The Thesis Committee for J'aime Christianne Mitchell
Certifies that this is the approved version of the following thesis:

The CoopePueblos Carbon Initiative:

An Assessment of Impacts After One Year

APPROVED BY
SUPERVISING COMMITTEE:

Steven Moore, Co-Supervisor

Sarah Dooling, Co-Supervisor

Bjorn Sletto

The CoopePueblos Carbon Initiative:

An Assessment of Impacts After One Year

by

J'aime Christianne Mitchell, BA

Thesis

Presented to the Faculty of the Graduate School of

The University of Texas at Austin

in Partial Fulfillment

of the Requirements

for the Degree of

Master of Science in Sustainable Design

The University of Texas at Austin

May 2011

Dedication

This paper is dedicated to my aunts, and to my mother, who pushed me to keep going.

Acknowledgements

I would like to express my deepest gratitude to Dr. Bjorn Sletto and Dr. Steven Moore for their technical direction throughout all the stages of this thesis. I am also greatly indebted to Dr. Sarah Dooling, my advisor, whose sustained enthusiasm and continuous advice provided invaluable encouragement.

I could never have finished this paper without the egomaniacal ravings of my business partner, Eliot Logan Hines, the encouraging wisdom of my mother, Randi Mitchell, the timeless inspiration of my late aunt, Janna Wissler, the morning coffee of the Whole Foods Lamar Specialty Team, or the musings of my partner in crime, Chris "Thesis" Cribb.

And "Gracias" to all my friends and colleagues that supported the CoopePueblos Carbon Initiative and that continue to empower the community of Agua Buena.

Abstract

The CoopePueblos Carbon Initiative:

An Assessment of Impacts After One Year

J'aime Christianne Mitchell, MSSD

The University of Texas at Austin, 2011

Supervisor: Steven Moore

Co-Supervisor: Sarah Dooling

This study analyzes the multiscalar interactions of the emerging carbon market and the social, environmental, and economic implications it may hold for small-scale landholders in the tropical rainforest. Based on a change detection analysis from a case study in Costa Rica, this report argues that 1) the scalar mismatch between national carbon trading markets and small scale agroforestry sequestration efforts is driven by insignificant land holdings; 2) secondly, the scalar mismatch limits the small scale landholders' access to the carbon market; and 3) that in order to link global and local approaches to climate change we need to understand the local economic contexts within which these global markets are interacting.

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction and Background

1.1 The Challenge

There is scientific consensus that we are facing a threat to the wellbeing of our global ecosystem due to anthropogenic pollution, unsustainable resource extraction, and global climate change (Vitousek 1997). This consensus is a global phenomenon with international, multinational, and national responses. From these concerns a range of specific strategies have emerged to incentivize the craft, implementation, and management of carbon sequestration technologies. The carbon credit market has been advocated as a powerful approach to this, as evidenced by the turnout at the COP15 world summit in Copenhagen last year.

However, these international and national markets are influenced by both regional and local economic development strategies. Central America is an example of a region that holds great interest for the carbon market – because of the tropical rainforest's ability to sequester carbon dioxide from the atmosphere – but has endured a history of underdevelopment, commodity dependency, and exploitive economic regimes that left much of the region bereft of infrastructure for participation in the global carbon market. All too often these regions are left in the margins of international carbon market policy or forgotten altogether in favor of regions with large, emergent economies. Many times the reason for this omission is one of economic viability: the underdeveloped regions contain mostly small-scale carbon credit earning efforts that do not promise large enough economic returns to warrant the cost of credit verification and certification.

However, local strategies – as the one presented in this thesis – can exist at a much smaller scale in terms of commodity production and sufficient economic capital and, with the proper political support, have the capacity to both participate in and take advantage of the carbon market. Therefore, I will argue in this thesis that 1) a scalar mismatch exists between the high costs associated with entry into the international carbon credit market and the low incomes in the global South where carbon sequestration efforts are expected to produce the greatest benefits, 2) that these high costs are driven by terms of trade and technologies designed by a core of developed countries in the global North; and 3) that by limiting access to carbon sequestration efforts in the South, the carbon market is in danger of perpetuating neoliberal structures of dependency and decreasing the efficacy of the market to mitigate climate change. I conclude that only if this scalar mismatch is reconciled can local efforts directly influence the success of global climate change mitigation strategies.

1.2 THE RESPONSE

It is possible to mitigate greenhouse gases in our atmosphere through the process of sequestration. Agriculture, Forestry and Other Land Use (AFOLU) projects have great potential to contribute to help in this process since plants naturally sequester carbon dioxide as part of photosynthesis. Tropical forests, in particular store approximately 46% of the global terrestrial carbon pool and about 11% of soil carbon (Rozo, 2005).

The tropical rainforests of Costa Rica are considered one of the world's most biodiverse environments. These rainforests are home to over 500,000 different species of living organisms. This small country contains 4% of the total species estimated worldwide. Vitousek (1997) cites evidence of human processes, including obvious modifications of energy flows and nutrient cycles, reconfiguring of the planet's surface through land use, and species extinction through hunting. In southern Costa Rica, this means the loss of important keystone species like bats and birds through disruption of migration patterns and destruction of ecological corridors (Rickert 1998 and Joyce 2006). In the study area there are significant wildlife reserves striving to maintain or regenerate these important corridors.

The forest provides natural resources for economic benefits, medicinal herbs, and a symbol of cultural traditions for many of the people living in it (Cole-Christensen 1997). Many of the native plants have medicinal value, and there remain many plants that are undiscovered or have untested medicinal properties. There are currently 121 prescription drugs sold worldwide that are derived from rainforest plants (Balick 1998). Twenty-five percent of the active ingredients in today's cancer-fighting drugs come from organisms found only in the rainforest (Balick 1998). Without protection and re-growth of these rainforests, we risk losing this immense reservoir of genetic and medicinal resources.

Unfortunately, due to increasing financial pressures, these same people are faced with the difficult decision to exploit the forest for its fungible benefits just to make ends meet for their families. By supporting exploitive economic policies in these areas we are putting greater stresses on the ecosystems that sustain all life (Vitousek 1997). Therefore, carbon sequestration projects coupled with financial incentives are an effective means of promoting environmental and economic sustainability in the tropics. The following AFOLU project proposal considers both agroforestry of coffee and small-scale reforestation to improve the livelihood of farmers, communities and the southern region of Costa Rica.

1.3 THE PROJECT

Finca Project is a US-based non-profit dedicated to the restoration of human and ecological communities in southern Costa Rica through small-scale reforestation and project-based community education. Co-directors, Brendan Havenar-Daughton and Eliot Logan-Hines, have graduate degrees in natural resource management and environmental management respectively.

Over the last five years, from 2005-2010, the Finca Project has worked with different groups of coffee producing members of the Coopepueblos Cooperative on reforestation efforts in Agua Buena. Specifically, the Finca Project worked with the Coopepueblos Cooperative and the Association of Development of Agua Buena to create a management plan for riparian areas, including reforestation along the river running through Agua Buena. Finca Project also hires Costa Rican foresters as consultants.

Finca Project expanded their mission in 2008 in an attempt to further incentivize reforestation because they recognized both the symbiotic relationship between native trees and agroecosystems as well as the growing need to ameliorate economic instability in Agua Buena. The CoopePueblos Carbon Initiative was developed with the objectives to preserve important relationships while stimulating economic development. The initiative is an incentivized AFOLU project that transitioned a mosaic of coffee agroecosystems in southern Costa Rica to shade-grown practices between 2008 and 2009.

The project area comprises a total of 6,118 hectares in the community of Agua Buena, specifically in the easternmost canton of Coto Brus, Puntarenas. Project activities will be conducted on small-scale agroforestry plots, between 0.1 and 10 hectares per farm. The boundary for this project is the collective agroforestry land area comprised of a total of 64 hectares of privately owned coffee farms involving 54 farm owners. The project will utilize two mechanisms, Afforestation, Reforestation, and Revegetation (ARR), and prevention of land conversion, specifically the prevention of conversion from coffee plantation to pasture land. Under the ARR mechanism the project will plant trees to sequester the carbon from the atmosphere, and the prevention of land conversion mechanism will prevent land use change from coffee plantation to pasture land resulting in the emission of carbon into the atmosphere.

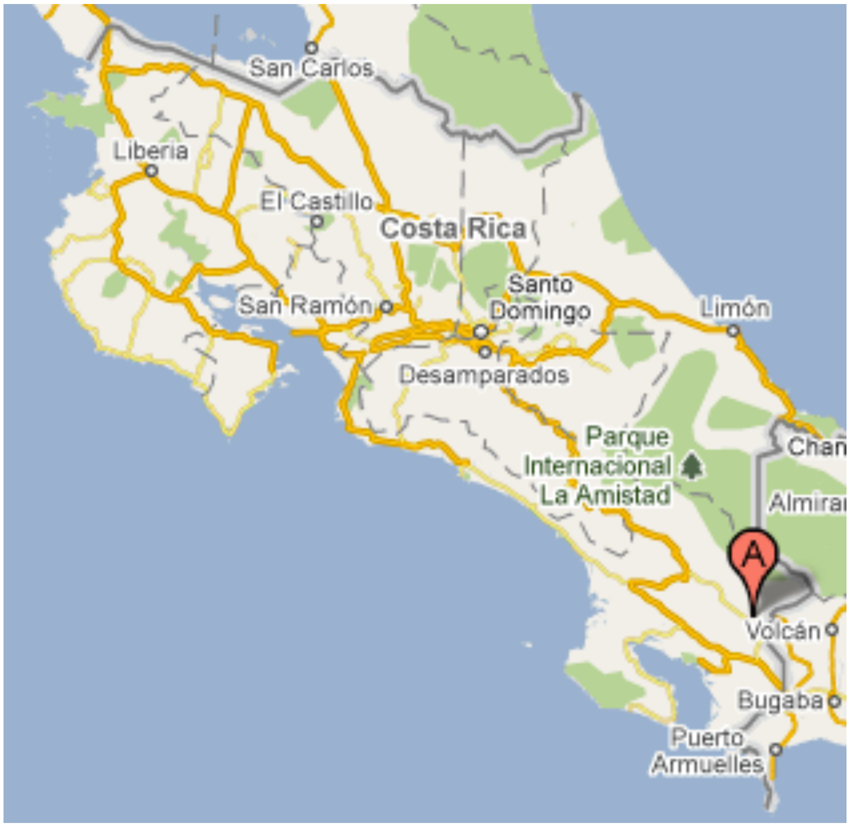


Figure 1 Project site. Source: Google Maps

The geographical distribution of the 64 hectares will be determined by the location of the farms of owners who voluntarily join the program and do not represent a contiguous coffee plantation. Project implementation is restricted to ARR and prevention of land conversion activities of the agroforestry properties affiliated with the coffee cooperative CoopePueblos, R.L. No national parks or biological reserves are included in the land eligible for recruitment. Land management was the target objective for three main reasons: encouraging rainforest biological diversity, mitigation of global climate change, and fostering economic sustainability for the people dependent upon the rainforest for their livelihoods.

1.4 Organization of this Study

This study is organized to be accessible to both academic and lay audiences, so it presents qualitative data in narrative format while maintaining scientific formulae where appropriate. The second chapter outlines the nested contexts for coffee producers and the carbon market and reviews the associated literatures. In the third chapter, I discuss my theoretical frameworks and reasons for employing specific strategies. Then I review literature associated with this framework. Chapter 4 describes my strategies, processes, and findings. Finally, I return to the narrative of coffee producers and the carbon market to analyze these data in terms of social, environmental, and economic impacts. In conclusion, I summarize my findings and present a picture of potential futures for coffee and carbon.

This study does not present a conclusion about the CoopePueblos Carbon Initiative because it would be too hasty at this point. The project is still in its nascent phases and the effects are designed for sustainable realization over time. Instead, I understand that this ever-evolving support system is an educational tool for all human and environmental ecologies and is far from a failure in regards to the lessons learned through this process. However, an analysis of the first year's shortcomings in reference to the initiative's original goals, as well as an explanation of the reasons behind these shortcomings, provides opportunity for improvement. In other words, the goal of this study is to assess the impacts of this initiative and create constructive feedback loops for further project development.

Chapter 2: Nested Contexts

This chapter reviews literature on three nested scales. It offers a look at the global state of climate change and the emergence of the carbon market as a response to it. Then it will describe the global network that the carbon market is entering, through the example of the coffee as a parallel commodity market. The next section reviews the historical context of economic regimes in Latin America and the historic precedents that have led to current economic regimes. Finally, I review the coffee industry of southern Costa Rica to provide a local context for the project. In conclusion, I will discuss the consequences that these three scales hold for policy.

2.1 Global Commodity Chains

The following is meant to show the similarities and differences between global commodity chains.

2.1a Carbon

Global climate change is occurring as we emit greenhouse gasses (GHGs) like carbon dioxide, methane, and nitrous oxide into the atmosphere. The greenhouse gasses act as insulators in our atmosphere, trapping solar radiation and causing high temperatures zones that can alter global weather patterns (IPCC 2003). This section presents a review of the literature surrounding climate change and the emergence of the carbon market in order to provide the reader with a basic understanding of the carbon market's scale, purpose and function.

The majority of greenhouse gas emissions are a direct result of energy consumption, especially carbon dioxide, created as byproducts of combustion. Therefore, the majority of emissions in the last century have come from the industrialized Northern

Hemisphere. However, it is now estimated that between 20% and 25% of annual GHG emissions result from land use and land use change (LULUC) like deforestation and unsustainable farming techniques (IPCC 2003). A growing number of these impacts are located in the developing Southern Hemisphere where there are fewer precedent policies to regulate land use as urban expansion puts increased pressure on the rural areas. With over 10 years of experience behind us since 184 countries ratified the Kyoto Protocol, it has been recognized that a century and a half of industrial activity and irresponsible resource extraction has coincided with the acceleration of carbon dioxide emissions.

Policy makers and scientists are among many interested parties around the world examining carbon credit markets and their contribution to global efforts of addressing the climate crisis. With a short but rapidly evolving history, these markets are a conglomeration of financing options put together by experts in the fields of ecology, forestry, natural resource management, foreign policy, community development, finance, business management, and agriculture (Wilson 2008).

These fields have intersected on many points, but it is only in the more recent past that they have begun to overlap significantly. As business becomes more socially conscious, and social sciences become more aware of the environment, likewise, the environmentalists and businesses have begun to market themselves. Since the Kyoto Protocol was ratified in 1997, it has been globally acceptable to place a price tag on the tons of carbon present in various parts of the world's surface and atmosphere. As global climate change rapidly worsens, world leaders have placed more and more effort into identifying, quantifying, and tracking every ton of greenhouse gas that contributes to the problem. This emergent idea has revolutionized the way world markets do business.

The Kyoto Protocol designed and implemented the Clean Development Mechanism (CDM) to provide a market structure for developed countries and industrial companies to offset their carbon emissions through emission reduction projects. Emission reduction projects are created in developing countries to earn certified emission reductions (CER) that are equivalent to one ton of carbon dioxide. Since it's first sale in 2006, there have been 1,726 registered projects, over 300 million issued CERs, and the UNFCCC expects another 1.6 billion CERs to be registered before the end of 2012. CERs sale for higher than any other type of voluntary market credit.

However, the CDM has a large number of critics who believe that the CDM has failed and the idea needs to either be scrapped or radically transformed. The main complaint of the critics is that the CDM allows companies to continue polluting. While the critics agree that these projects are necessary, they feel that they should be additional to companies actually reducing their carbon footprints (Pottinger, 2008).

The next evolution of the Protocol is likely to include better opportunities for offsetting industrial GHG emissions with the natural GHG sequestration – particularly carbon dioxide – that happens with labor-intensive land use practices. Protecting forests not only curtails the GHG to be released into the atmosphere, but it also reduces the existing level of GHG because the trees naturally capture and store carbon dioxide through photosynthesis. The challenge with LULUC programs thus far has been a lack of standardized methodology for the quantification of carbon dioxide tons sequestered as well as inefficient regulation for verification of the credits earned. Gretchen Daily (1997), a progenitor of payments for environmental services, argues it is necessary to develop these methods for recognizing the economic value our natural world in order learn to integrate nature into our daily economic decisions and truly value the finite resources available to us.

The other challenge faced by the current carbon market is regulatory inequality that has been inadvertently built into the market and makes the market more accessible to certain regions than others. For instance, the carbon market currently available to Latin Americans is based on the assumption that all players receive equitable opportunity for producing CDM projects. However, two incongruities appear within CDM models. First, CDM projects are labor-intensive to certify and maintain. And, secondly, carbon credits trade at fixed European rates and therefore have a higher comparative value in regions with high exchange rates. Therefore, places like Costa Rica that protect minimum wage at the national level and have low Euro to local currency exchange rates cannot meet the demands of the market at a global scale (Penman 2003). The local advantage clearly lies in the hands of densely populated countries, like Brazil, who have the comparative advantage of inexpensive labor and low exchange rates.[1] This is an example of international regulations failing to recognize differences among locally competing regions. This scalar discrepancy is characteristic of all commodity markets, and its consequences can be more thoroughly observed in older markets.

2.1b Coffee

It is important to remember that comparative advantage is at play in any free market like in order to understand the benefits and disadvantages inherent in free market mechanisms. Here we look at coffee as an important commodity that has experienced cyclical price swings since its deregulation.

Coffee is the second largest commodity market in the world – with trading values over $70 billion USD annually (Pendergast 1999). Commodities traders on the New York Coffee, Sugar, and Cocoa Exchange set the price for coffee. From the early 1960s to the 1980s, the International Coffee Organization (ICO) strictly regulated export quotas and controlled prices. They developed the International Coffee Agreement (ICA) that adjusted quotas for producers and consumers to maintain agreed upon prices. The world price for coffee during this period fluctuated between $1.00 and $1.50USD per pound, a reliable return for producers.[2]

Because of its market stability, coffee emerged as a viable new means of development for tropical countries that had not produced it before. Many countries

---

[1] Shrestha, 2005, compares the Brazilian living wage of $327 USD per month to $795USD per month in Costa Rica.

[2] Conventional farmers receive far less than this price because the crop passes through so many intermediary parties in exportation.

experimented with coffee for the first time and those already producing it increased production. But on July 4, 1989 the ICA collapsed. Changing consumer coffee preferences, a growing surplus of coffee, and shifting US geopolitical goals collectively destroyed the ICA by demanding impossible quantities of high-quality coffees from Brazil and Colombia (Dictum 1999). This threw the coffee growers into the throes of free market forces like never before. By 1992 the price of coffee had plummeted to $.49 per pound, well below production costs. The effects on small-scale farmers, who make up a 2/3 majority of worldwide coffee production, were devastating. In some regions, they lost up to 70% of their income – a loss that was attributed to everything from child malnutrition to outmigration in tropical regions (Dictum 1999).

After rebounding to profit levels between 1994 and 1997, the price of coffee dropped precipitously in 1999 and kept falling. In the winter of 2001, the market hit an all time low of $.41 per pound. Even as prices are beginning to rise again, they do so within the same market structure as before – and are therefore still as precarious.

Here I have looked at a brief history of the carbon market and explored the interdisciplinary efforts incentivized by it. I have also discussed how assigning economic values to natural resources can help integrate environmental principles into the global economy, but also how turning these resources into commodities can present new challenges. The coffee example illustrated the consequential boom and bust cycles associated with unregulated trade and showed how competitive markets are imperfect at integrating local social equity at the international scale. The following section will discuss regional effects of participation in these markets.

2.2 Regional Underdevelopment and Commodity Dependency

The historic instability of Latin American economies has been driven by their dependence on volatile international commodity markets and their characteristic boom and bust cycles. From a broad lens, it is possible to see how the markets in developing countries in the global South are tied to the boom and bust cycles of their consumer markets of the North through terms of trade. Following the history of Latin America, it is possible to trace these terms of trade back to initial relationship created through colonization.

When the conquests for the new world landed, the Spanish and Portuguese crowns distributed territory and mining rights to individuals who returned part of profit to these reigning powers. This system of mercantilism led to development of only a few, key port cities – such as Cartagena, Veracruz, and Havana – which became wealthy. Land ownership became concentrated in large latifundas or fazendas, setting up highly unequal socioeconomic systems (Cardoso, 1979).

Queen Isabella of Spain set up the encomienda system in 1503 that entrusted indigenous people to owners of haciendas and mines. This indentured indigenous population, as well as an increasing slave trade, started to solve the shortage of labor for the emerging industries. But peasants and indigenous populations didn‘t own clear title to their land and therefore lived subsistence lifestyles or produced for small local markets. Meanwhile, large landowners invested in Europe instead of in national industries. Because of small domestic markets, agricultural production and mining became oriented towards export to Europe, too.

The colonizing entities of the early 17th century were the first to build export economies that exploited the raw resources of the Americas. During this period land was indiscriminately devastated in order to extract raw resources that were then sent overseas for manufacturing. The foreign-owned extraction companies exploited cheap labor and designed debts through worker housing and company stores that lasted for several generations (Frank, 1969). Meanwhile, the raw resources of the New World dwindled without any advancement in processing or manufacturing technologies. Foreign finance was just an avenue for pillaging resources, exploiting labor, and ensuring the permanent underdevelopment of Latin America. This system of mercantilism lasted for nearly 200 years.

When the Napoleonic Wars devastated the world economy, at the beginning of the 19th century, Britain stood as one part of a governing triumvirate in Latin America. The other colonizing power was the effluent elite - foreign owners of Latin American mining, agriculture, and communications companies that sought to maintain the structure of underdevelopment with themselves at the top (Cardoso, 1979). The third, mostly subjugated power was comprised of struggling nationalist startups that flourished during brief periods of dispute between the British and elite. The nationals fought to develop domestic industry and self-reliant infrastructures. When Britain's interest was diverted to the African colonies, it was just the latter two powers that fought for opposing development structures (Cardoso, 1979).

