Tierra Despierta: A Social and Physical Study of the Agriculture Land in Santa Cruz, Galapagos, Ecuador

A Field Practicum Report submitted in partial fulfillment of the requirements for a Master of Sustainable Development Practice Degree

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I. Acknowledgement

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I could not have imagined having a better committee, work or classmates. This quest has allowed me to tap into my strengths and discover the importance of landscape architecture and planning in developing countries.

I am determined to follow my passion to foster leadership, work with under-represented communities, and use land planning to create nature- and culture-conscious design and programs that will foster education.
II. **Abstract**

The question being addressed in this field practicum is: Can farming and conservation of land co-exist in the agricultural area of the island of Santa Cruz, Galapagos, Ecuador? This project combines the application of landscape architecture, land planning and design practices with the use of socio-economic data to help develop recommendation strategies that protect natural resources within the agriculture hub and the adjacent areas to Galapagos National Park (G.N.P). Working with a Non-Governmental Organization (NGO), this practicum addresses social (research, interviews & surveys) and physical (landscape architectural land planning and design) aspects in order to develop long-term sustainable conservation strategies for farming in Santa Cruz adjacent to protected lands. The results from the social aspects include an analytical document providing a synthesis of key socio-economic data including: demographic information, education, nutrition, food security, health, water, soils, economics, and energy use. From the physical aspects, illustrative graphics delineate recommendations for the agriculture buffer lands and will include proposed measures for enhancing resource protection. The recommendation drawings, or design guidelines, offer farmers strategies to reduce impacts to adjacent conservation areas.
III. Contextual Information

a. History

Human history in the Galapagos dates back to 470 years ago. According to archives, the world first knew about the existence of the archipelago by the writings of the Dominican friar, Bishop of Panama Fray Tomás de Berlanga, who officially discovered the group of Islands on March 10, 1535. Bishop Berlanga was sailing to Peru from Panama, but oceanic currents drove his boat towards the Galapagos. His accounts narrate the magnificent nature of the giant tortoises, unique flora, such as cacti, the harsh unreceptive terrain, and the difficulty in finding fresh water for drinking. Once the first populations settled the island of Santa Cruz in 1925, and before tourism, the populace lived as a subsistence economy; agriculture provided basic food and fish were abundant.

With the arrival of tourism more financial capital circulated and the population grew, which included not only tourists, but also migrants from mainland Ecuador. Therefore, food could no longer be sufficient to fulfill subsistence needs and importations from the continent to the island. (History | Galapagos Conservancy, 2013).

The flora and fauna of the Galapagos have their own history. About ten million years ago, the top of underwater volcanoes formed landmasses now known as the Galapagos Islands. It took many decades for plants and animals to start living in this arid region of the world. Most of the native plants came to the Galapagos through long distance seed dispersal, and while ferns and grasses abound, flowering plants are scarce. The salt-tolerant seeds of coastal plants, such as mangroves and saltbushes, may have arrived on the islands by ocean currents. There are also many wind-pollinated plants in the islands (History | Galapagos Conservancy, 2013). The fauna of the Galapagos is unique to the region, with many species of reptiles found throughout the islands but no amphibians; the islands are home to several species of land and sea birds but comparatively few species of mammals. Similar to seed dispersal in plants, many animal species came to the Galapagos by wind or sea (History | Galapagos Conservancy, 2013).
b. Location of the project

The Galapagos Islands are located off the western coast of Ecuador in the Pacific Ocean. They are classified as a World Heritage site by the United Nations Educational, Scientific, and Cultural Organization (UNESCO). The Galapagos Islands and its immediate waters form an Ecuadorian province, a national park, and a biological marine reserve. The main language on the islands is Spanish. The archipelago is composed of 13 main islands, 3 smaller islands, and 107 rocks and islets. The Galapagos Islands are known worldwide for the discoveries of Charles Darwin, and are home to unique animal and plant species. The whole archipelago originated from the uplifting and eruption of volcanoes (Galapagos Islands – UNESCO, 2013).

There are about 25,000 inhabitants in the Archipelago of Galapagos, most of them situated in the islands of Isabela, Santa Cruz, San Cristobal and Floreana. Santa Cruz, located in the center of the archipelago, is the second largest island, having an area of 986 square kilometers (381 sq. miles) and a maximum altitude of 864 meters (2,835 ft.). The island is home to approximately 15,000 inhabitants and contains the most populated urban city in the archipelago, Puerto Ayora. The Charles Darwin Research Station and the headquarters of the Galápagos National Park Service are located in Puerto Ayora and in the outskirts of the city there are agricultural and cattle raising villages. Santa Cruz is the only island with road access to its interior, therefore providing locals and tourists a rare opportunity to navigate across the island and see the magnificent flora and fauna. It is estimated that 11,432 hectares, 11.60% of the island territory, are devoted to agriculture. The agricultural area has a hemispherical outline whose extent is about 20 km long from east to west and 5-7 km wide from north to south. It is located between 100 meters to its southern boundary and 520 meters to the Gemelos craters. The altitudinal gradient opens potentials for crop diversification. However, in the lower parts towards Bellavista, most of the land is dedicated to urban growth (Santa Cruz 2013).
c. Overview of socio economic and environmental factors

Santa Cruz is a shield volcano, located in the center of the Galapagos archipelago. It is the hub of human activity in the Galapagos. The south side of the island is home to the National Park Headquarters, the Darwin Research Station, and Puerto Ayora (the largest settlement in the Galapagos) (Santa Cruz 2013). The main industry of the area is eco-tourism.

