Assessing the land cover feasibility and potential governance structures for the Bayano Carbon Project

by

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ABSTRACT

In February 2020, McGill University committed to offsetting the carbon emissions from the flights of its faculty and staff through a carbon forestry project in two indigenous Emberá communities in Eastern Panama, Ipetí and Piriatí. This reforestation project raises the need to think critically about carbon offsetting, and how to engage in a way that prioritizes benefits for people participating in the projects. The aim of this thesis is to assess the land cover feasibility and potential governance structures for this new carbon project, so as to ensure equitable benefit-sharing. Remote-sensing land cover classification over time in Ipetí and Piriatí indicates that there is sufficient physical space for new reforestation to occur. An analysis of other forest carbon projects in Latin America through a framework developed by Holmes and Potvin (2014) highlights the importance of developing plans that ensure income generation over time and inclusion of marginalized community members in project design.

1. INTRODUCTION

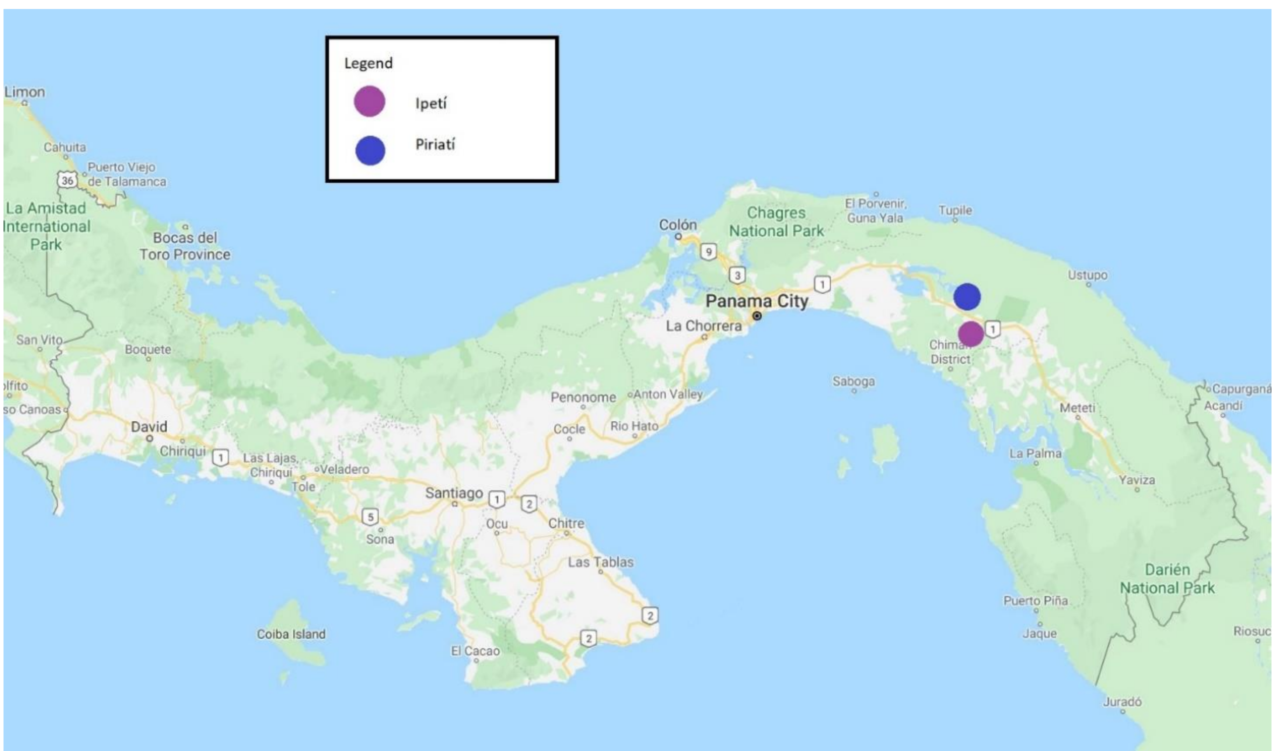
In February 2020, McGill University committed to offsetting carbon emissions from the flights of its faculty and staff through a reforestation project in two indigenous Emberá communities, Ipetí and Piriatí, in the Bayano region of Eastern Panama. The funding for the Bayano Carbon Project will come through the Sustainable Project Fund (SPF) at McGill. The reforestation project was proposed by members of AMARIE, the *Asociación de Mujeres Artesánas Ipetí Emberá* (Association of Artisan Women of Ipetí Emberá), with support of the Neotropical Ecology Laboratory at McGill. This reforestation project raises the need to think critically about carbon offsetting, and how to engage in these community-level reforestation projects in a way that prioritizes the needs and benefits for the people participating in the affected communities.

The collective territories of Ipetí and Piriatí have been inhabited for the past five decades. In 1970, the Panamanian government relocated Emberá families from the Lago Bayano region in order to flood the area for the construction of a dam (Kirby & Potvin, 2007). Since this relocation, the Emberá communities have dealt with issues surrounding land claims and land use options (Wali, 1993). The land to which the Emberá families were moved was less fertile than the land closer to the lake, but part of the argument that they used to gain access to the land was that they would take care of the forests (Wali, 1993). In the negotiations and disagreements with the government, however, the Emberá families were not given secure tenure to their land; they were given a collective territory rather than an indigenous reserve. The lack of secure tenure impacted community investment in the land (Wali, 1993, p. 122).

The Bayano Carbon Project will not be the first reforestation initiative to take place in the Emberá Bayano communities. In 2008, Ipetí entered into a 25-year contract with the Smithsonian Tropical Research Institute (STRI) to offset their carbon output for three years. The planting process took place over three years, from 2008 to 2010, and the contract extends through the full maturation of the trees and sequestration of the carbon (Holmes, Kirby, & Potvin, 2017). The project was implemented and managed jointly by a community-based NGO and a national NGO that verified the plantations (Holmes, Kirby, & Potvin, 2017). Some of the reforestation plots were solely hardwood trees, while others incorporated fruiting trees to include agroforestry benefits into the system as well.

As two of the three plantation year plots have reached a maturity of 10 years and the third is approaching this milestone, the labor involved in maintaining the plots has diminished, and community members and members of AMARIE have expressed a desire to engage in further reforestation projects. Community consultations revealed a desire for different management of the new project (Forgues & O'Driscoll, 2019), prompting the need for discussion and analysis about the best way to structure the newest iteration of the reforestation project.

While the previous reforestation contract with STRI was only with the community of Ipetí, the community of Piriatí has also expressed interest in participating in the new project funded by the McGill SPF. Additionally, the new reforestation project could potentially add an element of ecological tourism, with the hope of providing a market for artisan women in the community to sell their work at an appropriate price. Both the addition of tourism and the reforestation provide not just a source of income, but also a means to continue to prioritize activities and environments that are culturally important.



Map 1.1: Locations of Ipetí and Piriatí within Panama. Source: Google Maps

While McGill's decision to participate in the voluntary carbon market through investing in the Bayano Carbon Project has many positive elements, it also brings up important questions about ethical engagement in carbon offsetting programs. Offsetting is not in itself a sufficient means for addressing climate change, and institutions need to ensure that they are taking other actions to mitigate their carbon emissions. At the same time, projects like the Bayano Carbon Project have direct support from people in the community and need funding from somewhere. It is critical to design carbon offsetting projects such that benefits are appropriately shared between stakeholders, particularly emphasizing benefits for those engaged in sequestering the carbon.

Considering the lessons from the previous reforestation project and taking into account the increasing scope and scale of the project with the inclusion of Piriatí as well as Ipetí, additional research into the structure and context of the project is necessary. The overall aim of this thesis is to assess the land cover feasibility and potential governance structures for the Bayano Carbon Project to inform its design and development stage. My research questions are: How has forest cover changed in Ipetí and Piriatí from 2008-2019, and does that change indicate that there is space for this further reforestation to take place? In thinking of possible governance structures for the new project, what lessons could be learned from the project design of other forest carbon projects to adequately prioritize benefit sharing going towards community needs?

I begin by reviewing the literature on fairness in the voluntary carbon market, centering on key critiques and how they can be addressed. I outline my methodology for addressing each research question: first, remote sensing classification to analyze land cover patterns over time; and second, an analysis of other forest carbon offset projects in Latin America based on a best practice framework laid out by Holmes and Potvin (2014). I address the results of both these methodologies, focusing first on the observed changes in land cover and areas where reforestation could be possible, and second on how different governance structures of forest carbon projects do and do not accommodate best practices. I then bring these two analyses together to discuss lessons for the Bayano Carbon Project.

