University of Alberta

Climate change, adaptive capacity and new land use innovations implemented by local farmers and indigenous peoples in Puerto Carreño, Colombia

by

Julio Arregoces

A thesis submitted to the Faculty of Graduate Studies and Research

in partial fulfillment of the requirements for the degree of

Master of Science

Department of Renewable Resources

Fall 2012

Edmonton, Alberta

Abstract

A case study research was conducted in the city of Puerto Carreño, Colombia to assess adaptive capacity for the Farmers' community and indigenous people to face climate change. Some of these inhabitants understand these changes in the weather as natural processes, others as climate change. The major finding of this study was that these communities started perceiving changes in the weather between the years of 2010 and 2011. These changes refer to the increase in the temperature and alteration of the rainy and dry seasons. Another important finding is related to the new economic activities, which are seen by some participants as contributors to the climate change in the region. The results suggest that these two communities have been and will continue feeling changes in the weather in the Orinoco region. Although these communities possess some of the tools necessary for adaptive capacity to climate change, these tools are not strong enough yet.

Acknowledgement

First of all, I would like to thank my supervisor, Dr. Debra Davidson, who always trusted me in this process of doing an M Sc. Since the beginning of my program, Dr. Davidson was always there to guide me, correct me, and suggest the best solutions in my education process. Thanks to her patience, today I can say I had the best educator ever, who taught me how an educator should be in relation to students. Second, thank you to my brother Carlos and my parents who gave me the opportunity to come to Canada to improve my academic formation. Their support of me in the hardest moments of my program as well in the happiest moments was appreciated. Thanks also to my committee members, Brenda Parlee and John Parkins, who were professors as well during my formation and were always open to answer my questions. Finally to Rhonda Flagler, my fiancée, for her support and love during all this process. The achievement of this goal is dedicated in special to her for her care and trust on my capacities.

Table of Contents

List of Tables

List of Figures

List of Abbreviations

DANE: Departamento Administrativo Nacional de Estadistica – National statistical department -

FTA: Free trade agreement

IDEAM: Instituto de Hidrologia, Meteorologia y Estudios Ambientales **-** Institute of Hydrology, Meteorology and Environmental Studies -

IPCC: Intergovernmental Panel on Climate Change

ONIC: Organizacion Nacional Indigena de Colombia – National indigenous organization of Colombia

INTRODUCTION

Climate change is a natural response that the earth has for some pollutants (specific to greenhouse gases) discharged into the atmosphere. In addition, there are modifications in the atmosphere that have been happening for centuries, caused by human activities (such as fossil fuel consumption) and also by natural phenomena (such as volcanic activity). Many people refer to this as the "sickness of the earth," others as "the beginning of the end."

> In pursuit of a thorough, scientific understanding of the world around us, ecologists and social scientists have worked within their academic disciplines to develop a wide range of empirical studies, methods, and models to identify key drivers, processes, and controls that regulate human behavior and interactions with the environment. (Redman et al., 2004, p. 161)

Different studies about climate change and the reaction in rural areas of the communities in terms of land management have been conducted around the world such as "Seeing people through the trees and the carbon: mitigating and adapting to climate change without undermining rights and livelihoods" (White, 2010) and "The role of indigenous knowledge in crafting adaptation and mitigation strategies for climate change in Latin America" (Kronik and Verner, 2010). However, for Puerto Carreño, the capital city of the Department of Vichada in Southeast Colombia, little has been done in regards to climate change. Puerto Carreño is located in the Orinoco Region, a vast basin that has an area of approximately 991.587 km^2.

According to a study conducted by the Institute of Hydrology, Meteorology and Environmental Studies (IDEAM 2007), some possible effects have been generated by climate change in this specific part of Colombia where this research project took place as well as in other regions of the country. By assessing global climate models that best represent the climate support regional and regional climate model of high spatial resolution, climate change scenarios were simulated over the Colombian territory for the coming decades.

In the Amazon and Vichada departments, some possible effects of climate change have implications for thermal comfort, in which the change in the temperature could have a drastic impact on the population, because the Colombian land area status "uncomfortably warm" will increase in much of the Caribbean region, Orinoco, Amazon, along the Magdalena valley, and in the Andean region. A second effect is an increase in precipitation which will increase the numbers of victims around Colombia, especially in those regions with high levels of poverty. In mountain areas, the cold chill would be gradually reduced; the agricultural sector would be particularly vulnerable, and advanced processes of desertification would be more sensitive. However, Puerto Carreño and the Orinoco region in general are seen by the national government of Colombia as a potential economic development area for the future of the country. This perspective of being the new potential economic development of the region caught the attention of the forest industry, which are developing forest crops in a

basin plain of grassland and poor nutrient soil. As described by community members of Puerto Carreño, changing the landscape from a savanna to a forest would bring major impacts for the region and for the world. Nevertheless, the forest industry is not only an economic activity but also a remediation to climate change by CO sequestration.

