Environmental Impact Assessment of *Guadua aculeata* Plantations

San Jose ERF, El Rama, Nicaragua

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1. INTRODUCTION

1.1. GENERAL INFORMATION

EcoPlanet Bamboo Central America (EPBCA) is an LLC company located in the Nicaraguan municipalities of Rama and Kukra Hill. Since 2011, EPBCA has developed plantations of *Guadua aculeata* covering 1300-ha for commercial use in a variety of products for construction, biomass energy, and charcoal products. Industrial processing of more than 150 thousand tons of bamboo culms are predicted annually. Its operations are concentrated in these areas based on criteria of efficiency, effectiveness, and operational opportunities to reduce costs. Additionally, these areas meet the environmental and social goals of EPBCA where it aims to have significant positive environmental and social impacts on climate change and poverty alleviation. The company includes within its development plans to expand their plantation areas along the surrounding river network to optimize operations and production centers. EPBCA also has a strict policy associated with the type of land acquired and used for their plantations in terms of legality and previous land use.

In August 2012, EPBCA purchased a new property in the municipality of Rama and lies on the southern edge of the Rio Escondido approximately 14-km southeast of the Port Rama property (main offices). The new property is called San Jose ERF and has an area of 1391-ha. This property will be managed against the criteria of international certifications (FSC, VCS and CCBA) and consequently an Environmental Impact Assessment (EIA) must be conducted across the new property. For plantations of the genus *Bambusa* or *Guadua* it is not required by Nicaraguan legislation, as these are species of the family *Poaceae*. However, at EPBCA strives to meet international certification standards an EIA of environmental and social impacts will be conducted.

This analysis will complement the EIA document prepared by the company "Fiallos Consultores y Asociados SA" for the project of *Guadua* plantations in Central America by EcoPlanet Bamboo on Rio Siquia and Rio Kama. It should be emphasized that EPBCA holdings are held within the same municipalities, watersheds, biomes, and ecosystems. Their natural ecosystems, achieved through conservation areas, share similar environmental conditions, historic land use, soil and climate conditions, and socioeconomic conditions. It is noteworthy that these environmental factors are similar or identical within the same agro-ecological zone since management systems are anticipated to impact these conditions in similar manners as outlined in the original EIA's for Rio Siquia and Rio Kama. We utilize results and proposals from the Rio Siquia and Rio Kama EIAs as well as the measures outlined in the mitigation plan as they are valid for the expansion of areas. Nevertheless, EPBCA has conducted an internal EIA of the San Jose area in order to detect any possible environmental impacts that may be unforeseen due to unique conditions of San Jose.

1.2 SUMMARY OF THE PROJECT

EcoPlanet Bamboo has initiated several projects in Nicaragua for the development and management of *Guadua aculeata* plantations. The goal of these plantations are to provide quality fiber products that are competitive with traditional forest products such as construction materials, biomass pellets, and charcoal products. EPBCA has been recognized for its excellent business principles supported, transparency, profitability, improvement in quality of life, environmental protection, and promoting local economic development through various awards including the IAIR Sustainability Award, National Leader in Occupational Health, and has been recognized by WWF for a solution to address tropical deforestation. It should be reiterated that the company has a large financial commitment to investors, to receive the benefits of the proposed investment and maintains a detailed environmental policy in the context of all that develops and manages plantations. Beyond its financial obligations, EPBCA seeks to provide returns based on promoting sustainable development, ecosystem protection, and welfare of communities. The operations generate positive impacts on socio-economic aspects in the surrounding populations in plantation areas through job creation, income families, and land management. EPBCA provides support to local initiatives in the area of El Rama and improving productive infrastructure to reduce carbon footprint.

The company has also made inroads into the voluntary carbon market, business opportunities, and sustainable management that have been approved in audits conducted by the Rainforest Alliance in 2012. EPBCA managed to achieve three international certifications:

1. Forest Stewardship Council (FSC) for sustainable forest management.
2. Climate, Community and Biodiversity Standards (CCBA)
3. Verification of Carbon Standard (VCS) for certification of carbon credits tradable

In this context the actions undertaken by the company are activities that contribute to mitigation and adaptation to severe climate changes affecting the world, pollution generated by industries in developed countries, and prevention of high rates of deforestation in tropical countries. This financially viable and environmental friendly project contributes to local and global reduction of greenhouse gases that are creating worldwide catastrophic weather events and the occurrence of extreme weather events such as the variability of climate, summers, excessive sun exposure, disease, fire, drought, or melting of the poles. In this sense, bamboo species is important as some species can adsorb more than 12 tons of carbon dioxide/ ha making it a valuable asset in the fight against global warming. Many studies indicate an estimated 54 metric tons / ha of carbon dioxide fixation in the first six years of plantation growth potential of *Guadua.*

In addition to the beneficial climatic benefits of *G. aculeata* it also possesses the ability to be a highly sustainable. At full productivity *Guadua* bamboo can produce approximately 91 dry tons of bamboo each year. In comparison to other natural fiber resources this ranges from 4.5 – 144 time more productive (Table 1.1). Bamboo far outpaces the productivity of other land uses and represents an efficient land use for the production of alternative fiber sources.

Wood Type	Dry tons/ha/year	Bamboo: Wood Type biomass ratio
Loblolly Pine	17.1	**5**
Eucalyptus	20.2	**4.5**
Natural Hardwood	2.2	**41**
Teak (short rotation)	8.1	**11**
Teak (long rotation)	3.375	**27**
Tropical Forest	.711	**144**

Table 1.1. Comparison of bamboo productivity in dry tons per year to other plantation and natural forests

1.3 GOALS

1.3.1 PURPOSE OF THIS DOCUMENT

This document will demonstrate the environmental impacts, both positive and negative, of the project activity in the expansion areas for plantations of *Guadua aculeata*. This document will analyze the geographic and administrative context of the San Jose farm, the current environmental baseline of the farm, project activities to be implemented during the project, assessment of the environmental impacts of each activity, and mitigation strategies for any negative environmental affects.

1.3.2 OBJECTIVES OF THE EIA

Identification and assessment of environmental impacts, to indicate possible corrective measures to mitigate environmental damage or alterations, through the implementation of actions identified in the mitigation plans specified in the EIA for the expansion of 455.61 acres of bamboo plantations in FRA Siquia River Villa, in the municipality of El Rama, RAAS plantations in Bamboo *(Guadua aculeata).*

The specific objectives of the EIA include:

1. Characterize the current environmental baseline and interpretations of environmental impacts in the management, production and processing of bamboo, on environmental factors in the area of influence of the San Jose ERF;
2. Contribute to decision making about environmental sustainability of plantation area expansions with technical support;
3. Design the necessary mitigation measures and prepare the implementation plan and monitoring of cause - effect and assess the magnitude of the environmental impacts that may be caused in each of the phases of the project as a new phase of expansion
4. Propose additional environmental measures if necessary to strengthen the process to prevent, avoid, control or compensate for the potential negative impacts that may incurred in the project area

5. Identify environmental risks of expanding the project Rio Siquia and consider the environmental effects and their probabilities of occurrence in each of the project phases (nursery, planting and harvesting).
6. Design the Environmental Management and designing respective actions to be implemented in each phase of the expansion project, establishing complementary plans for monitoring, contingency plans, waste management plans, monitoring plan, in case required.

1.4 EIA INVESTIGATE TEAM

According to the basic standards for the preparation of an EIA it is necessary to have a multidisciplinary team of the appropriate size and expertise. In this instance a team of specialists in natural resources and plantation management will be assembled in order to collect the appropriate data. Each specialist was responsible for the proposal of an effective methodology and the collection of data from the field. The multidisciplinary team collaborated to achieve consensus on indicators that impact positive or negative environmental factors and through meetings of experts reach a consensus on the criteria and rating for each element in the application of the methodologies to be applied.

The following information will be generated and collected through field work:

1. Primary data source: tours, visualization and sampling of forests, wildlife, terrain, topography and physical and chemical soil conditions (soil sampling). Socioeconomic data through interviews and polls of local community leaders, officials, and individuals
2. Data obtained from secondary sources of information in the project area and the region.
    a. Satellite images, if possible:
    b. Aerial photographs:
    c. Cartography.
    d. General base, obtained of seismometers, maps 1:50,000 or 1:10,000 scale mapping.
    e. Existing thematic maps.Specialized documents about natural physical and socioeconomic conditions of the study area.

The multidisciplinary team for the execution of the EIA included the members and their associated expertise outlined in Table 1.1.

Item	Profession/ Skill	Person/ Group	Function within the team
1	Coordinator & Principal Author	Jonathan Sullivan (EPB)	Coordinator of the team and provides orientation of the study. Presents appropriate methods and survey designs to be used and schedules implementation in the field. Responsible for the technical quality of the EIA.
2	Sociology, Anthropology	FUNDENIC	Responsible for the methodology, collection, analysis, and presentation of results of a socioeconomic study of the project areas.
3	GIS Specialist	Dein Muñoz	Responsible for generating all maps relevant to the report including maps of the general area, abiotic environment, biotic environment, sampling methodologies, and collection of GPS data in the field.
4	Soil Specialist	Juan Carlos Camargo/ DisAgro	Responsible for determining the classification of soils in the surrounding project area by physical and chemical properties from sampling and analysis.
5	Operations Specialist	Bernard Vogel (EPBCA) & Sergio Sanchez (EPBCA)	Responsible for presenting updated knowledge on all operations within the San Jose farm and summarizing. Additionally, responsible for delineating future activities such as harvest and roads and potential areas for their construction.
6	Forestry	Juan Carlos Camargo, Sergio Sanchez (EPBCA), and Jonathan Sullivan (EPB)	Coordinator of the team and provides orientation of the study. Presents appropriate methods and survey designs to be used and schedules implementation in the field. Responsible for the technical quality of the EIA.

Table 1.2. Multidisciplinary team with internal resources and hired groups to carry out an EIA.

2. PROJECT LOCATION & DESCRIPTION

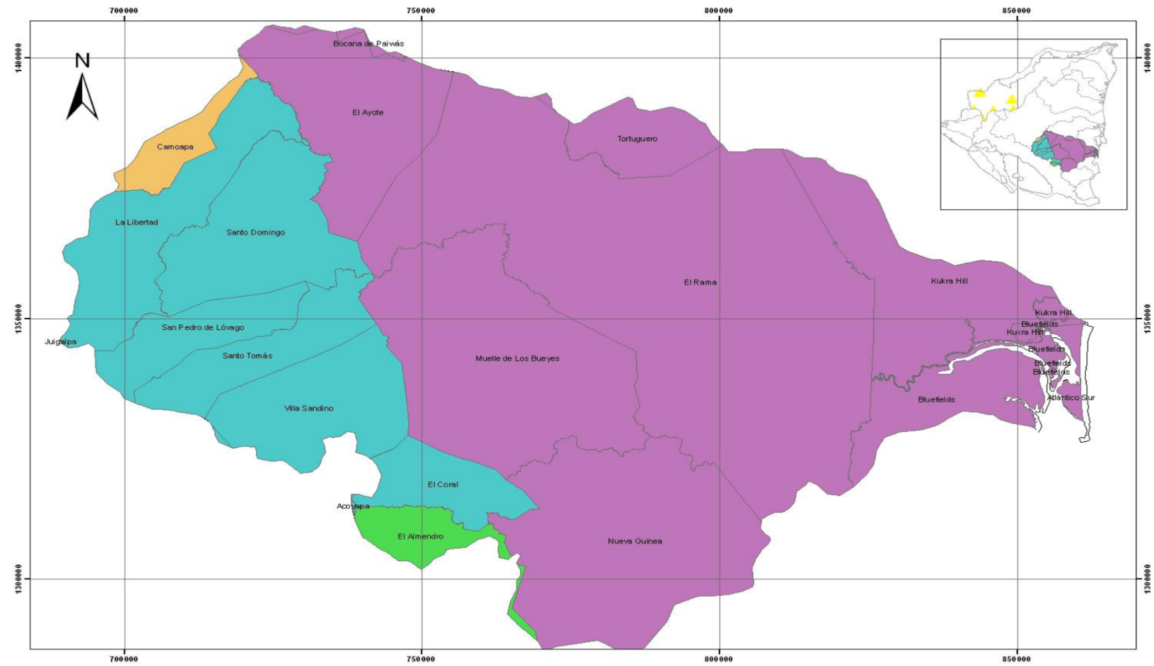
2.1 PROJECT LOCATION

2.1.1 MACRO LOCATION

The Autonomous Region of the South Atlantic (RAAS) is located in the south-eastern part of Nicaragua, between 11º 41' and 13º 06' north Latitude and between 83º 03'and 85° 07' west longitude. It extends from the River Grande de Matagalpa north up to the Indian River to the south and from the Caribbean Coast to the east to Boaco, Chontales, and San Juan River to the west and covers 21.1% of the country. The RAAS is divided into twelve municipalities with the departmental capital of Bluefield (Map 2.1). The department extends from the mountains of central-south of the country to the Caribbean Coast in an extensive plain with highly diverse ecosystems, including lowland rainforest, mangroves, wetlands, flooded forests and ecosystems of ecological and economic importance such as lagoons, estuaries, and marine areas. The RAAS receives more precipitation than in the north, with precipitation increasing to the south and inland to the coast. The temperature is fairly uniform across the territory and is high throughout the year (average 27º C).

Map 2.1: Map of municipalities within the RAAS

An additional important geographic boundary for the project area is the Rio Escondido watershed (No. 61). San Jose ERF is located in the southeastern portion of this watershed which contains portions of the Chontales, Rio San Juan, and RAAS departments. With the El Rama department this watershed includes El Ayote, Muelle de Los Bueyes, Tortugeuro, El Rama, Nuevo Guinea, Kukra Hill, and Bluefields municipalities (Map 2.2).



Map 2.2. Rio Escondido watershed (No. 61) in the RAAS

The RAAS and Rio Escondido watershed are considered to be part of the "agricultural frontier" which has seen the expansion of cultivation and livestock management at the cost of natural forests. The primary land use within the RAAS is tacotal and shrublands, a form of degraded forest, which is followed second by managed pasture lands (MARENA, 2010) (Table 2.1). The remaining natural ecosystems left in the Caribbean Coast are characterized by a variety of representative ecosystems and wildlife species that holds a natural wealth of great importance, both nationally and regionally. However, it is a sensitive area to the anthropogenic pressures and natural disasters, both of which have an impact on its biodiversity´s potential. All these ecosystems are important habitats for various residents, migratory water, and land species.

The RAAS is characterized by a multicultural and multilingual population descended from indigenous peoples. They are Afro Caribbean immigrants composed mainly by mestizos (81%), Creole (8.5%) Miskito (6.5%), Sumo (2%), Garifuna (1.5%) and Ramas (0.5%). The Atlantic Coast is considered to be one of the poorer regions within Nicaragua and is lacking in a number of key development categories. Census data shows that enrollment in secondary school precipitously declines following primary school (INIDE, 2012) (Table 2.2). Consequently significant portions of the population in the RAAS remain without higher degrees of education. Infrastructure within the Atlantic Coast also lags behind the rest of Nicaragua as it produces only 0.10% of the country's potable water despite hosting 6% of the population (INIDE, 2012). This region falls behind in other categories such as energy, transportation, and employment.

Land Use	Area (km^2)	Area (%)
Water	33.93	0.32
Bamboo Forest	0.58	0.01
Coniferous Forest	0.16	0.00
Deciduous Forest	470.34	4.38
Sugar Cane Agriculture	39.30	0.37
Cacao & Plantain	2.70	0.03
Urban Areas	21.82	0.20
Annual agriculture	89.12	0.83
Grassland with Trees	1600.94	14.90
Mangroves	2.41	0.02
Managed pasture	3411.42	31.75
Bare soil	1.14	0.01
Tacotal and Shrublands	4931.43	45.89
Inundated land	138.19	1.29
Invasive Vegetation	1.76	0.02

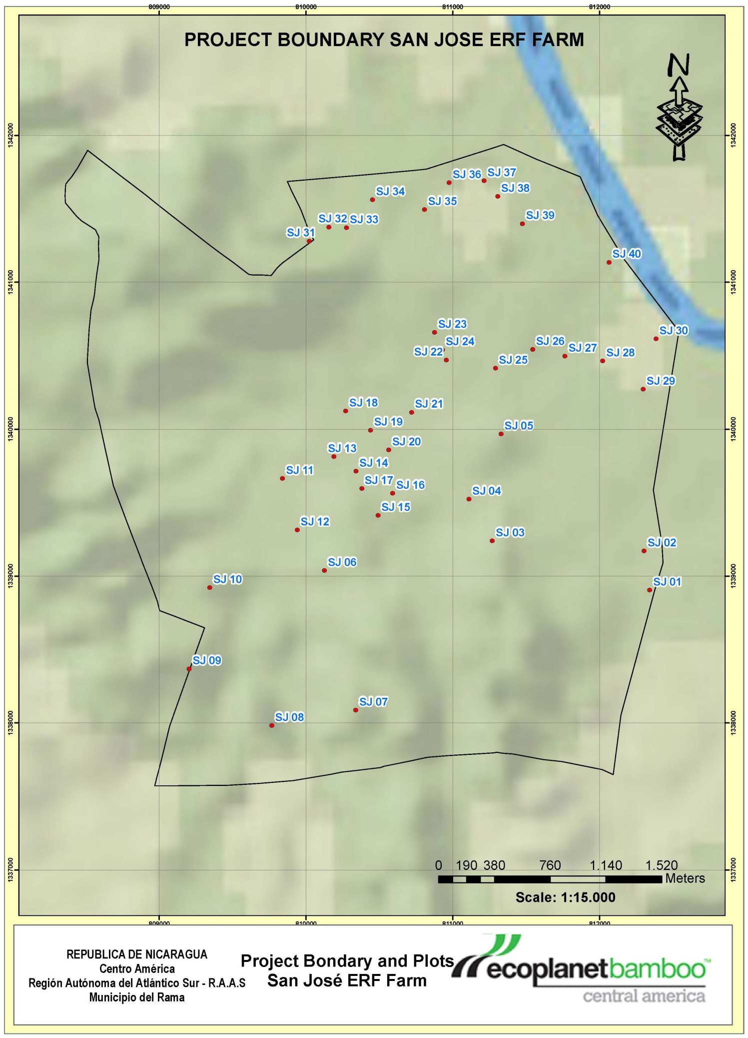
Table 2.1: Land uses with the Rio Escondido watershed (Adapted from MARENA 2010)

	Preschool	Primary School	Secondary School
Men	6,110	37,283	11635
Women	6,101	35,162	13397
Both	12,211	72,445	25,032

Table 2.2: Census data of initial enrollment in preschool, primary school, and secondary school

2.1.2 MICRO LOCATION

San Jose farm is located in the municipality of El Rama. The municipality of El Rama is located at coordinates 12° 09 'North latitude and 84° 13' West longitude. The height above sea level is 9.71 meters. It has an area of 3752.9 km^2, an area that represents 13.6% of the RAAS that records a total of 27,546.32 km^2. From the 12 municipalities of the RAAS, El Rama is the second in area. It is bordered to the North by the municipality of El Tortuguero, to the South by the municipalities of Muelle de los Bueyes and Nueva Guinea; to the East with the municipalities of Kukra Hill and Bluefields and to the West by the municipalities of Santo Domingo and El Ayote. The county seat is located at the confluence of the Rivers Rama and Siquia, where the Escondido River rises. The capital city of Managua is at 292 km on paved road from the project area. El Rama contains a river port that is an active national and international asset for trade and commerce. The port is within the town Rama, located approximately where the paved road to Managua ends, and empties via the Escondido River into the Atlantic Ocean near Bluefields.



Map 2.3: Project boundary of San Jose ERF in El Rama, Nicaragua

2.2 National and International Policies

2.2.1 National Policies

The two bodies that govern forestry in Nicaragua are:

- MARENA: the Ministry of Environment and Natural Resources
- INAFOR: the National Forestry Institute

Within these two institutions, the laws governing the development of forest resources in Nicaragua are as follows:

- Ley General del Ambiente
- Ley forestal

- Reglamento forestal
- Normas Técnicas y Disposiciones Administrativas del Instituto Nacional Forestal (INAFOR)
- Ley de áreas protegidas y su reglamento
- Ley de Autonomía de las Regiones de la Costa Caribe (RAAN y RAAS)
- Código del Trabajo

In addition to laws concerning the environment there are several laws pertinent to the conduct of EPBCA within the health and municipal sectors:

- Law 394, Law on Sanitary Provisions
- Law 618, General Law on Hygiene and Safety
- Law 40, Municipal Law
- Law 261, Amendments and Additions to Law 40, Municipal Law

EcoPlanet Bamboo's San Jose ERF plantation has been developed in line with all above laws and regulations. These laws are available within EcoPlanet Bamboo's offices in Managua and Rama, and are familiar to all management.

EcoPlanet Bamboo met with MARENA and INAFOR in April 2011, prior to project development, and obtained verbal approval for the development of plantations of *Guadua aculeata* in the RAAS. On March 13, 2012 we received an official letter from the regional government of Bluefields (RAAS) stating that we have approval from their government for all present and future activities in their region. This letter is available in Annex I.

While domestic use is well established, the development of bamboo as a commercial resource is a relatively new concept in Nicaragua. As such, EcoPlanet Bamboo is committed to working with MARENA and INAFOR to develop appropriate policies and regulations surrounding the growing, harvesting, and export of a bamboo product.

2.2.2 International Policies

In addition to national laws, Nicaragua is a party to the below conventions which revolve around environmental concerns. Abiding by the regulations of the FSC and various standards for project design and carbon certification, EcoPlanet Bamboo works towards ensuring that its plantation is not only in line with the below conventions, but contributes positively to their objectives.

- CITES
- ILO Convention
- ITTA
- UN Convention on Biological Diversity
- UN Framework Convention on Climate Change
- UN Convention to Combat Desertification

2.3 PROJECT PHASES

The San Jose ERF Project consists of three phases: nursery (PI), plantation maintenance (PII) and harvesting (PIII). The number of staff will vary from one stage to another. At each stage the involvement of experienced personnel is very important considering that bamboo is a new resource for commercial plantations. Local labor will be used whenever available, and maintenance workers will be hired for long-term employment, making it a sustainable source of income to local communities. It is estimated that over 150 people will be hired, among which are going to work in the nursery and in the plantations.

2.3.1 NURSERY OPERATIONS – PHASE I

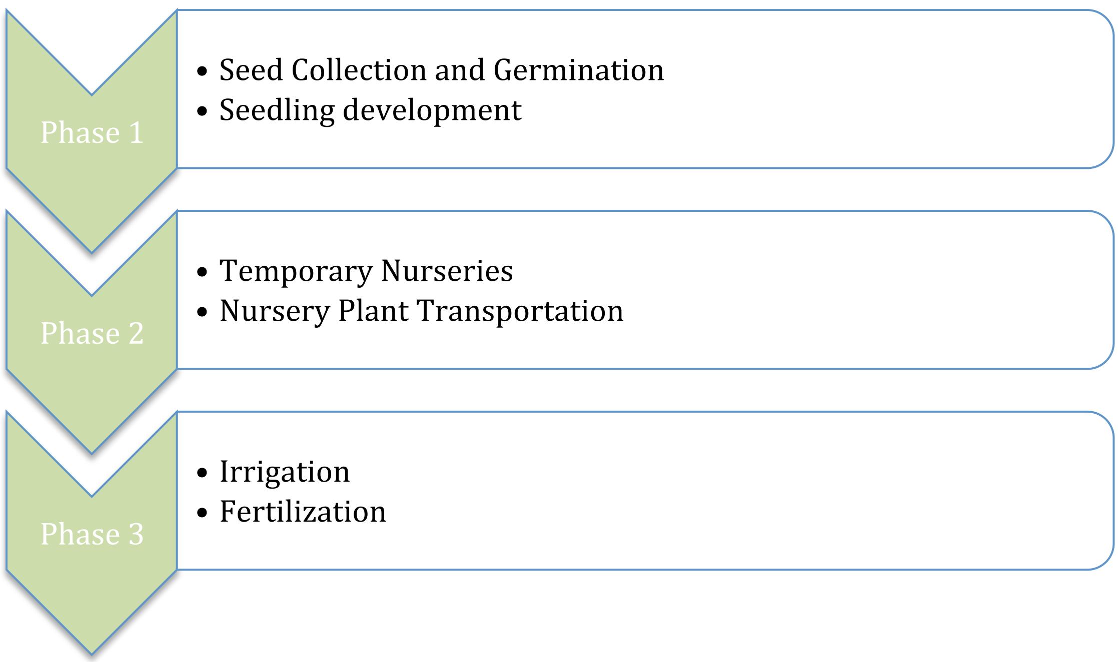


Figure 2.1. Project phases for nursery operations

SEED COLLECTION AND GERMINATION

Guadua aculeata mass flowered in Nicaragua from 2008 – 2011; enabling EcoPlanet Bamboo to acquire propagation material for its reforestation activities. EcoPlanet Bamboo entered into a contract with Ruben Rugama, a community leader in an area called El Cua, who has been cultivating Guadua on his land for the past decade. In addition Ruben has organized the communities with access to seeds and seedlings within the forest to collect such seed, therefore earning valuable income.
Upon the collection of seed it is cleaned and dried and sown into seedbeds within the nursery. Once in the seedbeds, it germinates within 3-4 days. The seedbeds undergo regular weeding, and once the seedlings are big enough, at approximately 2 weeks old, they are carefully removed and planted in to seedlings bags of 6 by 8 inch. At this point each seedling will have developed a couple of small roots.

One kilogram of seed represents approximately 28,500 seeds, of which there is about a 70-75% survival rate, 15 days after germination.

Seedling development

Within the nursery the bagged seedlings are put in parallel rows of 12 with walkways between them. The seedlings remain in the nursery for 3-4 months before going to the field. The Nursery plants were collected in Port Rama and Rio Kama Farm while the San Jose nursery site was established.

Temporary Nurseries

Temporary nurseries were maintained in Rio Kama, Rio Siquia ERF and Port Rama to ensure that adequate planting material was available by the time EcoPlanet Bamboo's purchase of the current property in San Jose ERF was finalized.
During this time the plants are watered regularly and checked for survival rates.

Nursery Plant Transportation

On May 2013, Rio Kama, Rio Siquia and Port Rama transported the nursery plants to Rama's International Port, Arlen Siu; the plants are then carefully loaded into River barges with a capacity of 32,000 plants per trip, taking the nursery plants through Rio Escondido into the San Jose ERF farm.
By June 2013, San Jose ERF Farm established its own nursery operations; a fully functioning nursery operation was developed on the predetermined nursery sites, allowing minimal disruption to the seedlings upon planting.

Irrigation

Irrigation of the seedlings in the nursery occurs every two hours until noon in winter, and every two hours throughout daylight hours during summer due to lack of rainfall. If there is rainfall, irrigation activities are stopped.

Irrigation comes directly from the Dos Bocas River, which borders the plantation, and upon whose banks the nursery is located. EcoPlanet Bamboo has installed a sprinkle irrigation system, and in addition backpacker applicators are available as a back up option.
Irrigation and ensuring that the seedlings are healthy is the responsibility of the nursery supervisor.

Nursery Fertilization Application Procedures

The following products were used while the seedlings are still under development stages in the nursery.

- *Triple-20:* Frequent irrigation can sometimes washout some nutrients and foliar fertilizer is needed to maintain availability of nutrients in the plant, stimulating growth and health.

These Foliar fertilizers/fungicides were applied with the following prescriptions (unless otherwise noted):

- Triple-20
  - Quantity: 100g /21 L of water applied in sprinkler system
  - When: every 15 days.

JOB DESCRIPTIONS OF MANAGERIAL STAFF

Nursery and Warehouse Supervisor

- Nursery Duties
  - Conveys knowledge and basic understanding of plant health.
  - Encouraging teamwork within the workforce to ensure set productivity targets are met.
  - Keep inflow and outflow of plants in nursery
  - Manage nursery inventory
  - Oversee and supervise irrigation procedures
  - To control, evaluate, and keep nursery in optimal state.
  - Manage fertilization
  - Manage Equipment

- Warehouse Duties
  - To oversee the efficient receipt, storage, and dispatch of inventory.
  - Providing regular reports on a bi-monthly basis.
  - Keeping warehouse clean and orderly
  - To oversee and request maintenance of vehicles, equipment or machinery.
  - Making sure quality and environmental objectives and precautions are taken.

2.3.2 PLANTATION OPERATIONS – PHASE II

EcoPlanet Plantation Management will administrate the plantation through direct Management and the sub-contracting of EcoPlanet Bamboo Nicaragua S.A. as the local operating company. The lands will be managed in strict accordance with the norms and regulations of the Forest Stewardship Council (FSC) and will strive to employ the most current and best management practices in all phases of the company's operations. Every effort will be made to protect native vegetation, flora & fauna, soil and water resources. Each zone supervisor will be trained on all tasks pertaining to their zone by the general supervisor and Farm Director.

LAND SURVEYING, MAPPING AND PRE-PLANTING

Land preparation activities began in June 2013. The farm was surveyed and conservation areas identified. All watercourses and remnant forest sites were left untouched and zoned as the sites of enrichment plantings to enhance species diversity. The Internal EIA team delineated sensitive areas in compliance to their mapping of these areas. This would include areas designated as possible flood zones based on elevation mapping. To mitigate this problem, drainages will be

created to alleviate waterlogging and ensure low plant mortality rates. If an area is labeled as a high flood area planting will not commence in that area until mitigated. After clearing the planting sites, 1 hectare plots are surveyed and delineated. Each hectare plot contains 400 bamboo clumps planted at a 5m x 5m density. These plantings are established on a grid system, with some allowances made for natural features and plantings along elevation contours to help minimize erosion and ease maintenance.
Each individual bamboo-planting site is prepared with a 40cm x 40cm hole dug and marked by a 150 cm diameter 'bare earth' clearing. Holes are treated with lime and fertilizers.

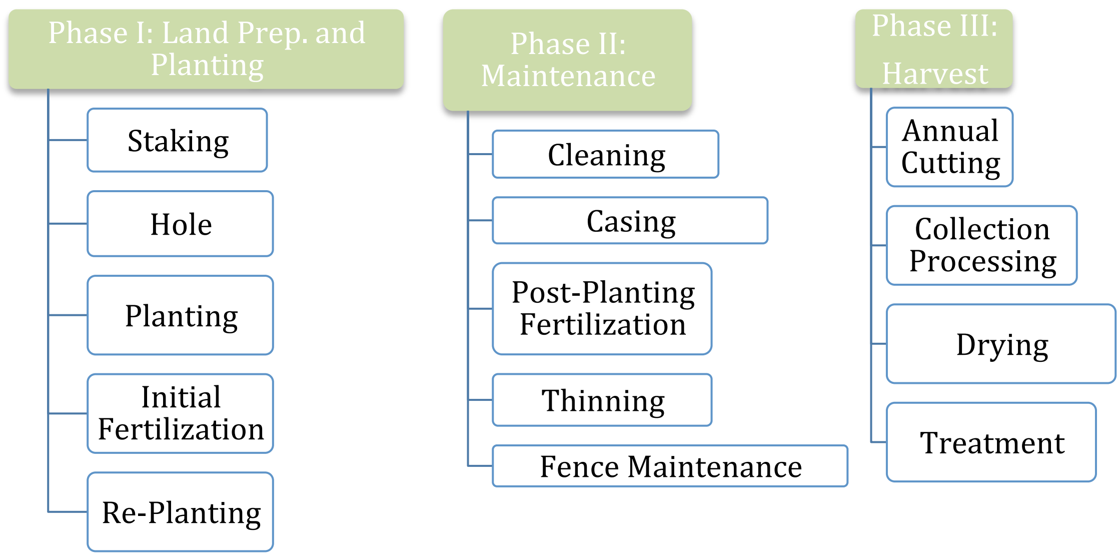


Figure 2.2. Project phases for plantation management

PLANTATION MANAGEMENT

Plantation Management involves two stages after initial surveying and mapping; Phase I – Land Preparation and Planting and Phase – II Plantation Maintenance. Below are the job descriptions and responsibilities based on the specific phase of plantation development.

PHASE I – LAND PREPARATION AND PLANTING

Phase I - Staking: Zone Supervisors Responsibilities

- A stake 60 cm or more in length is set 5 M X 5 M distance to provide a grid for planting.
- The supervisor counts the stakes to verify each hectare is accurate before the casing takes place
- The supervisor keeps a written report of total stakes/worker in which he will provide to payroll to pay each worker based on the number of stakes set. The

supervisor is also responsible making a budget for how many stakes are needed every two weeks.
- Assisting personnel with tasks
- Training employees properly to achieve their duties
- Reviewing that stakes are set correctly (5x5)

Phase I - Hole: Zone Supervisors Responsibilities

- Maintain count of holes dug/worker and total/day, then reporting daily to Farm Director or General supervisor.
- Managing the workforce
- Assisting Personnel with tasks
- Training employees properly to achieve their duties
- Reviewing that each hole is dug 40cm x 40cm and check depth and width with a long pole
- Holes should have a dimension of 40cm x 40cm.

Phase I - Planting: Zone Supervisors Responsibilities

- Maintain count of plants planted/worker and total/day, then reporting daily to Farm Director or General Supervisor.
- Managing the workforce
- Assisting Personnel with tasks
- Reviewing that each plant planted is in compliance

Phase I – Initial Fertilization: Zone Supervisors Responsibilities

- Managing Workforce
- Assisting Personnel with tasks
- Training employees proper fertilization procedures
  - Application to plant.
  - Frequency
  - Mix used.
  - Procedures
  - Safety and precautions necessary
- Reviewing the health of the plant and checking if fertilizer is working properly

Phase I - Re-planting: Zone Supervisors Responsibilities

- Frequency: 1 month after the planting with plants showing no signs of growth or with a disease are removed and sent back to the nursery for treatment if recovery is considered possible.
- Techniques used:
  - The supervisor does a plant count one month after planting to check for damaged or dead plants.

