Ecovillage Design

Incorporating regenerative practices into a new village design for Catavela, Panama

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You Must Not Quit

When things go wrong as they sometimes will.
When the road you're trudging seems all uphill.
When funds are low and the debts are high,
And you want to smile, but you have to sigh.

When care is pressing you down a bit.
Rest, if you must, but don't you quit.
Life is strange with its twists and turns.
As everyone of us sometimes learns.
And many a failure turns about.
When he might have won had he stuck it out:

Don't give up though the pace seems slow -
You may succeed with another blow.
Success is failure turned inside out -
The silver tint of the clouds of doubt

And you never can tell how close you are.
It may be near when it seems so far:
So stick to the fight when you're hardest hit -
It's when things seem worst that you must not quit.

- Anonymous

Dedicated to my Grandma and Grandpa Walker who taught me
the importance of perseverance.
This project would not be completed without the dedicated people who devote themselves to bettering the lives of other people and spreading the word of Christ to the remote places of the World.

To my wonderful family and friends who have supported me through the last five years.

A special thanks to John Motloch and Ron Spangler for advising me throughout the year.

Mostly importantly, to my Father in Heaven who has blessed me tremendously and will continue to guide me in all my future endeavors.

Isaiah 41:13

Acknowledgements
“Ecovillages embody a way of living. They are grounded in the deep understanding that all things and all creatures are interconnected, and that our thoughts and actions have an impact on our environment.”
– Karen Svensson

This study resulted in the design of a village in Panama called Catavella that stresses the importance of a functional ecologically based ecovillage, sustainable permaculture techniques and practices, and water management system that can be utilized to solve the purification needs of the village. The result was a series of conceptual design drawings and diagrams relating to a specific design that can be implemented in the local village.

This study explored the advantages of an environmentally friendly community and low impact development. It revealed a system of design that uses the natural environment as an efficient way of building a community with the integration of microclimates, local plants and animals, water management, and soil quality as a foundation for layout and design. The ideas, concepts, and techniques of ecovillage design were the focal point of the redesign of the village.

In order to examine this further, an analysis of successful ecovillages that have permaculture practices was introduced.

This report highlights the major principles and design elements which are essential when it comes to effectively designing a village that relies directly on the environment for its every need.

There were many strategies to evaluate and examine to see if they could be incorporated into an existing village. An evaluation of case studies, prominent leaders of the field, site interviews and observations, as well as content analysis of articles and periodicals were evaluated on the content of design guidelines and design elements that must be included in developing a village design program.

This project showed how the elements of ecovillages, permaculture design, and water management techniques could be incorporated into Catavella as well as become an example to other villages in the area of the benefits of a self-sustaining community. A master plan of the site will be designed which incorporates important features which have been highlighted in previous research.

Abstract
Table of Contents

Introduction
Significance of the Study .......................... 2
Scope of Study .................................. 2
Purpose of Study ................................. 3

Research
Introduction ...................................... 6
What is an Ecovillage? ......................... 7
Permaculture .................................... 8–13
Water Resources ................................. 14
Ngobe Bugle Indian Tribe ..................... 15

Site Information
Global Context .................................... 18
Regional Context .................................. 19
Eco-Region ....................................... 20
Natural Environment ......................... 21
Site Description ................................. 22–23
Opportunities and Constraints ............ 24
Clients Objectives ............................... 25
Site and the Surroundings ..................... 26–27

Site Elements
Problem Statement .............................. 31
Goals and Objectives ......................... 32–33
Program ......................................... 35

Site Design
Zonal Concept .................................... 38
Linear Concept .................................... 39
Final Site Design ................................. 40–41

Site Details
Seasonal Crop Enlargement Details .... 44–51
Palm Clump Enlargement Details ....... 52–55
Orchard Enlargement Details .......... 56–59

Site Culmination
Phase and Drainage Diagrams .......... 63
Matrix ............................................. 65

Sustainable Alternatives
Alternative Housing ............................ 68
Alternative Roofing ............................ 69
Human Waste Treatment ...................... 70
Animal Waste Treatment ..................... 71

Appendix
Works Cited ................................. 75
Appendix B ...................................... 76–79
INTRODUCTION

Significance of the Project
Scope of Study
Purpose of Study
Significance of the Study

The fundamental theme of protecting the environment and living with nature instead of against it has been around for centuries. Back when civilizations first started forming, they depended on their surrounding natural environment for their resources. Their unique concept of conservation and designing with the environment instead of depleting the resources is a design technique that indigenous people mastered and we are slowly rediscovering.

It was not until recently that a move towards sustainable development began to catch on. Conserving the earth’s natural resources is suddenly becoming top priority for not only the design industry but also many businesses throughout the world. The sudden awareness of limited resources is finally hitting home for many people who once were unaware.

Many organizations around the world have formed to increase awareness of sustainable design and conservation. Organizations like LEED have constantly been promoting sustainable alternatives for developing ideas and designs. The idea that there is an alternative to the traditional techniques that works with the natural environment and utilizes its resources such as the sun, wind, and rain to create a design that is in touch with the surrounding. The basic idea is taking what nature has and using it for your advantage. This promotes excess energy and resources from being wasted and encourages reuse.

Scope of Study

The village of Catavela, located off of Bay of Chiriqui in the province of Bocas de Toro in Panama is an area that is in need of a community design plan that considers the natural environment and the surrounding resources for a community design which supplies the villager’s everyday needs.

The information gathered has been analyzed and interpreted through detailed research in order to be incorporated successfully into a final design solution. The process included the identification of the client’s requests, site selection and exploration, a listing of goals and objectives, the development of a project program, and the integration of researched material into successful concepts which were incorporated into the final design of the village.
Purpose of Study

Only recently have people referred to these design characteristics in a formal sense. Phrases such as green architecture, LEED certified design, Ecotourism, and even Ecovillage design, which was the focus of this study, has become increasingly popular among the design professions. Ecovillage design is spreading throughout the world as a design alternative that can be applied on the family-scale or village-scale to restore the earth and provide a sustainable substitute to community design. The existing settlements are models for the planning and organization in the 21st century. However, the design of an ecovillage varies from place to place depending on the local landscape and environmental conditions.

It is extremely important to understand the environmental conditions and design within that realm instead of against it.

Along with design variations, come many consistent techniques and attributes that need to be included into the community plan that will sustain the village and the land for generations. For example, the idea of permanent agriculture in the form of permaculture was explored in the study. This idea has made significant contributions in the planning of ecovillages that are ecologically sound.

A community plan with ecovillage guidelines of working with nature instead of against it and using the resources available without exceeding the resources is exactly what was needed for the layout of a new village in Panama. This project analyzed the relationship and design characteristics and components of what makes a successful ecovillage and how does it relate to the surrounding natural environment. The research illustrated the relationship of different design characteristics between permaculture and water purification, or water storage, which must be integrated successfully into the entire ecovillage design in order for the village to be environmentally sustainable.
Literature Review
What is an Ecovillage?
Permaculture Defined
Water Resources
Ngöbe Bugle Indian Tribe
The concept of ecovillage design is relatively new in the field of Landscape Architecture. The underlying theme of protecting the environment and living with nature instead of against it has been around for centuries, but recently people have referred to it as ecovillage design. Ecovillages are spreading throughout the world as a community design alternative. However, ecovillage design varies from place to place depending on the local landscape and environmental conditions. The techniques and attributes discussed in this review help in understanding what main elements need to be included and how they need to be designed. A community plan with these design guidelines of working with nature and using the resources available without exceeding the resources is needed in a Panama village. The village of Catavela, located off of Bay of Chiriqui in the province of Bocas de Toro, is an area that is in need of a community design plan that is sustainable to the environment while meeting their everyday needs.

