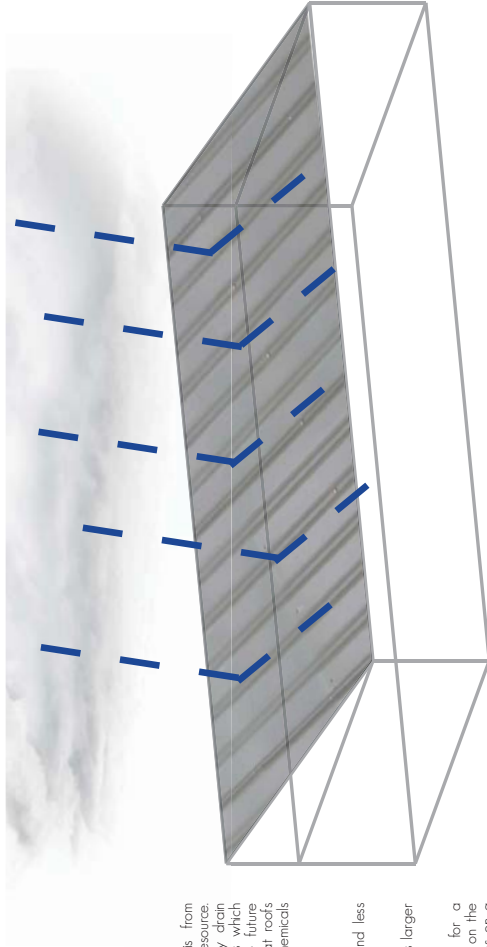
### Metal Roof

**Estimated Net Runoff from a Catchment Surface**  
Adjusted by its Runoff Coefficient from a Single Rain Event

Catchment Area (1500 sq. ft.) x Rainfall (inches) x Metal Coefficient (.95) = Runoff (gal)

Impervious catchment surfaces such as roofs or non-porous pavement can lose 5% to 20% of the rain falling on them due to evaporation, and minor infiltration into the catchment surface itself. The more porous or rough your roof surface, the more likely it will retain or absorb rainwater. On average, pitched metal roofs lose 5% of rainfall, allowing 95% to flow to the cistern. Concrete or asphalt roofs retain around 10%.

Figure 39. Rainwater Collection



A pitched roof prevents less debris from accumulating for a cleaner water resource. During storm events, runoff will quickly drain versus a flat roof that collects debris which eventually decomposes to contaminate future runoff. Along with collecting waste, flat roofs generally contain material with toxic chemicals that will leach over time.

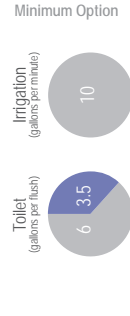
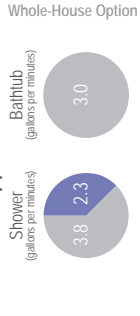
**Advantages:**

Roof angle promotes quick drainage and less evaporation

The square footage of a pitched roof is larger catchment due to the overhangs

The conveyance or drainage system for a pitched roof is cheaper since it resides on the outside versus internal drainage systems on a flat roof

**Conventional vs. Energy Saving Appliances**



**Whole-House Option**

As the term whole-house clearly states, this option addresses the entire household's water needs, including food and drink. However, this cannot include toilets. Considering concerns of supply and demand with respect to global rainfall, addressing a minimum amount of water in home management, the use of a flush toilet in a home where this option is considered becomes highly illogical.

**Estimated Net Runoff from a Catchment Surface**

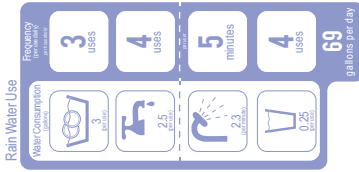
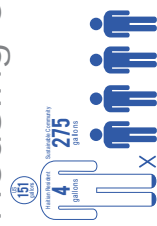
Adjusted by its Runoff Coefficient from a Single Rain Event

$$\text{Catchment Area (Sq. Ft.)} \times \text{Rainfall (ft)} \times 7.48 \text{ gal/ft}^3 \times \text{Runoff Coefficient} = \text{Net Runoff (gal)}$$

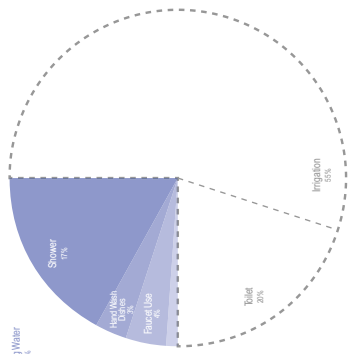
Impervious catchment surfaces such as roofs or non-porous pavement can lose 5% to 20% of the rain falling on them due to evaporation, and minor infiltration into the catchment surface itself. The more porous or rough your roof surface, the more likely it will retain or absorb rainwater. On average, pitched metal roofs lose 5% of rainfall, allowing 95% to flow to the cistern. Concrete or asphalt roofs retain around 10%.

