Evaluation of Solid Waste Management In Cartago, Costa Rica

(Municipalidad Jimenez, 2010)

IQP Proposal

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Chapter 1: Introduction

The idea of sustainability and conservation of the environment has become a major concern in the world today. Recycling is one approach to sustain natural resources, by transforming used materials into new products. It lessens the burden on the earth caused by extraction and processing, consequently reducing the demand for raw materials (McDonough, 2002). Implementing recycling programs builds the groundwork for increasing a population's willingness to participate and strive to be more sustainable (Canterbury, 2003). Subsequently, products that are made from recycled materials consume less energy in manufacturing than those of virgin materials. This reduces waste-disposal methods that may be damaging to the environment in favor of eco-friendly recycling options.

In many countries, recycling has become a routine practice in everyday life. Other countries, however, face difficulties initiating recycling programs due to factors such as insufficient recycling infrastructure and a lack of education. Although local governments may have the resources available to establish recycling programs, the success of these programs is highly dependent on the cooperation of the citizens of these municipalities. For household recycling to be effective, residents must be willing to recycle and programs must be readily available for the public (Halvorsen, 2012). Municipal officials can help the process by identifying trends and habits specific to their communities in order to properly implement various recycling programs (Schoot, 2011).

In a study done in the Borough of Burnley, England in 2002, data revealed some of the common factors that affect participation of residents in recycling programs such as convenience, knowledge of recycling centers, social values and norms associated with recycling, time constraints, and willingness to make the sacrifice (Martin, 2006). Countries around the world are taking the initiative to keep waste from going directly to waste streams, such as landfills, by recycling more frequently. Costa Rica is among the leaders in the recycling trend (Al Día, 2009). Laws have recently been passed to help citizens become more familiar with the practice of recycling.

Like many nations, Costa Rica faces serious environmental impacts from the inappropriate disposal of solid waste. Many residents resort to dumping trash into the rivers,

instead of using solid waste management methods such as composting and recycling due various reasons such as lack of education or lack of resources. For example, collection trucks do not reach all residencies in each municipality in which case waste cannot be taken to landfills, recycling, or composting centers. Actions such as these have negative secondary effects, including risk of flooding from the accumulation of solid waste in rivers and tributaries (PREVDA, 2010). Because of these threats, it is important to establish laws and organizations in charge of implementing appropriate plans to reduce these negative effects as well as encouraging citizens to become active participants in the process as well as taking initiative themselves.

The Commission of Management and Ordinance of the basin of the Reventazón River (COMCURE) was created on October 24th, 2000 to help with the order and management of the Reventazón River. COMCURE's aim is to ensure that the area surrounding the Reventazón River as well as the river itself are protected and uncontaminated for the benefit of the surrounding communities. They have the power to initiate and implement plans and to organize committees amongst the communities along the river. The main goals of COMCURE are to define and execute plans of managing and regulating the Reventazón River and to educate community leaders, business administrators, and residents about managing and protecting the river. The organization focuses specifically on geology, human health, protection of the environment, and Costa Rican culture.

Since the intervention of COMCURE, flooding and landslides have decreased along the river. The agency has measured an 11% increase in sediment trapping vegetation of the watershed (a region encompassing the river as well as surrounding area whose runoff all leads to the Reventazón River) which helps reduce toxic runoff. Furthermore, in the past decade, COMCURE has implemented actions that have reduced the amount of anthropogenic debris that has reached dams by roughly 20%. COMCURE is dedicated to improving Costa Rica's natural environment, particularly along the Reventazón River, and this includes the practice of recycling solid waste.

COMCURE has implemented three recycling plans in communities located in the Reventazón River watershed (COMCURE, 2012). Jiménez, a municipality located at the basin of the river, has had a plan in place for a decade in the central district of Juan Viñas. The plan includes the separation of waste at the origin, which means that households and businesses much separate their own waste into specified bins according to waste type before it is collected by the

city. The city then composts organic waste, and recycles other solid waste such as plastic and glass (COMCURE, 2012).

Another municipality that COMCURE has been working with to improve recycling participation is Alvarado, which is also located along the river basin. Community members have been working with the municipality to educate the residents of Alvarado about the waste management program that began in January, 2011. Although a relatively new program, the community has been very proactive in tackling the problem of implementing a new recycling project. Since being established, the program has performed studies on disposal of solid waste, educated residents by approaching them at their homes, and began the steps necessary to build a composting center (COMCURE, 2012).

San Rafael, the central district in the Oreamuno municipality, has a relatively new program in place for the recollection and separation of solid waste. Unlike Jiménez, the separation of solid waste is done by the city government, instead of the residents and businesses. The municipality has established a collection center that is in charge of separating and recycling reusable materials (COMCURE, 2012).

In order to focus their efforts and measure the outcomes in each community, COMCURE would like to assess the habits and attitudes of residents in each of these communities. This project will assist COMCURE in evaluating the programs that have been established in these three locations. To evaluate these programs, we will focus on the social, economic, and environmental impacts in each community. Through a careful assessment and evaluation, we will better understand the current status of each municipality's plan, allowing us to make customizable recommendations specific to each community.

Chapter 2: Literature Review

As the population increases around the world, so do the impacts people have on the environment. A growth in population and increasing standard of living in developing countries has caused the amount of waste being produced to reach new levels (Schoot, 2011). An important concern for many of these developing countries is what to do with all of that waste. Costa Rica has recognized the importance of protecting the environment and has made that one of its priorities. In 2007, Costa Rica's president, Oscar Arias, announced that he intended the country to be one of the first developing country to become carbon neutral by 2021(Long, 2011). In order to achieve this goal, Costa Rica began implementing various laws to reduce the damage caused by urbanization. Several municipalities in Costa Rica, including Alvarado, Jiménez, and Oreamuno have taken the initiative by establishing systems to dispose of solid waste. In order to optimize the success of each program, it is important to consider the current social and legislative situations in the country, locate and study the municipalities of interest, and research other waste disposal strategies used around the world.

2.1 Recycling

Today, there are several methods for managing solid waste; some are more harmful to the environment than others. Figure 1 shows the hierarchy of the impacts waste management methods have on the environment (Tam, 2006).

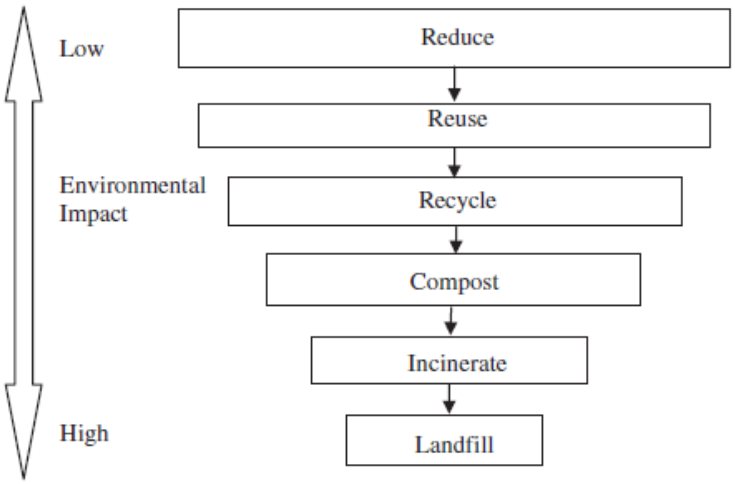

Figure 1: Hierarchy of Waste Disposal

(Tam 2006)

Although reducing the amount of garbage being generated has the lowest environmental impact, the difficulty of implementing it lowers the efficacy. It is difficult to reduce the amount of waste created because more products are being made than ever before. With more developing countries, a higher percentage of the population is consuming more goods. This means they are buying more products and consequently disposing of more waste (McDonough, 27, 2002). The next method with a low environmental impact is reuse. It is important to reuse materials, but impractical for things such as everyday household waste. This is where recycling comes into play as the next best option. Composting and recycling are both sustainable methods of disposing of waste; recycling is directed towards man-made items, while composting is a process for organic materials. These methods are considered to be sustainable because they maintain the quality of the environment, as opposed to improper disposal of waste which can be harmful to the environment.