Recently with the increased popularity and awareness of the topic, there has been much written about ecovillages. There are newly developing techniques and strategies being used when it comes to designing a sustainable community. Permaculture and water resource in regards to storage and purification are elements which are necessary to understand when designing an ecovillage. This literature review explores the topics of what exactly is an ecovillage, how is permaculture used, and how does water treatment take place. All these elements are important as a whole when it comes to designing a sustainable village that works with nature instead of against it.

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a. What is an Ecovillage?
b. Permaculture
c. Water Resources
d. Ngobe Bugle Indian Tribe
What is an Ecovillage?

In the article “What is an Ecovillage?,” Karen Svensson explains it as a different way of living, but also includes a “deep understanding that all things and all creatures are interconnected.” It is also a realization that our “thoughts and actions have dramatic impacts on the environment” (Svensson 10). Diane and Robert Gilman were asked to define an ecovillage as part of the GEN’s research. Their definition included many similarities as Svensson but added upon it as being human scale, a full featured settlement in which the major functions of life are all present, supportive of healthy human development, and successfully able to continue into the future. Also included is the idea of low-impact development, built environments are looked at holistically, economic systems, and the final being the whole system is part of a greater whole and impacts the surrounding environments. Ecovillages primarily focus on the relationship they will have with the rest of the world (Bang 27-32). Ecovillages take this idea of inter connectedness and use it as the foundation of a community design. The motivation for ecovillage residents is “to take responsibility for one’s own life by creating a future that does not deplete energies and resources, is regenerative for nature, and thereby sustainable into the future” (Svensson 10). The book Sustainability in Agriculture and Rural Development by Gerard D’Souza and Tesfa Gebremedhin reiterates this idea of meeting the needs of the current population without compromising the future generations needs (D’Souza xi).

There are three dimensions of ecovillages discussed in multiple resources. They are the ecological, social, and spiritual/cultural dimensions of ecovillages (Svensson 10-12). Svensson’s research suggests that many ecovillages are built and designed on combinations of the three. While Ross Jackson states in his article, The Ecovillage Movement, that ecovillages are “dominated by one of these dimensions then gradually, with natural evolution, the other two become more apparent as the ecovillage continues to grow and come in contact with other members of the network” (R. Jackson 2). Another perspective is that a village design will be based on people’s motivation which will result in different patterns of design (H. Jackson 13). Regardless of the design motivation, the result should be a sustainable community that is “socially vital, economically viable, and environmentally sound” (Dykeman 7).

Hildur Jackson says whichever is the underlying dimension or dimensions of an ecovillage design, it is “vital that each project/village clearly defines their priorities” (H. Jackson 13). (See appendix B for a diagram showing the three dimensions of ecovillages along with 15 elements which are included).

Although this study does not address the specific aspects involved in the social and spiritual dimension, they are still important when designing a successful ecovillage. The focus of this study is related to the ecological dimension of ecovillages, although a successful ecovillage incorporates all three dimensions working together to sustain into the future. The ecological dimension represents people’s connection with the Earth. It encompasses low-impact living, saving energy and recycle waste, water treatment, restoration, and ecological building (Svensson 10).

The creation of an ecovillage starts with simply observing the patterns in nature. Jan Martin Bang states,

“When we observe natural systems around us, we see reflected in them other patterns, reminders of other truths; and the ability to see this is one of the faculties we need to train as designers. Our creativity is dependent upon developing this faculty of perceiving patterns and using them in diverse situations” (Bang 53).

By observing natural situations surrounding the site is the only way to be completely certain that the community or village fits into the current ecosystem without depleting resources. The key is to contemplate the patterns in terms of the sequences and situations in order to finally be able to design a community that is sustainable to that specific environment (Bang 53-54).

Ecovillage Dimensions

1. Ecological
2. Cultural – Spiritual
3. Social – Economic
Bill Mollison, who is known as the father of permaculture, defines the term as: “Perma(nent Agri)culture is the conscious design and maintenance of agriculturally productive ecosystems” (Bang 18). He named the term from the basic idea of producing a sustainable agricultural system that is based on multi-crop production. This production includes perennial trees, shrubs, herbs, vegetables, weeds, fungi, and root systems all working together support each other. Mollison also states that it is “the integration of architecture with biology, agriculture with forestry, and forestry with animal husbandry. People who are dissatisfied with agriculture as it is now practiced and are now looking towards a more natural, ecological system” (Mollison vii). Mac Griswold includes in his article Permaculture, that it combines traditional farming and modern technology to make sustainable ecosystems that replicate natural ones (Griswold 60).

What started for Mollison as a “beneficial assembly of plants and animals in relation to human settlements with the aim of community self-reliance” has come to mean more than just food-sufficiency. It has progressed into an entire community system of self-reliance that even includes legal and financial strategies as well as building structures. Permaculture is a design system for creating sustainable human environments (Mollison vii). The article entitled Permaculture in Practice takes this idea and describes permaculture as “the relationship that can be created between plants, animals, buildings, and energy systems by how they are placed in the landscape.” It is necessary to create systems that “are ecologically sound and economically viable” to produce life-supporting system for both urban and rural areas. “The holistic approach of creating a ‘permanent culture’ distinguishes it from the other ecologically-based design systems” (P. Practice 14).

In Hildur Jackson’s article, Ecovillage Design Patterns, he mentions permaculture and permaculture analysis techniques are extremely important when designing a village that is ecologically oriented. This idea is also supported by Bill Mollison and Jan Martin Bang in their individual research. Permaculture design includes placement of elements according to the four directions, exposure to sun and wind, observation and use of rainfall, capacity to retain water, as well as many more (H. Jackson 13).

It also deals with plants, animals, buildings, and infrastructures and the ‘relationships we can create between them by the way they are placed in the landscape.’ The goal is to create systems that

“Does not exploit or pollute the environment and therefore are sustainable in the long term. Permaculture uses the inherent qualities of plants and animals combined with the natural characteristics of landscape and structure to produce a life-supporting system for city and country, using the smallest practical area” (Mollison 1).

The idea of working with nature rather than against it is the dominant theme. This idea of being connected to nature is not a new concept for humans. Many people have lost the mentality of thinking about our environment and how we support our needs.

Permaculture is a completely different way of looking at design. Instead of emphasizing a design that is merely aesthetic, the emphasis needs to be placed on producing a functional and productive landscape that works with the natural environment” (Bang 45). The design system is based “on the observation of natural systems, the wisdom contained in traditional farming systems, and modern scientific and technological knowledge” (Mollison 1). From there, it takes a look at plants and animals in all their natural functions and from there develops a design that can be applied to virtually any human situation and is a “philosophical and practical approach to land-use” (Bang 45).

“Permaculture is functional design in the ways of 1) it must be sustainable and provide for its own needs and 2) it must have a surplus yield beyond the needs for maintenance of the system.” Providing a functional use for all the products/elements in the design must be able to meet their own needs within the system of design (P. Practice 15). The big idea is analyzing how a natural system works and imitating this as much as possible (Bang 45). The realization that nature has already developed a solution to possible problems in nature. The issue becomes how to integrate the solutions into a successful community design.

