Worcester Polytechnic Institute
Digital WPI

Interactive Qualifying Projects (All Years) Interactive Qualifying Projects

March 2018

Promoting Carbon Neutrality CR18

Joshua Manning
Worcester Polytechnic Institute

Kyle James Havey
Worcester Polytechnic Institute

Riley Matthew-Clancy Lopez
Worcester Polytechnic Institute

Victoria Tianyu Velashea
Worcester Polytechnic Institute

Follow this and additional works at: https://digitalcommons.wpi.edu/iqp-all

Repository Citation
Manning, J., Havey, K. J., Lopez, R. M., & Velashea, V. T. (2018). *Promoting Carbon Neutrality CR18*. Retrieved from https://digitalcommons.wpi.edu/iqp-all/292

This Unrestricted is brought to you for free and open access by the Interactive Qualifying Projects at Digital WPI. It has been accepted for inclusion in Interactive Qualifying Projects (All Years) by an authorized administrator of Digital WPI. For more information, please contact digitalwpi@wpi.edu.

Promoting Carbon Neutrality in Monteverde, Costa Rica

An Interactive Qualifying Project Report Submitted to the Faculty of WORCESTER POLYTECHNIC INSTITUTE in partial fulfillment of the requirements for the Degree of Bachelor of Science

By: Kyle Havey, Josh Manning, Riley Lopez, Victoria Velashea

March 2, 2018

Submitted To:
Professor Melissa Belz
Worcester Polytechnic Institute

Katy VanDusen
Director and Coordinator
CORCLIMA

Monteverde Project Center

This report represents the work of four WPI undergraduate students submitted to the faculty as evidence of completion of a degree requirement. WPI routinely publishes these reports on its website without editorial or peer review. For more information about the projects program at WPI, please see: http://www.wpi.edu/Academics/Projects.

Abstract

Costa Rica is aiming to be the first carbon neutral country worldwide. Although there are national policies to accomplish this, Monteverde lacks a local plan to reduce and capture carbon emissions. In this project, we investigated how Monteverde is promoting carbon neutrality, analyzed data of carbon emissions and sequestration, and created infographics, blogs, and a video as part of a carbon neutrality awareness campaign, on behalf of CORCLIMA. We aimed to develop a campaign targeted at the Monteverde community that raises awareness of carbon emissions to both residents and organizations.

Executive Summary

In 2017 Hurricanes Irma and Maria hit Puerto Rico and caused massive destruction. Other extreme events such as earthquakes, droughts, wildfires and floods have all been common themes and occurrences in the news and media. While it is unfair to attribute these recent events solely to climate change and rising temperatures, it is irresponsible to neglect the effect that the earth's rising temperature has on the severity and frequency of natural disasters (Roberts, 2017). The Intergovernmental Panel on Climate Change (IPCC) in their 2014 report claimed a strong and direct correlation between the increased number of these extreme events and climate change (IPCC, 2014). Disasters like these greatly increase the threat towards ecosystems, wildlife, infrastructure, human health and well-being.

Monteverde, Costa Rica is known for its complex ecosystems and cloud forests that house thousands of biodiverse species. Therefore, climate change is an important issue that threatens many of its natural resources. Although Costa Rica has a methodology for reducing its carbon footprint on a national level, there is no plan targeting the regional level. Due to this, there is a lack of cohesive action within the community for carbon neutral initiatives at the local level (VanDusen, Personal Communication. 2017, November 8). A lack of results about greenhouse gas emissions has caused the community of Monteverde to be unsuspecting of its contribution to the magnitude of carbon pollution which is weakening their cherished biodiverse environment (VanDusen, Personal Communication. 2017, November 8). Therefore, it is important that the community becomes aware of how their choices and actions add to the impact of their carbon footprint. In this project, by working aside CORCLIMA, we aimed to reveal the significant sources of carbon pollution in Monteverde in order to devise media campaigns and initiatives to increase awareness and participation in the community.

The main cause for the vast acceleration of climate change within the past century can be explained by the increasing levels of carbon dioxide concentrations being emitted into the atmosphere (Solomon, 2008). Carbon dioxide is a greenhouse gas emission caused by human activities, such as the combustion of fossil fuels, transportation, deforestation, waste management, industrial processes and livestock.

For years Costa Rica has observed subtle changes in the wildlife that have drawn the attention of the country and its policy makers. Therefore, Costa Rica has been one of the more ambitious and persistent countries fighting to reduce carbon emissions among other greenhouse gases (Welch, 2015). In 2015, the Costa Rican government presented its Intended Nationally Determined Contributions (INDC), which outlines Costa Rica's plan for carbon neutrality by the year 2030. Costa Rica has addressed climate change in many different sectors of the government through laws, national parks and technology. Although the National Policy has led to the

implementation of legislations and laws, there is a still a need for a behavioral change campaign aimed at residents of the community. Our sponsor, CORCLIMA, seeks to fill this gap within the Monteverde region.

Coordinator of CORCLIMA, Katy VanDusen, describes the commission as a movement where everyone is working to create a more sustainable world. Over the past two years CORCLIMA has collected data pertaining to carbon emissions for three organizations, including, the Monteverde Friends School, Monteverde Institute, and Monteverde Conservation League. The goal of this project is to find the top contributors of carbon emissions and the amount of carbon offset by the three initiatives as well as find a system which successfully communicates our findings to Monteverde residents.

Project Goals and Objectives

The goal of this project is to aid carbon reduction efforts in Monteverde by analyzing carbon emission data and determining the best methods for sharing outcomes with the community. To accomplish this goal the team outlined the following objectives:

1. Determine how Monteverde, Costa Rica is promoting carbon neutrality
2. Determine the top contributors of carbon emissions and the carbon footprint for the three Monteverde initiatives
3. Determine ideal public relation mediums and social marketing techniques that target the Monteverde community in order to develop a campaign to aid carbon reduction efforts

Methods

We began our project by visiting and assessing local initiatives that focused on carbon mitigation and environmental sustainability. This research allowed us to gain a sense of how these initiatives reach out to the public and local community as well as how they are educating people about the subject of climate change.

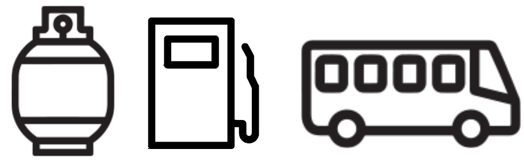
We then gathered carbon emission data from three organizations. From the data we identified the main contributors of carbon emissions of each organization. Additionally, we determined the total amount of net carbon footprint of each organization by gathering sequestration data through tree plots owned by the organizations. This information provided us with the total amount of carbon sequestration and net carbon output of all three organizations.

Next, we conducted surveys to understand ideal public marketing mediums, how information is obtained, and how to convey information to the Monteverde community. In addition, we analyzed data from a previous survey in Monteverde on the same topic. The results of these surveys directed the elements of the infographic and provided us with the most ideal marketing techniques to reach members of the community.

Results

The Monteverde region is densely populated with initiatives that focus on environmental education and promoting sustainable lifestyles. These organizations are each unique and offer a variety of services to the community. For example, the Monteverde Institute and Life Monteverde are open to public involvement and participation by hosting different presentations. A majority of the initiatives we visited offer educational opportunities about climate change awareness as well as mitigation and adaptation practices. In addition, all the organizations provide direct or indirect services to residents of the community. This being said, there are not a lot of organizations that emphasize and prioritize local involvement in their initiatives. We also assessed the organizations on the cost of their programs and how their initiative missions impact the larger scope of the national plan. Through this assessment, we found that the Monteverde Friends School and CIEE had the biggest tuition and cost. We also discovered that all of the organizations impacted the national plan either directly or indirectly.

We identified the top contributors of carbon emissions for each of the three organizations. Transportation was the highest emission for the Monteverde Friends School and the Monteverde Institute. Liquid petroleum gas was the second highest for the Monteverde Institute, and the highest for the Conservation League.

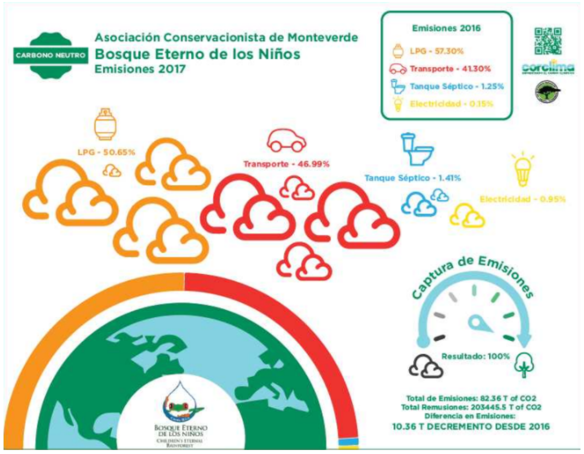


Icons of the Top Contributors

One conflict that arose during this process was that not all of the organizations collected data from each of the sectors of emissions. Therefore, the total emissions calculated for each organization was not completely accurate and was an advanced estimate. In addition, we calculated the sequestration data for each organization. Following these calculations, it was determined that the Monteverde Institute and the Conservation League had already reached carbon neutrality.

We then conducted interviews with local high school students, in conjunction with a survey conducted previously in the Monteverde region with a larger sample size, to identify the modes of communication and marketing that are most prevalent for the region. By analyzing the responses from the surveys, we identified that the majority of students did not consistently consume any type of local media. The students were also surveyed on aspects of informational graphics that they believe is best to depict data analysis. From this, we found that the students believe graphs, pictures and minimal text is ideal in getting people's attention.

Finally, we used the results from objective one, two and three to create various types of medias, including an infographic, video and blogs. From the carbon emissions data, we constructed an infographic for each organization that displays the percentage of carbon emissions from each source.



Infographic for the Conservation League

We also produced a short educational video that focused on transportation because it was the overall top contributor. The purpose of the video was to raise awareness on how greenhouse gases affect climate change, where the gases come from, and what residents can do to reduce their carbon footprint. Lastly, we created blogs on the various subjects we covered throughout our project. The blogs gave local residents quick and in depth insights into the different talks and presentations we attended as well as more technical information about sequestration and solar panel payment systems.

Recommendations

Through detailed analysis from our findings, we formulated four recommendations for future work for CORCLIMA:

1) **Place a greater focus on community outreach to increase attendance at local presentations and events**. This will not only increase the visibility and support of local initiatives, but will also increase the number of people engaging in the initiative and will strengthen the community's progress towards carbon neutrality.
2) **Ask for one employee within the organization to dedicate time to efficiently organize data used for the registries.** By implementing a more organized and central system of data collection focused on section, each organization will have the same scope of data. Multiple employees can collect the raw data, however one employee should be responsible for organizing it into this centralized system every month. This will allow the organizations to have a more accurate representation of their carbon emissions and decrease the workload for multiple employees.
3) **Invest in a device that can accurately measure emissions from septic tanks such as a static flux chamber**. For this project, an inaccurate equation was used to estimate the amount of human waste produced by each organization. A static flux chamber will allow the organizations to properly determine the emissions from septic tanks with more accuracy and ease.
4) **Develop a system to measure sequestration data from mature forests within Monteverde**. At this moment, data about the diameter base height and carbon biomass of mature forests for use in sequestration equations has not been

collected in Monteverde. The development of a system for this data collection, similar to the plot system already in place for newly planted and secondary trees, will allow for a more accurate and in-depth analysis for each of the organizations' carbon footprints, and could be expanded to the community as a whole.

Conclusion

One of the current goals of the Costa Rican government is to become a leader in the global climate change movement. This is portrayed specifically through their goal of carbon neutrality by 2030. The movement towards this goal is very apparent in the Monteverde community. This is observed through the organizations and initiatives already in place that are working towards education and the implementation of sustainable practices and techniques. These organizations include Life Monteverde, Monteverde Institute, the Monteverde Friends School, the Monteverde Community Fund, CIEE and VTR.

Following the analysis of the emissions data from the Monteverde Institute, the Monteverde Friends School, and the Conservation League, it was determined that the top carbon contributors were transportation, diesel, and LPG. However, through the sequestration practices of reforestation occurring within all three of these organizations, it was found that the Conservation League and Monteverde Institute have already surpassed carbon neutrality and have reached carbon negativity as organizations. Due to its higher transportation numbers, the Friends School is still working towards the goal of carbon neutrality.

Through the creation of our baseline infographic, CORCLIMA has the capability to display the progress each organization has made on their carbon footprint annually. This will serve as a progress report for the organizations mentioned above by showing changes in the amount of emissions each year. In addition, a video and blogs were created to assist CORCLIMA in launching a carbon neutrality awareness campaign and establish a platform for the distribution of information to the community.

Acknowledgements

We would like to thank our sponsor Katy VanDusen from CORCLIMA for designing this project and providing guidance and support throughout this entire experience

We would also like to thank our advisor Professor Melissa Belz for providing helpful feedback and advice which helped us improve the quality of our paper and success of our project

We would like to thank Hazel Guindon for her assistance with the design and creation of our final infographic

We would like to thank Pam Holschuh from the Friends School who allowed us to join her class for a day and conduct the surveys

We would like to thank the students from the Monteverde Friends School who participated in our surveys

We would like to thank Debra Hamilton and Erick McAdam for their help with the carbon sequestration equations and data

We would like to also thank all employees from the Monteverde Institute, Monteverde Friends School, and the Conservation League who welcomed us into their facilities and provided help along the way

Without the help or support from all of these people, this project would have been impossible to complete. We appreciate all the help we received along the way and thank everyone for making this such a rewarding and unforgettable experience

Table of Contents

Table of Authorship

Section	Author	Edit
Abstract	All	
Executive Summary	All	
Acknowledgements	All	
Chapter 1: Introduction and Background	Victoria Velashea	All
1.1 Global Climate Change	Kyle Havey	All
1.1.1 Climate Change and Forests	Kyle Havey	All
1.1.2 Carbon Pollution	Joshua Manning	All
1.2 Climate Change in Costa Rica	Victoria Velashea & Riley Lopez	All
1.2.1 National Policy	Victoria Velashea	All
1.3 Promoting Community Involvement	Joshua Manning	All
1.3.1 Communicating with the Community	Joshua Manning	All
1.4 CORCLIMA	Kyle Havey	All
Chapter 2: Methodology	All	All
2.1 Objective 1	Victoria Velashea	All
2.2 Objective 2	Victoria Velashea & Joshua Manning & Riley Lopez	All
2.3 Objective 3	Victoria Velashea	All
Chapter 3: Results and Discussion	Joshua Manning	All
3.1 Objective 1	Vicky Velashea & Riley Lopez	All
3.2 Objective 2	Joshua Manning	All
3.3 Objective 3	Victoria Velashea & Joshua Manning & Kyle Havey	All
3.4 Additional Deliverables	Joshua Manning	All
4.1 Recommendations	Kyle Havey & Riley Lopez & Joshua Manning	All
4.2 Conclusion	Victoria Velashea & Josh Manning	All

List of Figures

List of Tables

Chapter 1: Introduction and Background

In September 2017, Puerto Rico was hit with two back to back crippling category five hurricanes. In their wake over one million people were without potable water, three million did not have cellular service, and the entire population was in the dark without electricity (Sutter, 2017). These hurricanes caused “Apocalyptic” damage to Puerto Rico and its infrastructure as described by CNN correspondent Nicole Chavez. Puerto Rico and its residents will endure the lasting effects of hurricane Irma and Maria for years as they try to recover from the devastation.

Hurricanes Irma and Maria are just two examples of recent natural disasters that have occurred this past year. Earthquakes, droughts, wildfires and floods have all been common themes and occurrences in the news and media worldwide. While it is unfair to attribute these recent events solely to climate change and rising temperatures, it is irresponsible to neglect the effect that the earth's rising temperature has on the severity and frequency of natural disasters (Roberts, 2017). The Intergovernmental Panel on Climate Change (IPCC) in their 2014 report claimed a strong and direct correlation to the increased number of extreme events, such as wildfires, cyclones, hurricanes, and droughts (IPCC, 2014). Disasters like these greatly increase the threat towards ecosystems, wildlife, infrastructure, human health and well-being.

As a result, across the globe, countries are implementing policies to improve the status of their “carbon footprint.” Within Costa Rica, carbon pollution is an important issue that weakens many aspects of the country’s rich and natural resources. Although Costa Rica has a methodology for reducing its carbon footprint on a national level, including lowering emissions, increasing tree coverage, and investing in hydroelectric, there is no plan targeting the regional level and specifically the rich ecosystem of the Monteverde cloud forest (Daniels, 2010). Due to this, there is a lack of action within the community for carbon neutral initiatives at the local level (VanDusen, Personal Communication. 2017, November 8). Monteverde is known for its complex ecosystems and cloud forests that house thousands of biodiverse species. Increased temperatures have a direct correlation with a decreased presence of clouds which changes the habits that these living species rely on to survive (Brenes, 2016). A lack of campaigning has caused the community of Monteverde to be unsuspecting of their contribution to the magnitude of carbon pollution which is weakening their cherished biodiverse environment (VanDusen, Personal Communication. 2017, November 8). Therefore, it is important that the community becomes aware of how their choices and actions add to the impact of their carbon footprint. In this proposal, we aim to reveal the significant sources of carbon pollution in Monteverde in order to devise media campaigns and initiatives by working alongside CORCLIMA to increase awareness in the community. In chapter one, we begin with the background of climate change, carbon pollution, the effects in Costa Rica, the national policy, and the current state in Monteverde. In chapter two, we outline and highlight specific objectives and methods that we used on site in Monteverde to accomplish the goal of our project.

1.1: Global Climate Change

Climate change is happening across the globe and no country or person is immune to its effects (EPF, 2017). For a number of years, the earth has experienced cyclic heating and cooling as seen in Figure 1. Both scorching heats and bitter colds have been experienced during the Archean Super Warmth and both Ice Ages, neither of which were ideal for living. The variation and frequency of these extremes is shown in Figure 2. It is not uncommon for the earth to experience high and low temperatures, however recently these changes have become more drastic and are not showing any signs of improvement (Letcher, 2009).

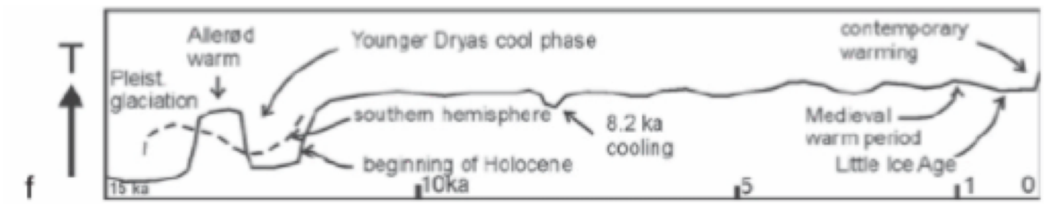


Figure 1: History of global temperatures dating back fifteen thousand years. Current spike can be seen as "contemporary warming" (Letcher, 2009)

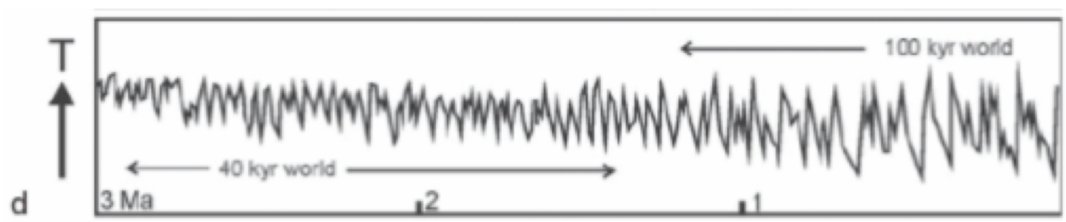


Figure 2: History of global temperature cycles dating back three-million years (Letcher, 2009).

The current increase in global temperature has not only affected quantifiable events like melting ice caps, it has also derailed ecosystems through animal actions and changes in living conditions. For example, migratory birds are significantly affected by the rising temperatures (Beever, 2012). It has been recorded that their migrations begin a month earlier, and they are wintering in more northern locations. This seemingly simple change creates a butterfly effect which alters ecosystems. Plants that rely on birds for seed distribution have a smaller time period where their seeds are ready to germinate and birds are present to eat the seed-carrying fruit, resulting in reduced reproduction success rates (Beever, 2012; Letcher, 2009).

Rising sea levels, water acidity, and shrinking ice caps have all been identified as consequences of climate change (Letcher, 2009). The consistent average annual loss of ice caps is proportional to the annual average sea level rise, showing a strong correlation (Letcher, 2009). Though the effects are not visible yet, as the average sea level has risen only about six centimeters, there will be extreme consequences if this trend is not stopped soon. The Greenland Ice Sheet, one of only two major ice sheets left on the planet, is most affected by the increase in temperature, and its degradation is only accelerating (Letcher, 2009). Ocean acidification is attributed to the fact that the ocean has absorbed more carbon dioxide than it can buffer. The pH level of the world's ocean is projected to decrease by 0.4 before the year 2100 (Letcher, 2009). This means that ocean's ecosystems will be vastly changed as many marine organisms can only survive in certain pH regions. As a result, the oceans will lose beautiful biodiversity, and people who rely on fishing to survive will find it increasingly harder to get by as the world's population of marine life declines (Letcher, 2009; Beever, 2012).