Recycling is the recovery of materials that would otherwise simply be discarded as solid waste and the process of transforming them into products that can be used again. Instead of following the "cradle to grave" model, in which raw materials are converted into products that are sold and then thrown away into a permanent repository such as a landfill (McDonough, 2002), recycling follows the "cradle to cradle" model. This model takes materials that have already been made into a product and creates a new product with those materials. There are two types of recycling, defined by the similarities between first-generation and later generation products. These are called closed loop recycling and open loop recycling. Closed loop recycling is a process in which, after use, the product is recycled back into a new but identical or similar product (Schoot, 2011). For example, when old paper is recycled, it is usually transformed into new paper. Open loop recycling, on the other hand, refers to the process of transforming the material of one product into a completely different product (Schoot, 2011). An example of open-loop recycling is converting used plastic water bottles into plastic casings for pens.

There is currently a variety of household materials that can be recycled. In the United States and many other regions of the world, the most common household products recycled include paper products, glass jars and bottles, metal products like foil and cans, and many types of plastic containers (Curbside Recycling, 2012). These materials tend to have the shortest time in the first use phase, which is the time between the manufacture of the product and when it is

used and discarded. Because so many of these products are made, used, and discarded at such a fast pace, it is important to recycle them to reduce the amount of raw materials used to make new versions of these products. Because raw materials do not need to be extracted from the earth to make recycled products, recycling reduces the demand for energy usage. It also reduces the volume of waste and the negative effects on the environment associated with improper waste disposal because the materials are being reused. As leaders in the communities, country officials can help implement sustainable programs such as recycling in order for citizens to be encouraged to adapt new day-to-day habits. This will help countries conserve the world's natural resources.

2.2 Costa Rica

Costa Rica is a country known for its diverse natural ecosystems, which has fostered a thriving ecotourism industry (Honey, 2003). By taking small steps toward economic development, Costa Rica has become a leader in the reduction of poverty in Latin America (PNUD, 2012). In 2000, the United Nations Development Program challenged the world to accomplish eight goals by 2015; one of these goals was to eradicate extreme poverty and hunger (PNUD, 2012). In the mid-1980s, the poverty rate in Costa Rica was at a 40% and by 2004, it had decreased to 20% (FMI, 2004). Not only did the country exceed in fighting poverty, but also the literacy rate is at an astounding 96% (UNICEF, 2004). This level of literacy is so high that it competes with and is at the same levels of countries that are more developed than Costa Rica such as the United States and Germany. This motivated and inspired Costa Ricans and kept them moving forward in the development of their country (FMI, 2004).

2.2.1 The Advancement of Costa Rica

In 2007, the Costa Rican government made a commitment to become carbon neutral by 2021, a pledge that few countries have made (UNEP, 2003). Reaching carbon neutrality in fourteen years is not an easy task and will not be accomplished by just turning off light bulbs and planting trees. According to an article on the government's plan of action, published on September 8, 2009 by a newspaper in Costa Rica, *Al Día,* carbon neutrality is a challenging goal (EFE, 2009). One of the biggest problems of becoming sustainable is the fact that diesel, the most popular fuel in Costa Rica, generated over five million metric tons of CO_2 in 2005. The remaining CO_2 emissions from industrial resources, livestock, agriculture, and landfills added up

to another seven million metric tons of CO_2 (see Figure 2). However, reforestation increased from 40% to 50% throughout the previous decade. Other improvements include the preservation of forests and planting trees in new areas. The funding for these undertakings originated from tax revenues, mainly tax on fuels. These efforts resulted in the removal of over two million metric tons of harmful greenhouse gases from the atmosphere (Environmental Entrepreneurs, 2012).

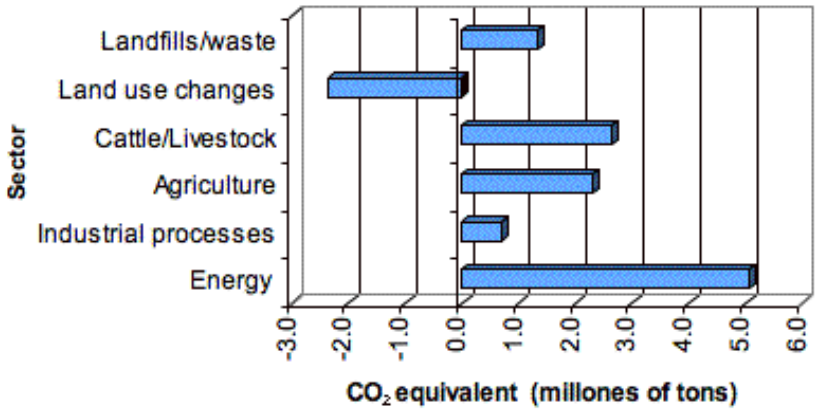

Figure 2: Emissions of CO2 in Costa Rica

Source: (President Aim for Carbon Neutrality, 2012)

2.2.2 National Sustainability Plans

There are several programs throughout the country that motivate entire communities to recycle. Non-profit groups, like the Planeterra Foundation, are trying to inculcate good recycling habits among the youth. This foundation has been working with schools all around the world including a school in Playa Matapalo, located along the west coast of Costa Rica. This foundation has invested money in the school's curriculum to establish a class where students are taught methods of "sustainable agriculture and rural community tourism management" (Plantera Foundation, 2012). Children are also taught to separate recyclables with safe equipment. Skills developed in these funded programs will allow underserved children to acquire future employment (Planeterra Foundation, 2012).

Another program in Costa Rica is called REDCICLA (in English, Recycling Web of Costa Rica), a community project, established in 2004. Unlike the Planeterra Foundation, this program was founded and funded with the help of a foreign nation, Japan, in 2005. The Japanese

embassy financed this program because they wanted to help the health, environment and economy sectors of Costa Rica. This program was established to inform communities of the three R's: reduce, reuse, and recycle. Rather than only teaching children, this program was aimed toward the entire population, from the working mother to the business owner. REDCICLA offers advice for companies who need it and want to help improve the current state of the country (REDCICLA, 2010).

There are also programs directed by the government and managed by a specific government division. An example of one of these programs is the *Programa de Reciclaje para la Asamblea Legislativa de Costa Rica* (Recycling Program for the Legislative Assembly in Costa Rica). This program is run by the Health Services Department and led by Dr. Mario Martinez Bolivar. Unlike the previous two programs REDCICLA and Planeterra, this program is more detailed and explains step by step how to successfully achieve the goal of educating the community about recycling appropriately. With this approach, recycling is taken one step further and explains what products could be created with the materials that have been recycled. Dr. Bolivar's report mentions astounding facts such as that in the last 47 years humans have produced more waste than since the beginning of recorded history up to 1960 (Aguero, 2009). This gives skeptics more reasons to recycle.