- If damaged or dead plants are found and are not recoverable with the use of fertilizers, zone supervisors meets with Nursery supervisor to discuss needed quantity to be replanted.
- The new plants are then hauled to the desired location by tractor, vehicle, or horse, depending on terrain accessibility.

- Quality Assurance/ Quality Control Used:
  - Routine consistency checks have been established to assure correctness and completeness of tasks

Phase II - Plantation Maintenance

Phase II – Cleaning/Chopping: Zone Supervisors Responsibilities

- Frequency: every two month for the first year or when necessary thereafter
- Quality Assurance/ Quality Control Used:
  - The suppliers of the weed whackers trained supervisors and their workforce with all the proper conditions and procedures to use the equipment safely and productively
  - Workers must use protective gear while using equipment: Safety glasses, helmets and ear protection
  - Routine consistency checks have been established to assure correctness and completeness of tasks
  - Identify and address errors present
- Instruments: Machete's are used in terrain where weed whackers cannot penetrate.

Phase II - Casing: Zone Supervisors Responsibilities

- Frequency: Every 2 months for the first year then just before every fertilization
- Techniques used:
  - The supervisor and his delegates set the distance between seedlings/plants
  - The workers clean the grass with a shovel clearing an area with a diameter of 1.5 meter
  - Plants are located in the center of this clearing.
- Quality Assurance/ Quality Control Used:
  - Routine consistency checks have been established to assure correctness and completeness of tasks
- Instrument: Shovels

Phase II – Post Planting Fertilization: Zone Supervisors Responsibilities

- Frequency: Bi-Anually

- Techniques used: half a line in the shape of a circle is dug around the plant approximately 10cm deep where the fertilizers is spread out and then covered by dirt to avoid washout.

- Quality Assurance/ Quality Control Used:
  - Routine consistency checks have been established to assure correctness and completeness of tasks

Phase II - Thinning: Thinning supervisors Responsibilities

- Frequency: plants will be thinned after they have reached 2.5 years in order to remove dry culms. Thinning should be done once a year only during dry season.
- Techniques used: The thinning staff will remove from 10-13 culms per plant
- Quality Assurance/ Quality Control Used:
  - Specific precautions are taken in order to prevent damaging new shoots.

Phase II - Fencing: Zone Supervisors Responsibilities

- Frequency: The supervisor reviews the fences in each lot of the farm weekly while also double-checking newly constructed fencing project
- Techniques used: The fencing supervisor is in charge of repairing all affected and damaged/weak fences surrounding the farm.
- Quality Assurance/ Quality Control Used:
  - Specific precautions are taken depending on situation involving security. For instances such as bordering farms with livestock, the original 4 barb wire fencing plan is increased to an 8 barb wire fencing coverage between posts

PLANTATION FERTILIZATION AND APPLICATION PROCEDURES

In the beginning of operations the plantations were regularly monitored and fed traditional fertilizers, as well as organic fertilizers and special soil amendments designed to enhance nutrient uptake and overall plantation performance. Foliar fertilizers was also applied directly to the plants, and soil based fertilizers will be judiciously applied to the base of the clumps to avoid 'spillover' fertilization of adjacent competing vegetation.

As of June 2012 the use of chemicals of any kind have been discontinued. Each plant receives an application of Dolomite and a custom-made fertilizer bi-annually the components in this fertilizer were determined after multiple soil analysis, lysimeters and close monitoring. Bamboo is able to grow on degraded land with no chemical intervention or enhancement needed after the first year.

Guadua has few known pests in Nicaragua, but nonetheless will be very closely monitored for nematodes, viral, fungal or bacterial pathogens, as well as insect damage. EcoPlanet Bamboo's company policy is to avoid the use of harmful chemicals to the extent possible, however to assure the completion of production goals and the satisfaction of responsibilities to lessees, the application of organically derived, synthetic chemical pesticides and biological pesticides has been determined through a system of integrated pest management .

EcoPlanet Bamboo Central America has a well-developed and operational Integrated Pest Management system. This document is detailed separately.

The General Supervisor is fully responsible for the understanding and use of all EcoPlanet Bamboo's safety procedures, precautions, and is responsible for training his workforce to practice the use of fertilization safely.

The following fertilizers are applied to the plantation (unless otherwise noted):

- *Ferti-Bamboo:* Fertilizer to supply the soil with Nitrogen, Phosphorus, Potassium, and other essential nutrients in order to enhance growth and productivity.
  - Formula(21N-12P-8K+5S+1B+1Zn)
  - Quantity: 8oz/plant
  - When: Bi-annually
- *Dolomite:* to supply the plants with Calcium and Magnesium ; also neutralizes the hydrogen that acidify the soil.
  - Quantity: 8oz/plant
  - When: Bi-annually

2.3.3 Harvesting – Phase III

Guadua aculeata is a long-lived grass that reaches harvestable maturity within five years, sometimes sooner. The plant itself typically reproduces and thrives for an excess of 80 years. The individual culms however, have a life span of seven to ten years. The harvesting of culms is to occur in a sustainable manner, cutting only mature culms -- typically five per plant per year.

As part of EcoPlanet Bamboo's on going measuring and monitoring activities, the fecundity of the clumps will be noted, and silvicultural practices will reflect that regeneration rate and new growth observed.

San Jose ERF plantation has a planting density of 5m x 5m spacing that results in 400 clumps per hectare. Each ¼ hectare plot, the sale unit size for investment, therefore will have 100 clumps. Five culms from each of the 400 clumps results in about 2000 culms harvested per hectare per year. Each culm has a milled volume of roughly 0.1m^3. Given this scenario, each hectare should sustainably produce in excess of 200m^3 each year.

Harvesting operations will occur primarily in the dry season. Dry season harvests will reduce logistical complications, increase worker safety, plant sanitation and will also assure that the company capitalizes on the incrementally increased growth associated with the rainy season. During the dry season the culms contain less water, as the phloem and vesicles constrict to react to the increases hydrologic stress. This makes the bamboo harder, denser, and lighter. This also will reduce the drying time needed for the culms, and should increase their resistance to pest attacks.

Harvesting will occur after marking of culms by the company's timber team, using informed plantation productivity specifications from monitoring sites and the harvest plan as prescribed by the harvesting manager. Harvests will ideally occur in the waning phase of the moon, when the culms have the least amount of water in the stems.

Marked culms will be harvested with a chainsaw as close to the base of the clump as possible. This method will reduce waste and stimulate new growth. Harvested culms will have tops removed, with harvest slash further reduced in size with machetes to speed decomposition and recycling of nutrients.

Culms will be harvested and transported to previously identified landings by human, horse, and oxen power when possible. In flatter sites the culms may be harvested and directly loaded on tractors and skidders. Culms will be brought to a central site at or near the farm gate, where they will be tallied, marked and entered into the company's harvest database.

ANNUAL CUTTING OF CULMS

Each year after 2018, EcoPlanet Bamboo anticipates cutting five, culms from each bamboo clump. The cutting will occur on the most mature stems that were already destined for senescence and decline, harvesting while still structurally robust. The bamboo clumps will continue to sprout an annually variable number of new culms, with harvests taking into account the individual fecundity of each plant to maintain a homeostasis of harvest and continued production. Guadua shoots contain almost no photosynthetic area apart from the shoot itself, so it is important to maintain a vigorous canopy of mature stems to assure sufficient leaf area and root carbohydrate stores for continued sprouting.

COLLECTION CENTER PROCESSING

After harvest the culms will be delivered to the farm gate and registered in the companies database where additional processing will occur. Culms may be processed and dried on site, and/or shipped to the Company's processing facilities in Port Rama. All materials leaving the farm gate will be weighed and tallied, fulfilling internal accounting needs, as well as FSC standards, and carbon project development requirements related to the measurement of carbon sequestration related to long-lived wood products derived from the plantation's bamboo.

DRYING

Although Guadua has considerable resilience to biological damage, the culms can be afflicted with fungi if stored incorrectly. Therefore, it's important it is well dried, either outdoors or in specifically designed drying chambers. Outdoor drying takes approximately 15 days leaving the culm exposed to the sun, rotating it halfway throughout the day.

TREATMENT

Fresh culms are immersed in a 5% boron solution which consists of boron and boric acid, culms stay immersed for a minimum of five days, consequently air dried for a week. To saturate the inner wall layer, which is especially susceptible, the internodes are drilled on both sides or the nodes inside the culm are drilled through lengthwise, with subsequently less dry cracks and more useable volume. EcoPlanet Bamboo will explore various technologies related to the treatment of the Guadua, in an attempt to find the most effective and least toxic methods of bamboo biomass protection.

3. Land Use History and Historical Context

3.1 Natural Landscape of the Atlantic Coast

According to Fiallos & Associados (2011a) forests have been highly exploited since the 1930s when American investors settled down on the Caribbean Coast. Specifically in the RAAS investors were involved in the exploitation of oil palm, rubber and banana plantations. Initially the extraction of timber species in the primary forest was selective (i.e. *Swietenia macrophylla* - Mahogany). Thereafter, in the 60s, the pressure upon the forest increased and it was the beginning of the cattle boom which was supported and funded by the National Bank (BND) that encouraged the farmers to establish pastures. Later, in the 80s and 90s state-owned enterprises promoted the extraction and marketing of several species of exotic wood (Fiallos & Associados 2011a). The process described is confirmed by INAFOR (2001) which found that the RAAS was one of the regions with higher pressure upon the forests and with the advance of the agriculture frontier in the 90s.

As a result of the national forest inventory (INAFOR 2009) the current forest cover of Nicaragua is 3,254,145 ha (25% of the total country area). According to this study, a trend of deforestation has been occurring in Nicaragua since 1950 (Table 2). This data comes from different studies and methodologies and should therefore be considered on a relative basis. If 1950 is the reference point of forested area across Nicaragua, a total of 2,598,549 ha were deforested up to the year 2000 (51,970 ha /year). Later, the difference from 2000 to 2009 is 3,195,855 ha (55,100 ha / year) (Table 3.1). The trend of deforestation has persisted and has increased since the 1950s. Additionally, in regions like RAAS the increase of areas in cattle farming and agriculture is ongoing and remaining patches of forest are still highly pressured.

Executing agency	Year	Forest Cover (ha)
FAO	1950	6,450,000
Cadastre	1973	5,412,500
Nicaragua Central Bank	1975	4,515,418
Plan de Desarrollo Forestal de la República de Nicaragua,	1983	4,367,000
Mapa Forestal de Nicaragua, Ministerio de Recursos Naturales y Medio Ambiente , MARENA	1992	5,110,900
Valoración Forestal de Nicaragua, 2000, Ministerio Agropecuario y Forestal, MAGFOR	2000	3,851,451
INAFOR, National Forest Inventory	2009	3,254,145 ha

Table 3.1 Forest cover estimates of Nicaragua since 1950. Adapted from INAFOR 2009.

The rate of deforestation in Nicaragua was 10 times of that in Amazonia in the 1990s (Barney et al, 2002). This can be seen from national forest cover maps between 1983 and 2000 where significant deforestation occurred (Map 3.1). Due to this the San Jose farm has been significantly impacted by anthropogenic activity such as road building, forest clearance, and agriculture.

Map 3.1. Forest cover maps of Nicaragua from 1983 to 2000 demonstrating the scale of deforestation within the country.

A more recent forest cover analysis can be retrieved from the MODIS Land Cover Type product (short name - MCD12Q1). This MODIS product provides data characterizing five global land cover classification schemes derived through a supervised decision-tree classification method with a resolution of 500m. Map 3.2 below shows the forest cover of southeastern Nicaragua in 2009 using the IGBP global vegetation classification scheme. Different types of deciduous and evergreen forests were combined into two overall classes of “Deciduous forest” and “Evergreen forest” since forest cover extent is of interest. From Map 3.2 it can be seen that the forest cover of Nicaragua continued to decline since 2000. In the immediate area surrounding San Jose farm is a matrix of small forest patches and predominantly cleared land for agriculture. Near Bluefield, Nicaragua is a large extent of evergreen rainforest that is delineated as a Ramsar site and currently part of the protected area network of Nicaragua.

[INCLUDE MAP 3.2 HERE]

3.2. HISTORICAL AND LAND USE CHANGE ANALYSIS OF PROJECT AREA

Remote sensing analysis was employed in order to demonstrate the previous land uses within San Jose ERF farm as well as characterize the current land use including forest cover. To determine the vegetation on the land thresholds for forest cover were used for a number of measurements that can be taken in the field and from GIS analysis (e.g. tree crown cover or equivalent stocking level, tree height at maturity in situ, minimum land area). From the remote sensing analysis and the previous activities within San Jose predictions of land use without the project activities of EcoPlanet Bamboo are given.

A multi-temporal analysis of satellite imagery, ground reference data, and information from land cover maps were used to provide evidences of previous land use history. Multispectral Landsat images, (resolution 60m for 1978 and with 30m resolution for 1992 and 2002) were used for multi-temporal analyses. Rapideye images (5m resolution) were acquired for 2011 to analyze the current land use. During the baseline fieldwork, information on current land cover as well as trends of land use change were also confirmed or verified.

For both farms, land cover in 1978 was derived by interpreting Landsat 3 MSS satellite image of April 1st of 1978. The second year of reference was 1992 and land cover was derived by interpreting Landsat image 7 TM of May 5st of 1992. The third year of reference for San Jose ERF farm land cover in 2002 was derived by interpreting Landsat image 7 TM of May 5st of 2002.

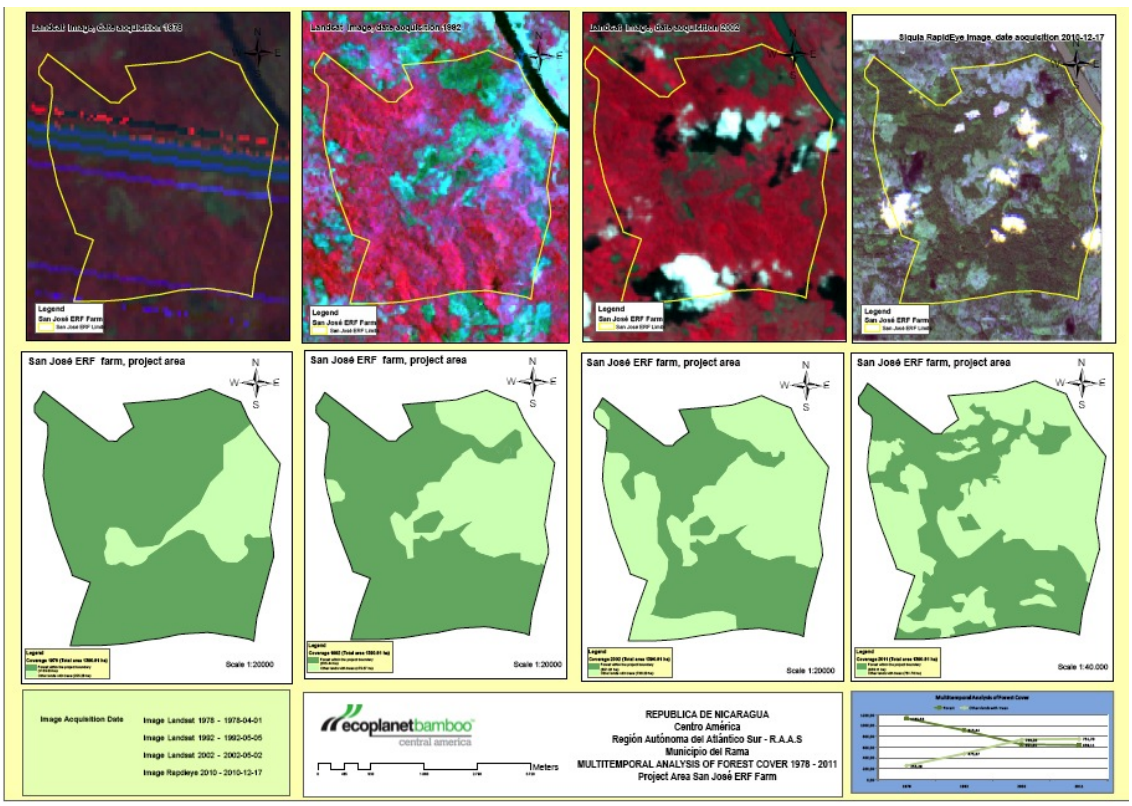
All images come from free digital files of the US Geological Service. The ERDAS remote sensing software was used to process the image by the supervised classification approach in 1978 and unsupervised in 1992, and 2002, due to lack of spatial reference information. Additional information was also acquired from basic cartography and information provided by habitants of the study zone.

In order to define the current land coverage Rapideye satellite images, 5 m of spatial resolution and 5 bands were acquired and used to derive the current vegetation structure. These images were taken in December 17th of 2010. The ERDAS remote sensing software was used to process the images. In order to define the types of coverage, a supervised classification approach was carried out. In addition, during the baseline sampling, the coverage was verified in field and adjusted by means of direct observations (Map 3.3).

Change detection is defined as the identification of differences between two consecutive spatial datasets taken from the same spatial location. These differences may be due to error or actual changes and therefore the manual comparison with field based data is the only way to verify the results obtained by means of the methods utilized for processing the images, the cover classification, or interpretation (Sotirios 2005; Armenakis et al., 2002). In the current analysis, field data was one of the strategies used to improve the interpretation carried out on the Rapideye images. The analysis of 1978, and 2002, obviously cannot be supported with field data, however, villagers settled in the surrounding region provided confirmation of deforestation within San Jose ERF.

According to the national forest inventory (INAFOR 2009), the forest definition to Nicaragua is as follows:

"..Forest is a natural or planted vegetation association at any stage of the natural cycle life, with trees reaching a height greater than 5 m, with a canopy cover greater than 10%, which extend more than 0.5 hectares and a minimum of 20 m wide, with or without management, is able to produce goods and ecosystems services, can influence the water regulation regime, the soils, the climate and can provide habitat for wildlife. The term specifically excludes tree stands used in agricultural production systems[1], such as fruit plantations and agroforestry systems. The term also excludes trees growing in urban parks and gardens..."



Map 3.3. Landsat and Rapideye imagery for a multi-temporal land use analysis of San Jose ERF.

This definition of a "forest" within Nicaragua was used to structure the field data collected across San Jose farm to inform the classification of the 2011 Rapideye image. Information on tree height, diameter, species, crown radius, and canopy cover were collected and used to calculate the presence of trees over 5-m and their

[1] It also includes cattle farming systems

associated crown coverage. This information was collected across 40 randomly selected plots within San Jose and the full results are presented in Annex IV.

In San Jose farm, the forest coverage drastically decreased between 1978 and 2010. In San Jose ERF forest cover decreased from 81,6% in 1978 to 46% in 2011. That means a decrease from 76% to 37% of the total forest coverage. The critical period of deforestation occurred between 1978 and 1992, where forest coverage by 16 %. At the project start point, (2011), the total area of forest coverage is 639 ha, while the area destined for plantations that correspond to pastures with scattered trees (other land with trees) is 752-ha.

Coverage	1978	1992	2002	2011
Forest (ha)	1136	915	652	639
Other land with trees (ha)	255	475	739	752
Total (ha)	**1391**	**1391**	**1391**	**1391**

Table 3.2. Results of multitemporal land coverage analysis.

Table 3.2 summarizes the results of land coverage analyses. In figure 3, are also showed the multi-temporal changes in forest cover in absolute terms. The resolution of Landsat images is 60-m for 1978, 30-m in 1992 and 2002, and 5-m in 2011 with the Rapideye images. With this analysis the possibility of including forested areas not detected with Landsat images is higher given the increased resolution for 2011. In addition, as a field data collection was also carried out to inform the classification of remote sensing images, the inclusion of forests into the analysis with Rapideye imagery rather than Landsat suggests that this is a conservative estimate of deforestation.

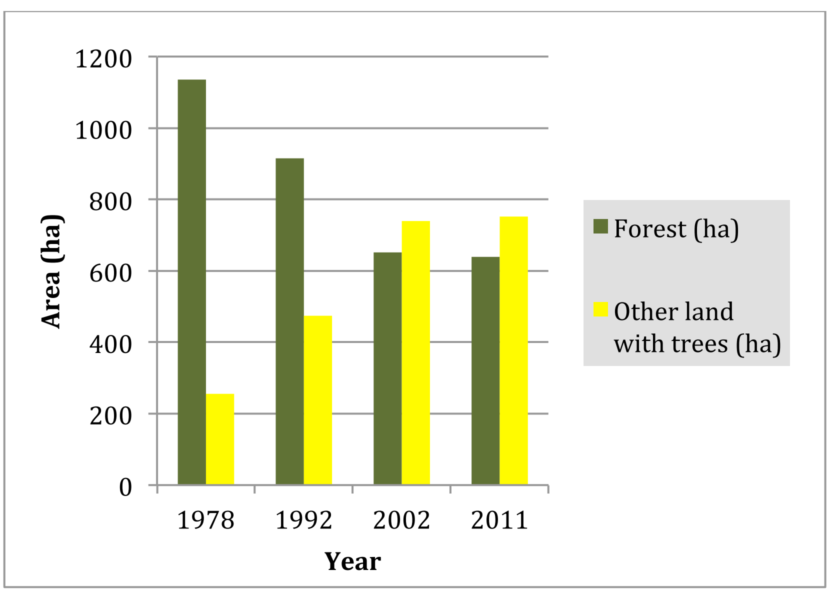


Figure 3.1. Results of multi-temporal land use analysis.

When analyses on land cover include elements with areas smaller than the detectable limit due to image resolution, there is a low probability of being identified (Lunetta, et al. 2006). An important portion of the forest patches found within the project boundary area are long and narrow shape and sometimes no are no more than 10 meters wide. Therefore these cannot be detected by the Landsat imagery utilized. On the contrary, as the analyses are done on image pixels, there is an inherent and significant overestimation of area represented by the pixel which is therefore extended. This issue is particularly problematic for the graphic representation of change extent, because there is no practical way to directly compensate for the overestimations (Lunetta et al., 2006). Additionally, the accuracies of classification results can be very low due to shadows and other objects that reduce the quality of the images (Weiqi, et al 2008).

During the baseline measurements, the sampling design included the evaluation of natural regeneration of trees within the project area. Young individual trees such as seedlings and saplings were not found within any of the plots measured. The low intensity cattle farming was the main land use during several years and is attributable to why no seedlings or sapling were present.

Scattered trees, which still remain in the project area, were found within some of the plots measured. However, due to the characteristics of the prevalent land use (cattle farming) and its impact on natural resources, these trees and shrub have little prospect of growing. Most of them have reached the maximum size and represent a potential fuel source for locals and farmers alike. In the absence of EPB's project activities it is likely that this land area would result in further degradation from deforestation and cattle grazing. It is important to remark that the project activities will guarantee the permanence of these trees as well as those areas which still remain under forest.

When trees were found during the baseline sampling, in order to determine if in any case some areas could reach the threshold of crown cover established for forests definition in Nicaragua, the total area covered by tree canopy was estimated from measurements of tree crown area within the sample plots. In both farms, the crown cover threshold, the height of the trees and the current land use (cattle farming) do not permit to classify this area as forest. In this sense, when the canopy of those trees higher than 5 m is calculated, the area covered by this canopy is below the threshold established to be defined as forest which is 5%.

In summary, the general trend of deforestation and increase in agricultural activities that has been seen across the RAAS has also occurred within the boundaries of San Jose ERF. In 1978 the forested area of San Jose ERF accounted for 81.6% of the area while in 2011 it accounted for 46.0% of the land area. The trend of land degradation would be expected to continue in the absence of the project activity as cattle grazing and fuel wood extraction would continue.

4. ENVIRONMENTAL BASELINE STUDY

4.1 INTRODUCTION TO THE BASELINE STUDY

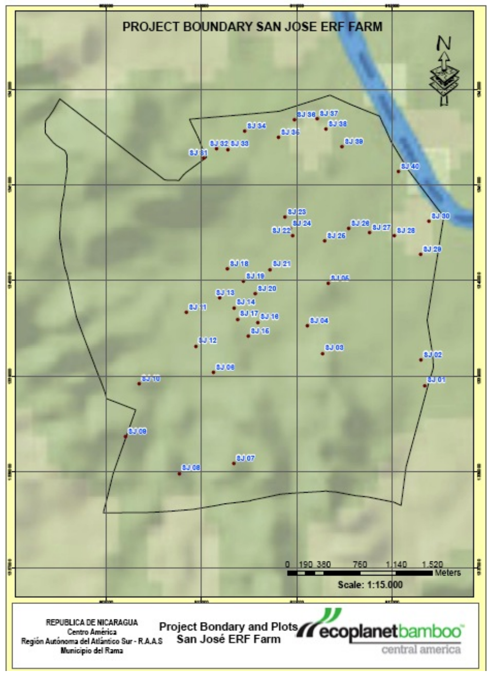
An environmental baseline study was designed in order to define the status of soil conditions and vegetation across the property in order to assess the impacts project activity could have on these aspects of the property. For the analysis of soil conditions metrics that were of interest were the level of compaction, physical characteristics, and chemical characteristics. For vegetation the aim of the baseline was to delineate areas that fit within the definition of forest provide by the Nicaraguan forest department (INAFOR). In addition to these baseline studies, descriptive conditions of the climate and environment are provided as well as measures of biodiversity that are built off of previous EIA studies and other published studies within the RAAS region.

4.1.1 SOIL BASELINE METHODOLOGY

The soil baseline study consists of two separate study designs, one to measure the compaction and litter across the property and the other to gather baseline data on physical and chemical properties of the soil. The former was carried out by a team directed by Juan Carlos Camargo, a soil and bamboo specialist from the Universidad Tecnologica de Pereira in Colombia, and a GIS specialist. The latter study was designed by DisAgro in partnership with EcoPlanet Bamboo to define the soil characteristics before project activities were established and to map the changes over time.

The methodology proposed by Camargo for the measurement of compaction and biomass was a randomized sampling design carried out in the project area. A total of 40 circular plots of 707 m^2 were randomly established for gathering the information required. Within each the penetration resistance of soil also was evaluated. Information on slope, soils and elevation as well as the geographical localization were also registered. The penetration resistance of soils was measured within the plots by using an Eijkelkamp penetrometer. Three points per plot were measured each 5cm to 45cm of depth.

The random process to choose the sampling plots consists of two steps. First, a grid with 25 x 25 m pixels was overlaid on the digital map of the project boundary area, considering just the effective area or non-forest area (739 in San Jose ERF farm – determined by remote sensing analysis described above). Then using the Hawth extension of the software ArcMap 9.2, a total of 40 points were selected and placed as the centroid of the pixel. Thereafter, the coordinates of each point were registered and subsequently uploaded in a GPS which was used to find each point in field. Points selected were defined as the center for establishing each circular sample plot (Map 4.1). A frame of 0,5 x 0,5 m was used for sampling litter. Three replications per plot were done, the total biomass of litter within each frame was cut and weighed and then subsamples were sent to the lab of water and soils of the Universidad Nacional Agraria (Managua, Nicaragua) to estimate dry matter.



Map 4.1. Map of the sampling points

The physical and chemical characteristics of the soil with San Jose ERF were also measured in a baseline measurement. Similar to the compaction soil study plots were randomly assigned across the San Jose ERF property (Map 4.2). Plots were then uploaded into a GPS which was used to identify the location of each individual parcel. The point identified within the field for each plot was considered to be the plot center where a soil sample was taken. The soil sample was then handled by DisAgro for the soil analysis of the following physical and chemical characteristics: percent sand, percent clay, percent silt, organic content, pH, nitrogen concentration, phosphorus concentration, calcium concentration, potassium concentration, and magnesium concentration.

[MAP 4.2 POINT SAMPLES FOR DISAGRO MONITORING]

4.1.2 VEGETATION CLASSIFICATION METHODOLOGY

The vegetation classification portion of the baseline study sought to delineate areas of forest from other vegetation types. The selection of plots followed the methodology outlined in the soil baseline study. These studies were joined in order to create an economical experimental design. The plot design (shape and size) was defined according to literature references, where circular plots with similar size have been used to assess the components of silvopastoral systems with isolated trees within pastures (e.g., Camargo et al. 2000; Camargo and Ibrahim 2001; Camargo et al., 2007)

When trees were found within the sampled plots, their total height was measured by using an optical reading clinometer. In addition, diameter at breast height (dbh) and crown diameter were also measured. Besides, dead wood within plots was also accounted and measured. In this sense, the length and diameter of dead logs were measured to estimate their volume. Mensuration methods used in this sampling were applied according to those established in forest inventory (i.e. Kleinn 2011, Husch et al. 2003, Açka 2000, Prodan 1997).

The sampling size was calculated according to the margin error of the A/R methodological tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" (UNFCC/CCNUCC 2011a). Thus, the variable total carbon t ha^{-1} (soil, litter and tree) calculated from data obtained in the sampling was used in order to determine the number of plots to be sampled during the baseline assessment. Therefore the margin of error of the variable was calculated as follow:

$$e_{var} = t_{VAL} * S_{var}$$

Where;

e_{var}	Margin of error of the mean total carbon within the plots sampled; t ha^{-1}
t_{VAL}	Two-sided Student's *t*-value for: (*i*) Degrees of freedom equal to *n*-*M*, where *n* is total number of sample plots within the project boundary, and *M* is the total number of strata; and (*ii*) The confidence level required by the methodology applying this tool (90%); dimensionless.
S_{var}	Square root of the variance of mean of the variable considered (i.e. the standard error of the mean); t ha^{-1}

If e_{var} / m_{var}*100% is greater than the maximum allowable relative margin of error of the mean prescribed in the methodology, then additional sample plots should be installed.[1] Therefore the calculation was done as follow:

[1] m_{var} is the mean of Total Carbon

Variable	m_{var} (t ha^{-1})	S_{var}	Degree of freedom	t_{VAL}	e_{var} / m_{var} *100%
Total carbon	30.51	1,10	39	1,68488	6,07

In this case 40 plots seem to be a proper sample size because e_{var} / m_{var} *100% (6,08 %) is smaller than the allowable margin of error which is 10% .

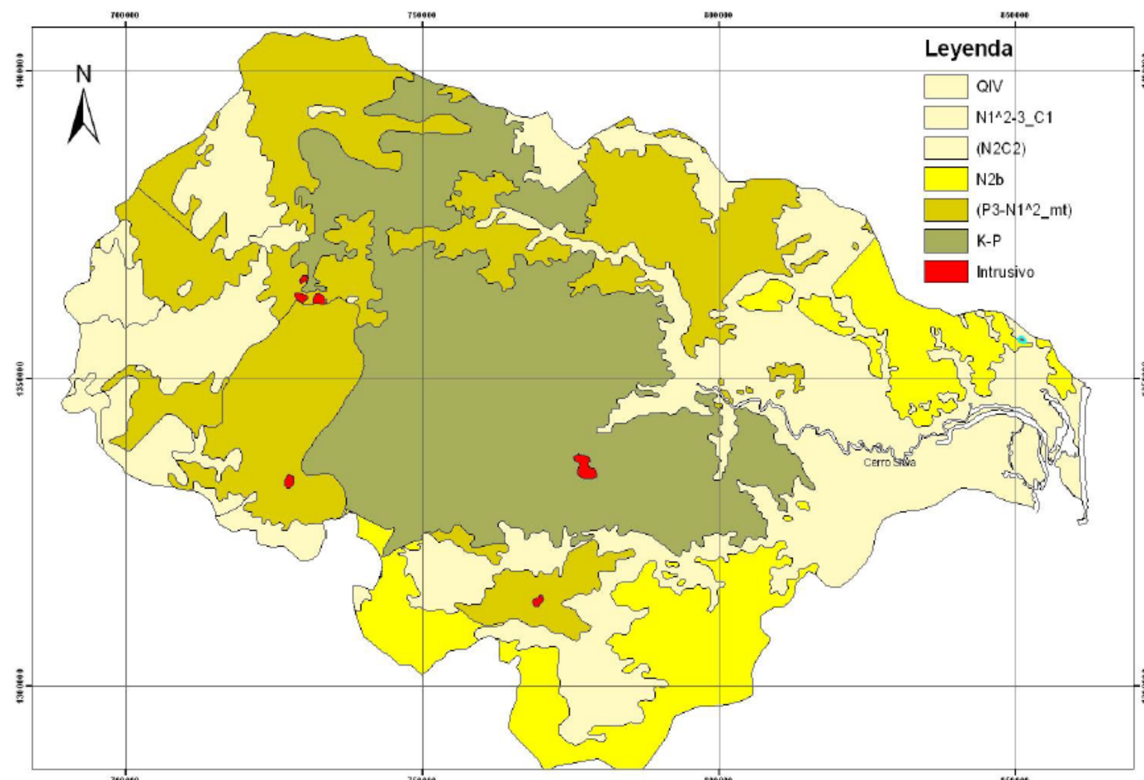
4.1.3 Biodiversity Methodology

The assessment of biodiversity across San Jose ERF included the collection of data from the vegetation classification described above as tree species were recorded. However, this biodiversity assessment only included areas outside of the forested area of San Jose and was only for flora. A review of biodiversity studies provided on other EPBCA properties and from the surrounding area found in literature is discussed and results are provided.

4.2 Abiotic Environment

4.2.1 Geology

The study area belongs, in geological terms to the Sedimentation Basin of the Atlantic Coast (Geological Province of the Plains of the Atlantic Coast). The Atlantic province is bounded on the south and northwest by Tertiary geological formations, the west part by the Paleozoic and Mesozoic platform, and east by the Caribbean Sea (Map 4.3).