By the time of the independence movements of the mid 19th century, a semi-feudal system had developed. The independence movement was not about colonial autonomy, but instead driven in large part by demand for landowners' rights. Many countries gained independence during this time, however no land redistribution occurred. Existing large landowners (usually of foreign descent) used their economic stability and political influence to impede land redistribution and incentives for reinvestments that would have built domestic industries. This elite class was also against investment in education and technological development, so a technology gap started developing between Latin America and the US and Europe.

Late in the 19th century, the elite classes began to demand political authority. This led to close ties between landowners and politicians and further cemented unequal ownership of territory and the means of production. Foreign firms begin to assert control in Latin America through their investments in infrastructure and primary industries. This meant that the early 1900s was a golden age of primary product exports driven by growing industrial and consumer demand in Europe and North America. The elite in

Latin America continued to base the economy on commodity exports, a practice founded upon colonial relationship and perpetuated well into the 20th century. Liberalism, or deregulation of industry, was further facilitated by political instability of Latin American governments, expansion of transportation and communication systems, promotion of foreign investment by the international development agencies, and secondary production industries that opened new opportunities for the exploitation of cheap labor (Vernengo, 2004).

The large metropolitan interests continuously quelled the autonomous capitalism of budding industries. There are many examples these where private interests armed citizens and paid them to revolt against nationally financed infrastructure and independent development efforts (Klaren 1996). Finally by the end of the 19th century, elite mining, agriculture, and communication interests defeated their domestic rivals and the Latin American state was formally allied and subservient to the metropolitan interests.

During the 1900s, the expansion of the elite class solidified underdevelopment. Land was concentrated into a few hands by this point and there was a large unemployed agricultural labor force. Government was dependent upon the elite business class that ruled from the metropolitan centers, and which opened more doors for internal metropolitan trade and new imperial finance. National development was bought with foreign bonds; investments were channeled into elite hands and never financed national development or social support systems. Latin America was thereby subsidized purely as a primary monoproduct export economy. This period firmly consolidated the underdevelopment of Latin America by condoning satellite imperial rule and endorsing unequal terms of trade in global markets (Frank, 1969).

In the mid 1900s, commodities were declining in terms of trade. As income increases, the demand for primary products only increases slightly but demand for manufactured products increase exponentially. High rates of growth in the primary product sector, therefore, were not enough of a catalyst for economic development and the developed countries maintained market advantage. The underdeveloped countries were left with no choice but to expand production of commodities.

Soon all domestic resources were devoted to the "hot" commodity of the season, but profits went to monopoly owners that didn't invest in other domestic industries. Soon export enclaves developed: with little tax paid to Latin American countries, little investment in education or domestic industry, and control by foreign companies dependency on exports to few markets meant the nations were vulnerable to fluctuations in those markets.[3]

Country	First Product	Percentage	Second Product	Percentage
Costa Rica	Bananas	50.9	Coffee	35.2
Guatemala	Coffee	84.8	Bananas	5.7
Nicaragua	Coffee	64.9	Precious Metals	13.8
Panama	Bananas	65.1	Coconuts	7.4

Table 1 Export Commodity Concentration Ratio in 1913. Source: Klaren 1996.

Latin America also suffered a lack of linkages between primary product sector and other sectors (e.g. coffee export industry did not lead to other manufacturing). The high cost of labor rose again because it was tied up in primary products sector, creating disincentive to develop industry. Low wages kept domestic markets small, further discouraging development of domestic industry and a consumer or middle class (Klaren, 1996). Foreign control of export industry continued occurring through large capital investments and by the mid 1900s neoliberal policies were implemented by international

[3] For example, sugar prices in May 1920 were 22.5 cents/kilo, in December 1920 they were 3.625 cents/kilo, and in December 1929 they were 1.471 cents/kilo. Another example, coffee, fell 40% between 1929-1930.

economic development agencies that further incentivized these foreign investments and perpetuated export-driven economies.[4]

Country	Commodity	% Total Exports
El Salvador	Coffee	92
Venezuela	Petroleum	92
Cuba	Sugar	78
Panama	Bananas	77
Bolivia	Tin	68
Guatemala	Coffee	66
Honduras	Bananas	64
Colombia	Coffee	61
Chile	Copper	52
Costa Rica	Coffee	49
Nicaragua	Coffee	47
Brazil	Coffee	45

Table 2 Single Commodity as a Percentage of Total Export in 1938. Source: Klaren 1996.

But in the last part of the 20th century urbanization began and labor unions followed, more openings for political organization by the middle class appeared. This domestic mindset focused on new economic frameworks and social welfare reform. Latin American intellectuals devised models of core-periphery commodity dependency and Dependency Theory, which I will discuss in the following chapter. Proliferation of dependency theory and sentiments of nationalism created new awareness of Latin America's role in the global markets (Klaren, 1996). Latin Americans were finally laying a foundation for internal development. But, just as progress was being made, the global economic crisis in 1980s led to debt crisis, structural adjustment, and political turmoil in 1990s.

[4] Neoliberalism is an economic and political doctrine that emphasizes market-led growth, deregulation of business, cutting public expenditure for social services, privatization of state-owned resources, reducing the role of the state in the economy, and the creation of flexible labor markets. Neoliberal policies have been imposed on developing nations by international financial institutions, including the International Monetary Fund and the World Bank, and are now reinforced by the World Trade Organization rules.

The last section provided a regional economic background for Latin America. It demonstrated patterns of development in these countries. First, a developed country colonizes a nation on the periphery and sets up an unbalanced economic structure both within the peripheral community and between the periphery and the developed nation. This leads to limitations on self-sustained growth in the periphery and favors certain socioeconomic classes. In the next section I will focus on a specific industry in a commodity-dependent nations to explore the challenges and opportunities created by these patterns of development.

2.3 Local Development of Coffee

Coffee production began in Costa Rica in 1779. A native plant of Ethiopia, the blend introduced to Costa Rica had been first cultivated in Saudi Arabia and is therefore known as the Arabica variety. Coffee growing soon surpassed cacao, tobacco, and sugar in importance and by 1829 it had become the country's major export. As of 2007, Costa Rica produced roughly 250,000 pounds of coffee (FAO 2010).

Workers receive only around 60 ¢ to $1.50 per basket picked. Each basket weights around 15 pounds and a good worker can fill as many as 12 per day. Although it seems incredibly low, these rates are proportional to other agricultural salaries, whose minimum is set by government mandate. The hand picked berries are trucked to beneficios (processing plants), where they are scrubbed and washed to remove the fruity outer layer and dissolve the gummy substance surrounding the bean. Then the pulp is returned to the slopes as fertilizer and the moist beans are then laid out to dry in the sun. The leather skin of the bean is then removed by machine agitation, and the beans are sorted according to size and shape before being vacuum-sealed and exported.

As with any plantation crop, one of the major drawbacks is that the income is subject to price fluctuations. When this market fluctuates, the livelihoods of the coffee producers dependent on it fluctuate as well, especially since the majority are small-scale producers. The coffee crisis of 2001 has left small-scale coffee-producing communities socially, environmentally, and economically devastated as they search for quick-fix solutions (Babin 2009). The markets proved vulnerable because dependent on exports to one or a few countries.

Small-scale coffee farmers have no control over international coffee prices and are made vulnerable by the ever-shifting market. The price fetched for coffee has fallen below the cost of production for many farmers, causing them to abandon or convert their land to other uses. Cattle pasture is a popular form of land use conversion because most farmers do not have much start up capital. Foundations for this research are based on an abundant literature that describes the devastating aftermath of the coffee crisis of the early 2000s. Authors like Daniel Jaffee (2007) chronicle the transitions experienced by many communities, previously dependent on a monoculture of coffee, which showed economic downturns and ecologically destructive actions by desperate people.

The community of Aguabuena de Coto Brus, Costa Rica has suffered both economically and ecologically from the crash of the coffee market in 2001. The crash of the coffee market often referred to as "The Coffee Crisis" has led many humanitarian groups including Oxfam to declare a humanitarian disaster throughout the tropical world (Oxfam, 2006). The drop in the price of coffee has led to loss of jobs and forest cover as farmers have resorted to cutting trees for profit. In Aguabuena, an estimated 50% of coffee farms and forested land has been cut for cattle pasture since 2001 (Jimenez, 2009). The youth see little to no future in agriculture. Most young people after graduating or dropping out of school are pushed to urban centers or the United States (illegally) in search of work (INEC Census 2000).

Figure 2 Coffee cherries are picked, pulped, and dried. Source: Author.

Learning from the mistakes of older generations, the young Costa Rican people are eager to repair the effects of years of damaging behaviors (Jimenez, 2009). Because this small movement is already motivated by personal experience, we found that encouragement and facilitation were the only components necessary to foster a successful and prepared generation of agriculturalists. Additionally, according to household surveys, which will be discussed at length in Chapters 5 and 6, men and women between the ages of 18-25 favored jobs based on money rather than on family tradition, we concluded that monetary incentives would be the most successful means of encouragement.

The project in this study examined options for entrance into the carbon market and their viability for providing both diversification to a small-scale agricultural community's economy and a socially responsible way to manage ecologically sensitive land. If successful, the Finca Project's CoopePueblos Carbon Initiative would unite the local efforts of landholders to earn a premium for their coffee, have agency within their regional economies, trade carbon credits on the international markets, and mitigate carbon dioxide emissions. This project would thereby bridge multiple scales and provide a multifaceted approach to poverty alleviation, oppressive economic regimes, and carbon dioxide levels in the atmosphere.

2.4 CONCLUSION

This chapter has illustrated that global markets tend to develop with unbalanced economic structures that benefit the parties in power. This leads to limitations on self-sustained growth in some regions, while leveraging other regions into technological development. The markets discussed in this chapter take on different appearances of specific patterns through the various scalar lenses, though they are all expected to integrate seamlessly at the global level. I argue that this requires modifications in regulations to guarantee both the functioning of multiple economies and the political articulations of the participating communities.

Chapter 3: Research Design

This chapter is meant to provide transparency to my study. Any agenda or motive I had in framing the study, choosing research strategies or writing the results in the language I did will be made clear in this chapter. I start with my ontological perspective and discuss my perception of reality and what I know to be real. Then, I will discuss my epistemology and the way I know things. Finally, I include my research framework and theory behind my research strategies. This chapter concludes with intended goals of my research.

3.1 Ontology, Epistemology, and Methodology

My research is framed by a qualitative methodology of inquiry that includes a set of perspectives that are exploratory and generative. Naturalistic inquiry is one name for this methodology, although other terms include phenomenology, hermeneutics, and constructivism (Guba and Lincoln 1998). It depends upon artifactual and experiential evidence to elucidate the many narratives of the carbon cooperative experiment. My system of inquiry framed the articulation of my research and directed my research methods, but is used only as an assessment tool and not a strict regimen. I explain it here only to highlight the vital link between theory and method, not to perpetuate a dichotomous parallel between quantitative and qualitative methods. In fact, I perform some quantitative analysis to triangulate my qualitative findings and supplement the narrative.[5]

My ontological assumption, or my lens for the nature of reality, is a subjective one where there are multiple truths in which reality is socially constructed. In this study,

[5] Triangulation is a social science research strategy that uses qualitative and/or quantitative data gathered from at least three separate sources to identify the consistency across data sources (Groat and Wang 2002). Originally a concept used in navigation, it refers to the use of multiple reference points to locate the exact position of an object. In the case of social science, this object may be intangible, like a socially constructed fact.

for instance, it was important for me to garner narratives from many different community members in order to view the cooperative intervention from all facets. I did not want to limit my investigation to one age group, gender, or socioeconomic class because social issues surrounding landscape interventions like the cooperative are complicated by opinions that vary by experience. Instead, I performed surveys at each of the 51 households on any resident that was available to speak with me. I include a sample of these in Appendix 3. The stories I collected came from both men and women between the ages of 18 and 64. I wanted to weave these narratives together to provide the most comprehensive picture of the community – that is I wanted to gain a holistic understanding of the commonalities and contradictions at play in order to identify areas of convergence and divergence in public interests. The benefit of mapping these narratives is that networks begin to emerge in which the community members are identifiable as stakeholders acting within specific relationships. The repeated reinforcement of certain relationships begins to detail a description of how common activities, habits, and procedures sustain themselves within the community.

My epistemological position is that it is not possible to establish a value-free objectivity as a researcher. Instead, I recognize that reality – and especially policy – is an agreed upon framework that reflects social values and can be used as a tool to reinforce social values. The carbon market is a perfect example of this social construction: it is an economic system created by policy that incentivizes the craft, implementation, and management of new carbon sequestration technologies. Some of these technologies are new innovations, whereas the one utilized in the CoopePueblos Carbon Initiative is simply a recognition and codification of an old, organic process: photosynthesis.

I was studying technologies that were socially constructed, and so I chose research strategies that were interactive and allowed me to observe first-hand the values and social constructions of my study participants. This meant that my research methods involved an inductive process of multiple critical factors affecting the carbon cooperative's success; an exploratory form of reasoning in which the conclusion, though supported by the premises, does not follow from them necessarily. Instead, it acknowledges the content-based limitations of any suite of variables and makes a generative argument through triangulated facts.

In order to establish credibility in my study, I also triangulated data between research methods. I recorded daily notes that correlated to survey data and historical research so that I could track inconsistencies and follow up on emerging perspectives. In this way, I created feedback loops for myself and continuously revised incoming data.

3.2 Theoretical Framework

The theoretical framework that I draw upon is a body of social science, called Dependency Theory, which is predicated on the center-periphery model where resources flow from a periphery of poor and underdeveloped states to a core of wealthy states (Cardoso, 1979). This theory uses this model to explain why some world powers always seem to be enriching themselves at the expense of other nations. The theory shares many arguments with Marxist theories of imperialism, like the division of skilled and unskilled labor and technological stress, but distinguishes itself with its emphasis on terms of trade.

Dependency Theory gained popularity in the 1970s as a reaction to Modernization Theories that suggested all societies progress through similar stages of development. In other words, today's underdeveloped areas were thought to be in the same situation that today's developed areas were in at some point in the past – all traveling down one path to enlightenment (Cardoso, 1979). Under Modernization, the task of accelerating development happened through urging less developed countries down this path by means of investment, technology transfers, and closer integration into the world market.

In backlash, Dependency Theory rejected this view and argued that underdeveloped countries are not merely primitive versions of developed countries but have unique characteristics and are stuck with the perpetual disadvantage of being weaker members in a world market economy (Vernengo, 2004). Conversely, the developed nations are in a constant position of power in market interactions and therefore have a perpetual advantage for development. The dependency theorists, in contradiction to the Modernization theorists, recommended reduced connectedness to the global market place as a counter measure to the social structures that held these power inequalities in place.

The structures have been constructed through years of historical precedents in Latin America, as I discussed in Chapter 2, and there are a few main themes worth repeating. One is that a high proportion of the developing nations economic activity consists of exports and imports from the developed nations – in many cases these are unilateral relationships developed with only one country (Klaren, 1996). By contrast, only a small proportion of the economic activity of the developed nations consists of trade with the developing nations; a developed nations trade consists mostly of internal trade and trade with other developed nations. This asymmetry puts a poor nation in a weak bargaining position with a developed nation. Also, the poor nations are almost all former colonies of the developed nations so their economies were built to serve the developed nations as sources of cheap materials and as highly populated market for the absorption of the developed nations' manufactured output (Cardoso, 1979).

The history of Latin America also details the consequences of these structures. The peripheral nations provide natural resources, cheap labor, and a destination for obsolete technologies and markets for developed nations, without which the latter could not have the standard of living that they enjoy. Also, wealthy nations actively enable a state of dependence by various means involving economics, media control, politics, banking and finance, education, culture, sport, and all aspects of human resources development. Finally, those wealthy nations actively counter attempts by dependent nations to resist their influences by means of economic sanctions and/or the use of military force. Dependency theory states that the poverty of the countries in the periphery is not because of a lack of integration into the world system, but because of how they are integrated in to the system (Cardoso, 1979).

This framework provides many useful lenses for deconstructing the relationships within global markets. Its tenets examine different kinds of production and consumption habits that can be related to commodities, such as coffee, and to newer markets like carbon. Dependency Theory helps delineate vectors of power within economic relationships such as those that benefit from regulations (usually the countries with influence at world meetings) and those that do not. This theory also serves as a foundation for the value-added markets that developed from it, namely fair trade markets and social value markets, which will be discussed in the following chapter. The theory helps frame ideas of progress and development as nonlinear feedback loops – a model much more in line with my constructivist understanding of the world and its emergent social processes.

Limitations of this framework include an assumption that wealthy nations act as insidious market forces, bullying less wealthy countries into economic stagnation. There are also critics that dissect the economic and political spheres, claiming that even if a nation is economically developed (a wealthy nation), one may be either politically autonomous or dependent. This creates doubt that a model as simple as the core-periphery is useful in extracting the multifaceted relationships between developed and developing nations.

3.3 Case Study Approach

The town was chosen for this pilot project for several reasons. First, the economic recession has resulted in a boon of foreigners purchasing Latin American properties. Therefore this town is experiencing increased pressure from both private developers and commercial investors. Also, the national government just paved the first road in this area, increasing local access to external markets, also promising an exponential influx of outside influences. The threat of development is important because it implies further destruction of natural resources.

Secondly, farmers in the area have an increased awareness of market fluctuations and of low-impact farming techniques. Many of them have experienced first-hand the consequences of the deforestation and industrial farming that occurred over the last century in Costa Rica (and heavily in this region in the last two decades). Some of them have responded by employing sustainable farming methods such as organic fertilizers, composting, biogas production, and increased biodiversity in place of pesticides. This internal awareness is important because responsiveness can be a powerful driver for change.

And, finally, a proximate botanical garden houses a satellite research station of the Organization for Tropical Studies, and attracts top scientists from many fields every year. Currently, they are focused on academic pursuits, but have begun community outreach with their findings. A scientific community is important because they potentially play an important role in monitoring and circulating project results.

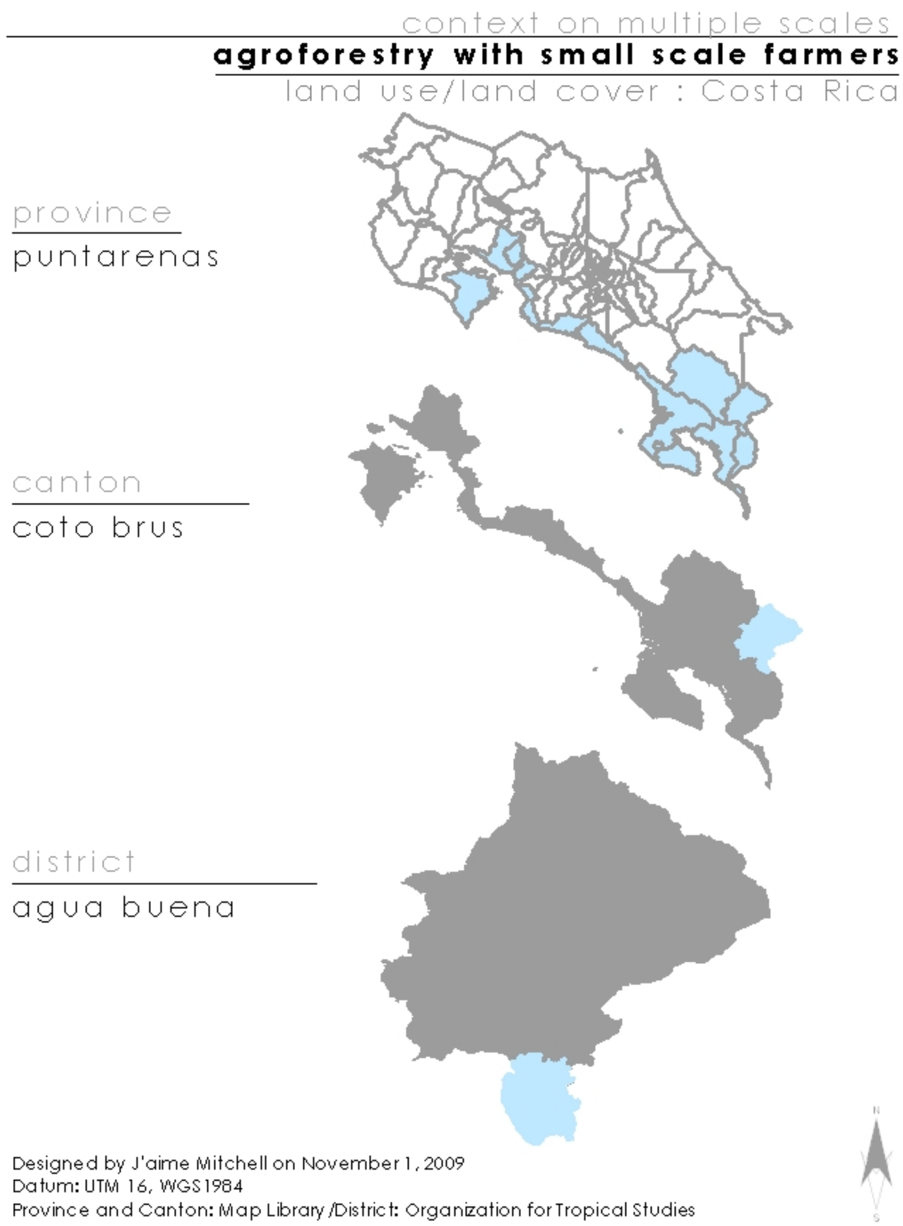


Figure 3 The district of Agua Buena in southern Costa Rica.