Programa Regional de Reduccion de la Vulnerabilidad y Degradacion Ambiental (The Regional Program for the Reduction of Vulnerability and Environment Degradation, or PREVDA*)* is a program in which independent entities and the government work together to pass environmental laws in select regions of Costa Rica. Along with these laws, committees are created to govern programs and to enforce the laws (PREVDA, 2010) . PREVDA and the local government created the *Comisión para el Manejo y Ordenamiento de la Cuenca Alta del Río Reventazón* (The Commision for the Management and Ordinance of the Basin of the Reventazón River) (COMCURE, 2012) by law number 8023. The formation of COMCURE confronted the problems of sedimentation along the Reventazón River, the poor management of solid waste, and the inability for the community to understand these problems (SICA, 2009)

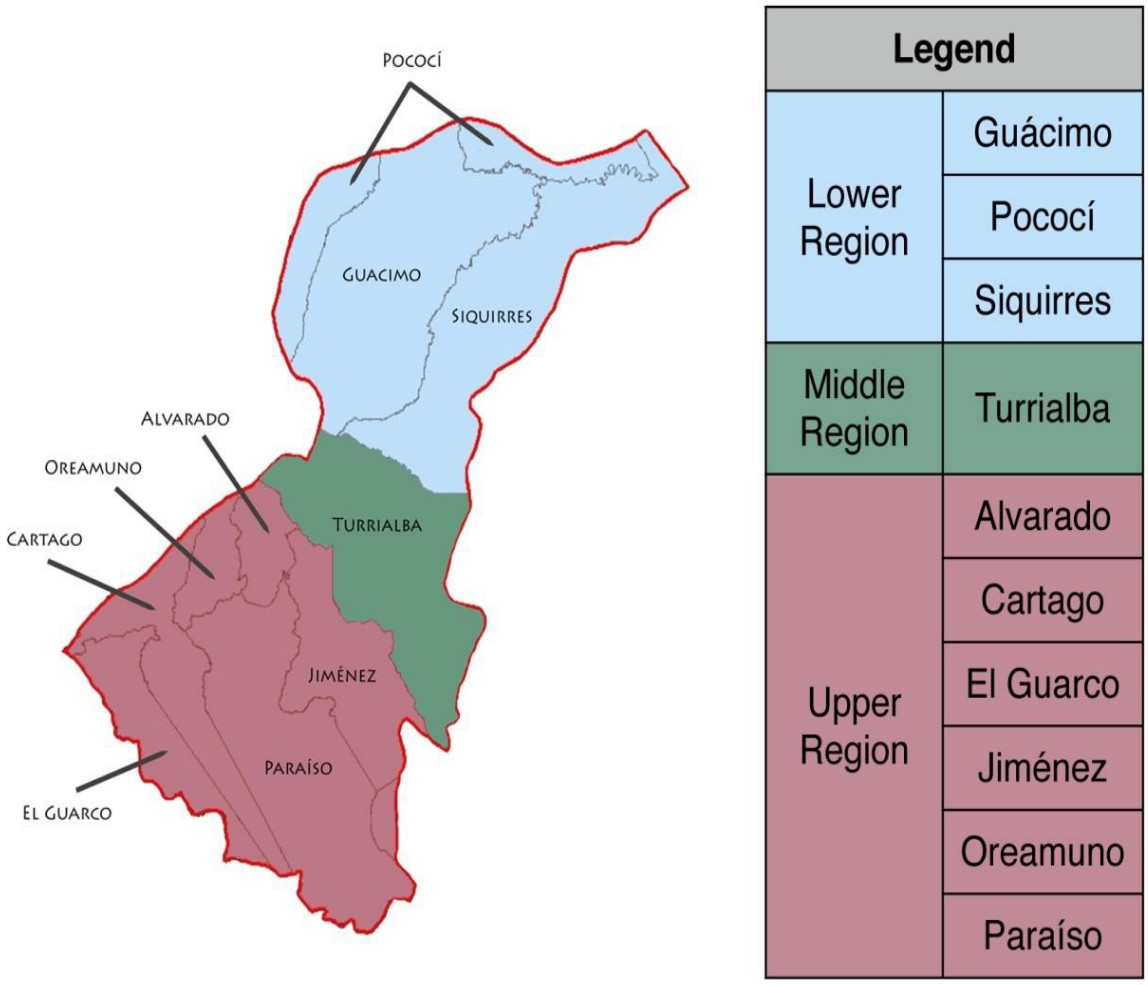

Figure 3: Surrounding Areas of Reventazon River

(Wang et al, 2012)

2.3 The Reventazón River Basin

The region surrounding the Reventazón River is divided into three different sections that share the water shed, the upper, middle, and lower sections (see Figure 3). The three municipalities studied in this project are located in the upper section. There are various characteristics associated with each one of the sections of the Reventazón River. Both the upper and middle sections are characterized by a dense population, commercialization, and increasing urbanization (Wang et al, 2010). In contrast, the lower section is characterized by the prominent existence of forests and protected reserves. Due to the lower section's steep terrain and protected national forests, roads are not common and therefore this results in a low population density.

(C.N.E., 2012)

The Reventazón River is an important source of hydroelectric power for Costa Rica. It receives the highest precipitation rate of all the rivers in Costa Rica. This results in a high water volume and therefore a higher flow rate, making the river an ideal candidate for the production of hydroelectric power, an alternative source of power. The Reventazón River is responsible for 27% of the nation's hydroelectric capacity, which is the highest in the country. This permits the country to obtain energy at a low cost, benefitting the country's economy (Locatelli et al, 2011). For these reasons, it is crucial to maintain the Reventazón River in optimal condition and establish various effective recycling plans in municipalities that are fully functional (Karak and Bhattacharyya, 2012).

2.3.1 Urbanization and Waste Management in the Reventazón River Basin

Urbanization in all three municipalities has had many negative effects on the Reventazón River region. The population density causes a higher demand on construction of houses and other resources. This demand is difficult to satisfy since some of the land close to the river is affected by sedimentation and is unsafe for new construction. More solid waste is being generated as the population increases, which puts a strain on current waste management plans. Water treatment plants cannot properly manage the poor water quality in the river caused by solid waste due to the lack of established plants (C.N.E., 2012). According to Costa Rica's national census statistics, the percentage of people that recycle in urban areas is lower than the percentage of people that recycle in rural areas. For example, in Table 1a, only 31% of urban households separate their organic waste, whereas 50% of rural households do (Instituto Nacional, 2011). These statistics demonstrate that not all waste management methods can be applied in all areas. Programs must be established that are tailored to the needs and convenience of each community.

Total Number of Households That Separate Organic Waste

Costa Rica			
Region	**Yes**	**Unknown**	**Total**
Urban	255,776 (31%)	0	814,774
Rural	240,979 (50%)	0	482,748

Table 1-a: Total Number of Households that Separated Organic Waste in 2011 (Instituto Nacional, 2011)

Total Number of Households That Separate Plastic Waste Costa Rica			
Region	Yes	Unknown	Total
Urban	326,974 (40%)	0	814,774
Rural	193,539 (40%)	0	482, 748

Table 1-b: Total Number of Households that Separated Plastic Waste in 2011 (Instituto Nacional, 2011)

Total Number of Households that Separate Paper/Cardboard Waste Costa Rica			
Region	Yes	Unknown	Total
Urban	284,760 (35%)	0	814,774
Rural	164,056(34%)	0	482,748

Table 1-c: Total Number of Households that Separated Paper/Cardboard Waste in 2011 (Instituto Nacional, 2011)

Not only is solid waste management (SWM) an issue for the municipalities along this river, but it is also a concern all around the country. There are various techniques for disposing of waste besides taking it to a waste management center or having it picked up by a collection truck. Many residents resort to disposing of their waste into bodies of water or by throwing it into holes and burying it. Hence, organizations such as COMCURE are dedicated to protecting the river through the implementation of recycling programs. In Table 2, methods of disposal are outlined for the central region of Costa Rica, which includes the Cartago province consisting of Oreamuno, Jiménez, and Alvarado (Instituto Nacional, 2011).