1.1.1: Climate Change and Forests

Climate change has also been identified as a catalyst of destruction of forest environments, causing increased frequency, strength, and duration of forest fires, droughts, and disease (Dale, 2001; Sturrok, 2011). Droughts occur sporadically in many climate zones, but are becoming increasingly common worldwide (Dale, 2001). Higher temperatures have led to greater evaporation rates in trees. This poses a problem because it causes more water than is sustainable to be taken from soil, eventually inducing a drought (Dale, 2001). As seen in California in recent years, frequent droughts lead to increased possibilities of forest fires. Frequent forest fires have severe negative effects on the longevity of forests because they "[increase] tree mortality, [increase] loss of soil seed banks, and cause species heterogeneity" (Dale, pg.725, 2001). This results in smaller, less reproductive, and less diverse forests where drought and fires are more frequent. Lower species diversity leads to increased susceptibility to disease (Sturrok, 2011). The infection rate of plant pathogens depend strongly on temperature, as tropical and subtropical regions have both the most diversity and highest infection rate of tree pathogens in the world (Sturrok, 2011). With global temperatures increasing, the range of hospitable areas for pathogens are also increasing, which allows them to spread into new ecosystems and new species, causing increased mortality rates in forests worldwide (Sturrok, 2011). Forests are now at a greater risk than ever for destruction due almost entirely to climate change (Dale, 2001; Sturrok, 2011).

1.1.2 Carbon Pollution

The main cause for the vast acceleration of climate change within the past century can be explained by the increasing levels of carbon dioxide concentrations being emitted into the atmosphere (Solomon, 2008). Worldwide, the amount of greenhouse gas emissions caused by human activities has increased by 35% between the years of 1990 and 2010 (IPCC Climate Change, 2013). These activities include the increase in fossil fuel combustion through the use of transportation methods and deforestation, the accumulation of waste through organic processes related to livestock, as well as through poor waste disposal systems, and through industrial and commercial processes which pollute chemicals into the atmosphere (United States, 2017). Greenhouse gases incorporate the emissions of multiple components, such as carbon dioxide, methane, nitrous oxide, and fluorinated gases (IPCC Climate Change, 2013). The increase in greenhouse gas emissions has presented a correlation with increasing global average warming and climate change as shown in Figure 3.

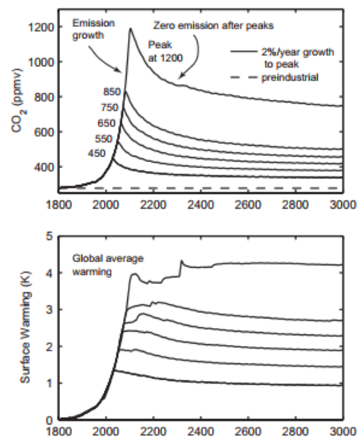


Figure 3:Relationship between Carbon emission and average temperature (Solomon, 2008)

1.2: Climate Change in Costa Rica

Costa Rica has been one of the more ambitious and persistent countries aimed at reducing carbon emissions among other greenhouse gases (Welch, 2015). One of the reasons for its commitment is the fact that Costa Rica currently emits around 14.6 million metric tons of carbon dioxide each year, and that number is predicted to increase to 21.7 million tons. To reverse this trend, Costa Rica is actively working to reduce its carbon dioxide emissions by 5.8 million tons (Climate Action Tracker, 2017). Due to this, there have been subtle changes in the wildlife that have drawn the attention of the country and its policy makers. For example, the extinction of the golden toad was the turning point for many Costa Ricans in realizing the dangerous effects of climate change on their treasured biodiversity (UMASS, 2008). Despite being a relatively small country, Costa Rica is at the forefront of various climate change initiatives and carbon neutral campaigns. In 2015, Costa Rica presented its Intended Nationally Determined Contributions (INDC). The document outlines Costa Rica's plan for carbon neutrality through 2030 and pledges that it will reach zero net emissions by 2021(MINAE, 2015). Costa Rica has been one of the leaders on the subject of climate change mitigation and adaptation (Shaver, 2015).

1.2.1: National Policy

Costa Rica's national climate change policy follows three main courses of action: 1. To set up and build governmental entities that are focused on developing climate change initiatives nationally and internationally 2. To encourage Costa Rican citizens to support climate change mitigation through increased forestation by individuals and the National Park Services 3. Invest in technological infrastructure to continue towards the path of renewable energy and public transportation (IPCC, 2014).

Costa Rica took the first steps towards establishing climate change policies in 1995, when its government formed the National Environmental Council (MINAE, 2015). This executive branch and others alike allow Costa Rica to be present and active on the global stage as a way to direct the climate change conversation onto the smaller countries who might not have as big of an impact on pollution, but whose entire economy relies on their natural resources and whose populations are most affected by climate change. In comparison, larger countries like the United States and China have many sources that contribute to their economic prosperity. In addition these branches were established to oversee the country's overall goal, such that coordinated efforts between commissions in agriculture and forestry, energy and transportation could be accomplished efficiently (VanDusen, Personal Communication. 2017, November 8; MINAE, 2015). Therefore, it is extremely important that Costa Rica remain a model for the world's de-carbonization process (MINAE, 2015).

Costa Rica is known for its natural beauty and therefore has placed great emphasis on preserving forests, trees, and wildlife in its national policy. Trees play a significant role in reducing carbon emissions because dense tree growth is directly proportional to the volume of carbon taken in by the atmosphere. In 1949, Costa Rica received a large influx of residents. During this time Costa Rica turned to farming along with other agricultural practices to support its new population. To this day, Costa Rica's agricultural sector accounts for over 35 percent of greenhouse gas emissions. Therefore, Costa Rica's National Park Service has worked to protect 25 percent of the country's territory, such that it cannot be deforested for agriculture use or damaged in any other way (Yglesias, 2017). As a part of Costa Rica's climate change policy, the National Park Service is constantly working on gaining more park protected land to offset the emissions produced from farming. In addition, Costa Rica stated that it works closely with National Forestry Financing Fund and the Costa Rican Payments for Ecosystem Program (PESP). These funds aim to encourage individuals through compensation for fallow land and trees (Le Croq, 2015; Daniels, 2010).

The National Climate Change Strategy of Costa Rica outlines transportation and energy as two of the major contributors to carbon pollution (Mauri, 2009). In Costa Rica's INDC, Costa Rica stresses the necessity and importance of renewable energy. In fact, Costa Rica's national policy has been extremely successful in implementing renewable energy sources, such as electricity, waste disposal and water treatments in Costa Rica. For example, according to the Costa Rican Electricity Institute nearly 98 percent of energy was produced by renewable sources (Okedu, 2017; Renewable Energy Focus, 2017). Costa Rica has spent years of investments on technologically advanced infrastructure in order to further their commitment to carbon neutrality. In the coming years, it has a plan set in place for additional investments for improvements of waste disposal and water treatments (Androvetto, 2013). As it witnesses and embraces the positive effects of the renewable energy, it moves forward with its initiatives and looks to implement larger scale and more reliable trains and buses throughout Costa Rica. Over the past 20 years, the number of cars in Costa Rica has grown by almost 600 percent (Ticotimes, 2017). Therefore, the government is pushing fuel-efficient energy sources such as electric, hybrid, and flex-fuel car models as well as developing plans that would build a commuter train going through "its urban core" (Toomey, 2017). The government is also "considering a carbon tax with high rates for older cars, and some lawmakers want to jumpstart a countrywide move to electric vehicles" (Welch, 2015). The hope is that the implementation of bus and train networks will greatly affect the accessibility of Costa Rica's rural areas to the point where visitors and community members will not feel the need to commute by car everyday (Welch, 2015).

1.3 Promoting Community Involvement

While the National Policy is a significant step in the right direction towards Costa Rica's goal of zero net emissions, the implementation of legislations and laws is only the foundational framework in actually making a difference. Over 85 percent of individuals within Costa Rica have knowledge and a concern of the basic impacts presented by climate change (Vignola, 2013). However, this does not guarantee that this same percentage of the population is willing or actively changing its behavior to support the reduction of carbon emissions. In a general sense, individuals do not necessarily consider the potential negative impacts of their actions or practices if these behaviors have been accepted into society (Cialdini, 1990). Such norms have become ingrained within society, leading them to go unquestioned and continue to be promoted on a daily basis, regardless of their harmful qualities.

A study conducted by Arizona and Pennsylvania State Universities focused on observing changes in littering behaviors, and whether the subjects were influenced by the behaviors of others. Figure 4 presents the differences in percentages of subjects who littered based upon the presence of litter already existing within the environment, and the actions of individuals surrounding them.

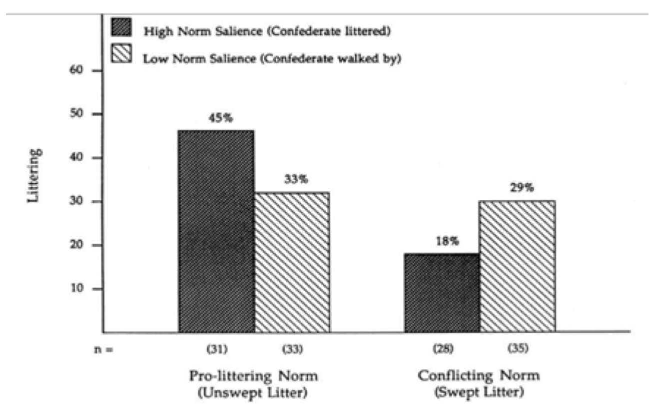


Figure 4: Results of littering study done by Arizona and Pennsylvania State University (Cialdini, 1990)

As shown in Figure 4, the frequency of measured littering increased in pre-existing littered environments. The rate of littering increased even more when the subject observed a separate individual littering in the area. This adheres to the conclusion that individuals tend to unwillingly follow social behaviors that they see around them. Therefore, it is necessary for individuals to become aware of how these practices negatively impact society, or specifically the environment as a whole (Cialdini, 1990). This is often done through the creation of awareness campaigns.

The application of marketing tools has previously brought about successful awareness campaigns by portraying results of quantitative data analysis in such a way that led to behavioral changes in the targeted audience (Black, 2001). When establishing which marketing practices to employ, it is necessary to gain a background of the targeted community and audience. For example, in 2002 a syphilis campaign was launched in multiple cities to raise awareness of the symptoms relating to the disease (Vega, 2005). The type of campaign implemented in each city varied based on differences within the communities. In San Francisco, a campaign was put in motion that incorporated humor and positive sex messages which provided information about the symptoms (Vega, 2005). This type of campaign would not have been acceptable and successful to communities that were on average more conservative, therefore it is necessary to get a good grasp on audience (Vega, 2005).

Advertisements are a significant aspect of marketing due to the number of people who see them on a day to day basis. Previous campaigns have established advertisements through the use of newspapers, radio spots, public service announcements, and posters (Vega, 2005). When creating an advertisement, it is also important to establish a logo or tagline to use. This offers a quote or visual which allows for the audience to remember your advertisement and specific campaign. These tactics allow for campaigns to reach a wide, yet intended community and promote its purposes in a positive and successful way.

Additionally, the incorporation of educational campaigns to involve students or the younger generation has had previous success (Aziz, 2016). Children and teens are more likely to accept change, because they have not yet been drawn into the social norms accepted by society and are more open to learning new things (Aziz, 2016). By directing a portion of the campaign towards students, it will establish a sense of responsibility and will compel them to communicate this information with their parents.

1.3.1 Communicating with the Community

The communities of Monteverde are unique in that they offer a vast diversity of individuals including scientists and entrepreneurs who have travelled to Costa Rica for research and business opportunities. Based on this combination, it is important to gauge how to best present analytical information to each section of the community, and which platforms should be used to best raise awareness throughout the entirety of the region.

The major platforms used to portray information to the Costa Rican community include television, radio advertisements, and newspaper articles (Vignola, 2013). These platforms are focused primarily towards the local residents. It is important to employ the use of different techniques in order to present data to the different groups of the Monteverde community.

1.4 CORCLIMA

The National Policy outlines the country's overall goal and hope for the future, however all the changes that it works to implement are large scale and will take many years to approve and accomplish. Climate change is immediate and the effects are imminent, therefore it is important that there are smaller, non-governmental organizations working at a local level to help address specific actions communities can practice to begin reducing carbon emissions. Our sponsor, CORCLIMA, seeks to fill this gap within the Monteverde region. CORCLIMA, or "La Comisión Resiliencia al Cambia Climático de Monteverde," is a group of eight individuals with connections to four major organizations in the Monteverde region who have come together to create a campaign. The commission is actively "...uniting and aligning the efforts of local organizations, businesses and individuals to make the Monteverde region climate resilient" (Berens, VanDusen, Welch, 2016, p23). Coordinator of CORCLIMA, Katy VanDusen, describes the commission as a movement where everyone is working to create a more sustainable world. Over the past two years CORCLIMA has collected data pertaining to carbon emissions. The main contributors of this information are the Monteverde Conservation League, the Friend's School, and the Monteverde Institute. The commission acts as a resource for the district to become carbon neutral, as it applies the national policy for carbon neutrality on a more local basis and identifies ways that all people can help mitigate the carbon emissions of the area. The Monteverde Commission for Resilience to Climate Change also works with the Monteverde Community Fund to sponsor a small grants program that helps fund research in climate change, environmental education, ecological projects, and studies in carbon offsets. Through supporting already existing committees, and inspiring new efforts to fight climate change, CORCLIMA aims to create a carbon neutral Monteverde, in line with the national policy, and eventually make the region carbon negative (VanDusen, Personal Communication. 2017, November 8).

The goal of this project is to find a system which successfully communicates and displays how regional institutions within Monteverde are emitting greenhouse gases through the use of media and technology. By analyzing data from our partner organization, CORCLIMA we hope to devise an effective way to communicate the results and encourage the community to reduce and capture carbon emissions. Using this knowledge the goal is to find ways in which people can personally affect change in their community, eventually leading to wide scale carbon neutrality.

Chapter 2: Methodology

The goal of this project is to aid carbon reduction efforts in Monteverde by analyzing carbon emission data and determining the best methods for sharing outcomes with the community. To accomplish this goal the team has outlined the following objectives:

1. Determine how Monteverde, Costa Rica is promoting carbon neutrality
2. Determine the net carbon footprint and top contributors of carbon emissions for three selected Monteverde initiatives

3. Determine ideal public relation mediums and social marketing techniques that target the Monteverde community in order to develop a campaign to aid carbon reduction efforts.

2.1 Objective 1: Determine how Monteverde, Costa Rica is promoting carbon neutrality

Our first step in accomplishing this objective was to use our sponsor's connections within the local community to attend various community meetings and presentations to gauge the level of participation from the community to become carbon neutral. We attended meetings about electric vehicles, solar panels and waste management. An electric vehicles presentation was hosted by Instituto Costarricense de Electricidad (ICE) who is the largest Costa Rican provider of electricity. This focused on the benefits of electric cars and also the potential expansion of car chargers throughout Costa Rica. A community presentation on solar panels was presented by Asociación Costarricense de Energía Solar (ACESOLAR), who in partnership with the Monteverde Institute, CORCLIMA and Monteverde Biologia Estación discussed opportunities, challenges and advice when evaluating solar providers. Next, we visited Vision to Reality's work site where Justin Welch and his interns, including WPI project students, explained their goal of finding solutions to waste management by repurposing organic waste material into useful resources. The next step in assessing the current state of affairs of initiatives was to gain a broader understanding of other local organizations working towards the same goal of carbon neutrality through different departments. To accomplish this, we met with another student researcher working from the University of Montana, Lindsey Ashton. In the meeting, she shared with us her project findings about initiatives pertaining to carbon reduction efforts specifically in the Monteverde area.

Through the interview with the other student researcher and a day hike to different sustainability initiatives within the community, we identified other organizations in Monteverde that provide the area with educational services about carbon neutrality and climate change related initiatives. By assessing these organization on their outreach to the community and their marketing strategy for events and presentations, we gained a general understanding of how familiar the public is with Costa Rica's climate change policy and more importantly how Monteverde is executing their push towards the national goal through organizations. The initiatives that we assessed included, the Monteverde Institute, Life Monteverde, the Monteverde Community Fund, the Monteverde Friends School and the Council on International Educational Exchange Monteverde branch (CIEE). We assessed these organizations on the following categories: the accessibility of the organization to public involvement, the educational opportunities offered by the organization, the direct service of the organization to the public, the emphasis on local participation, the cost of the class or service to locals, and the direct impact of the organization on the goal of the national plan. The results can be seen in the matrix in Appendix A.

2.2 Objective 2: Determine the net carbon footprint and top contributors of carbon emissions for the three Monteverde initiatives

To begin this objective, we first needed to collect data pertaining to carbon emissions. Through the connection of our sponsor Katy VanDusen, we were put in contact with three separate organizations that have been collecting data since the beginning of 2016. These organizations were the Monteverde Conservation League, the Monteverde Institute, and the Monteverde Friends School. For a brief summary about each location, see Table 1 below.

Table 1: Summary of each Organization

Conservation League	An organization consisting of offices and field locations working towards conserving and protecting the forested area of Monteverde. In addition, they offer tourist attractions and hikes through their land.
Monteverde Institute	An organization consisting of classrooms and offices which offers classes to foreign students and works towards the implementation of adaptation practices. A few of the adaptation practices include, water catchment systems, composting systems, reforestation and biogardens.
Friends School	An elementary through high school which also focuses on teaching and implementing mitigation practices.

Through the guidance of the Curso Carbono Neutro, each organization implemented an initial inventory protocol process. The course taught the organizations the sections of emissions that were important to measure as well as provided them with a preliminary emission registry. **The data collection categories included inorganic waste, organic waste, fertilizers, electricity, gasoline, septic tanks, liquid petroleum gases (LPG) and refrigerants between the years 2016 and 2017.** The inorganic and organic waste was measured by members of each organization in units of weight each time it was disposed of, excluding weekends and holidays. The gasoline, electricity, fertilizers, and liquid petroleum gases were recorded by the organizations through the collection of receipts. Using the receipts, we tracked how much of each category was purchased in units of weight or volume. The refrigerant data was measured using the make and model of each individual refrigerator. Through the direction of the Curso Carbono Neutro, the refrigerant data was only used if the refrigerator was disposed of because refrigerant only leaks and emits carbon upon disposal. The septic tank data was calculated through a standard equation given to us by CORCLIMA based on the number of visitors and employees present each day.

Next, with help from CORCLIMA's carbon inventory consultant, Larisa Arroyo, we used the course registries to convert the raw measured data into its carbon emission equivalent. The conversion required the use of an equation, which was based on information about emissions, heating factors, and carbon equivalents for each section of data. These factors and variables were taken from the report: *Factores de Emisión Gases Efecto Invernadero*[1]. The equation is as follows:

$$CO_2 \text{ equavilent} = \frac{\text{Quantity} \times \text{Emission Factor } (NH_4) \times \text{PCG } (NH_4) + \text{Quantity} \times \text{Emission Factor } (N_2O) \times \text{PCG } (N_2O)}{1000}$$

Each section of data released either carbon dioxide, methane or nitrous oxide. The gaseous emissions other than carbon dioxide were then converted into their carbon dioxide equivalents using heating factors found in Appendix B. Both of the 2016 and 2017 data was calculated using 2016 factors because the 2017 factors were not yet available. By taking the total emissions of each category for the three organizations per year, we were able to determine the top contributors of carbon emissions for each of the organizations.

In addition to the emission data taken by these local businesses, the Monteverde Friends School and Monteverde Institute collected carbon sequestration data over multiple years. We analyzed this data to calculate the net carbon footprint of each initiative.

The sequestration data was calculated through the measurement of growth in the diameter base height (DBH) of trees. These two organizations claimed land designated for offsetting carbon, and trees with a minimum DBH of 1.0 centimeter or larger were included in the calculations. The DBH of the trees was measured 130 centimeters from the base of the tree on the high ground. This sequestration data is collected once per year between the months of January and March. With assistance from sequestration experts from CIEE and the Monteverde Institute, we determined the amount of carbon sequestration by the Monteverde Friends School, and how this result compares to their total carbon emission. To accomplish this, we used a series of equations focusing on the above-ground biomass (AGB) of each tree per hectare. To begin, it is necessary to determine the biomass of each tree in kilograms using the equation:

$$AGB = e^{(-2.134+2.53\ln(dbh))}$$

It has been determined through a previous study that 48 percent of a trees AGB is composed of carbon (Tanner, 2016). Therefore, in order to deduce the total carbon weight per tree, the AGB calculated from the previous equation was multiplied by 0.48. This was completed for each DBH measured per plot. The total amount of AGB per plot in kilograms was found through the summation of each tree's AGB. This carbon summation was measured in terms of each 20x20 meter plot and converted to weight of carbon found per hectare. The calculated carbon summation per plot was then multiplied by 25 to portray the results in terms of hectares. Finally, the total carbon weight per hectare (AGB_{CARBON}) was calculated for each year and converted into metric tons. The differences of the AGB_{CARBON} between each year was then calculated and averaged per hectare to determine the total amount of carbon sequestration per year. To find the total sequestration related to carbon dioxide, the amount of carbon sequestration

[1]Report From Instituto Meterológico Nacional Costa Rica (IMN)

was then multiplied by a factor of 3.6663 to find the total carbon dioxide sequestered per hectare[2].

Additionally, with the help of Debra Hamilton from the Monteverde Institute, the team estimated the total sequestration for the Monteverde Institute and the Conservation League. Using data from the journal, *Biomass and Soil Carbon Stocks in Wet Montane Forest, Monteverde Region, Costa Rica: Assessments and Challenges for Quantifying Accumulation Rates* (Tanner, 2016), previous students measured the total AGB_{CARBON} of trees in two plots from the Monteverde Institute. Within these plots, the trees consisted of both newly planted trees 15 years of age and younger, and secondary trees between the age of 15 and 75 years old. Using the total AGB_{CARBON} from each type of forest per hectare and dividing that by the known time the plots have been growing, it was possible to determine an average sequestration amount in units of Mg/ha for both the newly planted trees and the secondary trees per year. The average sequestration for trees 75 years of age and older (mature plots) was estimated from data about tropical forests in Africa because no data from Monteverde about mature forests exist. Using total biomass data from the journal article, *Above-ground Biomass and Structure of 260 African Tropical Forests* (Lewis, 2013) about mature trees in Africa, we used the previous equation to find the total AGB_{CARBON} from these trees. The total age of tree was not specified, so a conservative estimate of 75 years was used to determine the average sequestration of metric tons per hectare occurring per year for this type of forest. Using these average sequestration benchmarks, the team determined the sequestration occurring from the 22,600 hectares found in the Conservation League, and the 28.2 hectares from the Monteverde Institute. To determine the net carbon footprint of the three associated organizations, we compared the carbon sequestration results with the carbon emission results.