2. LITERATURE REVIEW

In an era of increasing climate change, individuals, companies, and governments are turning to a variety of climate mitigation and adaptation strategies, including carbon offsets. This process is based on one person or group, often in what is considered a developed country, purchasing carbon credits produced from a project elsewhere, often in what is considered a developing country (Lovell H. C., 2010). Carbon offsets can come from a variety of different types of projects, including forestry, land use projects, and renewable energy (Corbera, Estrada, & Brown, 2009). In thinking about carbon offsetting, particularly through reforestation, I position the decision to engage in a carbon offsetting project as a land use decision among many alternatives for using land. After first providing a brief overview of the mechanisms of the carbon offset market, I will elaborate on some of the critiques that lead to the question of whether it is possible to produce and trade carbon in a fair manner, particularly focusing on whether benefits are reaching the producers of the carbon credits.

2.1 Structure of the Carbon Offset Market

The carbon offset market is comprised of both regulated and voluntary projects. Regulated projects fall under the strict guidelines of the Clean Development Mechanism (CDM) established by the 1997 Kyoto Protocol, whereas voluntary offset projects are those which do not comply to a specific set of standards or regulations (Corbera, Estrada, & Brown, 2009; Lovell H.C, 2010). Corbera et al. identify two main segments of the voluntary sector: offsets traded of the Chicago Climate Exchange (CCX), and over the counter (OTC) offsets (2009, p. 28). They define the CDM as “a market mechanism aimed at facilitating compliance with emissions reduction objectives by reducing the overall mitigation cost while promoting sustainable development (SD) in developing countries” (Corbera, Estrada, & Brown, 2009, p. 26), and voluntary offset schemes as “a means for individuals and entities to reduce emissions over and above mitigation goals set by regulations” (Corbera, Estrada, & Brown, 2009, p. 26). The two sectors, however, have a similar historical background, and overlap in projects (Lovell H. C., 2010, p. 354).

The governance systems for these two sectors of the carbon market are different (Lovell, 2010). Within the CDM, offsets are traded as certified emissions reductions (CERs), whereas for the over the counter market, the offsets are traded as Verified Emissions Reductions (VERs) (Corbera, Estrada, & Brown, 2009). There are a variety of standard setting organizations that operate as verifiers and traders of these offsets, including Gold Standard, the Verified Carbon Standard, Plan Vivo, and CCB standards, each which have their own specific focus (Corbera, Estrada, & Brown 2009; Lovell, H.C., 2010). Alongside these different verification standards, there are also "add-on" and dual-certification schemes, including a Fairtrade option and a dual certification with the Forest Stewardship council (Howard et al., 2014, p. 11). Numerous organizations participate in different capacities in this market. Forest Trends compiles a yearly list of different organizations that are providing and trading carbon credits on the voluntary carbon market (Forest Trends Ecosystem Marketplace, 2017). These organizations often participate outside the verification standards of the CDM, opting instead to use the Verified Carbon Standard or other certifications.

In contrast to previous literature, Corbera et al. (2009) found that projects operating within the CDM versus in the OTC are more similar than previous literature indicated. Both types of projects promote similar technologies and projects, and additional social benefits are dependent on context, not whether they are in the CDM or OTC markets (Corbera, Estrada, & Brown, 2009). Based on data from 2006 and 2007, the authors noted that, though there were many more projects in the CDM, there was a higher percentage of forestry projects in the OTC market. This was in part because CDM requirements for forestry projects at the time were very strict. Forestry projects were popular in the OTC market because of the perceived additional social and development benefits that came with them (Corbera, Estrada, & Brown, 2009). Corbera et al. (2009) noted that increasing the incorporation of Reducing Emissions from Deforestation and Forest Degradation (REDD) into the CDM also increased the likelihood of forestry projects in the CDM in the future.

In a more recent study, Lee et al. found similar results, indicating that forest carbon credits constitute a significant part of the voluntary market, in part because of the importance of co-benefits for market value (2018, p. 235). Projects operating in the OTC market have more chance of having development goals embedded within them than projects operating through the

CDM because projects in the OTC market do not have the same restrictions (Bumpus & Liverman, 2010). Boyd et al. (2007) discuss the possible growth of forestry projects in the CDM, particularly analyzing changes to governance mechanisms that would be needed for these smaller scale projects. The authors argue that local participation is important for designing these projects in a way that can contribute to sustainable development, particularly in ways that can build off previous projects and institutions (Boyd et al., 2007).

Regardless of differences between the voluntary and regulated sectors, both are market mechanisms for addressing climate change. This reliance on the market, which leaves space for fraud and lack of regulation (Bachram, 2004), is among the critiques of emissions trading, particularly within the voluntary market. As mentioned by Merger and Pistorius (2011), the sheer number of different standards in the voluntary market create confusion over the true quality of the carbon credits. Authors like Bachram (2004) argue that this creates the opportunity for conflicts of interest and poor quality credits. Some authors have argued that the voluntary carbon market should face more government oversight, criticizing the reliance on market mechanisms to address and resolve the issue (Savasta-Kennedy, 2009). Lovell et al. (2009) argue that consumption of carbon offsets is spurred by top-down pressures rather than by individuals, again highlighting its embeddedness in a market system.

Bachram (2004) raises the question of carbon colonialism, sometimes called CO2lonialism (for example, Ciscell 2010). Bachram argues that carbon projects have the potential for "opening the door to a new form of colonialism, which utilizes climate policies to bring about a variation on the traditional means by which the global South is dominated" (2004, p. 10). Other critiques center around the idea of whether carbon offsetting encourages continued consumption, particularly in the Global North. In providing alternatives to lifestyle and policy changes, carbon offsets take the emphasis away from the root causes of climate change, and allow continued economic growth in the Global North at the expense of the Global South (Lovell, Bulkeley, & Liverman, 2009).

2.2 Fairness in the Carbon Market

Considering these critiques of the voluntary carbon market, one lens that scholars and practitioners in the field have started to use to approach the carbon market is fairness. Ciscell (2010) was one of the first scholars to suggest the idea of applying fair trade certifications to voluntary carbon offsets. In addressing the idea of CO2lonialism, Ciscell (2010) argues that applying third party verification standards, particularly Fairtrade International, to carbon markets has the possibility of shifting away from some of the problems caused by a market-based mechanism. The idea of applying fairness to carbon took on a more tangible property with the announcement of a partnership between the carbon standard organization Gold Standard and Fairtrade International (Howard R. , Tallontire, Stringer, & Marchant, 2014). This particular partnership spurred research about whether and how fairness can be achieved in the market based on different levels of power and access that stakeholders have in these projects. Thinking about Fairtrade specifically, some authors have written about the impacts of fair trade certifications for food products. Phillips (2014) wrote about the impacts of a Fairtrade sugarcane project in Malawi, finding that there were consequences of the project that had not been considered before implementation, including that benefits only accrued to a few members of the community. Because of this, there is debate over the differences between achieving 'fairness' and implementing a Fairtrade standard.

There are a variety of different definitions of fairness and opinions about its place within the carbon market, both within the literature and amongst practitioners and stakeholders. Howard et al. (2014) focus their assessment of the operationalization of fairness on two key axes: access to projects and distribution of the benefits that derive from them, particularly for the smallholders involved in the projects. The authors conducted a literature review on fairness in the carbon market and found six challenges that related to access and benefits. The challenges impacting access include costs and number of participants, and those impacting benefits include marginal benefits and weak positioning of smallholders, and those impacting both access and benefits include institutional contexts and concept of carbon rights (Howard et al., 2014, p. 13). The authors pointed to differences between fairness in theory and in action, highlighting that understandings of how it operates in action can impact conceptual theorizations (Howard et al., 2014, p.6). Howard et al. (2015) expand their conceptualization of fairness to include equity and justice, and highlight that framing fairness around access and benefits is how standard-setting organizations, like Fairtrade International and the Gold Standard, approach the issue of fair carbon.

Howard et al. (2016) assessed how different stakeholders in a consultation group viewed notions of fairness. In identifying three different perspectives, they found that there was little to no consensus on what fairness means for the different actors in the market. The authors identified three different “factors:” one emphasizing producers; one a functional value chain; and one that highlights market efficiency (Howard et al., 2016). Different factors had different approaches to the idea of fairness. Some areas of debate the authors identified include how to share benefits, determine goals of fairness, and establish parameters. The first factor centered most on the producers, and argued that approaches to fairness need to include commitments from buyers to reduce their emissions.