Figure 40. Rainwater Reuse

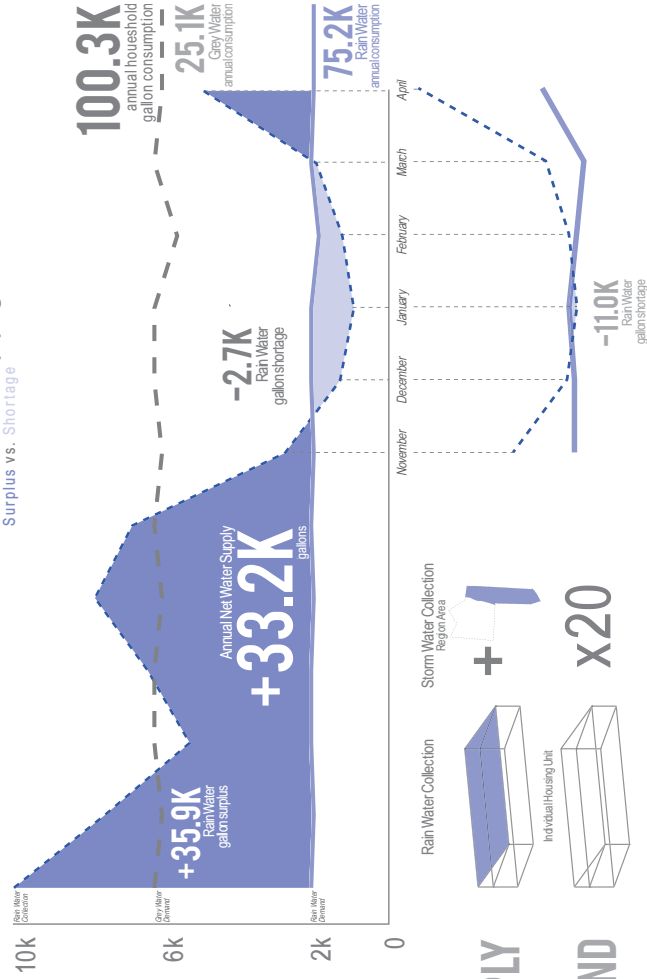
# Housing Community Water Usage



## Water Usage vs. Greywater



## Rain Water Supply Surplus vs. Shortage



**ON-SITE COLLECTION**  
Based on the average household water consumption it is necessary to collect storm water from the site to meet the resident demand. This water can be treated and filter for potable water use as well as collected with no treatment to use for grey water use.

**SUPPLY**  
**DEMAND**

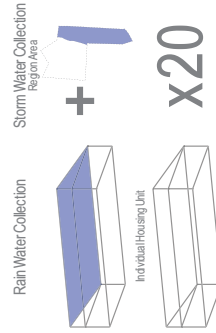


Figure 41. Household Water Use

## CHAPTER IV DYNAMIC VISUALIZATIONS

The thesis explored the potential of digital tools and dynamic visualizations to effectively communicate process design for a sustainable housing community in Fond-des-Blancs, Haiti. Process design is complex, involving temporal and progressive conditions impacting a site, requiring media tools for accurate representation of those influences. In this chapter I will elaborate on the success or failure of dynamic visualizations produced by digital tools, where in Chapter V I will evaluate the effectiveness of the digital tools. Digital tools simplify complex issues through compilation of diverse data and information into a comprehensive working media, or dynamic visualization. That outcome can have an overlay of analytical annotation to make a compelling design rendition containing quantitative and qualitative information. Site inventory and analysis formulate parameters to support creative ideas, successfully connecting information and aesthetics. This relationship of ideas can effectively communicate process design.

The comprehensive collection of analyses created appropriate guidelines within each site area, making the design process efficient. Logistical parameters from the analysis became a framework to the existing natural systems, one of the issues I investigated through design communication. Efficient and effective design processes involve reverting between creative, inspirational, and intuitive ideas and logistical, rational, and formal reason. The exchange of ideas and reason, as explored in “The Alternating Current of Design Process” by John Lyle allows for a thorough investigation

of practical application with a desired outcome. Using both aspects of thinking generates options that are disposed and refined through a cyclical process. This method is an important discipline with any project having effective design and communication principles. In Haiti, the guidelines from the analysis were a framework for program uses by the inhabitants and stormwater management within the landscape for an integrated relationship working in harmony with natural systems.

Cognitive mapping was relevant to the representation of design application within the various site areas through perspective illustrations. It was through this design application that panorama images, collected previously, would serve as a final outcome of integrating the information relevant to the design. The extensive analytical process of de-constructing the site would become the guidelines for appropriate design application. It was necessary to embed that rational logic to the qualitative characteristics of the design for a holistic conclusion.

## DESIGN APPLICATION

Data on each site area; Palm Grove, Upper Plateau, Lower Plateau, and West Side is a result from an extensive analysis from inventory and information collected by myself and students of the Haiti Studio. Dynamic visualizations are the result from this effort, displaying spatial usage directed by the global context, natural systems, and community needs. Hydrology, vegetation, erosion, agriculture, occupation, and water usage are parameters considered in each site area. Designing within these parameters

produced a functioning community of natural and built characteristics, resulting in a process driven design that I investigated.

### ***Upper Plateau and Palm Grove***

Both the Upper Plateau and Palm Grove were designated as appropriate locations for twenty housing units. Soil conditions permitted good drainage, slope percentages were low, and additional vegetation canopy around housing properties and catchment ponds would improve the limited existing canopy cover. In this site area, flat spaces promoted gathering within the housing clusters for an engaging social aspect. Porches would face each other, extending spaces for interaction between residents.

In addition to the social and community aspect of this area, conditions permitted runoff catchment, filtration, and collection within rain gardens and constructed wetlands. The conveyance of stormwater through rain gardens and bioswales filtered the water through passive measures to limit energy consumption by mechanical methods. After water circulated through, it would be collected into a communal catchment pond for either potable or non-potable use by the residents. Grey water use within the housing units would reduce the demand on ground water consumption from on-site wells, illustrated in *Figure 42. Upper Plateau and Palm Grove Section*, and *Figure 43. Upper Plateau and Palm Grove Perspective*. The relocation of on-site soil creates catchment ponds and an elevated berm, maximizing water capture. Stone walls lined the perimeter of the ponds. These walls confine water and act as walkways for residents.



# SITE DESIGN

The site analysis portion of the project provided guidelines for appropriate programming of each region that would address runoff and erosion concerns, re-vegetation, and intensity of user activity.