2.3 Objective 3: Determine ideal public relation mediums and social marketing techniques that target the Monteverde community to develop a campaign to aid carbon reduction efforts

In order to determine the best visuals to use for the infographics and other forms of media, we interviewed students from the Monteverde Friends School. We targeted this audience because younger generations are less likely to comply with social norms and are more likely to adhere to changes in behavior (Aziz, 2016). In our surveys, we asked the target audience how they best receive important information from the region, such as through radio, television, newspaper, and social media (see Appendix C). In addition, we asked them what ways they find easiest to read and understand data analysis.

Following the survey, we identified themes to use in our final infographic, which was created with help from the communication and marketing team at the Monteverde Institute, Hazel Guindon and Evelyn Obando. Through a drafting session with Ms. Guindon and Ms.

---

[2] *How to calculate the amount of CO2 sequestered in a tree per year*

VanDusen, we created a plan and prototype of the first iteration of the infographic. During this meeting, we used the data comprised from the student surveys to synthesize an infographic which appropriately displays the results from Objective 2 to the Monteverde community. After we completed the first iteration of the infographic, we discussed the positives and negatives of the draft. As a group we decided that the color scheme of the first iteration was a good representation of the urgency of climate change. In addition, we agreed that the emissions should be the focal point of the graphic and therefore should be presented in a larger image. Lastly, we determined that the tree sequestration legend should be removed because we wanted to emphasize not only sequestration, but adaptation and mitigation as well. We replaced the legend with a sequestration gauge that showed the amount of sequestration occurring from each organization. All of these changes were reflected in the second and final draft of the infographic. The infographic was designed to be multi-platformed and programmed to be automated. The purpose of this was so it could be used via various mediums, such as posters, flyers and social media. It was automated so that it could be used for other organizations without redesigning the infographic each time. The infographic was also designed with the intent to be identifiable as CORCLIMA's brand, by using pre-established color schemes and elements within our design.

Additionally, we determined a video as another platform to distribute the carbon footprint results of CORCLIMA's partner organizations to the Monteverde community. The goal of the video was to take an abstract idea and convert it into something tangible. Specifically, this was done for carbon emissions from transportation using iMovie. A similar drafting session that was used for the infographic was also used for the creation of the video. We met with a graphic design expert, Andrés Gamba, who assisted us in drafting the script and storyboard used in the video. The script was recorded into an audio file by Ms. Guindon, who we approached to be the voice of CORCLIMA. We chose Ms. Guindon because we were advised by Andrés to use a female voice because female voices are more likely to be accepted. The storyboard was made up of non-copyrighted still images and videos from various websites. Additional elements of the video were obtained from Google Earth and CORCLIMA designed logos. In the video we included features of a globe to relate Monteverde's carbon emissions to the bigger picture of climate change, we depicted the problem and challenge of transportation in Monteverde and around the world. We then provided steps and actions to mitigate the problem. Finally, we applied the recorded audio, music, subtitles and transitions to polish the final product.

Lastly, we supported our sponsor's mission of raising awareness through the creation of blogs that focused on topics from various initiatives and meetings we visited in Objective 1. The purpose of the blogs was to further explore specific questions, topics or concerns from the presentations and organizations. The blogs are meant to be a source of information for community members who did not attend the events or want to learn more about the carbon neutrality practices of the organizations. The blogs were published on CORCLIMA's webpage and social media accounts, and can additionally be found in Appendix K, L, M, and N of our paper.

Chapter 3: Results and Discussion

This chapter discusses the results from our data analysis of carbon emissions and sequestration, the feedback and responses from interviews with students, and a marketing assessment for local carbon neutrality initiatives. We focus on how the results aided in fulfilling our three objectives, specifically in determining how Monteverde is promoting carbon neutrality, the net carbon footprint for the three organizations, the top contributors of carbon emission, and the ideal public relation mediums and social marketing techniques to best portray our results to the Monteverde community. Additionally, we discuss some challenges that we faced throughout the duration of our project and how these affected our final results.

3.1 Objective 1: Determine how Monteverde, Costa Rica, is promoting carbon neutrality

CORCLIMA's goal is to encourage the Monteverde community to mitigate and adapt daily practices that promote carbon neutrality. However, before adaptation and mitigation is possible, it is important to educate and raise awareness on the issue. Therefore, we assessed five of the most influential initiatives in the Monteverde area that focus on climate change and environmental sustainability. These initiatives were, the Monteverde Institute, Life Monteverde, Monteverde Community Fund, the Monteverde Friends School, and CIEE. We assessed these organizations on accessibility to public involvement, educational opportunities, services provided to the community, emphasis on local participation, cost of class or service for locals, and impact on the national plan.

The first category in which we assessed each initiative was their accessibility to public involvement. After coding the information we gathered from each organization we came to the conclusion that the Monteverde Institute is one of only two organizations that is accessible to the public. Throughout the year, the Institute sponsors a variety of different talks and presentations on environmental sustainability which work to reach locals and benefit the community. The second organization that accomplishes this goal is Life Monteverde. This is done through offering programs to local students and residents at a discounted price. The other initiatives did not meet this goal because they are only inclusive to students and staff. Organizations such as the Friends School and CIEE are only available to specific demographics of the community and do not host many outside activities accessible to other community involvement.

Next, we assessed the organizations on the educational opportunities that they offer on the topic of climate change and carbon neutrality. Of the organizations, we found that all of them include educational programs as a part of their curriculums. The Monteverde Institute holds reforestation research projects for undergraduate students from the United States as well as other outside sustainability research. Life Monteverde hosts educational courses for local students to learn about sustainability and how to implement sustainable practices. The Monteverde Community Fund provides indirect opportunities by training project managers and organization leaders on grant writing and project management. The Monteverde Friends School offers many educational opportunities incorporated in the student's curriculum. The school offers an environmental course which focuses on climate change and sustainability. Additionally, our sponsor Katy VanDusen and the Monteverde Institute host presentations and talks on climate change and carbon neutrality for the school. The CIEE has opportunities for foreign students to participate in various projects about carbon neutrality and environmental work. This is completed through month long internships with small local initiatives that is incorporated in their semester long curriculum.

The next category we assessed was the services the organizations provide to the community. We found that two of the organizations, the Monteverde Institute and Life Monteverde, directly provide services for the Monteverde community. The Monteverde Institute helps with carbon sequestration through their reforestation programs and is a testing ground for new mitigation practices. The Institute focuses on implementing new practices such as bio gardens, water neutral bathrooms, tabletop gardens, and composters, and evaluates their effectiveness and whether they have the possibility of being implemented within the Monteverde community. Life Monteverde provides learning experiences for both local and foreign students about environmental sustainability. The other organizations indirectly provide services to the community. The Friends School and CIEE give access to project work with local initiatives working towards climate change goals. The Monteverde Community Fund funds nonprofit local initiatives to indirectly help the community. These initiatives focus on various environmental challenges and social and cultural developments, such as, clean production sustainability of local trades, and climate change. The Monteverde Community Fund grants between $2000 and $4500 per project, and give out approximately three grants per year.

Furthermore, we evaluated the initiatives on the amount of emphasis they put on local participation. We discovered that Life Monteverde was the only organization that has programs in place that allowed for easier access for local students and residents by creating discounted prices for locals of Monteverde. Both CIEE and the Monteverde Institute focus their courses and curriculums towards foreign students studying in Monteverde. The Friends School also has local participation in their curriculum, as the school incorporates permanent residents. However the majority are semi-permanent residents from other locations.

Next, we considered the cost of the class or service specifically for locals in the area. We concluded that Life Monteverde is the only organization that waived or offered discounts for local students. The programs at the Monteverde Community Fund are already very modest, therefore they do not offer any reduced payments for locals. The other organizations including the Monteverde Friends School, CIEE and the Monteverde Institute either do not offer their programs to Monteverde residents or have an established tuition for all students.

Lastly, we assessed how each organization was working towards the national goal of carbon neutrality through their classes, programs and company mission. We found that all the organizations either indirectly or directly impact the national plan. The initiatives focused on education, such as CIEE and the Friends School, accomplish this through the curriculum they offer by teaching students about sustainable practices and carbon emissions. The Monteverde Institute and Life Monteverde directly work towards the national goal through presentations that they host to help educate the community. Finally, the Monteverde Community Fund indirectly assists the national plan through their small grants funding that funds climate change related community projects.

In conclusion, our assessment has supported the notion that Monteverde is a beacon and leader on the topic of climate change. From our research it is evident that certain sections of the Monteverde community are determined to reach carbon neutrality and continue to raise the awareness of climate change in both locals and foreigners. That being said, there is still a lot to be done about the marketing of these initiatives to other parts of the community and on emphasizing local participation from long term residents and native Costa Ricans.

3.2 Objective 2: Determine the net carbon footprint and top contributors of carbon emissions for the three Monteverde initiatives

The research of this objective focused on determining the total carbon emission and sequestration occurring per year for the Monteverde Conservation League, the Monteverde Institute, and the Monteverde Friends School. Work on this objective started prior to our arrival with the collection of data for carbon emissions from the three organizations during the years of 2016 and 2017. The data for carbon emissions were collected independently by members from each organization. As stated in Chapter 2, the types of data collected were organized into separate sectors, specifically organic waste, inorganic waste, recycling, septic tanks, electricity, gasoline, fertilizer, LPG, diesel, and refrigerants. Additionally, the Friends School, the Monteverde Institute and the Conservation League gave us data for carbon sequestration analysis.

An initial qualitative analysis of the data collected gave way to the team's first finding: **There is not a consistent protocol between each of the three organizations**. One of the challenges that we ran into when first attempting to analyze the data was that not all of the organizations collected quantitative data for every separate sector of emission.

Table 2: Sections of Data Collected for each Organization

	Organic Waste	Inorganic Waste	Recycling	Septic	Electricity	Gasoline	Fertilizer	LPG	Diesel	Refrigerants
Friends School	x	x	x	x	x	x	x	x		
Monteverde Institute	x	x	x	x	x	x		x	x	
Conservation League				x	x	x		x	x	x

As seen in Table 2, the Friends School collected data which included organic waste, electricity, inorganic waste, fertilizer, LPG, gasoline, recycling, and septic tanks. The Monteverde Institute collected data which included electricity, gasoline, LPG, diesel, recycling, organic waste, inorganic waste, and septic tank. Finally, the Conservation League collected data which included electricity, gas, diesel, LPG, septic tank, and refrigerants. Therefore, there was an incomplete collection of data for organic waste, inorganic waste, recycling, refrigerants, diesel, and fertilizer.

In addition, the gasoline data from the Friends School was solely completed in 2015. This was done through a school survey on how many students are driven to school each day. This survey was not repeated for 2016 and 2017. However, after communication with our sponsor, we decided that this data would still be included in our carbon footprint calculations as a baseline per year.

The absences of these sections of data can be attributed to the lack of an organized collection system in which one person is responsible for the recording of the raw data. During the past two years, the data was collected and organized by multiple people in the form of receipts once a year. The receipts needed for collecting the data were not separated from the rest of the organization's receipts. The problem with this system is that it leads to a buildup of receipts, which causes the data collection to be more tedious and time consuming. As a result, employees either do not have the ability or motivation to actively take time away from their other job responsibilities.

This lack of data led to multiple implications in both the accuracy and completeness of our results. With respect to our final results, the team was unable to determine the exact amount of emissions that one organization produced per year. Due to the missing sections of data per organizations, we were solely able to use the equations to make a very advanced estimate based on the information we were given. Additionally, this situation led to an inability to give an accurate comparison between each of the three organizations. One result that would be very helpful to the goal of carbon neutrality is the ability to deduce which practices are best working towards mitigation. Had a complete set of data been gathered, it would have allowed for the team to determine how the amount of emission per each section of emitter varies for each organization. This knowledge would have led to a comparison between potential practices being used at each organization adhering to each of the sectors of emitters. A complete comparison between the results of the organizations would have allowed for a quantitative representation of which practices are most successful towards carbon mitigation.

After gathering the data, we processed and analyzed it through the guideline inventory presented in the Earth University course. We edited the existing registry to make it easier to understand by separating the types of emissions and adding columns for CH_4 and N_2O.

Table 3:Blank guideline inventory used for measuring carbon emission data

Asociación de los Amigos 01 REGISTRO DE EMISIONES DE CO_2e POR COMPOSTAGE DE DESECHOS SOLIDOS													
Emisiones Iidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Mes	Cantidad (kg)	Factor de emisión CH_4	PCG	CH4 eq en toneladas	Factor de emisión N_2O	PCG	N2O eq en toneladas	CO_2e en toneladas
Emisiones	Operación				Enero								
directas por gestión de residuos	generales				Febrero								
					Marzo								
					Abril								
				Hoja de Excel	Mayo								
					Junio								
					Julio								
					Agosto								
					Septiembre								
					Octubre								
					Noviembre								
					Diciembre								
					TOTAL								

As seen in Table 3, the registries consisted of tables for each emission sector, with each table containing sections for quantity, emission factor (Factor de emision), heating factor (PCG), and total carbon equivalent in metric tons. The data was separated and calculated based on monthly quantity totals. In these inventories, we inserted the equation used to calculate the total amount of carbon emission per month as stated in Chapter 2. The quantity measurement used units of kilograms, liters, or kilowatt hours depending on the emission section. The emission factors we used were based on the emissions section and emission type (carbon dioxide, methane, nitrous oxide). The PCG factors for carbon dioxide, methane and nitrous oxide were 1, 21, and 310 respectively. The heating factors accounted for the magnitude each gas emitted and the speed at which it burned. These factors allowed us to convert all gas emissions into their carbon equivalent in metric tons per month. We then summed the carbon emissions per month to determine the total yearly carbon emission for each year.

While calculating the emissions for each section we came across a second finding: **There is no accurate way of calculating septic emissions using a formula.** The equation that we were introduced to is a variation of the carbon emission equation from Chapter 2. However it incorporated number of people as the quantity, and the emission factor was created under the assumption that the person would stay in the same location for 24 hours. We could only use this equation to create general estimations of how much solid human waste was produced by the organizations as there are many factors that this equation could not account for. These factors included: the amount of time that people were actually present in the buildings, since the equation was built for permanent residents who spent the majority of their days in the buildings being evaluated, biological functions, because people relieve themselves at different times in the day and might not need to use the restrooms during their time in the buildings, and social or personal preferences, as some people prefer to only use the restrooms in their private rooms or houses instead of using public or communal lavatories. The final factor that the equation could not accurately account for was the actual amount of waste produced per person for their given time period in the building.

3.2.1: Carbon Emission Results for the Three Organizations

Following the conclusion of the calculations and data analysis, we portrayed the total carbon emissions per organization in metric tons for each year (CO_2e). Using this information we determined the top contributors of emission for the three organizations.

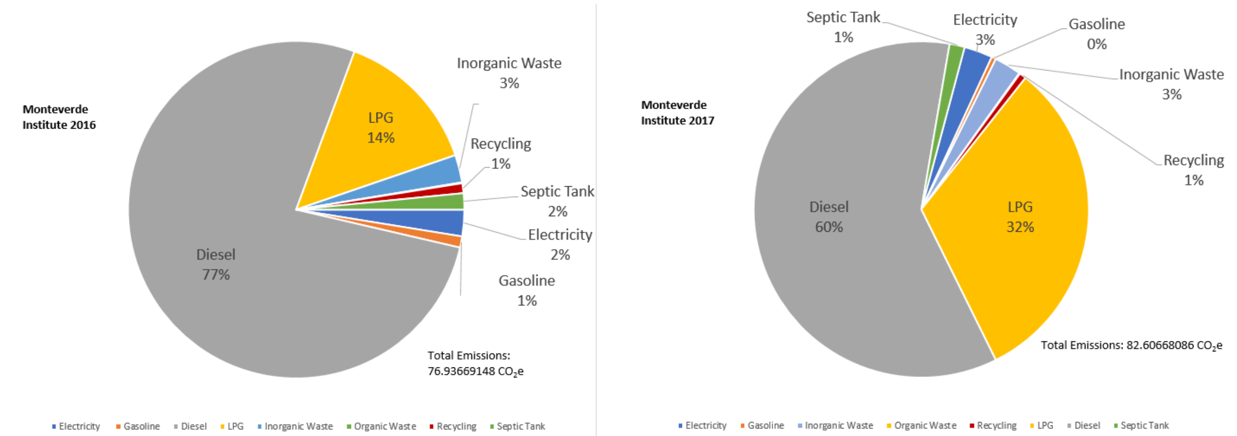


Figure 5: Carbon Emission Results for the Monteverde Institute for 2016 (left) and 2017 (right)

As seen in Figure 5, during the 2016 calendar year the Monteverde Institute emitted a total of 76.94 CO_2e. Diesel was the most significant form of emission for the Institute during this period, as it accounted for 77% of the total carbon emission. During the 2017 calendar year, the Monteverde Institute emitted a total of 82.61 CO_2e. This is an increase of approximately 5.67 CO_2e from the 2016 total emissions. Additionally, diesel was again the highest emitter of carbon for the Institute, showing a correlation from 2016. However, the amount of emissions accounted for by liquid petroleum gases increased during 2017 as well. Between 2016 and 2017, the emission percentage of LPG increased from 14% to 32%. Therefore, LPG and diesel were the two most significant emitters of carbon for the Monteverde Institute.

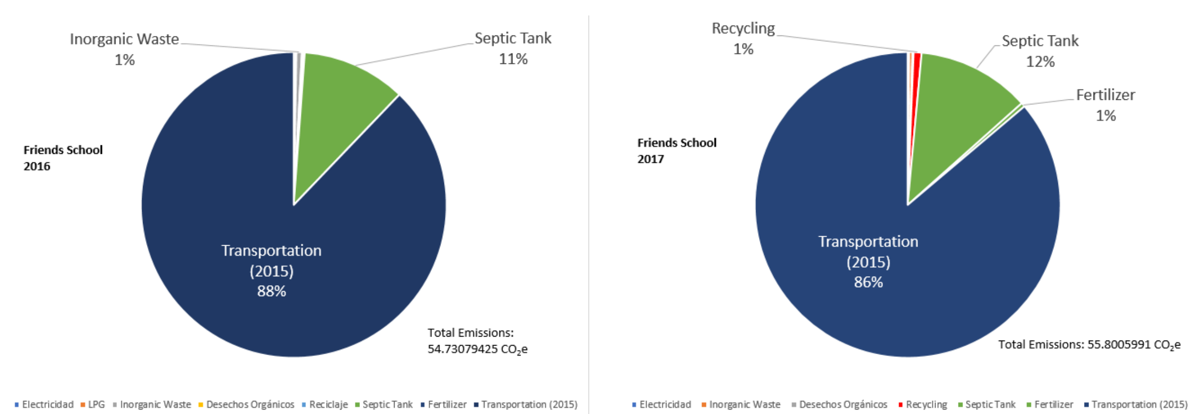


Figure 6: Carbon Emission Results for the Friends School for 2016 (left) and 2017 (right)

As seen in Figure 6, during the 2016 year the Friends School emitted a total of 54.73 CO_2e. The baseline measurement of transportation from 2015 that was applied offered the highest carbon emissions for 2016 and accounted for 88% of the total emissions.

During 2017, the Monteverde Friends School showed an increase in the amount of carbon emissions when compared to 2016. Between the years, the school had an increase of emissions equal to 1.07 CO_2e. This brought the total emissions to 55.8 CO_2e. During 2017, transportation was again the largest source of emissions for the school, with it accounting for 86% of the total emissions. Once again, this data for transportation is a baseline number being used from a 2015 study, and is being applied to 2016 and 2017. Transportation is shown to be the only significant source of emission for the Friends School, and proves to be the one area where changes can still be made to move towards decreasing emissions. Another study identical to the one from 2015 will be repeated later in 2018 to determine an accurate change in emissions between the three years.

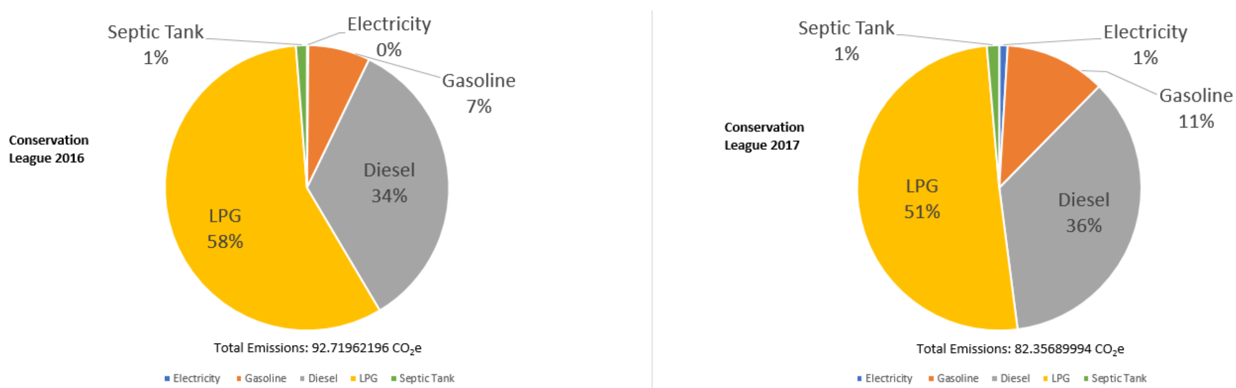


Figure 7: Carbon Emission Results for the Conservation League for 2016 (left) and 2017 (right)

Figure 7 shows the total emissions for the Conservation League for 2016. As seen in the graph, there is no data on recycling, organic waste, or inorganic waste. The lack in this data was due to the difficulty in collecting it for this organization. The Conservation League incorporates 22,600 hectares of forest, consisting of five separate field locations. It would be necessary for one person at each location to weigh the three types of trash every time it is taken out. This system was not implemented during the two years of collection, so these sectors of data were not measured.