When discussing the issue of fairness, some authors address the concept directly, while others focus on access, benefit sharing, equity, or justice. Robinson et al. (2016), for example, discussed carbon offset schemes in Indigenous communities in Australia, focusing on distribution of benefits. The authors highlighted the difficulty in balancing international standards with achieving local development goals (Robinson 2016, p. 130). There are many studies that look at the concept of benefit sharing within REDD projects in particular. A report commissioned by the International Union for Conservation of Nature (IUCN) highlighted the need for clear definition of benefit sharing systems in REDD projects. Among their many conclusions, the authors argue that the benefits distributed may need to be greater than those calculated by purely economic costs and considerations, including through social dimensions of projects, and that the benefits need to be shared in both vertical (i.e. from national to local level) and horizontal (i.e. between and within communities) directions (Lindhjem et al., 2011). Gebara (2013) analyzed a REDD project in Brazil, looking at benefit sharing through the lens of local participation in project design. Her research centered on equity in benefit sharing, finding that local participation is important in both defining benefits and in achieving the desired results from the project.

The idea of benefit sharing is important because the decision to engage in a carbon offsetting project is one among different alternatives for to how to use and manage land. Because landholders are choosing offsetting through reforestation among different alternatives for using their land, the idea that the benefits appropriately reach them is important. Lipper and Cavatassi (2004) developed a conceptual framework for thinking about “land-use decision-making to assess the potential for sequestration adoption among the poor" (S374), highlighting that a household's decision to participate in a project is based on whether the payments coming from sequestration cover the costs of engaging in that land use practice. In other words, clear benefit sharing may be important for smallholders' decision to engage in offsetting projects.

The voluntary carbon market comprises projects aiming to address both climate change and development needs but faces a range of critiques. One approach that some scholars have taken to approach these critiques is through the lens of fairness. While there are a variety of conceptualizations of how to achieve fairness in theory and in practice, two themes that often appeared were benefit sharing and access to projects. The emphasis on sharing benefits throughout the project development and operation provides one lens through which to view and analyze fairness in carbon projects.

3. METHODOLOGY

Given the critiques presented of the carbon market and the question of whether credits can be traded in a fair manner, my research surrounding the Bayano Carbon Project centers on ways of structuring the land use decision of participating in an offset project in a way that prioritizes benefits for the communities participating. I used two different methodologies to approach my research questions. I address my first research question (How has forest cover changed in Ipetí and Piriatí from 2008-2019, and does that change indicate that there is place for this further reforestation to take place?) through remote sensing land cover classifications. To investigate the second research question (In thinking of possible governance structures for the new project, what lessons could be learned from the project design of other forest carbon projects to adequately prioritize benefit sharing going towards community needs?), I assessed other forest carbon projects using a framework of best practices identified from the literature by Holmes and Potvin (2014).

3.1 Remote Sensing Classification

Preprocessing

All the satellite imagery was accessed from PlanetLab (Planet Labs Inc. 2019). Planet satellites did not start collecting their own data until 2009, meaning that to find data to asses land use in Ipetí and Piriatí from around the time of the previous reforestation project, the only available imagery comes from RapidEye satellites. The data was less frequently available between 2009 and 2012, and many of the options were full of clouds. For this reason, the earlier images of Ipetí and Piriatí do not come from the same year and are not the exact date of the previous reforestation.

The raw data for the PlanetScope satellites came from the PlanetLab analytic package, with images already orthorectified with map coordinates and one of the available files already in surface reflectance. The files were already atmospherically corrected by the Planet software. Their process for atmospheric correction involves first converting the products from Top of Atmosphere Radiance to Top of Atmosphere reflectance, and then to surface reflectance. Their resulting surface reflectance does not account for haze, thin cirrus clouds, stray light, or adjacency effects. Each pixel is 3m orthorectified. The resulting data in the analytic package is given in the Universal Transverse Mercator (UTM) projection, using the WGS84 horizontal datum (Planet Labs Inc. 2019). All of the images downloaded from the PlanetLab satellites were 4-band PlanetScope Scene images, with the four bands being blue, green, red and near infra-red. The images from Ipetí and Piriatí were both taken on July 16th, 2019 (Planet Team 2017). There were multiple date options for images for Ipetí, but most had significant cloud cover.

The satellite imagery for the images from Ipetí in 2012 and Piriatí in 2011 came from RapidEye satellites. The images came orthorectified and radiometrically, sensor, and geometrically corrected with map coordinates (Planet Labs Inc. 2019, p. 33). The resulting pixel size is 5m. The images from the RapidEye satellites included five bands: blue, green, red, red edge, and near infra-red (Planet Labs Inc. 2019). This provided the key difference between the RapidEye images and PlanetScope Scene images but did not impact the method for classification.

To perform the classification, I used the remote sensing software ENVI by Harris Geospatial. ENVI is not able to automatically read the metadata for PlanetScope imagery, meaning that for each image given by PlanetLabs, I had to manually input the data about the wavelengths for each band into the image header. I drew the information from the Planet Imagery Product Specifications Guide from April 2019. Using the range of wavelengths that they provided for each band, I calculated the average and input it into the wavelength information for each band for the file that was already given in Surface reflectance. The wavelength for the blue, green, red and near infra-red bands were 485nm, 545nm, 630nm and 820nm, respectively (Planet Labs Inc. 2019). ENVI was able to read the RapidEye imagery at the outset, so the same header manipulation was not necessary.

The general process for preparing the images for Ipetí and Piriatí in each of the time settings was quite similar. More than one satellite image was needed to cover the whole area of each community. Satellite images had to be prepared individually, and then mosaiced together to create one image that covered the entirety of each community. For each PlanetScope Scene image, I opened the file given in surface reflectance with the updated header, along with a Planet-provided file of unusable data. I built a mask from this unusable data file and then applied it to the surface reflectance image. With these masked images, I mosaiced them together to create a full coverage image of each community. Using shapefiles of each community provided by Milton Solano, a GIS technician of the Smithsonian Tropical Research Institute, I then cropped the mosaiced image so that it just centered on the area of the community. Because the unusable data did not include all cloud coverage, an additional cloud mask was needed, based on a spectral signature threshold region of interest. In creating this cloud mask, some of the roofs from houses in the villages were also covered. This was not a problem for this particular analysis because the focus is on forest versus non-forest areas, and the reflectance of the village areas confused the classification.

Classification

The goal of the classification process was to understand the land cover changes in Ipetí and Piriatí, with an emphasis on forested lands versus non-forested lands. For the purposes of my classification, "forest" meant an area where there was already tree cover (i.e. an area where reforestation activities could not take place). This simple definition of forest was also needed in part because the imagery was multi-spectral rather than hyper-spectral, which limited in specificity of spectral differences that can be noticed. I initially ran unsupervised classifications on the preprocessed images of the correct size, but the results were not adequate based on visual comparison of the classification results with the satellite imagery. I then turned to maximum-likelihood supervised classifications. Before performing the classifications, I masked out the roads based on visual interpretation because they confused the classification results. The river in Ipetí did not spectrally behave like water, which confused the analysis as it was classified as land, so I masked it based on visual interpretation so that it did not impact the total land use area. I then created three to four regions of interest for each community at each time period: forested area, low-lying vegetation, and soil (divided between dark and light). This division between dark and light soil was solely because the spectral signatures were too different to be considered as one and confused the classification results.

The region of interest (ROI) for the forested area was based on a threshold in the blue band. The ROIs for non-forested land regions were based on polygons. With the resulting ROIs, I then ran a maximum-likelihood classification that covered all the area of the communities. In general, the ROIs were based off polygons for non-forested land and on thresholds for forested lands. After running the classification, I ran a post-classification grouping analysis which smoothed the resulting classes.

Transfer to ArcMap

After performing the post-classification analysis, I opened the data in ESRI's ArcMap, converting it into a shapefile. For the images where I had used four classes, I combined the polygons for dark and light soil into one file. I re-opened the cloud masks that I had created in ENVI, converting those to shapefiles as well to clip the unclassified data from the final area calculations. Once the data was all grouped by land-use class, I used the field calculator to find the area in hectares of each land use class.

3.2 Best Practice Analysis

To address the question of governance structures that maximize benefits to the community, I assess whether and how different Latin American community-level reforestation projects participating in the voluntary carbon market include best practices for REDD projects. I use the framework developed by Homes and Potvin (2014). Homes and Potvin identified "best practices (BPs) from people-centered approaches to conservation and rural development" (2014, p. 1) from a review of the literature, specifically a qualitative research synthesis. After identifying best practices, the authors developed a framework of indicators that they then gave to field practitioners to evaluate different REDD+ projects on their uptake of the best practices. They identified seven best practices, and associated indicators were recommended as a way to evaluate different stages and forms of development of REDD+ projects.