“Every technique for conserving and restoring the earth is already known; what is not evident is that any nation or large group of people is prepared to make the change,” Bill Mollison.
Permaculture Ethics

According to Bill Mollison’s *Introduction to Permaculture*, “Ethics are moral beliefs and actions in relation to survival on our planet.” Permaculture deals with a threefold ethic

1. Care of the Earth
   This ethic implying caring for all living and nonliving things such as: soils, species and their varieties, atmosphere, forests, animals, water. It also includes harmless and rehabilitative activities, active conservation, frugal use of resources, and working for useful and beneficial systems.

2. Care of People
   This means satisfying our basic needs for food, shelter, education, and employment. Although this makes up a small portion of the entire living system, if we can provide for our basic needs, we will not be inclined to indulge in destructive practices against the environment.

3. Contribution of surplus time, money, and energy
   This ethic aims at extend our abilities and energies to helping other achieve this goal of living with nature instead of against it. This can only be done after the other two have been achieved.

Recognizes the basic worth of living things. Permaculture ethic pervades all aspects of environmental, community, economic, and social systems.

**Cooperation is the key!**
Permaculture Principles

The principles discussed below are general guidelines that can be followed in any permaculture design, in any climate and at any scale. Bill Mollison has put together these principles from collaboration with various disciplines such as: ecology, energy conservation, landscape design, and environment science to guide the design process. (Mollison 5).

The following information is from Bill Mollison’s book Introduction to Permaculture pages 5-29.

1. Relative Location
   Every element (such as house, pond road, etc.) is placed in relationship to another so that they assist each other. In order for things to function efficiently we must put them in the right place. It is important to design for the relationships that could be created. For example, if one element needs can be filled with another by another element in close proximity.

2. Each Element Performs Many Functions
   As much as possible it is vital to place each element in the system so that it performs as many functions as possible. A pond can function as irrigation, watering livestock, fire control as well as many other things. If put in the correct position, plants can be windbreaks, mulch, food, erosion control, soil conditioner along with many other functions.

3. Each Important Function is Supported by Many Elements
   Basis needs should be protected in more than one way. A design will incorporate both annuals and perennials that can be used as a food source for humans and livestock and mulch for other planting beds.

4. Efficient Energy Planning
   Another term for this is efficient economic planning. This can be accomplished either through Zone Planning or Sector Planning. (See Appendix B for diagrams of Efficient Energy Planning)

   Zonal Planning
   Zone Planning places elements strictly according to how much they will be used or how often they will need to be served. Areas that are visited frequently are located near the place of residence while areas which do not require a lot of maintenance are further away. The underlining reason for this is simply to save or conserve energy.

   Zone 0 is the center of activity which is where houses or a barn is located.
   Zone 1 is close to the house and is the most controlled and frequently used area. This is where a garden, greenhouse, and small animals are located.
   Zone 2 is still heavily maintained with dense plantings and small fruit trees. Animal which require care are located in this zone and water is easily accessible.
   Zone 3 contains unpruned orchards, or large pastures for animal production.
   Zone 4 is semi-manged, semi-wild. It is used for hardy foods, unpruned trees, and wildlife.
   Zone 5 is unmanaged or a natural system. This area is not designed.

   Sector Planning
   Sector Planning deals with energies and placing elements according to these elements such as sun, light, wind, rain amount, and water flow. These are outside elements that cannot be directly controlled. Analyses of these elements are sketched out in a plan view and then elements are assigned to the appropriate locations. The idea is to place design components to manage in coming energy to our advantage.
5. Using Biological Resources over fossil fuels
   
   Using plants and animals effectively wherever possible will save energy for the residents and do much of the work of the farm. Plants and animals can be used to provide fuel, fertilizer, tillage, insect control, weed control, nutrient recycling, habitat enhancement, soil aeration, fire control, erosion control etc. It is a key strategy for long term investment because the process recycles energy and developing a sustainable system. It is important to use these resources effectively and at the appropriate time in the entire cycle.

6. Energy Cycling on Site
   
   Designing a community that is independent from the distribution trade will ensure all energies spent will benefit the community while not destroying land. The basic idea is to keep nutrients and energies on site and later turn them back to help the entire process. For example, kitchen waste is used as compost and animal manure is used in the propagation of the soil. A good design will use the natural energies and the ones generated on site to ensure a complete energy cycle. It is also a goal to not only recycle the energy but also to catch, store and use everything before it is degraded and lost.

7. Using and Accelerating natural plant succession to establish favorable sites and soils.
   
   Ecosystems will develop and change over time giving opportunities for other pant and animal species to thrive. Each stage of the succession will create the right conditions for the next stage. Because of this knowledge we can direct and accelerate it to build the needed environment in a shorter time frame. We can do this by using what is already growing, introducing plants that will easily survive, raising organic levels artificially, and substituting our own climax species.

8. Polyculture and diversity of beneficial species for a productive, interactive system.
   
   The idea for this principle is to take plants in their natural habit and group them in a planting system to make the area extremely efficient. This will cause a sum of all the yields to be more productive than a monoculture planting system. The aim should also be to disperse the yields over time in order to have products during every season. Diversity is related to stability in a permaculture design system which results in cooperation of species that do not affect each other. The elements need to be functional connected to result in the highest yield in the least amount of area.

9. Use of Edge and Natural Patterns for Best Effect.
   
   An edge is an interface between two mediums. Such as shoreline and land and water and air. Basically it is where any natural condition or artificial boundaries meet. These edges are where productivity increases because resources from both systems can be used. We can increase complexity by designing and constructing our own varied ecosystems.
Permaculture Concepts

Bill Mollison in his book Introduction to Permaculture gives many examples of how elements can fit together on site to make it most efficient. He mentions a variety of ways to layout a garden space to increase productivity while using the least amount of space possible. Many of the resources and elements are supported by other functions and elements on site, and items are placed where they will be most productive and beneficial. Below are some conceptual ideas of some design criteria.

1. Ideal Planting Layout

According to Bill Mollison, a village layout that locates the most frequently visited elements should be located closest to the place or residence. While the elements that require the least amount to care should be the farthest away. This is true in the Zone Planning Principle. Below is a conceptual sketch of this relationship.

2. Planting Layout

This cross-section shows the relationship that can occur within an adjacent planting community. The plants planted on the mound require less water or moisture than the plants that are planted in or next to the swale. This planting section allows a variety of plants to be planted in the same area even though there are different growth habits and conditions for each. This allows increased diversity among planting combinations.
3. Keyhole Plantings

Keyhole plantings are mulched circles surrounded by bananas or papayas. On the lower plain there is a small plant such as sweet potatoes growing to make effective use of the area. These keyhole plantings accommodate excess water or runoff and are a place where compost can decompose. The result will be nutrient rich soil as well as a fruit production space.

4. Mound and Ridge Planting for Tropical Environments

Because of the abundance of water located on site, there are many alterations that need to happen in order for produce to thrive. Mounded or ridge plantings are successful in this environment because of the water that is shed and kept away from the plant material.
Water resources are important in any sustainable design. When it comes to designing in an ecovillage, two main water techniques are indicated. The first being water harvesting and the second wetland design. The book Rainwater Harvesting by Arnold Pacey and Adrian Cullis stresses the importance of “collecting and conserving water at the earliest stage possible in the hydrologic cycle” (Pacey n.p.). The benefits of early water collection coincide with Nigel Dunnett books Rain Gardens. The publications state that early collection of rainwater reduces soil erosion, decreases pollution, reduces the demand for treated water, and can also be a useful resource for many communities (Pacey n.p., Dunnett 7). They also stress the design phase to be the most important. The design should also contribute environmentally and economically to the space. Rainwater Harvesting addresses practical solutions that can be done by rural communities to use and storage rainwater for their everyday use both large and small scale. The design solutions are very subjective relating to only one particular area. If the conditions of the landscape do not correlate with the book, then many of the solutions have to be reconfigured. It does provide basic solutions for water harvesting problems. See appendix 2 and 3 for additional diagrams relating to water resource development. Rain Gardens looks at water conservation in a completely different aspect. It focuses on using plants to slow down water, to purify water, and to absorb water. The design solutions are related to smaller scale and commercial areas, but can be implemented in a village design.