However, using the results we were given, we determined that the estimated amount of emissions for the League was 92.72 CO_2e. The sectors of LPG and diesel offered the highest sources of emitters, with their percentages being 58% and 34% respectively.

As seen in the results above, the Conservation League was the only organization which decreased emissions between 2016 and 2017. The total emissions calculated for 2017 was 82.36 CO_2e. This presented a significant decrease of 10.36 CO_2e. However, the top contributors of these emissions were consistent between the two years, with LPG and diesel making up for 51% and 36% of the total emissions in 2017.

The conclusion of this analysis led us to the following finding: **The top contributors from the three organizations were LPG, diesel, and transportation.** The emissions from diesel are generally from trucks and landscaping equipment, such as lawnmowers, weed whackers, and chainsaws. LPG emissions come from the use of a stovetop and kitchen equipment, as each organization contains and uses a full kitchen. This poses a problem for the organizations, since LPG, diesel, and transportation have the highest emission factors. Therefore, these sectors cause the highest pollution per equal parts to the other sectors. This means that they produce more pollution when compared to other sectors of equal quantity.

Using our findings on the total amount of emissions occurring per organization per year, we determined whether each organization has reached its goal of carbon neutrality. Carbon sequestration is a very important aspect when discussing carbon neutrality. An organization can still be carbon neutral or carbon negative without completely eliminating carbon emissions. If the amount of carbon being taken in by the environment is equal or greater than that of the emissions presented by the organizations, they can still be carbon neutral or negative respectively. Therefore, another important aspect of data collection is measuring carbon sequestration. This was completed for the organizations through the process explained in Chapter 2. Following the completion of these calculations, we were able to determine that **the Conservation League and the Monteverde Institute have already reached carbon neutrality**. Using the data presented from *Biomass and Soil Carbon Stocks in Wet Montane Forest, Monteverde Region, Costa Rica: Assessments and Challenges for Quantifying Accumulation Rates* (Tanner, 2016) and *Above-ground Biomass and Structure of 260 African Tropical Forests* (Lewis, 2013), and with help from Debra Hamilton from the Monteverde Institute, the team determined the average sequestration from each type of forest to be as follows: newly planted forests sequester an average .714 Mg/ha per year, secondary forests sequester an average 4.22 Mg/ha per year, and mature forests sequester an average 2.5 Mg/ha per year. Yuber Rodriguez, from the Conservation League, gave us the total amount of hectares in each specific type of forest. The League contains 21,976.02 hectares of mature forest, 29.98 hectares of secondary forest, and 594 hectares of newly planted forest, for a total of 22,600 hectares. Applying the averages to the amount of each type of forest in the 22,600 hectares found within the Conservation League, we determined that per year this land sequesters 203,445.5 Mg of CO_2. This accounts for 247,199.3% of the Conservation League's CO_2 emissions per year. Therefore, we determined that the Conservation League is significantly carbon neutral.

Debra Hamilton and Randy Chinchilla from the Monteverde Institute, created an estimation for the size and type of each forest that the Monteverde Institute owns. The Institute owns two areas of land, La Calandria and Crandell. La Calandria is composed of 4.2 hectares of newly planted trees and 9 hectares of secondary forest. Crandell is composed of 2 hectares of newly planted trees and 13 hectares of secondary forest. Using these estimations and the average baselines of sequestration for each type of forest, we determined that the total sequestration of the Monteverde Institute per year is 356.61 Mg of CO_2. This amount accounts for 431.7% of the

Institute's total emissions per year. Therefore, we determined that the Monteverde Institute was also carbon neutral.

The data collected from the Monteverde Friends School consisted of three 20x20 meter plots. Through carbon biomass calculations and difference in total carbon present in the plots between each year, we determined that the total CO_2 sequestration from their plots is equal to 19.4 Mg of CO_2 per year. This only accounts for 35% of their emissions per year. Therefore, the Friends School has not yet reached carbon neutrality.

One consideration worth explaining for the carbon emissions for the Friends School was that it included the transportation data. As stated previously, this data came from a 2015 study run by the school to determine how many people drive there per day. A problem with this addition is that this is the only organization for which transportation on the part of staff and students was accounted for. It is important to note that if the transportation data was not included in the registry for the school, the organization would be carbon negative. Without the addition of this sector, the total emissions per year would be 7.812 CO_2e. This is significantly less than the 19.4 Mg of CO_2 sequestered by the school each year. However, including this data shows how detrimental excess driving can be to the amount of emission for each organization. Therefore, since the data was available our sponsor thought it a worthy addition in the final calculations.

3.3 Objective 3: Determine ideal public relation mediums and social marketing techniques that target the Monteverde community to develop a campaign to aid carbon reduction efforts

Through the interviews with the students from the Monteverde Friends school, we determined the most popular and successful techniques of social marketing occurring in the Monteverde area. Due to time constraints, prior saturation of surveys, and accessibility, we did not conduct more than twenty-nine interviews with local students. However, using our responses in conjunction with a thesis which evaluated how residents of Monteverde receive information and use social media, *Creación de un plan participativo de comunicación del Instituto Monteverde con la comunidad* (Avendaño Leadem, 2017), we gained more insight into the features of successful public relation mediums and social marketing techniques.

The responses from the interviews brought forth many themes and a general consensus of the area. The first theme identified was that students do not consume many types of media. Through both surveys we found that the majority of students do not consume television, radio, online newspapers or hard copy newspapers unless already influenced by their parents or grandparents. We discovered that the students rely heavily on social media as their main news source, such as Snapchat Stories as well as political Facebook videos and articles. However, even within this small group of students, we determined that while students will occasionally use social media to gather national news, their main use for social media is to connect with friends. When compared to the survey of the Monteverde community conducted in 2017, which had over 50 percent of its respondents under the age of twenty-five, our findings were supported as the survey asserted that for the group of participants aged fourteen to twenty-four, over 80 percent used Facebook, over 50 percent used Instagram, and over 90 percent used other social messaging applications as major sources of communication and information sharing (Avendaño Leadem, 2017). This finding required us to shift our preconceived ideas as to one possible form of advertisements for the community. Before conducting our surveys, we looked into possibilities for advertising carbon neutrality and carbon neutrality initiatives through local television or radio stations in Monteverde. However, since the majority of students do not watch television or listen to the radio, this idea seemed highly implausible and ineffective. In addition to asking students about what type of social media they use, we also surveyed them on their attitudes towards sponsored advertisements on social media, such as Instagram and Facebook. The majority of students concluded that they did not pay attention to these advertisements, however a few said that they would stop to take a look at it if they were Monteverde related.

Next, the survey focused more on the local marketing practices of the community. Almost all the students identified the Monteverde Coffee Center as the main place for posters and flyers to be advertised. Others also mentioned downtown Santa Elena as another area where they noticed events being advertised. Additionally, students suggested local store and restaurant windows as a place for promotions. Despite most students being able to identify places in the community where local events and initiatives were being advertised, we found that students generally did not attend any of these events. This was even more astonishing because the Monteverde Friends School, where some of these surveys were conducted, are faithful supporters of the local and national goals of carbon neutrality and climate change. In fact, these students are educated on various initiatives happening in the area through their schools curriculum. When asked about their familiarity with initiatives in the area and where they learned about them, all of the students, except one, cited their school as the main source of information about local events happening in the area. From both surveys, we discovered that students were partially aware of initiatives and presentations in the area, however none of the students attend these events unless mandated by the school. Two students mentioned that although they did not attend these presentation themselves, members of their family would typically attend, such as parents, grandparents or cousins.

Lastly, we surveyed the students on the aspects of informational graphics that they believe is best to depict data analysis. Most students felt that pictures and graphics were the most effective tools to get people's attention. They also agreed that some numbers and words are needed to help make sense of the graphics and explain what is being shown. Students explained that the more pictures there are, then the more likely someone will be willing to stop and look. However, they also cautioned that the more abstract it becomes the more confusing it will be to readers and the less likely observers will take their time to understand it. Therefore, they recommended a balance between pictures, numbers, graphs and words. Using these student insights, we developed infographics for the Monteverde Institute, Monteverde Friends School and the Monteverde Conservation League.

Final Iteration Infographic:

The final iteration of the infographic incorporated findings from our student interviews about how to best present quantitative information. The themes we gathered from our interviews included aesthetically appealing color schemes, minimal text, and the importance of easily understood visuals. Our drafting process consisted of two iterations before the completion of our final product. For our final infographic, we placed the main visual on the bottom of the page in order to create space for additional information. For this main visual we decided on the use of a half globe. This was used to show that the carbon emissions not only affect the organizations and Monteverde as a region, but also have global impacts. In addition, the organization's logo from which the results came from was placed in the center of the globe. The logos of CORCLIMA and the Monteverde Institute were also added to each infographic, as these organizations aided in the creation of it. A QR code was added next to the CORCLIMA and Monteverde Institute logos. This code is connected with the CORCLIMA website and will be used for the poster iterations of the infographic. This was added in an effort to increase the public's awareness and accessibility to CORCLIMA's website. Small icons taken from our sponsor CORCLIMA were assigned to each of the different sectors of emissions to clearly identify and separate each source. In addition, each source of emission was portrayed using a unique color as a way to further exemplify each sector. Bright contrasting colors of red, orange, yellow, green, blue, and purple were used and kept consistent for each sector across the infographics. To create a visual representation of the effect of top emitters, the team decided to use clouds covering the globe. These clouds were scaled based on the percentage of emission occurring between each sector. Therefore, the higher the percentage, the larger the cloud. Additionally, the clouds were color coated to match the scheme of each individual sector for easier visualization.

To portray which organizations had already reached carbon neutrality, a "sequestration meter" was added to the graphic. This meter showed what percentage of their total emissions was accounted for from the sequestration data analyzed in Objective 2. If the meter shows that the organization is carbon neutral, a badge will be added next to the name of the organization in the top left corner, with the phrase carbon neutral inside to show their accomplishment. If the organization has not yet reached carbon neutrality, the badge will not be present on the infographic. For comparison purposes between the different organizations, the total amount of emissions and total amount of sequestration that occurred for that year was added to the bottom right of the product, as well as the difference in emissions between 2016 and 2017. This can also be used as a way to track an organization's progress between each year. An example infographic completed for the Conservation League is seen in Figure 8.

Figure 8: Final Iteration of Conservation League infographic (2017)

Although this is the final iteration for this project, there are potential future changes that can be made to this structure. One change consists of moving the orientation of the clouds. We recommend that the clouds be moved to encircle the meter around the globe, instead of being placed in a line in the middle of the paper. This would allow for the clouds to relate to the color bars around the globe more directly, and additionally make more space on the infographic. In order to make this change possible, the scale of the clouds may have to shrink in order to fit all of them around the globe. This would allow for both the sequestration meter and the data for the total emissions, sequestration, and differences to be moved below the emissions percentages from 2016. This will aid with the visual layout of the infographic, and also allow for the difference between years and the percentages from 2016 to support each other more.

3.4 Additional Deliverables

In addition to our final infographic synthesized from the organization's data results, the team created multiple deliverables for the purpose of education and summarization of additional contributors and practices about climate change in Monteverde. These deliverables were presented in the form of a video and four blogs.

Transportation was found to be one of the top contributors of carbon emissions in Monteverde. This is shown through our data analysis from the Monteverde Friends School, as it was the top contributor from this organization. As a result, our sponsor felt it necessary to create an additional deliverable to portray this information to the Monteverde community. Therefore, we developed an educational awareness video about the problems of increasing transportation rates and actions that can be taken by the community to decrease these emissions. The actions presented in this video included ride sharing, using electric vehicles, walking and biking as substitutes to driving. The script for this video was recorded in Spanish by Hazel Guindon. This video can be found both on CORCLIMA's Facebook page and website (corclima.org) or at this link: https://youtu.be/QC0kr6QFBS0

Throughout the duration of this project, the team visited and attended multiple talks and presentations about practices for reducing carbon emissions. These talks included a discussion about electric vehicles and their prevalence within Costa Rica, a presentation put on by ACESOLAR portraying information about the applications and advantages of solar energy, and the hike completed by the team for use in the assessment of initiatives for Objective 1. Using information gathered from each of these presentations and the knowledge we have of tree sequestration, the team completed a blog about each presentation and practice offering a summary of important topics and points from each application. The blog about the electric vehicle presentation focused on information about maintenance and cost of these vehicles and why they offer as an appropriate alternative to traditional vehicles. The blog can be found in Appendix K. The blog created following the solar energy meeting focused on a specific payback system in place between the customers and the solar companies. This can be found in Appendix L. The third blog summarized the practices already in place by initiatives within town. This shows practices that anyone can do in an effort to reduce emissions outside of the organizational level. The blog can be found in Appendix M. The final blog focused on carbon mitigation through the practice of tree sequestration. The purpose of this blog was to summarize the amount of sequestration occurring in Monteverde. The blog also serves as a call to action for local community members to follow this practice as a way to increase carbon mitigation within Monteverde. This blog can be found in Appendix N. In addition, all of these deliverables can be found on both CORCLIMA's Facebook page and their website: corclima.org.

Chapter 4: Recommendations and Conclusion

4.1 Recommendations

CORCLIMA and the Monteverde Community have made great steps towards CORCLIMA's and Costa Rica's goal of becoming carbon neutral. However, we identified possible areas of focus for the future as they continue on their path to carbon neutrality. The following section will state our recommendations and supporting arguments to aid CORCLIMA's efforts.

4.1.1 Public Outreach

Through the interviews with the students from the Monteverde Friends School, we discovered that a majority of the students were only slightly familiar with the names of local environmental and carbon neutrality initiatives. Most of the students could not identify initiatives outside of the Monteverde Institute and could not describe their mission and purpose. In addition, we observed that the events we attended such as the community meeting, electric vehicle presentation and solar panel lecture were not highly attended. Therefore, we recommend that CORCLIMA as well as other environmental and carbon neutrality initiatives **place a greater focus on community outreach to increase attendance at local presentations and events.** Improving community outreach will not only increase the visibility and support of the initiatives, but will also increase the number of people actively engaging in the goals of these initiatives. Currently, the Monteverde community markets upcoming events by posting on social media and posting flyers in Santa Elena and the Coffee Center. The main problem with this is that these forms of marketing only target a specific group of individuals in the community. In order to see these visuals, a person must already follow the organization on social media or actively stop by the Coffee Center to check on upcoming events. This form of marketing limits the people who see the advertisements to residents who already have interest in the topic of climate change. If the organizations would like to inform a larger portion of the community about these events, it would be beneficial to increase the number of places these posters and flyers are displayed. These places can include restaurants and popular business's windows, bulletin boards in Centro Comercial, next to the bank in the center of town, as well any other place with a large volume of people.

4.1.2 Data Acquisition

During the course of our project, we noticed that there was data missing from each of the organizations. For this project each organization determined their own scope for what sections of data to collect and had multiple people collect and organize the data once per year. Therefore, there were sections of emissions that one or two of the organizations did not have any data on because they did not know to collect that information or did not have a singular person work on organizing the data throughout the year. As a possible solution to this issue, we recommend that each organization **ask for one employee within the organization to dedicate time to efficiently organize data used for the registries.** These employees need to have knowledge on which sections of emissions need to be collected. By implementing a more organized and central system of data collection focused on section, each organization will have the same scope of data. Multiple employees can collect the raw data, however one employee should be responsible for organizing it into this centralized system every month. This will allow the organizations to have a more accurate representation of their carbon emissions and decrease the workload for multiple employees.

Another problem we discovered with the data was how to accurately calculate septic tank emissions. The current equation used to calculate these emissions only provided us with a rough estimate. This was due to limitations of the equation mentioned in the results of Objective 2. Therefore, one of our recommendations is that the organizations **invest in a device that can accurately measure emissions from septic tanks such as a static flux chamber.** A flux chamber, or similar devices, is a metallic chamber which connects to the septic system through a gas release valve. It then measures the amount of gaseous emissions produced through the analysis of the amount of greenhouse gas per unit volume of air exhausted. This will allow the organizations to properly determine the emissions with more accuracy and ease. A picture of a static flux chamber can be seen below in Figure 9.

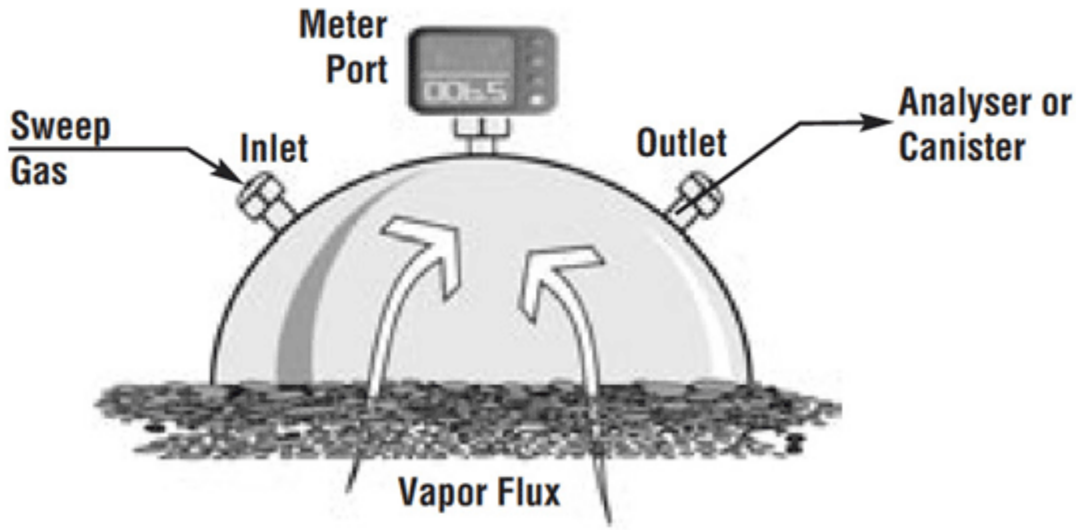


Figure 9: Static Flux Chamber

Another area that we identified for possible improvement is through the carbon sequestration data. Using the information provided to us from the Monteverde Institute, the team gave an accurate calculation of the total amount of carbon dioxide being sequestered by newly planted and secondary forests. However, the lack of data collected on the sequestration rates of mature forests within Monteverde creates a large gap in determining total sequestration occurring within the region. Therefore, we recommend that there be **a system to measure sequestration data from mature forests within Monteverde.** This could be completed in the same manner as it is currently being done for primary and secondary forests, through the measurements of AGB and AGB_{CARBON}. Ninety-seven percent of the Conservation League is composed of mature trees. The establishment of plots within this area would allow for data collection for this type of forest. This could be completed by volunteer students either from the Monteverde Institute or CIEE, and collected every year in addition to the data already collected from the newly planted and secondary plots.

4.2 Conclusion

One of the current goals of the Costa Rican government is to become a leader in the global climate change movement. This is portrayed specifically through their goal of carbon neutrality by 2030. The movement towards this goal is apparent in the Monteverde community. This is observed through the organizations and initiatives already in place that are working towards education and the implementation of sustainable practices and techniques. These organizations include Life Monteverde, Monteverde Institute, the Monteverde Friends School, the Monteverde Community Fund, CIEE and VTR.

Following the analysis of the emissions data from the Monteverde Institute, the Monteverde Friends School, and the Conservation League, it was determined that the top carbon contributors were transportation, diesel, and LPG. However, through the sequestration practices of reforestation occuring within all three of these organizations, it was found the Conservation League and Monteverde Institute have already surpassed carbon neutrality and have reached carbon negativity as organizations, while the Friends School is still working towards the goal of carbon neutrality when transportation is accounted for.

Through the creation of our baseline infographic, CORCLIMA has the capability to display the progress each organization has made on their carbon footprint annually. This will serve as a progress report for the organizations mentioned above by showing changes in the amount of emissions each year. In addition, a video and blogs were created to assist CORCLIMA in launching a carbon neutrality awareness campaign and establish a platform for the distribution of information to the community.

References

Amanda Zúñiga. (2016a, -01-09T03:00:28+00:00). Dealing With Climate Change in Costa Rica's Treasured Monteverde Cloud Forest. *The Tico Times | Costa Rica News | Travel | Real Estate* Retrieved from http://www.ticotimes.net/2016/01/09/dealing-with-climate-change-in-costa-ricas-treasured-monteverde-cloud-forest

Anderson, B. (2010). *Methane and Nitrous Oxide Emissions From Natural Sources*. Washington, D.C.: U.S. Environmental Protection Agency, Office of Atmospheric Programs. Retrieved from http://purl.fdlp.gov/GPO/gpo18640

Androvetto, E. (2013). *Costa Rica - Ordinary Solid Waste NAMA.* San Jose, Costa Rica: Ministry of Health, Ministry of Environment and Energy, GIZ Agency. Retrieved from http://ccap.org/assets/Costa%20Rica_Waste_May_2013_NAMA_Executive_Summary.pdf

Avendaño Leadem, S. (2017). *Creación de un plan participativo de comunicación del Instituto Monteverde con la comunidad* (Graduation Dissertation). Retrieved from Repositorio de la Universidad Estatal a Distancia de Costa Rica.