Disclaimer: Before arriving to the field. There was a lack of contextual information, particularly for the agriculture area of the island of Santa Cruz. Therefore, one of the objectives for this field practicum became the consolidation of key socio economic factors for the area.

d. Current Issues

Environmental concerns: Human activity has drastically changed the Galapagos Islands ecosystems, especially within the occupied regions of Floreana, Santa Cruz, San Cristobal, Baltra, Isabela, Española, Santiago, Pinta, and Pinzon. Through hunting and other exploitative activities, animals such as whales, fur seals, giant tortoises, grouper, lobsters and sea cucumbers have suffered significant population losses. In addition to endangering animal populations through hunting, humans have introduced over 500 foreign insect species to the islands through the transport of wood, fruits, vegetables and other organic material. Fire ants and wasps have become a major threat to the microenvironment of the islands; they are altering the pollination cycle, and attack different animal species. Furthermore, the number of introduced species in Galapagos continues to increase, with many of these species impacting the native ecosystems. A total of 36 vertebrates have been recorded as introduced species, with mammals such as goats, pigs, dogs, cats, and rats being considered the most hazardous. (History | Galapagos Conservancy, 2013).

With regards to water, the islanders in Santa Cruz buy potable water from small companies that use desalination plants, while water for non-portable uses comes from different sources. In Santa Cruz, brackish water (a mixture of rain water and sea water) is found in crevices near the coast; this is the main source of water for the town
of Puerto Ayora. However, the growing demand and rapidly growing population is putting increasing pressure on this vital resource. Furthermore, due to leakage from domestic use, waste water is mixed with water from the crevices, causing health risks to the public (Dirección, 2013).

Social concerns: The local population depends on imported foods which come over on ships from mainland Ecuador, in precarious condition, posing a health threat to the inhabitants, and allowing the introduction of invasive flora and fauna species. Mass tourism is growing faster than improvements in food production or water protection can keep up with. There are an increasing number of illegal immigrants from mainland Ecuador augmenting the need for drastic migration control and implementation to guarantee a sustainable livelihood for the residents, visitors, and farmers (Dirección del Parque Nacional Galápagos, 2013).

Agricultural concerns: Farmers face low profitability of their farms, characterized mainly by the following aspects: lack of organization of farmers to plan production; lack of a regulatory system to control food and prices that are imported from the mainland; poor marketing system; lack of water for irrigation in large areas during dry season; low production and productivity levels of local agricultural crops; and presence of pests and diseases in crops (Plan de Desarrollo y Ordenamiento Territorial del Canton Santa Cruz, 2012-2027).

IV. Background information on the host organization

Ecuador Tierra Viva (ETV) is a non-profit organization whose aim is to “improve the quality of life of Ecuador’s neediest communities through provision or improvement of water, health and education services” (Vivanco, 2013). The foundation has an array of different projects throughout the country of Ecuador and collaborates with other institutions within the Galapagos to protect the fragile ecosystems of the islands through active educational endeavors. In this way, Ecuador Tierra Viva contributes to the community
development of the Galapagos in social, cultural, and economic aspects to improve the quality of life. ETV’s goal is to provide consultation for conservation authorities, education, and social services in order to achieve their objectives, which combine concerns for the ecological balance of the Galapagos Islands with the social welfare of its inhabitants. An overall aim is to extend successful strategies to other similar populated islands in the archipelago (Vivanco, 2013).

V. Conceptual Framework

As noted previously, Ecuador Tierra Viva aims to improve the quality of life of the Ecuador’s neediest communities through the “provision of improved water, health and educational services” (Vivanco, 2013). This field practicum aims to support that goal by gathering socio-economic data about Santa Cruz and the agricultural sector in particular to develop strategies to enhance the sustainability of the farmers’ livelihood and by enhancing the agricultural buffer lands to help protect the resources of the Galapagos National Park.

The collection and analysis of the field data will provide Ecuador Tierra Viva with a strong foundation for future funding and programming to improve the livelihoods of the farmers in the island of Santa Cruz.

On the Island of Santa Cruz, seasonal products can only be harvested during a specific time in the year. Seasonality does not limit the volume of production, but rather its continuity throughout the year. Samples of seasonal products are plantains, bananas, cabbage, cauliflower, broccoli, cucumber, lettuce, tomato, pepper, orange, lemon, melon, pineapple, and papaya. When not locally available, these crops are imported from the mainland. Labor-intensive means that crops such as beans, peas, onion and carrots, due to high costs in labor and machinery, are more costly to produce in the island. Therefore, it is cheaper to import them. (Gobierno Autonomo Decentralizado Muncipal de Santa Cruz, 2012).
SOCIAL
(Interviews, research, surveys)

Government and community input

Compile socio-economic data

PHYSICAL
(Landscape architecture and planning)

Site inventory, analysis, and synthesis

Create a master plan for agricultural buffer land and recommendation drawings with guidelines that offer farmers strategies to reduce impacts on adjacent conservation areas.

With the practicum deliverables, ETV will create future programs to improve livelihoods and conserve agricultural buffer zones

Ecuador Tierra Viva
“Improve the quality of life of the neediest communities by providing water, health and educational services”

Question that the field practicum strives to address:
Can conservation land and farmland coexist in the island of Santa Cruz?
### VI. Objectives

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<th>PROJECTED RESULTS</th>
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<tr>
<td>Enhanced understanding of socio-economic information on the Island of Santa Cruz and the agricultural sector to be used by the nonprofit organization as baseline data for present and future projects seeking to enhance natural resources protection and farmers livelihoods</td>
<td>The NGO currently does not have any base data. What are the key socio-economic factors from the agricultural sector?</td>
<td>Compile data from governmental institutions through data collection and informal interviews: Municipio de Santa Cruz; Secretaria Técnica de Desarrollo Sostenible, Departamento de Planificación Urbana y Rural de Santa Cruz.</td>
<td>Analyze information and prepare a synthesis of the major findings, including tables of the findings.</td>
<td>Analytical document provides a synthesis of key socio-economic data including: demographic education, nutrition, food security, health, water, soils, economic and energy resources. To be used by the NGO for present and future endeavors.</td>
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<td>Assess the agricultural buffer lands of the Galapagos National Park (G.N.P.) and determine their potential to help protect the natural resources of the Park.</td>
<td>What measures might be taken in agricultural buffer lands to enhance the effectiveness of conservation, to protect natural resources?</td>
<td>Site inventory of hydrology, soils, vegetation, wildlife, erosion potential, forestry and agricultural systems.</td>
<td>Analyze site inventory information. Use this data to identify measures to enhance conservation, protection. Opportunities and constraints within the agricultural buffer will be developed.</td>
<td>Illustrative plans delineating practices for the agriculture buffer lands. Recommended drawings offer guidelines to farmers to reduce the impacts on adjacent conservation areas.</td>
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VII. Methods utilized

The following diagram illustrates how the methods were linked during the field practicum. Procedures used to conduct these methods are described in the following sections:

Compile information from governmental institutions through data collection and informal interviews.