While the framework does not specifically discuss fairness, the seven best practices relate to ensuring that the project focuses on community benefits. Best Practice 1, for example, focuses on local participation, and includes indicators about whether marginalized community members are included in the project (Holmes and Potvin, 2014, p.6). Best Practices 3 and 4 are focused on ensuring that the project matches existing needs and expectations for community development livelihood needs (Holmes and Potvin 2014, p.6). The framework addresses a variety of levels of benefits, including distribution of financial compensation, capacity building, and community development, and the indicators provide a way to assess whether the benefits coming from the project are being directed to and shared within the community.

Table 3.1: Best Practice and Indicator Framework (Holmes and Potvin, 2014, p. 6)	
Best Practice	**Indicators**
1. Ensuring local participation in all phases of the project	Empowerment: sharing power between government and communities and within community members
	Communities having greater control over their resources
	Inclusion of more marginalized members of communities
	Existence of strong local organizations and good leadership
2.Project supported by a decentralized forest governance framework	Policies that allow communities to have greater control over their resources
	Communities' ability to develop and enforce local norms for resource use
	Access to support to enforce these rules
3.Project objectives matching community livelihoods priorities	Providing adequate alternative livelihood options
	Understanding existing community livelihood strategies
	Acknowledging heterogeneity of community groups in their livelihood portfolios
4.Project addressing community developmental needs and expectations	Providing equitable compensation and incentives (household level)
	Providing (tangible) social development benefits
5.Project enhancing collaboration and consensus-building among stakeholders	Communities' ability to build strategic alliance with relevant project stakeholders
	Identification of project stakeholders and their objectives and roles
	Bridging institutions that facilitate dialogue amongst stakeholders
6.Project applying an adaptive management approach to implementation	Iterative approach to learn from implementation adjusting project strategies accordingly
	Monitoring and evaluating information systems to inform implementation
7.Project developing national and local capacities	Existence of bridging institutions that assist communities and government in building capacities

In analyzing the forest carbon projects, I assess whether certain internal governance structures (i.e. cooperatives, NGOs, businesses, and government managed) are associated with the implementation of the best practices, and consider the advantages and disadvantages of each organizational structure in terms of their impact on best practices.

To find organizations to include in the analysis, I first looked at lists compiled by Forest Trends (Forest Trends Ecosystem Marketplace, 2015) that gives a yearly overview of the voluntary carbon market. This report includes companies and organizations that are participating in the market. I was able to access reports from 2015 and 2017, which I used as my initial starting point. From this list, I looked at the individual projects and communities that were producing the carbon offsets. I limited the projects to those that included a reforestation element and were operating in Latin America. Non-forestry-based offset projects were not included. The projects in this list were generally certified using standards like the Verified Carbon Standard, but also included some from the Plan Vivo Standard and the Clean Development Mechanism. I was unable to include some projects from these lists because the information about their project development was only in Portuguese. With this initial selection of organizations, I also included projects that I had come across in the literature, and from companies identified by Forest Trends (Forest Trends Ecosystem Marketplace, 2015) that sponsored more than one community project. In total, I selected five projects that produce carbon offset credits on the voluntary carbon market in Latin America.

Table 3.2: Community-level reforestation projects

Project Name	**Location**
CommuniTree	Nicaragua
ArBolivia	Bolivia
Scole'te	Mexico
COOPEAGRI	Costa Rica
ACOPAGRO	Peru

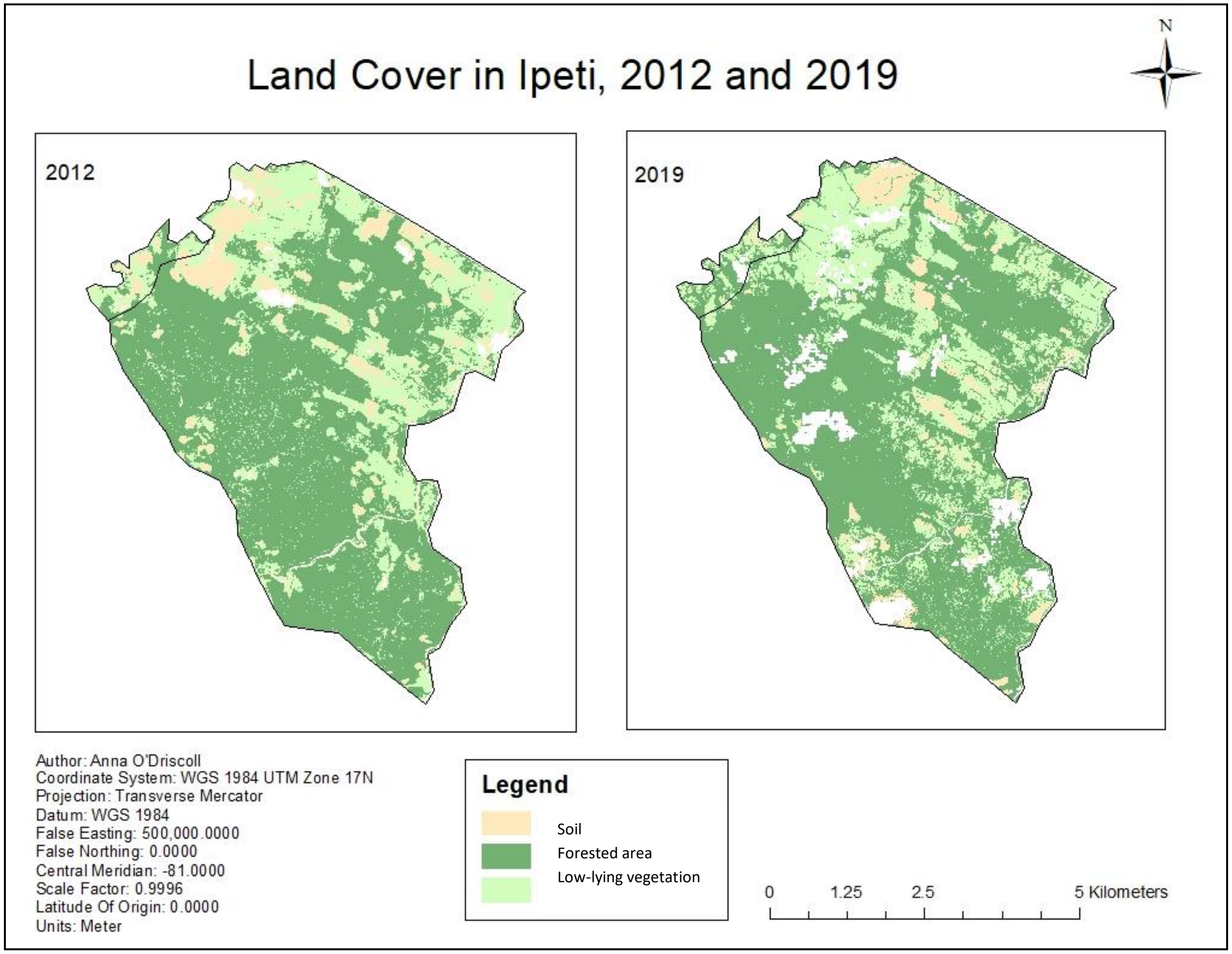
Because the Bayano Carbon project is still in the development phase, my focus for the different projects was on their project design and development stage. While it is also important to assess whether the projects are successful in addressing these best practices in their implementation phase, I specifically focused on whether different organizational and governance structures lend themselves to addressing and engaging with the best practices identified by Holmes and Potvin (2014). Whether or not they are successful in implementing the best practices is a place for further research. For this reason, I focused primarily on the project proposal and development plans available for each project's website. These plans were created for a variety of reasons, usually to apply for carbon certification and verification structures. These included the Verified Carbon Standard, Plan Vivo Standard, and Clean Development Mechanism proposals.

After identifying the projects and finding the proposals, I first took notes on how each project was structured, particularly the different stakeholder organizations involved in the operations of the projects, the relationships between them, and how each of these individual organizations were governed. With the framework from Holmes and Potvin (2014), I then went back to see if there was an indication of the proposal addressing the different best practices, and how it engaged with the indicators of these projects. I assessed this based on whether the project design had something in place that directly engaged with the best practice and indicator, and then wrote a brief explanation for why it did or did not address the indicator and overall best practice. Once I had assessed whether there was engagement with the indicators and why, I looked at all the projects together to see if there were certain practices that were often strongly engaged with or often neglected. There was not a large enough sample size to run tests to see if the results by different structures are statistically significant, so I focused on overall trends.