3.3a Why a Case Study

My study offers an in-depth description of the behaviors and land use patterns affected by the CoopePueblos Carbon Cooperative in Agua Buena, Costa Rica. This case study encapsulates general circumstances around a specific phenomenon so that a more comprehensive contemporary context can be presented. This empirical approach is most useful in studying complex social phenomena (Yin 1994). It requires a systematic reporting of all evidence and strict time limits on data collection and writing, but has the ability to produce a web of holistic and divergent narratives of meaning and function in a community. Many authors find strength in the ability to tailor the case study process, for it creates a portrait of any community that a reader will be able to experience vicariously (Stake 2005; Eisner 1991). Case studies can also adeptly explain causal links with a compelling wealth of data if they are done well.

In addition, the field-based experience provided tangible results with real world impact. If successful in the future, the ARR project would allow coffee farmers to be less dependent upon coffee prices and have a diversified income. This would allow landowners to reinvest in their own land and community. The data resulting from this case study will definitely provide these small-scale landowners the options and knowledge to continue their ecological investment and spur other investments of their choosing once access to financial assets is provided.

3.3b Limitations of a Case Study

However, there are limitations to such focused case studies. While analysis and findings can follow specific processes, they vary greatly according to the characteristics of the community. This can make it difficult to replicate the studies and therefore to find a generalizable theory. Although constructivists like Flyvberg (2006) argue that case studies can be generalized “to a degree”, it is important not to underestimate the unique complexities involved in each case. For instance, the abundant data sources can become incoherent while an author is integrating them into the multi-faceted complexity of causal links. Instead, I acknowledge the content-based limitations of any suite of variables and makes a generative argument through triangulated facts. In other words, this is not an essentialist explanation of events; rather, it is a methodological stance with a constructivist result.

3.4 Conclusion

This reflexive section has described my ontological and epistemological assumptions explicitly so that the reader may understand the influence they have had on framing my research question and any changes in perspective that may have emerged throughout the course of my research. The theoretical framework that I have chosen is not the only way to frame these issues, but the focus on both technological dependency and unequal terms of trade provide both a deeper theoretical understanding and practical opportunities for solutions.

Chapter 4: Literature Review

This chapter reviews bodies of literature that relate to Dependency Theory and alternative options for commodity markets. This chapter will also demonstrate that these bodies of literature are incomplete if they are to be used to foster changes in economic policy and regulation of markets.

4.1 Dependency Theory Disadvantages

Traditional dependency theory posits that the discrepancy between developed and undeveloped countries is technological advancement. Former Brazilian president Fernando Henrique Cardoso wrote extensively on Dependency Theory while in political exile and is revered for his passionate approach to studying the economic disparities between the core and periphery. He argues against internationalism and any hope of progress towards industrialization in less technologically developed countries unless social revolution first liberates the nation. His arguments highlight the inarticulateness and structural imbalance in a society controlled by external forces. He describes the "technological and financial penetration" of core nations into the periphery as the root of this imbalance.

Vernengo, a critic of Cardoso, says that although he claimed to be a leftist and supporter of social democracy, he also had distinctly neoliberal economic leanings. For example, he helped pioneered the largest privatization movement in the history of Brazil and used his economic triumphs to make friends with American politicians. However, he also chartered a decree that gave autonomy to a number of indigenous groups and supported legislation that subsidized domestic industry. It could either be said that Cardoso had conflicting views of politics and economy or that he imagined a hybrid system that gave autonomy to the people of his nation and then removed economic barriers to provide them the greatest profitability. His writings lack clarity and consistency, according to Vernengo, leaving the reader confused about the ideal course of Latin American development.

In addition, Cardoso's theories cater to urban regions like Brasilia and Rio de Janiero but do not make recommendations for the rural population. This is a grievous oversight since land use changes are primarily in the hands of the rural population in the global South. Although there is a recent trend among populations towards urbanization, the majority of the land is still classified as urban and agricultural (INEC 2000). Cardoso's lack of clarity and rural consideration leaves much to be desired from his writings.

In response to Cardoso, sociologist Matias Vernengo suggests that the source of the dependency relationship is not a discrepancy of technological sophistication, but rather the difference in financial strength between two trading nations. Vernengo specifically cites a country's inability to trade in its own currency as a contributing factor to the global South's culture of poverty. He believes that the hegemony practiced by the Unites States is very strong because of the importance given to its reserve currency. Vernengo states that this is more influential than the strict definition of the technological division of labor, and the theoretical problems caused by the effective industrialization of several countries in the periphery, the debt crisis, and the failure of the neoliberal agenda. Vernengo argues, "in the new era of globalization and great transformations in the international economy the new dependency seems to be financial in nature" (Vernengo 2006, pp 16).

Vernengo's arguments are erudite in the case of the carbon market. Access to the market is restricted because carbon credits are traded strictly in Euros and Euros exchange as disparate values in many cases, creating unequal terms of trade (as discussed in Chapter 2). Vernengo's arguments have not been applied to the carbon market, however, leaving a gap in the analysis of these new commodity markets. They also do not examine the multiple scales of currency exchange that lead up to trade on the international scene and instead, Vernengo focuses on finding solutions for regulation at the global scale. I argue that this approach only addresses one symptom of a much more complex multiscalar problem.

This section has reviewed literature on commodity dependency theory and the politicians and policies that are working to reform the world systems that maintain this power structure. Next I will look at market-based strategies that work within the current structure to eliminate commodity dependency, specifically the spiraling prices associated with the coffee market.

4.2 VALUE ADDED MARKETS

There have been several attempts to present alternative economic rents to the coffee farmers of Latin America. Among many, the most famous among them are the fair trade markets. These markets present an opportunity for importers and roasters to pay a premium wage to farmers for higher quality, more ecologically friendly coffee. In the consumer markets these premium coffees are sold at specialty shops and cafes with an added price tag and a story that appeals to the public's conscience. This section evaluates critiques of this alternative.

In the fair trade culture, the entry point into the material and symbolic economy of value is to consider the efforts of the various actors in the coffee producing network and to elevate their product above generic commodity status – above "commodity" connotations of bulk supply, homogenized attributes, and lack of refinement. Consumption has already reached a saturation point in the United States and the European Union markets, so producers have instead pursued a variety of product-differentiation strategies to capture premium prices.

Researcher and lecturer Christopher Bacon investigates these alternative methods in his book Confronting the Coffee Crisis. In this book he links changing global coffee markets to opportunities and vulnerabilities for sustaining small-scale farming livelihoods. Changing governance structures, corporate concentration, and oversupply complicate the attempts of fair trade alternative markets to escape the neoliberal traps of the commodity coffee market. Additional chapters examine the certification and eco-labeling, discussing the politics and market growth of specialty coffees (Bacon, 2008).

Daniel Jaffee, a sociologist, approaches the topic from the uncertain equity of technology distribution. He describes the export crisis in the tropics and its destructive forces. The book presents a series of interdisciplinary, empirically rich case studies showing how small-scale farmers manage ecosystems and organize collectively as they seek to create opportunities for themselves. The findings demonstrate the interconnections among farmer livelihoods, biodiversity, conservation, and changing social values among consumers (Jaffee, 2007).

Both authors analyze scales ranging from the global to the local and reveal the scalar pitfalls of efforts to create a more sustainable coffee industry. Bacon concludes that the third parties charged with certifying fair trade practices can actually incite internal instability in communities because they create a system of favorites. At the regional level, Jaffee shows evidence that funding for better farming practices go exclusively to cooperatives in most countries. This creates a negative feedback loop between independent farmers and available resources. And, finally, at the global scale both authors argue that there is no way to regulate fair trade practices or monitor their redistributive abilities. Research thus far has only gathered the success stories collected from quantitative studies and reported by fair trade institutions themselves, but there has been no long-term proof that these value-added markets support or sustain the micro-economies upon which they rely.

Figure 4 Coffee cherries ripen at different times on the tree. Source: Author.

4.3 STUDY CONTRIBUTION

The dependency theory literature sets a theoretical foundation for examining the advantages and disadvantages created by powers in the global North in order to exploit and repress the global South, but it does not specifically address economies of scale. The value-added literature does address small-scale farmers need to interact with overarching regional and international policies to take advantage of the global marketplace. It discusses their attempts to counter commodity dependency by entering these larger networks through alternative avenues and the challenges they face as they realize the disadvantages they face in regard to terms of trade and technology.

However I did not find a body of literature that presented a critical review of the carbon market through the lens of these well-known economic mechanisms. My study will contribute a field-based review of access to the carbon market and the reality of challenges facing small-scale farmers as they try to enter larger scale markets. It presents scalar mismatches driven by terms of trade and technological disadvantages and shows that dependency theory is still a useful lens for examining new commodity markets.

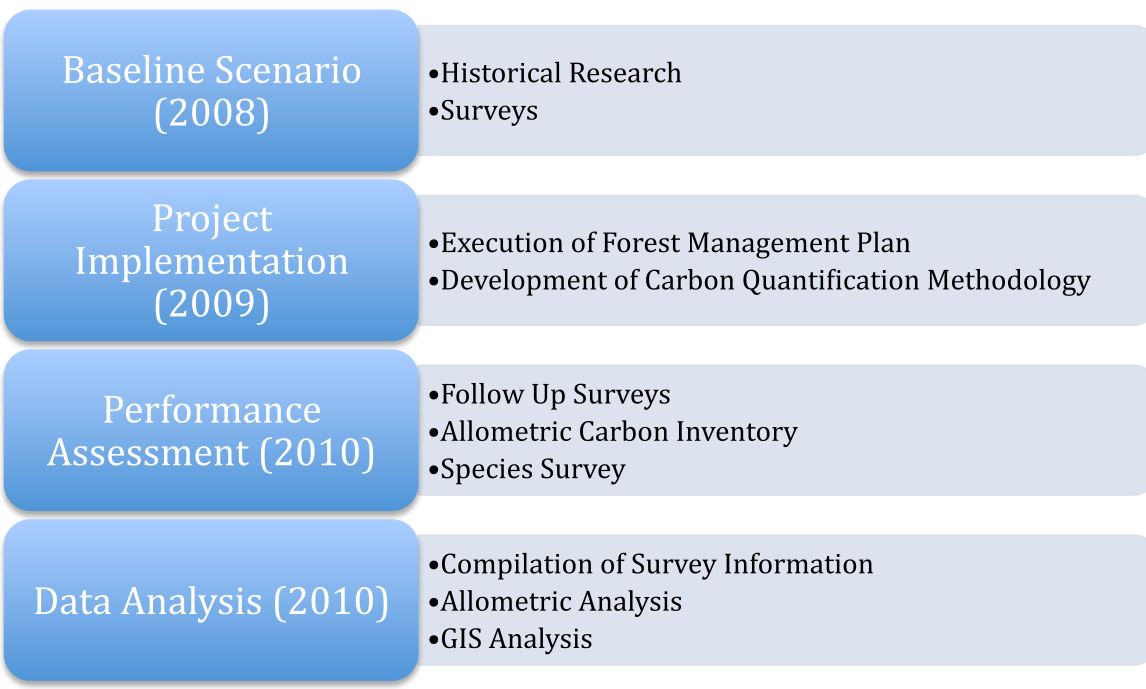
Chapter 5: Strategic Methods and Analysis

This chapter describes the strategic design and research process. The first phase of this project began in 2008 when Finca Project hired three interns, including myself, to demonstrate the need for a carbon sequestration project for CoopePueblos, a small-scale coffee farmers' cooperative. A baseline scenario was generated using approved Agroforestry, Reforestation, and Revegetation (ARR) methodologies.[6] This baseline included a LULUC detection analysis that involved a historical analysis of cultural and legal structures, which I developed through a triangulation of historical research, household surveys, and Geographic Information Systems (GIS) analysis. This change detection analysis presented historic trends that predicted continued destruction of the regional forest. Therefore, a need for incentivized reforestation was demonstrated and research from the other interns demonstrated promising financial incentives through carbon credits. We then devised a forest management plan that prepared farmers of CoopePueblos to enter the carbon market.

In the second phase, all 51 participating farms implemented our forest management plan. During this time period I worked with Brendan and Eliot, co-founders of Finca Project to collect appropriate carbon quantification methodology from ARR-related literature, lectures, workshops, and conferences. This process is not presented in this thesis, though our justification for chosen methodologies is discussed. During this year, Brendan also stepped down as President of Finca Project and I was elected in his stead. I include this information here in order to maintain transparency about my stakeholder status in the development of this project.

[6] CoopePueblos is made up of 54 farmers with under 10 hectares of cropland each.

After a full year, I returned with a different group of interns to perform the third phase of the project. The new group investigated the economic, environmental, and social impacts of the CoopePueblos Carbon Initiative through follow-up surveys, an inventory of sequestered carbon, and more GIS analysis. We measured the environmental impacts and found that the increased tree cover benefited the nutrient cycle of the agroecosystems and reduced pressure on surrounding forest. We measured the economic impacts and found that the improved nutrient cycles provided additional ecosystems services and supplied sustainably extractable resources. And we measured the social impacts and found that the additional ecosystems services created better quality of life for the community and the sustainable extraction promised fungible benefits for generations to come.



5.1 Baseline Scenario

A baseline scenario is an examination of expected conditions in the project area in the absence of AFOLU project activity and presents what may be referred to as a "business as usual" scenario. It is meant to provide a description of the project's physical context and the cultural, legal, and historical influences on land use activity patterns. The physical boundaries framing this scenario are small-scale agroforestry plots in an agroforestry land area comprising a total of 64 hectares. The geographical distribution of the 64 hectares are scattered over a total area of 6,118 hectares and do not represent a contiguous coffee plantation. Through a combination of historical research, surveys, and GIS analysis, this baseline scenario demonstrated significant land use activity trends embedded in the cultural and economic context of the community that will be discussed in the following chapter.

5.1a Historical Research

An important component of data gathering was collecting relevant documents that included aggregate data from the local, regional, and state levels. I began doing historical research on Agua Buena in the spring of 2008 in Austin, TX. I used historical documents, periodicals, and peer-reviewed articles to build a foundation of data that would prepare me for fieldwork in the Costa Rican town. I started my search generally, first reading about life in the tropics and in Central America before narrowing my focus to Costa Rica.

When I arrived in Costa Rica, I triangulated my sources as best I could by consulting local sources. For instance, the census of 2000 provided me with many socioeconomic statistics and I fleshed these out with cooperative records of production levels and received prices for each of the farmers. Any inconsistencies that I found became the basis for survey questions that I would use during my research in the field. Through contact with other researchers, non-governmental coffee organizations, and state agencies, I gathered many valuable articles, books, and reports that I used to understand how Agua Buena and the CoopePueblos cooperative fit into the bigger picture of small-scale coffee producers worldwide.

5.1b Surveys

I was initially reluctant to use a structured survey to gather data in the coffee-producing households. In addition to recognizing the documented limitations of survey research, I was uncomfortable with the prospect of an outside researcher bringing a prepared document and asking people to respond to intrusive questions about their personal lives. However, I eventually concluded that a carefully applied survey would help fill in the gaps in current knowledge and triangulate the more qualitative historical data. I settled on a hybrid survey, in which the majority of questions solicited discrete-choice answers and numerical data (on coffee production and prices, household income and expenses, agricultural production and labor, and family structure) but also included many open-ended questions that allowed for the expression of opinions. A sample survey is included in Appendix 2.

To design an effective survey I contacted a PhD student, Nico, who had been doing dissertation research in the area for nearly a decade and was able to help me translate my questions into the local dialect. I was able to use some of his data from a 2000 household survey with similar questions in order to triangulate my data from 2008 and 2010. After drafting, soliciting input, revising, pre-testing, and further revising, the final result was a 45-minute survey that repeated similar themes in different words in an attempt to confirm the validity of the responses.

We both surveyed the same 51 households, so our sample pool represented 100% of the cooperative, and asked native Costa Ricans to perform some of our surveys. The purpose for the assistants was to derive whether any outlying data should be attributed to miscommunications in our translation or to misleading information given to us because we were foreigners. There is, however, a margin of error present in the survey data because the population I surveyed was not identical to Nico's. Although we surveyed the same households, we did not speak with the same household representatives. Also, we each used different assistants for performing the surveys: his was a male Costa Rican farm hand, and mine was a female university student.

The female university student, Merlin, accompanied me on the first 11 surveys. Merlin was raised in Agua Buena but her family has no affiliation with coffee and so she was able to serve as a neutral party. We performed the initial ones together so that I could adapt to the technical vocabulary of agricultural land uses and so that she could witness how I wanted to conduct the survey sessions. We then divided the remaining 40 surveys and conducted them individually over the next two weeks.

We made appointments in advance with each household and always arrived at the households by foot or motorcycle, as these are the traditional modes of transportation in Agua Buena and I wanted to be unimposing as possible. Upon arrival we each read the same introductory paragraph that explained the survey's purpose and assured them that the survey was voluntary. We also presented a letter from the board of directors at CoopePueblos that endorsed our purpose, but assured the households that the responses would not affect their eligibility for federal support programs in any way. We surveyed the first member of the household (over 18 years old) that was available to answer our questions. While I realize that this approach may have altered some of the information presented to us, I was not prepared to assume that any one member of the household's narrative was more valid than any other.

In total we surveyed 51 households with a range of incomes, ages, and levels of education. These data were used to triangulate census data and are discussed in more detail in Chapter 6. The information was also incorporated into my GIS analysis when I needed to derive land use change information that was on a scale too small for satellite imagery to produce. This process is discussed the end of this section.

5.2 PROJECT IMPLEMENTATION

At the end of 2008, after all of these research methodologies had been executed, the three Finca Project interns collaborated on a set of recommendations for the community. My colleagues had been working closely with organic farmers and local forestry consultants to build a foundation of local knowledge that complimented our academic expertise. Synthesizing these two types of knowledge we devised a four-part forest management plan that would optimize the land for carbon collection.

The Finca Project asked farmers in the Agua Buena area to plant seven (nonspecific) species of trees on their farms. As outlined in the table below, each farmer signed a contract outlining the requisite for participation in the project. The contract was based on four principles of conservation: conservation of the ecosystems and the life of the forest, conservation of the soil, management of fungi and diseases, and the sustainable subsistence harvesting.

For the principle of conserving ecosystems and the life of the forest, they were asked to incorporate a diversified forest cover with at least seven distinct varieties of trees. We provided them with a list of suggested trees and their benefits. I also created a manual for tree management that covered basic tenets of shade cover for optimizing understory crop growth, minimizing fungi, and enhancing soil quality through leaf litter and nitrogen fixation.

The structural diversity of shade trees influences the carbon-stock of coffee agro- ecosystems. Farmers may choose to plant a variety of fruit trees for household use, timber trees also for house hold use or to sell within the community, specific species for live fences, and lastly nitrogen fixing trees to enrich the soil. Specifics of tree incorporation were left up to the families; there is no one size fits all strategy for this because each farm and family is unique and has different needs and knowledge as far as tree selection and spacing. Most farmers have an personal opinions about which trees they want and where to put them, so we relied on their knowledge and instead worked towards putting incentives in place as well as making the trees easily available.

For the conservation of the soil, they were asked to control erosion on their farm where the slope of the land exceeded 20%. The areas were excluded from planting space, and not included in the calculations for total carbon sequestration calculations. Instead, these areas were populated by native grasses and retained as buffers between labor-intensive reforestation plots.

Agrochemicals were to be reduced over a two-year period in the management of fungi and diseases. The initiative also sought a sustainable diversification of land uses. Therefore, the contract sought to preserve some agricultural practices of the farmers, specifically subsistence farming and coffee.[7]

We designed the plan to improve the social and economic livelihood of the coffee farmer, both of which are dependent on the land they own, namely the successful cultivation of coffee for sale in national and international markets. We predicted, therefore, that the coffee farmers and their families would therefore benefit greatly from the supplemental investment in the community through the sale of carbon credits because it would help promote the economic viability of coffee cultivation while maintaining the number of hectares dedicated to coffee plantations.

5.3 Performance Assessment

In 2010, I returned to Agua Buena with a new group of interns. The forest management program that the original group designed had been in effect for a little over a year. I performed follow up surveys with Merlin while the other interns – all environmental scientists from the Yale School of Forestry – focused on designing sample plots and allometric equations for carbon quantification. This section describes the

[7] According to the surveys in 2008, coffee was still the primary commercial crop in Agua Buena.

research strategies used to gather data about the impacts of the forest management plan's first year. The methods were chosen to highlight three different areas of impact: social, environmental, and economic. Chapters 6 and 7 will describe the implications these impacts hold for the CoopePueblos Carbon Cooperative.

5.3a Follow Up Surveys

These surveys attempted to follow the protocol of the first surveys exactly, however this was not always possible. Appointments were made when possible, but summer thunderstorms had knocked out many of the communication lines around town. We continued to survey any household member over the age of 18, so as not to discriminate against any one narrative. Of the 51 households, two participants refused to participate while we were obtaining verbal consent and one suspended participation in the middle of the survey. In all 3 cases we were able to find another member of the household willing to participate, but we noted that in each case the reason for nonparticipation was cited as "conflict with the cooperative". This unease in three separate households signified increasing internal struggles for our project's continuation and the conflicts were recorded.

While this conflict weighed on me heavily, the surveys were easier the second time around because my presence was less of a distraction. By the time we conducted the second round of surveys, I had been visiting Agua Buena over a period of more than 13 months. I had chosen my relationships carefully to maintain neutrality in the town and had earned the trust of its citizens. The surveys took almost one month the second time because I had to perform them in between other field inventories.