The conclusions for each region are:

## Upper Plateau/Palm Grove : **Catchment**

- Housing and Multi-use development
- Community Outdoor Space
- Stormwater Catchment and Filtration

## Lower Plateau Region : **Conveyance**

- Retaining Walls and Terraced Gardens
- Managed Stormwater Conveyance

## West Side Region : **Preservation**

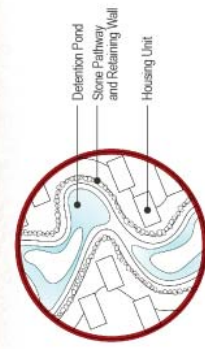
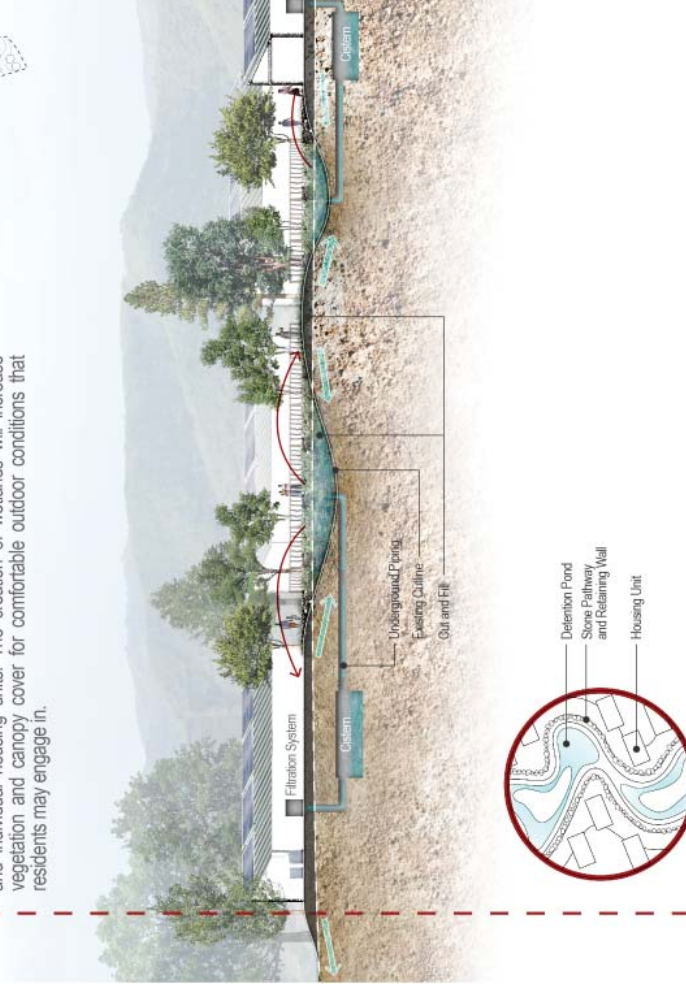
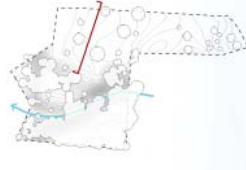
- Pathway for Accessibility to Stream
- Preservation of Existing Vegetation with Minimal Grading Change

# OVERALL SITE SECTION 1

## Upper Plateau/Palm Grove : **Catchment**

With flat and minimal slope change in addition to good soil conditions, the upper level of the site is suitable for housing units and other built facilities. Serving not only as a gathering place for people, the region is also appropriate for storm water catchment.

Wetlands and detention ponds will serve as catchment devices for capturing storm water for alternative use on site for the entire community and individual housing units. The creation of wetlands will increase vegetation and canopy cover for comfortable outdoor conditions that residents may engage in.



Schematic Plan

Figure 42. Upper Plateau and Palm Grove Section

# GATHERING

The Upper Plateau and Palm Grove regions intend to serve as a gathering for both families and water in an integrated space of human comfort and water resource functionality. Additional shading for relief from the harsh outdoor conditions along with adequate potable water promotes active healthy lifestyles in the community. Provided amenities of shelter, food, and water alleviate the burden these life necessities once required on a daily basis.



**Rain Garden**  
Each household's vegetated buffer provides passive filtration to the communal detention pond.

**Outdoor Activity**  
With patio extensions and improved vegetation, the additional shade promotes active living involving cooking, recreation, socializing, that were otherwise impractical due to the sun intensity and temperature.

**Detention Pond**  
Once storm water has traveled through the rain gardens, it collects into the community pond for alternative water use with improved aesthetic qualities for surrounding homes to embrace.

Figure 43. Upper Plateau and Palm Grove Perspective

These design representations communicated the connection between residential program with runoff collection and reuse of site materials for the community. It was important to communicate this integrated relationship of the built and natural environment through these dynamic visualizations. Overlaying the process of cut and fill, circulation, and water reuse over the section cut and perspective explained the intention of this site area.

### ***Lower Plateau***

The analysis of the Lower Plateau site area indicated soil stabilization was necessary due to a high slope percentage and little vegetation cover. Re-vegetation of the slopes would not be effective because of the extremes throughout the area with erodible top soil. Structural support would be necessary to mitigate erosion and runoff by terracing.

For an efficient and performative landscape, the terraces would be a productive area for agriculture. Through this programming of the space, a nutritional diet could be had by the residents. Based on the tropical climate, established trade goods, and nutritional produce, specific crops were chosen to meet the community's needs. Some of the crops proposed include: corn, sorghum, rice, sugarcane, and avocados. With agricultural production, maintenance and harvesting of the crops would be necessary; providing job opportunities for both the residents in the community and local inhabitants. This productive landscape promotes community involvement for either household

consumption or employment of locals for maintaining communal plots.

Retaining walls served as the soil stabilization method. These walls can be built with labor from locals in the community who constructed similar walls throughout the town. Stone material from on-site would be used as stepping stones for access throughout the landscape. With the improved slope conditions, stormwater could continue to flow naturally on site, while serving as irrigation for the agriculture, illustrated in *Figure 44. Lower Plateau Section* and *Figure 45. Lower Plateau Perspective*.