Disposal Methods	**Amount Participated**
Collection truck	813,787
Thrown in hole, buried	12,156
Burning	22,402
Thrown in vacant lot	1,384
Thrown in river, ravine	268
Other	21,101
Unknown	0
Total	851, 089

Table 2: Disposal of Waste, Central Costa Rica (Instituto Nacional de Estadística y Censos)

As can be seen in the tables above, various harmful methods of solid waste management are used by community members. In the central region of Costa Rica alone, 37,302 of the residents that completed the national census answered that they discarded their waste in various harmful ways. Solid waste that is discarded into the Reventazón River and surrounding area

produces a domino effect that impacts various industries. When garbage is thrown into the river, all of the systems that are dependent on it are affected. Such is the case in all three of the municipalities that are of interest in this paper. Improper disposal of solid waste causes flooding since the debris causes a reduction in the capacity of the water flow. Flooding affects the surrounding infrastructure as well as the land itself by disturbing the soil. Contamination of the water affects the health of surrounding communities due to the spread of disease and harmful chemicals in the water. This contamination also affects biodiversity which is crucial for the country's ecotourism. Due to the multitude of harmful secondary effects that improper SWM methods have on the country, it is necessary to adjust current SWM plans.

2.3.2 The Municipality of Jiménez

Although Jiménez's recycling program has been established the longest time in comparison to the other two municipalities, 60% of the waste is not properly handled. Many of the landfills are not designed to handle the waste that is deposited into them, which causes some garbage to be taken to what are called "botaderos", or dumps, which are not properly regulated and located in close proximity to the Reventazón River. The Juan Viñas district established a recycling program in 2002, which has reduced the amount of garbage that ends up at a landfill down to 10% (Personal Communication, Flores Guillermo, 2012).

This plan, led by an environmental group that consisted of municipality leaders and volunteers, includes both recycling and composting. When the waste management plan was put into effect, the environmental groups created informative posters and visited homes, schools, and churches to educate community members about the importance of recycling and composting, . To date, this municipality has led five environmental awareness campaigns to educate community members. In 2004, the municipality built a compost center and established a system for the collection of organic waste twice a week. Although the land for composting did not come at any initial cost, a portion of the fertilizer produced is given back to the original owners. (Buenas practicas, 2010)

The Jiménez waste management plan has great advantages that benefit the community. Community members can benefit from the advantages of composting since it is not used for profit; instead fertilizer produced in the composting center is donated to local farmers. Since a recycling system was established, landfills are being used less than in previous years, which are

causing contamination levels to drop in the surrounding rivers. Additionally, jobs were created as a result of the municipality's waste management program and money saved from transportation costs due to a reduction in the number of trips to the landfill which is located farther from the community (Buenas practicas, 2010).

2.3.3 The Municipality of Alvarado

Currently the municipality of Alvarado uses an open landfill in which garbage is not treated and usually incinerated. Surrounding vegetable processing centers produce additional harmful waste from the agricultural industry, in addition to garbage that originates from households and businesses. This particular municipality has the potential to greatly benefit from an established recycling process since less that 5% of the garbage that is disposed of cannot be reused, according to a study done by Competitividad y Medio Ambiente (Competitiveness and the Environment). This statistic indicates that a successful recycling program would considerably lower the amount of garbage taken to the landfill. The coverage that is provided by collection trucks is in need of improvement since this service is not provided for 20% of the population, in which case garbage is instead incinerated.

The current recycling program was organized in 2005 by a group of women that had the intention of cleaning up the rivers and streets of their community. A major concern for this area is the proper disposal of chemical waste since the municipality consists largely of an agricultural economy. Typically, chemicals used by farmers' runoff into rivers or ravines. However farmers have also disposed of chemicals intentionally into the surrounding river and ground, as well through incineration. All of these methods have negative health effects on the community. (Buenas practicas, 2010)

In 2009, an agreement was reached with the Fundación Limpiemos Nuestros Campos (Foundation Clean up Our Fields) to establish containers for the proper disposal of chemicals and hazardous containers used by farmers. This prevented 27,000 kg of the municipality's chemical waste from being dumped into the environment. Currently the plan continues to operate through donations and loans from various organizations (Buenas practicas, 2010).

2.3.4 The Municipality of Oreamuno

More recently the municipality of Oreamuno has begun to take steps towards establishing a solid waste management program. With the help of various universities and governmental

organizations, this municipality started a pilot program for recycling and is in the process of building a compost facility. Their goals are to launch a center for the separation of solid waste, as well as a bioreactor for the processing of organic waste. In this case, the profit obtained from fertilizer that is produced will be used towards the education of community members about the solid waste management system. Another strategy that this municipality uses is the placement of trash containers along national roads, with the ultimate objective of mitigating flooding that can be caused by solid waste being dumped into rivers (Municipalidad de Oreamuno, 2012).

The collection of garbage is currently managed by a private company, which covers 70% of the population. In San Rafael, the most urbanized district, solid waste management has been successful; however waste continues to be disposed of improperly. Chemicals and other hazardous waste used by agricultural companies are not properly discarded and often are thrown into the river. Flooding in this municipality has also occurred due to the large amount of construction in the areas surrounding the Reventazón River related to the current state of development of the municipality.

2.4 Recycling Programs

The initiative to recycle began in 1953 when steel cans were introduced in packaging soft drinks and beers (Recycling, 2007). Recycled materials are sent to a facility to be sorted and remanufactured. The manufacturing process consists of remaking products with the recycled materials. To complete this "loop", consumers and recyclers buy the recycled materials.

There are three main steps to recycling a product. They are the collection and procession of the material, the manufacturing of new products (with the recycled materials) and the purchasing of recycled products. Within these three steps, the most popular methods of collecting recycled materials are curbside pickup and drop off recycling (Recycling, 2007).

2.4.1 Curbside Recycling

Curbside recycling involves local city waste management trucks traveling door-to-door and collecting recycled materials in containers or trash bags. It is generally more popular and convenient than recycling at drop-off locations (Saphores, 2012). Throughout the United States, programs have been introduced and successfully implemented. In Santa Fe, New Mexico, residents are charged $10.79 per month for the pickup service (Curbside Recycling, 2003), and in Cheyenne, Wyoming residents are asked to pay a moderate fee of five dollars each month

(Staff, 2009). In Indiana, a third-party waste company, Super Waste General, charges its customers only $3.25. Due to this low cost, the company got forty percent of the population to participate in its first effort in curbside recycling (Falda, 1995).

Research shows that there are several factors that affect curbside recycling. In St. Petersburg, Florida, the program is on the verge of being shut down. The charge for curbside recycling is only $2.75 a month, yet only 7,249 homes out of a total of 76,290 are using the service. The reason for the lack of success is due to residents not being satisfied with the company who provided the service; they indicated that it was disorganized (Bond, 2012). In Indianapolis, curbside recycling is a political issue. The cost of collecting and disposing waste was roughly $34 million, and even with participation of the community and profit through recycling, the revenue does not counterbalance the costs (Universal Curbside. 2011). Although many places embrace curbside recycling, these programs do not excel due to lack of participation. In terms of expenses, facilities that are maintained for take-back programs, which are programs that recycle large appliances and electronics that cannot be normally recycled from other recycling methods, are generally less expensive than curbside programs (Saphores, 2012).