Wetlands also provide a source of water purification was well as water storage for an area. In the book A Guide to Wetland Functional Design by Anne Marble, she examines the main functions of a wetland into the physical, chemical, and the biological process (Marble 3). Throughout the book, she explains why these functions are valuable to society and how each aspect can be manipulated into a functional wetland design (Marble 5). The book, Constructed Wetlands in the Sustainable Landscape by Craig Campbell and Michael Ogden, focuses mainly on the biological and physical processes but reiterates what Anne Marbles says that site selection and site design are the two critical phases when designing a wetland (Marble 5, Campbell viii). Constructed Wetlands in the Sustainable Landscape goes into more detail about the individual aspects of what is included in a system and how to design for different operations like wastewater treatment (41) and stormwater renovation (123). It states that effective constructed wetlands have the potential to provide an effective, low-cost, natural method of removing pollutants from waste and stormwater that has intriguing aspects such as aesthetic, landscape, and wildlife habitat (Campbell v).

While Constructed Wetlands in the Sustainable Landscape focuses on the design of the whole process, Anne Marble is organized as a conceptual produce manual of ideas not specific to any one location (Marble 5). Both publications provide a great detail of information relating to the function of wetlands, how a wetland works, and how to design an effective constructive wetland that meant the needs of the area.
The Ngöbe Bugle Indian tribe is one of seven indigenous tribes located in Panama. They live in the Northwestern section of Panama in the Bocas del Toro province and the surrounding islands. They are formed by two separate etnik-linguistic groups; the Ngöbe and the Bugle. According to the 2000 Panamanian census, 110,080 Ngöbe Bugle Indians live in Panama making up 63.6% of the national Indian population. They have their own political systems and inhabit the Ngöbe-Bugle Comarca which is a protected area comparable to a reservation.

The women's attire is very colorful with bright gowns with geometric shapes worn throughout the year. During ceremonies, the men will paint their faces with geometric shapes and dress themselves with exotic bird feathers. They retain many of their aboriginal practices. The Ngöbe Bugle original necklaces are called chiquira and are constructed out of color beads and pebbles, seeds and sea shells colored with homemade dyes.

The Ngöbe Bugle live in ‘Chozas’ or thatched huts made of palm leaves and wooden planks for the floors. Most of the huts are elevated to protect from the moisture of the ground and to provide ventilation for the family. They reside in areas which are near rivers or in the valleys. Their diet includes fish, chickens, pigs, cattle, and fruits such as bananas, coconuts, papaya, pineapple, and avocados found in the jungles. Little farming is done because of the poor soils and constant moisture of the ground. If farming is taking place, it is based on slash and burn techniques and they produces corn, cassava, bananas, peach palm, and other fruits. Poor nutrients and the lack of an alternative diet that is more nourishing for the people is one of the main struggles facing the tribe.

Other struggles facing the tribe daily are the distance from needed resources, poor nutrition and medical services, and the lack of education. Over time the tribe has lost many of its traditional means for generating income which in turn has created a harsh environment for the families to raise their children in. It is a constant struggle for the people to try to maintain their traditions as a culture along with their independence while competing and interacting with the developing world surrounding them in order to survive. How can they develop and maintain the services they need to survive while keeping their rich heritage and culture intact? This is an important question that needs to be addressed by the tribe in order to decrease the daily struggles that they have.

The roles of the village are quite different from what many people expect. The main responsibilities for the home and the food fall in the hands of the women. The women are not only expected to raise the children and complete the duties around the house, but they are also expected work in the fields constantly throughout the year to feed the family. The women are basically enslaved to their husbands.

The men do work out in the fields, but not as hard as the women do. They are aloud to have as many wives as necessary to get the work done. They maintain control over the village through dictating what people will do.

The head of a village is the chief who is elected by the people of the village. Both men and women get to express their input on the decision. The chief is the leader of the village and they take that title or job extremely seriously. They are not only responsible for their village, but they also have to communicate and interact with surrounding village leaders to ensure peace and corporation. The chief is also the head of the three member committee that also includes a spokesperson and secretary. Every discussion relating to the village goes through this committee. If someone wants to move in, if projects are to be started, and where a new house is to be built all need to be approved by the committee.

Beyond village leaders there is a Township of Wider Authority. A person from every village has a member who represents that village. These people join together and speak for their village in front of the Panama Government.
SITE INFORMATION

Global Context
Regional Context
Site and the Surroundings
Opportunities and Constraints
Site Description
Clients Objectives
Global Context

The Republic of Panama is the link between North and South America. It is the southernmost country in Central America. It boarders Costa to the north-west and Colombia to the south-east. To the north is the Caribbean Sea and to the south is the Pacific Ocean. It is a relatively small country with the total area being 29,157 square miles with a population of 3,320,000. The country population is divided into nine provinces and five indigenous territories. Panama is the second most industrialized country in Central America and has the third largest economy in Central America.

The Panama economy is mainly service based although the country is largely involved in the exportation of food products. Panama exports a large amount of coffee, bananas, sugarcane, cotton, shrimp, and lobster. Unfortunately, according to the Government of Panama the extreme poverty rate was 16.6% in 2004.
Regional Context

On the western side of Panama facing the Caribbean Sea is the location of the Ngöbe Buglé Indian tribe. The Indian reservation is located off the Bay of Chiriqui in the province of Bocas del Toro adjacent to Costa Rica. Around this very large bay is the area where many small villages are located in the midst of thick jungles. The proposed village of Catavela will be located on the south-east corner of the bay.

Unlike many of the existing villages, Catavela will not be positioned directly on the bay’s coast. The River of Catavela extends from the bay approximately five miles into the thick jungle and mangrove forests. Roughly a mile and a half down the river is the site’s location.
Eco-Region: Isthmian-Atlantic

Panama is located in the Isthmian-Atlantic (NT0129) moist forest Eco-Region of the world. This ecosystem covers the lowland slopes along the Atlantic Ocean. Mainly concentrated in Nicaragua, northern Costa Rica, and most of Panama. Preservation of this eco-region is vital since there is no other place in the world that supports the vast amount of flora and fauna found in the ecosystem.

The biome is characterized by the tropical and subtropical moist broadleaf forest as well as the epitome of wet, jungle located throughout the lowlands of the country. The landscape features constant streams, weathered bedrock, and rounded hills. The abundance of water causes run-off and evaporation. Swamps along the coasts and lowlands are frequent and rivers usually have flood-plains and deltaic deposits. It contains habitats from coastal mangrove forests to swamp forest and even evergreen forests.

The condensation from the warm land and the moisture form the Caribbean Sea collides with the mountains producing high humidity and precipitation. These forests are distinguished from the surrounding ecosystems by the warmer temperature the region receives. The average temperature is around 75°F throughout most of the year. The climate is extremely wet. The rainfall ranges from 100 inches in Panama to well beyond 200 inches in southern Nicaragua.