Within this site area, it was important to visualize the multi-functioning performance of the landscape, by promoting agricultural production within the improved slope conditions. Using retaining walls for a terraced landscape communicated a design application addressing issues of erosion, limited vegetation, and high runoff volume. The visualization from the section cut elaborated on the moderation of a steep slope while reducing runoff and erosion. The terraced landscape perspective visualized the potential for agriculture, job placement, and engagement of the community.

### ***West Side***

Preservation of the existing conditions was the primary purpose of this site area. The combination of vegetation cover, slope conditions, and runoff quantity suggested any disruption or intense programming would be detrimental to the natural systems of biodiversity and hydrology. The West Side preserves the quality of the site as the slope,

# OVERALL SITE SECTION 2

## West Side Region : Preservation

Based on the conditions found in the analysis, this region requires minimal design intervention, but rather treated more as a preserved space. The removal of vegetation and reduction in the permeability of the site will have drastic environmental concerns that include destructive runoff and major erosion.

Low impact structures, such as observation decks and pathways are the appropriate measure for this area.

## Lower Plateau Region : Conveyance

The conditions of this region require erosion control devices that includes a terracing system utilizing stone retaining walls that promote storm water conveyance, filtration, and reduced storm water velocity. These devices will also perform against issues of major runoff and soil loss.

Benefits with these design guidelines will include increased vegetation and accessibility down the steep hillside. These multi-functional aspects combine Functionality and inhabitation for an immersive environment.

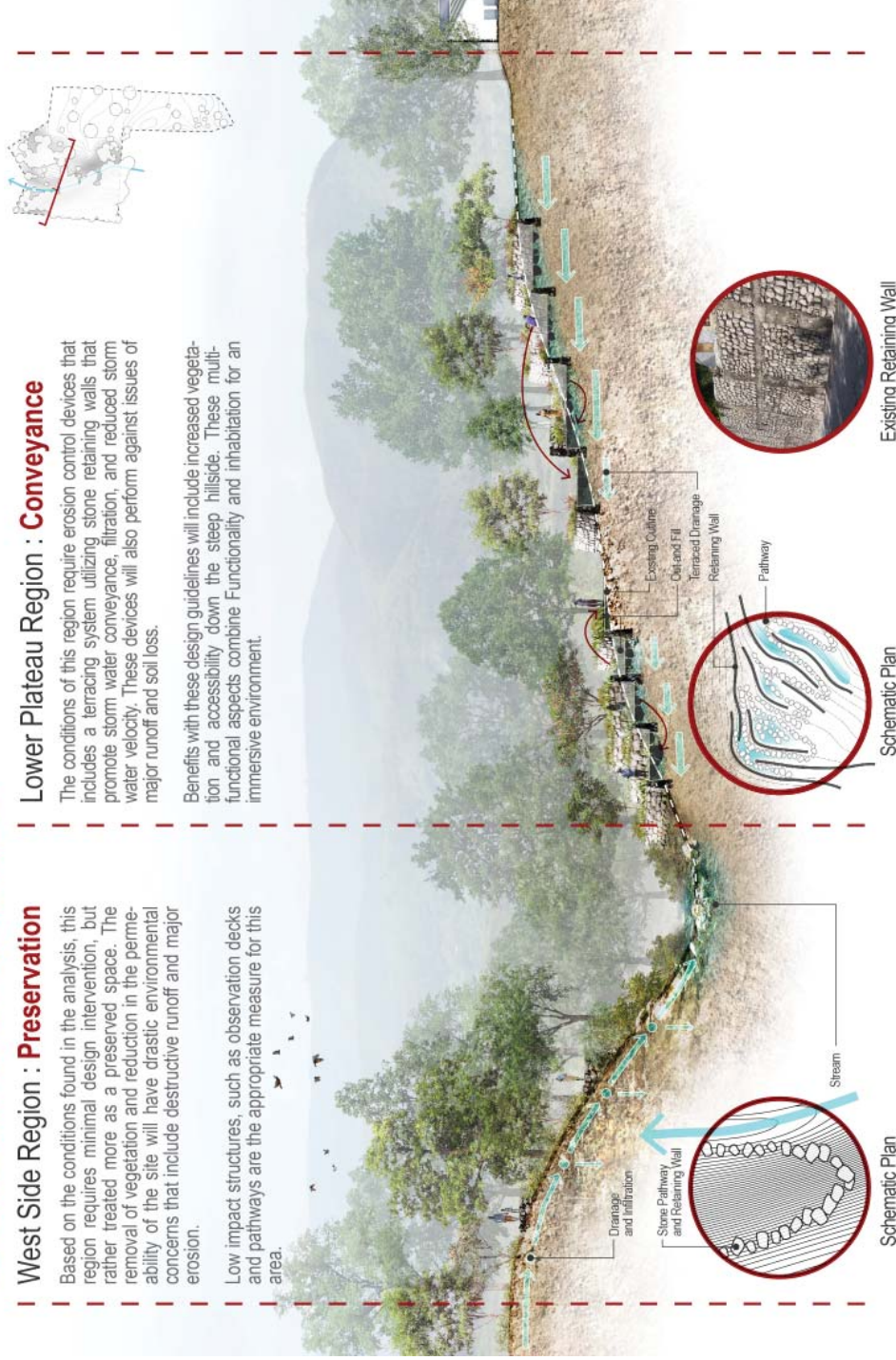
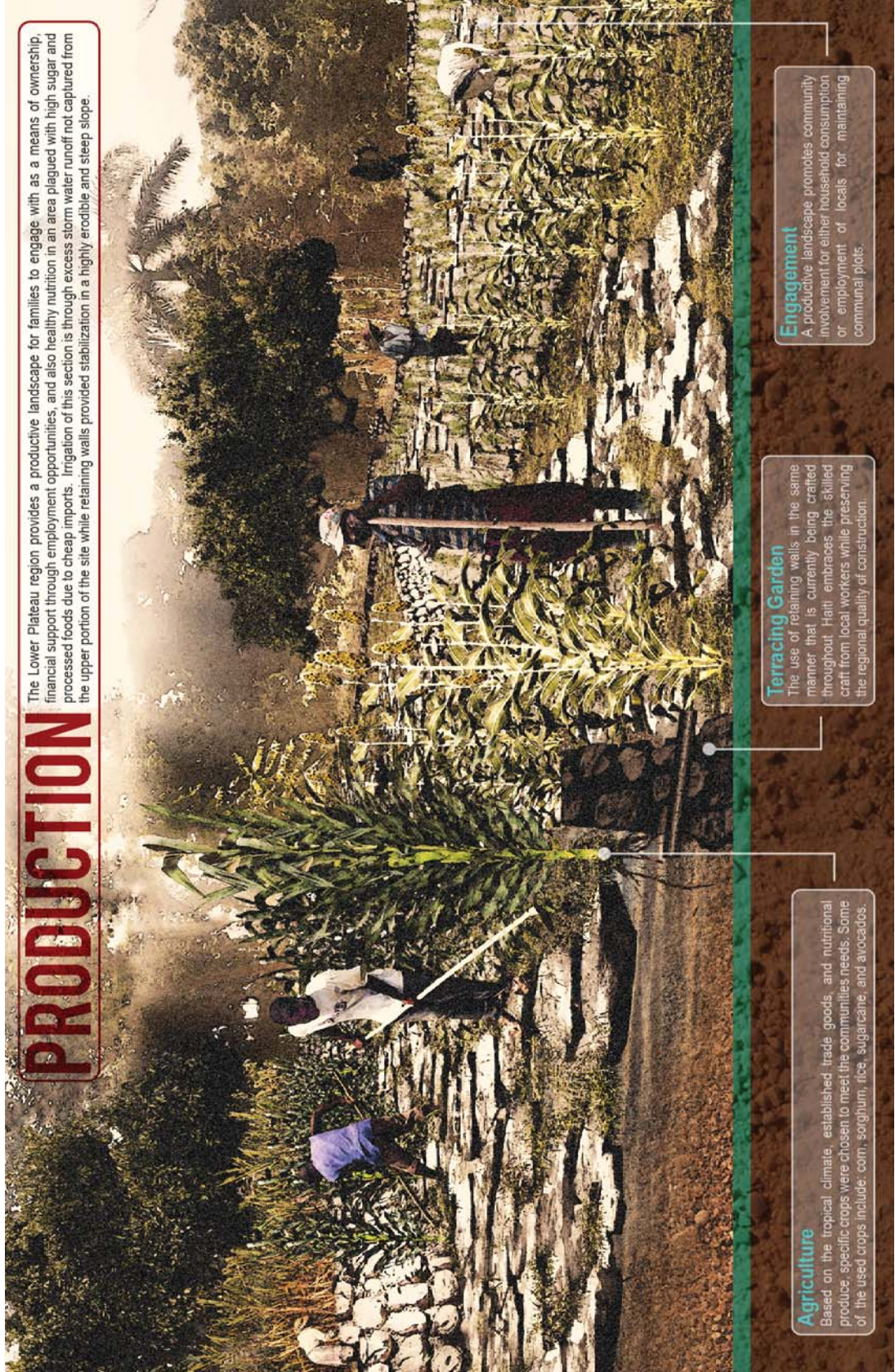