2.4.2 Drop-Off Recycling

Today, drop-off recycling is the most common recycling program in the United States (Sidique, 2010). However, a recent study shows that drop-off recycling is less knowledgeable than curbside recycling (Figure 4B) and Figure 4A shows that all respondents of the survey believe that storing materials at home is safe. The results from Figure 4B display a problem considering how it is generally easier to execute than other programs and faster than take-back and deposit refund programs (Sidique, 2010). Many people do not see the conveniences but rather see the inconveniences of drop-off recycling. One inconvenience is that the person recycling must travel to the drop-off location. (Saphores, 2012) With a curbside recycling program, they have the comfort of leaving it outside of their home for city officials to pick up.

In Michigan, recent studies related recycling participation rates at drop-off locations to location distance, familiarity (with recycling) and social pressure. All of these are key factors in a recycling routine. In Maine, a study was done at the drop-off facilities and included factors such as fees, operation schedule and driving distance. These components were studied to examine the collection rate of computer monitors from 92 municipalities in Maine. Results

showed that the facilities collected more recyclables when the fees were low and the numbers of days open were frequent. Driving distance was a minimal factor (Saphores, 2012).

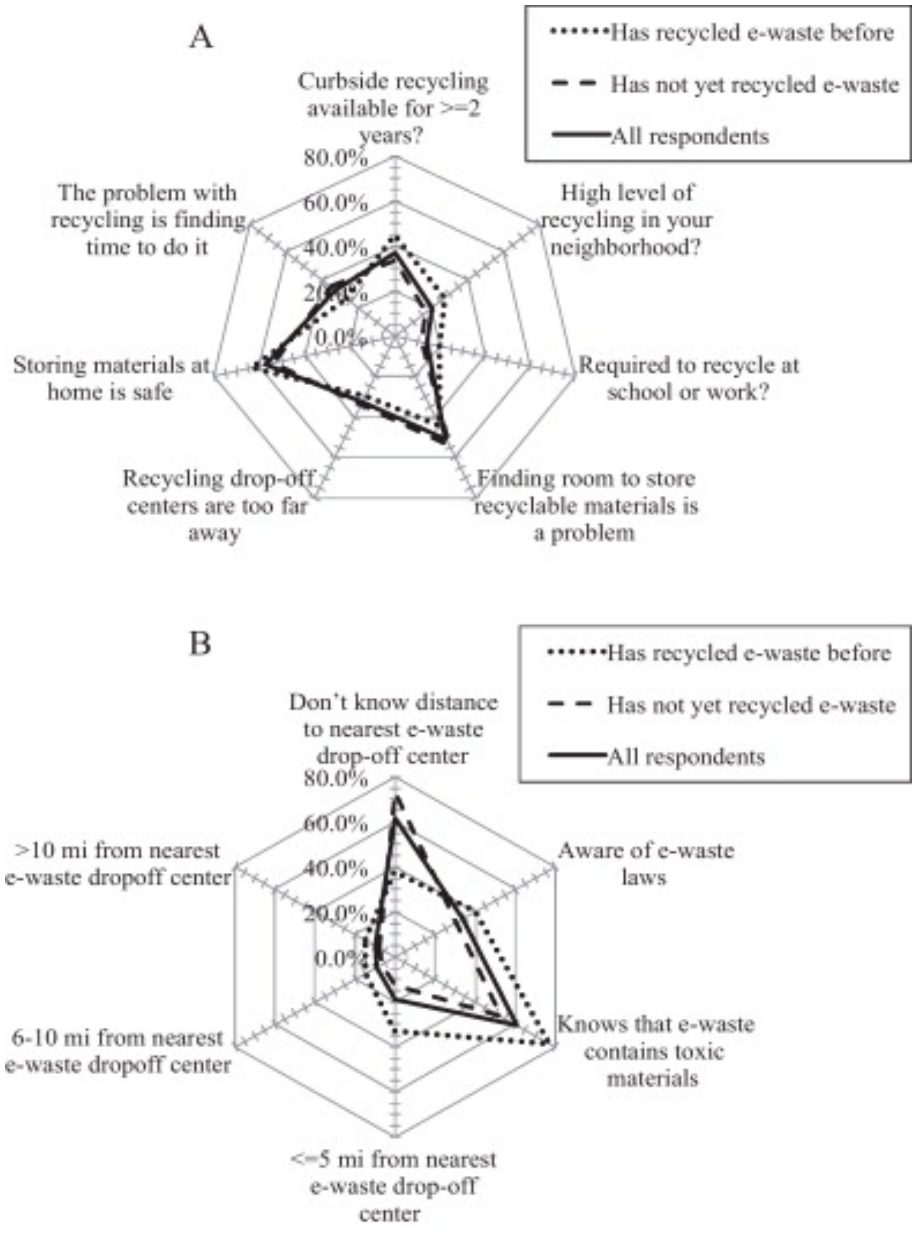

Figure 4: Key Factors of Recycling E-Waste at Drop-off/Curbside (Saphores, 2012)

2.4.3 Pay-As-You-Throw (PAYT)

A pay-as-you-throw program charges residents based on the amount of trash they throw away. This encourages citizens to generate less waste and recycle more. The Environmental Protection Agency in the United States supports PAYT since it incorporates three components to positive recycling programs. These include environmental sustainability, economic sustainability, and equity. Communities that participate in PAYT have seen an increase in recycling as well as a reduction in waste. With more recycling and less waste, fewer natural resources have to be removed to produce new products. In terms of economics, the PAYT program allows communities to focus less on waste management fees. Instead of residents being charged a general fee for handling trash, they only pay for what they throw away, a sign of equity to all communities (Environmental Protection Agency June, 2012).

There are several strengths and weaknesses to the pay-as-you-throw programs. Householders accept it fairly well showing that the program is popular. The program also increases the sorting of recyclables and encourages home composting. Weaknesses include increase in costs, illegal waste dumping and an increase in contaminants in recyclables (Dahlén, 2010).

Although communities face challenges like time commitment and poor organization, there have been benefits from PAYT. It is an environmental solution but also an economic one. In Worcester, Massachusetts, 40 million pounds of solid waste was reduced from 1992 to 1999 under PAYT. In Portland, Oregon, the recycling rate went from seven percent to thirty-five percent only one year after implementing PAYT in 1992 (Canterbury & Newill, 2003).

2.5.0 Case Study: International Comparison

Halvorsen (2012) reported on a study executed in 2008 on the effects certain factors have on household recycling participation. This international comparison surveyed 10,251 citizens in ten OECD (Organization for economic co-operation and development) countries. The countries surveyed included Norway, Sweden, Canada, France, Netherlands, Italy, Mexico, Australia, Czech Republic, and Korea. The survey was a “web-based panel” (Halvorsen, 2012) that posed questions relating to topics on household behavior. The topic this case study focused on was “household waste generation and recycling”. Demographic information, household

characteristics, and attitudes toward environmental issues were taken into consideration (Halvorsen, 2012).