This eco-region is located at the juncture of Central and South America. It supports a unique combination of flora and fauna coming together form the north and south. It is characterized by lush, tropical evergreen forest of large, buttressed canopy trees reaching around 40 meters high. The vegetation is lush with up to as many as 800 tree species per square kilometer. The shaded forest floor contains little growth and it is rare for direct sunlight to penetrate through the dense tree canopy. Plant species grow rapidly and are many times uninterrupted by outsiders. The rich tropical environment is home to extremely rich flora and fauna found only in this part of the world. Some of the rarest butterfly species and birds species nests in the lowland forests within the eco-region. Along the coast seasonal swamps occur in the lowest and flattest areas where mangrove forests thrive.

Cultivated foods of the area are plantain and banana, cassava, yams, coconut, corn, taro, paddy rice, ducks, pigs, poultry, and fish.

Houses are usually raised, thatched roofs with permeable walls constructed out of local materials.

Health problems related to sewage disposal, insect vectors, and skin fungi are common.

Currently this precious eco-region is in threat of extinction. The lack of protection of the lowlands and forest areas have caused deforestation and fragmentation and elimination of these forests. Many of the gradual slope areas have been converted into small cultivation fields using slash and burn techniques or cattle pasture fields. The remaining forests are under tremendous logging pressure.

Site Information

Site Eco-Region Map
NT129: Isthmian–Atlantic

North-West Section of Panama Eco-Region Map
Natural Environment of the Site

The proposed Village of Catavela is located in the Isthmian-Atlantic Eco-region where climate, soil conditions, and vegetation changes between the lowlands and the high mountain regions. Since Catavela is located inland among the midst of thick jungle adjacent to the Catavela River there is a present dynamic natural environment which resembles the whole eco-region of the area.

1. Climate

Although the Eco-Region averages around 75°F throughout the year, the location of the village will decrease the average temperature slightly. This microclimate is caused by the dense forest surrounding the area as well as the winds which are received from the Bay of Chiriqui and the Catavela River. The continual presence of water in the soil will provide a cooler area surrounding the village.

2. Soils

The combination of water and vegetation will provide a challenge when thinking about the potential for food production. The vegetation uses about 85% of the nutrients from the soils. This intern causes the soils themselves to be infertile. Soils are old and deeply leached and not renewed from glacier deposits. The majority of the site is covered with an extremely dense and saturated clay soil. Because of the abundance of water to the region, much of the nutrients have been depleted resulting in a soil that has a pH of 5.5. The soils tend to erode and leach insoluble oxides or iron and aluminum. There is not an abundance of silica and calcium in the soil. Most of the soils are replaced by acidic elements such as aluminum and iron giving the soil a negative charge. Nutrients will have to come back into the soil in order to make it more productive for food production. Since much of the site was covered with thick, healthy vegetation, certain species of plant thrive in these conditions.

3. Water

Since the site is located adjacent to the Catavela River, which is a tributary to the Bay of Chiriqui, there is an abundance of water. Water plays an important role with the site’s natural environment. The presence of water affects the microclimate of the area as well as the soil conditions on site. The majority of the time, the ground is saturated in many areas. It is hard to find completely dry land on the site. The presence of water is important for the surrounding vegetation. The mangrove habitat depends on the availability of water, and the forest ecosystem thrives from the continual presence of water to gain the needed nutrients.

4. Vegetation

The unique characteristic of the eco-region is the vast amount of diversity among the vegetation. The forest is home to numerous plant and animal species which are only found in this specific area. The layers of the jungle all play an important role in the entire forest ecosystem. Each plant depends on the surroundings for survival. The plant and animal species located on site are consistent to the entire eco-region.

According to Bill Mollison’s book, *Permaculture: A Designer’s Manual*, the following are design essentials for the wet tropical environment such as Panama:

- Clean water sources
- Integrated insect control techniques
- Preservation of natural stands of trees
- Gradual replacement of found crops by trees
- Evolution of natural products
- No-dig (mulch) techniques on root crops
- Hygienic faeces disposal
Site Description

The proposed village is intended to cover an area of four hectares which is approximately 9.88 square miles. The terrain of the area is relatively flat since it is in close proximity to the bay’s edge which is at sea level. An elevation change of no more than twenty feet exists throughout the site.

The flat terrain and the close proximity to the river cause an influx of brackish water into the site. The constant presence of water saturates the soil and keeps it moist throughout the year. The abundance of water has caused the soil to have a high concentration of clay particles which results in an acid soil that has a pH of 5.5. Surrounding the site to the east and west is a low land area that is covered with wetland or marsh conditions. Mangroves and reeds thrive in these conditions. High tide causes the water to proceed adjacent to the existing structure.

To the East of the river, there is currently a thatched roofed house where one family resides. Beyond the house, is a cleared area equivalent to a football field surrounding their house where their eight pigs graze and where the family can have protection from the thick jungle beyond.

The site is covered with an abundance of vegetation. There are many fruit bearing trees surrounding the house and throughout the jungle which the family has depended on for nourishment.

The fruit trees include: coconut, bananas, papaya, mango, and pineapple. A type of yam is also grown wild throughout the jungle. These consist of 90% of the people’s diet. Also into the jungle there is a natural fresh water spring where the family has access to bacteria

| a. | Catavela River |
| b. | High Tidal Overflow |
| c. | Low-land Marsh |
| d. | Existing Thatched House |
| e. | Small Site Clearing |
| f. | Thick Jungle |
| g. | Existing Topography Lines |
| h. | Site Boundary |
Site Opportunities

The projected village location is basically an open slate. There is nothing permanent which is currently on the site that needs to stay with the construction of the new village. Although, it is important that the current jungle ecosystem is kept intact in order to continue to support the wide diversity of flora and fauna that is currently in that region. Since the location of the site is adjacent to the Chiriqui Lake, the topography is relatively flat. This makes for minimal topography changes and adjustments that might have to be made for the proposed design elements to work together. Along with the physical location of the site as well as the geographic location, there is an abundance of water that can be used to water crop production. Unique to the area is a fresh water spring that will be extremely useful for the indigenous people.

Site Constraints

Although there is nothing permanent located on the site, there are still a few challenges that exist. The first one being the constant supply or abundance of water. The ground is always saturated either from the tide coming from the river or the constant presence of rainfall to the area. The heavy rains have caused much of the soil to be leached of the available minerals used for crop production. The presence of the jungle causes many issues like fire hazards, insect and disease transportation, and animal threats.
Client's Objectives

The wishes of the client for the village of Catavela are extremely basic. The client, Juan, has been working with the indigenous Indians of the Bocas del Toro region in Panama for over 15 years. Over the years he has become very familiar with the culture and the people of the area. He has become a voice for the Indians in an effort to get their basic needs met. Juan, who I have talked with and who I am currently working with, is speaking for the Indians of the village. The wants and wishes they have in finding a better way of life.

Juan expressed the desire to provide for the villagers basic needs such as clean, fresh water and an ample amount of food to feed the families of the village. Currently, the people are dying from lack of clean, drinkable water that does not have bacteria and disease throughout it. The water is taken from either a hand dug open pit where animals and insects can freely have access to, or from the river that is contaminated by bodily and animal waste.