Figure 44. Lower Plateau Section

# PRODUCTION

The Lower Plateau region provides a productive landscape for families to engage with as a means of ownership, financial support through employment opportunities, and also healthy nutrition in an area plagued with high sugar and processed foods due to cheap imports. Irrigation of this section is through excess storm water runoff not captured from the upper portion of the site while retaining walls provided stabilization in a highly erodible and steep slope.



## Agriculture

Based on the tropical climate, established trade goods, and nutritional produce, specific crops were chosen to meet the communities needs. Some of the used crops include: corn, sorghum, rice, sugarcane, and avocados.

## Terracing Garden

The use of retaining walls in the same manner that is currently being crafted throughout Haiti embraces the skilled craft from local workers while preserving the regional quality of construction.

## Engagement

A productive landscape promotes community involvement for either household consumption or employment of locals for maintaining communal plots.

Figure 45. Lower Plateau Perspective

soil texture, and vegetation do not make it conducive for development. Disrupting the conditions of this area would create high risk of erosion and increased stormwater runoff filled with topsoil and sediment. By maintaining the conditions the water table will be stable with an adequate flowing stream around the year. Along with preservation of the area, a modest stone path was placed for accessibility to the established stream for consumption or recreation, illustrated in *Figure 46. West Side Perspective*.

## OUTCOME

Based on the results from the dynamic visualizations produced, it can be argued that the outcome is an effective communication tool for design process, specifically the sustainable community in Fond-des-Blancs. This will be further examined by self and student evaluations, in addition to comments from the thesis committee and reviewers in Chapter V. The representations are both informative and compelling, connecting the analysis and guidelines into a holistic design proposal. The analytical information explained how a functional landscape can be designed and the visual graphics showed the positive impact the design can have for the community in Haiti. The issues of temperature, vegetation, erosion and water resources became opportunities for an effective solution.

Process design presents the issues at the beginning, examines how they can be addressed in the analysis, and concluding with a design proposal based upon those assumptions. The outcome revealed a healthy quality of life achieved through proper



**PRESERVE**  
 The West Side region preserves the quality of the area as the slope, soil texture, and vegetation do not make it conducive for development or intense programming. Disrupting the conditions of this area would create high risk of erosion and increased stormwater runoff filled with topsoil and sediment. By maintaining the conditions the water table will become stable with an adequate flowing stream year round.

**Stream**  
 The existing ephemeral stream has transformed into a constant flowing water source as the design interventions on site have managed water supplies appropriately for a healthy natural and built environment.