Inventory hydrology, soils, vegetation, wildlife, erosion potential, forestry, and agricultural systems OF THE SITE.

a. Informal Interviews

The informal interviewing and research process utilized was adapted from the Qualitative Research Guidelines Project by Cohen and Crabtree (2009). The informal interviews took place within the different governmental institutions, including Municipio de Santa Cruz (Santa Cruz Municipality), Secretaria Tecnica de Desarrollo Sostenible (Technical secretary for sustainable development) and Departamento de Planificacion Urbana y Rural de Santa Cruz (Urban and Rural Planning Department in Santa Cruz). The reason for utilizing “informal interviews” was to encourage open dialogue with the organizations being consulted. An additional advantage was that these interviews did not require the scheduling of formal meetings. Consequently it worked well with busy governmental agencies, and facilitated bureaucratic procedures required to secure key data. As a researcher, information was recorded in personal notes and memory. While in the field as an observer, informal interviews were carried out in an unpremeditated fashion. These informal interviews were particularly important during the initial stages of the study, since literature characterizing the local situation was quite scarce. Informal interviews were also used to draw attention to innovative topics of importance that may have been unnoticed by prior studies (Cohen and Crabtree, 2006).
b. Surveys

The survey was carried out to determine the community’s perception about the current state of the farms in the agricultural area of Santa Cruz. The target group was 100 individuals, male and female older than 18 years old that either worked, lived, or both in the Agricultural hub of Bellavista. As noted in Kelley et al. (2003), surveys are typically carried out using a questionnaire or interview. The surveys were intended to take a snapshot of how things were at a specific moment in time. The survey was carried out face-to-face, which required that respondents be approached individually, either in the street or by networking through a local person. A series of questions were posed to each respondent and their answers were recorded. Face-to-face interviews were a more expensive and laborious method than postal surveys; however, for Bellavista it was the right approach for the community and local context as people are more relational and the postal service is not efficient (Kelley et al, 2003). Moreover, convenience sampling was engaged which permitted the deliverables to include a sample population selected because it was readily available and convenient at hand. It was also highly suggested by the non-profit organization to conduct them this way. Convenience sample is a non-probability sampling method where subjects are chosen due to their convenient accessibility and proximity to the researcher. I used this sampling technique because it is fast, inexpensive, easy and the subjects are readily available. The disadvantage from this technique is that it does not provide a sample of the entire population (Convenience Sampling, 2013).

c. Land Planning

According to the Site planning and design handbook (Russ 2009), most national decrees necessitate that zoning regulations be established and employed in harmony with a comprehensive land use plan, oftentimes known as a "general plan" or "master plan." Characteristically, a comprehensive plan embodies an expression of an agreed upon vision for the future development of a municipality. Comprehensive plan frequently report topics significant to future growth through components regarding housing, public infrastructure necessities, recreational facilities, transportation, economic progress, open space, and agriculture. Furthermore, they should
ensure that sustainable site planning limits the impact of
development on native ecosystems (Russ, 2009). The land planning
exercise encompassed the whole agricultural area in the area of
Santa Cruz, with the aim of delineating the agriculture buffer lands
and proposing measures for enhancing resource protection.

i. Site Analysis and Synthesis

In the field of landscape architecture, site analysis is a process that
includes a complete inventory of physical data, analysis of this data,
and a synthesis of all the analyzed data to determine the
opportunities and constraints for land to be used for agricultural,
buffer or urbanized uses. (Contents - Site Planning and Design,
2013). This site analysis process provides a “reading of the land” to
make informed decisions as a basis for the master plans and detailed
conceptual designs. (Analysis and Site Reconnaissance, 2013).

An inventory, analysis and synthesis were conducted of the
agricultural areas in order to determine the opportunities and
constraints of these lands to function as buffer zones for protected
areas of the island. The process began by documenting the physical
characteristics of the agricultural areas including the topography,
soils, hydrology, vegetation, and infrastructure such as building,
roads and utilities (Russ, 2009). These features were analyzed
individually and then synthesized with the analysis of all the other
features to determine the overall opportunities and constraints of the
farmland to function as buffer lands.

The inventory maps were obtained from different stakeholders,
including Municipio de Santa Cruz (Santa Cruz Municipality),
Secretaría Técnica de Desarrollo Sostenible (Technical Secretariat
for Sustainable Development), and Departamento de Planificación
Urbana y Rural de Santa Cruz (Urban and Rural Planning Department
in Santa Cruz). The information, maps and data were compiled to
later be used in analysis and synthesis.

ii. Conceptual Master Plan
Based on the opportunities and constraints information, the master plan was responsive to the characteristics of the land, the needs of the farmers to maintain viable farming practices and the requirements of an adequate buffer zone to protect the resources of the protected areas. Additionally, detailed designs were developed that helped to illustrate the intent of the master plan for more sustainable farm practices and the use of agricultural lands as buffer zones.