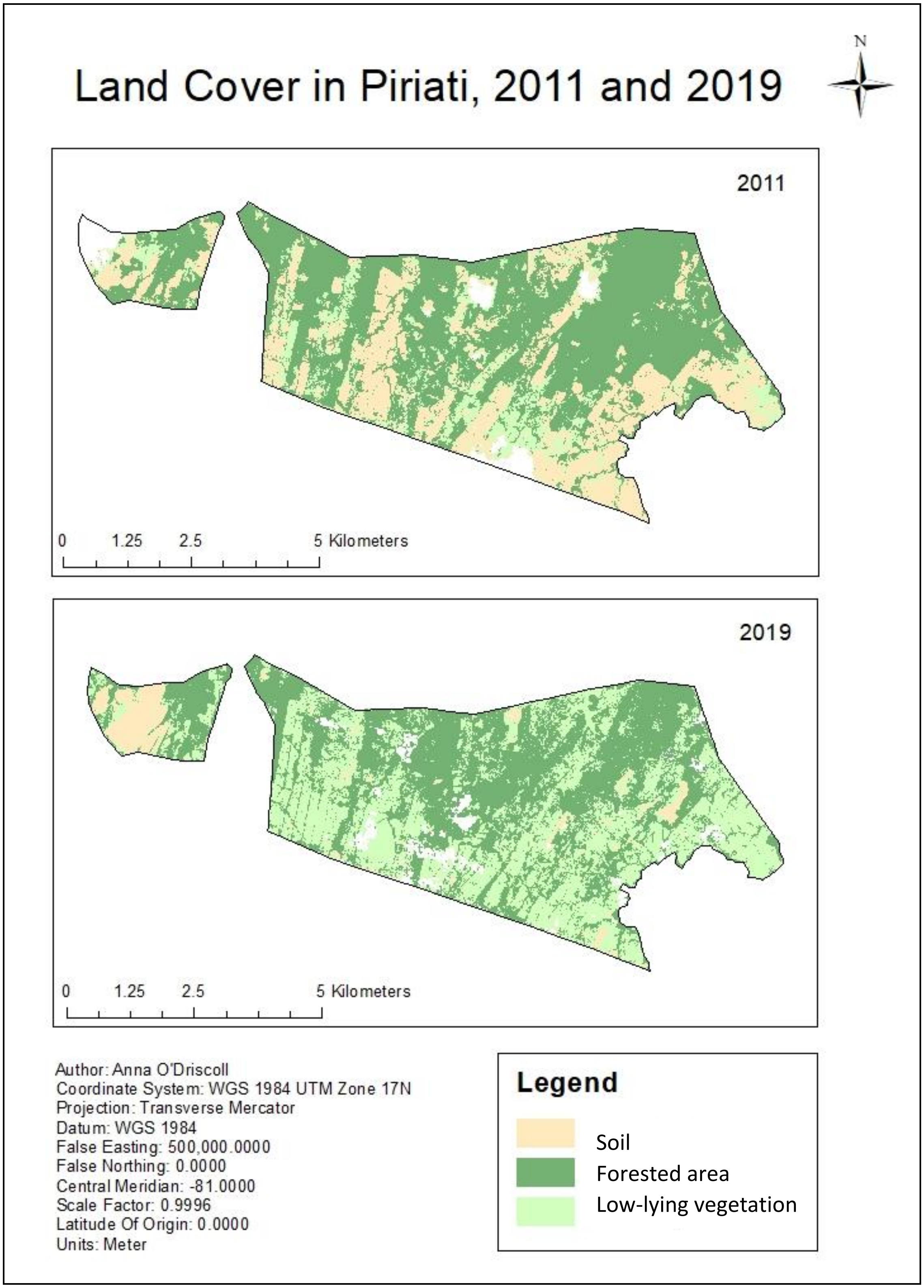
4. REMOTE SENSING RESULTS

The land use patterns demonstrated in Maps 4.1 and 4.2 suggest that Piriatí has faced more deforestation than Ipetí in the previous 10 years. The percent forest cover in Ipetí changed from 65.14% in 2012 to 65.33% in 2019; in Piriatí, the percent forest cover changed decreased from 56.91% in 2011 to 49.8% in 2019. The main areas of forest loss in Ipetí are along the eastern portion of the community. In Piriatí, Map 3.2 indicates loss of forested area in the eastern part of the community, and an overall decrease of non-forested cultivated land (see Tables 2 and 3). While a greater percent of Ipetí is forested, Table 4.1 and Map 3.2 indicate that there is more land for reforestation in Piriatí, where a smaller percentage of the overall classified land is forested. The deforested area is most significant farther south in Piriatí, which follows the road.

There are two key data limitations to keep in mind when assessing these resulting tables. The combined area of the forested and unforested land does not cover the whole area of the community because certain areas were masked out because of cloud cover or otherwise unusable data. Calculations were based on the un-masked area rather than the total area of the community, which could impact the percentage changes demonstrated in Table 3.2. The second limitation is that the time of year in which the pictures were taken could impact the level of vegetation, which could particularly have an impact on the difference between low-lying vegetation and soil (for example, the decrease in low-lying vegetation in Piriatí). As mentioned in the methodology, the timing was not the same for all the analysis. The satellite imagery available was limited by cloud cover for the more recent images, and by lack of access to Planet imagery for the older pictures. In both tables 2 and 3, the numbers for forested land are based from the forest class of each classification, and the numbers for the unforested land are based on adding the remaining classes together.



Map 4.1: Results of land cover classification in Ipetí, 2012 and 2019. Satellite imagery from PlanetLab.



Map 4.2: Results of land cover classification in Piriatí, 2011 and 2019. Satellite imagery from PlanetLab.

For both communities, the maps indicate that there is space for reforestation to happen, given that McGill's contract specifies 20 hectares of reforestation per year (C. Potvin, personal communication, June 2020). It is important to note, however, that the availability of land is not only dependent on physical space but also on whether people are interested in participating. This is critical because participation in this project is voluntary, meaning that this map alone cannot provide information about where reforestation could take place. Previous consultation in the community, however, indicated that there were many families who were interested in participating in the new reforestation project (Forgues & O'Driscoll, 2019).

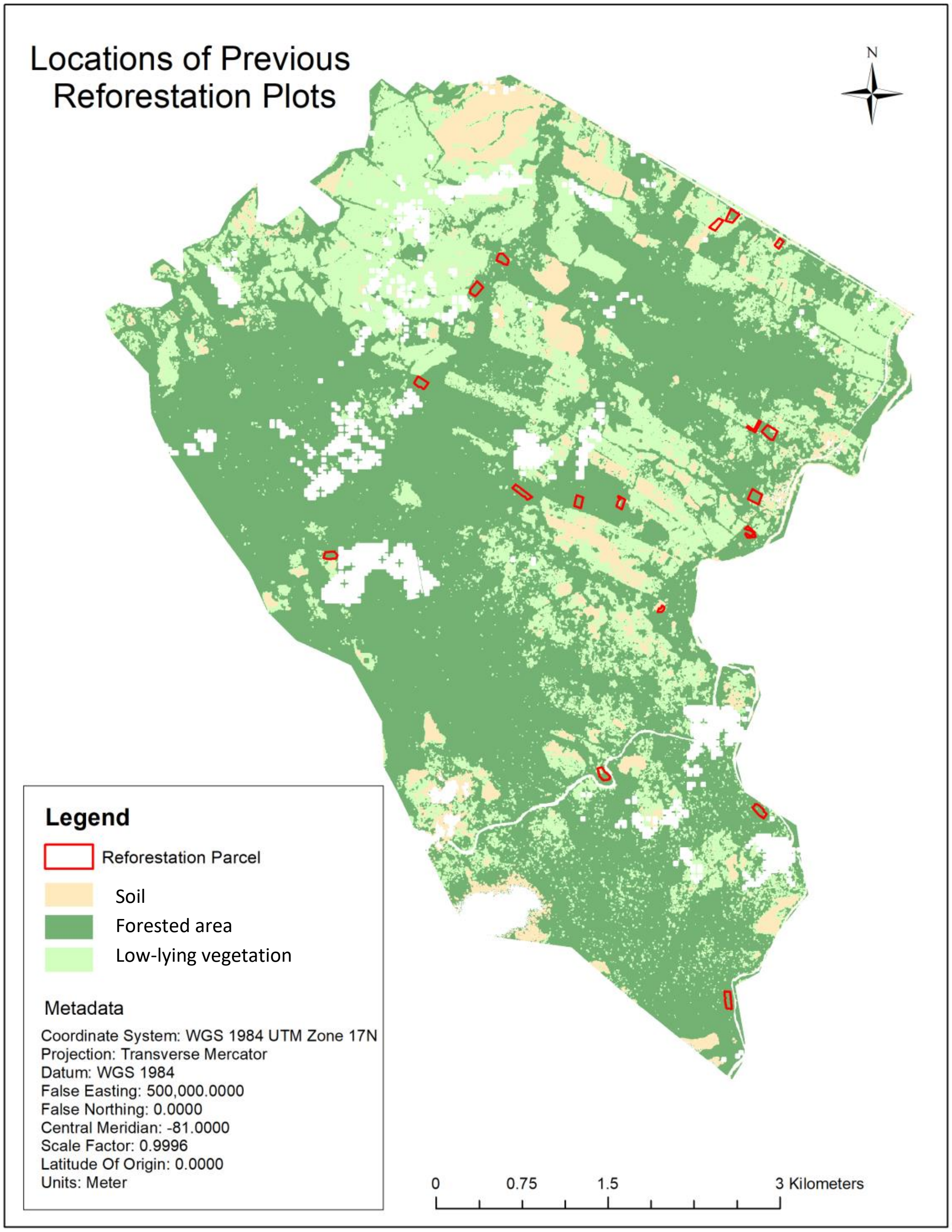
Table 4.1: Area of forested vs non-forested land in Ipetí and Piriatí, hectares (ha)