**Stone Path**  
 The meandering pathway allows for accessibility throughout the site and stream while following the same construction and detail of the retaining walls on site and village.

Figure 46. West Side Perspective



water resource management, improved vegetation, stable soil, and engagement from the community with the landscape. Functional space was successfully integrated with natural systems, while maintaining comfort and appeal for the residents. The holistic design outcome was possible through process design with the assistance of digital tools and dynamic visualizations.

## CHAPTER V CONCLUSIONS AND RECOMMENDATIONS

Digital tools are an effective design media to combine data and information with creative imagery for a dynamic visualization tool. Explaining the complexity of performative design, reliant on functionality with the natural environment, is difficult with conventional methods often limited by their capability to integrate quantitative and qualitative solutions. With the use of digital tools, overlaying components through interactive or animated media makes ideas legible for users. Accessibility to the design media is another advantage associated with digital tools. Through publication and multi-media projections of the design, a wider audience can be met. These advantages can only be justified if the efforts and timetable were permissive for the maker. Although many digital tools were explored, only a few were utilized for this project based upon that requirement.

Visual representations throughout the thesis integrated analytical information and creative thoughts into a holistic process design through dynamic visualization tools. Process design is complex, consisting of infinite possibilities and options from derived analytical research, but it can produce compelling outcomes if intuitive steps are taken. The process generates opportunities for appropriate outcomes within the parameters established by the analysis. Dynamic visualization tools assist in the process through efficient and effective platforms to input data. The digital tools were selected based on that criteria of efficiency.

The outcome concluded that dynamic visualizations can work effectively in communicating significant information. Visual representations generated by digital tools can be educational and influential for landscape architects and allied professions based upon these results. An argument can be made through this evaluation that graphics generated by digital tools should be used for future projects. Flash Catalyst can communicate information effectively through animation and interactive capabilities, granting the user a unique experience of the visualizations. A flexible and customized experience with this digital tool can cater to the user's interest, rather than a universal or standardized interpretation of the information. Three dimensional modeling programs, such as 3D Rhinoceros and Google SketchUp, provide depth and diverse perspectives to information. When including plug-ins with these models, specifically Grasshopper for 3D Rhinoceros, data sets from outside sources and the analysis can be efficiently integrated with the design for a comprehensive overview of quantitative and qualitative aspects. The dynamic visualizations produced with these digital tools can inspire users to implement these same techniques in their own projects to communicate process design. Although the result may have been effective, the effort and efficiency to produce these outcomes must also be considered effective for a full evaluation. If the ability to recreate these dynamic visualizations is unattainable or inaccessible, then digital tools are not appropriate platforms.

The thesis was an investigation to answer several questions regarding digital tools and dynamic visualizations. How do various visual dynamics and communication

methods become effective and informative of high performance design in landscape architecture? Can visual dynamics make the design ideas legible for allied professions? In addition, can they create a positive image of sustainable design and applications? Finally, can we determine if the new tools give the viewer an insight into design processes? Self, student, and professional evaluations helped answer these questions. The self evaluation will focus on digital tool efficiency to produce dynamic visualizations. Both student and peer evaluation will determine if the image of sustainable design is improved and if the information is significant for design process. After those results are indicated, a conclusion can be determined by connecting the evaluations with the new opportunities dynamic visualizations present, shown earlier in *Figure 5. New Opportunities*.

### ***Self Evaluation***

Based upon my experience and knowledge of computer programs, I was able to explore programs for their potential in effectively communicating high performance design. I understand the potential of digital tools quickly and can determine if they will produce a desired outcome. When learning new programs, the learning curve may be steep at first, but quickly becomes easier because of my ability to learn and adapt to the interface. My ability to quickly learn programs is a result from many years prior investigating digital tools. I have been using Adobe Creative Suite for over seven years and 3D modeling programs for over six years. Experience with those programs created a foundation of resources to explore the capabilities of digital tools for landscape

architecture. When using digital tools, I create dynamic visualizations by relying upon experience and knowledge to work efficiently towards a desired outcome. The programs Autodesk Ecotect Analysis and Adobe Flash Professional are examples of digital tools investigated, but were not effective in generating a suitable outcome.

Being inexperienced and unfamiliar with these two were the lead reasons for not pursuing them further, because of the time and effort required to be effective with the programs. Ecotect is a powerful tool to incorporate weather data into a digital model. It is compatible with 3D Rhino and its plug-ins, generating an efficient transition between programs. Utilizing its capabilities and interface would require experience and training for future interest. Flash Professional allows for advanced animation and interactive interfaces within dynamic visualizations. Manipulating the perspective renderings from Chapter IV into immersive panoramas, similar to NFB's *Out My Window* visualization, could be achieved with this program. The effort to do so would require advanced script writing and additional resources that I could not achieve in the given time table. As a result, I was able to make compromises by using Flash Catalyst to generate a similar interpretation with interactive characteristics.

After being exposed to the potential of different digital tools, creative intuition becomes a factor for creating dynamic visualizations. The experience accumulated over time improved upon creative instincts. As Lyle stated previously, after compiling a vast level of information, a foundation is created to explore a new level of detail and

creativity. This is important to advance forward in design process, so that an inspiring and clear outcome is achieved by connecting quantitative and qualitative characteristics.

### ***Student Evaluation***

It was necessary to conduct a student survey covering all the media used in the project for proper evaluation. The survey had two main categories, evaluating if the effectiveness of communicating a topic on the website and if that information communicated had a significant role in the student's project. By answering these questions, the various digital techniques could be classified as being successful. The survey is provided in *Figure 47. Student Survey 1, Figure 48. Student Survey 2, and Figure 49. Student Survey 3.* After the results were collected, they were tabulated to reach an average score for the different dynamic visualizations. As mentioned before, they were judged on being both effective communication and significant information. The effectiveness and significance both scored relatively high at values of 2.16 and 2.21 in a scale of 1 through 6, and 1 being the highest. The survey was also broken down into scales of information within the visualizations: Global Analysis, Site Analysis, and Design Guidelines. These categories were also evaluated with results being the best for Design Guidelines (1.99), then Global Analysis (2.24) and last Site Analysis (2.30) in the same value scale.