The people of the village are lacking in proper diet. Not only do they barely have enough food throughout the year, they do not have a good source of protein in their diet. Most of the food consumed is found in the jungle. It consists of local fruits such as bananas, coconuts, papaya, pineapple, and occasionally avocado. Yams are also harvested in the jungle to eat and small fish are caught in the river and bay. This is their diet all year. A problem also arises near the end of the dry season when the fruit is sparse in the jungle. Juan suggested the possibility of rice production in the wetlands near the edge of the village. His hope is to not only produce enough to sustain the people but also enough to sell to the local villages to increase the revenue of the village. Juan also mentioned the importance of protein in the diet. He expressed the need of raising chickens for the villagers to have not only for the meat but also for the eggs.

Along the lines of providing for the people's basic needs is the need of an alternative to the traditional thatched roof housing structure. Although there are a number of benefits to this form of indigenous house technique, there are a lot of diseases and insects that thrive in this environment. These pathogens are killing a number of children throughout the village. There is a need for a different structure that continues to provide the benefits of the traditional housing, but is healthier for the people of the village. It is also important that the new structure stay within the context of the existing culture and uses the materials in nature. This is important in sustaining the existing culture.

While talking with Juan, he also mentioned the need for the children to be educated. The new village will have a primary school for children to attend. The school building is a standard building provided by the government. It is 60' long by 23' wide and has three classrooms inside. Juan mentioned that the current generation will not change their ways of living. It will be the next generation who is educated that will impact the villagers the most with the knowledge of a better way of living and ideas that can be brought back to the village.

The village of Catavela is located along the river of Catavela. The land beyond the river is very low and is filled with brackish water which is constantly coming onto the shorelines. This causes the soil to be extremely moist and hard for anything to germinate. Juan stated the need of the site to be drained or have a system of canals and trenches throughout it to control the water flow. This will also decrease the amount of insects on the site thus decreasing diseases.

The vision Juan has for the village of Catavela is simply to provide for their basic needs of life. To improve the life that they have is a simple goal and can be done with the design and implantation of permaculture and ecovillage techniques for the a new village.
The Site and the Surroundings
The Site and the Surroundings

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Front Perspective of Site
Problem Statement

How can the ideas, concepts, and design characteristics of an Ecovillage be implemented in a Panama village design while incorporating the ecological aspects of permaculture and water resources to sustain the villagers needs?

Subproblems

1. What are the water resource and agricultural needs of Catavela?
   - What exactly are those needs in regards to size of agriculture land and how much space a water purification system will encompass?
   - What are the needs according to the local in regards to water and water use?

2. What low cost and low maintenance tools and resources are readily available?

3. What is the local perception of community?
Goals and Objectives

As a further description of the problem statement is the goals and objectives stated below. These goals continued to guide the research and design development phase. They are in conjunction with the needs of the village and the program statement.

Goal 1: Ecovillage Design
Provide a sustainable living design that works harmoniously with the natural ecosystem.

Goal 2: Basic Needs
To provide for the daily needs of the villagers to ensure a healthy lifestyle.

1. Objective One: Ecological
   Connecting people to the Earth by integrating a low-impact lifestyle that emphasizes the understanding that all things are interconnected.

2. Objective Two: Social/Economic
   Create a supportive living environment where individuals can thrive and be a vital part in the entire village system.

3. Objective Three: Cultural/Spiritual
   Enhance the lifestyle and the residents’ connection with the surrounding natural environment and their unique belief system.

1. Objective One: Permaculture
   Design an agriculturally productive tropical guild that is harmonious integrated into the existing landscape that will be productive throughout the year providing food, shelter, energy, and other needs of the villagers.

2. Objective Two: Water Storage
   Provide a system of water storage that catches the pure rainwater for future use.

3. Objective Three: Water Purification
   Incorporate purification techniques to the existing landscape in order for disease and bacteria to be less prominent in the area.
Goal 3: Sustained Culture
Enhance the local culture and preserve the indigenous techniques of the village.

1. Objective One: Building Techniques
   Provide a healthier alternative to the current housing while enhancing the benefits of the structure.

2. Objective Two: Education
   Educate the children as well as the adults with important life saving skills that will benefit the village in years to come while keeping their rich culture.

3. Objective Three: Cooperation
   Design a village that is owned and operated by all and displays a sense of pride.

Goal 4: Create Spaces
Design spaces that have distinct purposes and are interconnected with each other by utilizing the natural topography of the land.

1. Objective One: Gathering
   Serve the residents needs by providing an area that is capable of hosting a variety of functions.

2. Objective Two: Living
   Provide a safe and healthy living environment.

3. Objective Three: Food Production
   Provide a year-round crop and animal production that will provide a balanced diet to the villagers.
Program

The program includes a list of the elements that are included in the village design in order to make it successful for Catavea. The following guided the design process and were integrated together in order to result in a sustainable village system.

1. Ecovillage  
Design a new Village of Catavea using ecovillage ideals to design a sustainable village system that conserves the ecosystem while promoting ecological awareness and conservation, social and economic development, and cultural preservation and enhancement.

2. Permaculture  
Design agriculture plots that will allow for increased production and an alternative to the slash-and-burn farming method currently used by the village. The permaculture techniques will be incorporated into the existing landscape providing high productivity with minimal land used in order to preserve the surrounding ecosystem. The following permaculture systems will be incorporated:
- Keyhole Plantings
- Organic Gardening
- Palm Clumps
- Orchard
- Guild Plantings

3. Water Treatment System  
Design a water storage solution for the village that provides clean, bacteria free water year round to the village. The water from rainwater will be harvested and the fresh water spring located on site will need to be the continual source of fresh water to the villagers. A solution for the excess amount of water located on site will need to be designed to control the water continuously coming on site.

4. Agriculture  
Include 1.5 hectares of rice fields production in order to provide for the villagers daily needs while supplying excess to sell to surrounding villages to gain revenue for the village. Multiple agriculture fields that provide a variety of foods sources as well as providing a balanced diet throughout the year need to be included to sustain the villagers needs.

5. School  
A school will be built on site that will teach primary to 4th grade. The school will extend beyond Catavea and provide education to children from the surrounding villages. The school building will be divided into three classrooms with a total dimension of 60’x 23’ for the entire structure.

6. Housing  
The village will start with the building of ten housing structures made from wooden planks and a tin roof. These materials will provided a safe environment for family to live in that are free from disease and bacteria commonly found in the roofing systems. The houses will have a total dimension of 33’x17’ including a 5’ wide porch.

7. Clinic  
A clinic will be built on site to provide medical care and assistance to Catavea and the surrounding villages.
The idea behind this concept is to take one of Bill Mollison’s permaculture principles and see how it applies in the site location. Mollison uses zone planning as a means of placing elements according to how much they will be used on a daily basis. The elements that need frequent maintenance or visits will be closest to the residence while the lower maintenance items will be further away. This method is used to reduce energy being used by the village people.

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<th>Goals</th>
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**Strengths**
- Condensed Organization and layout
- Minimal ecological footprint
- Promotes community gathering and
- Interaction with Permaculture techniques

**Weaknesses**
- Does not follow cultural layout
- Drainage pattern
- Where to expand?
- Accessibility
This concept is based on the idea of connecting people with the agriculture production fields. It almost results in a forced connection between the two elements. The linear pattern that is created is not characteristic of the traditional layout of a village. It is important to keep the culture intact. Although this concept results in a great connection with agriculture and people it lacks in overall connections and accessibility.

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**Strengths**
- Promotes community gathering and interaction
- Forces interaction with agriculture
- Area to expand

**Weaknesses**
- Animal Separation from housing
- Loosely interaction of site as whole
- Drainage pattern
- Not characteristic of other native village layout
- Not a good use of space
The final plan brings together the program elements into a sustainable land conservation village design. The design takes the ideas of Mollison’s zonal energy efficient layout to work with the land to provide for the needs of the villagers.