Map 4.3. Geological formation within the Rio Escondido watershed (MARENA, 2010)

The Atlantic Coasts is characterized by lowlands, plains and undulating topography, interspersed with marshes and lagoons, deposits of gravel and sand, protruding formations of Matagalpa and pre-Matagalpa groups, and is covered by large areas of pine forests in the northern part of the country. Nicaragua's continental shelf extends due northeast, along the Caribbean Sea to Jamaica and divides the Caribbean Sea between the Yucatan Basin in the north and the Colombian Basin in south.

The region is covered by a band of young sediments from the Miocene-Pleistocene period that are partially overlying Tertiary volcanic formations and Cretaceous and Tertiary sedimentary rocks. These formation consist of sandstones, shale and limestone, that outcrop in the central region. It is assumed that the thickness of sediments reaches a few hundred meters. The surface layers of the coast consist mainly of clay and fine sand. Table 4.1 shows the geological formation for the Rio Escondido watershed which consist mainly of Alluvial, Matagalpa, and Rivas geological formations.

Geological Formation	Area (km^2)	Area (%)	Map Key	Period	Lithology
Alluvial	2929.94	25.07	QIV	Holocene/ Pleistocene	Gravel, sediments, sands, and clay
Volcanic	338.66	2.90	N2C2	Pliocene	Igneous, tuff, basaltic, lava basaltic
Bragman Bluff	1465.51	12.54	N2b	Pliocene	Clay, sand, and gravel
Coyol Inferior	694.90	5.95	N1^2-3-C1	Miocene/ Medio/ Superior	Lava basaltic, residual, tuff
Matagalpa	2906.60	24.87	P3-N1^2-MT	Oligocene/ Miocene/ Medio	Lava basaltic, sand tuff, and igneous
Rivas	3331.85	28.51	K-P	Deposito/ Cretacico/ Palogeno	Limestone and silica
Intrusives	20.76	0.18	Intrusivos	Intrusives	N/A

Table 4.1. Extent of different geological formations across the Rio Escondido watershed (MARENA, 2010).

4.2.2 CLIMATOLOGY

The area of San Jose ERF Farm belongs to climate classification of Very Wet Tropical Forest which includes the southeastern area of the El Rama municipality. Within Rama rainfalls between 3,000- 4,000 mm, an average temperature 25.4°C, and bio-temperature of 24.4°C. The meteorological analysis used data from the station of El Recreo with this season identified with No. 61002 and is located at 12º10´ north latitude and 86º19´ west longitude. In El Recreo the average rainfall is 3,044 mm per year, with an average temperature of 25.4 ºC and annual average relative humidity of 83%, which according to the Holdridge classification, corresponds to the life of the tropical rain forest.

4.2.3 PRECIPITATION

From the El Recreo meteorological station the average rainfall was found to be 3,044 mm/year with a distinct dry season from December to April. The rainy season starts in May, reaching their highest levels in July, after which it starts to decrease gradually until December (Figure 4.1, Map 4.4).

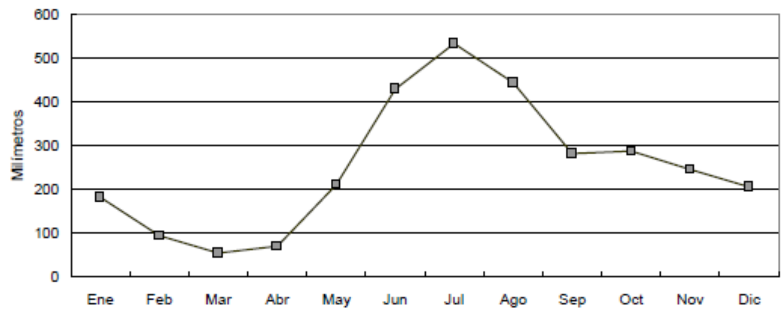
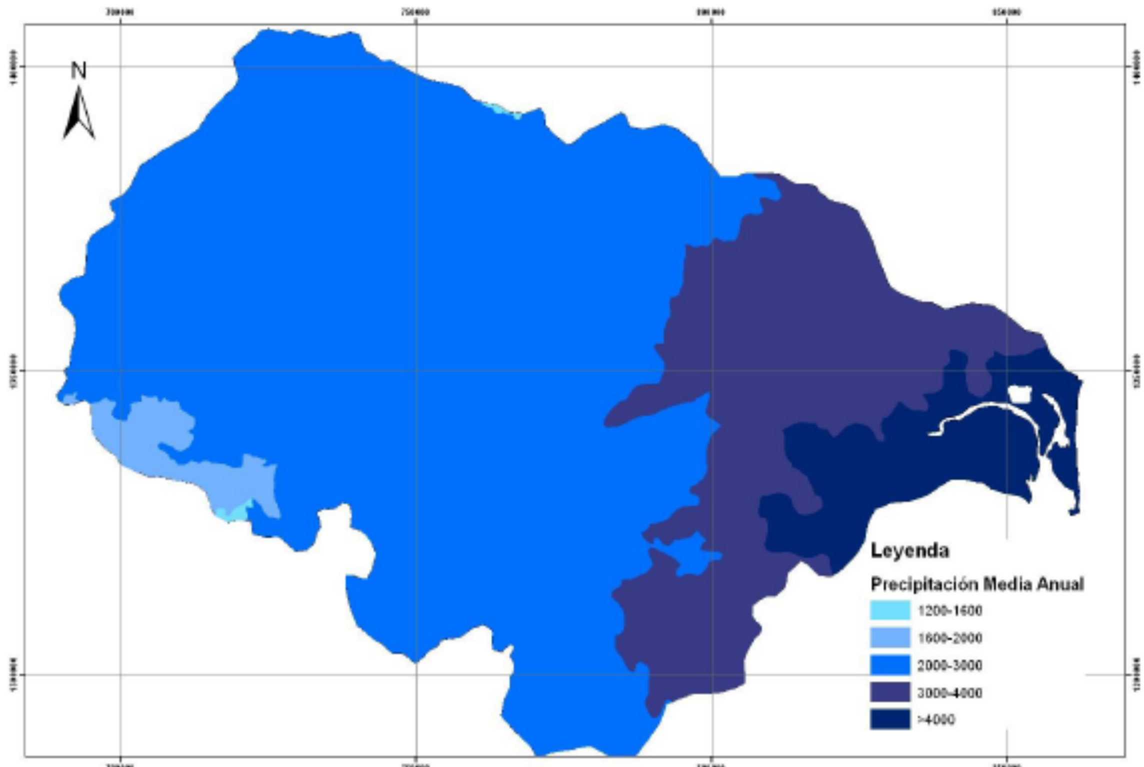


Figure 4.1. Average monthly rainfall.



Map 4.4. Average monthly rainfall within the Rio Escondido watershed (MARENA, 2010)

4.2.4 TEMPERATURE

The average annual temperature is 25.4 C with minor variations through the year. The lowest temperatures occur in the months of December and January while the maximum occur in May. The range of temperatures is only three degrees Celsius across an entire year. (44.2, Map 4.5).

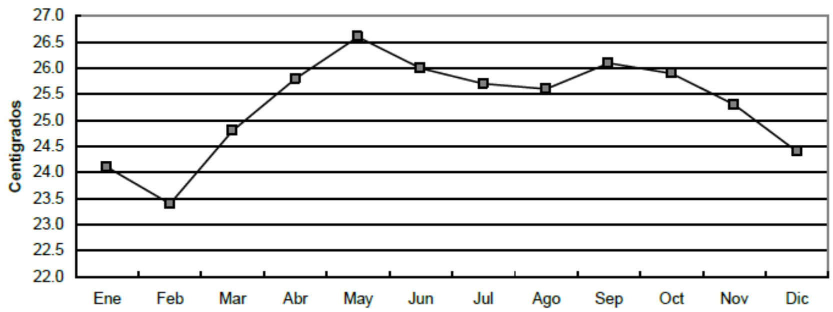


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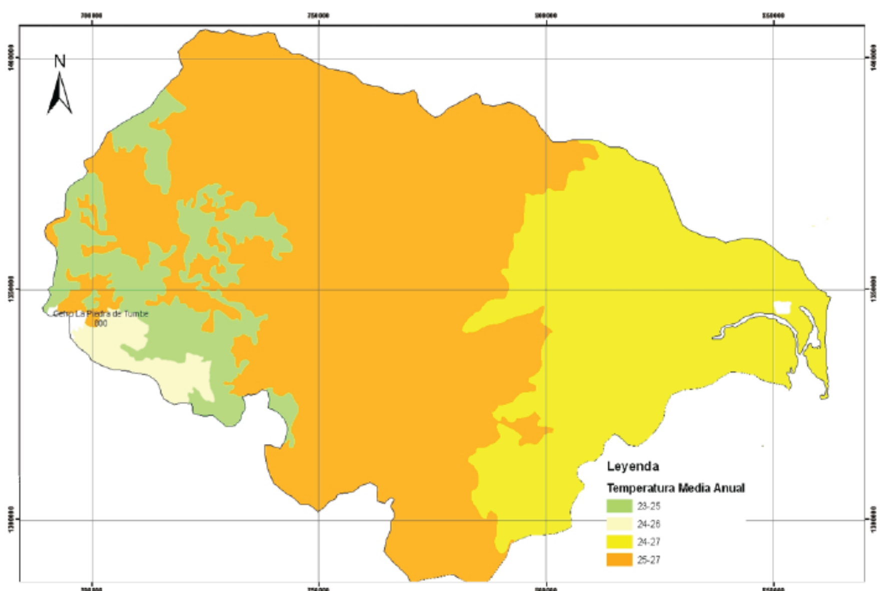
Figure 4.2. Average monthly temperature



Map 4.5. Distribution of the temperature ranges in the Rio Escondido Watershed (MARENA, 2010).

4.2.5 RELATIVE HUMIDITY

The annual average of relative humidity is 83%, showing the influence of Caribbean over the area of influence. Except April, the humidity is reduced to an average of 74%, the remainder is very stable, ranging between 80% y el 90%, alternating these two limits (Figure 4.3).

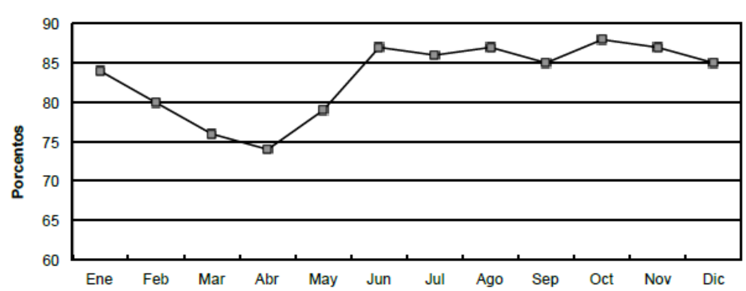
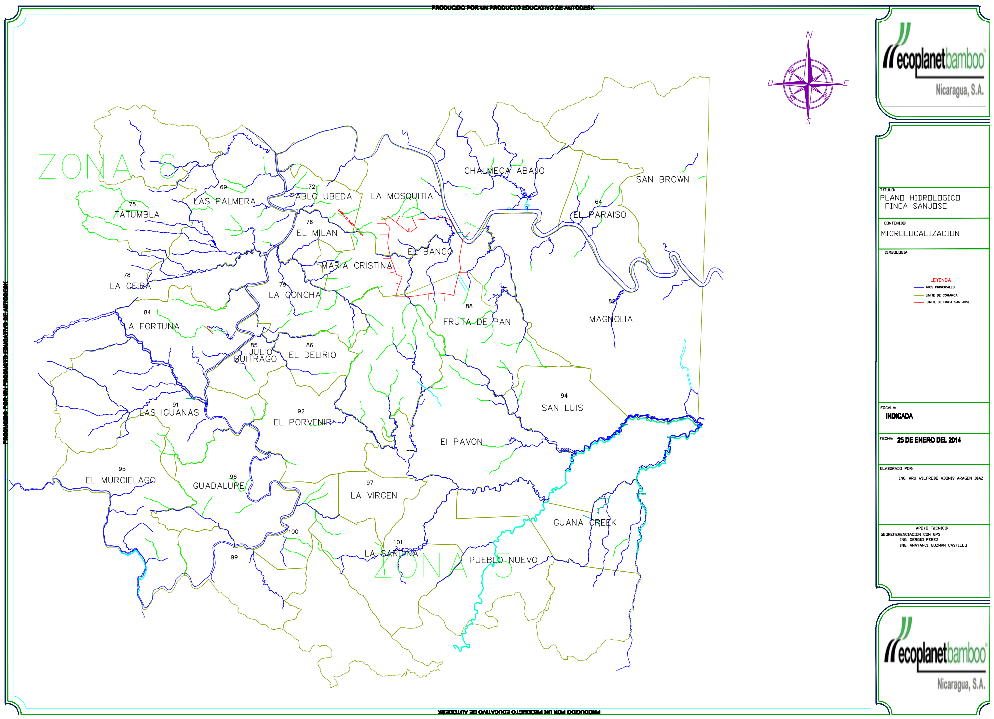


Figure 4.3. Monthly average of relative humidity

4.2.6 HYDROLOGY

The municipality of El Rama has a privileged situation in terms of abundance and distribution of its rivers. The capital of the municipality is at the confluence of three major rivers such as the Siquia, Mico, Kama, and El Rama that drain into the Rio Escondido. San Jose ERF is situated on the southern edge of the Rio Escondido approximately 14-km down river from the Port Rama property (main offices) (Map 4.6).



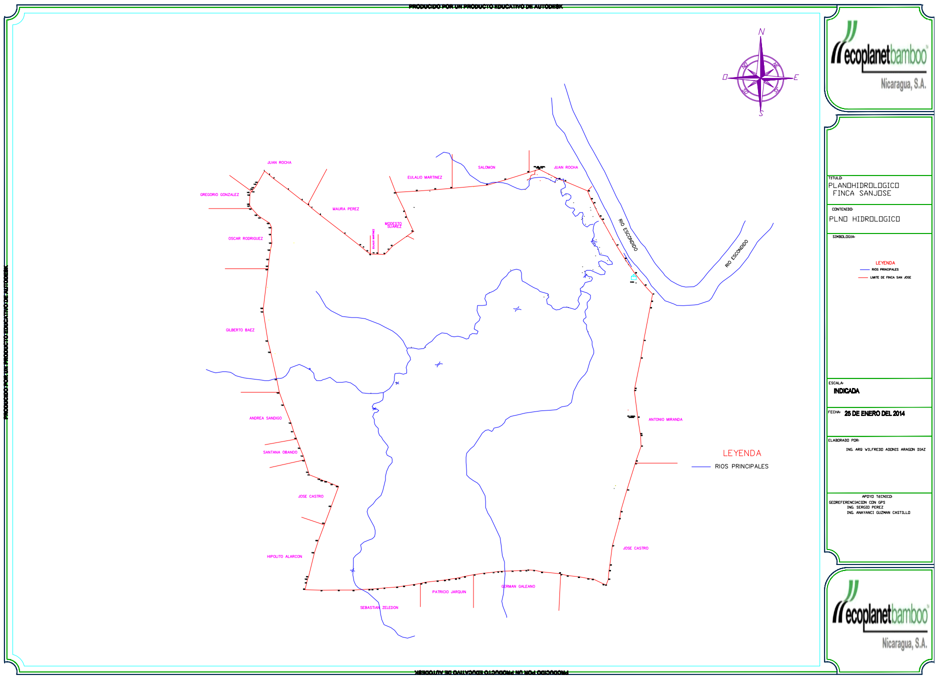
Map 4.6. The distribution of primary, secondary, and tertiary rivers surrounding San Jose ERF.

Within the San Jose ERF farm there are existing water resources including several rivers which run through the property and into the Rio Escondido (Map 4.7). In addition to these water areas are some areas that become inundated with water during the wet season (June-September) and remain dry during the dry season. These areas are also indicated in Map 4.7.

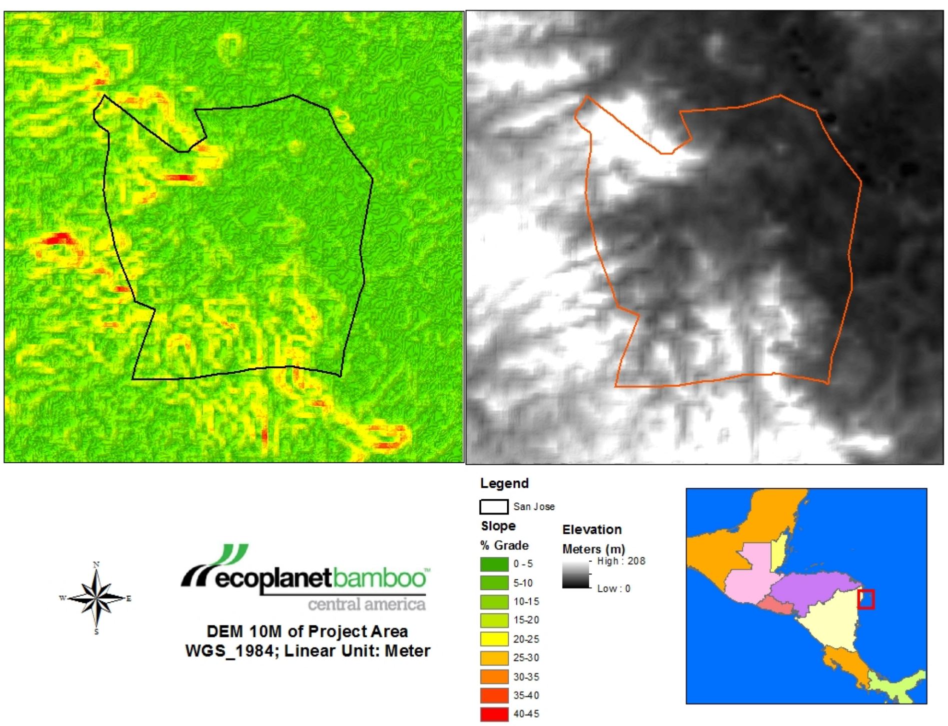
4.2.7 TOPOGRAPHY

The topography of the Atlantic coast is marked by undulating topography in lowlands that lye west of the volcanic belt to the west. The average elevation in the Atlantic Coast is 80-m with a range from 0-300m compared to the highest elevations in the western region of 600-m.

Within the San Jose project area the topography is characteristic of the Atlantic coast with elevations ranging from 0-300-m. In addition, the slope in the area is marked by very few steep slopes with X% of the area representing slopes above 30 percent-grade (Map 4.8).



Map 4.7. Water resources within San Jose ERF project area.



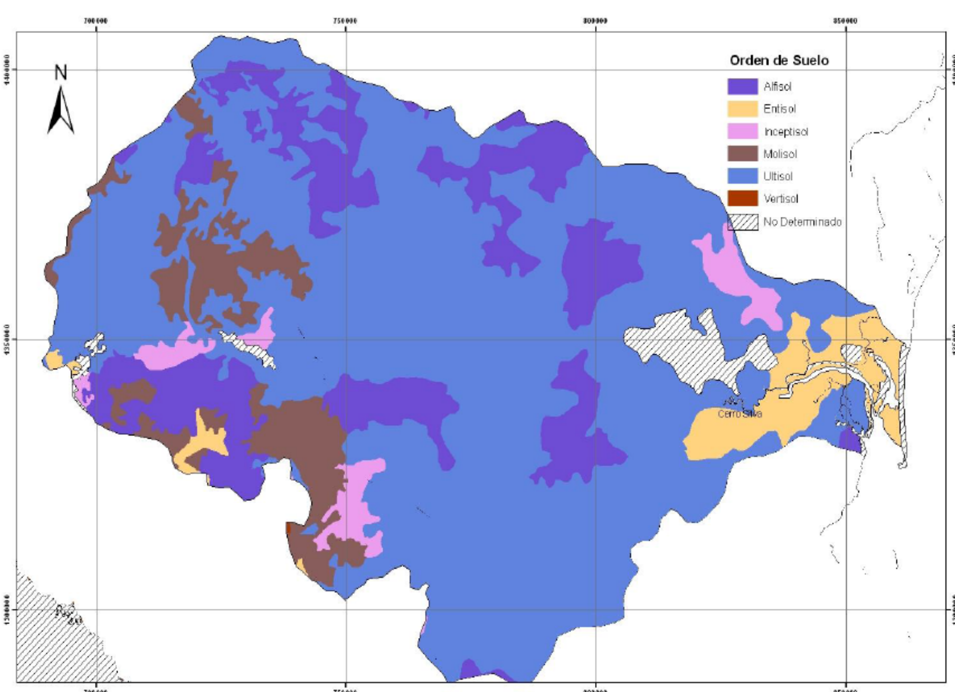
Map 4.8. The elevation and topography of the San Jose project area.

4.3 SOIL BASELINE

4.3.1 BACKGROUND

The municipality of El Rama has highly variable topography from the flood plain to the mountain range in the west. Approximately 42% of the territory is located in the low position near the mouth of the Mahogany River, which has a relief on recent alluvial sediments. In this Physiographic positions soils are subject to strong influence of hydromorphic due to poor drainage, high water table flooding and water logging. A third of the region (33%) is undulating land with slopes less than 15% where soils have good natural drainage are well developed and suitable for extensive agricultural use. The remaining 25% comprises soils heavily embossed with undulating and steep slopes of 15 to 30%, which are adapted only to forests and pastures eventually.

According to the taxonomic classification of the Department of Agriculture of the United States there are two types of soils in the Atlantic Coast of: Inceptisols and Ultisols both with their respective taxonomic subgroups of Typic Humitropepts, Typic Paleudults, or Rhodudults and Plinthaquic Paleudults (Map 4.9). The chemical characteristics of the Atlantic Coast soils include high acidity with a pH between 4.5 to 5.5, and rich in aluminum, iron and silica. The physical characteristics of the Atlantic Coast soils are defined by very fine texture, compacted clay of coffee-red color due to low oxide concentrations, clay horizons with medium capacity for cationic exchange, and low base saturation. These soils are suitable only for forestry or grassland. The surface of the Atlantic Coast, however, is covered with approximately 120,875 hectares of mature or secondary forest and represents, approximately 60% of the soil cover in the Atlantic Coast. Due to its physical characteristics, the constant rains that cause leaching of nutrients and clear-cutting in the region, these soils are easily eroded resulting in low fertility.



Map 4.9. Map of soil type within the Rio Escondido watershed (MARENA, 2010).

4.3.1 SOIL COMPACTION

The soil compaction across San Jose farm was investigated during a baseline study by measuring penetration resistance of soils. Penetration resistance of soil is a property that may be used as indicator of degradation, which also represents the loss of productivity capacity and the deterioration of physical properties. If penetration resistance of soils is high the conditions of rooting are constrained as well as the roots effective depth (Dossman et al, 2010). With values higher than 3.0 megapascals (MPa) the optimal development of roots is highly limited (DeLeon 1995; Reichert et al 2009).

The penetration resistance of soils was measured within sample plots using an Eijkelkamp penetrometer. Three measurements per sample plot were carried out from 5 cm to 45 cm of depth. Classes of penetration resistance of soils were defined according to the soil survey manual of the Soil Conservation Service, U.S., Department of Agriculture, Handbook 18 (1993) (Table 4.2).

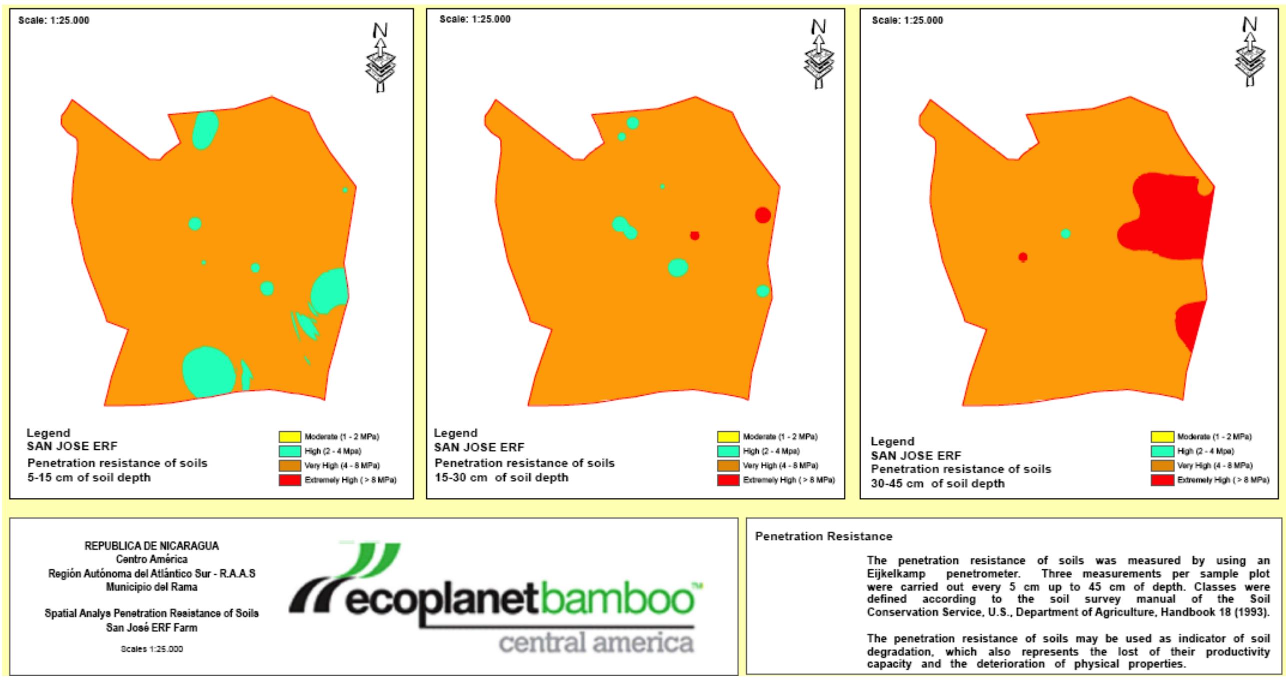
Classes	Penetration Resistance (MPa)
Small	<0.1
Extremely low	< 0.01
Very low	0.01 - 0.1
Intermediate	0.1 - 2
Low	0.1 - 1
Moderate	1 - 2
Large	> 2
High	2 - 4
Very high	4 - 8
Extremely high	> 8

Table 4.2. Penetration resistance classes (USDA, 1993)

A map of the penetration resistance of soils within the project area was generated from the information collected in the sampling (Map 4.10). Average values per plot were extrapolated using the method of inverse distance weighted (IDW) (See Annex II for full results). This approach is based on the assumption that the interpolation surface should be most influenced by the nearby points. The interpolation surface is a weighted average of the scatter points and the weight assigned to each scatter point decreases as the distance increases to the interpolation point. This process was performed with the spatial analysis extension in Arc Map GIS software, with a cell size of 8 x 8 meter.

Although the values of classes defined for the penetration resistance of soils by USDA (1993), start with values lesser 0.1MPa, the values registered in both farms are higher than 1.0 MPa and most of the project boundary area might be considered limited according to this soil property. In fact the range is between 2.6 - 10 MPa.

The classification established by USDA (1993), contemplates three classes (small, intermediate and large) as well as seven subclasses. In the case of the San Jose ERF, all values measured fall within the class larger and the subclasses high, very high and extremely high. This demonstrates the level of degradation of soils before project activities that are most likely due to the previous activity of cattle grazing.



Map 4.10. Penetration resistance of soils within San Jose

During the field inventory erosion processes were observed which were registered by photographs taken in the new farm. In this case, the images can show the degree of degradation of this areas occasioned by overgrazing. Most of the area is affected by laminar erosion and in critical points where water is usually running during rains or when the rainy seasons are presence of gullies (Photo 4.1). In San Jose farm, some areas where soils have drainage problems, the overgrazing increased the problems because the trampling has caused a highly deterioration of soils structure (Photo 4.1).

4.3.2 SOIL PHYSICAL AND CHEMICAL CHARACTERISTICS

Compaction affects physical soil characteristics such as bulk density, cation exchange capacity, water infiltration, and organic content. The physical and chemical characteristics of the soil with San Jose ERF were also measured in a baseline measurement (Annex III – full results). Similar to the compaction soil study plots were randomly assigned across the San Jose ERF property. Plots were then uploaded into a GPS which was used to identify the location of each individual parcel. The point identified within the field for each plot was

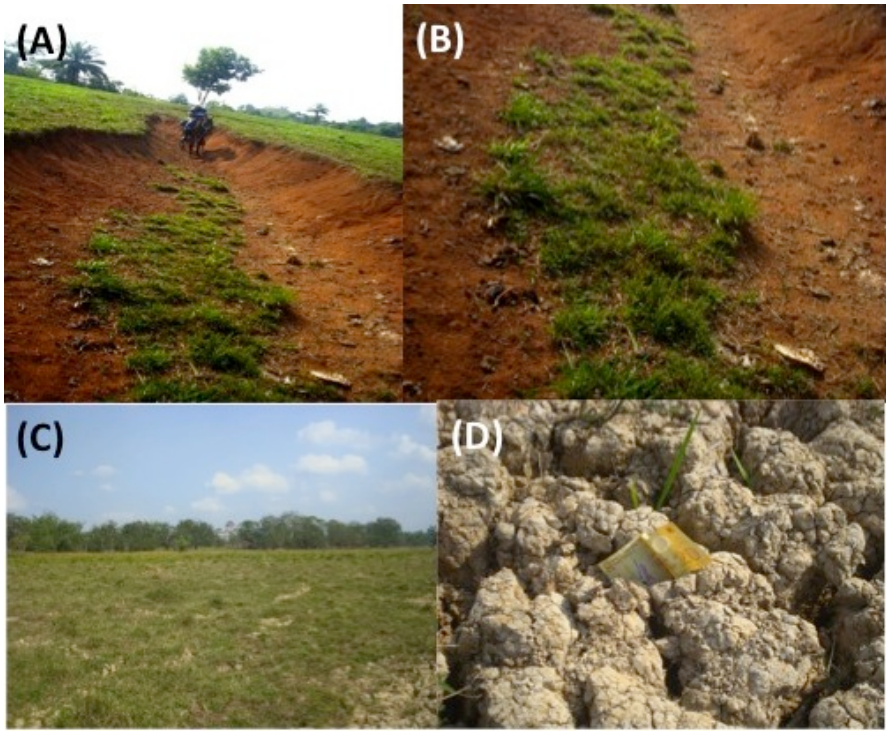
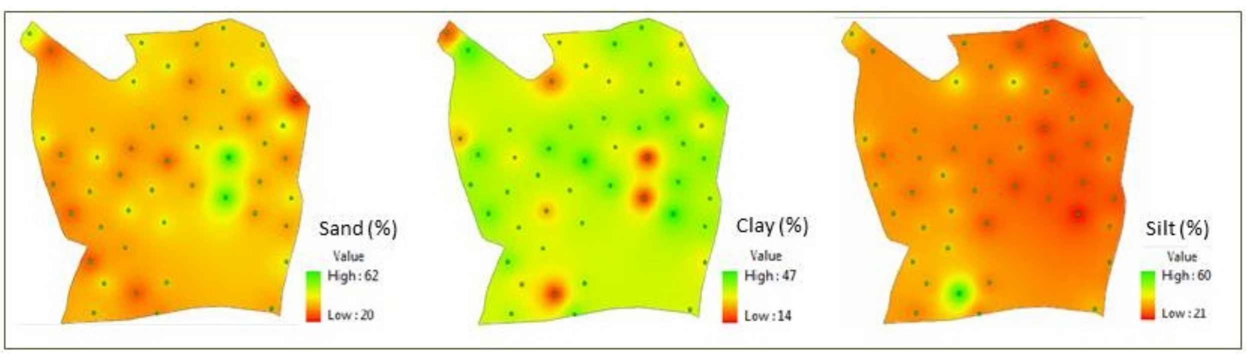


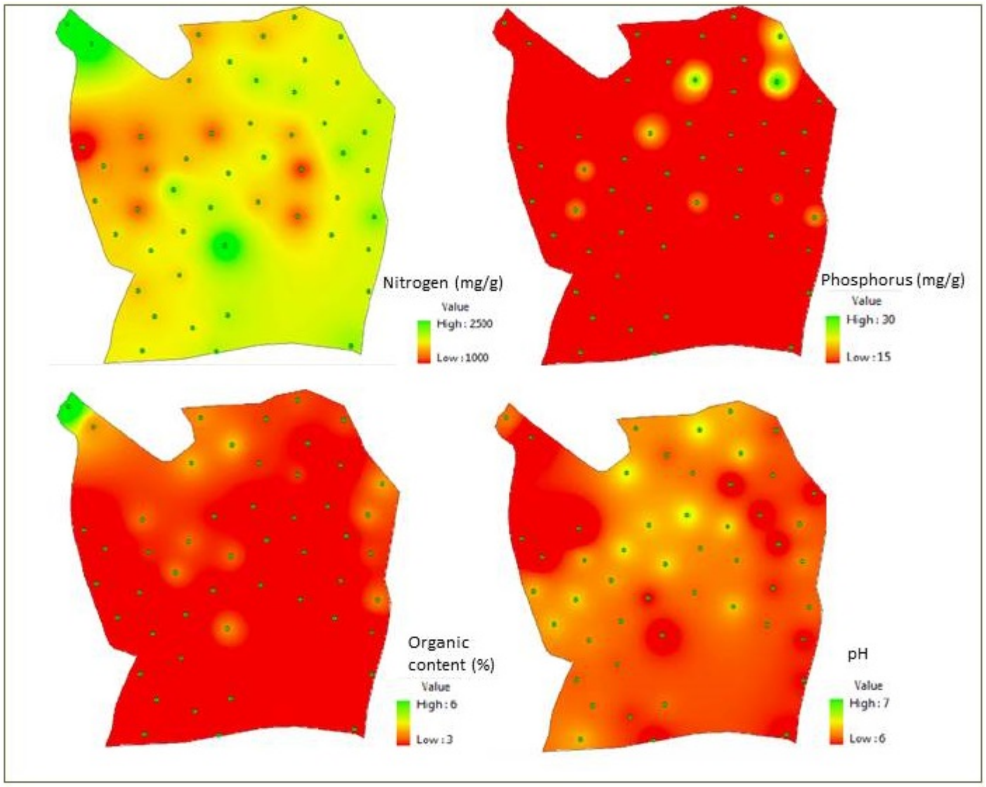
Figure 4.4a. Gully in San Jose ERF farm. Note the size and the volume of water that might through this; **b.** Soils in the gully are completely deteriorated; **c & d.** Areas with drainage limited and soil structure deteriorated due to trampling. San Jose ERF farm.

considered to be the plot center where a soil sample was taken. The soil sample was then handled by DisAgro for the soil analysis of the following physical and chemical characteristics: percent sand, percent clay, percent silt, organic content, pH, nitrogen concentration, phosphorus concentration, calcium concentration, potassium concentration, and magnesium concentration.