5.3b Allometric Carbon Inventory

For the carbon quantification the interns of 2010 chose pools that were anticipated to decrease with project activities. Based on land use change patterns we chose above-ground biomass of shade trees, coffee plants, below-ground biomass of shade trees, and soil organic carbon. Overall, coffee plants account for 2%, shade trees for 17%, below-ground biomass (roots) for 4% and soil carbon for 77%, of all the carbon stored in the system.[8] Also, this project only measured the net change of CO2, acting under the conservative assumption that the emissions of non-CO2 greenhouse gases account for less than 5% of the project's total GHG emissions reductions (Pearson, 2005).

Only the portions of farms dedicated to coffee cultivation were measured; other land use types within the farms were not included in the carbon estimations. Noticeably, forests are not part of the carbon budget calculations. Home gardens and other productive systems within the farms were also ignored for the carbon calculations. We recognize that these land uses are interconnected with the coffee production system and its carbon stock dynamics, but limited our framework to ARR activity.

First, the field technicians (two interns from Yale) established permanent plots for field sampling that measured 20m x 50m and recorded the GPS coordinates at the four corners and at the center. It was the responsibility of the field technician to measure and record the diameter at breast height (DBH) and height of all the shade trees greater than or equal to 5 cm and the respective species name. Average height and DBH of the coffee bushes were calculated by counting all of the bushes in the plot and recording the height and DBH of the coffee bushes in every other row. The technicians then created four subplots by walking 10m in each direction (north, east, south, west) to measure the herbaceous vegetation, roots and soil. It was then the job of all the interns to monitor within the permanent plots weekly.

5.3c Species Survey

The project attempted to guarantee the long-term sustainability of existing interactions between species communities. Biological relationships were protected and

[8] See Appendix 1 for definitions and quantification equations of these carbon stocks.

given the opportunity to evolve and progress naturally during the year of implementation. At the landscape level, our efforts monitored improvements in or deterioration of connectivity and function.[9] Any change in connectivity can change the biotic component of a location and lead to species loss. Therefore we wanted to monitor whether preserving connectivity of corridors had maintained migratory pathways and ensured that wildlife species were free to move about the region.

In order to accomplish this, a selection was made of taxomic groups that included critically threatened endemic species (plants and birds) as well as a bioindicator group for overall biodiversity. The following indicators were selected: for plants, diversity and regeneration of seedlings of interest; for birds, biodiversity and presence of key species; for insects/bees, diversity.

Data collection was assigned to both Finca Project interns and members of the community such as farmers. This decreased costs involved in monitoring impacts of the project while engaging community stakeholders. Each week we surveyed the forested sample plots by counting the number of indicator species and number of each population we saw during three one-hour periods schedule for sunrise, afternoon, and sunset. Overall, the Costa Ricans were far more successful at spotting species than the interns so the surveys required that each intern had a Costa Rican partner whenever possible.

5.4 Data Analysis

As a group, the interns analyzed all of the data gathered through these methods in various ways, and each group of data provided a measure of triangulation against data from other sources or methods. I used the survey responses to generate preliminary sets of findings. I manually compiled statistics and analyzed subsets of information to determine what the data showed in a key areas like education, farming practices, migration, debt, coffee production and yields, and producer's future plans for their land.

[9] Connectivity and function are defined, respectively, as the percentage of the area of biological corridors within the project zone and the percentage of protection of aquifers and other waterways (Kollmus, 2009).

Meanwhile, the students from Yale performed a complex carbon sequestration quantification analysis using the allometric equations contained in Appendix 3. Afterwards, all of this information was incorporated into my GIS analysis and mapped. The next chapter will discuss all of our findings.

5.4a GIS Analysis

I used GIS to do a land use change detection analysis. I used the contacts from the Organization for Tropical Studies website to acquire relevant shapefiles for the region. They are a research-based organization located outside of Agua Buena that keeps a library of GIS data and digitizes local aerial photographs. While OTS is primarily concerned with biological studies and forest management, they had much data that was tangential to my study. The following are the categories of information provided by the organization: climate, precipitation, growing conditions for a variety of tree and animal species, geology, seismic activity, soil types, topography, roads, power plants, fire stations, watersheds, rivers and aqueducts.

In addition, aerial photography, farm coordinates, and land use vector files are compliments of Victor Milla, GIS expert at the Center for Tropical Studies just north of Agua Buena. His polygons are derived from data collected by the National Institute of Coffee (ICafe) and independent researchers in the region. Excessive cloud cover in the aerial photographs made these remotely sensed data an incomplete source that had to be supplemented with local surveys. Because of the inconsistencies in methodology between ICafe's data gathering and my own, these maps are for working purposes only and should not be relied upon for quantification purposes.

I supplemented these layers with information that colleagues and I had collected in the field. Two surveys of the cooperative members, Nico's in 2000 and mine in 2008, informed the analysis of these layers with household facts like annual income, prioritization of land use, and number of family members available to tend the land.

Next, I perform a land use change detection analysis for the maximization of project areas. Once I had reprojected and clipped to the study area, I realized that many of the layers I had were on a landsat scale so the polygons were too large to provide any useful data. I garnered the following generalizations from these layers and then discarded them. This data scale limitation restricted the number of suitability analyses that I could perform. However, I felt that these were worth mentioning because they provided the large-scale framework within which I began and could therefore be mistaken for invisibly embedded assumptions:

- All farms fall within a "Moderate Agricultural Regulation" Zone. [Policy]
- All farms fall within the Rio Coto Colorado Watershed. [Watersheds]
- All farms fall within the district of Aguabuena. Population in 1997: 4805male, 4493female; Pop2000: 3536m, 34236f. [District]
- All farms have soils derived from volcanic material with evidence of earthquake. [Soils]
- None of them lay within aquifer bounds. [Aquifers]
- All farms fall within 1100-1200m elevation. [AguaBuenaElevations]

The following methodology was used to perform the land use change detection analysis. First, the 51 farms were plotted with coordinates and these farm points were used as centroids to create polygons. Next, I imported survey data from Access to Excel and reformatted tables for joining. I joined the tables from my surveys to the farm polygons, and linked old vector files to new polygons. In this way I was able to overlay past, current, and future land uses and analyze change percentages. I reprojected, cleaned and clipped this information and produced reference maps and posted these in the CoopePueblos cooperative as visual aids for the members.

This chapter has described various research strategies and the steps taken to analyze the data gathered. The following chapter will present our findings and discuss the implications of these data for the Coopepueblos Carbon Initiative.

Chapter 6: Findings and Discussion

The following section analyzes the findings from my research and fieldwork in order to provide a description of the local context and explain the many influences at work on land use activity and land use trends. As was stated earlier, the baseline scenario of a project is the expected conditions in the project area in the absence of project activity. The history of land use change in the region projected a baseline scenario of continued conversion of coffee plantations to cattle pasture. This section presents evidence for this and then discusses options for the future. First I describe the physical characteristics of the site, then the cultural identity of the community using data to give quantitative credence to qualitative assessments. From these two sections a narrative emerges that portrays a small community on the brink of some very complex decisions.

6.1 Site Information

Agua Buena lies between 1100-1300 meters altitude; the surrounding mountain peaks rise above 1800 meters. These unique topographical characteristics provide a microclimate for coffee and also host a variety of biodiversity. The Copa Buena region provides a unique habitat for flora and fauna species endemic to the area and also serves as a breeding ground during the dry season for migrating bird species.

At 8 degrees above the equator, Costa Rica has a sun path almost directly overhead with the sun in the sky from about 5am to 5pm year round. This means only about an hour's variation between the winter and summer solstice and a relatively constant growing season. Therefore the vegetation is lush with over 240 species of ferns, plants, shrubs, and trees in Coto Brus (Polzot, 2004). Farmers in the area have cultivated a select few of these in order to provide important products or nutrients on their land.

Staple crops in Copa Buena include corn, sugar cane, legumes, guava, and pineapple that are sold mostly to the lowlands. Many houses grow these subsistence crops in addition to a commercial coffee crop.

Figure 5 The Coto Brus valley that contains Agua Buena. Source: Author.

6.1a Climate

Agua Buena has a seasonal climate marked by distinct wet and dry seasons. The dry season lasts from December to April. Tempratures range from 12-27 degrees C.

While the western slopes of the Talamanca receive less rain than the 7.6m of rain that their eastern counterparts do, annual precipitation in Copa Buena is usually at least a meter more than the 250cm national average. Records from the Organization for Tropical Studies indicate that the Las Cruces meteorological station in San Vito best describes the climatic conditions of the project area. Data from 1973 to 2008 are presented as monthly averages in the following table.

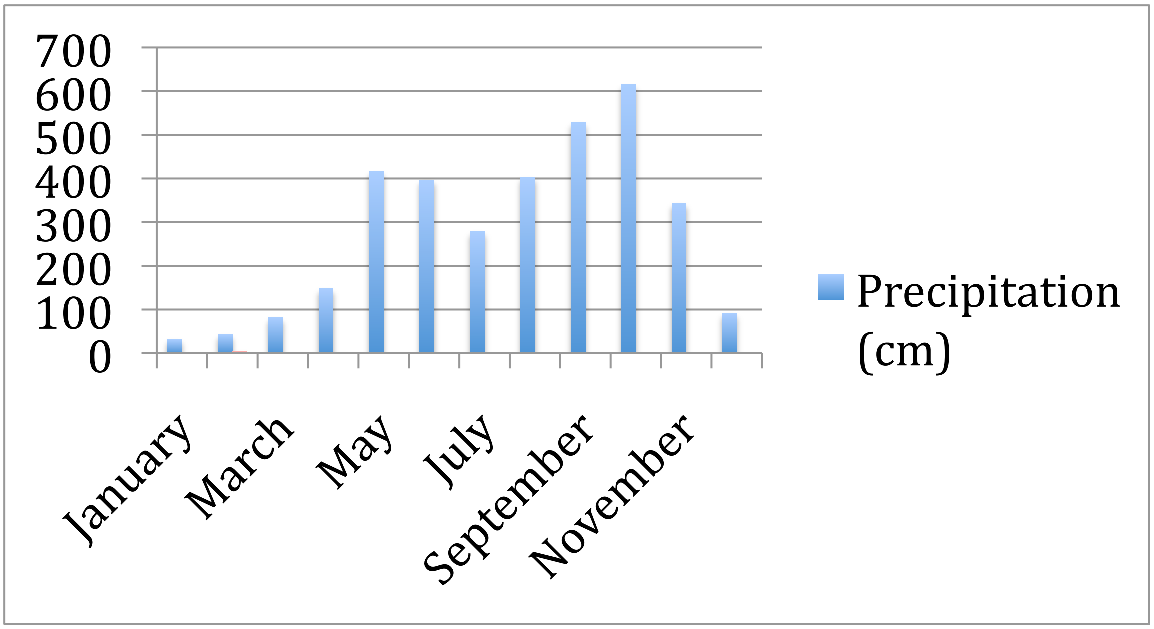


Figure 6 Annual Precipitation; Source: Organization for Tropical Studies, Las Cruces Station.

Rising winds from the Pacific Ocean can carry storm systems from as far away as Panama and Atlantic winds bring Nicaraguan storms. When the prevailing winds from the southwest collide with the Talamanca Mountains, humidity and temperature can change drastically causing sudden and frequent afternoon showers. These torrents, called aguaceros, can last for days on end and cause annual highway closures.

6.1b Landscape

The soil in the project area is composed of andisols, inceptisols, and ultisols. Human degradation of the landscape and natural disturbances play a role in the changing face of the Coto Brus region and in the project area. Landslides happen annually during the wet season as a result of heavy rains and earthquakes. In addition, the last major wildfire in 1992 burned 2,000 hectares of forest near Agua Buena, leaving vast swathes of land exposed to natural erosion. The majority of the soils are highly weathered oxisols with pockets rich in volcanic-origin andisols. These soil classes from parent material that is very low in carbonates. Therefore, this soil tends to have high exchange values and sequestration capacity for carbon molecules (Kollmus, 2009). It could be argued, then, that this soil has higher potential for carbon dioxide sequestration and is therefore valuable for earning carbon credits.

The Rio Aguabuena is the only drainage of the Aguabuena valley. This small river floods frequently during the rainy season. There are three main tributaries: Quebrada Bonita, the “Reserva” watershed, and the Rio San Gabriel. The Aguabuena River drains to the Pacific Ocean passing the town of Ciudad Neilly. This waterway was once an important source of drinking water but is now so polluted by agricultural runoff and coffee processing byproducts that by the time it passes Neilly it is too anoxic to be potable.

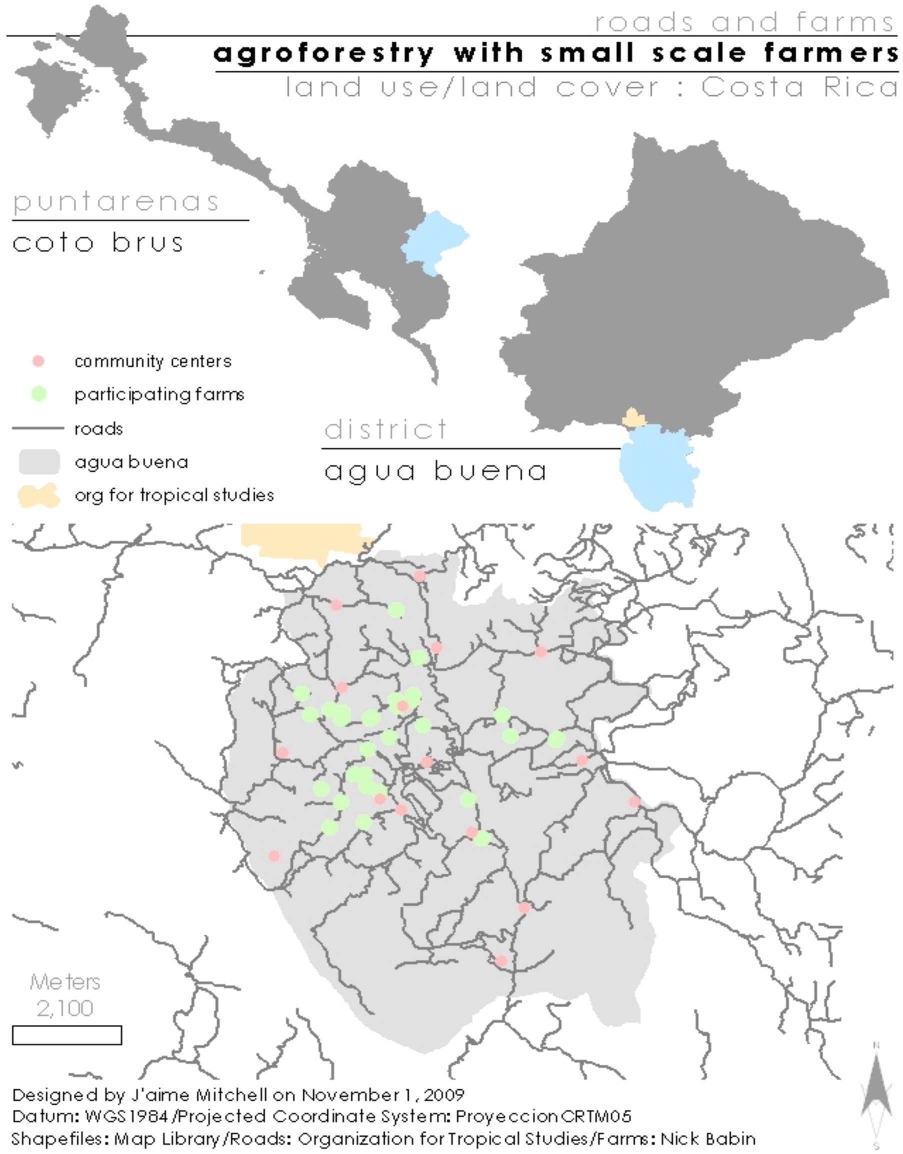


Figure 7 A reference map that was posted in the CoopePueblos cooperative as reference for study participants. Source: Author.

The trees that this project planted have the potential to act as filters between human activity and important waterways. The project also promotes the protection of natural riparian buffer zones and vegetative filters that prevent water-borne sediment from causing siltation of reservoirs, meaning that pesticides and other chemicals will not be able to travel easily to offsite locations nor contaminate their environments. These riparian zones will also defend against the movement of water and solutes during flood events that can drown organisms and destroy habitats downriver. Therefore the project increases vitality of water resources in the valley.

6.1C VEGETATION

The tree species of the mid-elevation forests in the project area are influenced by the lowlands species on the western Pacific side of the Coto Brus Valley, as well as the highlands species from the Talamanca Mountains. This convergence results in a high level of tree species diversity in the forests in this region, with no single dominant species. The Lauraceae (avocado family) is an integral component of the forest dynamic of the region because of its contribution to the forest canopy. The forest dynamic is specifically determined by elevation and soil composition, and does not support tall trees. The early stages of forest development are defined by the presence of Melastomataceae and Rubiaceae, while Lauraceae and Moraceae define the later stages (Polzot, 2004).

The most commonly planted trees in the area for coffee and tree plantations are Pinuscaribaea (Caribbean pine), Eucalyptus spp, Erythrina spp (poro), Inga spp (guaba), Terminalia amazonia (amarillion), Cedrela odorata (cedro), and Vochysia guatemalensis (mayo). The Erythrina and Inga are leguminous nitrogen-fixing species that are often planted in agroforestry systems. Pines and eucalyptus are both non-native species grown for the harvest and sale of timber, while Terminalia is the main native hardwoods species used for timber. In the next section I will discuss the community and their collective knowledge in greater detail.

6.2 Community Information

In the last section I discussed the physical characteristics of Agua Buena in order to provide the reader with a sense of space. Now I will describe the cultural and historical characteristics that contribute to this society's sense of place.

The establishment of this area was born through a 1951 agreement between the government and the Societa Italiano de Colonizacion Agricola (SICA). SICA would settle on 10 to 20 hectare parcels within the 10,000 hectares that had been sold to the organization at the low price of 10 colones per hectare (at that time about $0.55/acre). In exchange for an all-weather road built by the Costa Rican government, SICA agreed to organize schools, hospitals, and utilities networks.

6.2a Population

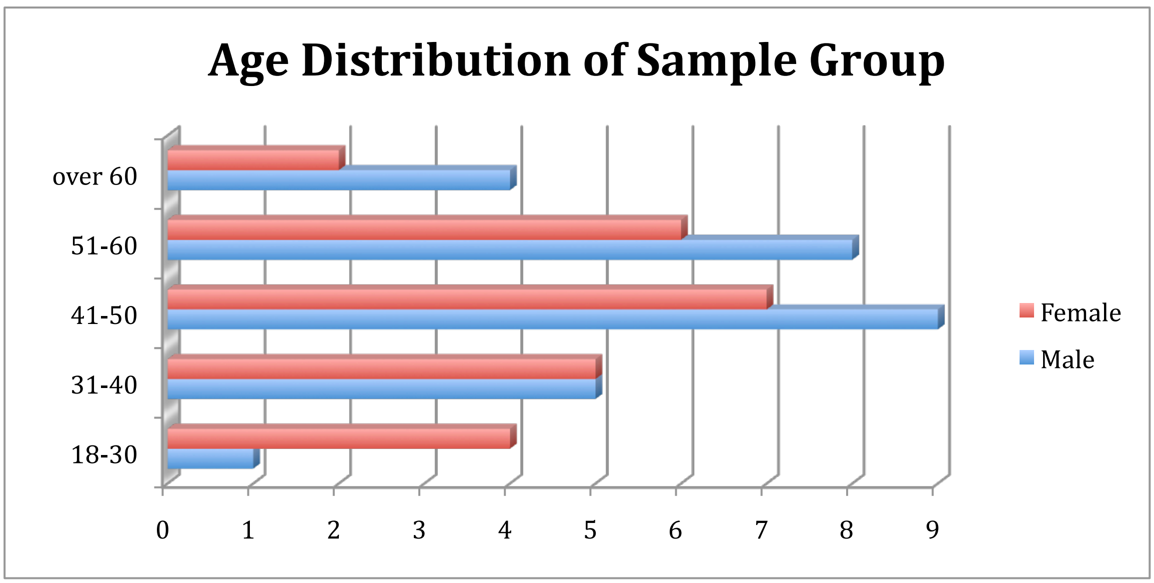
The people of Costa Rica refer to themselves as Ticos and Ticas. The people earned this nickname because they often use the diminutive form of words to be more courteous or friendly. They use, however, "-ico", instead the more common "-ito". Although "-ico" is a correct form of the diminutive, it is rarely used in other Spanish speaking countries. For instance, the word "momento" (moment) thus become "momentico" (a little moment) and even "momentitico" (a very brief moment). The Ticos of Agua Buena always combine this diminutive courtesy with formal "Usted" verb conjugation even when speaking with children and domestic pets.