Aziz, A., Omran, A., Mahmood, A., & Robinson, G. M. (2016). Investigating Households Attitude Toward Recycling of Solid Waste in Malaysia : A Case Study, *3*(1993), 1–5. Retrieved from https://ijer.ut.ac.ir/article_55_5a67224e88680e74f9ccc29814a6b8e1.pdf

Beever, E. A., & Belant, J. L. (2012). *Ecological Consequences of Climate Change*. Boca Raton: CRC Press.

Black, D. R., Blue, C. L., & Coster, D. C. (2001). Using Social Marketing to Develop and Test Tailored Health Messages. *American Journal of Health Behavior, 25*(3), 260-271. doi:10.5993/ajhb.25.3.13

Brenes, J., VanDusen, K., & Welch, J. (2016). *Pathways Toward Climate Change Resilience in Monteverde, Costa Rica*. Monteverde, Costa Rica: Monteverde Community Fund.

Camila Domonoske. (2015). 2 degrees, $100 billion: The World Climate Agreement, by the Numbers. Retrieved from https://www.npr.org/sections/thetwo-way/2015/12/12/459502597/2-degrees-100-billion-the-world-climate-agreement-by-the-numbers

Cialdini, R. B., Reno, R. R., & Kallgren, C. a. (1990). A focus theory of normative conduct: Recycling the concept of norms to reduce littering in public places. *Journal of*

Personality and Social Psychology, *58*(6), 1015–1026. https://doi.org/10.1037/0022-3514.58.6.1015

Climate action tracker Costa Rica. (2017). Retrieved from http://climateactiontracker.org/countries/costarica.html

EPA, Climate Change Indicators: Greenhouse Gases. Retrieved from https://www.epa.gov/climate-indicators/greenhouse-gases

CNN, Chavez. Nicole.'Apocalyptic' Devastation in Puerto Rico, and Little Help in Sight. Retrieved from http://www.cnn.com/2017/09/25/us/hurricane-maria-puerto-rico/index.html

CNN, John D. Sutter, CNN Video by McKenna Ewen. (2017). About 1 million Americans Without Running Water. 3 million Without Power. This is life one month after hurricane Maria. Retrieved from http://www.cnn.com/2017/10/18/health/puerto-rico-one-month-without-water/index.html

CORCLIMA logo. (n.d.) Retrieved November 09, 2017, from https://www.twitter.com/CORCLIMA

Dahal, K., & Niemelä, J. (2016). Initiatives Towards Carbon Neutrality in the Helsinki Metropolitan Area. *Climate, 4*(3), 36. doi:10.3390/cli4030036

Dale, V. H., Joyce, L. A., McNulty, S., Neilson, R. P., Ayres, M. P., Flannigan, M. D., Wotton, B. M. (2001). Climate Change and Forest Disturbances. *Bio Science, 51*(9), 723-734.

D'Angelo, E. (2009). *Global Climate Change: International Perspectives and Responses*. New York: Nova.

Daniels, A. E., Bagstad, K., Esposito, V., Moulaert, A., & Rodriguez, C. M. (2010b). Understanding the impacts of Costa Rica's PES: Are we asking the right questions? *Ecological Economics, 69*(11), 2116-2126. doi:10.1016/j.ecolecon.2010.06.011

Gössling, S. (2009). Carbon Neutral Destinations: A Conceptual Analysis. *Journal of Sustainable Tourism, 17*(1), 17-37. doi:10.1080/09669580802276018

Instituto Meteorológico Nacional (2017). *Factores de emisión gases efecto invernadero.* San Jose, CR

Jesper Krogstrup, & Gert Tinggaard Svendsen. (2004). Can the EU Persuade the US to Rejoin the Kyoto Agreement? *Energy & Environment, 15*(3), 427-435. doi:10.1260/0958305041494729

Kathy Dhanda, K. (2014). The Role of Carbon Offsets in Achieving Carbon Neutrality. *International Journal of Contemporary Hospitality Management, 26*(8), 1179-1199. doi:10.1108/IJCHM-03-2013-0115

Kenneth E. Okedu. (2017). Costa Rica Generates Almost 100% Renewable Energy in 2016. *Renewable Energy Focus, 18*(Supplement C), 22-28. doi:10.1016/j.ref.2017.03.003

Le Coq, J., Froger, G., Pesche, D., Legrand, T., & Saenz, F. (2015). *Understanding the Governance of the Payment for Environmental Services Programme in Costa Rica: A Policy Process Perspective*. Ecosystem Services, 16(Supplement C), 253-265. doi:10.1016/j.ecoser.2015.10.003

Letcher, T. M. (2009). *Climate Change* (Vol. 1). Amsterdam, Netherlands: NL: Elsevier Science.

Lewis, S. L. et al. (2013). Above-Ground Biomass and Structure of 260 African Tropical Forests. Philosophical Transactions of the Royal Society B, 368, Article ID: 20120295.
https://doi.org/10.1098/rstb.2012.0295

Lindner, M., Maroschek, M., Netherer, S., Kremer, A., Barbati, A., Garcia-Gonzalo, J., Marchetti, M. (2010). Climate Change Impacts, Adaptive Capacity, and Vulnerability of European Forest Ecosystems. *Forest Ecology and Management, 259*(4), 698-709. doi:10.1016/j.foreco.2009.09.023

Mauri, C.The National Climate Change Strategy and the Carbon Neutrality Challenge. *Ministry of Environment, Energy, and Telecommunications,* Retrieved from https://unfccc.int/files/meetings/sb30/press/application/pdf/session4_mitigation.pdf

MINAE (2015). *Costa Rica's Intended Nationally Determined Contribution.* San Jose, Costa Rica: MINAE, Retrieved from http://www4.unfccc.int/ndcregistry/PublishedDocuments/Costa%20Rica%20First/INDC%20Costa%20Rica%20Version%202%200%20final%20ENG.pdf

Monteverde Cloud Forest Reserve. (2013). Monteverde cloud forest. Retrieved from http://www.reservamonteverde.com/our-history.html

Monteverde Institute. (2012). *Habitat Restoration and Carbon Dioxide Sequestration in the Tropics*. Retrieved from http://www.monteverde-institute.org/fundraising-campaigns-of-the-monteverde-institute.html

Murillo, A. (2017). *Cars, cars, and more cars: Costa Rica's worsening love affair*. Costa Rica: Tico Times, Retrieved from http://www.ticotimes.net/2017/03/23/cars-cars-cars

Roberts, D. (2017). Climate Change did not "cause" Harvey or Irma, but it's a huge part of the story. Retrieved from https://www.vox.com/energy-and-environment/2017/8/28/16213268/harvey-climate-change

Shaver, I., Chain-Guadarrama, A., Cleary, K. A., Sanfiorenzo, A., Santiago-García, R. J., Finegan, B., Waits, L. P. (2015). *Coupled Social and Ecological Outcomes of Agricultural Intensification in Costa Rica and the Future of Biodiversity Conservation in Tropical Agricultural Regions* doi://doi.org.ezproxy.wpi.edu/10.1016/j.gloenvcha.2015.02.006

Solomon, S., Plattner, G., Reto, K., & Friedlingstein, P. (2009). Irreversible Climate Change Due to Carbon Dioxide Emissions. *Pnas, 106*(6), 1704-1709. Retrieved from http://www.pnas.org/content/106/6/1704.full.pdf

Sturrock, R. N., Frankel, S. J., Brown, A. V., Hennon, P. E., Kliejunas, J. T., Lewis, K. J., . . . Woods, A. J. (2011). Climate Change and Forest Diseases. *Plant Pathology, 60*(1), 133-149. doi:10.1111/j.1365-3059.2010.02406.x

Tanner, L. H., Wilckens, M. T., Nivison, M. A., & Johnson, K. M. (2016). Biomass and Soil Carbon Stocks in Wet Montane Forest, Monteverde Region, Costa Rica: Assessments and Challenges for Quantifying Accumulation Rates. *International Journal of Forestry Research, 2016*, 1-8. doi:10.1155/2016/5812043

Thomas L. Karnes Gary S. Elbow. (2017). Costa Rica - Demographic Trends | History - Geography. Retrieved from https://www.britannica.com/place/Costa-Rica/Demographic-trends

Trees for the Future. (2017). How to Calculate the Amount of CO2 Sequestered in a Tree per Year. Retrieved from https://www.broward.org/NaturalResources/ClimateChange/Documents/Calculating%20CO2%20Sequestration%20by%20Trees.pdf.

University of Massachusetts Amherst. (2008). Could Climate Change Impact Costa Rica? New Study Says Yes. Retrieved from https://www.sciencedaily.com/releases/2008/07/080710200232.htm

US EPA, O. A. (2016). Global Greenhouse Gas Emissions Data. Retrieved from https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data

Vega, M. Y., & Roland, E. L. (2005). Social Marketing Techniques for Public Health Communication: A Review of Syphilis Awareness Campaigns in 8 US Cities. *Sexually Transmitted Diseases, 32*(Supplement). doi:10.1097/01.olq.0000180461.30725.f4

Vignola, R., Klinsky, S., Tam, J., & McDaniels, T. (2013a). Public Perception, Knowledge and Policy Support for Mitigation and Adaption to Climate Change in Costa Rica: Comparisons with North American and European Studies. *Mitigation and Adaptation Strategies for Global Change, 18*(3), 303-323. doi:10.1007/s11027-012-9364-8

Welch, C. (2015). 2 Countries Reveal how Divided the World is on Climate Change. *National Geographic,* Retrieved from https://news.nationalgeographic.com/2015/11/151116-paris-climate-un-costa-rica-australia-co2-greenhouse-warming-carbon/

White, J. C. (1992). *Global Climate Change: Linking & nbsp; Energy, Environment, Economy, and Equity*. New York u.a: Plenum Press.

Yglesias, M. (2016). Vulnerable to climate change, Costa Rica works to become a carbon-free economy. World Politics Review. Retrieved from https://www.worldpoliticsreview.com/trend-lines/20546/vulnerable-to-climate-change-costa-rica-works-to-become-a-carbon-free-economy

Ysan Miguel. (2014). Integrated solid waste management. Retrieved from http://monteverdefund.org/community-recycling-program.html

Appendix A: Initiative Assessment

	Accessibility to public involvement	Educational Opportunities	Service Provided to the Community	Emphasis on Local Participation	Cost of Class or Service for Locals	Impact on National Plan
Monteverde Institute	Yes, sponsor many different talks and presentations to reach locals and benefit the community	Yes, sponsor reforestation research, education for tourists, sustainable future project, facilitate outside research	Direct impact, help Monteverde offset carbon emissions through reforestation, all their students go back to benefiting the community	No, do not emphasis local participation	Locals are not big participants in their programs, programs are directed towards foreign students (this is one source of their funding)	Direct impact on the goal of the national plan
Life Monteverde	Yes, reach out to the public by hosting presentations and classes	Yes, foreign students learn about sustainability and local students learn how to implement sustainable practices	Direct impact on the community, foreign students learn about sustainability and local students learn how to implement sustainable practices	Big emphasis on local participation since 2008	Local students learn about practices for bio digestion and composting for lower costs	Direct impact on the national plan, all their programs and classes directly affect climate change and carbon neutrality

Monteverde Community Fund	No, do not have opportunities for volunteers	Provide indirect opportunities by training project managers and organization leaders on grant writing, managing projects, and keeping organizations functioning	Indirect services by helping fund community projects	No, do not emphasis local participation	Very modest cost	Indirect impact through small grants funding for other organization s that have a direct impact
Monteverde Friends School	No, do not have opportunities for locals without affiliation to participate	Lots of educational opportunities that are a part of the students curriculum , and sponsor talks and presentations from outside initiatives	Indirect service to the community by educating students to become more responsible members of the community	No, do not emphasis local participation	Tuition for the school is fairly costly	Yes, they directly impact the national plan by educating student on carbon neutrality
CIEE	No, do not have opportunities for locals, only offer services to foreign students	Yes, sponsor educational opportunities for foreign students about carbon neutrality	Indirect impact, students work with local initiatives in the area that work towards climate change goals	No, do not emphasis local participation	Cost of class is high for foreign students, do not offer classes for local students	Indirect impact on the national plan by providing a space for students to work out.

Appendix B: Factores de Emisión Gases Efecto Invernadero 2017

Presentation sponsored by the Instituto Meterológico Nacional de Costa Rica containing information for sources of greenhouse gas emissions and equivalents for non-carbon dioxide emissions

Factores de emisión de gases de efecto invernadero

A continuación se presentan factores de emisión de gases de efecto invernadero avalados por el Instituto Meteorológico Nacional para ser utilizados en los inventarios de gases de efecto invernadero.

Se incluyen los factores de emisión más comunes, si se requiere otro factor de emisión consultar directamente al Instituto Meteorológico Nacional.

Sector energía

Dióxido de carbono

Combustible	Factor de emisión (kg CO_2/L combustible)	Incertidumbre	
		Límite inferior	Límite superior
Gasolina	2,231	4,59%	5,89%
Diesel	2,613	3,12%	3,19%
Búnker	3,101	3,57%	3,65%
Queroseno	2,541	3,83%	4,10%
LPG	1,611	8,41%	9,16%
Gasolina de avión	2,227	7,94%	23,50%
Jet fuel	2,505	4,68%	5,32%

1

Sector energía

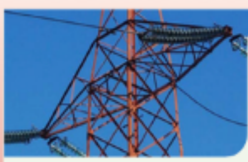
Óxido nitroso

Fuente/Combustible	Factor de emisión $g\ N_2O$ / L Combustible	Incertidumbre Inferior	Incertidumbre Superior
Generación electricidad/Diesel	0,02442	71%	190%
Generación electricidad/Bunker	0,02769	71%	190%
Manufactura y contrucción/ Gasolina	0,02211	71%	190%
Manufactura y contrucción/ Diesel	0,02442	71%	190%
Manufactura y construcción/ Bunker	0,02769	71%	190%
Manufactura y construcción/LPG	0,002745	72%	179%
Comercial e institucional/ Gasolina	0,02211	71%	190%
Comercial e institucional/Diesel	0,02442	71%	190%
Comercial e institucional/Bunker	0,02769	71%	190%
Comercial e institucional/LPG	0,002745	72%	179%
Residencial y agrícola/Gasolina	0,02211	71%	190%
Residencial y agrícola/Diesel	0,02442	71%	190%
Residencial y agrícola/Bunker	0,02769	71%	190%
Residencial y agrícola/LPG	0,002745	72%	179%
Transporte terrestre/gasolina/sin catalizador	0,116	48%	204%
Transporte terrestre/gasolina/ con catalizador	0,283	71%	173%
Transporte terrestre/diesel/sin catalizador	0,154	70%	175%
Transporte terrestre/LPG	0,0051	ND	ND
Todas la fuentes de combustión estacionaria/Biodiesel	0,0198	ND	ND

Sector energía

Metano

Fuente/Combustible	Factor de emisión $g\ CH_4$ / L Combustible	Incertidumbre Inferior	Incertidumbre Superior
Generación electricidad/Diesel	0,122	71%	191%
Generación electricidad/Bunker	0,138	78%	191%
Manufactura y contrucción/ Gasolina	0,111	71%	190%
Manufactura y contrucción/ Diesel	0,122	71%	191%
Manufactura y construcción/ Bunker	0,138	78%	191%
Manufactura y construcción/LPG	0,027	72%	179%
Comercial e institucional/ Gasolina	0,346	72%	179%
Comercial e institucional/Diesel	0,382	71%	177%
Comercial e institucional/Bunker	0,433	72%	177%
Comercial e institucional/LPG	0,139	72%	179%
Residencial y agrícola/Gasolina	0,346	72%	179%
Residencial y agrícola/Diesel	0,382	71%	177%
Residencial y agrícola/Bunker	0,433	72%	177%
Residencial y agrícola/LPG	0,139	72%	179%
Transporte terrestre/gasolina/sin catalizador	1,176	74%	201%
Transporte terrestre/gasolina/ con catalizador	0,907	74%	204%
Transporte terrestre/diesel/sin catalizador	0,149	62%	126%
Transporte terrestre/LPG	1,5835	ND	ND
Todas la fuentes de combustión estacionaria/Biodiesel	0,099	ND	ND



Sector energía

Uso de electricidad

El factor de emisión en el sector electricidad varía anualmente, los factores para los últimos seis años se indican a continuación:

Año	Factor de emisión kg CO_2 e/kWh
2016	0,0557
2015	0,0381
2014	0,1170
2013	0,1300
2012	0,0771
2011	0,0824

Sector procesos industriales y uso de productos

Fuente	Factor de emisión	Incertidumbres Límite inferior	Incertidumbres Límite superior
Cemento	0,5101 kg CO_2/kg Clínker	8,12%	8,12%
Cal	0,785 kg CO_2/kg cal	8,06%	8,06%
Vidrio	0,21 kg CO_2/kg vidrio	10,44%	10,44%
Uso de lubricantes	0,5101 kg CO_2/L de lubricante*	ND	ND

* El dato corresponde a lubricante alimentado. No se incluyen los lubricantes que se queman.

Sector agricultura, silvicultura y otros usos de la tierra

Cultivo de arroz

Régimen de cultivo	Factor de emisión kg CH_4 / ha / día*
Inundado	4,94

* Corresponde a un ciclo de cultivo de 120 días

Sector agricultura, silvicultura y otros usos de la tierra

Ganadería
a) Proceso digestivo
Ganado vacuno

Tipo	Carne	Leche	Doble propósito
	kg CH4 /cabeza año		
Terneros	19,48	20,00	16,81
Hembras en crecimiento	63,61	48,69	41,91
Machos en crecimiento	66,25	---	70,16
Hembra adulta	85,80	85,00	85,67
Macho adulto	111,70	111,70	111,70

Sector agricultura, silvicultura y otros usos de la tierra

Otras especies

Especie	Factor de emisión kg CH_4/cabeza/año
Búfalos	55
Ovejas	5
Cabras	5
Caballos	18
Cerdos	1

Sector agricultura, silvicultura y otros usos de la tierra

Sector Procesos Industriales

b) Manejo de estiércol

Especie	Factor de emisión kg CH_4/cabeza/año
Ganado	1,0
Caballos	1,64
Cabras	0,17
Cerdos	1,0
Aves de corral	0,02

6

Sector agricultura, silvicultura y otros usos de la tierra

Suelos agrícolas

Cultivo	Factor de emisión kg N_2O/ha/año
Caña de azúcar (123 kg N/ha)	4,81 ± 1,73
Café sin sombra (200 kg N/ha)	2,92 ± 0,13
Café con sombra	7,78
Banano (300 kg N/ha)	4,85 ± 0,52
Plátano	4,60
Cebolla	2,61
Papa	7,86
Pastos Estrella africana	4,94
Kikuyo (200 kg N/ha)	2,43 ± 0,05
Kikuyo sin fertilizar	1,22 ± 0,02
Ratana	3,55
Jaragua	5,33

Nota: Para otros cultivos usar 1% del fertilizante nitrogenado aplicado.

7

Sector residuos

Residuos sólidos

Tipo de tratamiento	Factor de emisión	
	CH_4	N_2O
Relleno Sanitario	0,0581 kg CH_4/kg de residuos sólidos	--
Compost	4 g CH_4/kg residuos sólidos	0,3 g N_2O/kg residuos sólidos
Biodigestores	2 g CH_4/kg residuos sólidos	--

Sector residuos

Aguas residuales domésticas

Tipo de tratamiento	Factor de emisión kg CH_4 /persona/año
Lagunas	2,63
Tanques sépticos	4,38
Descarga a ríos	0,876

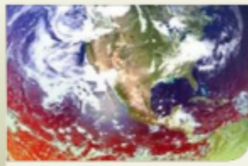
8

Sector residuos

Aguas residuales industriales

Tipo de tratamiento	Factor de emisión kg CH_4/kg DQO
Reactor anaeróbico	0,2
Laguna anaeróbica profunda	0,2
Laguna anaeróbica poco profunda	0,05
Descarga a ríos	0,025

9



Potenciales de calentamiento global

Gas	Potencial de calentamiento Horizonte: 100 años
CO_2	1
CH_4	21
N_2O	310
HFC 134a	1.300
HFC 152a	140
R402a	2.447
R402b	2.150
R404a	3.260
R404B	3.260
R407c	1.526
R410a	1.725
R507	3.300
R508B	10.350
ISCEON MO49	2.230
SF_6	23.900

10

Appendix C: Student Social Marketing Questions

Preamble:

We are a group of students from Worcester Polytechnic Institute in Worcester, Massachusetts in the USA and we are working with the CORCLIMA organization to create the foundation of an awareness campaign which portrays the current status of carbon emissions within Monteverde. Currently, we are conducting an interview of local residents and to better identify the appropriate mediums for conveying information which will be used in our campaign. Your participation in this interview is completely voluntary and you may withdraw at any time. Please remember that your answers will remain anonymous. No names or other identifying information will appear on the questionnaires or in any of the project reports or publications. If interested, a copy of our results can be provided through an internet link at the conclusion of the study.

Interview Questions:

1) Do you have access to television, radio, and/or internet?
    a. If YES: What is your favorite TV station?
    b. Do you ever watch the local news?
        i. If yes, which station?
2) Which Radio station do you listen to?
    a. Do you ever hear about local news over the radio?
3) Which social media platforms do you use? (i.e. Twitter, Facebook, Instagram)
    a. Which do you use most often?
    b. What do you usually use it for? (posting images, sharing stories, photography, politics)
    c. Do you get local news on these social media platforms?
    d. How much do you trust information relayed over social media?
4) Do you know if there is a local newspaper?
5) If yes, what is the name and do you read it?
6) In general, which graphics do you pay most attention to? Which aspects tend to catch your attention, if any? (For Example: Pie Charts, Colors, Numbers/Facts…)
7) Do you remember any advertisements, posters, or flyers during your daily routine? If so, where?
8) Are you aware of any local organizations or initiatives aimed at dealing with waste or carbon emission reduction? (Such as COMIRES, CORCLIMA, Vision to Reality, Life Monteverde)
    a. If yes, how did you find out about them or receive information regarding their initiative?
9) Have you or anyone you know of gone to community events regarding alternative energy and other environmental efforts?
    a. If yes, who ran this event?
10) Are you aware of any future events or talks regarding alternative energy options in Monteverde?
    a. If yes, who is it going to be run by?