VIII. Analysis, deliverables and discussion

a. Informal Interviews

Informal interviews were conducted to find out preliminary information about the current situation of the agricultural lands. Ecuador Tierra Viva guided me to the respondents from the different government institutions including Municipio de Santa Cruz, Secretaria Técnica de Desarrollo Sostenible, Departamento de Planificación Urbana y Rural de Santa Cruz, and informally people were encouraged to reveal what they felt about the agricultural land. Such interviews were entirely informal and were not measured by a specific set of meticulous questions, but in the process a hypothesis was elaborated: Most of the agricultural land in the Island of Santa Cruz has not been used to its maximum potential; farmers might not be using strategies to protect the conservation zones and people prefer to work in the tourism hubs of Puerto Ayora for it brings more revenue to the households. The informal interviews also provided an ample access to the socio economic data of the island. Therefore, this addressed the first objective of the practicum: Enhanced understanding of socio-economic information on the Island of Santa Cruz and the agricultural sector to be used by the nonprofit organization as baseline data for present and future projects seeking to enhance natural resources protection and farmers livelihoods.

From the analytical document found in Appendix A, which provides an in depth synthesis of key socio-economic data including: demographic education, nutrition, food security, health, water, soils, economical and energy resources. The data is relevant and useful for the illustrative plans delineating practices for the agriculture buffer lands. And the recommendation drawings that offer guidelines to
farmers to reduce the impacts on adjacent conservation areas, constitutes the following:

The degree of urban concentration of Puerto Ayora is the highest in the region with 11,974 people, and accounts for 47.66% and 77.8% within the canton. Most of the population is concentrated between 25 to 29 years old for both men and women. The two rural parishes have a regional concentration of 3.96% in Santa Rosa (994 inhabitants) and 9.65% in Bellavista (2,425 inhabitants), which translates cantonal level at 6.45% and 15.75% respectively. Furthermore, in Santa Cruz there has been an annual incremental growth of 3.5% (Gobierno Autonómico Decentralizado Municipal de Santa Cruz, 2012).

The main agricultural hub is the town of Bellavista. The pH level of Bellavista's soil ranges from very acidic levels to acid neutral levels. In the rural area, the pH levels range between 5 and 6. Most of the soil that is used for agricultural purposes is free from vegetative invasive species. The soil and vegetation dramatically changes in the highland area, where the soil is not arid and is able to produce verdant vegetation (Dirección del Parque Nacional Galápagos, 20).

About 90% of the introduced species of flora have been brought by humans for ornamental or agricultural use. The vehicle for many of these invasive flora and fauna species is imported food, on which the human population in the Galapagos is dependent (History | Galapagos Conservancy, 2013).

The highland area in Santa Cruz is entirely surrounded by the conservation land - Galapagos National Park, a conservation land. The border between the GNP and farmland is commonly disturbed by the introduced flora that comes through wind, birds, cattle, animals and even humans. In addition, GNP has sustained a park-only policy, which encompasses control of fauna and vegetative invasive species just for the park property. It is up to each farmer to eradicate the invasive species in their land and protect their borderlines, resulting in tensions within landowners and park property, especially for the landowners that are adjacent to the GNP borderline. Farmlands vary in scale from two to 200 hectares. It is also known that pesticide and herbicide practice is limited and controlled by the Galapagos
National Park and the local Municipality; however, some farmers and property-owners still obtain forbidden weed-killers and pesticides for the control of their lands (Brewington, 2013). This last piece was fundamental for the illustration of maps and design recommendations when farms are adjacent to a conservation zone.

b. Surveys

The survey in a convenience sample format was carried out with 100 that lived and/or worked in the agricultural hub of Bellavista. The population in Bellavista is 2,500. All participants were older than 18 years old, 45% male and 55% female. About 85% were married. The purpose was to find out the local perception from these 100 people about the current stage of the farm land.

1. In order to assess the overall perspective of informants about farming in Bellavista, we asked: What is the current condition of the agriculture and livestock farms in Bellavista? The results (Fig 1) show that a majority of those interviewed were positive about farming, but over 1/3 thought conditions were “bad” or “very bad.”

![Fig 1: Current conditions of agriculture and livestock farms in Bellavista](image)
2. Do you think the farms in Bellavista are self-sufficient (do they have daily products produced in the farm for daily intake)? The results (Fig 2) give a demonstration that a majority of those interviewed agreed that the farms are not self-sufficient.

![Bar Chart](Fig 2: Perception on self sufficiency of farms in Bellavista. The size of the farms varied on scale, and some use it for subsistence, for commercial purposes or mainly as another piece of land for investment.)

3. Do you trust the products that come from the agricultural and livestock sector of Bellavista? The results (Fig 3) display that ½ of the respondents have some trust in the quality of the products they buy from the agricultural sector, while the other ½ has doubts about the quality of the products they purchased.

![Pie Chart](Yes lots of trust Some trust)
Fig 3: Perception on trustworthiness of products that come from the farm. It seems that everyone has a lot of trust or some trust, no one has no trust at all.

4. Are the prices of the products that come from Bellavista cheaper, the same price, or more expensive than the ones that come from mainland Ecuador? The outcomes (Fig 4) show most of those interviewed were positive that the products sold from the agricultural land and the ones that come from mainland Ecuador are the same price. Fewer respondents thought the products are cheaper.

![Figure 4: Perception on product prices from local farm vs. the ones from the continent.](image)

5. Do you think the quality of the products from Bellavista can compete with those that get imported from mainland Ecuador? The results (Fig 5) show that a majority of those interviewed were positive about the quality of the products from Bellavista and that they can compete with those that get imported from mainland Ecuador.

![Figure 5: Perception on product quality from local farm vs. the ones from the continent.](image)
Fig 5: Perception on quality of the products from Bellavista and if they can compete with those that get imported from mainland Ecuador.

6. Do the farms in Bellavista act in a cooperative way, or do they act isolated from each other? The results (Fig 6) illustrate that a majority of those interviewed were positive about farms acting in isolated ways, while the remaining thought the opposite. Most of the land if not all of it is privately owned.

![Fig 6: Perception on farm cooperation in Bellavista](image)

7. Do you think the farms in Bellavista have a clear vision of where they want to be in 1 or 5 years from now? The results (Fig 7) demonstrate that a majority of those interviewed had a negative perception about farms having a clear vision for their future.