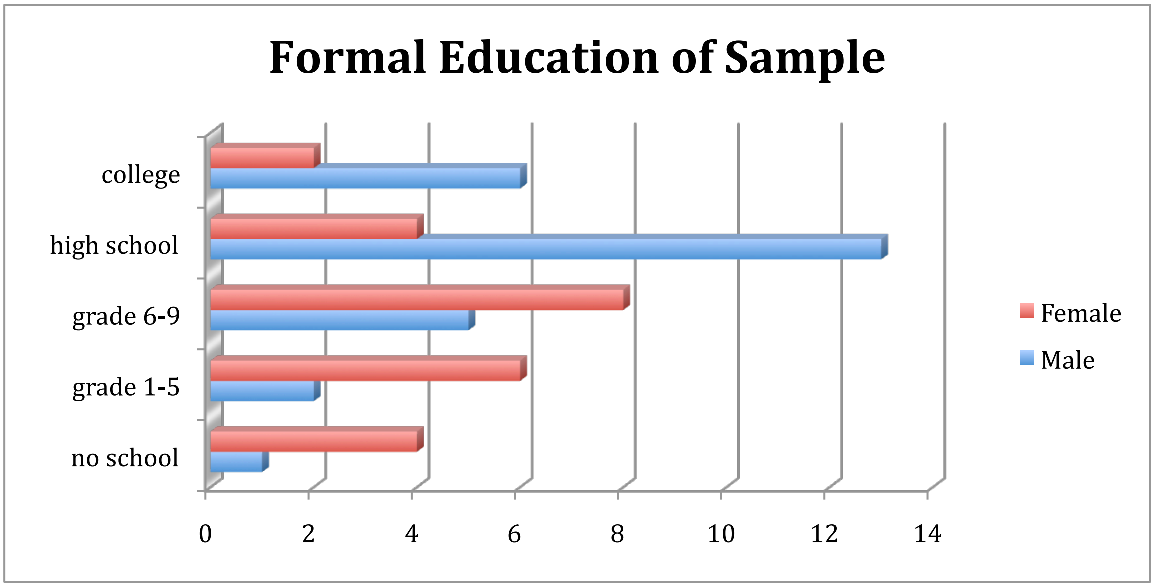
The largest surviving indigenous population also lives in this part of southern Costa Rica. They are called Guaymies and they descend from older South American tribes that migrated north through Panama years ago. In 1991, the indigenous tribes from the neighboring provinces banded together in a proposal to trade foreign debt for forest preservation. This proposal was accepted by the Agenda 21 Earth Summit in Rio de Janeiro, and more land rights were given to the tribes. This is significant because the overall percentage of protected land in the Cordillera Mountains region, which includes Coto Brus, is higher than any other region in the country. None of this protected land currently extends as far south as Agua Buena, however it affects federal policies and funding for the area. The Guaymies are frequently seen passing through Agua Buena and selling their traditional tapestries and bracelets.

Figure 8 A lady checking the ripeness of her coffee close to harvest season. Source: Author.

The majority of the population in this area is from homesteading families of the early 1900s. Federal development programs urged the expansion of coffee plantation in the south by subsidizing land prices, and many people moved from the Guanacaste region on the northwestern Nicoya Penninsula to Coto Brus. My surveys indicated an age distribution that was primarily older, with 30/51 sampled indicating that they were between the ages of forty and sixty. However, this data could imply that the younger age groups – especially males age 18-30 – were away from home, at work or university. When I surveyed education levels in the households, the information showed a correlation between younger populations and more formal education. This could be because the homesteading families spent many of the early years clearing the dense forest before they could build schools.

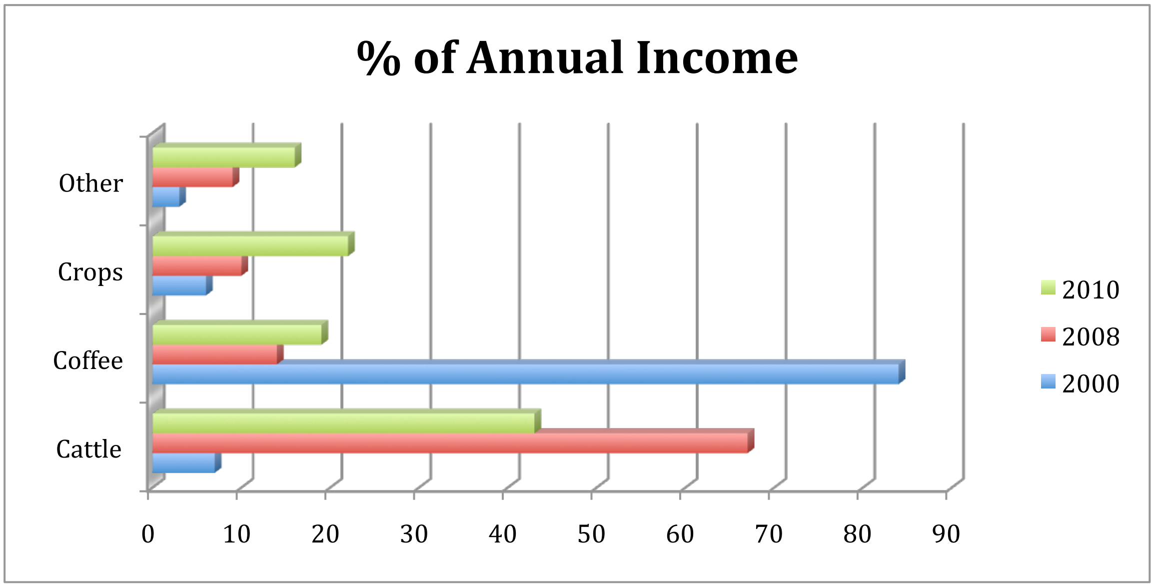
The census data reflects an almost equal distribution of males and females in the region, and my surveys affirmed this with 24 female participants and 27 male. The following charts give a quick summary of these data.





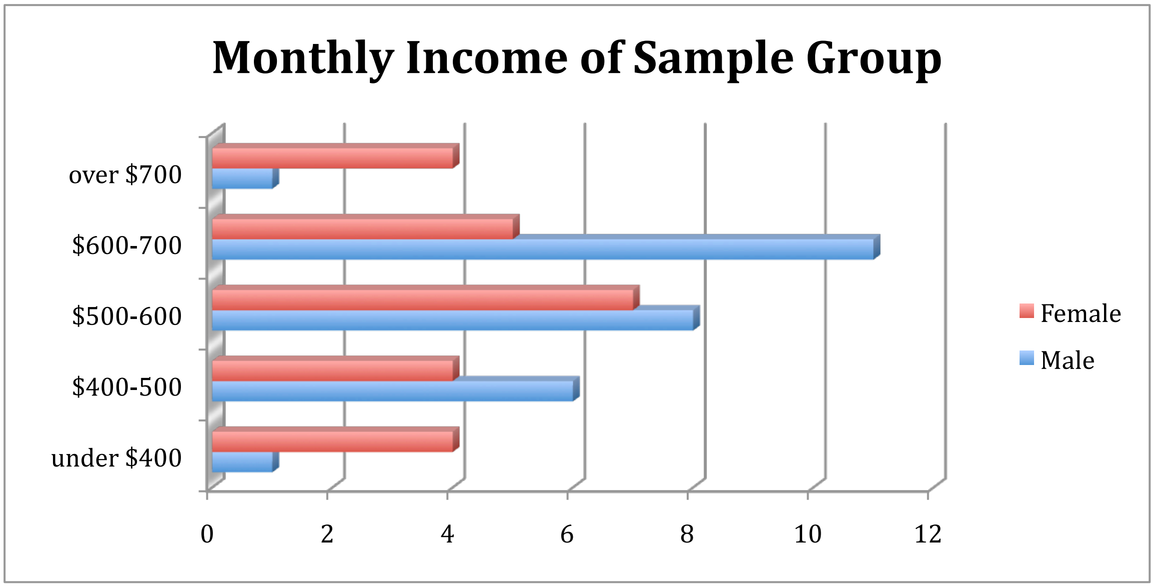
6.2b Local Economy

While this valley once enjoyed over 800 “cafetales” or coffee growing farms, now only these 51 are still producing. The coffee farmers are accustomed to a system of credit because they are always paid on the back end of the harvest season. They must accrue lines of credit with the local coffee cooperative simply to pay harvest costs; then they wait until the coffee is processed by the cooperative and sold to brokers; finally after a period of sometimes 6 months they receive payment for their coffee beans. However, the crisis in the coffee market over the past decade has driven the premium for beans down to such a low rate, that the line of credit is never fully paid off from one season to the next and the financial interactions that coffee farmers once had with the cooperative are now simply formalities on paper. So, even the exception in the community is no longer experiencing the kind of liquidity they once did.



In 2003 Copa Buena paid \$53.70 per fanega (or \$59.95 per 100lb of coffee), and even though this price was higher than the country average a high poverty level still exists (Rickert, 2005). Two studies estimate between \$1,319 and \$1,433 annual income per hectare used for cattle ranching (Howard/Valerio, 1996 and Kishor/Constantino, 1993). This is comparable to the \$1784 per hectare for coffee growth (Rickert, 2005). However, the average salary for those who find employment in the local service industry is \$6240 so it is apparent that the farmer must own at least 4 hectares of either coffee or pasture to earn as much as the local supermarket cashier (Jimenez, 2009).

If any kind of payment for environmental services policy is going to make sense, it is going to have to address these people in economic terms that they understand. Therefore, creating a policy that infuses capital into a community, but then translates it into goods or services for the individual would have far greater impact.



The project location Copa Buena is categorized as 100% rural, and the residents have little more than landmarks for addresses (Jimenez, 2009). In 2003 this region had the poorest households: 21.5% without basic needs and over 12% in extreme poverty. With the second lowest household income level in the country and little government funding reaching so far south, the only southern advantage is the beneficial proximity of their less expensive neighbor, Panama, for goods ranging from agricultural chemicals to household goods.

Foreign development in this region has increased over the last decade, and the price of land has climbed 60% during the same ten years. Though it was not possible to obtain individual profits from these land sales, it can be assumed by the high rate of emigration that it is a very profitable option - nearly 1 in every 5 family members has sold their portion of the family plantation and migrated to an urban destination since 2001 (Surveys). Local author Darryl Cole writes that the relationship between farmers and their land is a sacred thing for Costa Ricans, but in hard economic times they are forced to sell and give up a long-term livelihood for a short-term solution to a crisis (Cole, 1997).

6.2c Legal

There are a few options for national Payments for Environmental Service (PES) programs in Costa Rica, but only two have been made accessible to the community of Agua Buena. The Costa Rican government has not implemented a forest inventory system to take place at regular intervals using standardized methodology so they have no way of identifying area of greatest need. This means that provinces in the north, which receive media coverage and ecotourism dollars, also receive federal help for PES. According to a local forest authority, the only governmental funding that has reached the southern part of the country is a long history of subsidies for large commercial interests (Holl, 2009). This section describes the legal structure in Agua Buena that we were forced to work within for the carbon initiative.

The PES programs pertinent to this particular project, such as the Sistemas Agroforestales introduced in 2004, are seeking to improve communities lower on the socioeconomic index. This program is specifically designed for homesteading those with community organizations, indigenous organizations, and single female heads of household (Cole, 2007). They provide urban groups with plots of land and provide subsidies for constructing homes if the community agrees to environmentally friendly subsistence practices.

There is now another program that has been implemented by the National University that pays participants $1.50 over three years to plant trees and to ensure maintenance. The payments are $.75 the first year, $.50 the second, and $.25 the third. It is possible to write a contract each year with the university for new tree plantings. They have a federal organization, INISEFOR, do 4 inspections throughout enrollment in the program: one at planting, another at 12 months, a third at 24 months, and the final one at 36 months. The size of the tree planted depends on the species, but in general saplings are 6 months old or are 30cm tall. It was determined from these regulations that there is some incentive to reforest abandoned land, though there has been little proven success to date.

When the National University and INISEFOR were approached about signing contracts with the 51 participants in the CoopePueblos Carbon Initiative, the funding was denied.

The following are the most relevant elements of the regulatory framework guiding this project:

The Forestry Act #7575, 16/4/1996
Establishes the essential state functions to ensure the conservation, protection and proper management of forests, as well as the production, use and industrialization of forest resources based on a vision of sustainable development. MINAE

The Phytosanitary Act #7664, 02/05/1997
Promotes the integrated management of pests, as well as other sustainable productive practices. It also regulates the use, application and management of chemical and biological substances, their import and registration, as well as control of harmful residues. MAG

The Biodiversity Act # 7788, 30/04/1998
Ensures the conservation and sustainable use of biodiversity, as well as the equitable distribution of derived benefits and costs. Creates the National Commission for Biodiversity Management and the National System of Conservation Areas. MINAE

The Land Use Management and Conservation Act #7779, 21/05/1998
Promotes land use planning through land classification. This classification will allow a balance between actual and potential land use. Additionally, it promotes an active community and productive sector participation in decision making processes on land use and conservation. It also establishes agroecology as a means to ensure agricultural production and land and water resources conservation. MAG and MINAE

6.3 Land Use Activity Trends

In Chapter 2 I discussed why small-scale coffee farmers have no control over international coffee prices and are made vulnerable by the ever-shifting market. The price fetched for coffee has fallen below the cost of production for many farmers, causing them to abandon or convert their land to other uses. In 2001, the estimated average cost of production for Costa Rican farmers was $0.82 a pound while the average price receive by producers was only $0.46 a pound (ICO 2010). Cattle pasture is a popular form of land use conversion because most farmers do not have much start up capital. Overall, cattle husbandry requires less investment and labor inputs and represents less risk than other types of land use.

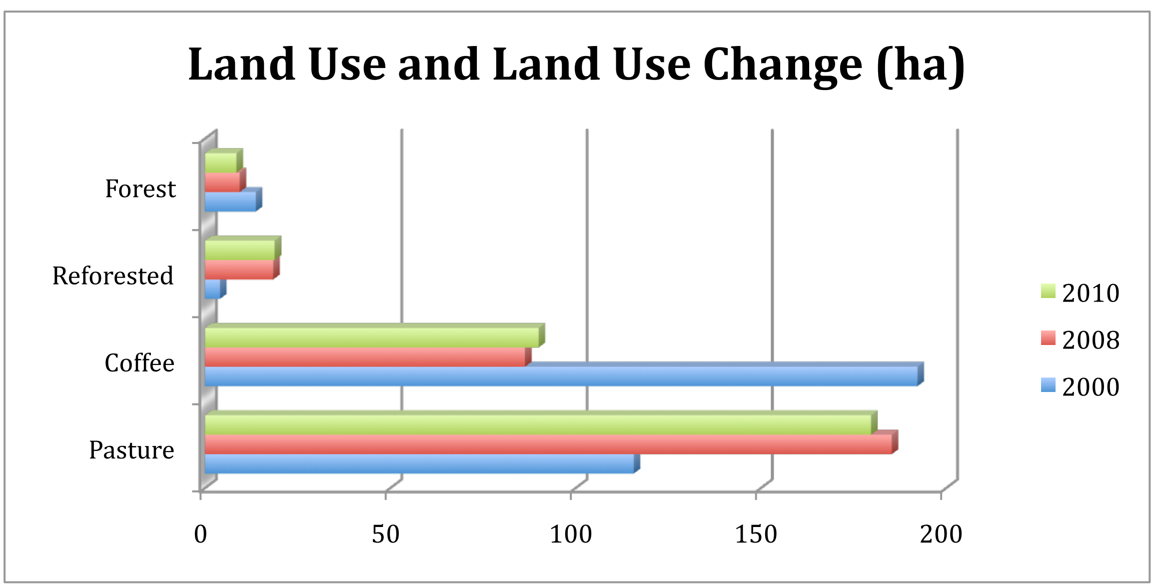
For the last 50 years in Agua Buena, people have been refining the practices of the coffee-growing industry. In the last decade worldwide overproduction has caused a price collapse, which has been calamitous for a community so dependent on this crop. Many in the community have turned to cattle ranching, some have sold their land to housing developers, and others have even abandoned their land after two seasons of crops had reaped all the nutrients from it.

My surveys estimate that 94% of land in Agua Buena has been deforested, a huge amount that is often overlooked because region-wide the number is only 24% (INEC, 2000). In contrast to the protected majority of the region, by 1994 the natural area around Agua Buena had been reduced to 80% coffee, 15% pasture, and 5% forest (Joyce, 2006). Today the town of Agua Buena is pocked by the aftermath of the coffee crisis. While some business is finding resurgence in the town, many buildings still stand vacant and dilapidated on the main street and signs on every surrounding hill advertise farms for sale. The view from the highest point overlooking Agua Buena exhibits a topographical quilt with very few scattered patches of coffee trees.

Many small-scale farmers have chosen to raze their crops in lieu of other, less resource intensive primary markets like beef. Overall, cattle husbandry requires less investment and labor inputs and represents less risk than other types of land use. In 2001, the estimated average cost of production for Costa Rican farmers was $0.82 a pound while the average price receive by producers was only $0.46 a pound (Surveys). These economic choices have only worsened the problem, however. Deforestation rates in Central America have been over 3% each year since the mid eighties when global beef prices began topping coffee (Buschbacher 1986). Ironically, this widespread deforestation is ultimately worsening the economic situation. Hillsides that have been clear-cut for agricultural production are extremely susceptible to erosion in areas that receive up to 10 meters of rain annually (Joyce 2006). This creates flooding, washing away the nutrient-rich topsoil and contaminating the water supply (Joyce 2006).

The planting of trees along waterways to prevent erosion and to maintain water quality must be a priority. In coffee-producing areas, the livelihood of farmers and the forest where they're crops grow, are inherently linked. In southern Costa Rica, 85% of a small-scale farmer's income is derived from the local forest (Rickert 1998). Therefore, long-term economic sustainability of small-scale farming in Costa Rica relies on integration of reforestation with agricultural practices (Redondo-Brenes 2005). Still, the benefits of the forest go far beyond the financial.

Of the farmers that produced coffee, 76% had removed at least some of their coffee from their land since the 2001 "coffee crisis" (Surveys). The majority of that land was converted to pasture. Landowners expressed their concern regarding the future price of coffee and were also surveyed on their plans for future land use conversion. My survey results predicted up to 95% conversion after 2010.



The proposed project activity, namely continuation of coffee farming, is less financially attractive than cattle husbandry because of the variable price of coffee. By offering carbon credits as a financial incentive, the project will encourage farmers to stick with current practices. The trees planted under the AR portion of the project can also offer valuable fruit and wood products in addition to carbon credits. The project coordinators anticipate that farmers will keep these products for their own private usage or for bartering with neighbors.

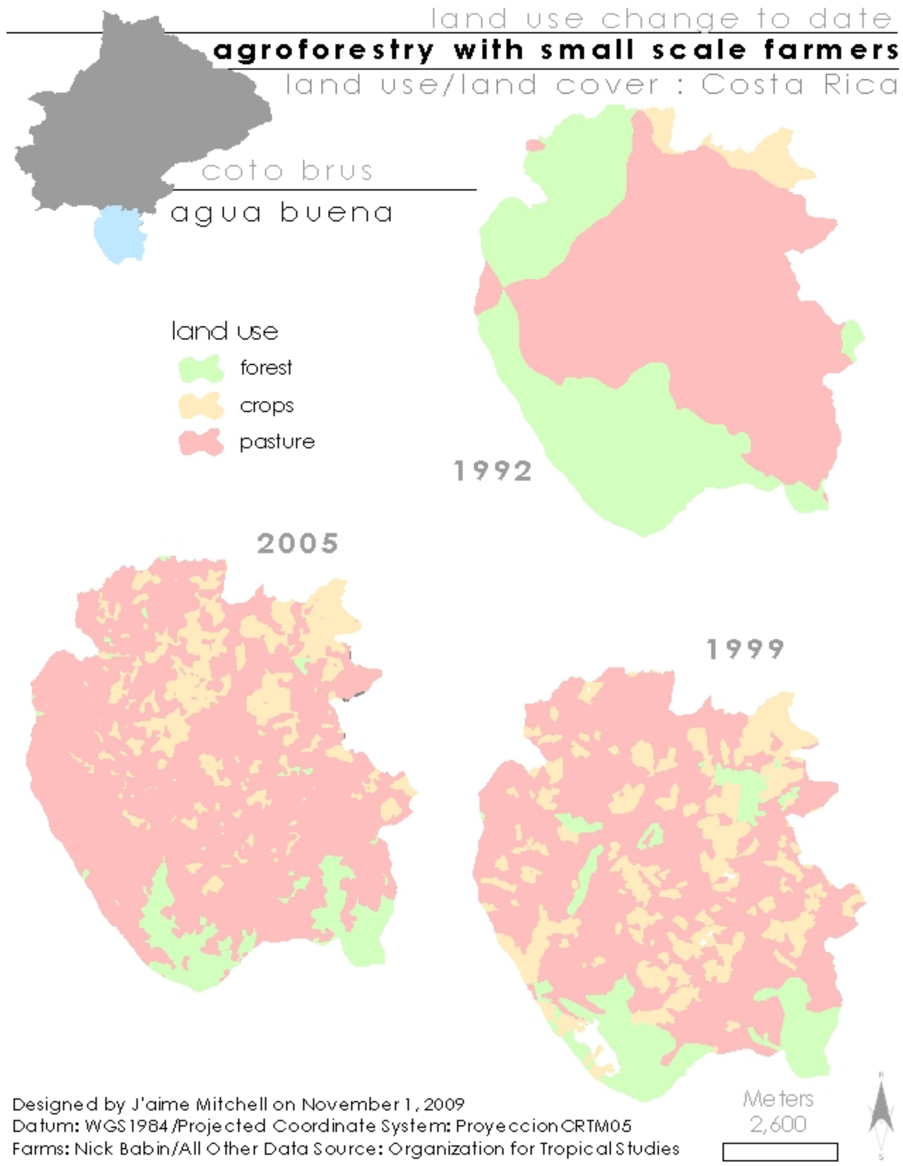


Figure 9 Land use change indicated by satellite images and household surveys. Source: Author.

6.4 Carbon Market Discussion

The CDM does not include forestry projects, particularly reforestation, agroforestry, and Reduced Emissions from Deforestation and Degradation in Developing Countries (REDD). Therefore, the CDM cannot be taken into consideration for this project at this time.

Since the Clean Development Mechanism is not currently an option for this project, this project must focus on the voluntary carbon markets. Within the voluntary markets, there is a multitude of options, yet each option is different in many ways. The primarily differences are the used methodologies of measuring and monitoring the carbon sequestration, offset prices, and project types. First, standards that do not include REDD are the Gold Standard, the Voluntary Offset Standard, and VER+. Next, the standards that fetch the lowest prices for their offsets are Plan Vivo and selling directly to the CCX. That leaves the Voluntary Carbon Standard (VCS) and the Climate, Community, and Biodiversity Standards (CCBS), with the VCS fetching slightly higher prices at the high end. The authors have chosen to attempt to use the VCS to enter the voluntary carbon market because of its international recognition as an authority for voluntary carbon offset certification and because they include specifications for ARR and REDD project activities (Kollmus, 2009).