Appendix D: Monteverde Institute Carbon Registries 2016

Asociación de los Amigos 01 REGISTRO DE EMISIONES DE $CO_{2}e$ POR ENERGÍA ELÉCTRICA									
Emisiones Iidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Mes	Consumo (KW/h)	Factor de emisión	PCG	$CO_{2}e$ en toneladas
Emisiones Indirectas por energía eléctricas	Operación generales	Iluminación, uso de cómputo y otros equipos		Hoja de Excel	Enero	1620	0.1170	1	0.18954
					Febrero	1446	0.1170	1	0.169182
					Marzo	1724	0.1170	1	0.201708
					Abril	1257	0.1170	1	0.147069
					Mayo	1245	0.1170	1	0.145665
					Junio	1259	0.1170	1	0.147303
					Julio	1974	0.1170	1	0.230958
					Agosto	1283	0.1170	1	0.150111
					Septiembre	1289	0.1170	1	0.150813
					Octubre	1190	0.1170	1	0.13923
					Noviembre	1146	0.1170	1	0.134082
					Diciembre	1272	0.1170	1	0.148824
					TOTAL	16705			1.954485

Carbon emissions for electricity in kilowatt hours

Asociación de los Amigos 01 REGISTRO DE EMISIONES DE $CO_{2}e$ POR CONSUMO DE GASOLINA																
Emisiones Iidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Mes	Consumo (L)	Factor de emisión CO2	PCG	CO2 eq en toneladas	Factor de emisión CH4	PCG	CH4 eq en toneladas	Factor de emisión N2O	PCG	N2O eq en toneladas	Todos $CO_{2}e$ en toneladas
Emisiones directas por gestión de residuos	Operación de la oficina			Hoja de Excel	Enero	62.8	2.26	1	0.141928	0.907	21	0.00119615	0.283	310	0.00550944	0.14273997
					Febrero	0	2.26	1	0	0.907	21	0	0.283	310	0	0
					Marzo	19.95	2.26	1	0.045087	0.907	21	0.00037999	0.283	310	0.00175021	0.04534494
					Abril	40.85	2.26	1	0.092321	0.907	21	0.00077807	0.283	310	0.00358377	0.09284917
					Mayo	0	2.26	1	0	0.907	21	0	0.283	310	0	0
					Junio	58.87	2.26	1	0.1330462	0.907	21	0.0011213	0.283	310	0.00516467	0.13380735
					Julio	0	2.26	1	0	0.907	21	0	0.283	310	0	0
					Agosto	0	2.26	1	0	0.907	21	0	0.283	310	0	0
					Septiembre	96.61	2.26	1	0.2183386	0.907	21	0.00184013	0.283	310	0.0084756	0.21958771
					Octubre	0	2.26	1	0	0.907	21	0	0.283	310	0	0
					Noviembre	83.24	2.26	1	0.1881224	0.907	21	0.00158547	0.283	310	0.00730265	0.18919864
					Diciembre	0	2.26	1	0	0.907	21	0	0.283	310	0	0
					TOTAL	362.32										0.82352778

Carbon emissions for gasoline in metric tons

Asociación de los Amigos 01 REGISTRO DE EMISIONES DE LPG																
Emisiones Iidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Mes	Concumo (L)	Factor de emisión CO2	PCG	CO2 eq en toneladas	Factor de emisión CH4	PCG	CH4 eq en toneladas	Factor de emisión N2O	PCG	N2O eq en toneladas	$CO_{2}e$ en toneladas
Emisiones directas por gestión de residuos	Calentamiento de comidas			Hoja de Excel	Enero	119.87	1.611	1	0.19311057	0.139	21	0.0003499	0.002745	310	0.000102	0.19356247
					Febrero	180.18	1.611	1	0.29026998	0.139	21	0.00052595	0.002745	310	0.00015332	6.09566958
					Marzo	329.16	1.611	1	0.53027676	0.139	21	0.00096082	0.002745	310	0.0002801	11.135812
					Abril	109.35	1.611	1	0.17616285	0.139	21	0.00031919	0.002745	310	9.3051E-05	3.69941985
					Mayo	112.86	1.611	1	0.18181746	0.139	21	0.00032944	0.002745	310	9.6038E-05	3.81816666
					Junio	233.56	1.611	1	0.37626516	0.139	21	0.00068176	0.002745	310	0.00019875	7.90156836
					Julio	166.29	1.611	1	0.26789319	0.139	21	0.0004854	0.002745	310	0.0001415	5.62575699
					Agosto	182.1	1.611	1	0.2933631	0.139	21	0.00053155	0.002745	310	0.00015496	6.1606251
					Septiembre	135.73	1.611	1	0.21866103	0.139	21	0.0003962	0.002745	310	0.0001155	4.59188163
					Octubre	95.72	1.611	1	0.15420492	0.139	21	0.00027941	0.002745	310	8.1453E-05	3.23830332
					Noviembre	126.6	1.611	1	0.2039526	0.139	21	0.00036955	0.002745	310	0.00010773	4.2830046
					Diciembre	74.61	1.611	1	0.12019671	0.139	21	0.00021779	0.002745	310	6.3489E-05	2.52413091
					TOTAL	1866.03										59.2679014

Carbon emissions for diesel in metric tons

Asociación de los Amigos 01 REGISTRO DE EMISIONES DE LPG																
Emisiones Iidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Mes	Concumo (L)	Factor de emisión CO2	PCG	CO2 eq en toneladas	Factor de emisión CH4	PCG	CH4 eq en toneladas	Factor de emisión N2O	PCG	N2O eq en toneladas	$CO_{2}e$ en toneladas
Emisiones directas por gestión de residuos	Calentamiento de comidas			Hoja de Excel	Enero	87.49	1.611	1	0.14094639	0.139	21	0.000255383	0.002745	310	7.445E-05	0.14127622
					Febrero	0	1.611	1	0	0.139	21	0	0.002745	310	0	0
					Marzo	0	1.611	1	0	0.139	21	0	0.002745	310	0	0
					Abril	0	1.611	1	0	0.139	21	0	0.002745	310	0	0
					Mayo	43.8	1.611	1	0.0705618	0.139	21	0.000127852	0.002745	310	3.7272E-05	1.4817978
					Junio	0	1.611	1	0	0.139	21	0	0.002745	310	0	0
					Julio	84.36	1.611	1	0.13590396	0.139	21	0.000246247	0.002745	310	7.1786E-05	2.85398316
					Agosto	117.53	1.611	1	0.18934083	0.139	21	0.00034307	0.002745	310	0.00010001	3.97615743
					Septiembre	0	1.611	1	0	0.139	21	0	0.002745	310	0	0
					Octubre	24.1	1.611	1	0.0388251	0.139	21	7.03479E-05	0.002745	310	2.0508E-05	0.8153271
					Noviembre	27.7	1.611	1	0.0446247	0.139	21	8.08563E-05	0.002745	310	2.3571E-05	0.9371187
					Diciembre	19.47	1.611	1	0.03136617	0.139	21	5.68329E-05	0.002745	310	1.6568E-05	0.65868957
					TOTAL	404.45										10.86435

Carbon emissions for LPG in metric tons

Asociación de los Amigos 01 REGISTRO DE EMISIONES DE $CO_{2}e$ POR ENVIAR BASURA AL RELLENO SANITARIO									
Emisiones Iidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Mes	Cantidad (kg)	Factor de emisión CH_4	PCG	$CO_{2}e$ en toneladas
Emisiones directas por gestión de residuos	Operaciones generales			Hoja de Excel	Enero	195	58.1	21	0.2379195
					Febrero	120	58.1	21	0.146412
					Marzo	150	58.1	21	0.183015
					Abril	131	58.1	21	0.1598331
					Mayo	196	58.1	21	0.2391396
					Junio	183	58.1	21	0.2232783
					Julio	117	58.1	21	0.1427517
					Agosto	193	58.1	21	0.2354793
					Septiembre	83	58.1	21	0.1012683
					Octubre	42.5	58.1	21	0.05185425
					Noviembre	101	58.1	21	0.1232301
					Diciembre	154.5	58.1	21	0.18850545
					TOTAL	1666			2.0326866

Carbon emissions for Inorganic Waste in metric tons

Asociación de los Amigos 01 REGISTRO DE EMISIONES DE $CO_{2}e$ POR COMPOSTAGE DE DESECHOS SOLIDOS													
Emisiones Iidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Mes	Cantidad (kg)	Factor de emisión CH_4	PCG	CH4 eq en toneladas	Factor de emisión N_2O	PCG	N2O eq en toneladas	$CO_{2}e$ en toneladas
Emisiones directas por gestión de residuos	Operación generales			Hoja de Excel	Enero	197	4	21	0.016548	0.3	310	0.018321	0.034869
					Febrero	56	4	21	0.004704	0.3	310	0.005208	0.009912
					Marzo	72	4	21	0.006048	0.3	310	0.006696	0.012744
					Abril	77	4	21	0.006468	0.3	310	0.007161	0.013629
					Mayo	93	4	21	0.007812	0.3	310	0.008649	0.016461
					Junio	184	4	21	0.015456	0.3	310	0.017112	0.032568
					Julio	117	4	21	0.009828	0.3	310	0.010881	0.020709
					Agosto	156	4	21	0.013104	0.3	310	0.014508	0.027612
					Septiembre	71	4	21	0.005964	0.3	310	0.006603	0.012567
					Octubre	73.5	4	21	0.006174	0.3	310	0.0068355	0.0130095
					Noviembre	72.5	4	21	0.00609	0.3	310	0.0067425	0.0128325
					Diciembre	51.8	4	21	0.0043512	0.3	310	0.0048174	0.0091686
					TOTAL	381.314							0.06749258

Carbon emissions for Organic Waste in metric tons

Asociación de los Amigos 01 REGISTRO DE EMISIONES DE $CO_{2}e$ POR ENVIAR BASURA AL RELLENO SANITARIO													
Emisiones Iidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Mes	Cantidad (kg)	Factor de emisión CH_4	PCG	CH4 eq en toneladas	Factor de emisión N_2O	PCG	N2O eq en toneladas	$CO_{2}e$ en toneladas
Emisiones directas por gestión de residuos	Operaciones generales			Hoja de Excel	Enero	115	58.1	21	0.1403115	0	310	0	0.1403115
					Febrero	49	58.1	21	0.0597849	0	310	0	0.0597849
					Marzo	0	58.1	21	0	0	310	0	0
					Abril	96	58.1	21	0.1171296	0	310	0	0.1171296
					Mayo	0	58.1	21	0	0	310	0	0
					Junio	0	58.1	21	0	0	310	0	0
					Julio	41	58.1	21	0.0500241	0	310	0	0.0500241
					Agosto	47.5	58.1	21	0.05795475	0	310	0	0.05795475
					Septiembre	0	58.1	21	0	0	310	0	0
					Octubre	0	58.1	21	0	0	310	0	0
					Noviembre	205.5	58.1	21	0.25073055	0	310	0	0.25073055
					Diciembre	38	58.1	21	0.0463638	0	310	0	0.0463638
					TOTAL	592							0.7222992

Carbon emissions for Recycling in metric tons

Asociación de los Amigos 01 REGISTRO DE EMISIONES DE CO_2e POR TANQUE SEPTICA									
Emisiones Iidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Año	#personas (x 177/365 or 485 days)	Factor de emisión	PCG	CO_2e en toneladas
Emisiones directas por gestión de residuos	Operación generales			Hoja de Excel	2016	13.09	4.3800	1	1.2040182
TOTAL									1.2040182

Carbon emissions for Septic Tank in metric tons

Appendix E: Monteverde Institute Carbon Registries 2017

Asociación de los Amigos 01 REGISTRO DE EMISIONES DE CO₂e POR ENERGÍA ELÉCTRICA									
Emisiones lidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Mes	Consumo (KW/h)	Factor de emisión	PCG	CO2e en toneladas
Emisiones Indirectas por energía eléctricas	Operación generales	Iluminación, uso de cómputo y otros equipos		Hoja de Excel	Enero	1187	0.1170	1	0.138879
					Febrero	1199	0.1170	1	0.140283
					Marzo	1240	0.1170	1	0.14508
					Abril	1595	0.1170	1	0.186615
					Mayo	1228	0.1170	1	0.143676
					Junio	2804	0.1170	1	0.328068
					Julio	2203	0.1170	1	0.257751
					Agosto	1981	0.1170	1	0.231777
					Septiembre	1651	0.1170	1	0.193167
					Octubre	1142	0.1170	1	0.133614
					Noviembre	1348	0.1170	1	0.157716
					Diciembre	1808	0.1170	1	0.211536
					TOTAL	19386			2.268162

Carbon emissions for electricity in kilowatt hours

Asociación de los Amigos 01 REGISTRO DE EMISIONES DE CO₂e POR CONSUMO DE GASOLINA															
Emisiones lidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Mes	Consumo (L)	Factor de emisión CO2	PCG	CO2 eq en toneladas	Factor de emisión CH4	PCG	CH4 eq en toneladas	Factor de emisión N2O	PCG	N2O eq en toneladas	Todos CO2e en toneladas
Emisiones directas por gestión de residuos	Operación de la oficina			Hoja de Excel	Enero	0	2.26	1	0	0.907	21	0	0.283	310	0	0
					Febrero	0	2.26	1	0	0.907	21	0	0.283	310	0	0
					Marzo	53.96	2.26	1	0.1219496	0.907	21	0.00102778	0.283	310	0.00473391	0.12264727
					Abril	0	2.26	1	0	0.907	21	0	0.283	310	0	0
					Mayo	0	2.26	1	0	0.907	21	0	0.283	310	0	0
					Junio	0	2.26	1	0	0.907	21	0	0.283	310	0	0
					Julio	22.5	2.26	1	0.05085	0.907	21	0.00042856	0.283	310	0.00197393	0.05114091
					Agosto	45.6	2.26	1	0.103056	0.907	21	0.00086854	0.283	310	0.00400049	0.10364558
					Septiembre	0	2.26	1	0	0.907	21	0	0.283	310	0	0
					Octubre	0	2.26	1	0	0.907	21	0	0.283	310	0	0
					Noviembre	0	2.26	1	0	0.907	21	0	0.283	310	0	0
					Diciembre	34.4	2.26	1	0.077744	0.907	21	0.00065522	0.283	310	0.00301791	0.07818877
					TOTAL	156.46										0.35562253

Carbon emissions for gasoline in metric tons

Asociación de los Amigos 01 REGISTRO DE EMISIONES DE LPG																
Emisiones lidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Mes	Concumo (L)	Factor de emisión CO2	PCG	CO2 eq en toneladas	Factor de emisión CH4	PCG	CH4 eq en toneladas	Factor de emisión N2O	PCG	N2O eq en toneladas	CO2e en toneladas
Emisiones directas por gestión de residuos	Calentamiento de comidas			Hoja de Excel	Enero	138.15	1.611	1	0.22255965	0.139	21	0.00040326	0.002745	310	0.00011756	0.22308047
					Febrero	81.7	1.611	1	0.1316187	0.139	21	0.00023848	0.002745	310	6.9523E-05	2.7639927
					Marzo	105.15	1.611	1	0.16939665	0.139	21	0.00030693	0.002745	310	8.9477E-05	3.55732965
					Abril	98.27	1.611	1	0.15831297	0.139	21	0.00028685	0.002745	310	8.3623E-05	3.32457237
					Mayo	112.8	1.611	1	0.1817208	0.139	21	0.00032926	0.002745	310	9.5987E-05	3.8161368
					Junio	149.7	1.611	1	0.2411667	0.139	21	0.00043697	0.002745	310	0.00012739	5.0645007
					Julio	340.8	1.611	1	0.5490288	0.139	21	0.0009948	0.002745	310	0.00029	11.5296048
					Agosto	184.93	1.611	1	0.29792223	0.139	21	0.00053981	0.002745	310	0.00015737	6.25636683
					Septiembre	148.37	1.611	1	0.23902407	0.139	21	0.00043309	0.002745	310	0.00012626	5.01950547
					Octubre	98.72	1.611	1	0.15903792	0.139	21	0.00028816	0.002745	310	8.4006E-05	3.33979632
					Noviembre	63.8	1.611	1	0.1027818	0.139	21	0.00018623	0.002745	310	5.4291E-05	2.1584178
					Diciembre	75.26	1.611	1	0.12124386	0.139	21	0.00021968	0.002745	310	6.4042E-05	2.54612106
					TOTAL	1597.65										49.599425

Carbon emissions for diesel in metric tons

Asociación de los Amigos 01 REGISTRO DE EMISIONES DE LPG																
Emisiones Iidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Mes	Concumo (L)	Factor de emisión CO2	PCG	CO2 eq en toneladas	Factor de emisión CH4	PCG	CH4 eq en toneladas	Factor de emisión N2O	PCG	N2O eq en toneladas	CO₂e en toneladas
Emisiones directas por gestión de residuos	Calentamiento de comidas			Hoja de Excel	Enero	130.92	1.611	1	0.21091212	0.139	21	0.000382155	0.002745	310	0.00011141	0.21140568
					Febrero	20.9	1.611	1	0.0336699	0.139	21	6.10071E-05	0.002745	310	1.7785E-05	0.7070679
					Marzo	147.5	1.611	1	0.2376225	0.139	21	0.000430553	0.002745	310	0.00012552	4.9900725
					Abril	45.1	1.611	1	0.0726561	0.139	21	0.000131647	0.002745	310	3.8378E-05	1.5257781
					Mayo	125.05	1.611	1	0.20145555	0.139	21	0.000365021	0.002745	310	0.00010641	4.23056655
					Junio	134.95	1.611	1	0.21740445	0.139	21	0.000393919	0.002745	310	0.00011484	4.56549345
					Julio	50.25	1.611	1	0.08095275	0.139	21	0.00014668	0.002745	310	4.276E-05	1.70000775
					Agosto	42.1	1.611	1	0.0678231	0.139	21	0.00012289	0.002745	310	3.5825E-05	1.4242851
					Septiembre	88.3	1.611	1	0.1422513	0.139	21	0.000257748	0.002745	310	7.5139E-05	2.9872773
					Octubre	0	1.611	1	0	0.139	21	0	0.002745	310	0	0
					Noviembre	77.6	1.611	1	0.1250136	0.139	21	0.000226514	0.002745	310	6.6034E-05	2.6252856
					Diciembre	42.9	1.611	1	0.0691119	0.139	21	0.000125225	0.002745	310	3.6506E-05	1.4513499
					TOTAL	905.57										26.4185898

Carbon emissions for LPG in metric tons

Asociación de los Amigos 01 REGISTRO DE EMISIONES DE CO₂e POR ENVIAR BASURA AL RELLENO SANITARIO									
Emisiones Iidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Mes	Cantidad (kg)	Factor de emisión CH₄	PCG	CO₂e en toneladas
Emisiones directas por gestión de residuos	Operaciones generales			Hoja de Excel	Enero	121	58.1	21	0.1476321
					Febrero	122	58.1	21	0.1488522
					Marzo	133	58.1	21	0.1622733
					Abril	96	58.1	21	0.1171296
					Mayo	208	58.1	21	0.2537808
					Junio	171	58.1	21	0.2086371
					Julio	246.5	58.1	21	0.30075465
					Agosto	116.5	58.1	21	0.14214165
					Septiembre	118	58.1	21	0.1439718
					Octubre	90	58.1	21	0.109809
					Noviembre	154	58.1	21	0.1878954
					Diciembre	186.5	58.1	21	0.22754865
					TOTAL	1762.5			2.15042625

Carbon emissions for Inorganic Waste in metric tons

Asociación de los Amigos 01 REGISTRO DE EMISIONES DE CO₂e POR COMPOSTAGE DE DESECHOS SOLIDOS													
Emisiones Iidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Mes	Cantidad (kg)	Factor de emisión CH₄	PCG	CH4 eq en toneladas	Factor de emisión N₂O	PCG	N2O eq en toneladas	CO₂e en toneladas
Emisiones	Operación			Hoja de Excel	Enero	121.5	4	21	0.010206	0.3	310	0.0112995	0.0215055
directas por gestión de residuos	generales				Febrero	61	4	21	0.005124	0.3	310	0.005673	0.010797
					Marzo	95	4	21	0.00798	0.3	310	0.008835	0.016815
					Abril	52	4	21	0.004368	0.3	310	0.004836	0.009204
					Mayo	164	4	21	0.013776	0.3	310	0.015252	0.029028
					Junio	168.5	4	21	0.014154	0.3	310	0.0156705	0.0298245
					Julio	148	4	21	0.012432	0.3	310	0.013764	0.026196
					Agosto	113.5	4	21	0.009534	0.3	310	0.0105555	0.0200895
					Septiembre	52	4	21	0.004368	0.3	310	0.004836	0.009204
					Octubre	63.5	4	21	0.005334	0.3	310	0.0059055	0.0112395
					Noviembre	149	4	21	0.012516	0.3	310	0.013857	0.026373
					Diciembre	119.5	4	21	0.010038	0.3	310	0.0111135	0.0211515
					TOTAL	381.314							0.06749258