![Fig 7: Perception on farm vision for the future.](image)
8. Do you think the farms in Bellavista are organized? The results (Fig 8) show that a majority of those interviewed were not sure, confident or accepting of the current organizational practices that the farms have. But about 1/3 thought conditions were not organized at all and a smaller percentage thought they were very organized.

![Pie chart showing responses to the question about farm organization. 30% said they are somewhat organized, 11% said they are very organized, and 59% said they are not organized.]

**Fig 8: Current conditions of agriculture organization in Bellavista.**

According to the survey’s findings and the Development Plan of Santa Cruz for 2012-2027 (Plan de Desarrollo y Ordenamiento Territorial del Canton Santa Cruz), 100% of those interviewed purchased produce from Bellavista including: papaya, dairy products, eggs, legumes and hens. Currently in the island of Santa Cruz there is a high dependence on crops that are imported from mainland Ecuador.

On the other hand, in the island of Santa Cruz there is no government price control for crops. Demand for food to support the massive uncontrolled tourist population in the island also creates a disadvantage for local farmers.

The results of the survey provided the following data of the socio economic factors: evidence of little self-provisioning; strong potential for local marketing; little farmer cooperation or planning. This last finding, the lack of planning, feeds into the design recommendations as follows: delineate recommendations, to which farmers can incorporate strategies to protect the border amid the GNP and their farmland properties. The bias of the convenience sample is that it does not represent the entire population; in addition, out of the 100 surveys, 30 were conducted to actual
farmers, and the rest to people that are created to the agriculture zone. Therefore, the farmers group was underrepresented.

c. Land Planning

i. Site Analysis and Synthesis

The site planning process began with a physical analysis of the land adjacent to the Galapagos National Park. The site analysis maps can be found in Appendix B. It is estimated that 11,432 hectares, 11.60% of the island territory, are devoted to agriculture. The agricultural area has a hemispherical outline whose extent is about 20 km (12.4 miles) long from east to west and 5-7 km (3.1-4.3 miles) wide from north to south. It is located between 100 meters (328 feet) to its southern boundary and located 520 meters to the north of the Gemelos craters.

The altitudinal gradient increases the potential for crop diversification. However, in the lower parts towards Bellavista, most of the land is dedicated to urban growth (Santa Cruz 2013).

The site analysis was based on the maps and documentation retrieved from the Santa Cruz Development Plan 2012-2027. (Plan de Desarrollo y Ordenamiento Territorial del Canton Santa Cruz 2012-2027).

Forest and agricultural land account for most of the area, with 53% used for perennial crops that have a cyclical duration of over three years, such as coffee, bananas and some citrus. The other 20.46% of marginal agriculture and forestry areas, characterized with a high maintenance and conservation measures, are suitable for grazing and/or forest. The rest of the agricultural area has slopes that are not suitable for growing crops and would be best as forests and conservation areas (Plan de Desarrollo y Ordenamiento Territorial del Canton Santa Cruz 2012-2027).

The site analysis process for the agricultural land is based on the McHarg analysis methodology. The analysis constitutes a graphic overlay of the different data sets to delineate the most appropriate areas for agriculture and for buffer and conservation uses (Corbett, 2013).
Based on the future zoning map by the Santa Cruz Development Plan 2012-2027, the local government has proposed to expand its urban settlement to the highland. This map and strategy currently lacks the creation of buffer zones that will protect the existing and fragile ecosystem. Following is a graphic site analysis of the agricultural area (Plan de Desarrollo y Ordenamiento Territorial del Canton Santa Cruz 2012-2027). The maps describe the various environmental characteristics of the agriculture zone in a graphic format (maps are not on scale). The site synthesis follows the site analysis, in which the opportunities and constraints of the site are determined. The map below illustrates the agriculture zoning for 2006.

Site Analysis

Agricultural Zones
- Potential for forest and agriculture
- Potential for agriculture
- Potential for conservation

Vegetative Zones
- Opportunity to maintain conservation
- Opportunity to eradicate invasive species
- Opportunity to maintain existing forest

Erosion Zones
- Good potential for agriculture and conservation.
- Not great potential for agri. or conv.

Flooding Zones
- Moderate potential for agriculture and conservation.
- Good potential for agriculture and conv.
- Best potential for agriculture and conservation.

Roads and Towns
- Opportunity to maintain main paved road
- Opportunity to maintain secondary dirt road
- Main population hubs - opportunity for urbanization expansion
Opportunity for: Endemic and native vegetative buffer

Constraint for: Population growth expansion

Opportunity for: Corridor expansion

Constraint due to: High traffic from main road to the north to Baltra airport.

Constraint due to: High traffic from main road to Puerto Ayora.

- White parcels denote areas for agriculture
ii. Conceptual Master Plan

According to the USDA National Agroforestry Center (NAC), "Buffer zones are designated areas used to protect sensitive landscape patches (e.g., wetlands, wildlife reserves) from negative external pressures. Corridors are used to connect the buffered landscape patches" (USDA, 2014). The succeeding picture from USDA demonstrates a sample of a buffer adjacent to an agriculture zone.

The width of a buffer zone is context specific; therefore the buffer must be based on the desired outcomes to protect the flora and fauna of the GNP. Plateau buffers of 250 to 1000 feet nearby wetlands have been suggested for wildlife such as turtles and amphibians (USDA, 2014). The following is a conceptual illustration of a buffer zone between the Galapagos National Park and an agricultural land.

The proposed vegetative buffer zone is an undeveloped area bordering the GNP land with native and endemic plantings. The reasons for vegetative buffer zones include:

- Decreases runoff by allowing storm water infiltration into the soil, decreasing pollutant flow into conservation areas.
- Reduces erosion along the shores in water bodies and secures plant root systems in water and land flora.
- Restores natural habitats by providing native flora that provides food, shelter, and shade.
- Increases the chances of wildlife survival (Vegetative Buffer Zones, 2013).