	Ipetí			Piriatí		
	2012	2019	Change (ha)	2011	2019	Change (ha)
Forested	2087.43	1980.72	-106.70	2122.24	1854.08	-268.16
Low-lying vegetation	821.24	832.84	11.60	484.94	1648.42	1163.48
Soil	295.98	218.18	-77.80	1121.82	220.758	-901.06
Total area	3204.65	3031.75		3729.01	3723.26	

Table 4.2: Area of forested and non-forested land in Ipetí and Piriatí, percent (%)

	Ipetí			Piriatí		
	2012	2019	Change	2011	2019	Change
Forested	65.14	65.33	0.20	56.91	49.80	-7.11
Low-lying vegetation	25.63	65.33	39.71	13.00	44.27	31.27
Soil	9.24	7.20	-2.04	30.08	5.93	-24.15

The land use classification maps of Ipetí provide an opportunity to assess the previous reforestation project that took place; in Map 3, the area of the previous reforestation plots is superimposed on the land use classification. Some of the plots are currently classified as forest and are surrounded by areas that are forested. Others are less forested or bordering areas that are less forested. Other ongoing research on the previous reforestation project in Ipetí indicates that certain tree species and plots experienced much higher rates of mortality than others (Forgues in preparation; Baker, Baumann, Gervais, & van Mossel-Forrester, 2014). Having them mapped could help for further research to see if there are spatial patterns to where the plots did well and where they did not, and guide research into the biological, environmental and sociopolitical factors that impacted the success of the different plantations.



Map 2.3: Location of reforestation plots from previous reforestation contract with STRI. GPS coordinates of plots provided by Christian Pacheco and Milton Solano. Background satellite image taken July 16, 2019.

5. LESSONS FROM PREVIOUS FOREST CARBON PROJECTS

Considering the role of benefit-sharing in addressing fairness in the carbon market, the best practice framework by Holmes and Potvin (2014) prioritizes the interests of local and indigenous communities. Using this framework, I analyze the project development plans from five other community-level forestry projects in Latin America, assessing how they do and do not incorporate these best practices, and drawing lessons to apply to the development of the Bayano Carbon Project in terms of adequately prioritizing benefits for community producers. I first discuss briefly how each of the projects is structured, including the key organizations in each of them and how they interact with each other. I then look at whether and how the projects incorporate the best practices.

5.1 Project Backgrounds

One of the certification mechanisms put in place within the voluntary carbon offset market is Plan Vivo, in which projects are coordinated by in-country non-profits or NGOs and interact with communities through already existing structures like cooperatives or associations (Plan Vivo, 2011). The in-country coordinators organize sale of the carbon credits on the market. Of the three Plan Vivo projects in Latin America, one operates under a small business, one as an NGO, and one as a cooperative. Scolel'te is the original Plan Vivo project, administered by the non-profit trust fund *Fondo Bioclimatico*, and implemented by the cooperative AMBIO (Plan Vivo, 2011). AMBIO is a cooperative that started in 1998 and works directly with the farmers involved in the project.

ArBolivia is one of the three Plan Vivo projects in Latin America. Operating as a small business, the ArBolivia project is administered by the Bolivian company SICIREC Bolivia Ltda, with technical operations coming from the joint venture *Asociación Accidental* CETEFOR SICIREC and community-based companies. This project is financed by outside groups which they have called "ethical investment," derived particularly from groups in Europe. Engagement with members of communities in which the project individual conversations as well as project-specific forestry committees and community enterprises (SICIREC Bolivia, 2011). The project is based on reforestation on individual plots of private property, including agroforestry and silvopastoral practices (SICIREC Bolivia, 2011), with a focus on community development through the creation of Integrated Land-Use Plans (also called Plan Vivo) that take into account each individual smallholder's whole plot, not just that part that is used for the program.

The third Plan Vivo project is CommuniTree in Nicaragua, coordinated by the Canadian non-profit organization Taking Root. The project is based on a sharing of power among the different organizations involved, with an emphasis on "campesino a campesino" interactions (Baker, Baumann, Gervais, & van Mossel-Forrester, 2014). Along with carbon offsetting, the project tries to provide other pathways to income, both in the short and long term (Baker, Baumann, Gervais, & van Mossel-Forrester, 2014). The project proposal includes an analysis of existing community structures and systems, and outlines systems for monitoring the project.

One project certified by the Verified Carbon Standard is the Alto Huayabamba reforestation project. The Alto Huayabamba project is coordinated by *Pur Projet*, a French organization, and operates alongside the cacao cooperative ACOPAGRO. *Pur Projet* is the project developer and coordinates the sale and monitoring of the carbon credits, while ACOPAGRO implements and monitors the project on the ground. ACOPAGRO already had strong relationships and connections within the community, as well as experience with Fairtrade and organic certification, which was part of the reason it was chosen to operate the project by *Pur Projet* (Pur Projet, 2011). The project operates in multiple communities, with a few cooperative members in each community. People participate voluntarily through the cooperative. The cooperative acts as the intermediary between the smallholder farmers producing carbon and *Pur Projet*, which sells the credits on the market. Farmers enter into contracts with the cooperative to sell carbon rights, and ACOPAGRO has a contract to sell them to *Pur Projet*. Farmers maintain rights to the wood produced through the contract and are encouraged to engage in timber production as an additional source of income (Pur Projet, 2011). Farmers enter into contracts with varying degrees of land rights, but one component of the project is that they will gain title by entering into this contract.

COOPEAGRI is a Costa Rican cooperative that hosts a Clean Development Mechanism forestry project. The cooperative has an existing relationship with the communities and smallholder farmers participating in the project. In this CDM project, COOPEAGRI provides the education and technical training to the farmers, and monitors the progress of the offsets. The

National Forestry Financing Fund (FONAFIFO) takes overall responsibility for the project, while financing comes from the BioCarbon Fund through carbon credit purchase. FONAFIFO (*Fondo Nacional de Financiamiento Forestal*) manages some funding and the payment for environmental services program. Farmers sign contracts directly with FONAFIFO, which gives FONAFIFO rights to the carbon. The farmers receive annual payments, but FONAFIFO does not provide any technical or legal assistance to the farmers; this instead comes from local NGOs, though the project proposal document does not specify which organizations (COOPEAGRI Project, 2012). The implementation of the program does not conflict with farmers' existing land use because the contracts are limited by the capacity of individual farmers, which the proposal argues will promote "sustainable rural livelihoods" (COOPEAGRI Project, 2012).

5.2 Inclusion of Best Practices

In order to inform the design of the Bayano Carbon Project, I focused on the project development documents of the five forest carbon projects. Because my analysis was limited to these planning documents, I cannot comment fully on all of the indicators or judge the effectiveness of their eventual implementation. Nonetheless, these documents are comprehensive, so it is worth noting areas of possible best practice that they fail to address.