6.4a Voluntary Carbon Markets

The goal for Voluntary Carbon Markets is to provide the opportunity for businesses, brokers, traders, and/or individuals to voluntarily (or with the goal in mind of accomplishing pre-compliance emissions reductions) by offsetting their own emissions via Verified Emissions Reductions (VER) or to trade these VERs in the secondary market.

These VERs can come from either compliance CDM or Joint Implementations (JI) or from within the voluntary markets. In comparison to the CDM/JI market, trading volumes are still relatively small in the voluntary markets, especially after the global financial crisis. However, “a key role of the voluntary market is to shape the rules and procedures for offsets in future compliance markets” (Kollmus, 2009). Voluntary Markets should attempt to follow and also expand upon the CDM standards. They should desire more stringent regulation than the CDM in an attempt to influence the future CDM and compliance standards. Voluntary Markets currently go a step further than the CDM in that they include sectors previously ignored, such as forestry and hydropower.

Within the Voluntary Markets, several standards exist. The two primary standards currently are the Gold Standard and the Voluntary Carbon Standard (VCS). Project developers also have the opportunity of selling directly to the Chicago Climate Exchange (CCX) within the United States. Several other smaller or less established exchanges exist such as the Regional Greenhouse Gas Initiative (RGGI) in the U.S. and others are being developed such as the Western Climate Initiative (WCI) in the U.S., as well as the Carbon Pollution Reduction Scheme (CPRS) in Australia. However, the Gold Standard only allows Renewable Energy offset projects and the RGGI is a joint effort among several States within the U.S. to trade credits from electric providers.

Greenhouse Gas Accounting standards have been established within voluntary markets to ensure the legitimacy of carbon measurements. The standards established for this accounting ensures “that offsets are real, additional, and permanent” (Kollmus, 2009). Here, methodologies are established for baselines, additionality, and measurement.

Standards boards to ensure accurate carbon measurement so that more accurate credits are created and sold to interested buyers must also establish guidelines. Typically, offset projects must be validated prior to the verification and certification phases. Afterwards, monitoring is conducted to ensure the continued success of the offset.

Many Standards are now implementing programs in which each credit is labeled with its own serial number to ensure that the credits are traded only once. Upon certification and the receipt of credits to the verifiers and project developers, the credits are placed on the registry to be sold and can be tracked by all interested parties.

Many Standards have begun establishing their own Registries on which credits can be traded. Examples of Standards Boards creating their own Registries are the Gold Standard, Voluntary Offset Standard (VOS), CCX, and Plan Vivo. However, VER+ uses the Blue Registry of TUV SUD and the VCS uses three separate global Registries: APX, TZ1, and Caisse des Dépôts. The role of the Registries is to prevent the double counting of the credits while tracking the sale of credits from account to account and doing so with complete transparency.

6.4b Benefits to Entering the Carbon Market

The stakeholders associated with the project are the 54 private coffee farm owners in the collective agroforestry land area of Copa Buena. The social and economic livelihood of these coffee farmers is dependent on the land they own, namely the successful cultivation of coffee for sale in national and international markets. The project provides financial incentives for land owners to continue coffee cultivation and farming activities rather than converting their land to pasture. In the absence of the project, the decreasing price of coffee and other economic concerns would likely press farmers to sell their land or turn it over to more profitable cattle pasture. The coffee farmers and their families would therefore benefit greatly from the supplemental investment in the community through the sale of carbon credits because it would help promote the economic viability of coffee cultivation while maintaining the number of hectares dedicated to coffee plantations. The project also increases carbon storage by promoting the addition of shade trees to existing coffee farms.

6.4c Risks to Entering the Carbon Market

The main risk for this project is the institutional risk associated with the economic situation and administration of the CoopePueblos Cooperative. From 2009-2010, CoopePueblos has endured low international coffee prices that have directly impacted total revenue. The administration of the cooperative has not been able to fully maintain its operations given the difficulties associated with diminished revenue, straining relationships with local coffee farmers and business partners in the United States. This recent shift has affected the outlook on the future viability of the cooperative's operations in the community.

Farmer participation is also an obstacle, as there exists some uncertainty with regard to the potential legal change in ownership if the farms are sold to external parties or deeded to other members of the family.

The primary financial risk will be the inability to attract financial lenders, donors, or to find a relevant grant for this project or the inability to agree to reasonable terms with a lender. The necessary expenses for this project will be quite substantial once verification, validation, registering, and monitoring are taken into consideration. The only way for this to be an option is to either find a group of interested private investors to fund this step of the project or attempt to register for a specific forestry sector fund. Therefore, this project will never make it past the verification stage without proper funding. Choosing to enter through the voluntary carbon market (specifically through the VCS), leaves the CoopePueblos Carbon Initiative cooperative members exposed to market risk.

In addition, world summits are held annually to revise carbon market regulations and standardize methodologies. While standardization would make investments commensurable across spaces, the problem is that not all spaces are alike. There is a possibility that the next summit will produce protocols for an international mandatory market. This means that the summit would agree on new methodology and technologies for calculating carbon credits. Should voluntary carbon markets fall into obsolescence after the next world summit, the lack of demand for VERs would most likely cause their prices to freefall, thus, endangering the abilities to repay the creditors. The VCS may also lose favor in many buyers' eyes, which could possibly lead us to the position of not being able to sell the credits. Lastly, forest project credits could saturate the voluntary markets around the time in which we would attempt to sell the credits, thus, driving down the price of forestry related credits.

This chapter has discussed my research findings and discussed the challenges of joining the carbon market as an alternative method of economic development. The next chapter will describe the social, environmental, and economic implications of these findings and the future options for both Coopepueblos and carbon markets.

Chapter 7: Conclusions

This chapter describes the implications of the evidenced impacts from Chapter 6. First it summarizes the research findings and gives evidence that this incentivized AFOLU project would provide benefits if the market were accessible. I then argue that the terms of trade and technology disadvantages imposed on the small-scale farmers in the global South by the political powers of the North are parallel to those imposed under commodity dependence. I conclude that policymakers must reexamine the carbon market in order to avoid the dangers of perpetuating neoliberal economic regimes that have exploited and repressed the developing world for centuries.

7.1 Summary of Findings

The most likely land-use change scenario without the project is the conversion of coffee farms to pasture land, leading to a loss of 40 tons of carbon per hectare (Allometric Analysis). Once converted, the pasture land would serve only in that capacity for generations, as the compacted soil and lack of nutrients would not support coffee, shade trees, or other locally cultivated crops. This would entail a significant loss of aboveground and belowground biomass since all of the coffee and shade trees would be cleared from the land. The soil carbon pool would likely increase from conversion to pasture however the loss of woody biomass would likely outstrip the gains in soil carbon.

Instead, the coffee farms maintained the current number of hectares of coffee and increased the amount of shade trees, with no conversion to pasture land. There is more canopy cover resulting from the planting of more trees on the farms because of this project, and there has been no conversion from coffee to a different system.

The proposed project activity, namely continuation of coffee farming, is less financially attractive than cattle husbandry because of the variable price of coffee. By offer carbon credits as a financial incentive, the project will encourage farmer to stick with current practices. The trees planted under the ARR portion of the project can also offer valuable fruit and wood products in addition to carbon credits. It is anticipated that farmers will keep these products for their own private usage or for bartering with neighbors. Since these products will not be sold, the project can be said to generate no economic benefit other than the income from carbon.

7.1a Social Impacts

The project has preserved local livelihoods dependent upon coffee farming and prevented migration into neighboring towns. The following positive impacts were identified following project implementation.

The project sought to preserve such community tenets by specifically addressing issues relative to sustaining the local economy, livelihoods, social fabric and cultural tradition. By preserving local livelihoods, the social and cultural components essential to the fabric of the community were also maintained. Preventing job migrations to neighboring towns ensured that family units remained together, thus maintaining the traditional social structure in this community.

In addition, successful project maintenance will require capacity building, education, and training of community members. Training and education will cover areas such as economics, marketing, and conservation; this allows for more sustainable land-management practices in the region while farmers learn marketable professional skills.

Additional positive impacts relate to public health benefits. Trees provide ecosystems services such as filtration of groundwater tables and aquifers. The project reduced runoff and therefore less contaminates in local waterways than would have occurred if coffee plantations were converted to pastureland for cattle operations.

7.1b Environmental Impacts

The conservation of designated coffee plantations maintained the habitat ranges of numerous species that provide significant ecosystem services. Trees incorporated into the coffee plantations through sustainable agroforestry management practices fixed nitrogen in the soil and provided shade for better growing conditions for coffee. These trees and the coffee plants themselves help to regulate healthy levels of ambient air quality. These trees also provide important habitats for birds and arthropods within the project zone that serve important functions such as seed dispersal, pollination, and biological pest control. The habitat ranges of all these different species shall be preserved as their services promote a healthy ecosystem and help to maintain high levels of biodiversity.

Regulation against land conversion and removal of vegetation will prevent soil from losing its permeability to water, thereby avoiding extensive erosion and surface runoff during rainstorms. As a result, flooding and water shortage during the dry season will be less common and ecosystems that rely on local waterways will remain intact. In addition, the introduction of native trees into the project zone created soil enrichment and nourishment for existing coffee plants while also providing ecosystem services and encouraging sustainability of biodiversity.

Forests maintain temperature and humidity levels and affect local and regional climatic conditions (Nobre et al., 1991). This is important for maintaining or enhancing the productivity of agriculture in adjacent areas (Lopez, 1997). Wildlife species protected by this project included canopy birds, primates, mammals, and insects that have developed mutualisms with tree species found in the project zone.

7.1c Economic Impacts

The project maintained the livelihoods of community members and helped to stimulate the local economy. Agroforestry interplanting systems introduced on the coffee plantations within the project zone provided cash crops for additional income. The fruit trees incorporated into the agroforestry systems – commonly avocado, carambolla, banana, oranges, and lemon – enhanced growing conditions for the coffee plants. Additionally, these crops provided families with food and income. The fruit was often times sold for profit or traded for other goods.

Sustainable management of the coffee plantation has been used as a marketing tool to increase sales of coffee in a niche market supporting eco-friendly products. Ecotourism has provided additional financial revenue through Finca tours, and university volunteer programs and research. These initiatives helped to proliferate the growing awareness about the coffee produced in this region, thus creating a larger customer base.

The average annual income of local families is around $4800 US. The Finca Project intern program not only provides an additional revenue source to host families but also offers the opportunity for the community to experience cultural exchange. Students also help work on the coffee farms with their host families, learn about the products, and spend money at local businesses. The one danger is that it is possible that the increased income due to carbon credits in the project zone will lead to greater consumer activity and an associated increase in emissions due to greater production and transportation, but it is impossible to measure and attribute these emissions increases to the project.

7.2 Closing Thoughts

Since 1999, small-scale coffee producers have suffered severely depressed export markets that are destroying their livelihoods, mortgaging their children's future, and undermining the cohesion of families and communities, and threatening ecosystems. Between 1999 and 2008 coffee prices plummeted lower than they had been in a century, throwing thousands of families into desperate struggles to maintain their traditional way of life and provoking others to abandon their land. These are struggles at the local level of oversupply and globally structural crisis.

The advocacy of development strategies for the global South based on the deregulation of markets, the privatization of state agencies and public services, and the liberalization of international trade is perpetuated in the current structure of the carbon market. Instead, it needs to recognize scalar needs in order to add a logic of rationality and become a true value-added alternative market place.

In other words, there are barriers to entry – the cost of certification and verification of credits – that determine who gains and who losses from the chain of production. Those who are able to create new domain when barriers fall are the beneficiaries while those who are stuck with low barriers to entry lose. The growing areas of rent are increasingly found in the intangible parts of the value chain – i.e. social values (Kaplinsky, 2000).

As the world faces climatic uncertainty, carbon markets are uniquely poised to potentially both incentivize and restructure changes in detrimental land use. Small-scale efforts, when aggregated, play a vital role in mitigating effects of global climate change at the local and regional scales.

The results of this study indicate that a scalar mismatch does in fact exists between high costs associated with entry into the international carbon credit market and low incomes in the global South where carbon sequestration efforts are expected to produce the greatest benefits. I conclude that only if this scalar mismatch is reconciled can local efforts directly influence the success of global climate change mitigation strategies.

Dependency Theory contributed to an understanding of the problem, ways to address the problem and structuring my analysis. This theoretical framework revealed parallels between the neoliberal disadvantages created by terms of trade and technologies in both alternative value-added markets and the carbon market. I can argue that the reconciliation is important to avoid the perpetuation of neoliberal economic structures and facilitate the greatest effectiveness of the carbon market.

Appendix A: Forest Management Plan

Below the table is the text from the original management manual.[10]

Principios	Requisitos	Indicadores Evaluadas
La conservación de ecosistemas y la vida silvestre	Incorpora en el cafetal una cobertura forestal diversificada con por lo menos 7 variedades distintas de árboles	*Inventario* 1. # de variedades distintas de árboles por parcela de 1000 m²
La conservación del suelo	Control de erosión en la finca cuando la pendiente excede 20%	*Inventario* 1. % pendiente de la parcela y obras de conservación del suelo
El manejo de plagas y enfermedades	Una reducción de 50% en el uso de agroquímicos entre el 2008-2010	*Encuesta* 1. Número de atomizaciones y químicos utilizados 2.Control de malezas 3.Tipos y cantidades de abonos
La sostenibilidad de los medios de subsistencia	Diversificación en la producción y en los ingresos de la finca	*Encuesta* 1. Uso de la tierra 2. Cultivos principales y crianza de animales 3. Rubros para la economía familiar

[10] Permission could not be obtained for illustrations, so only the text of the manual is reproduced here. Originally there was a diagram for each of the sections.

CoopePueblos, R. L. Manual para Manejar Árboles

La producción cafetalera ha sido afectada en el país por una inestabilidad en los precios en el ámbito internacional, muchas veces por debajo de los costos de producción y colecta, lo cual ha provocado una gran presión por la búsqueda de alternativas para enfrentar la crisis que afecta a miles de caficultores. En la forestería se ha visualizado una gran posibilidad, por cuanto la integración de árboles a los cafetales permiten no solo la utilización futura de la madera, sino que] promueve un desarrollo cafetalero en armonía con la naturaleza, para así buscar mejores precios en el mercado que beneficien no solo al caficultor nacional sino también al país.

Parte 1: Ventajas y Desventajas

Ventajas

- Fijación de nitrógeno especialmente cuando se plantan leguminosas.
- Las raíces de los árboles mejoran la aireación del suelo.
- Las hojas y la sombra de los árboles reducen la invasión de malezas.
- Los árboles y los arbustos incorporan materia orgánica al suelo aumentando la fertilidad.
- Se logra una sombra para los cafetales.
- La vida útil de los cafetos es más larga.
- Se promueve un control biológico de muchas plagas debido al incremento de la biodiversidad.
- Se modifica el microclima creando sistemas más estables.
- Se diversifican los productos a obtener.
- Se mejoran los ingresos económicos del cafetalero.

Desventajas

- Los árboles y arbustos pueden ser hospederos potenciales para plagas y enfermedades.
- Requiere recursos y mano de obra extra para el establecimiento y manejo de los árboles que se establecen en el cafetal.

Parte 2: Cafetales Arbolados

Los cafetales arbolados provocan una interacción muy estrecha entre los árboles y el café haciendo de la finca un verdadero centro de biodiversidad, donde no solamente se logra un café de la mejor calidad; sino que además, se produce madera, frutas, belleza escénica, leña, forraje, fijación de nitrógeno, se mejoran los suelos y la calidad de las aguas, se promueve y conserva la fauna silvestre y se eleva el valor de la propiedad.

Árboles maderables: se recomienda una distancia de siembra de 20 x 20 m debido esto al tamaño del árbol y la densidad de la Agua la cual presenta un diámetro amplio. Este distanciamiento provoca una densidad de 25 árboles / hectárea.

Arbustos: para este tipo se recomienda un distanciamiento de 10 x 10 m, ya que su forma y tamaño es pequeño y su Agua no muy pronunciada. Densidad de 100 árboles / hectárea.

Frutales: se utiliza un distanciamiento de 15 x 15 m, tomando en cuenta que existen especies como el aguacate u otras que tienen Aguas muy extensas que provocan gran cantidad de sombra con una densidad aproximada de 45 árboles / hectárea.

Parte 3: ¿Porque plantar árboles en su cafetal?

Las razones para plantar árboles pueden ser económicas o ecológicas. Una de las motivaciones mas fuertes para plantar árboles ha sido la reducción de los precios reales del café en los últimos anos. Desafortunadamente la reducción del valor del café no fue acompañada por una reducción de los costos de producción, sino mas bien, por una alza relativa de los costos monetarios debido al mayor uso de agroquímicos. La otra parte de la motivación viene de consideraciones ecológicas. Los sistemas agroforestales logran combinar muchos beneficios de un sistema agrícola con las de un sistema forestal. Donde los factores ambientales (modificados por los árboles) coinciden con los requerimientos del café, se generan beneficios para la combinación café-árbol. Estos beneficios incluyen efectos positivos en la producción y calidad de café, así como ahorros financieros cuando permiten bajar el nivel de insumos necesario.

Hay muchos factores que influyen sobre los beneficios de la asociación entre cafetos y árboles. Cultivar café “bajo sombra” no significa solamente dar sombra y reducir el estrés ambiental para el cafeto. Significa también que los árboles modifican el amiente para el café mediante sus raíces, ramas y hojas. Las raíces pueden competir con el café; las ramas pueden quebrar el café al caer; y las hojas forman una capa de hojarasca y materia orgánica con grandes beneficios para el suelo. Además, café bajo sombra significa que se pueden generar ingresos adicionales por la producción arbórea, sobre todo madera, leña y frutos.

Parte 4: La Sombra Optima

La intensidad de sombra debe variar durante el año en función del manejo del café y de las condiciones ambientales de la zona. Por lo tanto cada finca debe tener presente sus condiciones particulares y mantener un manejo regulado de la sombra. Como criterio general se puede considerar (dependiendo de cada zona) que la cantidad de sombra adecuada para producción de café esta entre un 20 y un 40%.

Para realizar un diagnostico para un cafetal, ubique el área que desea saber como anda el porcentual de sombra y demarque un cuadro que incluya 10 filas (surcos) de cafetos por 10 matas cada surco, de esta manera tendrá un cuadro de 100 cafetos. Marque en una hoja en blanco de papel los 100 puntos para representar las matas de café. Ahora con la hoja de papel una línea de contorno alrededor de los puntos (cafetos) que la Agua de cada árbol cubre (suponiendo la marca de la sombra que hace cuando pega el sol de medio día). Si el árbol es del tipo que pierde hojas completamente en algún momento y en especial en el verano, dejamos el contorno de la sombra en blanco pero si el árbol es del tipo que mantiene todo el tiempo sus hojas dentro del contorno alrededor de los puntos (cafetos) que la Agua de pega el sol de medio día). Si el árbol es del tipo que pierde hojas completamente en algún momento y en especial en el verano, dejamos el contorno de la sombra en blanco pero si el árbol es del tipo que mantiene todo el tiempo sus hojas dentro del contorno hacemos rayas paralelas dentro del contorno.

Parte 5: ¿Cuáles Arboles?

Hay una gran diversidad de tipos de sombra en los cafetales. Para satisfacer las diferentes necesidades de sombra se pueden utilizar diferentes especies arbóreas con sus características especificas de competividad o compatibilidad. Entre los atributos mas importantes que determinan la compatibilidad de un árbol están: su arquitectura de Agua y sus cambios fenológicos, su tasa de crecimiento y su desarrollo radicular. Dos especies que tienen muchos de los atributos deseables son: Cordia alliodora (laurel), principalmente por su crecimiento rápido, regeneración fácil, Agua angosta y abierta y alto valor de la madera; y Erythrina poeppigiana (poro o pito gigante) por su manejo fácil.

Parte 6: ¿Cómo Manejar los Árboles?

Una vez que los árboles principalmente maderables, son establecidos, hay que manejarlos de una manera que permita cosechar madera de buena calidad. Las practicas mas importantes para este fin son la escogencia de árboles de buena forma através de entresaques o raleos. Estas practicas se realizan entre los 3 y 6 anos (dependiendo de la tasa de crecimiento de los árboles), y permiten eliminar aquellos árboles de mala forma como, por ejemplo, árboles bifurcados o torcidos y árboles enfermos, para dar mas espacio para los árboles con buena forma. Aunque hay muchos conceptos sobre la forma y el tiempo mas oportuno para el manejo de árboles en plantaciones puras, hay que refinar y adaptar estos conceptos a la situación de árboles en su cafetal.

Appendix B: Sample Surveys

Presentación: Buenos días (Buenas tardes), mi nombre es...Estoy trabajando en un estudio sobre los cambios en los medios de vida rurales y practicas agrícolas desde la crisis de café y el impacto de mercados alternativos en el bienestar de las familias productoras del distrito de Agua Buena y queremos pedirle su colaboración contestando a las preguntas que le haremos. Durará 45-60 minutos aproximadamente, sus repuestas nos ayudarán mucho en nuestro trabajo, esperamos nos facilite tiempo... (Se esperan que la entrevista sea realizada con las personas cabezas de familia)

Datos Generales

Número de Ficha: _______ Entrevistador: ________________________________ Fecha: _____ / ____ / ______

Nombre entrevistado(a): ____ Hora inicio: _________ final: ______

Dirección: ______________________________
Comunidad______________Distrito ____________
No. Teléfono: ___________________________
Pertenece usted a la cooperativa con la cual comercializa su café: a. ☐ Sí; b. ☐ No.
[Si la respuesta es No, ir a la pregunta 6]
Nombre de la cooperativa: _________________
____
¿Años tiene de ser socio de la cooperativa? ______

¿Vive en la finca? a. ☐ Sí; b. ☐ No.
Número de personas que viven en la casa:_________
¿En 2000?: ______________________________
No. de familiares que dependen de usted: _________
¿En 2000?: ______________________________
¿Cual año llego ud. a Coto Brus? _______________
¿De donde vino? ___________________________
¿Donde nació ud. (cantón)? __________________

Composición Familiar, Educación

En el cuadro siguiente anotar todas las personas que duermen y comen en la casa hoy en día y después los hijos u otras que se encuentran fuera de hogar pero vivieron allí en 2000.