When the vegetative buffer lies near a body of water, buffer zones should contain aquatic florals in shallow water, moisture plants beside the shoreline, and upland plants in dry soils (Muscott, 1993). On the other hand, when a vegetative buffer lies near a dry zone an easement can be incorporated.
“Wildlife corridors can be incorporated into the design of a development project by conserving an existing landscape linkage or restoring habitat to function as a connection between larger protected areas” (Bond, 2003. To be most effective, the proposed wildlife corridors need to be restored as native ecosystems so that they act as viable pathways for movement of the unique fauna found in the region. The corridors should be at least 500 meters in width. Corridors provide pivotal links among larger areas of habitat, permitting migration, colonization and interbreeding of plants and animals (Natural Resource Management Advisory Series: Note 15, 2013).

Using the synthesis map and its determination of the potential of the land became the basis for the decisions in the final master plan that delineates the proposed areas for agriculture, livestock, urban, and conservation development in the agricultural zone.
IX. Design Recommendations

The following recommendations are based on a specific area of study that encompasses different dynamics within farm/human habitat use and conservation. The recommendation drawings include a series of guidelines that farmers may adopt to reduce the impact of farming adjacent to conservation areas. Each farmer may want to incorporate in these recommendations into their practices and adapt them to their specific context in order to maximize co-existence with the conservation areas. Study area illustrated below demonstrates recommendations for three different conditions:
Recommendations when agriculture is adjacent to a conservation zone

Corridor Features (Bond, 2003):

- The wider the wildlife corridor the better. At a minimum it should have a 304 meters (1,000 feet) wide dimension.
- Assign land uses adjacent to the corridor that reduce human impacts to the corridor.
- If housing or agriculture practices are near the wildlife corridor, place conservation easements on adjacent lots to exclude structures bordering the corridor (Drawing 1).
- Incorporate organic agriculture practices do not use pesticides and have processes that have a low impact on the environment.
- Plant as many native and endemic species as possible in the easement.
- Create bio swales to catch overflow rain water. This will help cleanse the water before it goes into the conservation zones.
- Dairy and cattle farms should have appropriate water treatment to mitigate for contaminants. This land use should not to be located on top of the watershed. The runoff from these areas can contaminate the conservation zones. Bio swales should be used to help the mitigate impacts to conservation areas.
- Include fences for cattle and wildlife protection.
Drawing 1. Sample of a farm land adjacent to a conservation zone.

**Recommendations for urban hubs adjacent to a conservation zone**

- Develop strict lighting restrictions for the urban centers near the wildlife corridors to avoid light pollution into the corridor. Lights must be directed downward and inward toward the homes or business.
- Create permeable sidewalks, paths or roads so rain can filtrate better.
• Collect rain water for irrigation.
• Keep garbage, recycle and compost areas well abdicated so no animals can get to it.
• Use sustainably harvested materials such as bamboo for construction infrastructure.
• Use endemic or native plants for gardens.

Drawing 2. Sample of an urban hub adjacent to conservation
Recommended sample of a farm adjacent to an urban area

To supplement their livelihoods, farms that are next to urban centers may want to incorporate agro-tourism or eco-tourism. A sample of it is shown below for a two hectare farm:

![Diagram of a farm with various features including office and cafeteria, bamboo workshop, vegetable and BBQ area, vegetative fence, bamboo cabins, various trees, rocky pathways, dirt pathways, pond, slim bamboo, bridge, and rain gardens.]

Scale 1:2000 meters

For all the design recommendations listed above, resource management agreements may be implemented and negotiated to regulate the land use practices of farmers and create policies that will be reinforced to temper the ecological impacts of human growth in the agricultural sector. This is especially important with rising population and economic development pressures adjacent to protected areas. Conservation organizations and protected area managers must begin to work with public policy experts to recognize key policy controls at national and local levels that will endorse conservation purposes like those of answering to the emergent
pressures of human in-migration to protected areas. Once these policy measures are known, international and national conservation NGOs can either advocate for their implementation at the national and international level, or track financing from government and contributors for the crucial work at the local level (Shrebinin, 1998).

X. Cross-scale and cross discipline considerations

A cross-disciplinary approach was utilized throughout the field practicum, because the project strives to integrate paradigms of social community endeavors, science, and different academia disciplines. Understandings from a wide-ranging spectrum of disciplinary areas embracing the environmental science, landscape architecture, sociology, philosophy, law, economic, rural planning and management are accessible to support this position (Meppen, 1998).

The different analysis and methodology used in this practicum validates the need for a cross-disciplinary approach in which the collaboration of various entities is taken into account for the formulation of results.

XI. Conclusion

The findings of key socio-economic data include: demographic education, nutrition, food security, health, water, soils, and energy resources can be found in Appendix A. The socio economic synthesis is based on the compilation of data from governmental institutions through data collection and informal interviews, from the Municipio de Santa Cruz, Secretaria Técnica de Desarrollo Sostenible, Departamento de Planificación Urbana y Rural de Santa Cruz.

Illustrative plans delineating practices for the agriculture/GNP buffer lands and the recommendations drawings listed above offer guidelines to farmers to reduce the impacts on adjacent conservation areas. It is acknowledged that each farmer deals with different terrain and thus different opportunities and constrains and has a more in depth knowledge of their land. The drawings simply serve as
a guidelines and recommendations, which can be built upon.

Impact to habitat may be mitigated to improve the ecological relationship between farm habitat and the surrounding landscape. These management tools may also help in monitoring the special effects of land-use practices in order to measure the efficacy of interventions (Complementary Strategies, 2013).

In order to make the buffer zones and corridors a reality the government could promote this endeavor by giving tax cuts to farmers, and/or offering payment for environmental services to them. In addition, the government should incorporate stronger population control policies that will protect the conservation zones and avoid over population in the fragile Galapagos ecosystem.