Local Participation and Decentralized Governance

The first best practice deals with local participation (Holmes & Potvin, 2014). All the projects have an administrative group that might not be in country along with a pre-existing implementing organization on the ground. The CommuniTree project, for example, builds community consultations into its development (Baker, Baumann, Gervais, & van Mossel-Forrester, 2014). Some of the projects specifically discuss how they plan to include more marginalized community members, but others do not. The CommuniTree Project states a desire to include more women in the project (Baker, Baumann, Gervais, & van Mossel-Forrester, 2014) but does not have a specific plan for how to do so. The COOPEAGRI CDM project proposal opens the door to smaller landholders to access the kinds of payments for ecosystem services that are often only accessible to larger, wealthier landholders (COOPEAGRI Project, 2012). Other projects, however, have less specific descriptions of how they plan to include more marginalized members of communities. In some cases, like with the ACOPAGRO project, it may be because much of the implementation is dependent on existing relationships and structures (Pur Projet, 2011). Further analysis is needed on how each of the projects included marginalized members, but my review indicates that plans for inclusion need to be explicitly articulated to meet the best practice criterion.

Sharing power may look different in different contexts. The ArBolivia project, for example, discusses the way power is shared through different organizations, federations, and individual landholders, as well as within the community through new forestry committees (SICIREC Bolivia, 2011). Projects under the Plan Vivo standard (CommuniTree Project, ArBolivia, and Scolel'te) in particular emphasize the community control of resources through their integrated land use plans. Many of the projects include conditions that participants prove title to the land, or lack of conflict. For those who do not have an official title, the ArBolivia project provides alternative methods for allowing people to prove their ownership of the land (SICIREC Bolivia, 2011). Provisions like the integrated land use plans in Plan Vivo and ArBolivia's forestry committees could meet the criterion for decentralized forest governance (Holmes & Potvin, 2014).

Community Priorities and Development Needs

The third and fourth best practices center on matching project goals to community livelihood and development needs, especially through compensation and livelihood strategies (Holmes & Potvin, 2014). Some projects include baseline livelihood surveys to ensure that the projects would not impede existing food production and livelihood alternatives. The CommuniTree project explicitly states short and long-term pathways to income generation (Baker, Baumann, Gervais, & van Mossel-Forrester, 2014). Along with the COOPEAGRI project, they also include different options for reforestation (e.g. agroforestry, silvopastoralism) from among which participants can choose. ArBolivia and other Plan Vivo projects develop Integrated Land Use Plans with each participant, with ArBolivia in particular including mechanisms for selling timber at better prices. ArBolivia has different provisions for how land can be distributed in Indigenous communities (SICIREC Bolivia, 2011).

For ACOPAGRO, the proposal states that in order to provide opportunity for those who cannot participate because their land does not meet standards for reforestation (Pur Projet, 2011), the project will provide mechanisms to sell timber that are not connected to the carbon market. However, the only explicit mention of providing financial benefits to the surrounding community is through the injection of income from participants into the local forestry economy. The proposal argues that it will strengthen community relationships and cohesion through the engagement with the organizational structure (Pur Projet, 2011).

Projects allocate varying percentages of overall profits to community members, to project management or to other stakeholders. For ArBolivia, carbon sales cover the cost of the project, and the rest goes to the smallholders. Farmers get 50% of the proceeds from timber sales in the ArBolivia project (SICIREC Bolivia, 2011). In the CommuniTree project, 60% of funds from carbon sales go directly to farmers, and the organization has a continuous review of the benefit sharing mechanism (Baker, Baumann, Gervais, & van Mossel-Forrester, 2014).

Consensus Building

The projects all identify their different participants, but only sometimes identify them as stakeholders. Very few proposals designate the people buying the credits as stakeholders, focusing instead on the organizations that administer and implement the project. ArBolivia specifically talks about benefit-sharing among different stakeholders (SICIREC Bolivia, 2011). COOPEAGRI has community consultations built into its project development phase, and the emphasis in terms of stakeholders is on community members (COOPEAGRI Project, 2012).

Adaptive Management

Many of the projects have specific monitoring systems built into their project designs. The CommuniTree project describes their Smallholder Carbon Project Management System (Baker, Baumann, Gervais, & van Mossel-Forrester, 2014). COOPEAGRI monitors impacts through the FONAFIFO, allowing for community input (COOPEAGRI Project, 2012). For these groups that build in monitoring systems, there are often reassessments every few years. For some, these evaluations focus on the carbon outputs. For others, they focus on the social benefits of the system.

Capacity Building

CommuniTree aims to create links between smallholders and the local environment agencies as well as broader municipal governments (Baker, Baumann, Gervais, & van Mossel-Forrester, 2014). ArBolivia interacts through existing levels of government (SICIREC Bolivia, 2011). COOPEAGRI and ACOPAGRO both work through existing community structures and are reliant on relationships that the cooperatives already had with other levels of government. ArBolivia's forestry committees focus on capacity building for participants (Plan Vivo, 2011).

6. DISCUSSION

Bringing together the literature review, remote sensing results, and best practice analysis, I now discuss implications for the Bayano Carbon Project. The maps showing change in land cover over time in the Bayano region of Panama can contribute to discussion about the successes of the previous reforestation project that took place in Ipetí. In considering the maps, it is important to keep in mind that they do not tell the whole story because they do not show the social context of landholders' decisions on how to use their land. There are also technical limitations, including when imagery is available and in what season the pictures were taken, that influence interpretation. With respect to my first research question, the maps (see Maps 4.1 and 4.2) indicate that there is adequate physical space for new reforestation in Ipetí and Piriatí, but maps alone are not sufficient to inform the decision of where reforestation could take place.

In assessing the performance of the previous reforestation project from 2008 in Ipetí, there are a variety of reasons why certain reforestation plots might not have been successful, including fires, species composition, or inattention to the plots. There are both biological and social factors that contribute to the results of the previous project (Forgues, 2020 (in progress)), but the social factors underscore the importance of governance structure. With respect to my second research question, along with the success of the carbon sequestering, governance structure is critical in ensuring that benefit-sharing reaches the small landholders in a carbon forestry project, as well as the broader communities. Benefit sharing is a critical component in thinking about the fairness of the carbon project.

While there was little consensus on the definition and application of fairness in the voluntary carbon market, the review of the literature emphasized the importance of *access* and *benefits*: peoples' ability to access the project, and adequate sharing of the benefits among stakeholders. The best practices identified by Holmes and Potvin (2014) provide a framework for thinking about how REDD projects promote sustainable development. Both the literature review and analysis of previous reforestation offset projects suggest that offset projects commonly depend on existing community structures for project implementation.

There are several themes that stand out from the analysis of the planning documents of the previous reforestation projects. In context of the reliance on existing community structures, detailing plans for the inclusion of marginalized community members in project development phase may be critical. The COOPEAGRI project, for example, mentioned ways in which the offset project was making government payment for ecosystem services options open to smaller landholders as well, but explicit plans were not common in the project development documents. Further research would be needed to indicate whether projects were actually successful in implementing the plan.

Of these five projects, three planned the implementation of the project through cooperatives, one through a small business, and one as a non-governmental organization. One area where there are questions of whether governance structure impacts implementation of the best practices centers around compensation measures. Different projects include varying built-in percentages of carbon sales that go directly to the smallholders versus to covering program costs. In the CommuniTree project, for example, 60% of the sale of carbon offsets goes directly to farmers (Baker, Baumann, Gervais, & van Mossel-Forrester, 2014), whereas in the ArBolivia project, "smallholders receive 50% of the net revenues obtained" (SICIREC Bolivia, 2011, p. 20). While this sample size is not large enough to draw concrete conclusions, it is important to consider whether different governing structures cost more to operate, leaving less compensation for the farmers.

To address the best practices surrounding livelihood goals and development options, one trend across a few projects involved systems they put in place to propose sources of income from the project in the short, medium, and long term, ensuring that the benefits of the project did not stop once the initial planting was done. However, many of the benefits were specific to individuals rather than communities.

Since the five projects operated under three different certification schemes, it is interesting to note similarities between the emphases of the projects and differences between schemes noted in the literature (for example, Corbera, Estrada, and Brown, 2009). The Plan Vivo projects emphasize integrating the project into overall land management, with a strong emphasis on co-benefits. Bumpus and Liverman (2011) argue that CDM projects place less emphasis on social co-benefits than projects operating on the over-the-counter market. With the case of the project operating through COOPEAGRI, the proposal indicates that co-benefits will come from improved land management practices that will "promote sustainable rural livelihoods" (COOPEAGRI Project, 2012). While there is a discussion of co-benefits, the emphasis is on how the program allows for them as well.