#	Nombre completo	Parentesco	Sexo (M/F)	Edad	Ocupación	Nivel escolar	Estud (S/N)	Esc. adulto (S/N)	Vive en la casa 2008	Vive en la casa 2000
1		1								
2										
3										

4										
5										
6										
7										
8										
9										
10										
11										

Sexo: M-Hombre, F- Mujer; Estud- Estudia (Sí, No);

Vive en la casa 2008 (S/N); Vive en la casa 2000 (S/N)

Clave parentesco: 1- Jefe de familia
2- Conyugue
3- Hijo(a)
4- Padre/Madre
5- Abuelo(a)
6- Hermano (a)
7- Otro familiar
8- No familiar

¿Algunas personas de su familia han recibido becas para estudiar en los últimos 8 años?
a. ☐ Sí; b. ☐ No. [Si la respuesta es Sí],
Como se llama la organización que les dio la beca?

____

Clave nivel escolar:
1- No aplica niños en edad aún no escolar
2- Analfabeto(a)
3- Preescolar
4- Primaria completa
5- Primaria incompleta
6- Secundaria completa
7- Secundaria incompleta
8- Técnico medio completo
9- Técnico medio incompleto
10- Universidad completa
11-Universidad

¿Hay adultos en su hogar que han recibido clases/ capacitaciones durante los últimos ocho años?

a. ☐ Sí; b. ☐ No [si la respuesta es Sí, llenar cuadro],

Fechas	Temas	Organización

¿Que clases/capacitaciones quisiera tomar en el futuro?

____

Migración
¿Hay algún miembro que ha emigrado a trabajar fuera del cantón durante los últimos 8 años (2000-2008)?

a. ☐Sí; b. ☐ No.

(Utilice la columna "#" de la tabla anterior para especificar los miembros de la familia que han migrado a otros departamentos o al exterior por motivos de estudio, trabajo u otros, también utilice claves para destinos y motivos)

# Miembro	Destino	Motivo del viaje	Año y mes salio	Año y mes regreso

Clave destinos: 1. Otro cantón, 2. Centroamérica, 3. EE UU, 4. México, 5. Canadá,
6. Cuba, 7. Suramérica, 8. Europa, 9. Asia, 10. otros.

Clave motivos de viaje: 1- Para vivir únicamente, 2- Trabajo, 3- Estudio

Si nadie ha migrado ¿Por qué no ha salido Ud. o alguien de su familia a EU o Canadá u otra parte de Centroamérica y Costa Rica para trabajar o vivir?:

Condiciones De Vivienda Y Bienestar Familiar (Entrevistador, use la observación directa para contestar algunas de estas preguntas. No se limite solo a preguntar)

¿Tiene el hogar acceso al agua? a. ☐ Sí; b. ☐ No.

¿Cual es la forma de accesar? [encierre numeral, pueden ser varias]

a. ☐ pozo; b. ☐ río; c. ☐ naciente; d. ☐ acueducto

¿Es limpia?: a. ☐ Sí; b. ☐ No

¿Tiene Energía Eléctrica? a. ☐ Sí; b. ☐ No.

¿Cuántas habitaciones tiene la casa?: ___________

¿Tipo de piso en la casa?

a. ☐ Cemento; b. ☐ Terrazo; c. ☐ Mosaico;
d. ☐ Madera; e. ☐Cerámica; f. ☐Otra ___

¿Ha realizado mejoras en casa en los últimos 8 años?

a. ☐ Sí; b. ☐ No; ¿Que tipo de mejoras?

Uso De La Tierra 2000-2008

¿Que áreas de la finca o parcelas están ocupada en los siguientes rubros?

Rubro	2000 Área he	2008 Área he	2010 Esperado Área he
1. Casa y Patio			
2. Café			
3. Maíz			
4. Frijol			
5. Hortalizas			
6. Pasto			
7. Tacotales			
8. Bosque reforestado			
9. Bosque natural			
10. Otros:			
11. Otros:			
12. Total			

Cambios En Los Medios De Vida 2000-2008

¿Cuales son los tres rubros más importantes para la economía de su familia?

En 2000	En 2008
a.	a.
b.	b.
c.	c.

¿Cuales son las nuevas actividades productivas en los últimos ocho anos?

____

____

¿De donde viene la iniciativa de las nuevas actividades?

a. Propia; b. Proyecto; c. Cooperativa
d. Otra. ________________________________

¿Desde su perspectiva como debería de diversificar la finca para tener diferentes fuentes de ingreso?

____

____

Cultivos Principales (Aparte de Café)

Cultivo 1: ____________________________

Pregunta	Cantidad	Unidad de Medida	¿En 2000?
¿Cual fue la producción total en los últimos doce meses?			
¿Cuanto destinó a la venta?			
¿Cuanto destinó a consumo del hogar?			
¿Cuanto destinó para regalar?			
¿Cuanto destinó para semilla?			
¿Cuanto destinó para crianza de animales?			

Cultivo 2:_ _________________________

Pregunta	Cantidad	Unidad de Medida	¿En 2000?
¿Cual fue la producción total en los últimos doce meses?			
¿Cuanto destinó a la venta?			

¿Cuanto destinó a consumo del hogar?			
¿Cuanto destinó para regalar?			
¿Cuanto destinó para semilla?			
¿Cuanto destinó para crianza de animales?			

Cultivo 3: ______________ ____

Pregunta	Cantidad	Unidad de Medida	¿En 2000?
¿Cual fue la producción total en los últimos doce meses?			
¿Cuanto destinó a la venta?			
¿Cuanto destinó a consumo del hogar?			
¿Cuanto destinó para regalar?			
¿Cuanto destinó para semilla?			
¿Cuanto destinó para crianza de animales?			

Cultivo 4:_ _____________ ____

Pregunta	Cantidad	Unidad de Medida	¿En 2000?
¿Cual fue la producción total en los últimos doce meses?			
¿Cuanto destinó a la venta?			
¿Cuanto destinó a consumo del hogar?			
¿Cuanto destinó para regalar?			
¿Cuanto destinó para semilla?			
¿Cuanto destinó para crianza de animales?			

Cultivo 5:__ ___________ __

Pregunta	Cantidad	Unidad de Medida	¿En 2000?
¿Cual fue la producción total en los últimos doce meses?			
¿Cuanto destinó a la venta?			
¿Cuanto destinó a consumo del hogar?			
¿Cuanto destinó para regalar?			
¿Cuanto destinó para semilla?			
¿Cuanto destinó para crianza de animales?			

Cultivo 6:__ __________ __

Pregunta	Cantidad	Unidad de Medida	¿En 2000?
¿Cual fue la producción total en los últimos doce meses?			
¿Cuanto destinó a la venta?			
¿Cuanto destinó a consumo del hogar?			
¿Cuanto destinó para regalar?			
¿Cuanto destinó para semilla?			
¿Cuanto destinó para crianza de animales?			

Cultivo 7:__ __________ __ _____

Pregunta	Cantidad	Unidad de Medida	¿En 2000?
¿Cual fue la producción total en los últimos doce meses?			
¿Cuanto destinó a la venta?			
¿Cuanto destinó a consumo del hogar?			
¿Cuanto destinó para regalar?			
¿Cuanto destinó para semilla?			
¿Cuanto destinó para crianza de animales?			

Numero de Animales

Animales	# 2000	# 2008
Ganado		
Cerdo		
Pollo		
Gallina		
Otros:		
Otros:		
Otros:		

Crianza de Animales: 2000

Pregunta	Ganado	Cerdos	Aves de corral	Otros:	Otros:
¿Cual es el valor de lo vendido en el año de 2000 (en 2000 colones)?					
¿Cual es el valor de lo consumido por el hogar?					
Total					

En 2008

Pregunta	Ganado	Cerdos	Aves de corral	Otros:	Otros:
¿Cual es el valor de lo vendido en los últimos doce meces (en 2008 colones)?					
¿Cual es el valor de lo consumido por el hogar?					
Total					

Productos Derivados: 2000

Pregunta	Leche	Queso	Huevos	Otros	Otros
¿Que cantidad vendió en el año 2000?					
¿Que unidad de medida?					
¿Que cantidad consumido en el año 2000?					
Total					

En 2008

Pregunta	Leche	Queso	Huevos	Otros	Otros
¿Que cantidad vendió en los últimos doce meses?					
¿Que unidad de medida?					
¿Que cantidad consumido en los últimos doce meses?					

Total					

¿Que cultivos tenia intercalados en su cafetal en 2000?

____

¿En el 2008?

____

De los alimentos básicos para la familia ¿cuanto produjo en 2000? [encierre numeral y escriba %]

a. ☐ todos; b. ☐ más de la mitad;

c. ☐ menos de la mitad; d. ☐ nada; % producido: ___

¿En el 2008?:

a. ☐ todos; b. ☐ más de la mitad;
c. ☐ menos de la mitad; d. ☐ nada; % producido:___

¿Contrato mano de obra externa para el manejo de café en el 2000?

a. ☐ Si; b. ☐ No

Personas temporales _____ Permanentes _______

¿En 2008?

Personas temporales _____ Permanentes _______

¿En el 2000 de donde viene la mano de obra? [puede ser más de uno]

a. ☐ De Panamá; b. ☐ De la comunidad;
c. ☐ Otros distritos o cantones

¿En 2008?

a. ☐ De Panamá; b. ☐ De la comunidad;
c. ☐ Otros distritos o cantones

Jornales por año (utiliza las siguiente cuadra para calcular con entrevistado(a))

	Días de trabajo familiar en la finca	Días de peón en la finca
2000		
2008		

2000 Días de Trabajo por Mes (Familiares y Peones)

Persona	Enero	Feb	Marzo	Abril	Mayo	Jun	Jul	Ago	Set	Oct	Nov	Dic	Total
Hombres													
Mujeres													
Jovenes													
Niños													
Niñas													
Peones													
												Total	

2008

Persona	Enero	Feb	Marzo	Abril	Mayo	Jun	Jul	Ago	Set	Oct	Nov	Dic	Total
Hombres													
Mujeres													
Jovenes													
Niños													
Niñas													
Peones													
												Total	

Trabajo familiar no en la finca en Coto Brus (no migración)

# miembro	Tipo de trabajo	2000 días de trabajo	2008 días de trabajo

¿En el último año ha tenido otra fuente de ingreso?
a. ☐ Si; b. ☐ No
¿Si la respuesta es si, de que tipo?
¿En los últimos 8 años como han cambiado sus ingresos?
a. ☐ Aumentado; b. ☐ Disminuido;
c. ☐ Ningún cambio
Y sus ahorros: a. ☐Aumentado; b. ☐ Disminuido;
c. ☐Ningún cambio

¿Ha sentido alguna vez que no ha podido cubrir sus necesidades básicas de alimentación?
a. ☐Si; b. ☐No

¿Siente que hay un riesgo de perder su finca?
a. ☐ Si; b. ☐ No

¿Quiere que sean agricultores sus hijos?
a. ☐ Si; b. ☐ No

Precios, Volúmenes, Calidades, Y Rendimiento Para La Cosecha

¿Cual fue su producción total de café en 2000 ______ fanegas; _____fanegas/he
En la última cosecha (2008)? ______ fanegas; _____fanegas/he
En 2007? ______fanegas; _____fanegas/he
Esperado en 2009? ______fanegas; _____fanegas/he

A quien vendió su café	Certificación	Mercado	Cuantos fanegas vendió	Cuanto recibió de adelanto Colones / fan	Pago a la entrega Colones / fan	Ultimo pago o reajuste C / fan	Mes de pago final	Precio completo C / fan

A quien vendió su café
1- Coopepueblos
2- Coopesabalito
3- Coopesanvito
4- Coyote
5- La Lila
6- Otro (especifique)

Certificación
1- Orgánico
2- Café Sostenible
3- Rainforest
4- Comercio Justo
5- Starbucks
6- No sabe

Mercado
1- Comercio Justo
2- Orgánico
3- Orgánico y justo
4- Convencional
5- Comercial
6- Mercado Directo
7- No sabe

¿Que piensa usted es un precio justo (por fanega)? ______________________

¿Recibe pre-financiamiento?
a. ☐ Si; b. ☐ No,

De quien? ____________________

¿A que tasa interés anual recibe pre-financiamiento?
____ %

¿En los últimos 2 años ha recibido crédito?
a. ☐ Si; b. ☐ No,

De quien? ____________________

Datos De Cooperativa y Comunidad

¿Como es su participación el la cooperativa?

a. ☐ muy activa; b. ☐ medio activa;
c. ☐ poco activa d. ☐ ha sido miembro de la junta

¿En el los últimos doce meses, cuantos días invirtió en los siguientes trabajos relacionados a la cooperativa:

Trabajo relacionado con la cooperativa	# días
días asistiendo a reuniones de cooperativa	
días en capacitaciones y intercambios	

¿Ser miembro de una coop. le ha ayudado a vender el café a mejores precios?

a. ☐ Si; b. ☐ No; c. ☐ No se

¿Cree que la cooperativa ayuda facilitar vínculos con otras redes y organizaciones?

a. ☐ Si; b. ☐ No; c. ☐ No se

¿Hay buena comunicación entre la administración y los socios?

a. ☐ Si; b. ☐ No; c. ☐ No se

¿Como es su participación en los grupos comunitarios, actividades religiosas, rituales de la comunidad y deportes:

a. ☐ muy activa; b. ☐ medio activa;
c. poco activa; d. ☐ ha sido miembro de la junta

Manejo Del Cafetal

Años en cultivo del café? ______________________

¿Por cuantas generaciones ha cultivado café?
a. ☐ somos primeros; b. ☐ nuestros padres;
c. ☐ nuestros abuelos; d. ☐ nuestros bisabuelos;
e. ☐ Otros (especifique) ______________________

¿Cual es la variedad principal de café sembrada?

a. ☐ Caturra; b. ☐ Costa Rica – 95
c. ☐ Catui; d. Otra (especifique)
____

¿Uso de la tierra antes de café? ________________

¿Cual es la distancia de siembra?
Entre plantas _________m.
Entre calles _________m.

¿Cual sistema de poda utiliza en el cafeto (si la respuesta es selectiva va a 64)?

a. ☐ Por calle; b. ☐ Por lote; c. ☐ Selectiva

Utiliza la poda selectiva por…
a. ☐ Planta; b. ☐ Rama; c. ☐ Parche

¿Que tipo de poda usa?
a. ☐ Poda baja; b. ☐ Poda alta

¿Deshijo el cafetal?
a. ☐ Si; b. ☐ No (pase a 69)

¿Cuantos hijos deja por planta ________________

¿Cuando fue la ultima vez que resembró su cafetal? (año)
____

¿Cual es la edad de su cafetal? _____años

¿Cuantas veces al año arregla la sombra?________

¿En 2000 realizó atomizaciones para controlar enfermedades y plagas?
a. ☐ Si; b. ☐ No

¿Cuántas veces al ano atomizó? _____

En 2008?

a. ☐ Si; b. ☐ No

¿Cuántas veces al ano atomiza? _____

Enfermedades, plagas y atomizaciones

Enfermedad o Plaga	¿Se encuentra?	¿Realiza atomizaciones?	¿Cuantas veces al año atomiza?	En 2000: ¿Se encuentro?	En 2000: ¿Realiza atomizaciones?	En 2000: ¿Cuantas veces al año atomiza?
ojo de gallo						
derrite o quema						
roya del cafeto						
chasparria						
mal de hilachas						
nematodos						
jobotos						
arañitas						
cochinillas						
broca						
otra						

Productos utilizados y en las atomizaciones

Producto	No. de atom.	Producto	No. de atom.	Producto	No. de atom.

Control de malezas

¿Como controla las malezas?	¿Cuantas veces al año?	¿En 2000?
Manual		
Herbicidas		

Abonos

¿Que tipo(s) de abono aplicado al suelo utiliza?	¿Cuantas veces al año?	¿Que productos químicos o orgánicos utiliza?	En 2000: ¿Cuantas veces al año?	En 2000: ¿Que productos químicos u orgánicos utiliza?
Orgánico				
Químico				
Ninguno				

¿Cuales cambios ha realizado en la finca desde 2000? (encierre el número, puede seleccionar varias opciones)

a. ☐ Menos uso de agroquímicos;
b. ☐ Más trabajo de conservación de suelo.
c. ☐ Conservación de Agua;
d. ☐ Otros (especifique) ________________

¿Quiere cambiar su cafetal al sistema orgánico?
a. ☐ Si; b. ☐ No

¿Porque? ____

¿Cual es el nivel estimado de la pendiente del terreno?
a. ☐ 0-25% b. ☐ 26-50% c. ☐ 51-75% d. ☐ 76-100%

¿Cuales prácticas de conservación de suelos utilicé?
Ninguna…………………… a. ☐ Si; b. ☐ No.
Siembra de contorno……. a. ☐ Si; b. ☐ No.
Gavetas…………………... a. ☐ Si; b. ☐ No.
Canales de desviación…. a. ☐ Si; b. ☐ No.
Barreras vivas…………… a. ☐ Si; b. ☐ No.
Barreras muertas………….. a. Si; b. No.
Acequias de ladera……….. a. Si; b. No.
Cultivos de cobertura…..… a. Si; b. No.
Otras________________________________

¿Que significa la sostenibilidad para usted? ____

____

____

¿Que es su plan/ visión para la finca en los próximos 5 anos? ____

____

____

¿Algún otro comentario o mensaje que usted quiera compartir con la cooperativa:____________________________

____

____

MUCHAS GRACIAS POR SU AYUDA

Appendix C: Carbon Quantification Methodology

For the ARR project activities, the project coordinators have chosen to use CDM methodology AR-AMS0004 ("Simplified baseline and monitoring methodology for small-scale agroforestry – afforestation and reforestation project activities under the Clean Development Mechanism"). This methodology requires the following conditions be met to be applicable:

(a) Project activities are implemented on croplands.
The project will be implemented in coffee agroforestry systems, coffee being the main crop produced in the system.

(b) Project activities include a cropping regime that is considered an agroforestry system that is consistent with international or national definitions.
Coffee is one of the most common crops produced in Costa Rica and elsewhere in Central and Northern South America. Trees and shrubs are often interplanted with the coffee plants for various reasons, especially for fixing atmospheric nitrogen. The tree cropping regime, which is annual, consists of pruning certain species of shade trees. Every three to seven years the coffee plants are also pruned. Every year the coffee beans are harvested in October through January. Coffee production, especially when mixed with trees and other plants (e.g. bananas) is considered an agroforestry system with an established cropping regime.

(c) The pre project living biomass in trees or woody perennials within the project boundary is:
(i) Not more than ten per cent of the maximum above- and below-ground biomass of trees with the project activity; or
(ii) More than ten per cent of the maximum above- and below-ground biomass of trees, and such biomass shall not be removed in the implementation of the project activity.
The farming practice will be the same. No trees will be removed from the system with the project. On the contrary, the project aims at increasing tree cover in the area and thus increase the amount of living biomass in the project area. We also expect the increase in carbon stored in the system to be less than 90% with the project.

(d) If there is a decrease in the area cultivated with crops attributable to implementation of the project compared to the total area cultivated with crops at the start of the project then the methodology is applicable if at least one of the following conditions is met:
(i) There is no displacement of crops; or
(ii) The displacement of crops will not cause deforestation; or
(iii) The displacement is to lands surrounding the project activity that contain insignificant biomass (for example degraded land with no or only a few trees or shrubs per hectare); or

(iv) The decrease in the area cultivated with crops within the project boundary as a result of the project activity is less than 50 per cent of the total project area.
Displacement of crops is unlikely. If it were to happen it only would a very small scale, not causing deforestation. Since coffee plantations are often surrounded by pasture or other non-forest land uses, its displacement would potentially displace crops into degraded landscapes, which would in fact have positive effects.

Appendix 4.1 Carbon Pools to be Measured
Above-ground biomass (shade trees and coffee plants): the average carbon stored in the above-ground biomass of shade trees and coffee plants is 27.0 Mg Ha-1 and 3.2 Mg Ha-1, respectively. A total of 1,755 Mg of C for shade trees and 209 Mg of C for coffee plants are stored in 65 hectares of coffee plantations in the project area. In terms of CO2 emissions, maintaining the current conditions would prevent the emission of 7,201 Mg of CO2.

Below-ground biomass (roots): the average carbon stored in the below-ground biomass of roots is 6.3 Mg Ha-1. A total of 409 Mg of C are being stored in 65 hectares of coffee plantations in the project area. The decomposition and CO2 release of this below-ground biomass after clearing the coffee plantations for pasture lands would account for 1,499 Mg of CO2.

Soil Organic Carbon: the average soil organic carbon pool in coffee plantations to a depth of 10 cm is 122 Mg Ha-1. A total of 7,930 Mg of C are being stored in the soil for the 65 hectares of coffee plantations in the project area. In terms of CO2, currently the soil store a total of 29,076 Mg of CO2.