One factor evaluated was the quantity of recycling services available. The types and supply of services available for the communities directly affected the amount of household recycling. The programs offered in the countries surveyed included door-to-door collection and drop-off centers or containers, which were the most common methods among the countries, and resulted in higher recycling participation rates compared to other strategies. Other methods included refunds on returns of recyclables such as plastic bottles and aluminum cans, as well as return centers that did not offer refunds. Furthermore, the more recyclable materials the program provided services for positively affected the overall recycling participation from households. For example, if a drop-off center accepted many recyclable materials such as bottles, cans, cardboard and glass, households utilized that center more than a center that only accepted a couple of those materials (Halvorsen, 2012).

Monetary incentives also influenced participation among households. Although Pay-as-you-throw programs have been successful in other countries such as the United States (EPA, 2012), this study suggests that this garbage disposal method, in which you pay for the amount of disposed trash y, actually reduces the amount of waste recycled. This is believed to happen because it implies that it is acceptable to pay a fee for garbage disposal instead of recycling; suggesting that lower-income families would be more inclined to recycle if it meant they save more money. However, the data in the survey shows that people with higher incomes tended to recycle more. The type of Pay-as-You-Throw method also affects how people dispose of their waste. Fee options include a flat-rate fee, a frequency-based fee, a volume-based fee, a household size based fee, a waste-based fee, and no fee. If households have to pay based on the volume of their trash, they are more likely to recycle more of their waste so they will have to pay a smaller amount for their trash. If the program offers a flat-rate fee or no fee at all, households will not feel pressured to reduce their amount of garbage by recycling (Halvorsen, 2012). It is important to analyze the types of Pay-as-You-Throw fees, and determine which method would be most successful in influencing households to recycle in specific communities.

Whether or not families felt that they had time to recycle also affected their decision to participate. If someone is not familiar with the recycling and sorting processes, it may take more time out of their day to sort their recyclables from trash. Many people may think it is too much of an effort, and therefore do not participate. Another reason people do not recycle is because they believe the process should be done by someone else (Halvorsen, 2012) such as the government or businesses. They would prefer to pay for the service, and if it is not available, they do not participate.

This international case study revealed the factors that influence how people recycle, who recycles, and why they recycle. This will help us analyze the profiles of recyclers in Costa Rica, and how to make it easier for them to contribute to their society through recycling. We will be able to use these parameters to design the survey and interviewing questions.

Chapter 3: Methodology

This chapter outlines the various methodological strategies we will be using to compare and contrast Jiménez, Alvarado, and Oreamuno. First we will state our goals and objective for the project. Next, we will discuss each of the specific methods we will be using in order to collect data, in chronological order. Accompanying each method, we describe the reasons the approach was chosen and the kind of information we want to attain. All three of these municipalities are at different stages in their waste management disposal programs and there is limited data on their plans. Because of the lack of data for these solid waste management programs, the municipalities are unsure whether or not they are effective. Our goal for this project is to evaluate the current recycling programs and analyze the social, economic, and environmental impacts on the communities.

3.1 Objectives

To achieve our goal, this project will evaluate the effects of the recycling programs on the communities as a whole through data collection in the three municipalities of interest. The areas of focus include assessing the environmental, social, and economic impacts on the three municipalities. Our first objective is to determine the effectiveness of each SWM plan from an environmental aspect. In order to do this we will travel to various locations and assess the current condition of each site. From these observations and speaking with municipality leaders via focus groups, we will be able to assess the changes in the environment over time. Municipality leaders will be able to give us insight from past environmental conditions. Our next objective is to evaluate the social correlations between the community and effectiveness of each SWM plan. By surveying the communities of interest, we will identify the characteristics of participants in the recycling programs as well as their motivations for participating. We will also facilitate focus groups comprised of municipality leaders. This will help us better understand how the plans are structured, which will allow us to relate the configuration of the plans to the participation rates. Our final objective is to determine the economic impact the SWM plans have on the communities by interviewing employees that work at the recycling and composting centers. We will use this information to evaluate the demand for employees in the centers.

Once we collect the data, we will analyze this data to make recommendations. We will form our evaluations based on comparisons between the three municipalities' programs. For example, when compiling data from the surveys, if we find that certain types of people tend to recycle more, we will focus on the people that do not participate and educate them through advertisements in the communities. Making recommendations is the most essential step of the project since these plans may be implemented into the existing programs to make them more effective.

3.1.1 Site Assessments

Site assessments of recycling centers as well as towns along the river will provide a visual representation of the current environmental status in each of the municipalities. Verbal communication can be limiting in the sense that the point of view of each person is different and some aspects may be emphasized more than others, depending on the observer. These visits will be arranged the first week we arrive on site according to directions given to us by our sponsors. The locations of interest for each municipality are the Reventazón River including its watershed, the collection centers, and nearby landfills. These locations offer us information as to how the SWM plans have affected the environment as well as the processes that occur at each collection center. When visiting landfills and the river, we will take note of the proximity between them, and investigate if the waste in the river originates from a nearby landfill. To determine the effect of accidental transference of trash to areas surrounding the landfill, observations will be made as to if waste is contained in these landfills by observing if the landfills have a covering over them or not. After observing these sites, we will compare the present conditions of each municipality to the descriptions of past and present conditions dictated to us by the municipality leaders, who we will talk to later in the focus groups. We will also visit recycling and composting collection centers to become familiar with how recycled products are processed once they are brought to these centers. This will help us determine if the processes have been efficient or if they are retaining any backlog materials.

Our first visit to each site will be quick but is necessary to prepare a second more in depth visit. During our first visit we will take pictures, map the area, and note first impressions. Two of us will be documenting pictures of pertinent areas of the site, while the remaining two of us will be taking notes on processes that are occurring. By visiting a site twice, observations that may have been overlooked the first time are noticed during the second visit. This way there is more attention paid to details on the effectiveness of each SWM plan. (Site Assessment, 2012)

3.1.2 Focus Groups

By organizing and moderating a focus group comprised of municipality leaders who play an active role in the implementation of SWM plans, we will be able to obtain pertinent data. Such data includes environmental changes occurring after the implementation of SWM plans, and any environmental impact indicators that exist. After visiting sites along the Reventazón River, we will be able to better understand each municipality leader's assessment of each site. Through these focus group interviews, we will also collect data related to the current economic state of each collection center. Specific information we are interested in includes what source of funding exists for each collection center and what the possibilities are for obtaining more funding for additional recycling centers. We will also discover which aspects of each recycling program have been the most effective, and which strategies have been difficult to implement. Refer to Appendix 2 for a sample of focus group questions.

The leaders we would like to include in our focus group will be chosen and reached according to information obtained by our sponsors. We chose this method of data collection because the atmosphere it provides stimulates conversation through the questions that the facilitator asks, as well as through the reactions brought on by a group member's response. Each leader has different experiences and ideas to contribute, which is especially crucial since each one of the municipalities is at different stages of development and puts short term and long term problems into perspective. This method of data collection is also preferred because it permits interviewees that cannot be physically present to participate through teleconference. (Berg, 2001) In order to avoid confusion that may arise from having multiple people participating in a teleconference at once, we will reschedule a meeting time to have the majority of participants attend the focus group physically.

3.1.3 Surveys

Analyzing the social norms of the individual communities will identify who is participating in the programs and the reasons why they choose to do so. More importantly, we will discover who is not participating and why through surveys. By understanding the reasons behind participation in the recycling programs, we will be able to make recommendations that might increase the participation rate of each plan. If one community has a high participation rate and satisfied residents, we can use the successful aspects of their recycling plan to make recommendations to another plan with a lower participation rate to motivate unsatisfied residents to recycle. To do this, we will make correlations between characteristics of one plan and the participation levels of that municipality. If the people living in these communities are satisfied with the functionality of their plan, participation will increase (Halvorsen, 2012). To determine the attitudes and opinions of the communities, we will need to gather opinions of a sampling of the populations from each community (Berg, 2001). Surveys are one strategy used to obtain basic information about a large group of people. The participants would also be asked socioeconomic questions related to their age, household size, and household income level (Halvorsen, 2012). Refer to Appendix 1 for a sample of survey questions. Surveying the residents of these communities will help us understand the types of people that participate in the recycling program and determine if there are any important correlations, meaning basic attributes of the communities and SWM plans.