The role of land tenure in the five reforestation projects I have reviewed is interesting in the context of historical struggles over land ownership in the Bayano Emberá communities (Wali, 1993). Having access to land title was a critical component for participating in these five projects, and some projects helped participants gain more official title to their land. While land titling and tenure systems are different everywhere, literature suggests that there is a relationship between tenure systems and the degree of adoption of conservation measures (for example, Abdulai, Owuso, & Goetz, 2011).

7. CONCLUSION

The expansion of the Emberá Bayano Carbon project, and decision from McGill University to invest in it, raises important questions broadly about fairness in the voluntary offset market and specifically about the design of the project to ensure that the benefits from the project adequately reach those who are participating. Offset projects like this are not stand-alone efforts to combat climate change; institutions like McGill University need to take other steps to combat climate change in conjunction with investment in small-scale reforestation initiatives like the Bayano project. Even though these projects are not the sole solution to combatting climate change, they can provide benefits to communities involved in carbon offset production outside the offsetting of emissions. In a context where climate change already has disproportionate effects on marginalized populations, the benefits from projects aiming to mitigate its effects should predominantly accrue to those populations.

The results of my remote sensing analysis indicate that there is sufficient physical space for further reforestation to take place in Ipetí and Piriatí, and my analysis of other forest carbon projects in Latin America raises important questions and considerations for how best to structure the Bayano Carbon Project so that the benefits reach community members. These considerations include the importance of plans for ensuring income generation over time and inclusion of marginalized community members in project design, especially in projects relying on existing community structures. The key components of the best practices need to be articulated in detail in project design. Project design must be rooted in local consultation. It is important to ensure that the governance structures of forest carbon projects adequately prioritize benefit-sharing from project design stage through implementation.

References

Abdulai, A., Owusu, V., & Goetz, R. (2011). Land tenure differences and investment in land improvement measures: Theoretical and empirical analysis. *Journal of Development Economics*, 66-78.

Bachram, H. (2004). Climate fraud and carbon colonialism: the new trade in greenhouse gases. *Capitalism Nature Socialism*, 5-20.

Baker, K., Baumann, D., Gervais, S., & van Mossel-Forrester, B. (2014). *Plan Vivo Project Design Document (PDD) CommuniTree Carbon Project.* Retrieved from Plan Vivo: https://planvivo.org/docs/CommuniTree-PDD-2014.pdf

Boyd, E., Gutierrez, M., & Chang, M. (2007). Small-scale forest carbon projects: Adapting CDM to low-income communities. *Global Environmental Change*, 250-259.

Bumpus, A. G., & Liverman, D. M. (2010). Carbon colonialism? Offsets, greenhouse gas reductions, and sustainable development. In R. Peet, P. Robbins, & M. Watts (Eds.). Routledge.

Ciscell, G. M. (2010). Beyond CO2lonialism: the potential for fair trade certification to embrace voluntary carbon offsets. *International Journal of Sustainable Society, 2*(2), 121-132. doi:10.1504/IJSSOC.2010.033625

COOPEAGRI Project. (2012). *Project 7572 : Carbon Sequestration in Small and Medium Farms in the Brunca Region, Costa Rica (COOPEAGRI Project) .* Retrieved from CDM UNFCCC: https://cdm.unfccc.int/Projects/DB/AENOR1349188271.57/view

Corbera, E., & Brown, K. (2010). Offsetting Benefits? Analyzing Access to Forest Carbon. *Environment and Planning A: Economy and Space*.

Corbera, E., Estrada, M., & Brown, K. (2009). How do regulated and voluntary carbon-offset schemes compare? *Journal of Integrative Environmental Sciences*, 25-50.

Forest Trends Ecosystem Marketplace. (2015). *Ahead of the Curve: State of the Voluntary Carbon Markets 2015.* Retrieved from Ecosystem Marketplace: https://www.forest-trends.org/wp-content/uploads/2015/06/State-of-the-Voluntary-Carbon-Markets-2015.pdf

Forest Trends Ecosystem Marketplace. (2017). *Unlocking Potential: State of the Voluntary Carbon Markets 2017.* Retrieved from Ecosystem Marketplace: https://www.forest-trends.org/wp-content/uploads/2017/07/doc_5591.pdf

Forgues, K., & O'Driscoll, A. (2019). *Development of a carbon tourism project in the Ipetí Emberá Community.* Panama City, Panama.

Gebara, M. F. (2013). Importance of local participation in achieving equity in benefit-sharing mechanisms for REDD+: a case study from the Juma Sustainable Development Reserve. *International Journal of the Commons*, 473-497.

Google. (n.d.). *[Map of Panama]*. Retrieved 04 20, 2020, from Google Maps: https://www.google.com/maps/@8.3777,-80.1053645,7z

Holmes, I., & Potvin, C. (2014). Avoiding Re-Inventing the Wheel in a People-Centered Approach to REDD+. *Conservation Biology*, 1-14.

Holmes, I., Kirby, K. R., & Potvin, C. (2017). Agroforestry within REDD+: experiences of an indigenous Embera community in Panama. *Agroforestry Systems*, 1181-1197.

Howard, R. J., Tallontire, A. M., Stringer, L. C., & Marchant, R. A. (2016). Which "fairness", for whom, and why? An empirical analysis of plural notions of fairness in Fairtrade Carbon Projects, using Q methodology. *Environmental Science & Policy*, 100-109.

Howard, R. J., Tallontire, A., Stringer, L., & Marchant, R. (2015). Unraveling the Notion of "Fair Carbon": Key Challenges for Standards Development. *World Development*, 343-356.

Howard, R., Tallontire, A., Stringer, L., & Marchant, R. (2014). *What lays at stake for standards organisations pursuing fairness in the carbon market? Lessons from literature applied to practice in the carbon market.* Unitersity of Leeds. Leeds: Sustainability Research Institute. Retrieved from https://www.cccep.ac.uk/wp-content/uploads/2015/10/WP-191-Howard-et-al-2014.pdf

Kirby, K. R., & Potvin, C. (2007). Variation in carbon storage among tree species: Implications for the management of a small-scale carbon sink project. *Forest Ecology and Management*, 208-221.

Lee, D.-H., Kim, D.-h., & Kim, S.-i. (2018). Characteristics of forest carbon credit transactions in the voluntary carbon market. *Climate Policy*, 235-245.

Lindhjem, H., Aronsen, I., Bråten, K. G., & Gleinsvik, A. (2011). *Experiences with Benefit Sharing: Issues and Options for REDD-Plus.* International Union for Conservation of Nature (IUCN).

Lipper, L., & Cavatassi, R. (2004). Land-Use Change, Carbon Sequestration and Poverty Alleviation. *Environmental Management, 33*, S374-S387.

Lovell, H. C. (2010). Governing the carbon offset market. *WIREs Climate Change*, 353-362.

Lovell, H., Bulkeley, H., & Liverman, D. (2009). Carbon offsetting: sustaining consumption? *Environment and Planning A*, 2357-2379.

Mathur, V. N., Afionis, S., Paavola, J., Dougill, A. J., & Stringer, L. C. (2014). Experiences of host communities with carbon market projects: towards multi-level climate justice. *Climate Policy*, 42-62.

Merger, E., & Pistorius, T. (2011). Effectiveness and legitimacy of forest carbon standards in the OTC voluntary carbon market. *Carbon Balance and Management*, 1-12.

Phillips, D. P. (2014). Uneven and unequal people-centered development: the case of Fair Trade and Malawi sugar producers. *Agriculture and Human Values*, 563-576.

Plan Vivo. (2011). *Project fact sheet | Scolel Té Plan Vivo Project .* Retrieved from Plan Vivo: https://www.planvivo.org/docs/Scolel_Te_factsheet1.pdf

Pur Projet. (2011, December 02). *Project Description Alto Huayabamba.* Retrieved 2020, from Verified Carbon Standard Project Database.

Robinson, C. J., Renwick, A. R., May, T., Gerrard, E., Foley, R., Battaglia, M., . . . Walker, D. (2016). Indigenous benefits and carbon offset schemes: An Australian case study. *Environmental Science & Policy*, 129-134.

Savasta-Kennedy, M. (2009). The Newest Hybrid: Notes toward standardized certification of carbon offsets. *North Carolina Journal of International Law and Commercial Regulation*, 851-890.

SICIREC Bolivia. (2011). *Plan Vivo Project Design Document ArBolivia.* Retrieved from Plan Vivo: https://planvivo.org/docs/ArBolovia_PDD_-1909-with-annex.pdf

Wali, A. (1993). The Transformation of a Frontier: State and Regional Relationships in Panama, 1972-1990. *Human Organization*, 115-129.