The ranking from the scores was not a surprise, as the graphic quality and standard within the "Design Guidelines" were higher and intriguing compared to the

Evaluation of Effective and Informative Visualizations and Communication Techniques  
for a Sustainable Housing Community in Haiti  
[pzawarus.squarespace.com](http://pzawarus.squarespace.com) - Click on Thesis Project

Graduate Thesis Project  
Phillip Zawarus M.S.L.A. Student

The intention of the thesis is to explore new opportunities in communicating sustainable design in an effective and appropriate manner to a diverse user group that is often not met with conventional methods, such as plans, sections, static graphics. Some of these new opportunities include dynamic visualizations that promote animation, interaction, and representation of temporal conditions.

Rate the following questions on how effective each component demonstrated the information and how you used it in your project. 1 being Very Effective/Significant and 6 being Not Effective/Significant

### Global and Regional Analysis

---

How effective is the website presentation in communicating wind patterns?

Very Effective			Somewhat Effective		Not Effective
1	2	3	4	5	6

How significant is it to understand the changing wind and weather patterns throughout the year in relation to designing in Haiti?

Very Significant			Somewhat Significant		Not Significant
1	2	3	4	5	6

How effective is the website presentation in communicating of the impact of tectonic plates colliding?

Very Effective			Somewhat Effective		Not Effective
1	2	3	4	5	6

How significant is it to understand the formation of the island with precipitation values in relation to designing in Haiti?

Very Significant			Somewhat Significant		Not Significant
1	2	3	4	5	6

How effective is the website presentation in communicating the impact of mountain ranges on precipitation values?

Very Effective			Somewhat Effective		Not Effective
1	2	3	4	5	6

How significant is it to understand a site's relationship to mountain ranges regarding collecting rain water for designing in Haiti?

Very Significant			Somewhat Significant		Not Significant
1	2	3	4	5	6

How significant was the global and regional analysis in making decisions on your project?

Very Significant			Somewhat Significant		Not Significant
1	2	3	4	5	6

### Site Analysis

---

How effective is the website presentation in communicating the massing of vegetation regarding runoff volume and erodibility of the site?

Very Effective			Somewhat Effective		Not Effective
1	2	3	4	5	6

How significant is it to understand vegetation cover for reducing runoff volume and soil erodibility in relation to designing in Haiti?

Very Significant			Somewhat Significant		Not Significant
1	2	3	4	5	6

Figure 47. Student Survey 1

How effective is the website presentation in communicating hydrology patterns and runoff volumes?

Very Effective			Somewhat Effective		Not Effective
1	2	3	4	5	6

How significant is it to understand runoff patterns and volume in relation to designing in Haiti?

Very Significant			Somewhat Significant		Not Significant
1	2	3	4	5	6

How effective is the website presentation in communicating the relationship between slope percentages and soil conditions?

Very Effective			Somewhat Effective		Not Effective
1	2	3	4	5	6

How significant is it to understand slope and soil conditions in determining runoff and erodibility of the site in Haiti?

Very Significant			Somewhat Significant		Not Significant
1	2	3	4	5	6

How effective is the website presentation in communicating region conditions through the analysis in the section cuts?

Very Effective			Somewhat Effective		Not Effective
1	2	3	4	5	6

How significant is it to understand the relationship between various site conditions for appropriate programming of a site in Haiti?

Very Significant			Somewhat Significant		Not Significant
1	2	3	4	5	6

How effective is the website presentation in communicating issues of water, soil, and vegetation in an integrated design with the site?

Very Effective			Somewhat Effective		Not Effective
1	2	3	4	5	6

How significant was the site analysis in making decisions on your project?

Very Significant			Somewhat Significant		Not Significant
1	2	3	4	5	6

## Design Guidelines and Perspectives

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How effective is the website presentation in communicating the relationship between daily sun conditions with building orientation demonstrated?

Very Effective			Somewhat Effective		Not Effective
1	2	3	4	5	6

How significant is it to understand the relationship between building orientation and thermal heat gain when designing in Haiti?

Very Significant			Somewhat Significant		Not Significant
1	2	3	4	5	6

How effective is the website presentation in communicating the comparison of roof materials with rain water catchment?

Very Effective			Somewhat Effective		Not Effective
1	2	3	4	5	6

How significant is it to understand the effects of roof conditions and rain water capture in relation to designing in Haiti?

Very Significant			Somewhat Significant		Not Significant
1	2	3	4	5	6

Figure 48. Student Survey 2



How effective is the website presentation in communicating the relationship between rain water catchment and water consumption?

Very Effective			Somewhat Effective		Not Effective
1	2	3	4	5	6

How significant is it to understand the alternative uses of rain water catchment and savings in water consumption in relation to designing in Haiti?

Very Significant			Somewhat Significant		Not Significant
1	2	3	4	5	6

How effective is the website presentation in communicating sections and perspectives of water opportunities, soil stabilization, and spatial arrangement?

Very Effective			Somewhat Effective		Not Effective
1	2	3	4	5	6

How significant were the design guidelines in assisting with decisions on your project?

Very Significant			Somewhat Significant		Not Significant
1	2	3	4	5	6

Comments or Suggestions:

*Figure 49. Student Survey 3*

predominately functional aspect of the analysis categories. Presenting process design to allied professions continues to be a challenge until a stronger balance between quantitative and qualitative information can be made. Landscape architecture has a unique vocabulary of concepts unfamiliar to other professions, emphasizing a needed effort to effectively communicate design, regardless of background and experience.