There are a variety of ways to survey the residents of these communities. One strategy is to visit households in each of the communities and talk directly to residents about their views on the local recycling programs. This strategy allows us to learn about individuals' concerns. A deterrent to this method is that residents may be hesitant to participate because the lack of familiarity we have with the community. In order to become more familiar with residents of the communities, it is important to get acquainted with them before asking in-depth questions. Another difficulty with the door-to-door approach is that it is time consuming which would result in fewer surveys answered. To overcome the time restriction, we will split into two groups in order to reach out to more residents. In addition to asking the survey questions to residents directly, another strategy is to leave surveys at their home, ask them to complete the form, and collect the surveys once they are completed by returning to homes. Since this strategy requires less time to accomplish, we would be able to distribute more surveys and therefore obtain more

opinions from the residents of the municipalities. We will obtain a sampling of residents from various backgrounds and socioeconomic statuses by choosing a variety of neighborhoods that we could send the surveys to as directed by our sponsors (Berg, 2001). The only disadvantage would be the possibility of residents not returning the surveys due to lack of incentive. Another strategy, a combination of the two previously mentioned strategies, is to go to a public place such as a park or town square and survey people who frequent the area. This is a safe and effective way to obtain willing survey participants and would still permit us to talk directly to the community members. Creating an incentive for the people to participate in the surveys would result in an even more participants. They would be entered into a raffle for a prize as a possible incentive.

3.1.4 Interviews

A key economic factor that recycling has is through job creation. We will evaluate how many jobs have been created due to the increase of recycling plans as well as variations of these plans by interviewing employees of the recycling programs in each municipality. In the United States, over 1 million jobs have been created thanks to the recycling industry, and it is projected to add another million jobs as recycling broadens into fields such as manufacturing and agriculture (Seldman, 2012). Job creation from the recycling programs will help the economy and create more income from recycled materials. In groups of two, we will perform one-on-one interview with the supervisors at each recycling center during site assessments to understand the employees' responsibilities and find out if more jobs are needed. Refer to Appendices 3a and 3b for a sample of the interview questions we will be asking the employees.

3.2 Projected Timeline

In order to complete all of the activities above mentioned we will follow the Gannt chart on the following page:

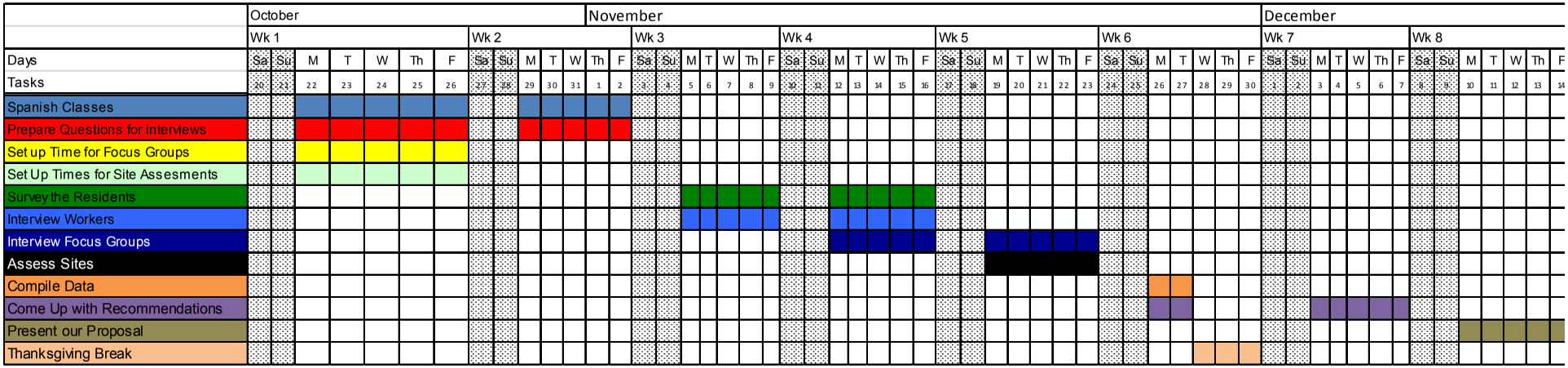

Figure 4: Projected Timeline

Chapter 4: Conclusion

In order to become more sustainable, Costa Rica has been implementing SWM (Solid Waste Management) programs throughout the country. Individual recycling programs in the municipalities of Alvarado, Jiménez, and Oreamuno, located in the canton of Cartago, are to be evaluated for the purpose of creating recommendations based on the social, economic, and environmental impacts they have on each community.

After researching various recycling case studies, it has become clear what recycling is, why it is a more environmentally sustainable alternative than other SWM plans, and what factors affect the participation of these programs. Costa Rica's goal to become more sustainable includes the implementation of recycling programs, such as the ones we will be evaluating. Practicing recycling in regions along the Reventazón River is especially important to keep it clean and free of waste. The recycling programs already implemented in the municipalities of Alvarado, Jiménez, and Oreamuno are at different stages, stressing the importance of evaluating the effectiveness of each program. We will use our results to improve upon the existing plans. Using various data collection techniques such as site assessments, focus groups, surveys, and interviews, we will be able to evaluate the impacts that the recycling programs have on the communities, as well as what factors contribute to the participation rates.

We are looking forward to working with our sponsor, COMCURE, and the people of Costa Rica to help improve these municipalities' recycling programs.

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Appendices

Appendix 1: Survey Questions

This survey is intended to help us understand the recycling habits of residents as well as their attitude towards recycling.

Please help us increase the amount of recycling participation by providing us with information about your recycling habits. This survey is completely confident and your identity will not be revealed in any way. Please answer this survey as accurately as you can. By helping us you will be helping the environment as well, Thank You.

1. **Please circle the municipality in which you reside:**
   - ☐ Alvarado
   - ☐ Jiménez
   - ☐ Oreamuno

2. **Are you:**
   - ☐ Female
   - ☐ Male

3. **Please select the range of age that's best applies to you:**
   - ☐ Less than 10
   - ☐ 10-19
   - ☐ 20-29
   - ☐ 30-39
   - ☐ 40-49
   - ☐ 50-59
   - ☐ Over 60

4. **What is your average monthly income? (hundred thousand colones)**
   - ☐ Less than 199
   - ☐ 200-399
   - ☐ 400-599
   - ☐ 500-699
   - ☐ Over 700

5. **How many people live in your household?**
   - ☐ 1-2
   - ☐ 3-5
   - ☐ 6-8
   - ☐ 9-11
   - ☐ Over 12

6. **Do you recycle?**
   - ☐ Yes
   - ☐ No

7. **Do you compost?**
   - ☐ Yes
   - ☐ No

If you responded "no" to either 6 or 7:

---

8. **What prevents you from recycling and/or composting?**
   - ☐ I do not have a collection program
   - ☐ Not enough time
   - ☐ Not familiar with the process
   - ☐ Lack of interest
   - ☐ Not enough space to store recyclables/composts
   - ☐ Not sure of collection times
   - ☐ Other

If you responded, "I do not have a collection program" to 8, you have successfully completed this survey, Thank you for your time!