Map 4.11. Physical qualities of soil found in San Jose

A map of both the physical and chemical characteristics of soil within San Jose ERF was generated from the information collected during sampling (Map 4.11 and 4.12). Average values per plot were extrapolated using the method of Kriging analysis (IDW). This approach is based on the assumption that the interpolation surface should be most influenced by the nearby points. The interpolation surface is a weighted average of the scatter points and the weight assigned to each scatter point decreases as the distance increases to the interpolation point. This process was performed with the spatial analysis extension in Arc Map GIS software, with a cell size of 16 x 16 meter.



Map 4.12 Chemical characteristics of soil samples from San Jose ERF

4.4 VEGETATION CLASSIFICATION

A vegetation classification of the San Jose ERF farm was undertaken in order to distinguish between areas that are considered forest by Nicaraguan definitions that will be targeted for conservation in the project activity. Additionally, the type of vegetative classes across the property was of interest in order to understand stocking levels within plantable areas. The definition of forest used was provided by INAFOR:

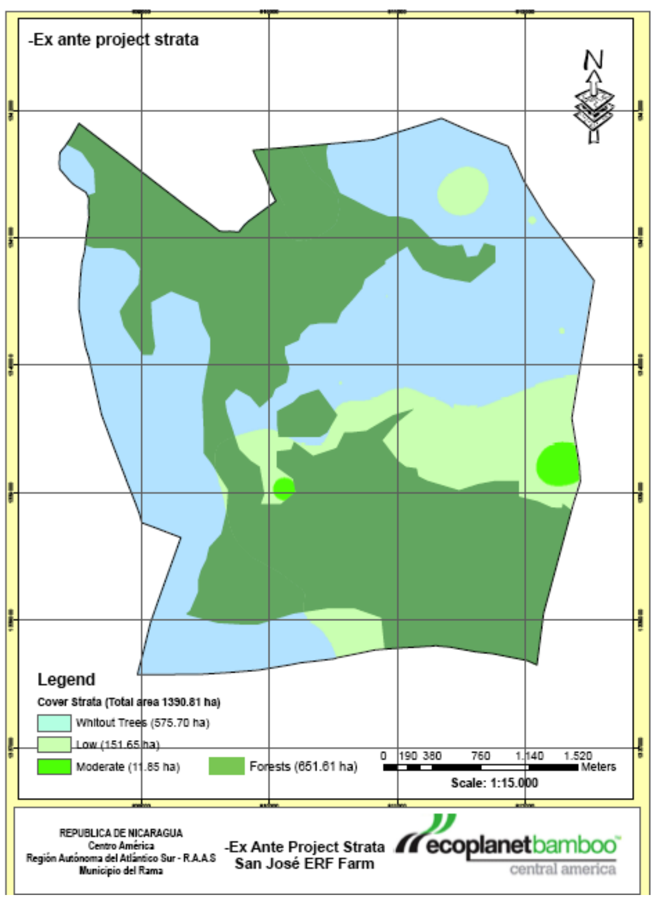
"..Forest is a natural or planted vegetation association at any stage of the natural cycle life, with trees reaching a height greater than 5 m, with a canopy cover greater than 10%, which extend more than 0.5 hectares and a minimum of 20 m wide, with or without management, is able to produce goods and ecosystems services, can influence the water regulation regime, the soils, the climate and can provide habitat for wildlife. The term specifically excludes tree stands used in agricultural production systems[2], such as fruit plantations and agroforestry systems. The term also excludes trees growing in urban parks and gardens..."

[2] It also includes cattle farming systems

Given this definition the crown cover was estimated from field based data as well as the height of trees within plots. Using this data combined the current land use was mapped by combining results from the satellite imagery analysis discussed in Chapter 3. Three classes of tree density per ha were defined (Table 4.3) each one being the key to the definition of land classes. The spatial definition of each land class was generated from the land class assigned to each sample plot which is defined according to the number of trees per ha (Annex IV). The extension spatial analyses of software ArcMap 9,2 was used to perform an interpolation process (interpolate grid) by means of the Inverse Distance Weighted (IDW) where each 5 x 5 m pixel takes a value which is used to group them in classes. In Map 4.13, the strata can be spatially seen. Note that forest area in in 2002 of 652 ha in San Jose ERF is overlaid on the different land classes.

Trees ha^{-1}	Land Class	San Jose ERF farm (ha)
0	Open pasture	576
1 - 50	Land with low trees	152
> 50	Land with moderate trees	12
Forest	Forest	652

Table 4.3. Land classes within San Jose farm, their definition, and area



Map 4.13. Land classes across San Jose farm

The trees remaining within the project area were sampled for their height, diameter, canopy cover per hectare, and canopy cover per hectare of trees exceeding 5-m. The results for the entire San Jose farm are shown in Table 4.4 and demonstrate the low density of trees across the property. In addition to there being few trees the trees found are typically small diameter and low in structure contributing very little to canopy cover.

Variable	San Jose ERF Farm	
	Mean	SD
Trees ha^{-1}	11	17
Total height (m)	4.6	1.2
dbh (cm)	24.6	11.4
Canopy ha^{-1} (%)	2.02	3.1
Canopy $_{\text{trees >5m of height}}$ ha^{-1} (%)	1.4	2.2

Table 4.4. Characteristics of remaining trees within San Jose farm.

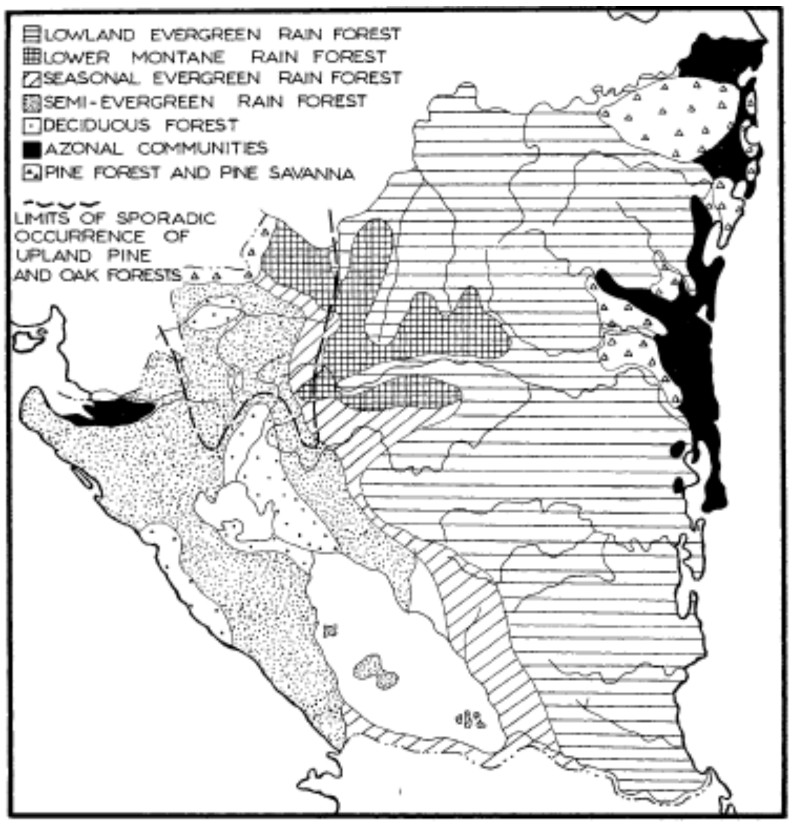
4.5 BIODIVERSITY

A biodiversity study for flora, mammalian, avian, and amphibian species has not been directly conducted within the San Jose farm. An EIA was carried out by Fallos and Asociados S.A. on the Rio Kama and Rio Siquia farms in 2011, which included an assessment of biodiversity. The San Jose farm is found within the same region, biome, watershed, and ecosystem as the Rio Kama and Rio Siquia farms. Consequently, the results of these EIAs for the observation of species diversity of flora and fauna are relevant here in addition to the results from the baseline study that captured tree species.

4.5.1 FLORA

Using the classification scheme set forth by Taylor (1963) the project area contains lowland evergreen rainforest that are characterized by *Andira inermis, Carapa nicaraguensis, Dialium guianense, Depteryx panamensis, Luehea seemanii,* and *Terminalia amazonia*. In 1963, this area was found to extend from the central highland region containing volcanoes and montane forest to the Atlantic coast (Map 4.14). Local forest inventories have also been carried out near the Bluefields area to account for biodiversity before and after natural disturbances due to Hurricane Joan that found a gradient of vegetation from swamps (*Carapa guianensis, Pterocarpus officinale*) to well-drained areas (*Vochysia ferruginea, Brosimum utile*) (Yih et al, 1991). Additionally, an EIA including an inventory of EcoPlanet Bamboo's Rio Kama and Rio Siquia farms was carried out, approximately 40-km north of San Jose. The complete lists of the inventories produced within lowland evergreen rainforest and the area of San Jose are shown in Annex V.

A total of 92 species were observed at the Rio Kama farm and 76 species at the Rio Siquia farm. Of the observed species there were five tree species found listed as Vulnerable or Endangered by the International Union for Conservation of Nature (IUCN) Red List (Table 4.5) (IUCN Red List, 2001). Of these species, Spanish cedar and big-leaf mahogany were also listed in Appendix III and Appendix II in CITES, respectively (CITES, year). Appendix II of CITES is defined as species not threatened with extinction but in which trade must be controlled and Appendix III contains species that are protected in one country that has requested assistance in controlling trade. From a national inventory carried out by INAFOR the stocking levels of different species were identified (INAFOR, 2009). The stocking levels of *Cedrela odorata* and *Swietenia macrophylla* were found to be 0.18 and 0.095 trees/ha, respectively. Within 650-ha of forest found within San Jose this represent 120 trees of *C. odorata* and 60 trees of *S. macrophylla*. Endangered species are expected to have even lower stocking rates.



Map 4.14. B.W. Taylor classification of forest types within Nicaragua.

Scientific Name	Common Name	CITES	IUCN
Cedrela odorata	Spanish Cedar	App III	VU
Swietenia macrophylla	Big leaf Mahogany	App II	VU
Platymiscium polystachyum	Granadillo	NA	EN
Vitex gaumeri	Fiddlewood	NA	EN
Zanthoxylum belizense	Zanthoxylum	NA	EN

Table 4.5. Vulnerable or endangered species found on the Rio Siquia and Rio Kama farms.

During the baseline inventory of vegetation and soil species information was collected for standing trees. The inventory was only specified for areas delineated a non-forest by the remote sensing analysis in order to determine the carbon stocks outside of the forest and if any areas met the definition of a forest specified by INAFOR. From this inventory across the ~740-ha of non-forested land in San Jose, only 13 unique species were observed (Table 4.6). Of these species none are listed within CITES or IUCN as a species of concern. As expected, the biodiversity of flora outside of the forest is considerably less than species observed within small fragments of forest in Rio Siquia and Rio Kama. As these species represent pioneer species that are capable of growing in open conditions and low-value species that are not listed as endangered.

Species Name	Common Name	CITES	IUCN
Acrocomia vinífera	Coyol	NA	NA
Byrsonima crassifolia	Nancite	NA	NA
Chimarrhis latifolia	Yema de huevo	NA	NA
Cordia bicolor	Muñeco	NA	NA
Geonoma congesta	Palma	NA	NA
Gossypium hirsutum	Algodon	NA	NA
Guazuma ulmifolia Lam.	Guacimo	NA	NA
Hirtella triandra Sandw.	Guaviluna	NA	NA
Melicoccus bijugatus	Mamon	NA	NA
Psidium guajava	Guayabo	NA	NA
Spondia mombin	Jobo	NA	NA
Tabebuia rosea	Roble	NA	NA
Thalisia nervosa	Mamon montero	NA	NA

Table 4.6. Species list of trees found in baseline inventory.

4.5.2 FAUNA

Annex VI contains the species list from the biodiversity study on fauna conducted within Rio Siquia and Rio Kama. The comparison between the fauna species found in the EPB project areas and IUCN list produces no endangered or vulnerable species and all are listed as Least Concern. A comparison with CITES reveals that one species, the Mantled Howler Monkey is listed as Appendix I. A closer examination of this listing shows that CITES hasn't been updated since 2003 whereas IUCN was updated in 2009. Additionally, it has been well established that the mantled howler monkey is a relatively resilient taxon. Threats to mantled howler monkeys in fragmented areas tend to be anthropogenic from hunting, further loss of habitat, and difficulty moving from forest patch to forest patch within a matrix of cattle pastures. From the project design of San Jose there are no concerns about threatening mantled howler monkey populations as the property is privately owned and forest fragments are signed for "no-hunting" and "conservation" policies. Additionally, the reforestation of the site provides an environment for mantled howler monkeys to move from patch to patch. Lastly, the sub-species *Alouatta palliata* found within Rio Kama and Rio Siquia is of Least Concern.

5. Socioeconomic Baseline Study

5.1 Introduction

The purpose of this study conducted in the municipalities of El Rama and Kukra Hill and its surrounding communities is intended to assess the relationship of communities to their environment, their history, their socio-economic dynamic, and their relationship with national and regional situation.

The project area is located in the municipality of El Rama and consists of EcoPlanet Bamboo's San Jose ERF Farm, which has an area of 1390 hectares. The mission of the company is to use bamboo as an alternative fiber in a range of manufacturing industries, as a substitute for both hardwoods and softwoods. Properties description and the farms´ workforce consist of a total of 40 employees shown in Table 5.1.

The groups with which the study was conducted include residents of nearby communities, business partners, representatives of different sectors of society, government institutions and non-governmental organizations. The selection of these actors was in response to the need of gaining an overview of the company and its activities in the territory from different perspectives.

Farm	Area of farm (Ha)			Map of farms	Workforce (Employees) as of Sept.2013		
	Total	Plantable	Conservation		Total	Women	Men
Farm San Jose	1390	751 (54%)	639 (46%)		40	6 (15%)	34 (85%)

Table 5.1: Area description of San Jose ERF.

The socio-economic study was carried out in the communities adjacent to the project area on San Jose ERF from the 16th to the 24th of September 2013. In each phase, it is essential to involve the participation of the people from the communities' subject of study, as well as collaborators, local authorities, representatives of governmental institutions and NGOs.

The study was also carried out in communities surrounding EcoPlanet Bamboo's Rio Siquia, Rio Kama, and Port Rama properties. A full copy of this study is provided in all EPB offices alongside the EIA for reference. Herein the results are summarized for San Jose ERF and full statistics and results can be found in the socioeconomic study provided in EPB offices (Fundenic, 2014).

5.2 Description of Methodology

The consultant team is made up of three people who will work in parallel on different methodological tools, namely: direct observation, workshops, interviews, a survey, focus groups, timeline, Venn diagram and classification matrix per pairs.

Regarding the survey, 20 surveys per farm were applied, a sample size based on the population of the municipality, data gathered by the National Institute of Information Development of Nicaragua 2011 during the visit to each community. Survey results provided information to make any adjustments to the design plans. The application of this survey - a quantitative tool - is performed to triangulate information obtained from in-depth interviews and focus groups.

In-depth interviews, focus groups made use of questionnaires that induce the respondents to address the various aspects of each topic, while the survey – a quantitative tool - analyzes the frequency of each variable to have a projection of the total sample.

To ensure the success of the socio-economic study, it is required that the organization and planning of all activities was done with care, both in the field research stage as well as in the stage of analysis, results, and report preparation, considering all details and unexpected events. This document includes aspects that are general in all the processes and work out as a reference framework.

By taking into account the context in which the study was to be performed, a methodology is chosen based on the theory of research-reflection-action that consists of first estimating what to evaluate and to implement actions afterwards under the framework of outcomes of the research. In each phase, the participation of all residents from the community's subject of study is of vital importance. The tools for the research process have a key human element, the daily participation of populations, as well as the national and local context.

After fieldwork and with the information obtained via different tools, it will make a comparison between the local reality versus the national census and the socio-economic indicators.

5.2.1 Technical Tools

The following are the detailed technical tools used for the socio-economic study.

Direct Observation

This tool is essential for researchers to interpret emotions, power relationships in families and the community, body language, surrounding conditions in which participants live and develop, and affective manifestations because these interactions often depend on the vision of a collective as for an initiative. The objective of such a study should be comprehensive and incorporate context elements.

WORKSHOPS

Workshops were performed with members of the communities by introducing the study team to make known the design of the study. Communities involved were: Calderon, La Fonseca, Kukra Hill, El Banco, La Mosquitia, La Esperanza, Cuidadela, El Rama.

In workshops with the inhabitants from the communities, a methodological tool of matrix of classification by pairs will be applied. It will be used to know about the development of priorities of men and women.

The participants were asked to think about the development needs of the areas, giving particular attention to sustainable projects and generate work opportunities, food security and a better quality of life.

INTERVIEWS

A team of three people performed the interviews. With the support of EcoPlanet Bamboo, there were meetings with collaborators, workshops with the people from the communities, and interviews with the representatives of institutions and municipalities.

A questionnaire was designed that will be applied at least to ten key stakeholders (leaders, authorities from the Municipal Major Office of El Rama and Kukra Hill as well representatives from the Ministry of Environment and Natural Resources (MARENA), the Nicaraguan Aqueducts and Sewers Systems Company (ENACAL), the Ministry of Education (MINED), the Ministry of Health (MINSA), the Ministry of Agriculture and Forestry (MAGFOR), The Nicaraguan Institute of Agricultural Technology (INTA) and the Nicaraguan Enterprise of Telecommunications (ENITEL).

The objective of these interviews was to explore the vision of key stakeholders regarding the indicators that are object of analysis. The outcomes of these interviews will serve as inputs to define the areas of work with focus groups. The interviews will be recorded for a maximum duration of 30 minutes.

The following a proposal of list of questions:

1. Do you know *EcoPlanet Bamboo*?
2. Do you think the presence of *EcoPlanet Bamboo* is important in the area?
3. Is *EcoPlanet Bamboo* a socially responsible company?
4. Is *EcoPlanet Bamboo* a reliable company?
5. What are the positive and negative impacts of *EcoPlanet Bamboo* in the community from a social, economic and environmental point of view?
6. Which changes do you expect to see in this company over time in the next five years?
7. Which projects or actions is your institution doing in the communities where *EcoPlanet Bamboo* is located?

The interviews will be conducted by phone and e-mail before starting the fieldwork. The municipal Major Office provided recent statistic data of the population in the communities to survey.

SURVEY

The survey is a needed tool to study the social and local situation and serves as basic information for future research. It is aimed to know the socio-economic situation, the environmental conditions, knowledge level and perception of the project under execution from collaborators and inhabitants who live around the Farms Rio Siquia, Siquia ERF, River Kama, Port Rama, Rio Escondido and San José. The content of the survey is based on other studies performed by EcoPlanet Bamboo, making some adjustments according to the context of the country.

The format includes personal and environmental data in which the community lives in, general interviewee data, family nucleus composition, ages and schooling level, social aspects, housing, utilities, current working situation, basic elements of local environment, knowledge level and project perception. Obtained data was systematized and processed in a database (Excel) arranged in accordance with the content of different indicators.

The entries are shown in graphics that present statistical data that will allow determination of qualitative and quantitative variables that show the socio-economic situation of respondent families.

To determine the number of people to interview, a sample of inhabitants from population data in the municipalities of El Rama and Kukra Hill 2013 will be calculated, producing a representative sample of surveys, with a security margin of 95% and 5% of precision. A formal methodology will be used to determine the size of the sample.

Given the fact the population is finite that is the total population is known and it is expected to know the representative sample, the calculation was made as follows:

$$n = \frac{N * Z_{\alpha}^{2} p * q}{d^{2} * (N-1) + Z_{\alpha}^{2} * p * q}$$

Where:

n= size of the sample
N= total of population
Za= 1,962 (for security of 95%)
p= expected proportion (in this case 5% = 0.05)
q= 1- p (in this case, 1-0.05 = 0.95)
d= precision (in this case, 5% is expected)

People who were interviewed were selected at random in the communities of more impact of the project.

FOCUS GROUPS

The objective of focus group or discussion was to explore the problems of the community and the options of development that the population faces. The participants were free to speak on different aspects of interest regarding a problem related to indicators; it is a space, a kind of forum where the exchange of ideas, analysis and reflection prevail and perceptions, feelings, opinions and thoughts of collective can be assessed.

The participation was guided and conclusions were the output of consensus, interaction and preparation of agreements as a whole. In the working plan it was considered to perform the focus groups independently regarding other proposed methodological tools. To work the focus groups, it will be performed the following guidance of questions:

- What do you think are the main existing problems in the area: environment, social or economic?
- Can you make a list of these problems?
- What do you think is the cause?
- How do they affect you?
- Which actions are done to face them?

There were focus groups per community/farm, in which eight and ten people can participate.

TIMELINE OR CHRONOLOGY

The tool of the timeline was aimed to aid in understanding the historic dynamic of the area from the inhabitants´ point of view that are older and have lived in the areas longer and to provide information on data and facts that have had an impact on current status of the community.

A guidance of questions to work with participants was prepared; for example, what is the most important event that the community recalls (social, economic, political, etc.), migrations, natural disasters, political situation, infrastructure development such as road construction, types of transportation, infrastructure transformations were possibilities for inclusion. The recollection of these data that go from the farthest dates to the most recent contrasted the presence of EPB in the before-and-after community history.

It was expected to identify the main natural, social and political events that have had an impact in current dynamic of communities and their populations. The area of the Caribbean Coast has been a region where some natural disasters like hurricanes occurred in the last thirty years, which have affected the status of biodiversity conservation and produced human migration. This phenomenon obviously has generated alterations and changes in the community dynamic; therefore, in the use of natural resources.

VENN DIAGRAM

This tool was used to show the institutions, organizations, groups and important people what there is in the community and the opinion of participants on their importance in the context. It also showed the contact and cooperation among the organizations and the community.

Participants were asked to prepare a list of organizations that includes: public sector, private sector, and community structures, such as groups of young people, groups of women, and religious groups. Once the list of organizations within the community were collected, the participants were asked to assign cardboard boxes of different sizes according to the importance given to the organizations they have listed.

The size of boxes shows the importance of the organization. The representation of the importance is as follows: the biggest boxes are the most important organizations while the smallest represents the least important organizations.

The facilitator will draw an X to mark the household or the center of the community in a piece of paper. Each organization, represented by different-size boxes, will be placed according to the proximity with the community. The location of the paper in the center of the community will show closeness or links among the organization and the community.

This tool lets us understand the dynamic of public and private organizations in the community and the relationships between the organizations and the community. It also gives an idea of links within the community.

CLASSIFICATION MATRIX BY PAIRS

Classification matrix by pairs was used to know about the development of priorities of men and women.

The participants were asked to think about the development needs of their areas, giving particular attention to the type of projects that create sustainability and generate work opportunities, food security and a better quality of life. The participants were asked to discuss some issues and at the end they prepared a list of projects ordered according to priority.

The facilitator made a list of projects in both vertical and horizontal axis of the matrix according to hierarchy of priorities. Each project was written on a separate card. The facilitator introduced the first pair of participants who presented to the group their pairs of cards with two different projects in the vertical and horizontal axis of the matrix. Then, the participants chose the project they think is the most important.

The facilitator recorded their election in the matrix. The participants explained the reasons of their choice. This process was repeated including all the possible combinations of the project in the vertical and horizontal axis. Once the ranking of priorities is complete, the facilitator counted the number of times each project is selected and then she will classified them according to importance or priority.

5.3 TIMELINE

The timeline provided data and information on local, national and international events that have influenced current state of the community and the region for example the tragic attack on the Twin Towers in New York, which was mentioned as an event that influenced the city of El Rama. This tragedy led to the sending of financial support from families abroad to be reduced and local migration to the U.S was decreased. There are political events that have had impacts in each community surveyed as the fall of the Somoza government and the rise of the Sandinista party to power, Natural disasters like Hurricane Jeanne in 1988 causing devastating effects to the environment and the war that occurred between the Sandinista government and the rebels in the 80's. All these events influenced what is now the social dynamics of the region. Similarly, in the communities nearby EcoPlanet Bamboo's San Jose ERF Farm, EcoPlanet Bamboo's presence is indicated as a significant event in the region due to high expectations for economic development and employment generation (Table 5.2 & 5.3).

Areas	Most Frequently Aspects	Recommendations
ECONOMIC	• High cost of living / global economic crisis • Low wages • Unemployment • Labor migration • Unfavorable credits	• Programs for entrepreneurship • Best credit conditions • Job careers
SOCIAL	• Alcoholism, sexism and domestic violence • Insecurity, lack of community leadership • Lack of sexual education and reproductive health	• Development of campaigns and education programs and information on family issues and sexual and reproductive health • More presence of authorities
ENVIRONMENTAL	• Contamination of soil and water sources due to poor management of solid waste • Hunting • Forest loss and contamination of water sources by harmful practices of African palm • Lack of education and environmental awareness at all levels • Missing conditions for solid waste management (landfills)	• More belligerences of the authorities for the implementation of policy in defense and protection of nature • Development of campaigns and environmental education programs to promote attitudinal change

Table 5.2: Summary of the most common issues in each area

1979	1980 -89	1988	1990	2003	2007	2013
The government of Anastasio Somoza was overthrown by the Sandinista guerrilla movement National Liberation Front (FSLN), which gives rise to a period of political instability and fighting between the Sandinista army and anti-government movements.	It is said it is the loss decade in the country due to the war that occurs between the Sandinista government and armed groups of the counterrevolution. The Caribbean region was one of the most affected regions by armed conflict that forced the displacement of communities into enclaves or military bases.	Hurricane Jeanne destroyed forests, species of animals. It destroyed everything. Many communities had to be relocated and moved to other sites to safeguard its security.	There are presidential elections and the National Opposition Unit (UNO) wins, defeating FSLN. It starts period of peace and the disarmament of guerrilla forces is produced.	Monoculture of African palm is expanded to 46 thousand ha destroying forests, polluting water sources and causing families to sell their lands to migrate to the city, thinking they will have better life options in the city.	Sandinista National Liberation Front party won the presidential elections. There are expectations and fears in the region to have war again and causes return migration of communities and social and economic instability.	The company's operations are indicated as a significant event in the region due to expectations for economic development and employment generation

Table 5.3: Synthesis of the timeline.

5.4 Demographics of communities

Origin of respondents

20 people who participated in the survey were from 8 nearby communities and neighborhoods. Although most of the inhabitants belong to the communities around the farms of EPB, some come from further afield, especially if their academic preparation level is higher (Table 5.4).

San Jose ERF Farm	
Q	**Communities**
10	La Mosquitia
3	El Banco
2	El Rama
1	La Raicilla
1	El Castillo
1	Maria Cristina
1	Muelle de los Bueyes
1	San Juan
20	**Total**

Table 5.4. Origin of respondents

Age of respondents

The age of respondents is between 20 and 61 years-old. The most common age range is in the communities nearby San Jose ERF Farm, corresponds to 30 to 39 years-old with 45% (Table 5.5).

Farm San José		
Age	**Q**	**%**
20-29	7	35
30-39	9	45
41	1	5
52-59	2	10
61	1	5

Table 5.5. Age of respondents

AGE RANGE BY SEX

Regarding the age according to the sex of the respondents, the biggest percentage corresponds to the gap of between genders (Figure 5.1).

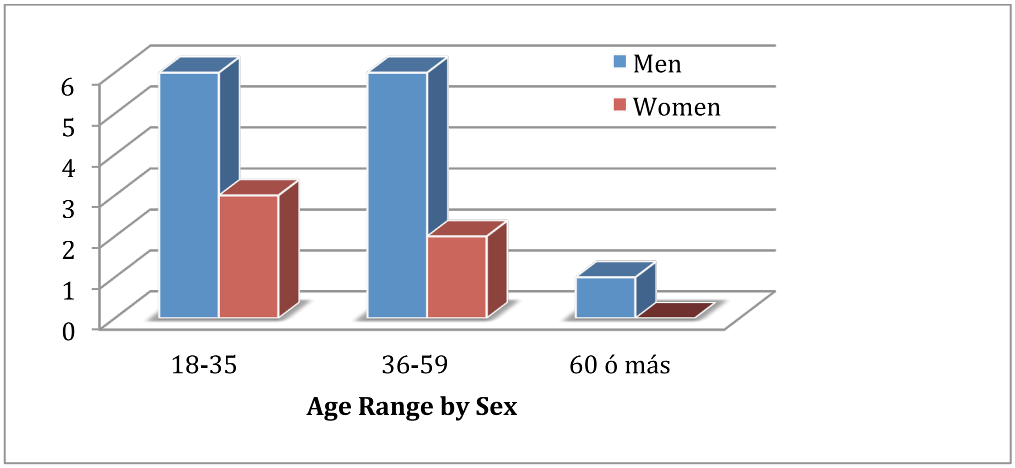


Figure 5.1. Age range of respondents by sex

RESPONSIBILITY AT THE HOUSEHOLD

In communities surveyed, the groups of heads of household that are most representative are male (65%) followed by female, spouses, and other family members (Figure 5.2).

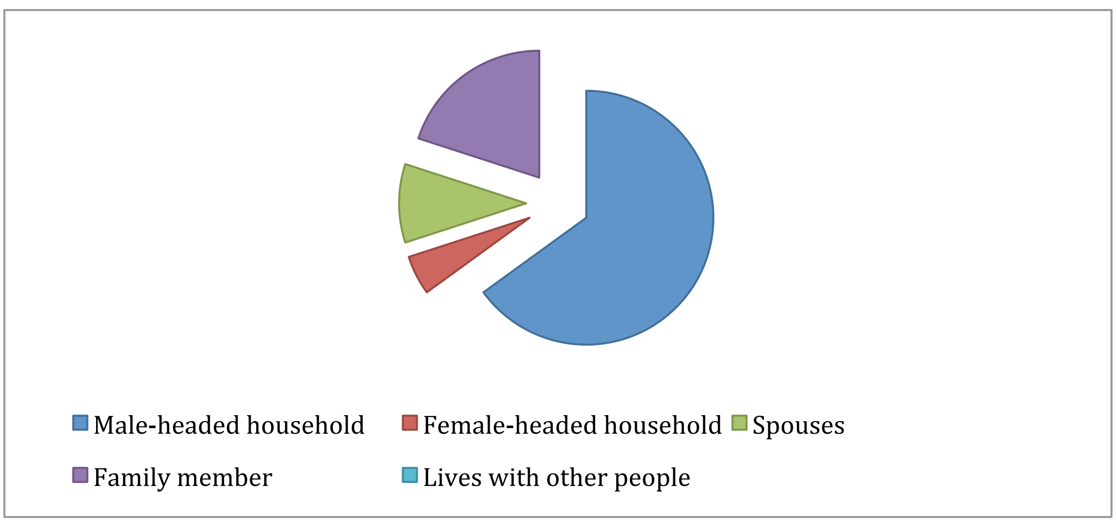


Figure 5.2. Household responsibility

YEARS OF LIVING IN THE AREA

People living in the communities for a period of 21-30 years are the most stable inhabitants (Figure 5.3).

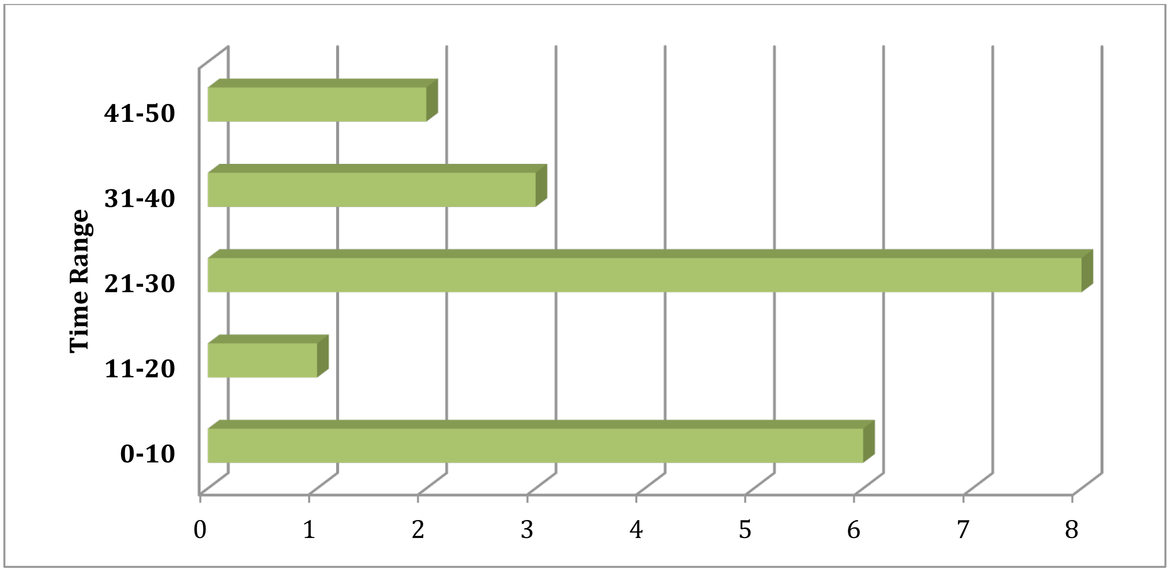


Figure 5.3. Time Range living in the area

STAYING IN THE AREA

55% of respondents have not always lived in the area or in communities around Farms San Jose ERF (Figure 5.4).