The limitations include unavailable updated GIS data, a cohesive inventory of the current agricultural practices in the area, the crops planted and their yields, the inventory of invasive species and a study of income and the farmers’ livelihoods. In addition, Landscape Architecture is not a known profession in the area, but through the elaboration of this project there is a hope people will see the pivotal value the profession can bring. The surveys conducted were convenient samples. It was very hard to mobilize though the agriculture land, for there is no public transportation other than private taxis. Making randomized sample extremely hard to execute. Therefore, the farm group was underrepresented. However, the research was conducted to best of my ability and overall it was a great enlighten opportunity to impact my homeland of Ecuador!
XII. Bibliography


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XIII. Appendix

A. Overview of the socioeconomic data in the Island of Santa Cruz, Galapagos.

People

Santa Cruz is not only the name of the most populated island in the archipelago, but is also the name of the canton, which is part of the Galapagos National Park and encompasses Santa Cruz Islands (986 km2), Santiago and San Salvador (585 km2), Marchena (130 km2), Pinta (59 km2), Baltra (27 km2), Finch (18 km2), Rabida (4.9 km2), and North Seymour (2 km2). There is a close relationship between Galapagos National Park, and the territory that is under the administration of the Decentralized Autonomous Municipal Government of Santa Cruz. The degree of urban concentration of Puerto Ayora is the highest in the region with 11,974 people, and accounts for 47.66% and 77.8% within the canton. Most of the population is concentrated between 25 to 29 years old for both men and women. The two rural parishes have a regional concentration of 3.96% in Santa Rosa (994 inhabitants) and 9.65% in Bellavista (2,425 inhabitants), which translates cantonal level at 6.45% and 15.75% respectively. Furthermore, in Santa Cruz there has been an annual incremental growth of 3.5% (Gobierno Autonomo Decentralizado Muncipal de Santa Cruz, 2012).

Education

In Santa Cruz 63.78% of the schools are public, 20.82 private, 14.38 with mixed funding from the government and private institutions, and 1.03% municipal. Most school-aged residents in the Galapagos attend public school but the reputation of the public education system is high among young people. However, access to higher education is limited and long distance education hubs representing universities from the mainland have not been able to meet the demand. While some young people in the Galapagos migrate to mainland Ecuador to further their education, many teenagers, especially those between the ages of 15 and 19, drop out of school and begin work on the islands in the industry of fishing or tourism. (Gobierno Autonomo Decentralizado Muncipal de Santa Cruz, 2012).
Health

Health services in the Galapagos are poor, with very limited access to proper medical equipment and few medical experts on the islands. Most residents on Santa Cruz travel to the mainland in search of care rather than risk the shoddy services of local health institutions. A survey by the Instituto Nacional de Estadística y Censos (National Statistics and Census Bureau or – INEC) in 2010 found that 52.3% of the population in Santa Cruz visited public healthcare establishments while 46.0% went to private healthcare. The same survey found, 8.6% of the children under five-years-old suffered from chronic diarrhea and 40.5% of the children were victims of chronic respiratory diseases. Regarding vaccinations, 98.5% of children under five received the BCG vaccine, 90.3% obtained the OPV, and 93.7% got the doses for SRP. Social problems are on the rise, with a recent increase in domestic violence being linked to increased drug and alcohol consumption. (Instituto Nacional de Estadística y Censos, 2009-2010).

Nutrition

According to a survey taken in 2010 by Encuesta de Condiciones de Vida 2009-2010 de Galápagos, 11,83 boys and girls suffered from malnutrition and are below-average in both height and weight. (Sistema Nacional de Informacion y Gestion de Tierras, 2013).

Water

The rainy season on Santa Cruz Island poses a number of ecological challenges: over 30 rivers and streams, which vary in size from five to fifty square kilometers, have their source on Cerro Crocker, the island’s highest peak. These aqueous bodies swell during the rainy season, which causes flooding and the formation of dangerous ravines. Although there is a much higher rate of precipitation in the rural highlands than at the sea-level urban coast, the population is affected by these ecological changes. While 81% of inhabitants on Santa Cruz have access to potable drinking water, the crevices and wells that this water comes from are often highly contaminated (Galapagos Report: 2006-2007). In most cases, the water contains a high concentration of salt. The subsequent mix of fresh and salt water puts aquifers at risk, because the saline oceanic water is being
mixed with the sweat water. Sewers and sewage treatment also create hazardous conditions, with underground filtration contaminating extraction points. Direct dumping into the ocean causes environmental dangers of its own (Sistema Nacional de Infomacion y Gestion de Tierras, 2013).

**Soil**

On Santa Cruz, soil in the highlands can reach a depth of three meters but becomes increasingly superficial toward sea level. The island’s soil varies in pH level and contain low levels of phosphorous and potassium (Gobierno Autonomo Decentralizado Municipal de Santa Cruz, 2012).

**Economy**

Santa Cruz has been recognized as the economic capital of the archipelago. Tourism is the main source of income and is responsible for 75% of economic output, employing 40% of the island’s inhabitants. The high volume of tourist traffic also attracts migrants looking for work, which increases the overall population and consequently leads to an increased demand for food and other basic services. Fishing plays an imperative role in the ecosystem even though it only represents 4% of the local economy; fishermen are organized in cooperatives that try to preserve the marine life, while bringing an adequate income to their families. The agricultural area however, does not guarantee the food security for the population. Furthermore, Puerto Ayora the capital of Santa Cruz and the island’s economic hub has become a mecca for tourists who prefer to stay in hotels rather than going on cruises (The Galápagos | Places | WWF, 2013).
The agriculture industry covers about 12% of the island. The agricultural zone on Santa Cruz stretches for 20 km in latitude and 7 km in longitude; the area grows melons, tomatoes and lettuce. The lower sector, Bellavista, has low productivity and some of its land has been lost to urbanization. The agricultural output depends heavily on the climate, with a lack of irrigation during the dry season and the presence of plagues and invasive species affecting overall productivity. Another troubling aspect related to agricultural production in Santa Cruz is the absence of planning methodologies, regulatory systems and overall organization. In particular, the lack of regulations systems threatens local farmers who are unable to compete with food imports from the mainland and other sources (Instituto Nacional de Estadística y Censos, 2009-2010).