---

9. **Which method of collection is used?**
   - ☐ Drop-off
   - ☐ Pick-up
   - ☐ I do not know

10. **Approximately, how much of your garbage do you recycle?**
   - ☐ 0% - 25%
   - ☐ 26% - 50%
   - ☐ 51% - 75%
   - ☐ 75% - 100%

11. **Please mark what types of materials you recycle:**
   - ☐ Paper products
   - ☐ Glass products
   - ☐ Cans/tins
   - ☐ Plastic products

Thank you for taking the time to complete this survey, your opinion will make a difference!

Appendix 2: Focus Group Questions for Municipality Leaders

1. In your opinion, how effective has the recycling program been in your municipality?
    a. Why do you think it has been/not effective?
    b. What would you do to solve the current problem? (if there is one)
2. What is one thing you would recommend to another municipality that is trying to start a program like yours?
    a. Why did you choose this?
    b. Are there any other things you would recommend?
3. Can you name one aspect of your program that you would recommend avoiding to a municipality that is trying to start a program?
    a. What went wrong with this?
    b. Did you try to solve it? If you did, how?
4. In your opinion, what do you think motivates residents of your municipality to recycle?
    a. Why do you think this is?
5. Since your program has been established, have you seen any changes on the streets/river of your municipality?
    a. If so, could you be more specific?
    b. Do you think these changes would have occurred if your program was not in place?

Thank you for your time, I realize you are all busy so we appreciate you guys taking the time to respond to our question.

Appendix 3: Interview questions for recycling/composting center employees

1. Is your recycling center usually busy?
    a. When is the center the busiest?
        i. What type of people do you see at these times?
    b. When is it the least busy?
        i. Why do you think people don't recycle at these times?
2. How long have you been working on this job?
    a. Would you feel comfortable training people if you were needed?

Thank you for your time, I realize you have a lot of work.

Appendix 4: Interview questions for recycling/composting center managers:

1. How many employees do you have working for your recycling center?
    a. Do you need more employees or volunteers?
    b. Do you have the budget to add more employees if you needed more?
2. What kinds of material are recycled here?
3. Do you keep records of how much gets recycled over a certain amount of time?
    a. How accessible is your data?

Thank you for your time

Apéndice 5: Esta encuesta pretende informarnos sobre los hábitos de reciclaje de los residentes, así como sus actitudes hacia reciclaje.

Por favor ayúdenos a aumentar la cantidad de participación en reciclaje al darnos información sobre sus hábitos de reciclaje. Al ayudar nos usted estará ayudando al medio ambiente también, Gracias.

12. Por favor marque la municipalidad en la que reside:

- ☐ Alvarado
- ☐ Jiménez
- ☐ Oreamuno

13. Por favor seleccione su sexo:

- ☐ Femenino
- ☐ Masculino

14. Por favor seleccione el rango de edad en que usted cabe:

- ☐ Menos de 10
- ☐ 10-19
- ☐ 20-29
- ☐ 30-39
- ☐ 40-49
- ☐ 50-59
- ☐ Mas de 60

15. ¿Cuál es su ingreso mensual promedio? (miles de colones)

- ☐ Menos de 199
- ☐ 200-399
- ☐ 400-599
- ☐ 500-699
- ☐ Mas de 700

16. ¿Cuantas personas viven en su hogar?

- ☐ 1-2
- ☐ 3-5
- ☐ 6-8
- ☐ 9-11
- ☐ Mas de 12

17. ¿Usted recicla?

- ☐ Si
- ☐ No

18. ¿Usted participa en compostaje?

- ☐ Si
- ☐ No

Si usted contesto "no" a 6 o 7:

---

19. ¿Cuál es la razón por la que no recicla y/o composta?

- ☐ No tengo un programa de recolección
- ☐ No tengo suficiente tiempo
- ☐ No conozco el proceso
- ☐ No tengo mucho interés en participar
- ☐ No tengo suficiente espacio para almacenar los materiales de reciclaje y/o compostaje
- ☐ No estoy seguro(a) de los tiempos de recolección
- ☐ Otro

Si usted respondió: "No tengo un programa de recolección" a 8, ha completado con éxito esta encuesta, ¡Gracias por tu tiempo!

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20. ¿Cual es el método de recolección usa?

- ☐ Llevo materiales a un centro de colección
- ☐ Recogen materiales en mi casa
- ☐ No se

21. Aproximadamente ¿cuanta basura recicla?

- ☐ 0% - 25%
- ☐ 26% - 50%
- ☐ 51% - 75%
- ☐ 75% - 100%

22. Por favor seleccione que tipo de materiales recicla:

- ☐ Materiales hechos de papel
- ☐ Vidrio
- ☐ Materiales de metal
- ☐ Productos hechos de plástico

¡Gracias por tomar el tiempo para completar esta encuesta, su opinión hará una diferencia en el medio ambiente!

Apéndice 6: Preguntas dirigidas a Líderes de Municipalidades

6. En su opinión, ¿qué tan efectivos han sido los programas de reciclaje en su municipio?
    a. ¿Porque cree que ha sido/no es eficaz?
    b. ¿Qué podría hacer para resolver el problema actual? (si hay alguno)
7. ¿Qué recomendaría a otras municipalidades que están tratando de empezar un programa similar al suyo?
    a. ¿Por qué esta recomendación?
    b. ¿Hay alguna otra sugerencia quisiera dar?
8. ¿Puede nombrar un aspecto de su programa que recomendaría evitar a otro municipalidad que esta tratando de empezar un programa?
    a. ¿Qué fue mal?
    b. ¿Lo trato de resolver? Si es así, ¿como?
9. En su opinión, ¿qué motiva a los residente de su municipalidad a reciclar?
    a. ¿Porque cree que esto los motiva?
10. Desde que su programa ha sido establecido, ¿ha visto algún cambio en la condición de las calles o ríos de su municipalidad?
    a. Si es así, ¿podría ser mas especifico?
    b. Piensa que estos cambios hubieran ocurrido si sus programas no hubieran sido establecidos?

¡Gracias por su tiempo! Sabemos que están muy ocupados y les agradecemos que ustedes pudieran tomar el tiempo de responder a nuestras preguntas.

Apéndice 7: Preguntas de Entrevista para los empleados de los centros de reciclaje y compostaje

3. Usualmente, ¿Este centro esta muy ocupado?
    a. ¿Cual es el horario en el cual el centro esta más ocupado?
        i. ¿Qué tipo de gente ve durante estas horas?
    b. ¿Cuándo esta menos ocupado?
        i. ¿Por qué cree que la gente no recicla en este horario?
4. ¿Cuánto tiempo lleva trabajando en este centro?
    a. ¿Se sentiría cómodo(a) enseñando a otras personas si es que fuera necesario?

Gracias por su tiempo, sabemos que debe estar muy ocupado(a).

Apéndice 8: Preguntas de Entrevista para administradores de centros de compostaje y reciclaje:

4. ¿Cuántos empleados trabajan en el centro que esta administrando?
    a. ¿Necesita más trabajadores o voluntarios?
    b. ¿Tiene suficiente presupuesto para agregar más empleados?
5. ¿Qué tipo de materiales son reciclados aquí?
6. ¿Mantiene un registro de cuanto se recicla sobre cierta cantidad de tiempo?
    a. ¿Que tan accesible son sus datos?

¡Gracias por su tiempo!