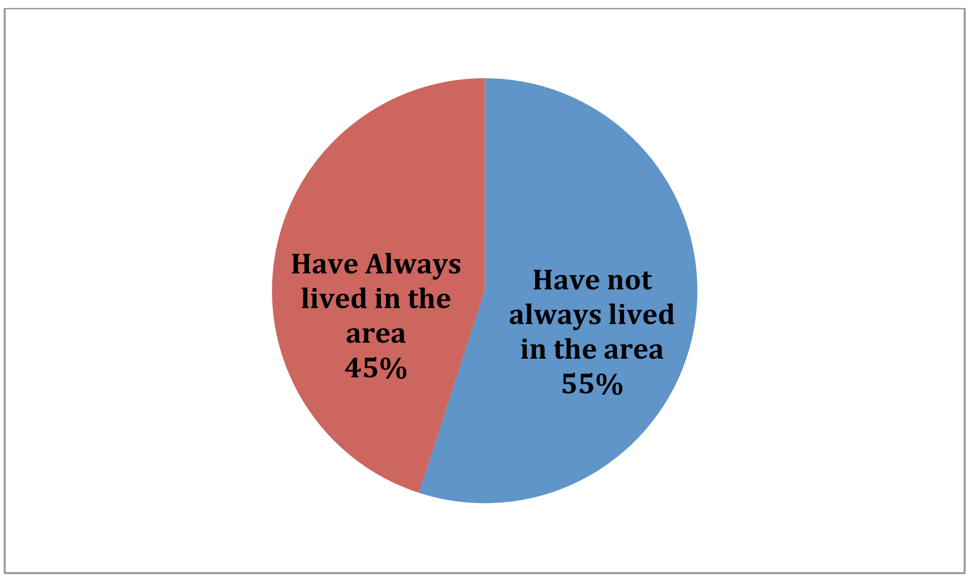


Figure 5.4. Staying in the area.

REASONS TO LIVE IN THE AREA

The main reasons for community members living in the area are the locals "the ones from the area" (45%), followed by "job opportunity" which has a representation of 25% well above the rest of the other reasons given by surveyed people (Figure 5.5).

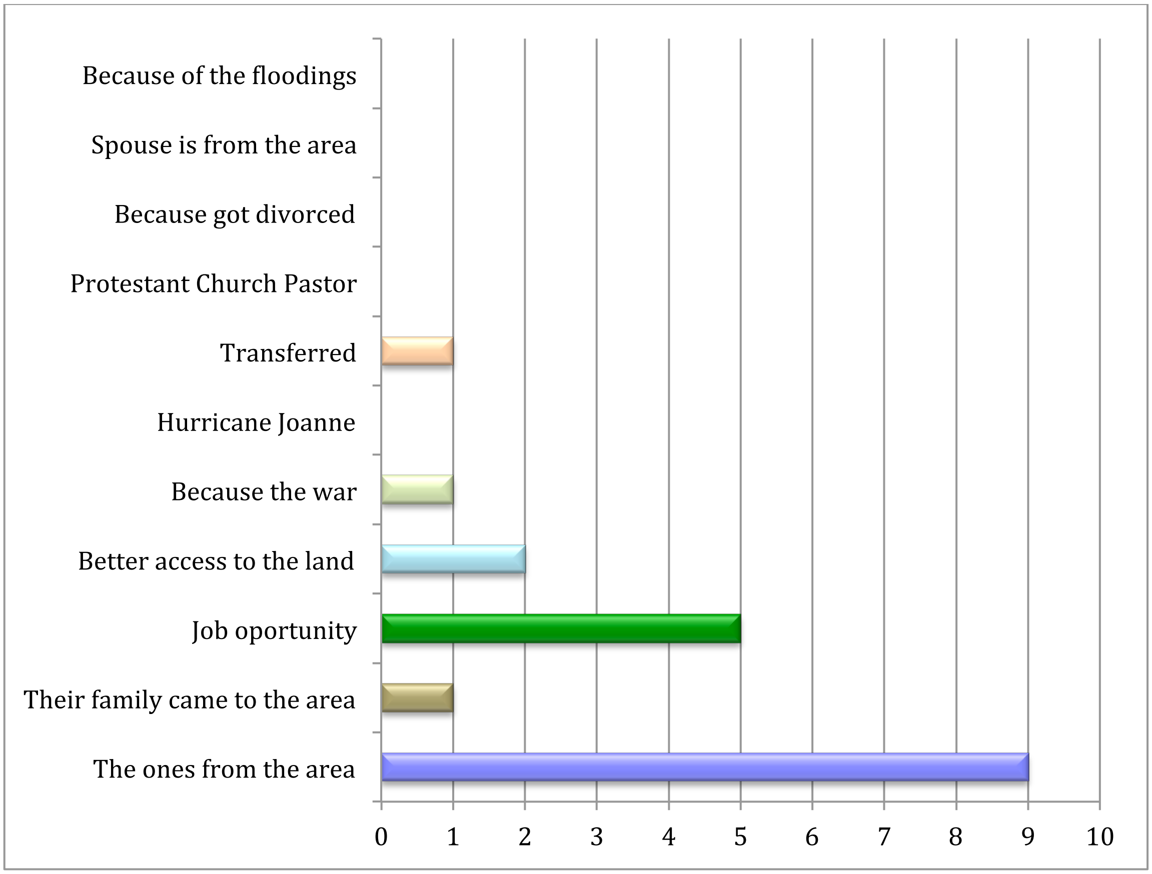


Figure 5.5. Reasons to live in the area

Migration is an important survival strategy for rural and urban poor households. National migration is toward Managua, urban cities and rural areas during the harvest seasons. International migration goes to Costa Rica, Honduras and El Salvador, mainly following the harvest seasons. In the Atlantic area people prefer to migrate to the Caribbean islands and the United States. Poor people perceive migration as negative and positive at once: household income increases, but it separates families (BM, 2000).

Number of people living the house

Other aspects covered by the survey were to determine the number of people living within households by their age and the number of partners. Information indicates whether there is overcrowding in the households.

At national level, 4.6% are single person households, 19.6% are households with four people, 52.9% had between three and five members, and 5.3% are households with 10 people and more. And almost 20,000 households (1.9%) consist of 12 members and more, which are signs of overcrowding (INEC, 2005).

In the communities surveyed, families with four to six people are the majority with this range is considered normal average among rural families. Households with seven and more people comprise a significant group. This indicator can be listed as a household with potential problems of overcrowding, depending on the size of the household (Figure 5.6).

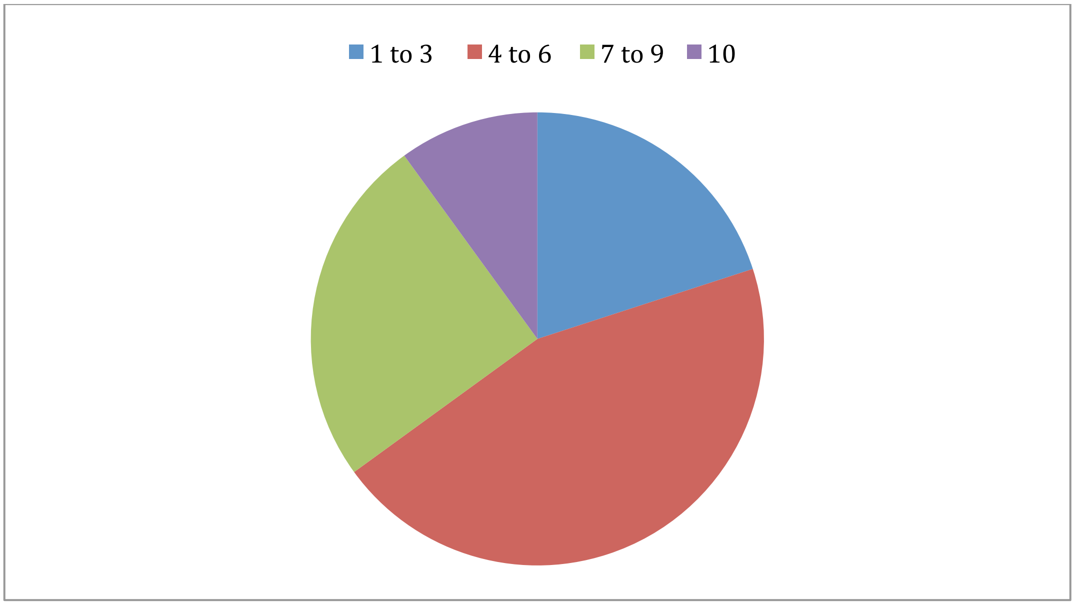


Figure 5.6. Number of people per household

NUMBER OF PAIRS WHO LIVE IN THE HOUSEHOLD

75% of surveyed Households are composed by one couple and is an absolute majority. Households with two couples represent 15% of surveyed people (Figure 5.7).

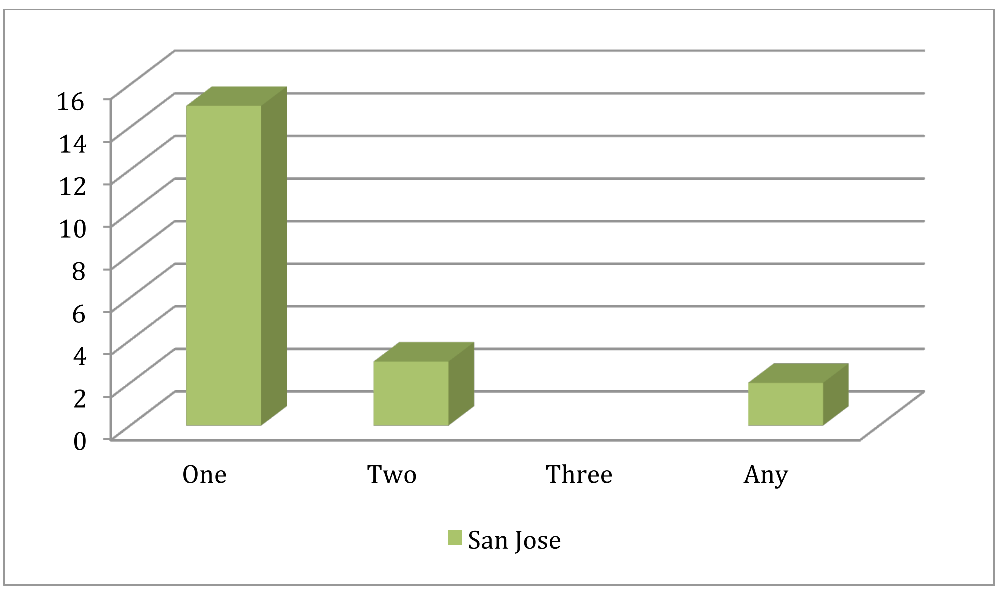


Figure 1.7. Number of couples with a household

AGE RANGE BY SEX OF RESPONDENT FAMILIES

The age range between 25-35 years for men and from 5-10 years of age for women are the most representative of the different genders by age (Figure 5.8).

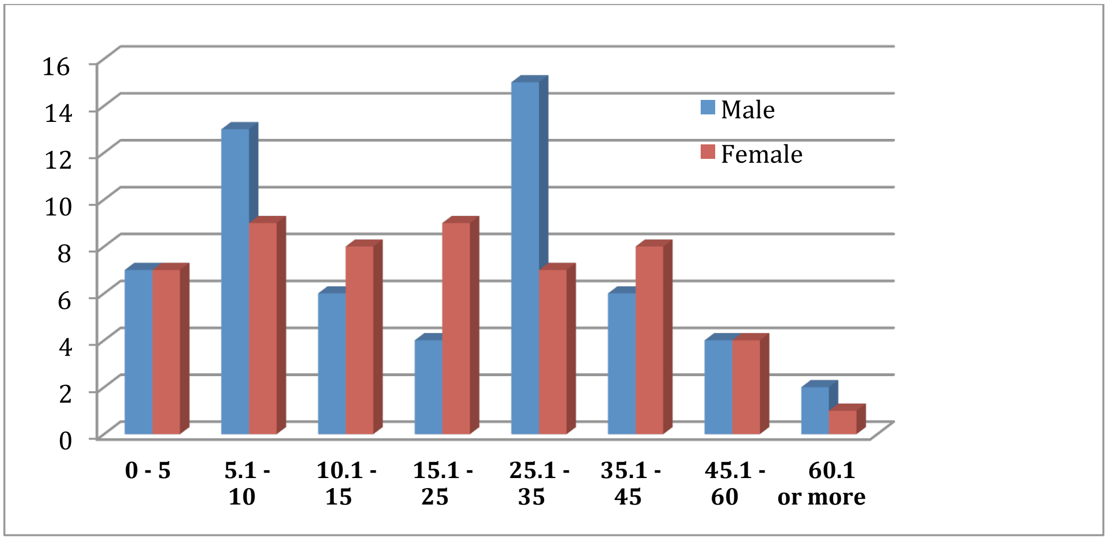


Figure 5.8. Age range by sex in Households

SOCIAL ASPECTS OF THE COUNTRY AND MUNICIPALITY

In Nicaragua, housing deficit is very high and the economic conditions of most households are to build homes with inadequate materials. The conditions that are generated in this type of housing increase the risk of disease transmission and well-being deterioration in the households (FIDEG, 2012).

5.5 TYPES OF HOUSEHOLDS IN THE COMMUNITIES

WALLS

The materials of household walls nationwide are as follows: 8.8% live in the households with inadequate walls. In urban areas, the deficiency of wall materials is higher, 12.5% live in houses with walls built by inappropriate materials. In households headed by women, they are slightly more likely to live in inadequate houses with walls than households headed by men (FIDEG, 2012).

In the communities surrounding San Jose Farm, it was found that 17 households (85%) have wooden walls (Figure 5.9).

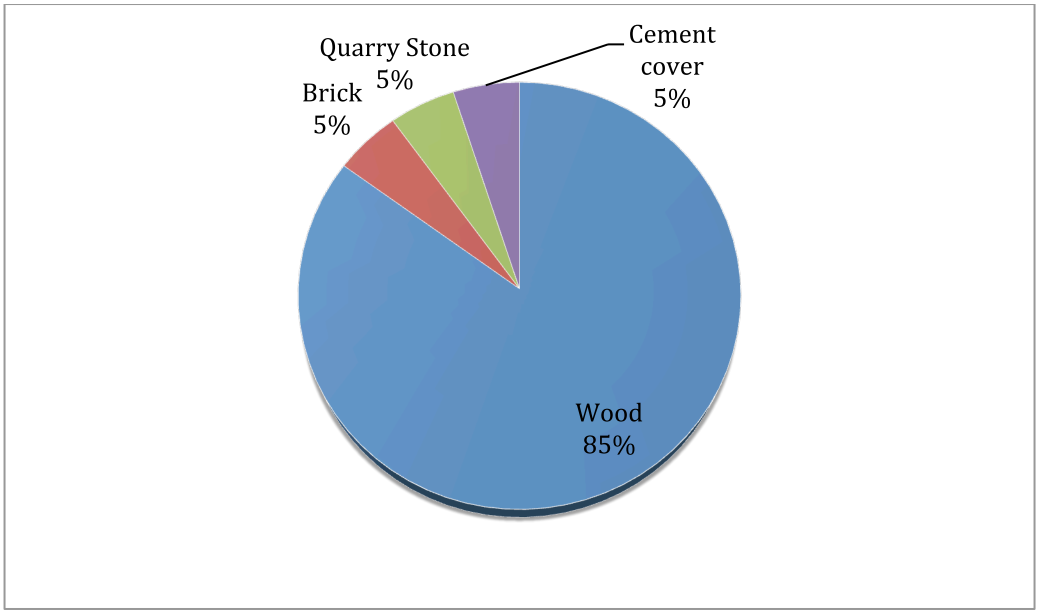


Figure 5.9. Materials used in house walls

Roof

As for roofing materials nationwide, it can be said that few households live in dwellings with inadequate ceilings; only 0.6% of households live in dwellings of this type (FIDEG, 2012). 100% of households in the communities use zinc sheets for roof. This material is more durable and resistant to withstand the climatic conditions of the area. The other four houses use tile, plastic and other materials not specified for roof (Figure 5.10).

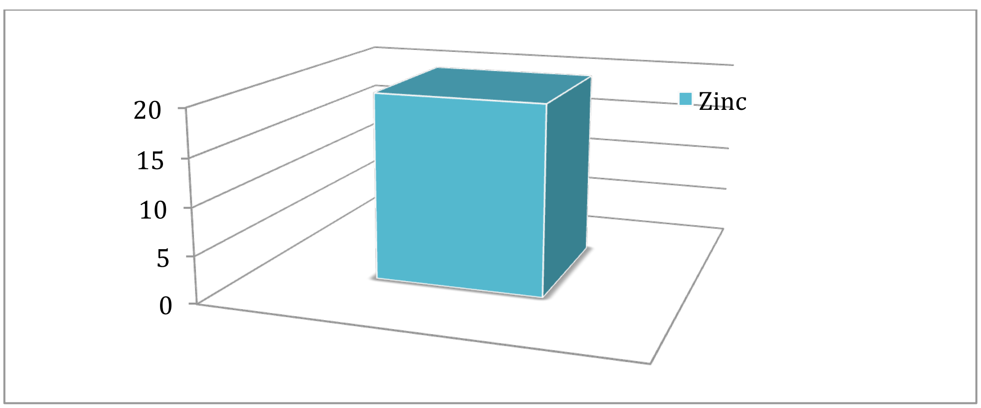


Figure 5.10. Household roof

Floor

In 2012, at the national level, 40.6% of households live in dwellings with inadequate floors. In rural areas, this percentage is higher, reaching 60.5%. Comparing male-headed households with female-headed households, the proportion of households living in dwellings with inadequate floor is higher for households headed by men

(44.5%). In the communities near San Jose Farm their was a distribution of 45% of the houses with wooden floor, (35%) other materials and (20%) cement cover (Figure 5.11).

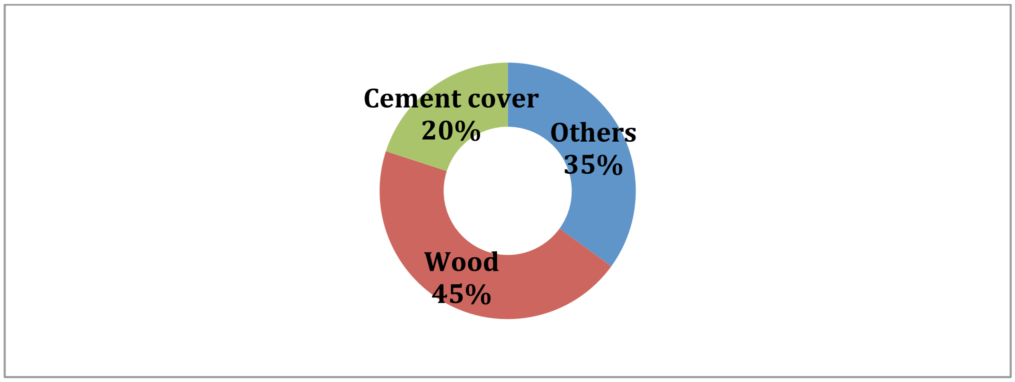


Figure 5.11: Household floor

5.6 Characteristics of households and land

According to CENAGRO (2001), in the RAAS, 99.52% corresponds to 22,696 farms that belong to individual producers, natural people. This form of legal status prevails in the region. The rest remain in legal conditions (cooperative, collective family household(s), company, indigenous community, government and other) and they are less than 1% (among all represent 0.48%).

According to CENAGRO (2011), in the RAAS there were a total of 22,714 farmers, of which 2,656 were individual producers, 18,284 men and 4,372 women. The land tenure under the category itself covers an area of 1.855.273.37 manzanas (mz).[1]

In the municipality of El Rama 3,911 farms equivalent to 99.72% owned by individual producers. The other types of legal conditions are less than 1%. In El Rama, 28 cooperatives were counted and established and legalized with 899 members and an area of 21,520 mz.

On the other hand, in RAAS, the average size of farms is 89.71 mz, which is above the national average, which is 44.77 mz. Both in the country and in the Autonomous Region, the largest number of farms is in the range of 20.01 to 50 mz, covering a total 77,644 mz, representing 34% of the total. Farms with area of 1 mz are to less have retail presence, being 185 farms representing just over 1% of the total (CENAGRO, 2001).

Farms having more 100.01 mz or more present 21%, but even cover 60% of the census area. Meanwhile, farms with sizes from 0.01 to 20 mz are 19% of the total, having only 2% of the census area. Most farms are in the range of 20.01 to 100 mz, meaning 60% of total holdings, contributing with 38% to the agricultural land available of the region.

[1] 1.00 manzana = 0.704 hectares

According to El Rama municipality, there was 3,911 production units (17%), covering an area of 256,315 mz. According to its size are distributed as follows: farms with an area between 0.5 and 50 mz are the majority with 50.5%, in second place there are the units with areas between 50.1 and 200 mz with 41.8%. Farms with more than 200.1 mz surfaces are up 7.6%.

Housing tenure

There was an equal amount of respondents that owned their house and were there temporarily (Figure 5.12).

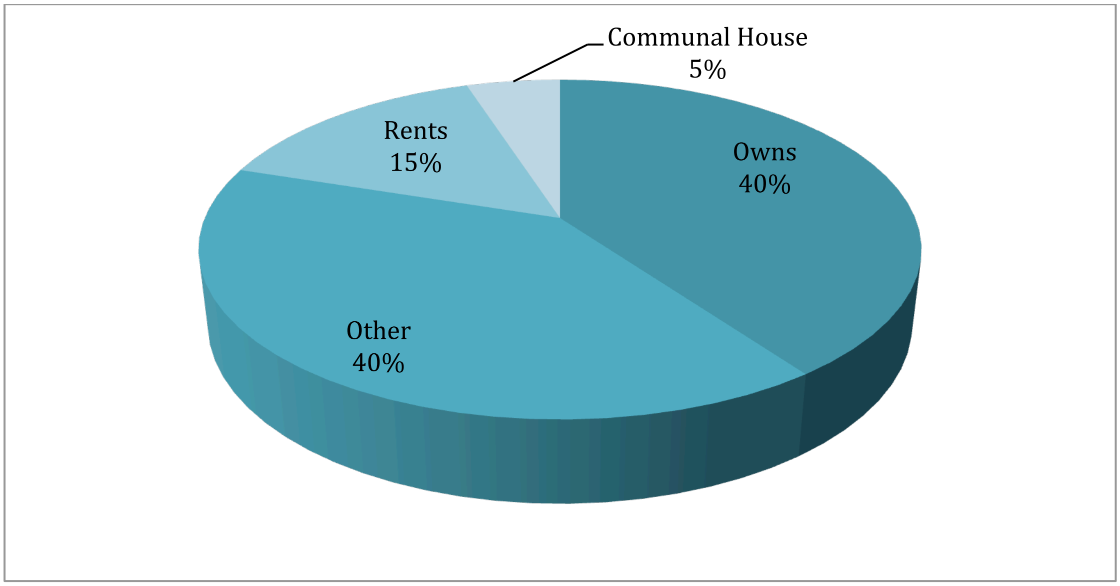


Figure 5.12. Household tenure

Legal status of housing

50% of the respondents have indicated they own a deed of their property. 40% are doing other paperwork. 60% of the registered reported they did not have homeownership (Figure 5.13).

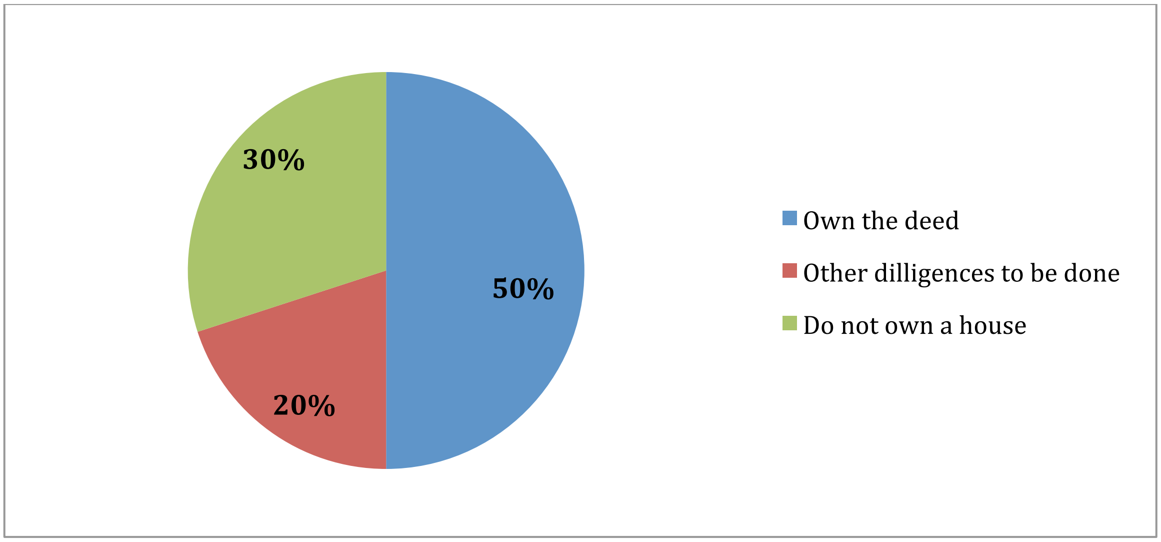


Figure 5.13. Legal status of the household

LAND TENURE

50% of respondents own the land they reside (Figure 5.14).

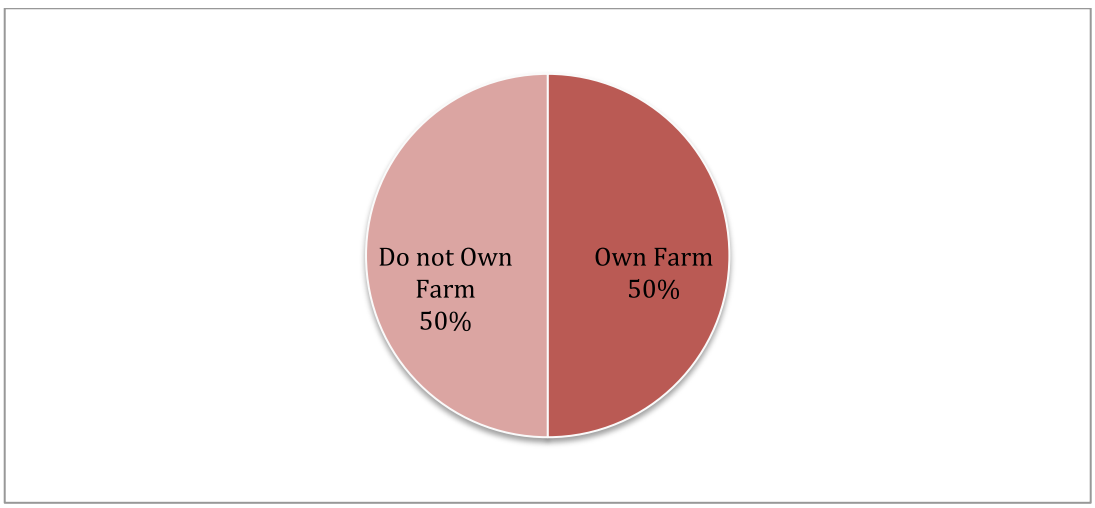


Figure 5.14. Land Tenure

LEGAL STATUS OF LAND TENURE

The percentage of ownership of the deed by surveyed people is 80%. The remaining 20% is distributed in the categories of other procedures and agrarian reform titles (Figure 5.15).

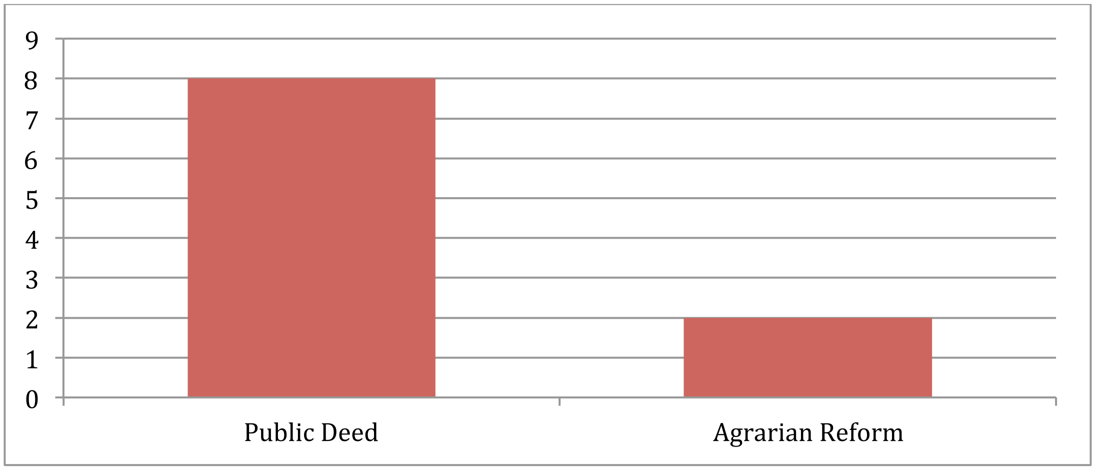


Figure 5.15. Legal status of land

5.7 Education

5.7.1 Status of Education in Nicaragua

Nicaragua is in Central America the country that has faced major impacts to its political, social and economic stability in the last thirty years. Earthquakes, wars, natural disasters and corruption have determined current national architecture, which has affected a substantial increase in poverty, macro economic imbalances and a large percentage of illiterates. It is also estimated that the annual growth of the national population for the period 2000-2005 is 2.6%, finding much of this growth among young people. This growth rate, although it has declined in the last decade, is still among the highest in Latin America and is a strong pressure for basic services, including education.

Nicaragua is also a country with diverse socio-demographic demands; it is multiethnic and multicultural, with clear educational differences in both coverage and quality as modalities and qualities, regarding its urban, semi-urban and rural composition. Thus, illiteracy is associated with poverty and 37% of the population in extreme poverty is illiterate. Similarly, 35.8% of men and 38.9% of women have this same condition.[2]

Illiteracy rate in Nicaragua is 7.5% of the population over 15 years old. The net enrollment rate at primary level is 91.8%. The net enrollment rate at the secondary level is only 45.2%, and the gross enrollment rate at the tertiary level is 18.0%. Also, the net enrollment rate stood at 46% while school retention is 90.9%. Moreover, the repetition rate at primary level was close to 11.0%, while the repetition at the secondary level was 7.9%. Meanwhile, the primary completion rate is low (about 80%) the end of sixth grade. Only two out of three students could only culminate the cycle (BCIE, 2009).

Public education is concentrated in the primary sector, while its share is much less relevant in the secondary sector and grows only in the tertiary sector. About 85% of

[2]http://www.nicaraguaeduca.edu.ni/uploads/DisenoCurricular.pdf

children attend public schools at the primary level; at the secondary level, this percentage decreases significantly and reaches only 30%. Spending on education in the country is close to 5.9% of PIB. It is important to note that spending on education represents a value of 42.0% above the so-called social spending (BCIE, 2009).

The basic and secondary education is the most complex and increased coverage of sub-systems that make up the national education system. It includes initial levels of education, primary education, accelerated basic education, youth and adult education, especially basic education and secondary education and is the responsibility of the Ministry of Education (MINED). Overall, this sub-system has faced in the last two decades an issue linked to the coverage, quality and management in the education service.

The subsystem basic and media education consist of the following levels:

1. Early Education: offering formal and non-formal mode. The age group of 0-3 years attending non-formal mode, more community participation and the age group of 3-5 years in non-formal and formal mode; the group of 5-6 years is treated in formal education.
2. Elementary Education: it includes regular primary, multi-grade, basic education, accelerated and adult education, basic special education and nocturnal primary education consists of two cycles: first cycle (1st to 4th grade), second cycle (5th and 6th grade) and innovative ways to bring educational supply to education demand.
3. Secondary education: It includes regular high school, evening secondary education, distance secondary for Young and Adult Workers, comprising two cycles, the third cycle (7th to 9th grade) and the Fourth School Cycle (10th to 11th grade), with alternative modalities, both the third cycle is in high school.

Passing from one grade to another is done through school promotion standards that qualify for passage by different degrees. This certificate is issued by the Education Center Director signed by the Chief Municipal Delegate at primary and secondary level. In the latter case, it generates credits for school.

5.7.2 Education of interviewed population

Education of respondents

The largest proportion of surveyed population said that their education is incomplete primary with 29% representation. The group of people registered with a university education reached 19%, above the category of people who did not study anything or 18% (Figure 5.16).