The students concluded that the visualizations presented were both effective and significant to the design process. Many students were inspired by the information presented, which impacted their design decisions as a result. Students were also interested in the digital tools used, wanting to explore the potential of the tools for future projects. It can be determined that with high results from the survey and interest in using digital tools in the future that this was an effective communication method.

### ***Professional Evaluation***

Receiving an outside perspective from professionals unfamiliar with a project is significant in determining if the desired outcome was achieved. For the thesis, it was important to make the information for allied professions legible, clear, and accessible. Their experience and knowledge provides a critical evaluation of dynamic visualizations.

In the presentation of the material during a final review the committee and professional visitors evaluated the visualizations on the criteria of effectively communicating high performance design in landscape architecture. The response

was positive and encouraging regarding all the digital tools investigated and utilized. Compiling various levels of information for critical assessment and implementation in process design is difficult, but was considered a success with the use of digital tools in the thesis. The application of digital tools was appreciated, however the quality and outcome needed improvement. This resulted from an emphasis on the functionality of the dynamic visualizations, rather than appearance. The quality standard may be considered low, but the visualizations were still able to effectively communicate the design intentions.

## FINAL ASSESSMENT

Referencing the new opportunities figure with digital tools presented in the beginning, along with the evaluations, a formal conclusion can be determined. Digital tools were argued to provide new opportunities within process design in landscape architecture. Issues of climate, vegetation, soil, hydrology, and spatial quality were examined for a sustainable community in Fond-des-Blancs. Each issue was explored through digital tools to determine if there is an effective method to communicate the temporal and progressive qualities of a site. Experience, knowledge, and exposure promotes creative intuition, in this case dynamic visualizations. With that criteria, I was able to successfully communicate high performance design in landscape architecture.

Climate was connected to the physical qualities of Haiti, demonstrating wind patterns, precipitation values, and temperature throughout different time periods. These

Table 1. Student Survey Results

Questions:	Results:	Category:	Average Results by Category
<b>Global Analysis</b>			
1	2.18	EFT	<b>Overall: Effectiveness</b> 2.16
2	2.35	SIG	
3	2.18	EFT	<b>Significance</b> 2.21
4	2.41	SIG	
5	1.88	EFT	<b>Global: Effectiveness</b> 2.08
6	2.06	SIG	
7	2.65	SIG	
<b>Site Analysis</b>			
8	2.35	EFT	<b>Site: Effectiveness</b> 2.26
9	2.47	SIG	
10	2.29	EFT	<b>Significance</b> 2.34
11	2.47	SIG	
12	2.53	EFT	<b>Design: Effectiveness</b> 2.10
13	2.24	SIG	
14	2.18	EFT	
15	2.25	SIG	
16	1.94	EFT	<b>Significance</b> 1.88
17	2.29	SIG	
<b>Design Guidelines</b>			
18	1.88	EFT	<b>Overall</b> 1.99
19	1.71	SIG	
20	2.06	EFT	<b>Effectiveness (EFT)</b> <b>Significance (SIG)</b>
21	1.82	SIG	
22	2.18	EFT	
23	2.12	SIG	
24	2.29	EFT	
25	1.88	SIG	

became guidelines for adaptive responses to the natural environment, specifically the need to collect and store water during the dry season. The student survey scored climate conditions within “Global Analysis” category with an overall score of 2.24, in a scale of 1-6, with 1 being the highest, shown in *Table 1. Student Survey Results*. Effectively communicating the information scored higher (2.08) than the significance of the information (2.37), shown in *Table 1. Student Survey Results*. Questions 4 and 7 scored the lowest, asking if the formation of the island explained precipitation values and if the information in the “Global Analysis” category influenced their own design. Both questions valued the significance of the information.

The new opportunities to communicate vegetation with digital tools investigated the potential in controlling erosion and runoff, in addition to providing shade and comfort for residents. Hydrological visualizations explored the potential runoff capture for alternative use, along with how vegetation and soil conditions influenced volume. A digital model determined runoff volume, watersheds and ridgelines, combined with vegetation and soil conditions for accurate results. Different slope conditions and erodibility were modeled for appropriate application of vegetation and structural elements to alleviate erosion and runoff. These variables were evaluated by students in the “Site Analysis” category with an overall score of 2.30. The information of vegetation, hydrology, and soil were effectively communicated higher (2.26) than the significance (2.34).

Communicating the importance of slope conditions and soil texture was the least effective for the students, with a score of 2.53. The influence of vegetation on runoff volume and erodibility scored the next lowest, with a score of 2.47.

The design guidelines, influenced and derived from the analysis categories, created functional space for residents, achieving a desired spatial quality throughout the site. Representations of these spatial qualities were building orientation, rainwater catchment, section cuts and perspectives of the different site areas. The outcome and information within the representations were evaluated by the students in the “Design Guidelines” category, having the highest score of 1.99 out of all categories. The effectiveness of the section cuts and perspectives scored the lowest at 2.29. Although the score is relatively high according to the scale, communicating the design can be visualized through other appropriate methods.

Overall, the information communicating process design was more effective (2.16) than significant (2.21). Both scores are relatively high, but dynamic visualizations produced need improvement on explaining significant information. This can be achieved through either alternative or appropriate renditions. Digital tools successfully communicated information by new methods but may need to be thoroughly elaborated upon within the outcome.

Each issues explored with digital tools revealed the multi-functional aspects of each category through dynamic visualizations, a difficult outcome to achieve through traditional methods. Dynamic visualizations are intended to capture different qualities and functionality of spaces with effective media tools. Evaluations of the tools concluded the outcome was achieved. This approach with digital tools can provide new opportunities of communicating process design. Efforts varied in success, but still functioned in ability to appropriately visualize temporal and progressive conditions. The thesis explored alternative opportunities of communicating information and design with encouraging results, establishing a platform to build upon.

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## VITA

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