Appendix 4.2 Methodology for Calculating Carbon Pools
1. Above- and below- ground biomass: The carbon stock in living biomass (above- and below- ground biomass) of trees and coffee plants for stratum i (Ctrees,i,t) was estimated by calculating the mean carbon stock in above-ground biomass based on field measurements in temporary plots. The Allometric Equations method was used.
Step 1: data was collected on diameter at breast height (DBH, at 1.3 meters above-ground level) and height of all trees and coffee plants in 0.1-hectare plots. One plot per farm was established (i.e. sampling intensity ranged from 2-40%).
Step 2: the volume estimations of trees and coffee plants was based on relevant regional allometric equations developed for coffee agroforestry systems in Nicaragua by Suárez-Pascua et al. (2002). To develop these equations, the authors destructively sampled 35 shade trees in the genera: Eucalyptus, Inga y Erythrina. The allometric equation for coffee plants was developed by destructively sampling 97 individuals.
Step 3: We estimated the carbon stock in above-ground biomass for each individual tree l of species j in the sample plot located in stratum i using the allometric equation $\log(Biomass) = -09578 + 2.3408 * \log(DBH)$. Where biomass is in kg and DBH in

cm. We sum the carbon stocks in the sample plot and extrapolated it to the rest of the coffee plantation areas for each farm. For the coffee plants we estimated the carbon stock for each individual l in the sample plot located in the stratum i using the allometric equation $\ln\ (Biomass) = -2.39287 + 0.95285 * \ln(d_{15cm}) + 1.2693 * \ln\ (height)$. Where biomass is in kg, d15cm is the diameter of the stem at 15 cm above ground and height is in m.

Carbon stocks were calculated from the biomass measurements by using the conversion factor 0.44 which is the lower end of the range recommended (IPCC, 2006). In this way, the carbon stock in above-ground biomass of trees of species j on sample plot sp for stratum I (in tonnes C) was calculated by solving the equation:

$C_{AB,i,j,t} = \sum_{l=1}^{N_{sp,t}} CF_j * f_j(DBH, H)$, where:

$C_{AB,i,j,t}$, is the carbon stock in above-ground biomass of trees of species j on sample plot sp for stratum I (in tonnes C).

CF_j, Carbon fraction of dry matter for species or group of species type j, tonnes C (tonne d.m.)-1, IPCC default value = 0.5. Range = 0.44 – 0.49 for above-ground biomass (IPCC, 2006). To be conservative, the 0.44 conversion factor was used.

$f_j(DBH,H)$, An allometric equation linking above-ground biomass of living trees (d.m. tree-1) to mean diameter at breast height (DBH) and possibly tree height (H) for species j, at time t, t.d.m tree-1.

i 1, 2, 3, …… MPS strata in the project scenario

j 1, 2, 3, …… SPS tree species in the project scenario

l 1, 2, 3, …… Nj,sp sequence number of individual trees of species j in sample plot sp

t 1, 2, 3, …… t years elapsed since the start of the A/R CDM project activity

Step 4: The carbon stock in above-ground biomass was converted to the carbon stock in below-ground biomass via the equation

$BBD(kg) = \exp\ (-1.0587 + 0.8836 * \ln\ (ABD)$, developed by Cairns et al. (1997).

Where,

BBD, is below- ground biomass density (Mg Ha-1)

ABD, is above-ground biomass density (Mg Ha-1).

Step 5: the total carbon stock in the living biomass of all trees present in the sample plot sp in stratum i at time t was calculated using the equation:

$$C_{tree,i,sp,t} = \sum_{j=1}^{Sps} (C_{AB,i,sp,j,t} + C_{BB,i,sp,j,t})$$

where,

$C_{tree,i,sp,t}$, Carbon stock in living biomass of trees on plot sp of stratum i at time t, Mg C

$C_{AB,i,sp,j,t}$, Carbon stock in above-ground biomass of trees of species j in plot sp in stratum i
at time t; Mg C tree-1
$C_{BB,i,sp,j,t}$, Carbon stock in below-ground biomass of trees of species j in plot sp in stratum i
at time t, Mg C tree-1
i 1, 2, 3, …… MPS strata in the project scenario
j 1, 2, 3, …… SPS tree species in the project scenario
t 1, 2, 3, …… t years elapsed since the start of the A/R CDM project activity

Step 6: the mean carbon stock in tree biomass for each stratum was calculated using the equation:

$$C_{tree,i,t} = \frac{A_i}{Asp_i} \sum_{sp=1}^{Pi} C_{tree,i,sp,t}$$

$C_{tree,i,t}$, Carbon stock in living biomass of trees in stratum i at time t, Mg C
$C_{tree,i,sp,t}$, Carbon stock in living biomass of trees on plot sp of stratum i at time t, Mg C
Asp_i , Total area of all sample plots in stratum i; ha
A_i , Area of stratum i, ha
i 1, 2, 3, …… MPS strata in the project scenario
t 1, 2, 3, …… t years elapsed since the start of the A/R CDM project activity

2. Soil organic carbon: Seven of 54 farms were sampled for bulk density and carbon concentration. Farm selection was based on the farm's coffee productivity and management intensity. A wide range farms with different management intensities were selected for measuring soil organic carbon.
In order to calculate the amount of carbon in the soil we used the bulk density of the soil in the first 10 cm. Also, the carbon concentration was measured for the first 20 cm of soil. For the bulk density analysis we followed the methodology recommended by the Natural Resources Laboratory at the University of Costa Rica. Two to three samples per hectare were randomly taken from within the coffee plantation areas. The top layer of decomposed organic matter was removed and any fallen debris were also excluded. A 10.3 x 5.5 cm cylinder (galvanized iron) was inserted into the soil using a rubber mallet and another cylinder to avoid compacting the top layer of the soil. The content of the cylinder was stored in a sealed plastic bag and sent for analysis to the laboratories at ICAFE (Costa Rica Institute of Coffee).
Step 1: Soil organic carbon was calculated as follows:

$$Soil\ Carbon\ (g) = bulk\ density\ (g/cm^3) * cylinder\ volume\ (cm^3) * \ [C](\%)$$

Step 2: In order to account for the 10-cm soil layer or carbon pool the area of the cylinder is extrapolated to the entire coffee plantation area, as follows:

$$Soil\ Carbon\ (MgHa^{-1}) = Soil\ Carbon\ (g) * EF$$

Step 3: The expansion factor is calculated as follows:

$$EF = \frac{1.0\ x\ exp^{10}\ (cm^2)}{area\ of\ the\ cylinder\ (cm^2)}$$

Where,

[C] is carbon concentration in the soil

EF is the extrapolation factor for converting carbon measurements to a hectare. Therefore $1.0\ x\ exp^{10}\ (cm^2)$ refers to the cm2 in one hectare.

Glossary

Key terms have been defined to ensure consistency throughout the document and transparency for all intended parties. The following definitions are adapted from the IPCC GPG for LULUCF protocol (2003) unless otherwise stated and are consistent with VCS guidelines (VCS 2007.1, 2008).

- Aboveground Biomass (AGB)

  Is defined as all of the living biomass above the soil, which includes stem, stump, branches, bark, seeds and foliage. For all activities in outlined in this project, AGB will refer to trees greater than 10cm in diameter at breast height, unless otherwise stated. The equations for this estimation include all parts of AGB.

- Accuracy

  Can be considered an increasing state of exact measurement.

- Additionality

  Finca Project is responsible for ensuring that the carbon sequestrations of project activities currently provided by trees are not additional to those that would occur in the absence of a certified project activity.

- Afforestation

  May be considered the anthropogenic modification of previously non-forested land of a minimum of 50 years to forested land.

- Allometric relationship

  Equations that mathematically relate physical characteristics such as tree trunk diameter and tree height to estimate biomass (Redondo, 2005). These equations are considered an indirect measurement of carbon. They are time and cost effective, in addition to being non-destructive. Studies have shown tree biomass-carbon allometric equations to be above 95% accurate (Redondo, 2005).

- Belowground Biomass (BGB)

  May be considered live root material below the soil.

- Biomass

  "Organic material both aboveground and belowground, and both living and dead, e.g., trees, crops, grasses, tree litter, roots etc. Biomass includes the pool definition for above - and below - ground biomass" (IPCC, 2003).

- Brokers and Exchanges

  Buyers and sellers will have access to these carbon credits through exchanges approved by the VCS. The two possible exchanges under consideration are the APX and the TV1.

- Conservativeness

  The principle of conservativeness should be followed when completeness or accuracy of quantitative estimates cannot be made - the reduction of emissions should not be overestimated (Grassi, 2008).

- Diameter at Breast Height (DBH)

  Is scientifically accepted to be 1.30 meters above the ground.

- Dead wood

  Consists of non-living biomass "larger than or equal to 10cm in diameter"(IPCC, 2003).

- Deforestation

  Is defined as the measurable and sustained decreased in crown cover below 10-30%.

- Forest

  Is considered land (minimum of 0.05-1.0 hectare) area with more than 10 - 30% crown cover and tree height of at least 2-5 meters at maturity.

- Leakage

  Is the accumulation of GHG emissions outside the project boundary, but still within the country boundary. Significant leakage effects must be taken into consideration of project calculations of net emission reductions according to VCS guidelines (2008).

- Litter

  Consists of decomposing non-living biomass.

- Precision

  In terms of understanding inventory is a lessening state of uncertainty.

- Project Developers

  The project developer would be the Finca Project as they are the ones who wish to create the emission reduction project.

- Project Funders

  The funding for this project will be used for the costs associated with validation and verification. The projects funders will be are yet to be determined.

- Project Owner

  The project owners will be the owners if each individual finca or farm (that are members of the cooperative) that allow us to use their land to develop an emission reduction projects.

- Reforestation

May be considered to be the intended modification of non-forested land to forested Sequestration is the accumulation of carbon in a pool, excluding the atmosphere.

- Stakeholders

  Those that will be directly or indirectly affected by this project include the owners of the fincas, the Finca Project, the project funders, CoopePueblos, R.L., the town of Agua Buena, and possibly the Costa Rican government.

- Standards Organization

  Since Costa Rica and the United States are non-Annex 1 countries and this will be registered in the voluntary market, this project will use the VCS as its legislative body.

- Third Party Auditors, Validators, and Verifiers

  Under VCS protocol, the third party validator cannot also be the third party verifier. The Finca Project will attempt to work with UNA to be its third party validator and will decide among the Rainforest Alliance and the SCS for its third party verifier.

- Trader

  Those that may be interested in purchasing and selling the carbon credits will include professional traders seeking arbitrage opportunities. Final Buyers – the final buyers of the created carbon credits will be businesses looking to offset their "carbon footprint" for CSR or pre-compliance reasons (Kollmus, 2009).

References

Alberti, M., J. M. Marzluff, E. Shulenberger, G. Bradley, C. Ryan, and C. ZumBrunnen. (2003). “Integrating Humans into Ecology: Opportunities and Challenges for Studying Urban Ecosystems” in BioScience, Vol. 53: pp 1169-1179.

Babin, N. PhD Researcher on Effects of Coffee Crisis in Agua Buena. Personal Communications. June 1-August 10, 2009.

Bacon, C.M, ed. 2008. Confronting the Coffee Crisis: Fair Trade, Sustainable Livelihoods, and Ecosystems in Mexico and Central America. Boston, MIT Press.

Balick, M.J. (1992). Assessing the Economic Value of Traditional Medicines from Tropical Rain Forests” in Conservation Biology, 6th Edition: pp 128-130. Oxford: Blackwell.

Bernard, H.R. (1998). Handbook of Methods in Cultural Anthropology. London: Sage.

Bijker, W.E. (1997). Of Bicycles, Bakelites, and Bulbs: Toward a Theory of Sociotechnical Change. Cambridge MA/London: MIT Press.

Bijker, W.E. and J. Law. (1992). “General Introduction,” and “Do Technologies Have Trajectories,” in Shaping Technology / Building Society. Cambridge, MA: MIT Press.

Bijker, W.E., T. Hughes and T. Pinch. (1987). The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology. Cambridge MA/London: MIT Press.

Brown, S. (2002). “Measuring, Monitoring, and Verification of Carbon Benefits for Forest Based Projects” in Philosophical Transactions: Mathematical, Physical and Engineering Sciences Journal, Vol. 360: pp 1669-1683.

Bryant, B. and J. Callewaert. (2006). “Why is Understanding Urban Ecosystems Important to People Concerned About Environmental Justice?” in Environmental Justice. New York: Rodopi, B.V.

Buschbacher, R.J. “Tropical Deforestation and Pasture Development” in BioScience,Vol. 36: pp 22-28.

Carruthers, D., ed. 2008. Environmental Justice in Latin America: Problems, Promise, and Practice. Cambridge: The MIT Press.

Cardoso, F. H. and Faletto, E. 1979. Dependency and Development in Latin América. San Diego: University of California Press.

Chave, J., C. Andalo and S. Brown. (2005). “Tree Allometry and Improved Estimation of Carbon Stocks and Balance in Tropical Forests” in Ecosystem Ecology, Vol. 145: pp 87-99.

Cole-Christensen, D. (1997). A Place in the Rainforest: Settling the Costa Rican Frontier. Austin: University of Texas Press.

Daily, G.C. (1997). Nature's Services: Societal Dependence on Natural Ecosystems. Washington, D.C.: Island Press.

Dewey, J. (1938). Experience and Education. New York: Macmillan.

Dicum, G. and N. Luttinger. 1999. The Coffee Book: Anatomy of an Industry. New York: New Press.

“Exerpts from the Intergovernmental Panel on Climate Change (IPCC)”. UNFCCC 2003.

Eisner, E.W. (1991). The Enlightened Eye: Qualitative Inquiry and the Enhancement of Educational Practice. Old Tappan, NJ: Macmillan.

Erickson, F. (1986). “Qualitative Methods in Research on Teaching” in Handbook of Research on Teaching. 3rd Edition: pp 119-161. Old Tappan, NJ: Macmillan.

Flyvberg, B. (2006). “Five Misunderstandings About Case-Study Research” in Qualitative Inquiry Journal, Vol. 12: 219-245.

"Food and Agricultural Organization of United Nations: Economic and Social Department: The Statistical Division". Faostat.fao.org. December 16, 2009. Retrieved March 26, 2010.

Forman, R.T.T. (2008). Landscape Ecology. Cambridge: Harvard Press.

Frank, A. G. 1969. Capitalism and Underdevelopment in Latin America: Historical Studies of Chile and Brazil, pp. 1-29, 279-318. New York: Monthly Review Press.

Geilfus, F. (1994). El Arbol al Servicio del Agricultor: Manual de Agroforesteria para el Desarollo Rural. Turrialba, Costa Rica: ENDA CARIBE/CATIE.

Gobo, G. (2004). “Sampling, Representativeness and Generalizability” in Qualitative Research Practice. London: Sage.

Goetz, S.J. (2009). “Mapping and Monitoring Carbon Stocks with Satellite Observations: A Comparison of Methods” in Carbon Balance and Management, Vol. 4: pp 2-9.

Greenhalgh, S., F. Daviet, and E. Weninger. (2005). “The Land Use, Land-Use Change, and Forestry Guidance for GHG Project Account” in The GHG Protocol: World Resources Institute.

Green, D. 2006. Faces of Latin America. London: Latin America Bureau.

Groat, L. and D. Wang. (2002). Architectural Research Methods. New York: John Wiley and Sons.

Guba, E. and Y. Lincoln. (1981). Effective Evaluation. San Francisco: Jossey-Bass.

Hamel, J. (1993). “Case Study Methods” in Qualitative Research Methods, Vol 32. Thousand Oaks, CA: Sage.

Harris, R. and J. Nef, eds. 2008. Capital, Power and Inequality in Latin America and the Caribbean. New York: Rowman & Littlefield Publishing.

Higgs, E. (1997). “What is Good Ecological Restoration?” in Conservation Biology, Vol. 11: pp 338-348.

INEC Census Data. (2000).

Jaffee, D. 2007. Brewing Justice: Fair Trade Coffees, Sustainability, and Survival. Berkely: University of California Press.

Jimenez, J.J. Coordinator of National University Environmental Payments Program. Personal Communication. July 7, 2009.

Joyce, A.T. (2006). Land Use Change in Costa Rica: as Influenced by Social, Economic, Political, and Environmental Factors: 1966-2006. Costa Rica: Litografia e Imprenta LIL, S.A.

Klaren, P. 1996. “Lost promise: Explaining Latin American Underdevelopment” in Democracy in Latin America: Patterns and Cycles, ed. Roderic Camp, pp. 91-120. Wilmington: Scholarly Resources.

Kuhn, Thomas S. (1996). The Structure of Scientific Revolutions. Chicago and London: University of Chicago Press.

Latour, B. (2005). Reassembling the Social: An Introduction to Actor-Network-Theory. Oxford: Oxford University Press.

Latour, B. (2004). Politics of Nature. Cambridge, MA: Harvard University Press.

Mittermeier, R.A., N. Myers, J.B. Thomsen, G.A.B. Da Fonseca and S. Olivieri. (1998). "Biodiversity Hotspots and Major Tropical Wilderness Areas: Approaches to Setting Conservation Priorities" in Conservation Biology, 12th Edition: pp 516-520. Oxford: Blackwell.

Muschler, R. (2000). Arboles in Cafetales: Coleccion Modulos de Ensenanza Agroforestal. Turrialba, Costa Rica: CATIE Press.

Orr, D. Ecological Literacy: Education and the Transition to a Postmodern World. (1992). New York: State University of New York.

Pearson, T., S. Walker, S. Brown. (2005). Sourcebook for Land Use, Land-Use Change and Forestry Projects. NY: World Bank.

Pelupussy, W. (1997). "The Sustainability of International Coffee Chains in Cote D'voire and Costa Rica" for the Symposium on Agricultural Marketplace in Tropical Africa, Afrika Studicentruum & Vakgroep Marktkunde WW.

Pendergrast, M. (1999). Uncommon Grounds: The History of Coffee and How It Transformed Our World. NY: Basic Books.

Penman, J., M. Gytarsky and T. Hiraishi (2003). "Good Practice Guidance for Land Use, Land-Use Change and Forestry (GPG-LULUCF)" in Intergovernmental Panel on Climate Change (IPCC). Kanagawa, Japan: Institute for Global Environmental Strategies.

Polzot, C.L. (2004). Carbon Storage in Coffee Agroecosystems of Southern Costa Rica: Potential Applications for the Clean Development Mechanism. Ontario, Canada: York University Press.

Redondo-Brenes, A. (2005). "Payment for Environmental Services in Costa Rica: Carbon Sequestration Estimates of Native Tree Plantations" in Tropical Resources Bulletin. San Jose, Costa Rica: Teco.

Rickert, E. (1998). Environmental Effects of the Coffee Crisis: A Case Study of Land Use and Avian Communities in Agua Buena, Costa Rica. Olympia: The Evergreen State College Press.

Rojas, F; Canessa, R; Ramírez, J. (2004). Incorporación de Arboles y Arbustos en los Cafetales del Valle Central de Costa Rica. Cartago, Costa Rica: ICAFE- ITCR.

Skidmore, T.E., and P.H. Smith. 2004. Modern Latin America, 6th ed. New York: Oxford University Press, pp. 36-58.

Stake, R.E. (2005). “Quantative Case Studies” in The Sage Handbook of Qualitative Research, 3rd Edition: pp 443-466. Thousand Oaks, CA: Sage.

Segura, M., M. Kanninen and D. Suárez. (2006). Allometric Models for Estimating Above-ground Biomass of Shade Trees and Coffee Plants in Agroforestry Systems in Matagalpa, Nicaragua” in Agroforestry Systems.

Shrestha, R.M., S. Sharma, G.R. Timilsina, and S. Kumar. (2005). “Baseline Methodologies For Clean Development Mechanism Projects” for the UNEP Risø Forum on Energy, Climate and Sustainable Development. Roskilde, Denmark: Risø National Laboratory.

Suarez-Pascua, D.A. (2002). Cuantificacion y Valoracion Economica del Servicio Ambiental Almacenamiento de Carbono en Sistemas Agroforestales de Café en la Comarca Yassica Sur, Matagalpa, Nicaragua. Turrialba, Costa Rica: Centro Agronomico Tropical de Investigacion y Ensenanza.

Tipper, Richard, R. Carr, and W. McGhee. (2002). “Guidance on Baselines Methodologies and Crediting Periods for LULUCF Projects in the CDM” for the UK Department for Environment, Food and Rural Affairs Forum. Ireland: The Edinburgh Center for Carbon Management.

Valverde, L. (2003). "Crisis Atasco Desarollo en Zonas Cafetoleras" in La Republica Newspaper, San Jose.

Van Noordwijk, M., M. Rahayu, K. Hairiah, Y.C. Wulan, A. Farida and B. Verbis. (2002). “Carbon Stock Assessment for a Forest-to-Coffee Conversion in Sumber-Jaya: from Allometric Equations to Land Use Change Analysis” in Life Sciences, Vol. 45: pp 75-86.

Vernengo, M. 2004. Technology, Finance and Dependency: Latin American Radical Political Economy in Retospect. Salt Lake City: University of Utah Press.

Virginio, M. and Haggar, J. (2004). Como Analizo y Manejo Los Arboles en mi Cafetal. Turrialba, Costa Rica: CATIE/CEDECO.

Vitousek, P.M., H.A. Mooney, J. Lubchenco, and J.M. Melillo. (1997). “Human Domination of Earth’s Ecosystems” in Science, Vol. 277.

Wilson, R. and K. D. Brown. (2008). “Carbon Neutrality at the Local Level: Achievable Goal or Fantasy?” in Journal of the American Planning Association, Vol. 74: pp 497-504.

Yin, R.K. (1994). Case Study Research: Design and Methods. Thousand Oaks: Sage.