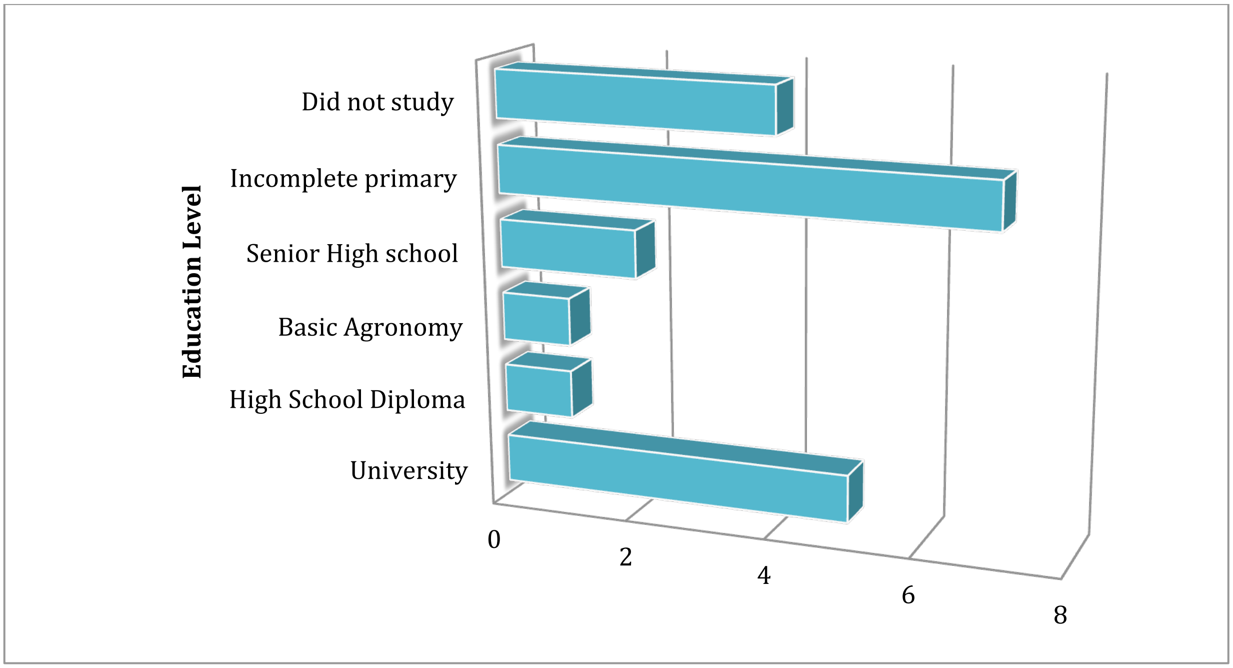


Figure 5.16. Education of respondents

In the area of urban residences, the average years of completed education of the population is 7.3 years; in the area of rural residence this average is 4.5 years. This proves once again the problem of retention, which is presumably associated with poor educational opportunities in the field a43nd early involvement of adolescents and young people in rural labor market.

FAMILY EDUCATION

90% of the families of the census have family members currently attending school (Figure 5.17).

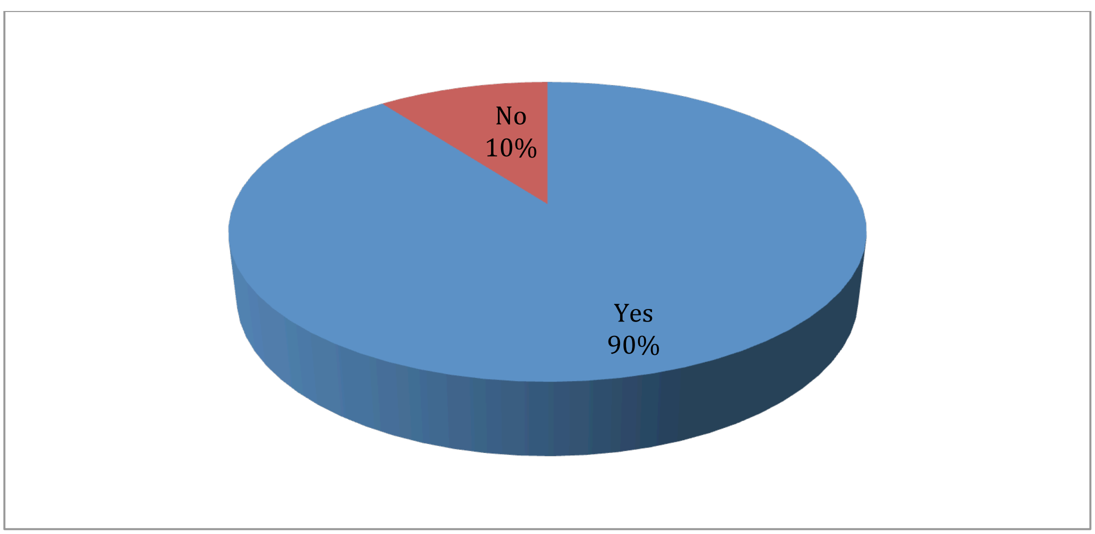


Figure 5.17. Family members attending school

The largest group of respondents reach their last year of high school for the communities surrounding our San Jose Farm (Figure 5.18).

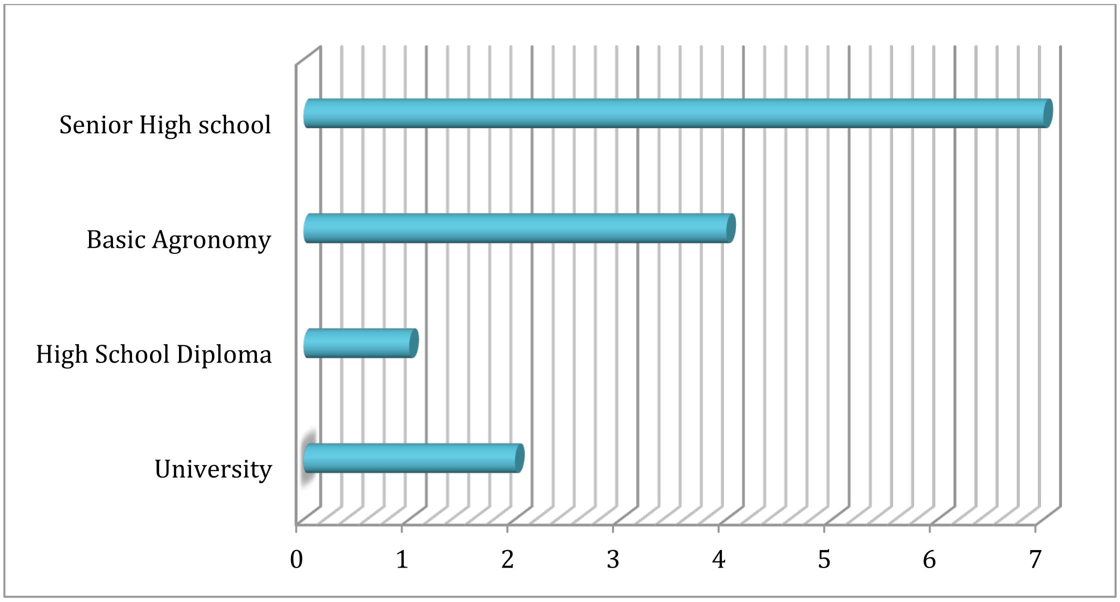


Figure 5.18. Education level obtained in the family

In 2012, the illiteracy rate of the population of 10 years of age or older was 15.3%, lower than in 2011 and 0.4 percentage lower than the one observed in 2009 by 0.9 percentage points nationwide. This reduction was mainly in rural areas, where illiteracy is manifested with greater intensity. The rural literacy rate for 2012 was 21.7%, almost below 2011 and 4.4 percentage points lower than the 2009 percentage point. In urban areas, no change was observed and in 2012 this was 10.2%. In other words, in rural areas there has been significant progress in reducing illiteracy, but have been offset by stagnation produced in the urban area.

5.8 Basic Resources

Public Services

58% of the population census showed that the existing educational infrastructure in the community is a primary education facility. Access to secondary education is reduced to 24% (Figure 5.19).

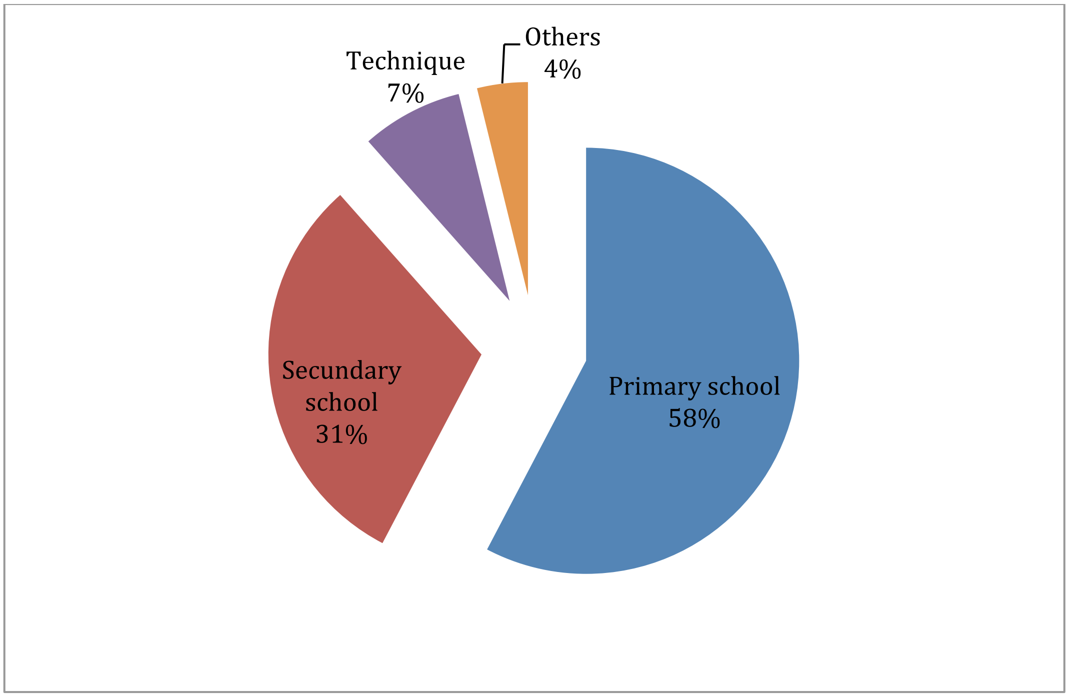


Figure 5.19. Educational services in the community

According FIDEG, in 2012, while in urban areas, the net secondary enrollment rate was 65.8% in the rural area that same rate is 38.5%. Similarly, the net rate of university enrollment in urban areas exceeds thirteen percentages to that observed in rural areas. On the one hand, because in this area of residence educational provision is essentially limited to the primary level and distance to secondary schools is considerably higher and, on the other hand, because parents feel the need to make use of their children hand force to ensure economic sustenance of their homes. This is consistent with the high rates of labor force participation of rural adolescents and young people.

HEALTH INFRASTRUCTURE

Interviewees receive care primarily through municipal health centers and the (RAAS) Department hospitals (Figure 5.20).

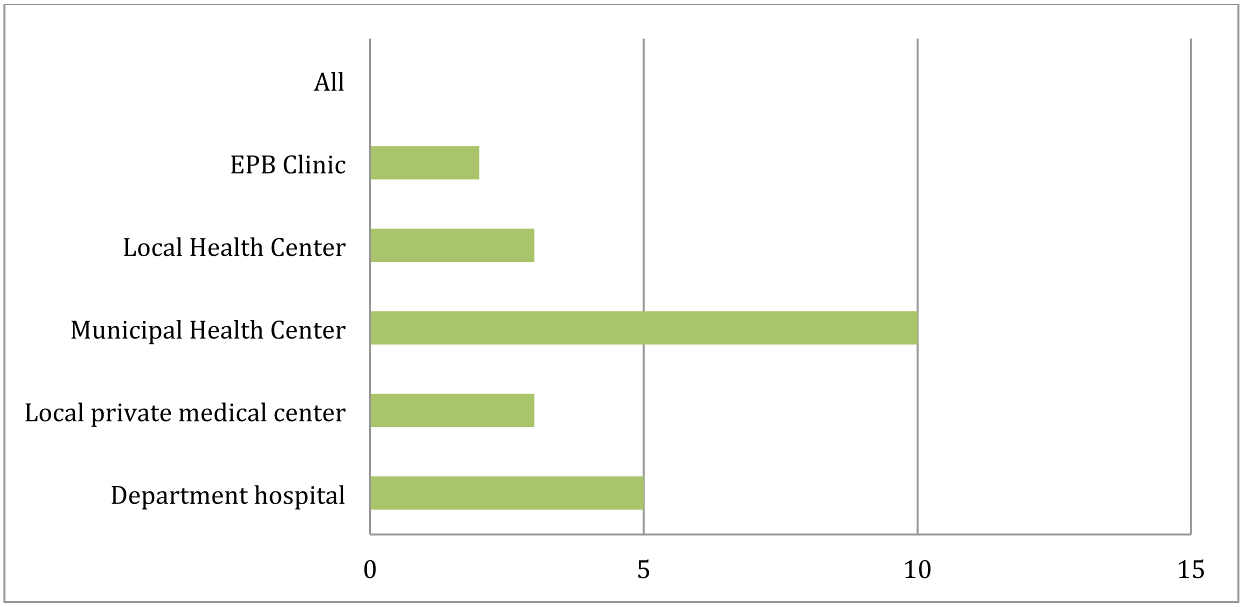


Figure 5.20. Health in the community

5.9 ACCESS TO BASIC SERVICES IN THE COMMUNITY

WATER ACCESS

At national level in 2012 according to FIDEG, 12.2% of households do not have access to safe drinking water in rural areas and this gap reached 18.5%, which increases the probability of occurrence of diarrheal diseases. By comparing male-headed households with female-headed households, it is noted that in the latest, the of households with poor access to drinking water is 8.7%, five percentage points less than in the case of male-headed households. From the population surveyed, 42% of the participants get their water through public service, followed by water wells (Figure 5.21).

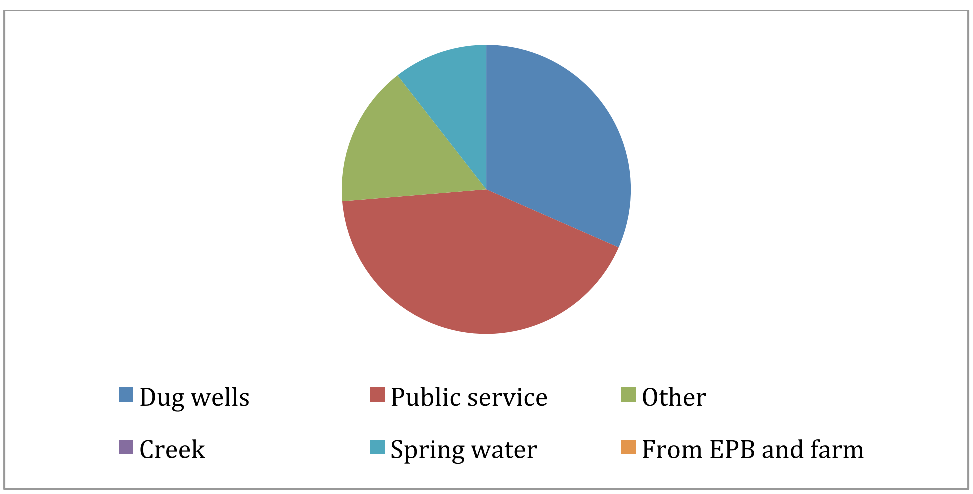


Figure 5.21. Form of water access

LIGHT ACCESS

As for the type of light access in the Communities nearby San Jose, 45% of households use kerosene, candles or torch to light. This form of lighting increases the likelihood of home accidents, whether fire or fire-related injuries the household members (Figure 5.22).

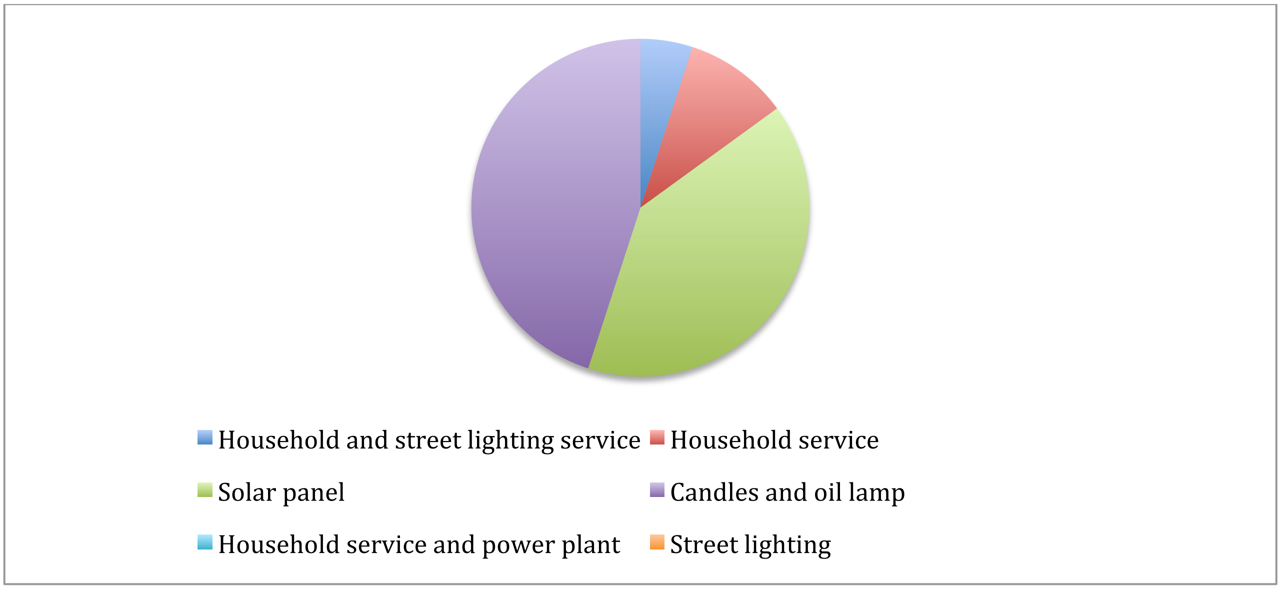


Figure 5.22. Light access

WASTE TREATMENT

In 2012, 7.1% of households nationwide did not have a system of sewage elimination (either toilet or latrine). In rural areas, it is the same percentage of 13.8%. By contrast, the male-headed households with households headed by women, it is observed that the proportion of households without adequate excreta disposal system is 8.6% in the case of male-headed households and 4.1% for the headed by women (FIDEG, 2012).

Latrines are used by 70% to handle runoff. The remaining respondents used sump and septic tank, which represents 6% in both cases. There is also a combination of sink and latrine, which corresponds to 4%, equal to those who said they do not use anything for management (Figure 5.23).

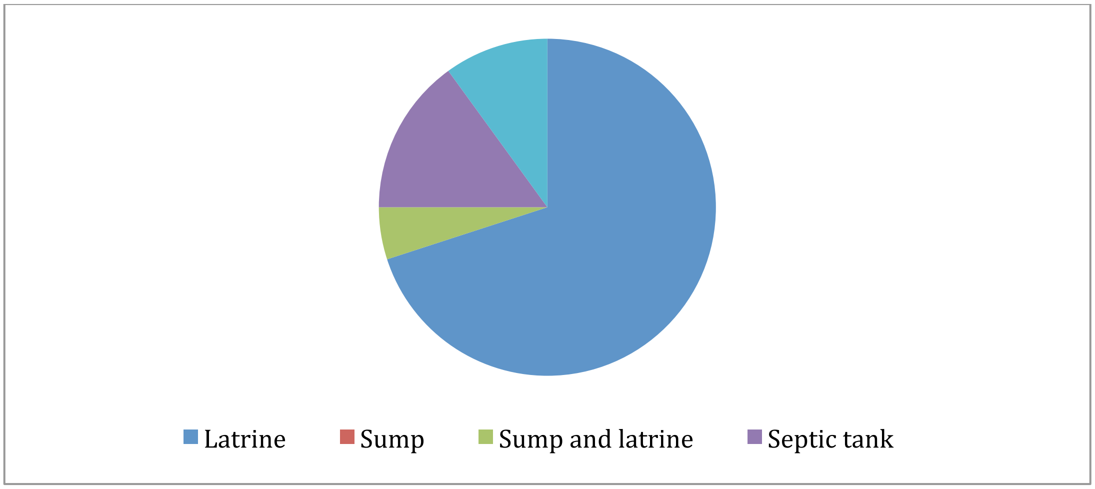


Figure 5.23. Treatment of liquid waste

ACCESS TO TELEPHONE COMMUNICATION

According to data reported in 2012, nationally, 78.5% of households have access to telephone service, primarily through the cell phone. Even in rural areas, 68.4% of households have this service, which can be particularly beneficial when making arrangements for their businesses, both agricultural and non-agricultural (FIDEG, 2012).
89% of respondents indicated they use Cellular phones to communicate. The rest is communicated via a combination of cell, landline and public telephones, with few representative values (Figure 5.24).

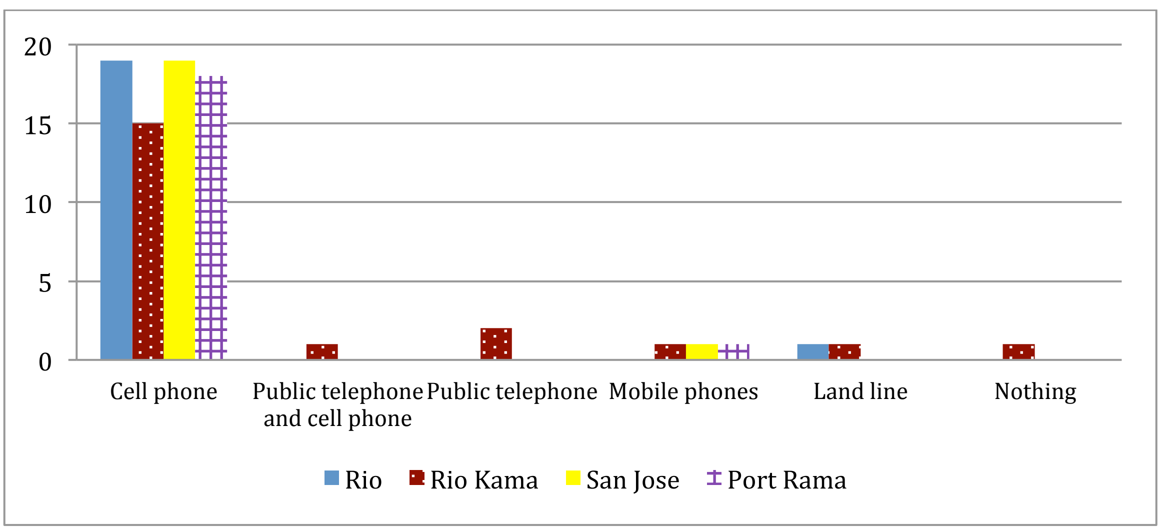


Figure 5.24. Access to telephone communication

TRANSPORTATION

The main means of transportation used by people from communities in the vicinities of Farm San Jose indicated that they use water transportation due to the communities location in the proximities of Escondido River (Figure 5.25).

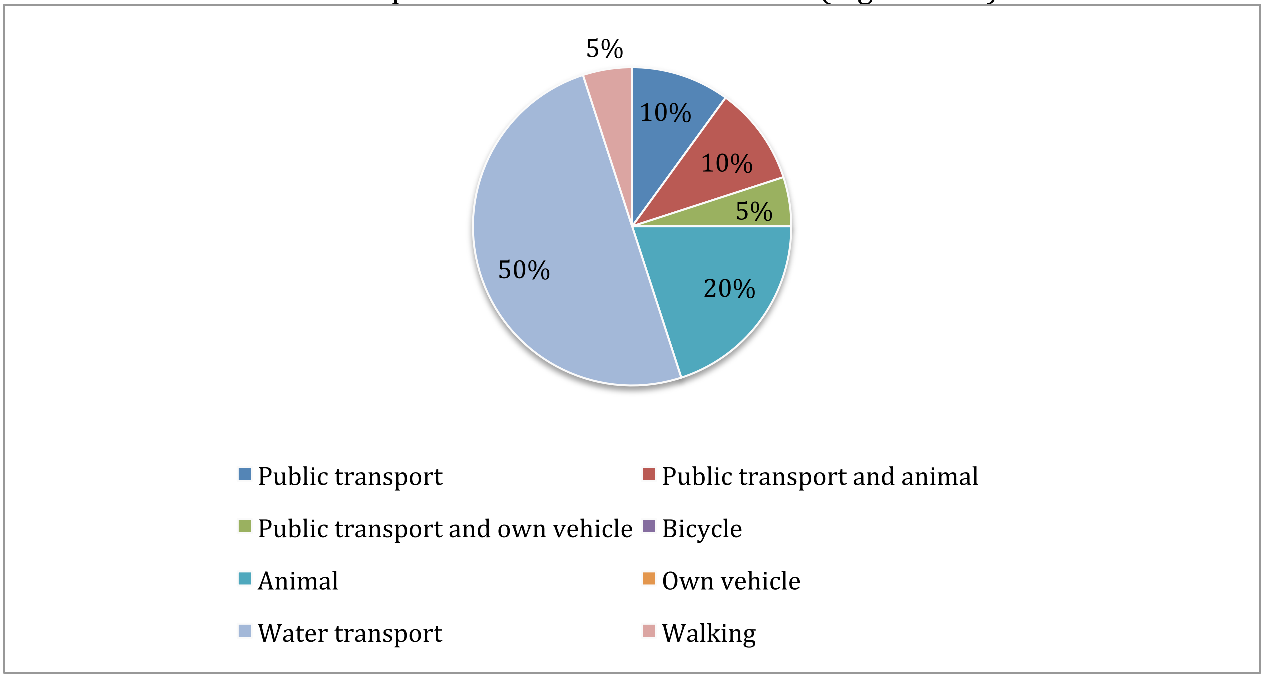


Figure 5.25. Transportation

5.10 SUMMARY

The results of the survey and timeline have been presented above to elucidate the baseline status of the surrounding communities of San Jose ERF. In general, indicators of development including education, infrastructure, access to public services, and housing are considered to be low. Results of the Venn Diagram and Matrix Pairs analysis discussed in the methodology above are provided within the full socioeconomic study available in all office (Fundenic, 2014). These analyses provide further data on development needs the community perceive compared to those found within the interviews and surveys.

6. IMPACT ASSESSMENT

6.1 IMPACT ASSESSMENT METHODOLOGY

The impact assessment methodology used for San Jose ERF is based off of the methodology proposed by Leopold et al (1971) that was adopted by the U.S. Department of the Interior. At the heart of this methodology is the construction of an impact matrix that defines the project actions and the environmental factors affected by those actions. In terms of the analysis of environmental impact the measurement of "magnitude" and "importance" were the main components for consideration. Where magnitude is intended to relay a degree of extensiveness or scale while "importance" conveys the significance of an environmental factor in the specific instance under analysis. In practice, the "magnitude" is more likely to be based on scientific evidence that can be related on a normalize scale while importance considers more value judgments of the relative of a project or the value of the actual environmental asset itself.

The methodology employed within this study is a modification of the Leopold matrix and the definitions of "magnitude" and "importance". Within the methodology used here a quantitative ecological quality index is used that proposes normalized scales of environmental impact. This methodology brings more transparency to the meanings within "magnitude" and "importance" and attempts to elements that are highly subject to value judgments. Subjective considerations are still present in this analysis as it is not possible to completely remove value judgment but those are based off of judgments of trained professionals within their field.

6.1.1 BUILDING AN IMPACT MATRIX

From the project description of project activities the investigative team reached consensus around the potential environmental impacts and built the matrix impacts. This is the phase in which the qualitative assessment of environmental impacts begin by supposing exactly which impacts occur. The matrix itself is based in cause and effect with a two-way table whose columns include project actions and with environmental factors in rows that are suspected of being impacted.

Environmental Factors	**Project Actions**					
	A1	**A2**	**A3**	**A4**	**A 5**	**A6**
F1						

Table 6.1. Table used to categorize the project actions and their impacts on environmental factors.

6.1.2 INTEGRATING ECOLOGICAL QUALITY INDEX

The ecological quality index (Qi) is the numerical expression of the joint interaction of the different criteria used in the rating of the environmental effects. The ecological quality index is used to establish a quantitative measurement through normative scales of the "magnitude" and "importance" definitions originally proposed by Leopold et al. The value of ecological quality is given by the following formula and must be rounded to the nearest integer. The range of values obtained from calculating the ecological quality is -10 to 10:

$$Qi = \frac{Ca\, x\left(I+Ex+Du+De+Re\right)\, x\; Ro}{5}$$

Ecological Quality Index (Qi)	
Very good	5 a 10
Good	0 a 5
Bad	-5 a 0
Very bad	-10 a -5

Table 6.2. The ecological quality index is based on a scale from -10 – 10 defining the impact of project actions on an environmental compartment.

Within the equation for the ecological quality index is several different variables that include Character (Ca), Risk of Occurrence (Ro), Geographic extent (Ex), Duration (Du), Development (De), Reversibility (Re), and Intensity (I). The definition and normative scale for each is proposed in Table 6.3. Again, these variables are intended to capture the "magnitude" and "importance" of each environmental impact.

Variable	Valuation	Scale
Character **(Ca)**: Define if the action behind the project generate a positive (+) or negative (-) affect on the environmental factor	Negative Positive	-1 1
Risk of occurence **(Ro)**: Rates the likelihood of environmental impact that may occur as a result of the project activity	Certain Very likely Likely Unlikely	9-10 7-8 4-6 1-3
Geographic extent **(Ex)**: Magnitude of the affected área or relative área that the effects of an incident impact	Local Regional National, international	0.1 - 0.3 0.4 – 0.7 0.8 – 1.0
Duration **(Du):** Refers to the period during which the effect of the activity persists in the environment	Immediate (< que 2 años) Average (2 a 5 años) Long (5 a 10 años) Permanent (10 años o más)	0.1 – 0.2 0.2 – 0.4 0.3 – 0.7 0.4
Development **(De):** Refers to the time that the environmental impact takes to fully develop which include all of its consequences	Very fast (<1 mes) Fast (1-6 meses) Average (6-12 meses) Slow (12-24 meses) Muy lento (más de 24 meses)	0.9 – 1.0 0.7 – 0.9 0.5 – 0.7 0.3 – 0.5 0.1 – 0.3

Reversibility **(Re):** Indicates the possibility that the ítem or affected envrionment component to recover its essential condition	Reversible Partially reversible Irreversible	0.1 – 0.3 0.3 – 0.7 0.7 – 1.0
Intensity **(I)**: Reflects the degree or alteration of the variable, independent of the geographical extent of the affect. Results from the interaction between the degree of disturbance and environmental values of the affected component	Very high High Medium Low	1.0 - 0.7 0.7 – 0.4 0.4 – 0.2 0.2 – 0.1

Table 6.3. Definition of each variable within the environmental quality index and its associated normative scale.

This analysis is done first without considering the mitigation measures and then takes into account these measures. This procedure allows for a prediction of the environmental quality of the site as a result of the execution of cleanup activities. After calculating the ecological quality index for each of the project actions the next step is to analyze the consequences of the effects on each potentially affected environmental factor.

Within the environmental quality index is the variable of intensity that requires a determination of the degree of disturbance. This information will be informative for the design of mitigation strategies in how significant they should be in scope, cost, and timely monitoring. The degree of disturbance is the amplitude of the disturbance on an affected environmental factor and will be evaluated based on the following range:

- *High:* significant change in the characteristics of the element
- *Medium:* modifying just a few features of the item
- *Low:* non-significant modification element characteristics.

In addition to the degree of disturbance a criterion of environmental value is also considered to be important in defining intensity. Environmental value is defined by the interst and quality that translate the opino of a specialist and the soicla value resulting from legal requirements and popular political considerations on environmental protection. It is evaluated with a range of very high, high, medium, and low. The degree of disturbance and environmental value are seen to interact to define the intensity (I) that is used in the environmental quality index (Table 6.4).

Degree of Disturbance	**Environmental Value**			
	Very high	High	Medium	Low
High	Very high	High	Medium	Low
Medium	High	High	Medium	Low
Low	Medium	Medium	Low	Low

Table 6.4. The definitions of interaction between environmental value and the degree of disturbance that determine intensity (I) in the environmental quality index.

6.1.3 DEFINING AREAS OF INFLUENCE

In order to address the environmental impacts within the project area and its surroundings the areas of influence must be defined. The concept of "influence" of the project area is defined as the space where significant environmental impacts occur at each stage of the project, but not necessarily each factor has the same area of influence. In this case, given the difficulty of defining a geographic area for study, it is preferable that each factor delimits an area of influence (e.g. climate impacts have a global impact). To define the boundaries and shape of the area the following considerations apply:

2. Administrative boundaries: corresponds to the department, municipality and region, and the limit of specific project area (land, grant, etc.)
3. Ecological and physiographic limits: they are determined by the relief, the landscape, the scales of time and space, significance criteria for each potentially impacted environmental component are used.
4. Ecological Sensitivity: the degree of vulnerability of a given area to an action or project including impacts, effects or risks. The following are considered as classes of sensitivity:
    a. *Low sensitivity:* those attributes whose original conditions tolerate project actions, where recovery from impacts may occur naturally, or with the application of some relatively simple mitigation
    b. *Medium sensitivity:* those attributes where the ecological or social balance is fragile. The recovery and control during the project requires the implementation of measures that involve some complexity.
    c. *High sensitivity:* highlights those attributes where intervention processes irreversibly modify their original condition or requires the application of complex or even compensatory mitigation.