Carbon emissions for Organic Waste in metric tons

Asociación de los Amigos 01 REGISTRO DE EMISIONES DE $CO_{2}e$ POR ENVIAR BASURA AL RELLENO SANITARIO													
Emisiones Iidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Mes	Cantidad (kg)	Factor de emisión CH_4	PCG	CH4 eq en toneladas	Factor de emisión N_2O	PCG	N2O eq en toneladas	$CO_{2}e$ en toneladas
Emisiones directas por gestión de residuos	Operaciones generales			Hoja de Excel	Enero	41.5	58.1	21	0.05063415	0	310	0	0.05063415
					Febrero	0	58.1	21	0	0	310	0	0
					Marzo	71.5	58.1	21	0.08723715	0	310	0	0.08723715
					Abril	0	58.1	21	0	0	310	0	0
					Mayo	52	58.1	21	0.0634452	0	310	0	0.0634452
					Junio	0	58.1	21	0	0	310	0	0
					Julio	0	58.1	21	0	0	310	0	0
					Agosto	0	58.1	21	0	0	310	0	0
					Septiembre	216	58.1	21	0.2635416	0	310	0	0.2635416
					Octubre	0	58.1	21	0	0	310	0	0
					Noviembre	0	58.1	21	0	0	310	0	0
					Diciembre	64	58.1	21	0.0780864	0	310	0	0.0780864
					TOTAL	445							0.5429445

Carbon emissions for Recycling in metric tons

Asociación de los Amigos 01 REGISTRO DE EMISIONES DE $CO_{2}e$ POR TANQUE SEPTICA									
Emisiones Iidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Año	#personas (x 177/365 or.485 days)	Factor de emisión	PCG	$CO_{2}e$ en toneladas
Emisiones directas por gestión de residuos	Operación generales			Hoja de Excel	2016	13.09	4.3800	1	1.2040182
					TOTAL				1.2040182

Carbon emissions for Septic Tank in metric tons

Appendix F: Monteverde Friends School Carbon Registries 2016

Asociación de los Amigos 01 REGISTRO DE EMISIONES DE CO_2e POR TANQUE SEPTICA									
Emisiones Iidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Año	#personas (x 177/365 or.485 days)	Factor de emisión	PCG	CO_2e en toneladas
Emisiones directas por gestión de residuos	Operación generales			Hoja de Excel	2016	65.475	4.3800	1	6.0223905
									6.0223905
					TOTAL	65.475			6.0223905

Carbon emissions for septic tanks in metric tons

Asociación de los Amigos 01 REGISTRO DE EMISIONES DE CO_2e POR ENVIAR RECICLAJE													
Emisiones Iidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Mes	Cantidad (kg)	Factor de emisión CH_4	PCG	CH4 eq en toneladas	Factor de emisión N_2O	PCG	N2O eq en toneladas	CO_2e en toneladas
Emisiones directas por gestión de residuos	Operaciones generales			Hoja de Excel	Enero	0	58.1	21	0	0	310	0	0
					Febrero	49.4	58.1	21	0.06027294	0	310	0	0.06027294
					Marzo	30.3	58.1	21	0.03696903	0	310	0	0.03696903
					Abril	0	58.1	21	0	0	310	0	0
					Mayo	0	58.1	21	0	0	310	0	0
					Junio	0	58.1	21	0	0	310	0	0
					Julio	0	58.1	21	0	0	310	0	0
					Agosto	0	58.1	21	0	0	310	0	0
					Septiembre	0	58.1	21	0	0	310	0	0
					Octubre	0	58.1	21	0	0	310	0	0
					Noviembre	0	58.1	21	0	0	310	0	0
					Diciembre	0	58.1	21	0	0	310	0	0
					TOTAL	79.7							0.09724197

Carbon emissions from recycling in metric tons

Asociación de los Amigos 01 REGISTRO DE EMISIONES DE CO_2e POR COMPOSTAGE DE DESECHOS SOLIDOS													
Emisiones Iidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Mes	Cantidad (kg)	Factor de emisión CH_4	PCG	CH4 eq en toneladas	Factor de emisión N_2O	PCG	N2O eq en toneladas	CO_2e en toneladas
Emisiones directas por gestión de residuos	Operación generales			Hoja de Excel	Enero	12.934	4	21	0.001086456	0.3	310	0.001202862	0.00228932
					Febrero	70.2	4	21	0.0058968	0.3	310	0.0065286	0.0124254
					Marzo	51.55	4	21	0.0043302	0.3	310	0.00479415	0.00912435
					Abril	53.83	4	21	0.00452172	0.3	310	0.00500619	0.00952791
					Mayo	56.14	4	21	0.00471576	0.3	310	0.00522102	0.00993678
					Junio	29.6	4	21	0.0024864	0.3	310	0.0027528	0.0052392
					Julio	21.45	4	21	0.0018018	0.3	310	0.00199485	0.00379665
					Agosto	85.61	4	21	0.00719124	0.3	310	0.00796173	0.01515297
					Septiembre	110	4	21	0.00924	0.3	310	0.01023	0.01947
					Octubre	50	4	21	0.0042	0.3	310	0.00465	0.00885
					Noviembre	83.8	4	21	0.0070392	0.3	310	0.0077934	0.0148326
					Diciembre	79	4	21	0.006636	0.3	310	0.007347	0.013983
					TOTAL	381.314							0.067492578

Carbon emissions from organic waste in metric tons

Asociación de los Amigos 01 REGISTRO DE EMISIONES DE CO2e POR ENVIAR BASURA AL RELLENO SANITARIO

Emisiones Iidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Mes	Cantidad (kg)	Factor de emisión CH4	PCG	CH4 eq en toneladas	Factor de emisión N2O	PCG	N2O eq en toneladas	CO2e en toneladas
Emisiones directas por gestión de residuos	Operaciones generales			Hoja de Excel	Enero	9.2	58.1	21	0.01122492	0	310	0	0.01122492
					Febrero	13	58.1	21	0.0158613	0	310	0	0.0158613
					Marzo	22.05	58.1	21	0.02690321	0	310	0	0.02690321
					Abril	18.5	58.1	21	0.02257185	0	310	0	0.02257185
					Mayo	33	58.1	21	0.0402633	0	310	0	0.0402633
					Junio	28	58.1	21	0.0341628	0	310	0	0.0341628
					Julio	0	58.1	21	0	0	310	0	0
					Agosto	42	58.1	21	0.0512442	0	310	0	0.0512442
					Septiembre	18.36	58.1	21	0.02240104	0	310	0	0.02240104
					Octubre	22.3	58.1	21	0.02720823	0	310	0	0.02720823
					Noviembre	30.8	58.1	21	0.03757908	0	310	0	0.03757908
					Diciembre	21	58.1	21	0.0256221	0	310	0	0.0256221
					TOTAL	258.21							0.315042021

Carbon emissions from garbage in metric tons

Asociación de los Amigos 01 REGISTRO DE EMISIONES DE LPG

Emisiones Iidentificadas	Procesos	Herramienta de cálculo	Mes	Concumo (L)	Factor de emisión CO2	PCG	CO2 eq en toneladas	Factor de emisión CH4	PCG	CH4 eq en toneladas	Factor de emisión N2O	PCG	N2O eq en toneladas	CO2e en toneladas
Emisiones directas por gestión de residuos	Calentamiento de comidas	Hoja de Excel	Enero	21.49	1.611	1	0.03462039	0.139	21	6.27293E-05	0.002745	310	1.82869E-05	0.03470141
			Febrero	0	1.611	1	0	0.139	21	0	0.002745	310	0	0
			Marzo	0	1.611	1	0	0.139	21	0	0.002745	310	0	0
			Abril	0	1.611	1	0	0.139	21	0	0.002745	310	0	0
			Mayo	0	1.611	1	0	0.139	21	0	0.002745	310	0	0
			Junio	0	1.611	1	0	0.139	21	0	0.002745	310	0	0
			Julio	0	1.611	1	0	0.139	21	0	0.002745	310	0	0
			Agosto	0	1.611	1	0	0.139	21	0	0.002745	310	0	0
			Septiembre	0	1.611	1	0	0.139	21	0	0.002745	310	0	0
			Octubre	0	1.611	1	0	0.139	21	0	0.002745	310	0	0
			Noviembre	0	1.611	1	0	0.139	21	0	0.002745	310	0	0
			Diciembre	0	1.611	1	0	0.139	21	0	0.002745	310	0	0
			TOTAL	21.49										0.03470141

Carbon emissions from LPG in metric tons

Asociación de los Amigos 01 REGISTRO DE EMISIONES DE CO2e POR ENERGÍA ELÉCTRICA

Emisiones Iidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Mes	Consumo (KW/h)	Factor de emisión	PCG	CO2e en toneladas
Emisiones Indirectas por energía eléctricas	Operación generales	Iluminación, uso de cómputo y otros equipos		Hoja de Excel	Enero	120	0.1170	1	0.01404
					Febrero	47	0.1170	1	0.005499
					Marzo	44	0.1170	1	0.005148
					Abril	29	0.1170	1	0.003393
					Mayo	71	0.1170	1	0.008307
					Junio	260	0.1170	1	0.03042
					Julio	62	0.1170	1	0.007254
					Agosto	106	0.1170	1	0.012402
					36	49	0.1170	1	0.005733
					Octubre	36	0.1170	1	0.004212
					Noviembre	46	0.1170	1	0.005382
					Diciembre	123	0.1170	1	0.014391
					TOTAL	993			0.116181

Carbon emissions from electricity in kilowatt hours

Appendix G: Monteverde Friends School Carbon Registries 2017

Asociación de los Amigos 01 REGISTRO DE EMISIONES DE CO2e POR FERTILIZANTE												
Emisiones Iidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Mes	Fertilizer (kg)	Factor de emisión N2O	PCG	N2O eq en toneladas	Factor de emisión CO2	PCG	CO2e en toneladas
Emisiones Indirectas por energía eléctricas	Operación generales	Iluminación, uso de cómputo y otros equipos		Hoja de Excel	Enero	22.67	0.01	310	0.11043529	0	1	0.11043529
					Febrero	22.67	0.01	310	0.11043529	0	1	0.11043529
					Marzo	22.67	0	310	0	0.2	1	0.01662467
					Abril			310			1	0
					Mayo			310			1	0
					Junio			310			1	0
					Julio			310			1	0
					Agosto			310			1	0
					Septiembre			310			1	0
					Octubre			310			1	0
					Noviembre			310			1	0
					Diciembre			310			1	0
					TOTAL	68.01						0.237495238

Carbon emissions from fertilizer in metric tons

Asociación de los Amigos 01 REGISTRO DE EMISIONES DE CO2e POR TANQUE SEPTICA									
Emisiones Iidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Año	#personas (x 177/365 or.485 days)	Factor de emisión	PCG	CO2e en toneladas
Emisiones directas por gestión de residuos	Operación generales			Hoja de Excel	2016	72.51	4.3800	1	6.6694698
TOTAL									6.6694698

Carbon emissions from septic tanks in metric tons

Asociación de los Amigos 01 REGISTRO DE EMISIONES DE CO2e POR ENVIAR RECICLAJE													
Emisiones Iidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Mes	Cantidad (kg)	Factor de emisión CH4	PCG	CH4 eq en toneladas	Factor de emisión N2O	PCG	N2O eq en toneladas	CO2e en toneladas
Emisiones directas por gestión de residuos	Operaciones generales			Hoja de Excel	Enero	19	58.1	21	0.0231819	0	310	0	0.0231819
					Febrero	36	58.1	21	0.0439236	0	310	0	0.0439236
					Marzo	36.5	58.1	21	0.04453365	0	310	0	0.04453365
					Abril	18	58.1	21	0.0219618	0	310	0	0.0219618
					Mayo	64.25	58.1	21	0.07839143	0	310	0	0.07839143
					Junio	50.75	58.1	21	0.06192008	0	310	0	0.06192008
					Julio	14.55	58.1	21	0.01775246	0	310	0	0.01775246
					Agosto	88	58.1	21	0.1073688	0	310	0	0.1073688
					Septiembre	2	58.1	21	0.0024402	0	310	0	0.0024402
					Octubre	17.5	58.1	21	0.02135175	0	310	0	0.02135175
					Noviembre	0	58.1	21	0	0	310	0	0
					Diciembre	36	58.1	21	0.0439236	0	310	0	0.0439236
					TOTAL	382.55							0.466749255

\Carbon emissions from recycling in metric tons

Asociación de los Amigos 01 REGISTRO DE EMISIONES DE CO_2e POR COMPOSTAGE DE DESECHOS SOLIDOS													
Emisiones Iidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Mes	Cantidad (kg)	Factor de emisión CH_4	PCG	CH4 eq en toneladas	Factor de emisión N_2O	PCG	N2O eq en toneladas	CO_2e en toneladas
Emisiones directas por gestión de residuos	Operación generales			Hoja de Excel	Enero	51.604	4	21	0.004334736	0.3	310	0.004799172	0.00913391
					Febrero	56.8	4	21	0.0047712	0.3	310	0.0052824	0.0100536
					Marzo	84.8	4	21	0.0071232	0.3	310	0.0078864	0.0150096
					Abril	52.3	4	21	0.0043932	0.3	310	0.0048639	0.0092571
					Mayo	79.8	4	21	0.0067032	0.3	310	0.0074214	0.0141246
					Junio	2.3	4	21	0.0001932	0.3	310	0.0002139	0.0004071
					Julio	56.7	4	21	0.0047628	0.3	310	0.0052731	0.0100359
					Agosto	94.9	4	21	0.0079716	0.3	310	0.0088257	0.0167973
					Septiembre	101.3	4	21	0.0085092	0.3	310	0.0094209	0.0179301
					Octubre	38.1	4	21	0.0032004	0.3	310	0.0035433	0.0067437
					Noviembre	88.45	4	21	0.0074298	0.3	310	0.00822585	0.01565565
					Diciembre	51	4	21	0.004284	0.3	310	0.004743	0.009027
					TOTAL	381.314							0.067492578

Carbon emissions from organic waste in metric tons

Asociación de los Amigos 01 REGISTRO DE EMISIONES DE CO_2e POR ENVIAR BASURA AL RELLENO SANITARIO													
Emisiones Iidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Mes	Cantidad (kg)	Factor de emisión CH_4	PCG	CH4 eq en toneladas	Factor de emisión N_2O	PCG	N2O eq en toneladas	CO_2e en toneladas
Emisiones directas por gestión de residuos	Operaciones generales			Hoja de Excel	Enero	0	58.1	21	0	0	310	0	0
					Febrero	0	58.1	21	0	0	310	0	0
					Marzo	0	58.1	21	0	0	310	0	0
					Abril	0	58.1	21	0	0	310	0	0
					Mayo	0	58.1	21	0	0	310	0	0
					Junio	0	58.1	21	0	0	310	0	0
					Julio	0	58.1	21	0	0	310	0	0
					Agosto	31	58.1	21	0.0378231	0	310	0	0.0378231
					Septiembre	20.5	58.1	21	0.02501205	0	310	0	0.02501205
					Octubre	16	58.1	21	0.0195216	0	310	0	0.0195216
					Noviembre	41.7	58.1	21	0.05087817	0	310	0	0.05087817
					Diciembre	45.5	58.1	21	0.05551455	0	310	0	0.05551455
					TOTAL	154.7							0.18874947

Carbon emissions from garbage in metric tons

Asociación de los Amigos 01 REGISTRO DE EMISIONES DE CO_2e POR ENERGÍA ELÉCTRICA									
Emisiones Iidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Mes	Consumo (KW/h)	Factor de emisión	PCG	CO_2e en toneladas
Emisiones Indirectas por energía eléctricas	Operación generales	Iluminación, uso de cómputo y otros equipos		Hoja de Excel	Enero	0	0.1170	1	0
					Febrero	0	0.1170	1	0
					Marzo	0	0.1170	1	0
					Abril	0	0.1170	1	0
					Mayo	133	0.1170	1	0.015561
					Junio	12	0.1170	1	0.001404
					Julio	73	0.1170	1	0.008541
					Agosto	0	0.1170	1	0
					Septiembre	0	0.1170	1	0
					Octubre	0	0.1170	1	0
					Noviembre	560	0.1170	1	0.06552
					Diciembre	16	0.1170	1	0.001872
					TOTAL	794			0.092898

Carbon emissions from electricity in kilowatt hours

Appendix H: Conservation League Carbon Registries 2016

BEN 01 REGISTRO DE EMISIONES DE CO2e POR ENERGÍA ELÉCTRICA

Emisiones Iidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Mes	Consumo (KW/h)	Factor de emisión	PCG	CO2e en toneladas
Emisiones Indirectas por energía eléctricas	Operación generales	Iluminación, uso de cómputo y otros equipos	Cuentas de electricidad	Hoja de Excel	Enero	0	0.1170	1	0
					Febrero	0	0.1170	1	0
					Marzo	0	0.1170	1	0
					Abril	0	0.1170	1	0
					Mayo	410	0.1170	1	0.04797
					Junio	762	0.1170	1	0.089154
					Julio	0	0.1170	1	0
					Agosto	0	0.1170	1	0
					Septiembre	0	0.1170	1	0
					Octubre	0	0.1170	1	0
					Noviembre	0	0.1170	1	0
					Diciembre	0	0.1170	1	0
					TOTAL	1172			0.137124

Carbon emissions for electricity in kilowatt hours

Asociación de los Amigos 01 REGISTRO DE EMISIONES DE CO2e POR CONSUMO DE GASOLINA

Emisiones Iidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Mes	Consumo (L)	Factor de emisión CO2	PCG	CO2 eq en toneladas	Factor de emisión CH4	PCG	CH4 eq en toneladas	Factor de emisión N2O	PCG	N2O eq en toneladas	Todos CO2e en toneladas
Emisiones directas por gestión de residuos	Operación de la oficina			Hoja de Excel	Enero	87.46	2.231	1	0.19512326	0.907	21	0.001665851	0.283	310	0.007672866	0.20446198
					Febrero	221.07	2.231	1	0.49320717	0.907	21	0.00421072	0.283	310	0.019394471	0.51681236
					Marzo	243.79	2.231	1	0.54389549	0.907	21	0.004643468	0.283	310	0.021387697	0.56992665
					Abril	242.79	2.231	1	0.54166449	0.907	21	0.004624421	0.283	310	0.021299967	0.56758888
					Mayo	299.26	2.231	1	0.66764906	0.907	21	0.005700005	0.283	310	0.02625408	0.69960315
					Junio	376.82	2.231	1	0.84068542	0.907	21	0.007177291	0.283	310	0.033058419	0.88092113
					Julio	371.77	2.231	1	0.82941887	0.907	21	0.007081103	0.283	310	0.032615382	0.86911536
					Agosto	224.03	2.231	1	0.49981093	0.907	21	0.004267099	0.283	310	0.019654152	0.52373218
					Septiembre	286.76	2.231	1	0.63976156	0.907	21	0.005461918	0.283	310	0.025157455	0.67038093
					Octubre	203.19	2.231	1	0.45331689	0.907	21	0.00387016	0.283	310	0.017825859	0.47501291
					Noviembre	202.59	2.231	1	0.45197829	0.907	21	0.003858732	0.283	310	0.017773221	0.47361024
					Diciembre	37.79	2.231	1	0.08430949	0.907	21	0.000719786	0.283	310	0.003315317	0.08834459
					TOTAL	2797.32										6.53951036

Carbon emissions for gasoline in metric tons

Asociación de los Amigos 01 REGISTRO DE EMISIONES DE CO2e POR CONSUMO DE GASOLINA

Emisiones Iidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Mes	Consumo (L)	Factor de emisión CO2	PCG	CO2 eq en toneladas	Factor de emisión CH4	PCG	CH4 eq en toneladas	Factor de emisión N2O	PCG	N2O eq en toneladas	Todos CO2e en toneladas
Emisiones directas por gestión de residuos	Operación de la oficina			Hoja de Excel	Enero	907.98	2.613	1	2.37255174	0.149	21	0.00284107	0.154	310	0.04334697	2.38429138
					Febrero	1070.75	2.613	1	2.79786975	0.149	21	0.00335038	0.154	310	0.05111761	2.81171391
					Marzo	889.25	2.613	1	2.32361025	0.149	21	0.00278246	0.154	310	0.0424528	2.33510772
					Abril	1071.62	2.613	1	2.80014306	0.149	21	0.0033531	0.154	310	0.05115914	2.81399846
					Mayo	1048.12	2.613	1	2.73873756	0.149	21	0.00327957	0.154	310	0.05003725	2.75228912
					Junio	1088.7	2.613	1	2.8447731	0.149	21	0.00340654	0.154	310	0.05197454	2.85884934
					Julio	919.32	2.613	1	2.40218316	0.149	21	0.00287655	0.154	310	0.04388834	2.41406942
					Agosto	1038.8	2.613	1	2.7143844	0.149	21	0.00325041	0.154	310	0.04959231	2.72781546
					Septiembre	1146.81	2.613	1	2.99661453	0.149	21	0.00358837	0.154	310	0.05474871	3.0114421
					Octubre	1197.97	2.613	1	3.13029561	0.149	21	0.00374845	0.154	310	0.05719109	3.14578464
					Noviembre	1050.43	2.613	1	2.74477359	0.149	21	0.0032868	0.154	310	0.05014753	2.75835502
					Diciembre	662.19	2.613	1	1.73030247	0.149	21	0.00207199	0.154	310	0.03161295	1.73886419
					TOTAL	12091.94										31.7525807