Energy and telecommunications

Internet and cable television have poor quality and low coverage on the islands. Energy attention is high and covers the necessities of the populace and the elevated number of the port premises. Energy is produced by thermal generation, which is used as diesel fuel. This generation produces a high dependency on the use of fossil fuels, and introduces another severe risk since the diesel fuel must be moved from the continent, land at the port and then be transported through the streets of the city to the generating station. There are no alternative power generation systems; however, there are two PV projects, which are expected to cover at least 50% of the demand of the canton of Santa Cruz. The execution of these alternative energy sources are projected to be completed by 2017 (Dirección del Parque Nacional Galápagos, 2013).

Environment

About 90% of the introduced species of flora have been brought by humans for ornamental or agricultural use. The vehicle for many of these invasive flora and fauna species is imported food, on which the human population in the Galapagos is dependent (History | Galapagos Conservancy, 2013).
The highland area in Santa Cruz is entirely surrounded by the Galapagos National Park, a conservation land. The border amid the GNP and farmland is commonly disturbed by the introduced flora that comes through wind, birds, cattle, animals and even humans. In addition, GNP has sustained a park-only policy, which encompasses control of fauna and vegetative invasive species just for the park property. It is up to each farmer to eradicate the invasive species in their land, resulting in tensions within landowners and park property, especially for the landowners that are adjacent to the GNP borderline. Farmlands vary in scale from two to 200 hectares. It is also known that pesticide and herbicide practice is limited and controlled by the Galapagos National Park and the local Municipality. However, some farmers and property-owners still obtain forbidden weed-killers and pesticides for the control of their lands (Brewington, 2013).

Overview of the socioeconomic data in Bellavista, the agricultural hub in the Island of Santa Cruz, Galapagos.

People

Out of the 15,500 inhabitants that live in the Island of Santa Cruz, about 2,500 live in the agricultural sector of Bellavista (Instituto Nacional de Estadística y Censos, 2009-2010).

Bellavista has a very young population, with 60% of its residents under 29-years-old and the largest demographic group between the ages of 18- and 29-years-old. Thus, there is an urgent demand for the proper educational infrastructure in this area. (Gobierno Autonomo Decentralizado Municipal de Santa Cruz, 2012).
Population in Bellavista according to age and sex. Most of the population is concentrated within the 16 to 25 years old. The green left side represents men, while the right beige side is for women. Source: CGREG (2010) “Principales Características Demográficas de Galápagos – Resultados de todas las variables del VII Censo de Población INEC-2010” [Informe Técnico]

Education

Though there is no high school center in the area of Bellavista, there are two public elementary-middle schools and one private school. There is a total of 235 students and 25 teachers in the area, which creates a 15:1 student-teacher ratio (Gobierno Autonomo Decentralizado Municipal de Santa Cruz, 2012).

Health

There is only one health center in Bellavista with very limited equipment. The center’s insufficient water supply causes many residents of Bellavista to travel to the urban center of Puerto Ayora

**Water & Energy**

Supply water for the agricultural sector of Bellavista is insufficient. Most rural areas have access to the water collected in barrels during the rainy season, which then becomes scarce in dry season; portable water from pipes is extremely scarce. About 4% of the population in the rural area has access to pipe water; while the other 96% collects water through rain barrels or water tanks. There is no sewer system in the rural area, forcing residents to excavate their own septic tanks. Energy on the other hand covers most of the areas; however, in some areas, sporadic cuts of electricity happen within different times of the day. (Dirección del Parque Nacional Galápagos, 2013).

**Economy**

The estates and farms in Bellavista vary in scale. Most of them are used for the agriculture production and they divide most of the rural area. However, some devote their land to raising cattle, and the production of milk and its deliverables. Most of the rural population has access to electricity, though they often experience random shortages. Though the economic livelihood of the residents is mostly concentrated in agriculture, there are some estates, which benefit from the Galapagos’ tourism industry. Most of these estates are bordered by mountains with scenic viewpoints and ancestral lava tunnels, or they serve as protective habitats for giant tortoises (Gobierno Autonomo Decentralizado Muncipal de Santa Cruz, 2012).

**Soil**

The pH level of Bellavista’s soil ranges from very acidic levels to acid neutral levels. In the rural area, the pH levels range between 5 and 6. Most of the soil that is used for agricultural purposes are free from vegetative invasive species. The soil and vegetation changes dramatically in the highland area, where the soil is not arid and is able to produce verdant vegetation (Dirección del Parque Nacional Galápagos, 20).

**B. Site inventory for the agricultural sector in Santa Cruz**
Basic services accessibility in the agricultural sector. The analysis for the agricultural area of Santa Cruz gave the following percentages of coverage in terms of the availability of basic services: Drinking water coverage → cantonal average of 4.86% (Very Low), light coverage → cantonal average of 91.57% (very high), and sewerage coverage → cantonal average of 13.10% (Very Low). Source: Información del "Programa de Regularización y Administración de las Tierras Rurales del Ecuador, U.E. MAGAP-PRAT, SIGAGRO y Gobierno Municipal de Santa Cruz".
Susceptibility to erosion: About 64.12% of the agricultural area of Santa Cruz has a slight susceptibility to erosion with features that have fine textured deep soils to very fine, with gentle slopes less than 12% and with plenty of vegetation. Therefore, the area is good for agriculture. Source: Información del "Programa de Regularización y Administración de las Tierras Rurales del Ecuador, U.E. MAGAP-PRAT, SIGAGRO y Gobierno Municipal de Santa Cruz".
Map of flooding susceptibility. In the agricultural zone, most areas have a moderate susceptible rate. The slopes in these areas oscillate between 0-5% and 5-12%. Source: Información del "Programa de Regularización y Administración de las Tierras Rurales del Ecuador, U.E. MAGAP-PRAT, SIGAGRO y Gobierno Municipal de Santa Cruz".
Landslide susceptibility map. Source: Información del "Programa de Regularización y Administración de las Tierras Rurales del Ecuador, U.E. MAGAP-PRAT, SIGAGRO y Gobierno Municipal de Santa Cruz".