The limits of ecological sensitivity are defined by taking into account the biotic and abiotic components. A table showing the levels of ecological sensitivity of the expansion of plantations in San Jose ERF was prepared. Based on the above description of the three types of areas impacted thematic maps were generated and presented with the following areas of influence:

1. area directly affected
2. area of influence
3. area of indirect influence

6.2 SAN JOSE ERF IMPACT ASSESSMENT

6.2.1 SAN JOSE ERF IMPACT MATRIX

From the prior environmental impact assessments done on Rio Kama and Rio Siquia a list of environmental impacts was proposed by Fiallos y Associados. This list is repeated here with additions made that are important to the contexts of San Jorge ERF and those found to be important to the investigative team. The project activities are those that were defined early in Chapter 2 of the project description. This is provided in list form here with the addition of several activities that take the form of accidents or unintended actions during normal project activities (e.g. chemical or waste spill).

PROJECT ACTIVITIES

The project activities are summarized from those elucidate above in the project description found in Chapter 2. These are activities found within the boundaries of San Jose ERF but those that are necessary for San Jose ERF to continue its normal operations (e.g. transportation)

Phase	Project Activity
Nursery Operations	Maintenance of temporary nurseries
	Plant Transportation
	Irrigation of nurseries
	Nursery fertilization
	Handling of solid and liquid chemicals
Plantation Operations - Land Preparation	Construction of drainages in flood prone areas
	Clearing of herbaceous vegetation
	Preparation of planting sites
	Application of lime and fertilizer
	Planting
Planting Operations - Maintenance	Weeding and casing of plants
	Post-planting fertilization
	Thinning of plants
	Application of pesticides
Harvest	Annual cutting of culms
	Culm collection and processing
	Drying
	Treatment in 5% boron solution
General Plantation Operations	Construction of roads
	Construction of water crossings
	Management of liquids and solid waste
	Construction of firebreaks
Socioeconomic Activities	Employment of seasonal staff, supervisors, and plantation manager
	Trainings of all staff

Table 6.5. Summary of the project activities within San Jose ERF and the surrounding areas.

ENVIRONMENTAL IMPACTS

The environmental impacts are elucidated below in Table 6.6 for each environmental compartment. These impacts are those previously used in the EIA for Rio Kama and Rio Siquia with additions that were found to be important by the investigative team. As bamboo for plantation development is a novel land use within Nicaragua not all impacts can be anticipated before their occurrence. However, these impacts are anticipated from experience in other planation development that has similar management characteristics to Guadua management.

Environmental Compartment	Potential Impact
Air	Air quality from local pollutants
	Impact on climate including carbon and nitrogen
	Noise pollution
Soil	Impacts on compaction
	Impacts on erosion
	Contamination of soil
Water	Water quality
	Impact on runoff
Flora	Change in diversity of species
	Change in land cover
Fauna	Wildlife habitat corridors
	Change in diversity of species
Aesthetic environment	Impacts on aesthetic value
Socioeconomic	Land use
	Cultural impacts (lifestyles, traditions)
	Social aspects (quality of life, health, welfare)
	Economic aspects (employment, per capita income)

Table 6.6. Summary of the environmental impacts within San Jose ERF and the surrounding areas.

Both project activities and environmental impacts were consolidated into one table to show which project activities are anticipate to have a negative or positive impact on the environment (Table 6.7). This table sets the basis for the analysis of impacts through demonstration of the areas of influence as well as the calculation of environmental quality.

6.2.2 SAN JOSE ERF ANALYSIS OF ECOLOGICAL QUALITY INDEX

The first step in determining the ecological quality index is to characterize the impacts predicts as negative or positive. This is based on best available information. The first step in determining the ecological quality index is to characterize the

Environmental Impact \ Project Activity	Maintenance of temporary nurseries	Plant Transportation	Irrigation of nurseries	Nursery fertilization	Handling of solid and liquid chemicals	Construction of drainages in flood prone areas	Clearing of herbaceous vegetation	Preparation of planting sites	Application of lime and fertilizer	Planting	Weeding and casing of plants	Post-planting fertilization	Thinning of plants	Application of pesticides	Annual cutting of culms	Culm collection and processing	Drying	Treament in 5% boron solution	Construction of roads	Construction of water crossings	Management of liquids and solid waste	Construction of firebreaks	Employment of seasonal staff, supervisors, and plantation manager	Trainings of all staff
Air quality from local pollutants		X																	X					
Impact on climate including carbon and nitrogen				X					X	X		X												
Noise pollution		X					X	X			X					X			X			X		
Impacts on compaction										X									X			X		
Impacts on erosion						X				X									X			X		
Contamination of soil					X									X							X			
Water quality				X	X	X			X	X		X		X					X		X			
Impact on runoff						X				X									X			X		
Change in diversity of vegetation							X			X														
Change in land cover										X														
Wildlife habitat corridors							X			X														
Change in diversity of fauna							X			X														
Impacts on aesthetic value										X									X					
Cultural impacts (lifestyles, traditions)										X													X	X
Social aspects (quality of life, health, welfare)										X													X	X
Economic aspects (employment, per capita income)										X													X	X

Table 6.7. The impact matrix for San Jose ERF considering project activities and environmental impacts.

impacts predicts as negative or positive. This is based on best available information for

The first step in determining the ecological quality index is to characterize the impacts predicts as negative or positive. This is based on best available information for similar project activities and the accepted scientific literature. The characterization (Ca) of each impact is provided in Table 6.8 that categorizes each impact across the different phases of the project.

Following this step each project activity that was found to have an impact was rated by its risk of occurrence, geographic extent, duration, development, reversibility, and intensity (Annex VII). As some project activities have both positive and negative impacts each variable was averaged across the impacts for an overall score of the project activity. This scoring is useful to summarize the affects of each project activity but for the purposes of putting in place mitigation practices each activity should be closely investigated in order to minimize all associated negative impacts (Table 6.9).

From this analysis it was found that soil and water have the largest associated negative impacts from project activities and can benefit the most from mitigation activities. From the impact matrix it is clear that these impacts are most realized along areas that use earth works (e.g. road building, drainage ditches, and fire breaks). Additionally, some of the soil and water contamination issues arise from accidental spills and the potential use of pesticides during a pest outbreak. Mitigation activities should focus on guidelines for building road and firebreaks, guidelines for developing drainage systems that avoid erosion, training for the prevention of spills, early identification of pests, and an integrated pest management plan to clearly outline the proper use of these chemicals.

The greatest positive impacts were seen in the socio-economic, flora, and fauna environmental factors. The project activity is anticipated to bring consistent employment opportunities that will benefit surrounding areas that have high rates of unemployment, low levels of education, and are below the poverty line. In the case of natural resources, the surrounding area has been demonstrated to have undergone high levels of deforestation, including the project area itself. In an area where natural forest is sparse the reforestation activity within San Jose ERF is anticipated to increase forest cover, habitat connectivity, and thermal protection that can bring biodiversity benefits to flora and fauna alike.

6.2.3 DETAILS FOR EACH ENVIRONMENTAL IMPACT

AIR COMPONENT

Prior to the project activity the land use was primarily cattle grazing and agriculture that had negative air quality impacts most significantly within climate emissions. With the implementation of the project the air quality drastically improves in terms of the climate benefit from the reforestation of the project area. Negative impacts to air quality include the emission of noxious fumes from machinery as well as the

Environmental Impact	Project phase						Comments
	N	LP	PO	H	GP	SE	
AIR							
Air quality from local pollutants	-	-	NA	NA	-	NA	In general, the operation of machinery during different phases of the project are seen to have a negative impact on air quality. This impact, however, is at a small-scale as operation of machinery is for small periods of time, in open spaces, and impacts those within close proximity. The intensity of these operations is considered to be low.
Impact on climate including carbon and nitrogen	-	+	-	-	-	NA	Again, the operation of machinery and application of fertilizer are known to emit greenhouse gases including CO2 and Nox. In comparison to the positive carbon benefit the planting presents, however, these emissions are negligible and the impact on climate overall by project activities is seen as positive as has been demonstrated through previous validations by the VCS certification.
Noise pollution	-	-	-	-	-	NA	The main sources of noise pollution are considered to be the operatio of trucks and other types of machinery (chain saw, weed wackers). This is considered to be a low intensity impact as only operators of machinery will be affected by noise pollution. Operations occurs in a rural area with low population centers.
SOIL							
Impacts on compaction	-	+	NA	NA	-	NA	The construction of roads and vehicular transport are considered to increase the compaction in traffic areas. However, the relative impact is small considering the level of compaction already presented across the property. Alternatively, the planting of bamboo over time will positively impact compaction and lead to better physical soil conditions.
Impacts on erosion	NA	+	NA	NA	-	NA	The construction of drainage ditches, firebreaks, and roads create areas for erosion to occur as it provides water with clear conduits to pass through. Overall, the practice of reforestation will prevent erosion and is seen as a positive impact.
Contamination of soil	-	NA	-	NA	-	NA	The contamination of soil is seen to occur in the case of accidental spill of chemicals or liquids for the operation of machines, fertilizer, or pesticides. In all cases it is considered to be a low probability of occurrence and consequently is a low impact.
WATER							
Water quality impacts	-	+	-	-	-	NA	With respect to water quality impacts the most significant damages are seen to arise from the use of pesticides in the case of a pest attack, accidental spill of chemicals, and increases I erosion from road building and other infrastructure.
Impact on runoff	-	+	NA	NA	-	NA	The cutting of the vegetation and the compacted areas, increase storm water runoff. If these are not captured and managed appropriately, may be beyond the capacity of natural ravines, cause erosion, dragging of sediment and other solids, and cause damages to roads and main internal communication
FLORA							
Change in diversity of vegetation	NA	+	NA	NA	NA	NA	The only planting of new native species occuring is that of Gudua aculeata. This represents an increase in the diversity of the current standing forests but a neglible one. The surrounding forested areas with be treated as conservation areas. The future impact of influences on biodiversity are unknown but at this point it is known that immediately no threats to diversity are posed.
Change in land cover	NA	+	NA	NA	NA	NA	The reforestation of previously degraded fields in an area that lacks connectivity among forest patches and a high rate of deforetation is a positive change in land cover. This change will bring climatic, soil, water, air quality, and aesthetic benefits. It also represents a change from a low productivity land use to a high productivity land use.
FAUNA							
Wildlife habitat corridors	NA	+	NA	NA	NA	NA	Currently the landscape consists of small patches of forest that lack connectivity. This reforestation project serves to connect several forest patches and provide cover for a number of species that are dependent on this missing element in the landscape.
Change in diversity of fauna	NA	+	NA	NA	NA	NA	The changes in land cover and habitat corridors are anticipated to bring biodiversity benefits as this is a missing element within the landscape.
AESTHETIC VALUE							
Impacts on aesthetic value	NA	+	NA	NA	-	NA	The Project area currently has one but not exceptional scenic beauty, the mere fact of having a combination of plantation and natural forests is substantially improved by the feature topography. While it is true that the project will install an infrastructure the scenic site will be kept, since the duration of the nursery and plantation activities are temporary as the harvest.
SOCIO-ECONOMIC							
Cultural impacts (lifestyles, traditions)	NA	NA	NA	NA	NA	+	The planting of bamboo is anticipated to have negligible impcts on lifestyles and traditions. One aspect that may be influence is the utilization of bamboo in surrounding areas in a sustainable manner. Currently bamboo resources are typically burned to make way for grazing activities. This may be change through influences of EPBCA.
Social aspects (quality of life, health, welfare)	NA	NA	NA	NA	NA	+	EPBCA will generate employment opportunities which will directly impact social aspects in the project area. Indirectly this will bring other economic activity in the area. Provision of professional training programs will also provide staff with skills not otherwise easily achieved.
Economic aspects (employment, per capita income)	NA	NA	NA	NA	NA	+	The operations of San Jose ERF will require seasonal and full-time labor all of which will be sources from local communities.

Table 6.8. Characterization (Ca) of each environmental impact across the different project phases.

production of noise from machinery. In comparison to benefits brought to air quality through other activities these negative impacts are comparatively small and are anticipated to bring little deleterious affects to the surrounding environment. This is demonstrated in the quality index rating of 0.5 ("good') for all of the impacts on air quality that arise from project activities.

Evaluation Criteria	Air	Soil	Water	Flora	Fauna	Socioeconomic
Characterization (Ca)	-0.67	-0.44	-0.50	1.00	0.50	1
Risk of Occurrence (Ro)	4.03	5.22	7.58	7.50	6.00	10
Geographic Extent (Ex)	0.40	0.18	0.15	0.30	0.30	0.6
Duration (Du)	0.25	0.63	0.58	0.90	0.73	1
Development (De)	0.70	0.42	0.63	0.20	0.35	1
Reversibility (Re)	0.28	0.38	0.35	0.85	0.55	1
Intensity (I)	0.24	0.32	0.44	0.85	0.58	0.7
Ecological Quality (Qi)	0.53	0.24	-0.77	4.66	2.60	8.6

Table 6.9. Summary statistics for each evaluation criteria of the environmental quality index for each environmental compartment.

SOIL COMPONENT

According to studies and observations, the predominant soil in the project area is the red clay Ultisoles, which are imperfectly drained and are related with the ecosystem of evergreen alluvial forest moderately. From the baseline study it was shown that the soil was impacted by human and natural effects, particularly those of cattle grazing that caused compaction and erosion. The initial activities of the project that include the construction of primary, secondary, and tertiary roads could lead to additional compaction although this will only occur on a very small extent of the property. The additional compaction that these activities will bring to soil is considered to be small given the high compaction already demonstrated across the property and this is considered to be a small impact. The use of such earthworks activities may also lead to increased erosion in the areas applied if no mitigation measures are used. Erosion is common among roads and drainage ditches which provide avenues for water to flow with high velocity, removing topsoil and nutrients.

Alternatively, the planting of *Guadua aculeata* plantations has many advantages including the slow recuperation of soils through added organic matter and reduction of compaction. Decaying leaves, rhizomes, and dried culms will also add to more porous soil over time and reduce the erosion impacts seen across the property prior to the project activity. The system of rhizomes and roots creates a woven mesh, which allows them to act as efficient biological containment walls that control lateral scour and tie tightly to the ground, preventing erosion and making the species of Guadua a protective function, especially for use in hillside soils in the watershed.

On balance the impacts of planting versus those of building roads is seen to have a net positive impacts on soils with an environmental quality rating of 0.24. However, this remains a low rating that can be improved through mitigation measures within areas of roads, drainage ditches, and firebreaks.

WATER COMPONENT

Water quality impacts are perceived to be those that arise from chemical contamination including the use of fertilizers, pesticides, and liquids for machine use. All of these activities vary in their geographic extent and intensity but in general should have mitigation activities in place when applied near waterways such as rivers or inundated areas. Additionally, erosion can contribute to water quality issue as increased sediment loads are connected with increased carrying capacity of water borne pathogens. In general, these impacts are seen to occur in areas where earthworks are being put in place as well as areas where chemical treatment is used. Mitigation strategies should focus on these activities.

Similarly, increased runoff is indirectly connected with water quality and erosion issues but also regional impacts of increased inundation and peak flow levels. As with other activities, the areas that can introduce this impact are roads, firebreaks, and drainage channels.

The planting of Guadua across the property will have a net positive impact as over time a canopy cover and increased porosity of soil will slow the water running into waterways during rain events. This activity has a greater geographic extent and intensity than the other activities but despite its positive affect the overall impact on water resources is -0.8. Mitigation strategies around chemical handling and guidelines for the construction of earthworks will provide a means to prevent these impacts.

FLORA AND FAUNA COMPONENT

The loss of biodiversity in the ecosystem of the farm where San Jose ERF is located is very high from the deforestation and agricultural impacts that occurred before the project activity. The advantages that planting native flora of Guadua brings includes increasing the connection of wildlife corridors, adjusting thermal temperatures in the understory Guadua plantations generally improve conditions for birds that are most abundant with the recovery of native flora as well as the connection of biological corridors. One advantage is that the temperature produced inside mature Guadua forest, between three and seven years, creates a cool atmosphere under the canopy that greatly favors the establishment of different species of animals, birds, and reptiles that favor the shade. The increased activity of mammals, reptiles, and birds can bring not only increases is fauna diversity but also flora diversity as these animals provide means of transport for different seed that wouldn't otherwise have access to the natural forest within San Jose ERF.

The net impact of the project activities is seen to be "good" to "very good" for flora and fauna using the environmental quality index. Mitigation strategies have nonetheless been put in place in previous EPBCA project and will be included with

San Jose ERF that protect flora and fauna in order to ensure this benefit.

SOCIOECONOMIC COMPONENT

In the survey applied in the project area it was found that overall that employment levels were low and most obtained levels of unskilled labor. In general, people must travel long distances to obtain work especially when they do not have their own land for farming. The opportunity to work and receive training close to where they live, is an advantage for the project to avoid the pendulum effect of people moving to other areas, overwhelmed by the demands they generate. The training EPBCA provides includes. With the implementation of the project it is anticipated the EPBCA will bring direct employment benefits, indirectly generate economic opportunities, and provide educational trainings for workers including safety, equipment use, reading and writing, and English language training.

6.2.4 ANALYSIS OF AREAS OF INFLUENCE

Once the project activities have been characterized for their impact on the environment and the overall impact through the ecological quality index understanding the areas that are influenced by these activities is important to inform mitigation strategies. Here only the negative impacts that require mitigation are mapped for their areas of influence using the definitions provided above. The results of the analysis of areas of influence are provided in Table 6.10. The decisions basis for each "negative" project activity for defining the area of influence is elucidated below.

AIR QUALITY FROM LOCAL POLLUTANTS & NOISE POLLUTION

The anticipated air pollutant from project activities includes nitrous oxides (NO_x), sulfurous oxides (SO_x), volatile organic compounds (VOCs), carbon black, and noise pollution. These arise from the operation of machinery including heavy trucks, boats, tractors, road building machines (bulldozers), chainsaws, and weed whackers. As shown above, this environmental impact is suspected to be negligent as machinery is used for short periods of time, in open-air conditions, and in areas with low population. The extent of this impact is expected to be within the project

Environmental Impact	Areas of Influence	Scale of Impact	Map
Air quality from local pollutants	Project area, local surroundings, transportation corridors	Local	
Noise pollution	Project area and adjacent properties	Local	
Impacts on compaction	Roads within the project area	Local	

Impacts on erosion	Roads, drainage ditches, and firebreak within the project area	Local	
Contamination of soil	Project area	Local	
Water quality impacts	Waterways within project area, waterways adjacent to property, waterways in watershed	Regional	

Impact on runoff	Waterways within project area, waterways adjacent to property, waterways in watershed	Regional	

Table 6.10. Areas of influence for each project activity based on ecological characteristics and sensitivity.

boundary itself and along transportation corridors (areas directly affected). Buffers of 0-100 meters (area directly influenced) and 100-200 meters (area indirectly influenced) were used to describe areas that may experience impacts, although they are considered to be negligible.

IMPACTS ON COMPACTION

From the baseline study it was demonstrated that more than X% of the farm had soils that had "very high" compaction according to the classification published by USDA (1993). This represents a high degree of compaction that already exists before the project activity commences. The project activity overall provides a large benefit to compaction as reforestation over time will lead to less compacted soils through root development and addition of organic matter. However, one area that can maintain the levels of compaction are the construction of primary roads and use of secondary or skid trails. The areas directly affected by this activity are proposed roads within the project activity making up X% of the property. For this environmental impact areas the are "directly influenced" and "indirectly influenced" are considered to be one in the same as the roads themselves since this is the only place where vehicular and animal traffic occur.

IMPACTS OF EROSION

The baseline study did not directly study the rates of erosion found with different areas within the farm but from direct observation it could be seen that drainage areas and steep areas had been affected by erosion. From experience in other forestry projects it is well documented that erosion generally occurs in areas that make use of earthworks. Roads, firebreaks, and drainages are the project activities within the plantation that are considered to be those that affect this environmental factor. Areas directly affected are those where the constructions of these features are located and buffers of 0-10 meters (areas directly influenced) and 10-20 meters (areas indirectly influenced) were implemented. These buffer zones should be considered during mitigation when the construction of these features occurs near sensitive areas such as natural forests or waterways.

CONTAMINATION OF SOIL

Contamination of soil is expected to occur through either accidental spills of chemicals and liquids used for the operation of machinery or farm maintenance. Additionally, the use of pesticides is warranted during a pest outbreak and could pose a threat to soil health. The area of direct affected, area directly influenced, and area indirectly influence is all considered to be the project area of San Jose ERF. Chemical application will not occur outside the boundaries of this area. Additionally, soil contamination doesn't have the risk of being mobile and will not impact surrounding areas.

WATER QUALITY IMPACTS

Water quality impacts are predicted to arise from chemical contamination from fertilizer, pesticides, or accidental spills and from erosion processes that feed into local waterways. The areas directly affected are considered to be waterways within the project areas. Areas directly influenced are waterways directly adjacent San Jose ERF and areas indirectly impacted are waterways within the local watershed.

IMPACTS ON RUNOFF

Increases in runoff can occur in areas that allow water to directly flow into streams and rivers without first being buffered by natural vegetation or wetlands. Typically road surfaces, drainages, and firebreaks are thought to increase runoff from properties but mitigation strategies can be used to prevent this occurrence. The impact areas are the same as those adopted for water quality impacts and is considered to be a regional affect.

6.3 MITIGATION MEASURES & RE-ANALYSIS OF IMPACT ASSESSMENT

From the impact matrix and analysis of areas of influence the areas for mitigation strategies within San Jose ERF have been determined and mapped. From the above analysis the areas that need the most attention in terms of mitigation include roads, drainage networks, firebreaks, specific management near waterways, and specific guidelines for the handling and usage of chemical products within the plantation. EPBCA has implemented mitigation strategies within their Rio Siquia and Rio Kama farms for all of these areas given similar impacts found in previous EIAs and they are reiterated here.

6.3.1 CURRENT MITIGATION MEASURES

Mitigation measures are aimed at reducing environmental harm and within the environmental quality matrix are typically aimed at reducing the risk of occurrence and Intensity of an impact. Once an impact occurs the elements of duration, development, geographic extent, and reversibility remain constant. The Mitigation strategies below are best at reducing the risk of occurrence through construction guidelines as well as training. In some cases these strategies also reduce the intensity of an impact when it occurs.

ROADS

EPBCA has guidelines for road construction including those for primary, secondary, and tertiary roads (EPBCA, 2013a). Elements within these guidelines dictate the timing of when construction and maintenance can occur in order to avoid deleterious affects of erosion and wash out. Additional measures set guidelines for the maximum slope, the construction of culverts and stream crossings, bridges, water bars, and drainages. The guidelines are aimed at preventing road deterioration in the rainy season and consequently the environmental impact of erosion is minimized lowering the intensity of this impact.

CHEMICAL AND PESTICIDE MANAGEMENT

San Jose ERF has a chemical store that contains all of the farms fertilizer, pesticides, and fuels that are stored according to the principles outline in FSC. Each employee is trained in the handling of these chemicals as well as procedures to follow in the case of a spill. Additionally, EPBCA has an integrated pest management plan (IPM) in place the dictates the use of pesticides in the case of a pest outbreak. This plan trains employees in the identification of pests and procedures of application. This ensures that pests will be identified quickly limiting the extent of which pesticides need to be applied. Additionally, no pesticides must meet FSC standards for toxicity set by the World Health Organization (WHO) that includes elements of human and environmental health, limiting the harm pesticides have on its unintended targets. Both of these measures limit the frequency (risk of occurrence) of chemical application or spill and the intensity.

OTHER MITIGATION MEASURES

EPBCA has a number of additional mitigation measures that are outlined for each phase of plantation development from the nursery through to harvesting (EPBCA, 2013b). Each phase addresses negative impacts on all environmental compartments including air, soil, water, flora, and fauna. Some of these mitigation measures are established to protect environmental properties that were not anticipated in the EIA above but ensure to protect elements such as flora and fauna in order to ensure they benefit from the project actions.

6.3.2 ADDITIONAL MITIGATION MEASURES

WATERCOURSE MANAGEMENT

Deferential management should be applied in areas near watercourse such as streams, wetlands, and ponds. Especially in areas with steep slopes approaching these areas where the risk of erosion and passing of chemical fertilizers into water have a higher risk of occurrence. These areas will still benefit from the planting of bamboo in order to stabilize banks, however, management should be practiced in order to maximize this benefit. Buffer zones to indicate different management strategies including no vehicular use and minimization of chemical use is recommended to reduce impacts on water quality and increased runoff.

DRAINAGE CONSTRUCTION

In areas that experience periodic inundation that reduced plant growth drainages are a strategy to reduce this effect on productivity. Construction of drainages, however, can increase sediment load, nutrient load, and total runoff into waterways and mitigation would benefit these deleterious affects. Options include the use of controlled drainage that reduced the velocity and volume of drainage water into surrounding natural waters. Additionally, the use of small existing or created riparian areas to control drainage before entry into streams or rivers has also been shown to reduce the impacts of drainage systems.

6.3.3 Environmental Quality Index with Mitigation

The environmental quality index was re-calculated for all of the individual environmental impacts taking into consideration the mitigation strategies that would be put in place. In general, the only modified elements between the two cases are the risk of occurrence and intensity of an impact as no other variable will be affected by these strategies. The summary of variable values for the environmental quality index is provided in Table 6.11.

Mitigation strategies for impacts on air, such as reduction of vehicular use, provide minimal returns in terms of reduced impact. In other areas such as soil and water the mitigation strategies implemented around construction guidelines of roads and chemical handling policies show good returns in benefit to the environment (Figure 6.1). IN the case of flora and fauna a negative effect wasn't anticipated on the environment but mitigation strategies including protection of conservation areas ensure this benefit is seen on San Jose ERF.

Evaluation Criteria	Air	Soil	Water	Flora	Fauna	Socioeconomic
Characterization (Ca)	-0.67	-0.44	-0.50	1.00	0.50	1.00
Risk of Occurrence (Ro)	3.17	4.22	5.00	9.00	8.25	10.00
Geographic Extent (Ex)	0.17	0.18	0.15	0.30	0.30	0.60
Duration (Du)	0.25	0.63	0.58	0.90	0.73	1.00
Development (De)	0.70	0.42	0.63	0.20	0.35	1.00
Reversibility (Re)	0.28	0.38	0.35	0.85	0.55	1.00
Intensity (I)	0.24	0.26	0.39	0.90	0.65	0.70
Ecological Quality (Qi)	0.71	0.74	0.51	5.68	3.98	8.60

Table 6.11. Environmental quality index for each environmental compartment after the implementation of mitigation strategies.

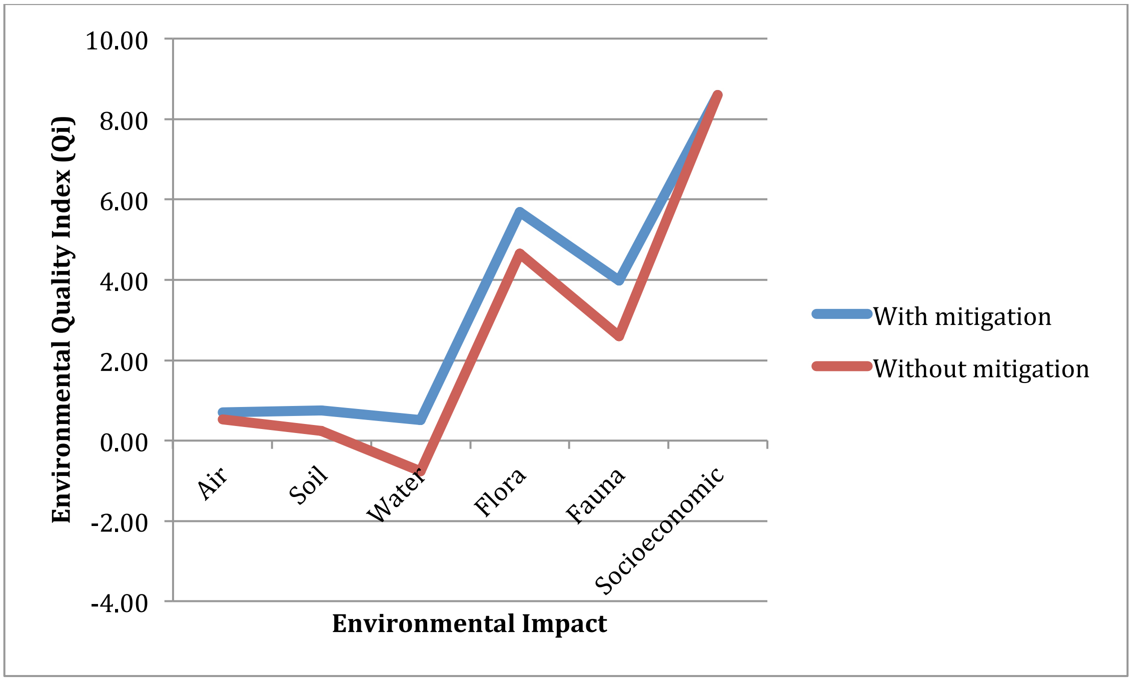


Figure 6.1. Environmental quality index before and after mitigation for different environmental impacts.

6.4 SUMMARY

The Leopold matrix allows for a quantification of the environmental impacts within a project activity. Using this methodology all of the predicted impacts from project activities were outlined using information provided in the project description and information from the baseline study where sensitive ecosystems and components within the farm were identified. Using the environmental quality index the predicted impacts were quantified across different variables and the benefits of mitigation strategies was demonstrated. From the impact assessment it was shown that with mitigation strategies no negative impacts are predicted to occur within San Jose ERF.

In addition to generating information on the environmental impacts this document has contributed to setting a baseline study for San Jose ERF and the mapping of its natural resources. This baseline study with set the template for the management of San Jose ERF in terms of how it treats resources such as standing forest, soil nutrition, waterways, and human resources.

CONSEJO REGIONAL AUTÓNOMO ATLÁNTICO SUR

Región Autónoma Atlántico Sur

Bluefields - Nicaragua

RESOLUCION DE JUNTA DIRECTIVA

621- 12 – 03 – 2012

Reunidos los miembros de la Junta Directiva del Consejo Regional Autónomo del Atlántico Sur, el día Lunes DOCE de Marzo del 2012, en el despacho del Presidente del Consejo Regional, estando presente, Rayfield Hodgson Babb, Presidente, Anthony Omeir S., Primer Vice-Presidente, Eduardo Ruiz Hernández, Primer Secretario, Alfred Wilson, Segundo Vocal, habiendo quórum de ley por unanimidad de votos emiten la presente Resolución.

CONSIDERANDO I

Que en receso del pleno del Consejo Regional la Junta Directiva ejerce las facultades y funciones establecidas en el Estatuto de Autonomía y su Reglamento y el Reglamento Interno del Consejo Regional Autónomo de la RAAS.

CONSIDERANDO II

Que los asuntos Regionales que le competen al Consejo Regional máxima instancia de Gobierno en la Región Autónoma de la RAAS, se resuelven a través de Resoluciones y Ordenanzas de Conformidad a la Constitución Política, Ley N° 28, el Decreto 3584, el Reglamento Interno del Consejo Regional y demás Leyes de la República de Nicaragua.

CONSIDERANDO III

Que la Junta Directiva del Consejo Regional tiene plena facultades para organizar los asuntos de su competencia de conformidad a normas establecidas en la Ley 28 y el Reglamento Interno del Consejo Regional Autónomo del Atlántico Sur.

CONSIDERANDO IV

Que los pueblos Indígenas y Comunidades Étnicas de la Región Autónoma del Atlántico Sur tienen pleno derecho de gozar plenamente de los beneficios de desarrollo que se impulsan en pro de mejorar las condiciones de vida de sus habitantes.

CONSIDERANDO V

Que existen proyectos forestales que no requieren de estudios de impactos Ambientales tal como el corte y la siembra de la Especie Forestal BAMBOO de conformidad a la Ley de la materia.

Bluefields, Barrio Central
Costado norte del Palacio Municipal
Telefax. 572 1005 – Teléfono 5722 2706

Edificio Odacan, del Busto José
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Teléfono: 2227171

621-12-03-2012

CONSIDERANDO V

Que en Sesión de trabajo de la Junta Directiva el DOCE de Marzo de 2012 se revisó la solicitud de aprobación del estudio de Impacto Ambiental y operación del Proyecto denominado "Eco Planet Bamboo" el que consiste en la siembra, corte y procesamiento para la confección de productos tablar entre otros derivados del bamboo, en Rio Siquia Municipio de el Rama RAAS y en Rio Kama Municipio de Kukra Hill RAAS, presentado por el Ing. **John Vogel**, Presidente de la Empresa **Eco Planet Bamboo Centro América** radicado en Nicaragua.

POR TANTO

En uso de las facultades que le Confiere la Constitución de la República de Nicaragua, la Ley No.28 denominado ESTATUTO DE AUTONOMIA DE LAS DOS REGIONES DE LA COSTA ATLÁNTICA DE NICARAGUA, el Decreto No. 3584 Reglamento a la Ley No.28, y el Reglamento Interno del Consejo Regional Autónomo del Atlántico Sur, la Junta Directiva Resuelve.

RESUELVE

Se aprueba el **ESTUDIO DE IMPACTO AMBIENTAL y OPERACIÓN** del Proyecto **"Eco Planet Bamboo"** el que consiste en la siembra, corte y procesamiento para la confección de productos tablar entre otros derivados del bamboo, en Rio Siquia Municipio de el Rama RAAS y en Rio Kama Municipio de Kukra Hill RAAS, el que fue presentado por el Ing. **John Vogel**, Presidente de la Empresa **Eco Planet Bamboo Centro América** radicado en Nicaragua.

La presente Resolución entra en vigencia a partir de la presente fecha, sin perjuicio de su posterior publicación en el diario oficial la Gaceta o cualquier medio de comunicación Nacional o Regional, Ejecútese y Cúmplase.