Carbon emissions for diesel in metric tons

Asociación de los Amigos 01 REGISTRO DE EMISIONES DE LPG																
Emisiones Iidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Mes	Litros (hay 19.6851 lts por clinlinro)	Factor de emisión CO2	PCG	CO2 eq en toneladas	Factor de emisión CH4	PCG	CH4 eq en toneladas	Factor de emisión N2O	PCG	N2O eq en toneladas	CO2e en toneladas
Emisiones directas por gestión de residuos	Calentamiento de comidas			Hoja de Excel	Enero	288.9236	1.611	1	0.46545592	0.139	21	0.000843368	0.002745	310	0.00024586	0.46654515
					Febrero	88.904	1.611	1	0.14322434	0.139	21	0.000259511	0.002745	310	7.5653E-05	3.00771122
					Marzo	196.9179	1.611	1	0.31723474	0.139	21	0.000574803	0.002745	310	0.00016757	6.66192947
					Abril	177.808	1.611	1	0.28644869	0.139	21	0.000519022	0.002745	310	0.00015131	6.01542245
					Mayo	311.1641	1.611	1	0.50128537	0.139	21	0.000908288	0.002745	310	0.00026479	10.5269927
					Junio	88.904	1.611	1	0.14322434	0.139	21	0.000259511	0.002745	310	7.5653E-05	3.00771122
					Julio	177.808	1.611	1	0.28644869	0.139	21	0.000519022	0.002745	310	0.00015131	6.01542245
					Agosto	270.7127	1.611	1	0.43611816	0.139	21	0.00079021	0.002745	310	0.00023036	9.15848135
					Septiembre	44.4528	1.611	1	0.07161346	0.139	21	0.000129758	0.002745	310	3.7827E-05	1.50388268
					Octubre	88.904	1.611	1	0.14322434	0.139	21	0.000259511	0.002745	310	7.5653E-05	3.00771122
					Noviembre	88.904	1.611	1	0.14322434	0.139	21	0.000259511	0.002745	310	7.5653E-05	3.00771122
					Diciembre	22.226	1.611	1	0.03580609	0.139	21	6.48777E-05	0.002745	310	1.8913E-05	0.75192781
					TOTAL	1845.6291										53.1314489

Carbon emissions for LPG in metric tons

Asociación de los Amigos 01 REGISTRO DE EMISIONES DE CO2e POR TANQUE SEPTICA									
Emisiones Iidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Año	#personas (x 177/365 or.485 days)	Factor de emisión CH4	PCG	CO2e en toneladas
Emisiones directas por gestión de residuos	Operación generales			Hoja de Excel	2016	12.6	4.3800	21	1.158948
TOTAL									1.158948

Carbon emissions for septic tank in metric tons

Asociación de los Amigos 01 REGISTRO DE EMISIONES DE CO2e POR ENERGÍA ELÉCTRICA									
Emisiones Iidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Mes	Refrigorator	Factor de emisión (ICE, 2014)	PCG	CO2e en toneladas
Emisiones Indirectas por energía eléctricas	Operación generales	Iluminación, uso de cómputo y otros equipos		Hoja de Excel	Enero				0
					Febrero				0
					Marzo				0
					Abril				0
					Mayo				0
					Junio				0
					Julio				0
					Agosto				0
					Septiembre				0
					Octubre				0
					Noviembre				0
					Diciembre				0
					TOTAL	0			0

Not included because no refrigator disposal

Carbon emissions for refrigerants in metric tons

Appendix I: Conservation League Carbon Registries 2017

BEN 01 REGISTRO DE EMISIONES DE CO2e POR ENERGÍA ELÉCTRICA

Emisiones Iidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Mes	Consumo (KW/h)	Factor de emisión (ICE, 2014)	PCG	CO2e en toneladas
Emisiones Indirectas por energía eléctricas	Operación generales	Iluminación, uso de cómputo y otros equipos		Hoja de Excel	Enero	473	0.1170	1	0.055341
					Febrero	862	0.1170	1	0.100854
					Marzo	1437	0.1170	1	0.168129
					Abril	119	0.1170	1	0.013923
					Mayo	1262	0.1170	1	0.147654
					Junio	0	0.1170	1	0
					Julio	0	0.1170	1	0
					Agosto	0	0.1170	1	0
					Septiembre	0	0.1170	1	0
					Octubre	909	0.1170	1	0.106353
					Noviembre	543	0.1170	1	0.063531
					Diciembre	1074	0.1170	1	0.125658
					TOTAL	6679			0.781443

Carbon emissions for electricity in kilowatt hours

Asociación de los Amigos 01 REGISTRO DE EMISIONES DE CO2e POR CONSUMO DE GASOLINA

Emisiones Iidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Mes	Consumo (L)	Factor de emisión co2 (2016)	PCG	CO2 eq en toneladas	Factor de emisión CH4 (2016)	PCG	CH4 eq en toneladas	Factor de emisión N2O (2016)	PCG	N2O eq en toneladas	Todos CO2e en toneladas
Emisiones directas por gestión de residuos	Operación de la oficina			Hoja de Excel	Enero	61.947	2.231	1	0.13820376	0.907	21	0.001179905	0.283	310	0.00543461	0.14481827
					Febrero	198.213	2.231	1	0.4422132	0.907	21	0.003775363	0.283	310	0.017389226	0.46337779
					Marzo	151.428	2.231	1	0.33783587	0.907	21	0.002884249	0.283	310	0.013284778	0.3540049
					Abril	275.977	2.231	1	0.61570469	0.907	21	0.005256534	0.283	310	0.024211462	0.64517268
					Mayo	149.551	2.231	1	0.33364828	0.907	21	0.002848498	0.283	310	0.013120109	0.34961689
					Junio	443.02	2.231	1	0.98837762	0.907	21	0.008438202	0.283	310	0.038866145	1.03568197
					Julio	516.005	2.231	1	1.15120716	0.907	21	0.009828347	0.283	310	0.045269119	1.20630462
					Agosto	186.758	2.231	1	0.4166571	0.907	21	0.00355718	0.283	310	0.016384279	0.43659856
					Septiembre	390.259	2.231	1	0.87066783	0.907	21	0.007433263	0.283	310	0.034237422	0.91233851
					Octubre	522.269	2.231	1	1.16518214	0.907	21	0.009947658	0.283	310	0.045818659	1.22094846
					Noviembre	293.919	2.231	1	0.65573329	0.907	21	0.005598275	0.283	310	0.025785514	0.68711708
					Diciembre	847.442	2.231	1	1.8906431	0.907	21	0.016141228	0.283	310	0.074346087	1.98113042
					TOTAL	4036.788										9.43711014

Carbon emissions for gasoline in metric tons

Asociación de los Amigos 01 REGISTRO DE EMISIONES DE CO2e POR CONSUMO DE GASOLINA

Emisiones Iidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Mes	Consumo (L)	Factor de emisión co2 (2016)	PCG	CO2 eq en toneladas	Factor de emisión CH4 (2016)	PCG	CH4 eq en toneladas	Factor de emisión N2O (2016)	PCG	N2O eq en toneladas	Todos CO2e en toneladas
Emisiones directas por gestión de residuos	Operación de la oficina			Hoja de Excel	Enero	530.155	2.613	1	1.38529502	0.149	21	0.00165885	0.154	310	0.0253096	1.3921496
					Febrero	666.211	2.613	1	1.74080934	0.149	21	0.00208457	0.154	310	0.03180491	1.74942305
					Marzo	734.021	2.613	1	1.91799687	0.149	21	0.00229675	0.154	310	0.03504216	1.92748732
					Abril	437.233	2.613	1	1.14248983	0.149	21	0.0013681	0.154	310	0.0208735	1.14814299
					Mayo	904.241	2.613	1	2.36278173	0.149	21	0.00282937	0.154	310	0.04316847	2.37447303
					Junio	1678.546	2.613	1	4.3860407	0.149	21	0.00525217	0.154	310	0.08013379	4.40774329
					Julio	1236.165	2.613	1	3.23009915	0.149	21	0.00386796	0.154	310	0.05901452	3.24608202
					Agosto	1374.182	2.613	1	3.59073757	0.149	21	0.00429982	0.154	310	0.06560345	3.60850491
					Septiembre	841.967	2.613	1	2.20005977	0.149	21	0.00263451	0.154	310	0.0401955	2.2109459
					Octubre	864.134	2.613	1	2.25798214	0.149	21	0.00270388	0.154	310	0.04125376	2.26915488
					Noviembre	1029.355	2.613	1	2.68970462	0.149	21	0.00322085	0.154	310	0.04914141	2.70301356
					Diciembre	847.442	2.613	1	2.21436595	0.149	21	0.00265165	0.154	310	0.04045688	2.22532286
					TOTAL	11143.652										29.2624434

Carbon emissions for diesel in metric tons

Asociación de los Amigos 01 REGISTRO DE EMISIONES DE LPG																
Emisiones lidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Mes	Litros (hay 19.6851 lts por clinlinro)	Factor de emisión CO2 (2016)	PCG	CO2 eq en toneladas	Factor de emisión CH4 (2016)	PCG	CH4 eq en toneladas	Factor de emisión N2O (2016)	PCG	N2O eq en toneladas	CO₂e en toneladas
Emisiones directas por gestión de residuos	Calentamiento de comidas			Hoja de Excel	Enero	0	1.611	1	0	0.139	21	0	0.002745	310	0	0
					Febrero	0	1.611	1	0	0.139	21	0	0.002745	310	0	0
					Marzo	133.356	1.611	1	0.21483652	0.139	21	0.000389266	0.002745	310	0.00011348	4.51156684
					Abril	0	1.611	1	0	0.139	21	0	0.002745	310	0	0
					Mayo	177.808	1.611	1	0.28644869	0.139	21	0.000519022	0.002745	310	0.00015131	6.01542245
					Junio	88.904	1.611	1	0.14322434	0.139	21	0.000259511	0.002745	310	7.5653E-05	3.00771122
					Julio	177.808	1.611	1	0.28644869	0.139	21	0.000519022	0.002745	310	0.00015131	6.01542245
					Agosto	99.5725	1.611	1	0.1604113	0.139	21	0.000290652	0.002745	310	8.4731E-05	3.36863725
					Septiembre	111.13	1.611	1	0.17903043	0.139	21	0.000324388	0.002745	310	9.4566E-05	3.75963903
					Octubre	177.808	1.611	1	0.28644869	0.139	21	0.000519022	0.002745	310	0.00015131	6.01542245
					Noviembre	266.712	1.611	1	0.42967303	0.139	21	0.000778532	0.002745	310	0.00022696	9.02313367
					Diciembre	0	1.611	1	0	0.139	21	0	0.002745	310	0	0
					TOTAL	1233.0985										41.7169554

Carbon emissions for LPG in metric tons

Asociación de los Amigos 01 REGISTRO DE EMISIONES DE CO₂e POR TANQUE SEPTICA									
Emisiones lidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Año	#personas (x 177/365 or.485 days)	Factor de emisión	PCG	CO₂e en toneladas
Emisiones directas por gestión de residuos	Operación generales			Hoja de Excel	2016	12.6	4.3800	1	1.158948
TOTAL									1.158948

Carbon emissions for septic tank in metric tons

Asociación de los Amigos 01 REGISTRO DE EMISIONES DE CO₂e POR ENERGÍA ELÉCTRICA									
Emisiones lidentificadas	Procesos	Componente Generador	Metodología	Herramienta de cálculo	Mes	Refrigorator	Factor de emisión (ICE, 2014)	PCG	CO₂e en toneladas
Emisiones Indirectas por energía eléctricas	Operación generales	Iluminación, uso de cómputo y otros equipos		Hoja de Excel	Enero				0
					Febrero				0
					Marzo				0
					Abril				0
					Mayo				0
					Junio				0
					Julio				0
					Agosto				0
					Septiembre				0
					Octubre				0
					Noviembre				0
					Diciembre				0
					TOTAL	0			0
Not included because no refrigator disposal									

Carbon emissions for refrigerants in metric tons

Appendix J: Monteverde Friends School Interviews Coded

	9th, 10th, 11th and 12th Graders *When coding the responses, we did not identify a change in responses between each grade, therefore we grouped the grades together
Type of media consumed, (i.e. television, radio, social media, newspaper)	8 students watch TV, but typically do not watch the news unless their parents are watching. 0 students listen to the radio, Spotify was most popular among the students. All students used Snapchat, Instagram and Facebook. Few used it for news, most used it just to connect with friends. 2 students said they read the newspaper (paper and online).
Sponsored advertisements on social media	Most students said they did not pay attention to advertisements on social media, unless they were very interested in the topic. 5 said that if they were to see a Monteverde related advertisement, they would stop and look at it because it related to them and their area.
Infographics and animations	28 students felt that pictures and graphics were the most effective tools to get people's attention. They also agreed that some numbers and words are needed to help make sense of the graphics and explain what is being depicted.
Placement of posters and flyers in Monteverde	27 students identified the Coffee Center as the main place for posters and flyers to be advertised. 20 mentioned downtown Santa Elena as another area where they noticed posters. 12 Students also identified local store and restaurant windows as a place for advertisements.
Familiarity and participation with CORCLIMA and other environmental initiatives in Monteverde	20 students were aware of CORCLIMA and more specifically Katy VanDusen. 16 were able to recall that Katy has presented to the school on carbon neutrality. 4 students also mentioned events put on by the Monteverde Institute. Some students were aware of the existence of other initiatives in the area, but couldn't identify them by name or goal. 9 students also mentioned a Ted Talk and presentation by Monica Araya. 1 student attended meetings or events about the environment or carbon neutrality outside of what the school made mandatory.
Source of marketing for events happening in Monteverde	25 students identified the school, Katy and their families as their source for hearing about events happening in the area.

Appendix K: Electric Car Blog

Saludos, my name is Kyle and I am an engineering student at Worcester Polytechnic Institute, in the United States, and I've spent the past seven weeks in Costa Rica as part of a group of students working on a project with CORCLIMA. In that time, we've been exposed to an incredible number of organizations that are environmentally conscious and sustainable practices here in Monteverde. However, I think the most exciting practice is yet to come.

During the afternoon of Wednesday, February 7th, two gentlemen from ICE held a community gathering to tell the people of Monteverde the plans of the *Ruta Eléctrica*, the first of its kind in North America. Simply, ICE and other cooperators wish to create a route through Costa Rica that a person can drive while still being 100% electric. The plan is to build car charging stations throughout a national route, including one in Monteverde. Ideally, this will allow both residents and tourists who already use electric cars to travel farther and more frequently, and encourage others to buy electric cars.

This was only a small portion of the talk. The bigger discussion point was that of electric vehicles in general. There was a presentation on the mechanics of electric vehicles and a discussion of the advantages of going electric. The biggest advantages fall into three major categories: accessibility, parts and cost.

There is a greater variety of areas of where you can charge electric cars than that of stations for gas or diesel cars. Instead of needing a gas station, which requires major construction, maintenance and constant deliveries of fuel, electric cars only need an electricity source. Though most common and feasible way to charge an electric car is in the garage overnight, the primary goal of the *Ruta Eléctrica* is the construction of public charging stations across the country. Electric charging stations require much less construction, very little maintenance, and zero fuel deliveries. Also, charging stations can be anywhere. You can charge your car while sipping on some coffee in a cafe, or buying groceries.

Another advantage of an electric vehicle is that it contains less moving parts than a car using an internal combustion engine, which reduces the number of parts that will need replacing, and the frequency at which they must be replaced. For example, there's no fuel injector, spark plugs, catalytic converter, exhaust system, or engine oil. Also, ZERO EMISSIONS.

The final advantage is cost. This is related to both the ability to charge up anywhere, which means you can charge in-house and not pay any service charges, and the reduced maintenance, which saves you money. Not to be forgotten, electricity is generally cheaper than gasoline. Finally, with new legislation, backed by Monica Araya, which was just passed into law in San José, there will be government assistance and incentives for people who buy electric vehicles, which means THE GOVERNMENT WILL PAY YOU to go electric.

Appendix L: Solar Energy Payback System Blog

49% Rule Explained
Riley Lopez

When considering investing in solar panels for your house, it is important to understand how the monthly payment system works and how it can save you money. Costa Rica has its own policy, called the “49% Rule,” for all solar panel owners. The rule means that 49% of the energy your panels generate per month is credited in your electric bill. Therefore, if you produce more energy than you consume, all imported energy from the “grid” will be charged at 5 cents per kWh rather than the electric company’s standard amount (for example: 19 cents per kWh). The remaining energy you produce will be accounted for in the next months bill. This rule was implemented so that customers make some payment every month in order to keep the electrical company in business, but it is at a minimal price and still allows you to save a large amount of money on your bills.

When installing the solar panels, there are two separate meters that are required with the system. One meter measures how much power is produced and the second measures imported and exported power. During the day when sunlight is available, the solar panels generate power but this power cannot be stored and any unused power produced during that time is exported to the grid. Therefore, if you use electricity while the panels are not generating power at night or during a cloudy day, your power must be imported from the grid. This is why you would have to import power from the grid even if your panels generate more than your total consumption. However, with a battery, the energy produced during daylight hours can be stored and is accessible at anytime, but you will not be exporting power to the grid. This is important to understand when looking at how the payment system works.

A simple way of explaining this is to break down an example of energy production and consumption for one month (without a battery).

March Solar Panel Production: 1650 kWh
Total Consumption (From panels and from the grid): 1470 kWh

Daylight
Production: 1650 kWh
Power Consumption from Panels: 625 kWh
Exported to the grid: 1025 kWh (production - self-consumption)

Non-Daylight
Production: 0 kWh
Power Consumption from Panels: 0 kWh
Imported from the grid: 855 kWh (total consumption - self-consumption)

The system produced more power than the amount consumed, so all energy will be charged at 3 cents per kWh.
Additionally, 49% of the 1650 kWh produced is found to be 808.5 which is less than the 855 kWh that was imported from the grid. This means that all 855 kWh will be 3 cents and the remaining 170 kWh (Exported - Imported) will carry over to the next month's production.

The cost for that month would be $25.65 plus tax
The cost for that month without solar panels would be over $200 plus tax

Although the payment from solar panel systems is complex, it is a cost effective strategy for producing power, even without the addition of a storage battery. A purchase of a battery can help your system to be more cost effective, but in the end it is not necessary for saving.

Appendix M: Local Initiatives Blog

Hi, my name is Vicky, I have been in Costa Rica for 6 weeks now, working with Katy and CORCLIMA on a project about carbon neutrality. I'm not going to lie to you, before coming here I didn't really know what to expect. Of course, I knew about climate change, carbon emissions, the fact that driving, eating burgers, charging my phone twice a day and just about everything else I do in my daily life is harmful to the environment, but that's all I really knew – the bad stuff. That's why my experience in Monteverde has been such a growing process because here people don't only care about the problems, they care about the solutions.

On February 17th, a few of my peers and I participated in an environmental hike through the Monteverde area. The hike took us to the Monteverde Institute, Katy's house, the Children's Eternal Rainforest, Monteverde Coffee Center, Café Caburé, the Friends School teacher housing and Hotel Belmar. Between drinking coffee at the coffee center, chocolate tasting at Café Caburé and indulging in some beer at Hotel Belmar, we learned about the different types of sustainable practices that all these places have implemented. We learned about rainwater catchment systems, above ground gardens, reforestation, air drying clothes, electric vehicles, bird net windows, repurposing household items, sustainable gardens, organic fertilizer, composting and bio digestion. These practices are super important in helping protect Monteverde and provided a lot of useful benefits. For example, one of the teachers from the Friends School explained to us that during Hurricane Nate they were one of the only places with water because they had stored so much previously with their rainwater catchment system. It was great to learn and observe easy practices that people can done at home.

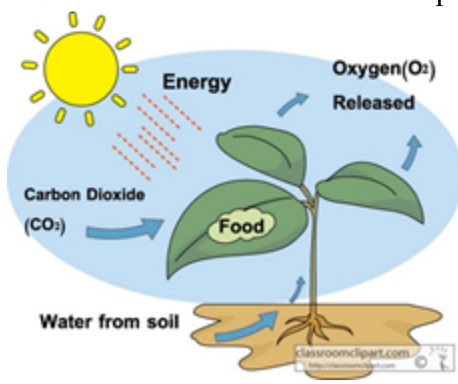
I have always been aware of climate change and sometimes even feel like I should do something about it. But was always hesitant because I never truly believed that one individual could make a big enough impact. After spending time in Costa Rica and on this project, I have changed my beliefs. It gives me hope to see that people here are so passionate about climate change and go out of their way to employ sustainable practices. I now feel that I have a responsibility to do my part no matter how small it seems because the only way to make a difference is by a lot of people doing small things together.

Appendix N: Tree Sequestration Blog

Capturing Carbon, One Tree at a Time
Joshua Manning

What actions should be taken in reversing climate change? While it is important to work on reducing carbon emissions, it is also important to take carbon out of the atmosphere. What is the best way to capture and contain carbon dioxide being emitted by people?

The simplest and most effective is to plant trees. Trees absorb carbon through photosynthesis and approximately 48% of their total mass is made up of carbon[3].



After only one year, a hectare of newly planted trees can intake an average of .714 metric ton of carbon. As the trees get older, the amount of carbon intake increases as well. Trees between the ages of 15 and 75 sequester approximately 4.22 metric tons per hectare per year, and trees older than 75 years take in about 2.5 metric tons per hectare per year.

The Bosque Eterno de los Niños managed by the Monteverde Conservation League is 22,600 hectares of trees. Therefore the BEN sequesters approximately 203,000 metric tons of carbon dioxide each year!

Now obviously, people aren't going to plant 22,000 hectares of trees, but just by planting a 10x10 or 20x20 meter plot of trees one person can make a difference in the movement towards carbon neutrality. The more trees being planted, the less carbon dioxide floating around the atmosphere. And the best part is, anyone with a patch of open land can do it.

[3] *Biomass and Soil Carbon Stocks in Wet Montane Forest, Monteverde Region, Costa Rica: Assessments and Challenges for Quantifying Accumulation Rates* (Tanner, 2016)