An important consideration for the layout is that it considers the cultural village layout, where everyone has their own space. Since the housing units being angled, it increases the amount of privacy the residents will have.

The concentrated area which includes the school and clinic are located next to the river for accessibility for the surrounding villages. As the village progresses further down the main access, the central concentration of housing units are places. For energy efficiency, the units are in the midst of the agricultural production systems. This gives convenience the residents when it comes to harvesting and managing the crops.

As the village progresses to the North, East, and West, the planting gradually progress into a more natural guild replication of the natural forest beyond. This will decrease the amount of forest needed to be cut down.

The chickens and pigs are located beyond the housing units to separate the insects and waste that might affect the villagers. This makes for a cleaner living environment for the villagers.

This layout promotes community gathering and interaction among the villagers. If the village were to increase in size beyond the size shown, there is plenty of space to expand the village. The people and the agriculture fields are integrated together for convenient accessibility.

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Seasonal Crop Enlargement and details
Palm Clump Enlargement and details
Orchard Enlargement and details
a. Rice Fields
b. Housing Units with Water Harvesting
c. Village Clinic
d. Row Crops
e. Seasonal Crops with Chicken Interaction
f. Crop Drainage Ways
g. Chicken House with Water Harvesting
h. Keyhole Plantings
i. Catavela River
The seasonal crop enlargement plan shows the relationship between the people and the surrounding plantings. This area requires less maintenance than the row crops and thus is placed further away from the main axis or community gathering area. It is located behind the housing units, for when the crops need to be harvested and planted, it is easily accessible. The seasonal crop area is used by the chickens as well. The chickens eat the excess foliage and control the pest and insects surrounding the crops. (Further explanation to follow)

The section below shows the relationship of the housing units to the row crops and seasonal crops. Both plantings are easily accessible to the residents for maintenance and produce gathering.

A list of plants that could be included in this area are:

- Cassava
- Taro
- Winged Bean
- Pigeon Pea
- Banana
- Passion Fruit
- Quava

(See Appendix B for a detailed description)
Keyhole Plantings Section

The section below is taking a closer look at how the Keyhole plantings from Bill Mollison are integrated into the village design layout. These areas will be used as a high production area with bananas, papaya, or palm trees. The middle will be used as an organic waste compost where food scraps can go, or excess foliage from the plant material. This will decompose and then be used as mulch or soil for the production fields. This area also forms a natural boundary of protection from the natural forest beyond.

Seasonal Plantings with Chicken Grazing
Compost for Organic Waste.
Chicken Tractor System

Purpose

The purpose of a chicken tractor besides providing eggs, meat, manure, is that they also eat insects, greens, and fallen fruit. If confined to a space, they can scratch clean an area to free it of insects and invasive weeds.

The chicken forage system is designed for chickens to take care of themselves. They can range and feed on the “waste” laying in the fields in order to help clean it for the next harvest.

How it works

Chicken are introduced to an enclosed area after harvest and before re-planting occurs. When that area is cleaned of its excess and unwanted material and the soil tilled from the chicken tracks, the chickens will be moved to the next field to do the same thing. While they are in field two, field one will be planted. This process will continue until the chickens get back to field one. By that time, field one will be harvested and ready for the chickens to ‘clean up’ again. This technique utilizes the chickens natural functions and uses them for energy efficient planting techniques that require little interaction by the village residents.

Basic matrix showing the Chicken Tractor Process
a. Rice Fields
b. Housing Units with Water Harvesting
c. Village School
d. Row Crops
e. Palm Clump Plantings
Row Crop Planting Section

The section below shows how the annual plantings relate to each other. The planting beds are mounded to shed excess water from the plants. It is easy to access because of the close proximity to the housing units.

A list of plants that could be included in this area are:
- Winged beans
- Sunn Hemp
- Picky Pear
- Rosella
- Pineapple
- Taro
- Yams
(See Appendix B for a detailed description)
Palm Clump Diagram

The idea behind a palm clump planting is to provide sun and shade for plant material. This will increase the variety of plants that can be planted in the area because of the different conditions which are formed. The plantings are low maintenance where the only work the villagers will have to do is to harvest the fruits and vegetables. In order for the area to be extremely effective, the plants should be chosen to complement each other. If one plants take away the nitration in the soil, another one should refurbish it.
a. Orchard Plantings
b. Row Crops
c. Pig Barn with Water Harvesting
d. Housing Units with Water Harvesting
The orchard plantings are located the furthest away from the main community gathering space of the village. As the village progresses away from this area, the plantings begin to reflect the natural forest beyond. The layers of the forest are mimicked through the planting design of highly productive fruit trees and shrubs.

This area is also where the pigs will be living. The pigs will perform the same functions as the chickens did in the seasonal planting area. The pigs will eat weeds and small unwanted shrubs of the area. They will dig up roots and aerate the soil for the surrounding vegetation. It will be important to have this area established before the pigs are introduced. Otherwise, the pigs will destroy the plant material.

A list of plants that could be included in this area are:

- Arracacha
- Pigeon Pea
- Leucaena
- Bamboo
- Palms
- Citrus
- Papaya

(See Appendix B for a detailed description)
Orchard Planting Relation to Natural Forest

Original Forest Layers

Emergent Layer

Papaya Trees

Canopy Layer

Palms Trees

Understory

Banana Trees

Lencera

Modified Production Layers

Forest Floor

Water Source

Hog Barn

Site Details
Orchard Section
Phase and Drainage Diagram

Village Phase Diagram

The site will be constructed in three different phases. When speaking with the village leader, he mentioned how the village would start with ten houses and a school. In order to support the residents, a rice field will be in production as well as the beginning stages of the row crops, seasonal plants, and palm clumps. Around 50 chickens will also provide for the people of the village at this time.

As families gradually begin to come to the village, more forest will be cleared and housing units will be added. The planting of crops and the addition of animals will progress as the village grows as well. Pigs will be introduced and the second rice field will be added.

The important factor is that no matter what stage the village is progressing towards, there should enough animals and crops produced to support the villagers as well as provide an ample amount to sell to the surrounding villages.

Site Drainage Diagram

The objective of the site design is to lead the water away from the housing units in order to control the amount of insects and diseases that could be spread. The water from the site will be guided through drainage canals in the planting fields into the rice fields where excess water is welcomed. From there it will flow into the Catavela River.

Since the site has an abundance of water and the ground is continually saturated, it will be important to control the water flow and direct it away from the housing units and the crops. As the water flows, the plants will consume what they need and control erosion and capture the mineral from the soil.
How does everything work together? How does one element relate to another? These are important questions that are at the heart of an Ecovillage design and are vital to the success of Catavela. Below is a simple diagram that skims the surface of how elements of the village are interconnected and how everything plays off of something else. It is interesting to see how one element such as rice can bring much back to the village. The results can support the village not only in the way of nutrition, but it can provide a healthier living environment for the villagers.

Every element should benefit from another as well as support it. For example, the excess green from vegetables and become food for the pigs or it can go into the compost to increase the nutrients in the soil. Everything needs to work together in order for the village to be successful. It isn't until this is accomplished that the village will not be 100% sustainable and self-reliable.