Dado en la ciudad de Bluefields sede administrativa de la Región Autónoma del Atlántico sur, República de Nicaragua a los DOCE DIAS del mes de MARZO del año **DOS MIL DOCE.**

Rev. Rayfield Hodgson Babb	*Eduardo Ruiz Hernández*
Presidente	**Secretario**
CRAAS	**CRAAS**

ANNEX II: RESULTS FROM COMPACTION ANALYSIS OF SAN JOSE ERF

	Depth			Classification		
Plot	Average 5-10 cm	Average 15-30 cm	Average 30-45 cm	5 - 15 cm	15 - 30cm	30 - 45cm
1	4.3	6.5	43.3	Very High	Very High	Extremely High
2	2.8	3.6	6.0	High	High	Very High
3	4.0	5.2	5.8	High	Very High	Very High
4	3.9	3.3	5.0	High	High	Very High
5	4.6	8.3	10.0	Very High	Extremely High	Extremely High
6	4.7	5.1	6.2	Very High	Very High	Very High
7	3.4	4.5	6.3	High	Very High	Very High
8	4.4	5.7	7.9	Very High	Very High	Very High
9	4.9	6.9	6.7	Very High	Very High	Very High
10	5.1	6.8	6.6	Very High	Very High	Very High
11	5.2	7.0	8.4	Very High	Very High	Extremely High
12	4.2	4.1	4.3	Very High	Very High	Very High
13	5.0	4.5	7.0	Very High	Very High	Very High
14	4.6	4.4	7.1	Very High	Very High	Very High
15	4.4	4.5	6.6	Very High	Very High	Very High
16	5.0	4.2	4.6	Very High	Very High	Very High
17	3.9	4.4	4.7	High	Very High	Very High
18	3.5	3.7	4.8	High	High	Very High
19	5.5	3.7	3.2	Very High	High	High
20	4.3	4.3	4.4	Very High	Very High	Very High
21	4.7	5.2	6.4	Very High	Very High	Very High
22	6.4	6.0	6.8	Very High	Very High	Very High
23	4.5	3.8	4.8	Very High	High	Very High
24	6.4	6.5	7.2	Very High	Very High	Very High
25	5.8	5.2	5.9	Very High	Very High	Very High
26	6.8	7.3	10.0	Very High	Very High	Extremely High
27	6.1	6.9	8.6	Very High	Very High	Extremely High
28	4.9	7.5	10.0	Very High	Very High	Extremely High
29	5.5	8.5	10.0	Very High	Extremely High	Extremely High
30	4.0	6.1	7.8	High	Very High	Very High
31	4.3	5.0	5.3	Very High	Very High	Very High

32	5.8	5.9	6.3	Very High	Very High	Very High
33	2.6	3.6	4.4	High	High	Very High
34	3.5	3.7	5.1	High	High	Very High
35	4.5	4.4	5.3	Very High	Very High	Very High
36	4.9	5.2	5.9	Very High	Very High	Very High
37	5.7	6.5	6.4	Very High	Very High	Very High
38	6.2	6.4	5.7	Very High	Very High	Very High
39	4.0	7.0	7.2	High	Very High	Very High
40	6.4	4.8	5.6	Very High	Very High	Very High

ANNEX III. PHYSICAL AND CHEMICAL ANALYSIS OF SOILS IN SAN JOSE ERF

Plot #	pH	Organic Material (%)	Nitrogen (mg/kg)	Phosphorus (mg/kg)	Calcium (meq/100g)	Magnesium (meq/100g)	Potassium (meq/100g)	Sand (%)	Clay (%)	Silt (%)
0	6.19	7.48	3020.1	14.16	4.44	1.73	0.31	45	18	37
4	6.53	3.97	1546.8	8.13	7.05	3.39	0.87	40	20	40
5	6.27	3.74	1441.9	15.18	8.28	4.62	0.34	40	30	30
6	6.12	4.13	1802.9	12.97	3.91	2.48	0.26	40	30	30
7	6.54	3.18	1543.0	9.81	1.70	1.61	0.14	35	40	25
8	6.43	2.77	1744.5	9.14	2.84	2.60	0.33	38	38	24
9	6.34	3.29	1666.2	12.64	3.07	2.47	0.17	38	38	24
10	6.06	3.22	1862.8	24.01	13.36	8.70	0.26	38	29	33
12	6.17	3.12	2030.6	27.07	8.41	3.53	0.63	30	30	40
13	5.76	3.14	2005.2	2.62	5.35	3.38	0.16	35	35	30
14	6.08	2.35	1791.7	30.04	13.52	6.72	0.13	48	29	23
15	5.93	3.87	1923.2	1.50	10.17	10.10	0.80	20	45	30
17	5.33	3.47	1220.9	1.32	4.81	2.16	0.18	35	35	30
19	6.41	2.94	1197.1	21.38	1.24	0.99	0.07	33	38	29
20	6.59	2.46	1671.4	15.25	0.73	0.43	0.08	33	38	29
21	6.45	2.31	1451.6	12.96	0.82	0.71	0.08	36	41	23
22	5.81	2.72	1865.7	1.98	3.84	2.32	0.22	29	43	28
23	6.19	3.70	1967.3	15.34	1.79	1.32	0.19	43	29	28
24	5.73	1.85	587.5	1.27	1.57	0.96	0.49	40	25	35
25	5.69	2.38	1424.7	1.11	3.07	2.46	0.28	29	43	28
26	6.31	3.09	1283.1	19.02	5.65	3.71	0.20	40	30	30
27	6.47	3.47	1557.4	13.54	1.44	1.16	0.09	29	43	28
28	6.44	3.44	1753.5	14.00	2.53	1.79	0.12	26	47	27
29	6.23	2.81	1870.4	13.08	1.16	1.16	0.11	40	30	30

30	6.23	1.88	1035.7	10.51	19.96	7.62	0.62	62	14	24
31	5.86	2.82	2138.7	1.80	1.51	1.55	0.21	35	40	25
32	6.22	3.20	1888.2	11.02	1.25	1.27	0.18	30	40	30
33	6.33	2.81	1592.9	13.73	4.93	3.44	0.43	29	38	33
34	6.4	1.83	1190.8	18.21	4.77	3.50	0.12	36	36	28
35	6.3	3.57	2109.9	13.69	1.14	1.11	0.20	30	35	35
36	5.97	2.81	1992.4	1.59	2.20	2.03	0.15	38	33	29
37	6.17	2.28	1554.8	18.47	3.40	1.54	0.12	33	43	24
38	6.37	2.22	1195.5	10.46	22.73	7.71	0.68	60	15	25
39	6.01	2.49	1753.2	16.31	1.13	1.24	0.22	33	43	24
40	6.15	3.62	2200.6	18.76	2.07	1.75	0.25	40	35	25
41	6.36	2.42	1667.8	12.55	5.76	3.46	0.19	26	42	32
42	6.23	2.41	1753.3	9.52	3.94	2.07	0.30	33	33	34
43	6.17	2.62	1703.1	14.06	6.43	4.50	0.46	40	25	35
44	5.75	3.72	3188.9	2.53	14.01	12.40	0.29	40	35	25
47	6.11	2.57	1779.3	13.42	8.20	2.68	0.25	32	47	21
48	5.96	2.36	1856.4	2.12	1.45	1.24	0.21	33	38	29
49	6.13	1.93	1579.9	10.23	4.57	2.47	0.11	25	40	35
50	6.11	1.72	1660.2	8.35	2.81	2.01	0.12	32	32	36
55	5.99	2.57	1884.1	1.97	3.97	2.72	0.16	40	30	30
57	6.16	2.19	1677.9	14.83	2.61	1.38	0.25	38	29	33
58	6.03	2.50	1723.7	9.34	12.18	8.20	0.79	25	15	60
59	6.15	2.77	1988.1	11.66	4.40	1.84	0.10	35	35	30
63	6.33	2.74	1746.9	14.24	2.68	2.14	0.34	35	35	30
64	5.89	1.76	1986.9	1.85	3.29	2.61	0.17	30	40	30
66	5.946	2.54	2104.2	2.05	10.79	11.24	0.31	33	33	34
67	5.7	3.76	2872.7	1.26	6.96	6.93	0.24	25	45	30

ANNEX IV: GROUND TRUTH DATA FOR LAND USE ANALYSIS

IVA. DATA COLLECTED FOR EACH PLOT

Plot	TYPE	Common Name	Species	Height (m)	Diameter (cm)	Crown radius (m)
1	TREE	Guayabo	*Psidium guajava*	3.6	8.5	2.55
2	TREE	Jobo	*Spondia mombin*	4	20.5	3.5
2	TREE	Jobo	*Spondia mombin*	4	20	3.5
2	TREE	Jobo	*Spondia mombin*	6.4	49.5	4.3
2	TREE	Roble	*Tabebuia rosea*	6.6	54	5.9
2	TREE	Palma	*Geonoma congesta*	6.4	49	7.2
3	TREE	Jobo	*Spondia mombin*	3	16	2.8
4	TREE	Guacimo	*Guazuma ulmifolia Lam.*	5.6	26	3.15
4	TREE	Guayabo	*Psidium guajava*	2.8	12	3.2
4	TREE	Nancite	*Byrsonima crassifolia*	6.6	34	6.6
5	NONE	NA	*NA*	NA	NA	NA
6	TREE	Coyol	*Acrocomia vinífera*	4.5	34	3.5
6	TREE	Nancite	*Byrsonima crassifolia*	5.5	24	5.6
6	TREE	Roble	*Tabebuia rosea*	5.5	41	7.3
6	TREE	Coyol	*Acrocomia vinífera*	6.2	33.5	2.7
7	TREE	Palma mielera	*Sp.*	4	17.5	2.3
8	NONE	NA	*NA*	NA	NA	NA
9	NONE	NA	*NA*	NA	NA	NA
10	NONE	NA	*NA*	NA	NA	NA
11	NONE	NA	*NA*	NA	NA	NA
12	TREE	Coyol	*Acrocomia vinífera*	4.6	28.5	3.8
12	TREE	Guacimo	*Guazuma ulmifolia Lam.*	5.2	28.5	4.6
13	NONE	NA	*NA*	NA	NA	NA
14	DEADWOOD	Sp.	*Sp.*	6.1	24.5	NA
14	DEADWOOD	Sp.	*Sp.*	3.7	32	NA
15	TREE	Guaviluna	*Hirtella triandra Sandw.*	5.5	25	2.9
16	TREE	Nancite	*Byrsonima crassifolia*	4.9	26	4.8
16	TREE	Nancite	*Byrsonima crassifolia*	5	27	6.3
17	NONE	NA	*NA*	NA	NA	NA
18	NONE	NA	*NA*	NA	NA	NA
19	NONE	NA	*NA*	NA	NA	NA
20	TREE	Yema de huevo	*Chimarrhis latifolia*	2.2	12	1.2
21	NONE	NA	*NA*	NA	NA	NA
22	NONE	NA	*NA*	NA	NA	NA
23	NONE	NA	*NA*	NA	NA	NA
24	TREE	Mamón montero	*Thalisia nervosa*	2.8	17.5	3.5
25	NONE	NA	*NA*	NA	NA	NA
26	NONE	NA	*NA*	NA	NA	NA

27	NONE	NA	*NA*	NA	NA	NA
28	NONE	NA	*NA*	NA	NA	NA
29	TREE	Guayabo	*Psidium guajava*	4.4	22.5	5.2
30	NONE	NA	*NA*	NA	NA	NA
31	NONE	NA	*NA*	NA	NA	NA
32	TREE	Mamón	*Melicoccus bijugatus*	3	16	2.5
32	TREE	Yema de huevo	*Chimarrhis latifolia*	4	21	2.8
33	TREE	Guarino	*Melicoccus bijugatus*	4.6	11	2.8
33	TREE	Algodón	*Gossypium hirsutum*	5.6	13.5	3.2
33	TREE	Muñeco	*Cordia bicolor*	5	19	1.9
34	NONE	NA	*NA*	NA	NA	NA
35	NONE	NA	*NA*	NA	NA	NA
36	NONE	NA	*NA*	NA	NA	NA
37	NONE	NA	*NA*	NA	NA	NA
38	NONE	NA	*NA*	NA	NA	NA
39	TREE	Yema de huevo	*Chimarrhis latifolia*	3	17	3.2
39	TREE	Yema de huevo	*Chimarrhis latifolia*	3.2	14	1.8
40	TREE	Guayabo	*Psidium guajava*	4.5	17	4.2

IVB. CALCULATED RESULTS OF EACH PLOT

Plot	Canopy	Trees per ha $_{>5m}$	%CANOPY$_{>5m}$	%CANOPYPLOT$_{>5m}$	%CANOPY$_{total}$	Project Strata
1	20.43	0.00	0.00	0.00	2.89	Low
2	38.48	0.00	0.00	6.61	5.44	Moderate
2	38.48	0.00	0.00			
2	58.09	14.14	8.22			
2	109.36	14.14	15.47			
2	162.86	14.14	23.04			
3	24.63	0.00	0.00	0.00	3.48	Low
4	31.17	14.14	4.41	3.36	4.41	Low
4	32.17	0.00	0.00			
4	136.85	14.14	19.36			
5		0.00	0.00		0.00	Without trees
6	38.48	0.00	0.00	5.78	5.44	Moderate
6	98.52	14.14	13.93			
6	167.42	14.14	23.68			
6	22.90	14.14	3.24			
7	16.62	0.00	0.00	0.00	2.35	Low
8		0.00	0.00		0.00	Without trees
9		0.00	0.00		0.00	Without trees
10		0.00	0.00		0.00	Without trees
11		0.00	0.00		0.00	Without trees
12	45.36	0.00	0.00	1.33	6.42	Low

12	66.48	14.14	9.40			
13		0.00	0.00		0.00	Without trees
14		0.00	0.00	0.00	0.00	Without trees
14		0.00	0.00			
15	26.42	14.14	3.74	0.53	3.74	Low
16	72.38	0.00	0.00	2.49	10.24	Low
16	124.69	14.14	17.64			
17		0.00	0.00	0.00	0.00	Without trees
18		0.00	0.00	0.00	0.00	Without trees
19		0.00	0.00	0.00	0.00	Without trees
20	4.52	0.00	0.00		0.64	Low
21		0.00	0.00	0.00	0.00	Without trees
22		0.00	0.00	0.00	0.00	Without trees
23		0.00	0.00	0.00	0.00	Without trees
24	38.48	0.00	0.00	0.00	5.44	Low
25		0.00	0.00	0.00	0.00	Without trees
26		0.00	0.00	0.00	0.00	Without trees
27		0.00	0.00	0.00	0.00	Without trees
28		0.00	0.00	0.00	0.00	Without trees
29	84.95	0.00	0.00	0.00	12.02	Low
30		0.00	0.00	0.00	0.00	Without trees
31		0.00	0.00	0.00	0.00	Without trees
32	19.63	0.00	0.00	0.00	2.78	Low
32	24.63	0.00	0.00			
33	24.63	0.00	0.00	0.87	3.48	Low
33	32.17	14.14	4.55			
33	11.34	14.14	1.60			
34		0.00	0.00	0.00	0.00	Without trees
35		0.00	0.00	0.00	0.00	Without trees
36		0.00	0.00	0.00	0.00	Without trees
37		0.00	0.00	0.00	0.00	Without trees
38		0.00	0.00	0.00	0.00	Without trees
39	32.17	0.00	0.00	0.00	4.55	Low
39	10.18	0.00	0.00			
40	55.42	0.00	0.00	0.00	7.84	Low

IUCN Category
Least Concern (LC)
Near Threatened (NT)
Vulnerable (VU)
Endangered (EN)
Critically Endangered (CR)

EPB EIA: RIO KAMA FARM (2011)	EPB EIA: RIO SIQUIA FARM (2011)	B.W. TAYLOR (1963)	YIH ET AL (1991)
Acacia farnesiana	Abona sp.	**Most Common**	**Swamp Species**
Albizia guachapele	Acacia magnium	Andira inermis	Carapa guianensis
Ananas cosmosus	Acrocomia aculeata	Carapa nicaraguensis	Pterocarpus officinalis
Andropogon bicornis	Alchorneopsis	Dialium guianense	**Moderately drained**
Antburium scberzerianum	Anacardium occidentale	Dipteryx panamensis	Dendropanax arboreus
Apeiba aspera	Apeiba aspera	Luehea seemannii	Tetragastris panamensis
Astrocaryum alatum (NT)	Artocalpus altilis	Terminalia amazonia	**Well-drained areas**
Bactris gasipaes	Bactris gasipaes	**Common**	Tetragastris panamensis
Bambusa aculeata	Bambusa vulgaris	Astronium graveolens	Brosimum utile
Brosimun alicastrum	Bracharia brizantha	Brosimum terrabanum	**Pioneer Species**
Byrsonima crassifolia	Bracharia decumbens	**Cedrela odorata (VU)**	Miconia elata
Calophyllum brasilensis	Bursera simaruba	Ceiba pentandra	Miconi spp.
Calyptranthes amarulenta	Byrsonima crassifolia	Cordia alliodora	Pourouma aspera
Carapa guianensis	Calophyllum brasilensis	Cordia collococca	
Castilla elastica	Carapa guianensis	**Dalbergia retusa (VU)**	
Ceiba pentandra	Cassia grandis	Ficus glabrata	
Chimarrhis latifolia	Castanea sativa	Guarea guara	

Chusquea simpliciflora	**Cedrela odorata (VU)**	Hieronyma alchorneoides
Citrus aurantrifolia	Ceiba pentandra	Licania hypoleuca
Coconut	Chimarrhis latifolia	Licania platypus
Cordia alliodora	Coccoloba caracassana	Nectandra glabrescens
Cordia bicolor	Coconut	Swietenia marophylla
Coursopoa panamensis	Cordia alliodora	Tabebuia guayacan
Cracopia obtusifolia	Cordia bicolor	Terminalia chiriquensis
Crescentia alata	Coursopoa panamensis	Virola koschnyi
Dalbergia cubilquitzensis	Cracopia obtusifolia	**Occasional**
Dendropanax arboreus	Cracopia sp.	Achras calcicola
Desmodium incanun	Crescentia alata	Albizia caribaea
Dipteryx panamensis	Cupania glabra	Amanoa potamophila
Echinocloa polystachya	Curatella americana	Anacardium excelsum
Enterolobium cyclocarpum	Dendropanax arboreus	Belotia panamensis
Ficus insipida	Ficus sp	Bravaisia integerrima
Gossypium hirsutum	Gliricidia sepium	Brosimum utile
Guazuma ulmifolia	Guazuma ulmifolia	Calocarpum viride
Hirtella triandra	Hanpea platanifolia	Calocarpum shankii
Hyeronima alchornoides	Hyeronima alchornoides	Campnosperma panamensis
Indigofera sufftricosa	**Hymenaea courbaril (LC)**	Cedrela mexicana
Inga mollifolia	Inga punictata	Clusia flava
Inga sapindoidos	Inga sapindoidos	Clusia rosea
Inga vera	Inga vera	Erythrina glauca
Juncus effusus (LC)	Ischaemun indicum	Ficus padifolia
Lacnulea	Lacnulea	Goethalsia meiantha

panamensis	panamensis	
Laetia procera	Laetia procera	Guarea aligera
Lecythis ampla	Mangifera indica	Hura crepitans
Lonchocarpus oliganthus	Manihot esculenta	Hymenaea courbaril
Lycianthes multiflora	Miconia argentea	Ilex guianensis
Manihot esculenta	**Minquartia guianensis (NT)**	Lecythis costaricensis
Melicocca bijuga	Ochroma pyramidales	Licaria cervanteseii
Miconia affinis	Ormosia sp.	Lonchocarpus spp.*
Mimosa pubica	Otoba novogranatensis	Lysiloma seemanii
Minquartia guianensis (NT)	Parkinsonia aculeata	**Manilkara spectabilis (CR)**
Muntingia calabura	Persea americana	**Minquartia guianensis (NT)**
Ochroma pyramidale	Pithacellobium longofolia	Mosquitoxylon jamaicense
Ocotea veraguensis	**Platymiscium pleiostachyum (EN)**	Nectranda gentlei
Ormosia coccinea	Ponoqueria latifolia	Ocotea nicaraguensis
Parkinsonia aculeata	Pouteria sapota	Ormosia schippi
Piper colonense	Psidium guajava	Pentaclethra macroloba
Pithacellobium longofolia	Pterocarpus sp.	Platymiscium polystachyum
Platymiscium pleiostachyum (EN)	Quassia amara	**Podocarpus guatemalensis (LC)**
Poeteria sp.	Saccarum oficinarum	Poulsenia armata
Policourea guianensis	Senna reticulata	Prioria copaifera
Ponoqueria latifolia	Senna siamea	Pterocarpus officinalis
Protium panamense (NT)	Simarauba glauca	Quercus oleoides
Psidium guajava	Spondia mombin	Schizolobium parahybum
Pterocarpus sp.	**Swietenia macrophylla (VU)**	Sloania picapica
Pyrus communis	Tabebuia chrysantha	Spondias mombin

Quassia amara	Tabebuia rosea	Symphonia globulifera
Raphia taedigera	Tamarindus indica	Tetragastris stevensonii
Rhynchospora cephalotes	Terminalia sp.	Trophis macrostachya
Saccarum oficinarum	Tetragastris panamensis	Virola sebifera
Sacoglottis trichogyna	**Vitex gaumeri (EN)**	**Vitex cooperi (EN)**
Scheelea gomphococca	Vochysia ferruginea	Zanthoxylum microcarpum
Senna reticulata	Vochysia guatemalensis	
Sida acuta	Welfia georgii	
Simarauba glauca	**Zanthoxylum belizense (EN)**	
Sloanea meianthera	Zuelania guidonia	
Solanum mammosum		
Spondia mombin		
Tabebuia chrysantha		
Tabebuia rosea		
Tecoma estans		
Terminalia sp.		
Tetragastris panamensis		
Virola koschny		
Virola sebifera		
Vitex gaumeri (EN)		
Vochysia ferruginea		
Vochysia guatemalensis		
Welfia georgii		
Zantedeschia aethiopica (LC)		
Zanthoxylum belizense (EN)		
Zuelania guidonia		

ANNEX VI. MAMMALS, BIRDS, AND REPTILES OBSERVED IN RIO KAMA AND RIO SIQUIA

MAMMALS: RIO KAMA & RIO SIQUIA FARMS			
Scientific Name	**Common Name**	**CITES**	**IUCN**
Didelphis virginiana	Virginia possum	NA	LC
Philander opossum	Gray four-eyed Opossum	NA	LC
Dasypus novemcinctus	Nine-banded armadillo	NA	LC
Cabassous centralis	Northern Naked-tailed Armadillo	NA	DD
Chloepus hoffmanni	Hoffman's two-toed sloth	App III	LC
Tamandua mexicana	Northern Tamandua	App III	LC
Alouatta palliata	Mantled Howler Monkey	App I	LC
Cebus capucinus	White Throated Capuchin	NA	LC
Potos flavus	Kinkajou	App III	LC
Lutra longicauda	Neotropical Otter	NA	DD
Mephitis macroura	Hooded skunk	NA	LC
Sciurus variegatoides	Variegated squirrel	NA	LC
Procyon lotor	Northern raccoon	NA	LC
Nasua narica	White nosed Coati	App III	LC
Agouti paca	Spotted Paca	NA	LC
Dasyprocta punctata	Central American Agouti	App III	LC
Sylvilagus floridanus	Eastern Cottontail	NA	LC
Odocoileus viginianus	White -tailed deer	NA	NA
Demodus rotundus	Common Vampire Bat	NA	LC

BIRDS: RIO KAMA & RIO SIQUIA FARMS			
Scientific Name	**Common Name**	**CITES**	**IUCN**
Coragyps atratus	Black vulture	NA	LC
Buteo magnirostris	Roadside Hawk	NA	LC
Patagioenas speciosa	Scaled Pigeon	NA	LC
Columbina talpacoti	Ruddy Ground-dove	NA	LC
Aratinga finschi	Crimson-fronted Parakeet	NA	LC
Brotogeris jugularis	Orange-chinned Parakeet	NA	LC
Aratinga nana	Olive-throated Parakeet	NA	LC
Piaya cayana	Squirrel Cuckoo	NA	LC
Crotophaga ani	Smooth billed Ani	NA	LC
Microchera albocoronata	Snowcap	NA	LC
Melanerpes formicivorus	Acorn Woodpecker	NA	LC
Melanerpes hoffmannii	Hoffmann's Woodpecker	NA	LC
Dryocopus lineatus	Lineated Woodpecker	NA	LC

Dendrocincla homochroa	Ruddy Woodcreeper	NA	LC
Tityra semifasciata	Masked Tityra	NA	LC
Tyrannus savana	Fork-tailed Flycatcher	NA	LC
Pitangus sulphuratus	Great Kiskadee	NA	LC
Conopias albovittata	White-ringed Flycatcher	NA	NA
Myiarchus tyrannulus	Brown-crested Flycatcher	NA	LC
Myarchus nuttingi	Nutting's Flycatcher	NA	LC
Thryothorus thoracicus	Stripe Breasted Wren	NA	LC
Cyanocorax morio	Brown Jay	NA	NA
Turdus grayi	Clay-coloured Thrush	NA	LC
Psarocolius montezuma	Montezuma Oropendola	NA	LC
Quiscalus mexicanus	Great-tailed Grackle	NA	LC
Sturnella magna	Eastern Meadowlark	NA	LC
Thraupis episcopus	Blue-grey Tanager	NA	LC
Tangara larvata	Golden-hooded Tanager	NA	LC
Ramphocelus passerinii	Scarlet-rumped Tanager	NA	LC
Volatinia jacarina	Blue backed Grassquit	NA	LC
Oryzoborus funereus	Thick billed seed Finch	NA	LC

REPTILES: RIO KAMA & RIO SIQUIA FARMS			
Scientific Name	**Common Name**	**CITES**	**IUCN**
Physalaemus pustulosus	Tungara frog	NA	LC
Iguana iguana	Green iguana	NA	NA
Corytophanes cristatus	Helmeted iguana	NA	NA
Mabuya unimarginata	Bronzed back skink	NA	NA
Oxybelis aeneus	Mexican vine snake	NA	NA
Bufo marinus	Cane toad	NA	LC

ANNEX VII. ENVIRONMENTAL QUALITY INDEX FOR EACH ENVIRONMENTAL IMPACT

VIIA. AIR QUALITY FROM LOCAL POLLUTANTS

Environmental Quality Index	Plant transportation	Construction of roads	Average
Characterization (Ca)	-1.0	-1.0	-1.0
Risk of Occurrence (Ro)	1.0	1.0	1.0
Geographic Extent (Ex)	0.1	0.1	0.1
Duration (Du)	0.1	0.1	0.1
Development (De)	1.0	1.0	1.0
Reversibility (Re)	0.1	0.1	0.1
Intensity (I)	0.1	0.1	0.1
Ecological Quality (Qi)	-0.3	-0.3	-0.3

VIIB. IMPACT ON CLIMATE

Environmental Quality Index	Application of fertilizer	Planting	Average
Characterization (Ca)	-1	1	0.00
Risk of Occurrence (Ro)	9	10	9.50
Geographic Extent (Ex)	1.0	1.0	1.00
Duration (Du)	0.1	1	0.55
Development (De)	0.1	0.1	0.10
Reversibility (Re)	0.5	0.8	0.65
Intensity (I)	0.05	1	0.53
Ecological Quality (Qi)	-3.15	7.8	2.33

VIIC. NOISE POLLUTION

Environmental Quality Index	Plant Transportation	Clearing of herbaceous vegetation	Preparation of planting sites	Culm collection and processing	Construction of roads	Construction of firebreaks	Average
Characterization (Ca)	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
Risk of Occurrence (Ro)	1.5	1.5	1.5	2.0	1.5	1.5	1.6
Geographic Extent (Ex)	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Duration (Du)	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Development (De)	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Reversibility (Re)	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Intensity (I)	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Ecological Quality (Qi)	-0.42	-0.42	-0.42	-0.56	-0.42	-0.42	-0.44

VIID. Impacts on Compaction

Environmental Quality Index	Planting	Construction of roads & firebreaks	Average
Characterization (Ca)	1	-1	0
Risk of Occurrence (Ro)	10	4	7
Geographic Extent (Ex)	0.3	0.1	0.2
Duration (Du)	0.5	0.7	0.6
Development (De)	0.2	0.2	0.2
Reversibility (Re)	0.2	0.6	0.4
Intensity (I)	0.6	0.1	0.35
Ecological Quality (Qi)	3.6	-1.36	1.12

VIIE. Impacts on Erosion

Environmental Quality Index	Construction of drainages in flood prone areas	Clearing of herbaceous vegetation	Planting	Average
Characterization (Ca)	-1	-1	1	-0.3
Risk of Occurrence (Ro)	4	4	9	5.7
Geographic Extent (Ex)	0.1	0.3	0.3	0.2
Duration (Du)	1	1	1	1.0
Development (De)	0.6	0.6	0.2	0.5
Reversibility (Re)	0.3	0.3	0.7	0.4
Intensity (I)	0.2	0.2	0.7	0.4
Ecological Quality (Qi)	-1.76	-1.92	5.22	0.51

VIIF. Contamination of Soil

Environmental Quality Index	Handling of solid and liquid chemicals	Application of pesticides	Management of liquids and solid waste	Average
Characterization (Ca)	-1.0	-1.0	-1.0	-1.0
Risk of Occurrence (Ro)	3.0	3.0	3.0	3.0
Geographic Extent (Ex)	0.1	0.1	0.1	0.1
Duration (Du)	0.3	0.3	0.3	0.3
Development (De)	0.6	0.6	0.6	0.6
Reversibility (Re)	0.3	0.3	0.3	0.3
Intensity (I)	0.2	0.3	0.2	0.2
Ecological Quality (Qi)	-0.9	-1.0	-0.9	-0.9

VIIG. Water Quality

Environmental Quality Index	Nursery fertilization	Handling of solid and liquid chemicals	Construction of drainages in flood prone areas	Planting	Application of pesticides	Construction of roads	Average
Characterization (Ca)	-1.0	-1.0	-1.0	1.0	-1.0	-1.0	-0.7
Risk of Occurrence (Ro)	5.0	3.0	10.0	9.0	4.0	10.0	6.8
Geographic Extent (Ex)	0.1	0.1	0.1	0.3	0.1	0.1	0.1
Duration (Du)	0.2	0.2	0.1	1.0	0.2	0.1	0.3
Development (De)	0.8	0.7	1.0	0.2	0.7	1.0	0.7
Reversibility (Re)	0.3	0.2	0.3	0.8	0.3	0.3	0.4
Intensity (I)	0.3	0.3	0.3	0.6	0.7	0.3	0.4
Ecological Quality (Qi)	-1.7	-0.9	-3.6	5.2	-1.6	-3.6	-1.0

VIIH. Water Runoff

Environmental Quality Index	Construction of drainages in flood prone areas	Planting	Construction of roads	Average
Characterization (Ca)	-1.0	1.0	-1.0	-0.3
Risk of Occurrence (Ro)	8.0	9.0	8.0	8.3
Geographic Extent (Ex)	0.1	0.3	0.1	0.2
Duration (Du)	0.8	1.0	0.8	0.9
Development (De)	0.7	0.2	0.7	0.5
Reversibility (Re)	0.1	0.8	0.1	0.3
Intensity (I)	0.4	0.6	0.4	0.5
Ecological Quality (Qi)	-3.4	5.2	-3.4	-0.5

VIII. Change in Diversity of Vegetation

Environmental Quality Index	Planting	Average
Characterization (Ca)	1	1
Risk of Occurrence (Ro)	7	7
Geographic Extent (Ex)	0.3	0.3
Duration (Du)	0.8	0.8
Development (De)	0.2	0.2
Reversibility (Re)	0.8	0.8
Intensity (I)	0.9	0.9
Ecological Quality (Qi)	4.2	4.2

VIIJ. Change in Land Use

Environmental Quality Index	Planting	Average
Characterization (Ca)	1	1
Risk of Occurrence (Ro)	8	8
Geographic Extent (Ex)	0.3	0.3
Duration (Du)	1	1
Development (De)	0.2	0.2
Reversibility (Re)	0.9	0.9
Intensity (I)	0.8	0.8
Ecological Quality (Qi)	5.12	5.12

VIIK. Wildlife Corridors

Environmental Quality Index	Planting	Average
Characterization (Ca)	1	1
Risk of Occurrence (Ro)	7	7
Geographic Extent (Ex)	0.3	0.3
Duration (Du)	0.9	0.9
Development (De)	0.2	0.2
Reversibility (Re)	0.7	0.7
Intensity (I)	0.6	0.6
Ecological Quality (Qi)	3.78	3.78

VIIM. Fauna Diversity

Environmental Quality Index	Clearing of herbaceous vegetation	Planting	Average
Characterization (Ca)	-1	1	0
Risk of Occurrence (Ro)	3	7	5
Geographic Extent (Ex)	0.3	0.3	0.3
Duration (Du)	0.1	1	0.55
Development (De)	0.9	0.1	0.5
Reversibility (Re)	0.1	0.7	0.4
Intensity (I)	0.4	0.7	0.55
Ecological Quality (Qi)	-1.08	3.92	1.42

VIIN. Socioeconomic Impacts

Environmental Quality Index	Employment of seasonal staff and permanent staff	Trainings of all staff	Average
Characterization (Ca)	1	1	1
Risk of Occurrence (Ro)	10	10	10
Geographic Extent (Ex)	0.6	0.6	0.6
Duration (Du)	1	1	1
Development (De)	1	1	1
Reversibility (Re)	1	1	1
Intensity (I)	0.7	0.7	0.7
Ecological Quality (Qi)	8.6	8.6	8.6

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