Basic matrix showing the effects of growing rice for the Village

- **Rice**
  - Sell
(  - Money for Catavela

- **Village Needs**
  - Education
    - School
      - Educated
      - Children
      - Jobs
  - Clean water
    - Water Purification System
      - Decreased Bacteria and Diseases
  - Food
    - Seeds
      - Fruit and Vegetables
    - Balanced Diet
      - Protein
      - Nutrients
      - Increased Health
  - Medical Supplies
    - Decrease Malaria
    - Decrease Diseases
SUSTAINABLE ALTERNATIVES

Alternative Housing
Roofing Diagrams
Waste Water Management
Energy Collection
Currently the thatched housing structures that the villagers are living in currently are not bacteria and disease free. The thatch roof is a breeding ground for bacteria that thrive in moist humid conditions that is provided for them through the layers of palms insulating the house. The bacteria and insects drop from the roof and bore into the skin of the children and adults underneath which unfortunately can cause death to the individual.

Below is a basic, conceptual alternative to a structure that would provide the same benefits as the thatched houses does, such as ventilation, insulation, protection, but be safer for the family below.

This housing unit would have permeable sides or an abundance of windows to ventilate the house from the hot summer temperatures. There would also be roof ventilation where the humid air can raise and escape from the house and a greenroof system that would insulate the house and reflect the direct sunlight.
Alternative Roofing Diagrams

Greenroof System

A greenroof system could be designed to fit the structure. This will not only insulate the unit, but it will also act as a cooling system by reflecting the direct sun rays from penetrating inside the structure. Since the Eco-Region receives an abundance of rainfall, this system could control the amount of runoff coming from the housing units. This water could also be harvested for later use.

There would be accentually two roofs on the structure. This will provide maximum ventilation for the house. The air will be able to flow through the two panes and then out the top of the structure to cool the structure. Warm air should not be trapped in the structure.

Greenroof System with Solar Collectors

Since this area receives constant solar radiation, the roof would be a good place to harvest that energy. This energy harvested from the roof tops, could then intern be used for the housing unit below. A greenroof system and the roof structure would still provide all the benefits previously stated. This would be a great way for the village to collect a form of energy that could be used to benefit the daily lives of the villagers.
Currently the surrounding villages of the area have no designated place to go to the restroom. The majority of the waste is placed directly into the river polluting the water and making it unhealthy for the villagers to swim or to fish in. The river and the water ways are extremely important to the people and finding a different alternative where as the river is not polluted is something that needs to be addressed.

**Process**

Below is a diagram that considers the waste and the products it has and clean is accordingly. If the waste is concealed to one location, the liquid waste could be directly transferred into a natural reed bed filtration area. This step would naturally clean the waste through infiltration into the soil. The plant material would also absorb and use to their benefit the bacteria found in the waste. From there the water would be gradually transferred into a wetland settling where bacteria, fish, algae would continue the natural cleaning process. Eventually the water would be released into the river. The result would be clean, bacteria free water entering the water systems.

The solid waste could be collected and used as a fertilizer for the vegetation of the village.

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**Sustainable Alternatives**

*Human Waste Treatment Diagram*
Animal Waste Energy Production

Not only are pigs a source of food and protein, but their waste can also be a value to the village. The pigs waste can become a sustainable source of energy. The current villages lack the ability to harvest energy. Pigs can solve that problem. The villagers can train the pigs to relief themselves in a certain area where the process will be started.

Process

The process starts with the collection of the pigs waste. The gasses, methane, that are excreted will be captured and flow into a large collection ‘balloon.’ When there is enough methane to cause the ‘balloon’ to rise in the collection area, the energy can be harvested to be used by the people of the village. This source of energy could be an inexpensive sustainable energy alternative for the village.

The solid waste that does not flow into the methane collector will progress into the filtration process. It will flow through reed beds and other filtration systems until it progresses into the river as a bacteria free source of water. The solid waste could be used to spread on crops as a fertilizer agent.
Works Cited


Dimensions of Ecovillages

Social-Economic
- Healthy Lifestyle
- Preventive Healthcare
- Complementary Medicine
- Building Community
- Decision-Making
- Conflict Resolution
- Modernizing Welfare
- Care of children & elderly
- Integration of Handicapped
- Localizing Economics
- Complementary Currencies
- Green Business
- Life cycle Analyses
- Ecological Building
- Renewable Energy
- Local Water Care
- Local Organic Food
- Production, Consumption and Recirculation
- Education & Communication
- Living and Learning
- Creativity, Personal Unfolding
- Spirituality
- Finding Divinity within
- Unity with Nature
- Celebrating Life
- Honoring Cultures
- Natural Cycles
- Holistic Circulatory Worldview, Science and Philosophy
- Localization, Bioregions
- Resisting Globalization
- Permaculture
- Ecovillage Design
- Wilderness, Biodiversity
- Earth Restoration

Cultural-Spiritual
- Creativity, Personal Unfolding
- Spirituality
- Finding Divinity within
- Unity with Nature
- Celebrating Life
- Honoring Cultures
- Natural Cycles
- Holistic Circulatory Worldview, Science and Philosophy
- Localization, Bioregions
- Resisting Globalization
- Permaculture
- Ecovillage Design
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- Earth Restoration

Ecological

Appendix B Dimensions of Ecovillages

Efficient Energy Planning

Zonal Planning

Sector Planning
Tropical Plant List

1. Plants with Tubers, Shoots, and Roots
   
   **Arracacha (Arracacha xanthorrhiza)**
   Excellent understory crop; herbaceous perennial

   **Cassava (Manihot esculenta)**
   Has starchy tubers; grows in nutrient-poor soils; used as a flour source.

   **Yam Beans (Pachyrhizus erosus)**
   Herbaceous, viney plant growing up to 6 meters long; tubers widely eaten; old starchy tubers can be used to feed cattle.

   **Taro (Colocasia esculenta)**
   Can be grown in wetland environments; can be used as mulch; grown to eat the roots

2. Animal Forages and Feed Plants
   
   **Winged Bean (Psophocarpus tetragonolobus)**
   Viney plant growing as long as 3 meters; good source of protein; Seeds contain oils, soil conditioner, nitrogen fixer in soil.

   **Pigeon Pea (Cajanus cajan)**
   Woody shrub, perennial, foliage for animals, leaves can be used as mulch; good plant to use as a windbreak.

   **Leucaena (Leucaena leucocephala)**
   Tropical tree reaching the height of 20 meters; prefers well drained soils; great plant to use as erosion control.

3. Pest Control
   
   **Sunn hemp (Crotalaria juncea)**
   Tall shrubby annual reaching the height of 3 meters; fibers can be used as twine; control insects such as nematodes in soil; can be used as mulch; vigorous grass weed; don’t sow thickly.

4. Other Tropical Plants
   
   **Bamboo**
   Can be used as food; animal forage; structural; mulch; windbreak

   **Passion Fruit**
   Evergreen perennial; climbable; poultry and pig fodder; used to cover water tank and structures to block direct heat.

   **Prickly Pear**
   Likes full sun; grows 2 meters; grows in poor soils; can be invasive

   **Guava**
   Great source of vitamin C; shrub or small tree that could grow up to 10 meters

   **Natal Plum**
   Thorny evergreen that grows around 2 meters

   **Citrus**
   Good source of vitamin C, Evergreen trees or shrubs that could grow up to 10 meters

   **Rosella**
   Fast growing annual shrub that reaches 1.5 to 2 meters; like well drained soils

   **Ginger**
   Herbaceous perennial that grows around 90 cm; it is easy to propagate and prefers partial shaded areas; can be interplanted.