This research project attempts to present the adaptation capacity that the indigenous people and local farmers in rural areas of Puerto Carreño have, by evaluating possible changes in the land management through conducting interviews with some indigenous leaders (names provided by local institutions in Puerto Carreño) and local farmers (as possible, one for each representative economic activity). By measuring resilience and adaptation capacity, the scope of this project will consider if local communities in rural areas (farmers and indigenous people) are changing their traditional land management methods as a result of climate change.

Recently, the Orinoco has been the site of rapid development of new forestry plantations, one intention of which is to mitigation climate change. The realization of this intent, and the long-term viability of these operations, however, depends upon the receptivity of local residents to such operations, and the potential for the emergence of conflict and other unintended consequences of new development in the local community. The current study will also evaluate local perceptions of new forestry plantations and their relationship to climate change.

1. Research Base: the Problem

Vulnerability to climate change could exist anywhere. In the research area of Orinoco, the indigenous group and the farmers could be affected or vulnerable to climate change. The livelihood and food security for both communities could be under threat because of possible changes in natural cycles, such as the rainy and dry seasons. However, this project evaluated the adaptive capacity that these communities possess in order to face the impacts of climate change and the new economic activities in the region.

2. Research Objectives and Questions

2.1. Questions

In order to choose the most fitting methodology to answer the problems described above, literature sources have provided empirical knowledge of the situation. This information has led to the following questions that are based on the evidence of climate change in the Orinoco region.

1. Are the indigenous people of Puerto Carreño modifying their ancestral knowledge and applying new technologies in current land management in response to climate change?
2. Are local farmers seeking new knowledge and modifying their practices in response to climate change?

3. How are each of these land user groups constrained in their generation and adoption of innovation by external, institutional (political, economic, regulatory) factors?
4. Is the forest industry activity affecting local changes in the weather conditions of Puerto Carreño and in the Orinoco's region from the perspective of farmers and indigenous people?
5. What are the perceptions of farmers and indigenous people about new forestry plantations and their relationship to climate change mitigation and adaptation?

2.2. Objectives

The main objective of this research is to evaluate if in the face of evidential climate change in the Orinoco region, the indigenous communities and local farmers in the county of Puerto Carreño have been making an effort to exchange information for future adaptability.

Some specific research objectives are as follows.

1. Determine if the current methodologies that indigenous people and farmers employ in land management in the county of Puerto Carreño have changed in response to perceptions about the impacts of climate change.
2. Compare the personal weather observations of indigenous land users and farmers to the findings presented in scientific reports such as those produced by IDEAM.

3. Identify potential new land uses (such as mining, forest, agriculture) that may intervene with the land use innovations being introduced by indigenous peoples and farmers in an effort to enhance their resilience to climate change.
4. Identify the perspectives and concerns among these two groups regarding new forestry plantations.

2.3. Thesis Structure

This research thesis is organized into five different chapters. The first chapter provides the background and historical context for Colombia and for the Orinoco's region, especially Puerto Carreño. This chapter also includes current issues for indigenous peoples and farmers in the region. In chapter two, a literature review is provided in order to gain an understanding of terms such as "vulnerability" and "adaptation capacity." A general description of the project, personal goals, interviewees, and the interviews are provided in chapter three. In chapter four, the findings from the interviews are provided from indigenous peoples' and farmers' perspectives in terms of climate change and the forest plantations, highlighting the consequences on the community, environment and the economy. Chapter five is the discussion section. At the same time, this chapter concludes the project and also suggests future possibilities for Puerto Carreño in building their adaptive capacity to face climate change in the future.

1. HISTORICAL CONTEXT

1. Colombia

Colombia, officially the Republic of Colombia, is a unitary constitutional republic comprising thirty-two departments. The country is located in northwest South America, sharing borders with Panama (to the northwest), the Caribbean Sea (to the north), Venezuela and Brazil to the east, Ecuador, Peru, and Brazil to the south, and the Pacific Ocean to the west (see figure 1-1). Because of the natural structure and the location, Colombia is divided into six distinct natural regions: the Andean region, covering the three branches of the Andes Mountains found in Colombia; the Caribbean region, covering the area adjacent to the Caribbean Sea; the Pacific region, adjacent to the Pacific Ocean; the Orinoquia region, part of the Llanos plains mainly in the Orinoco river basin along the border with Venezuela; the Amazon region, which is part of the Amazon rainforest; and finally, the Insular region, comprising islands in both the Atlantic and the Pacific oceans[1] (see figure 1- 2).

1.1. Relationship between the Orinoco Region and the Vichada's Department

As is evident in the natural regions of Colombia's map, the relationship that the Vichada department holds with the Orinoco region is that approximately 87% of the total extension of this department is located

[1] http://en.wikipedia.org/wiki/Natural_regions_of_Colombia

inside of the Orinoco. However, this region covers mostly four departments in Colombia, continuing its extension into the Venezuelan territory.

Figure 1-1: Colombian departments and international borders.
Source: http://www.trailmonkey.com/latin/Colombia_MAP.jpg April 05, 2012. 13:30 WT

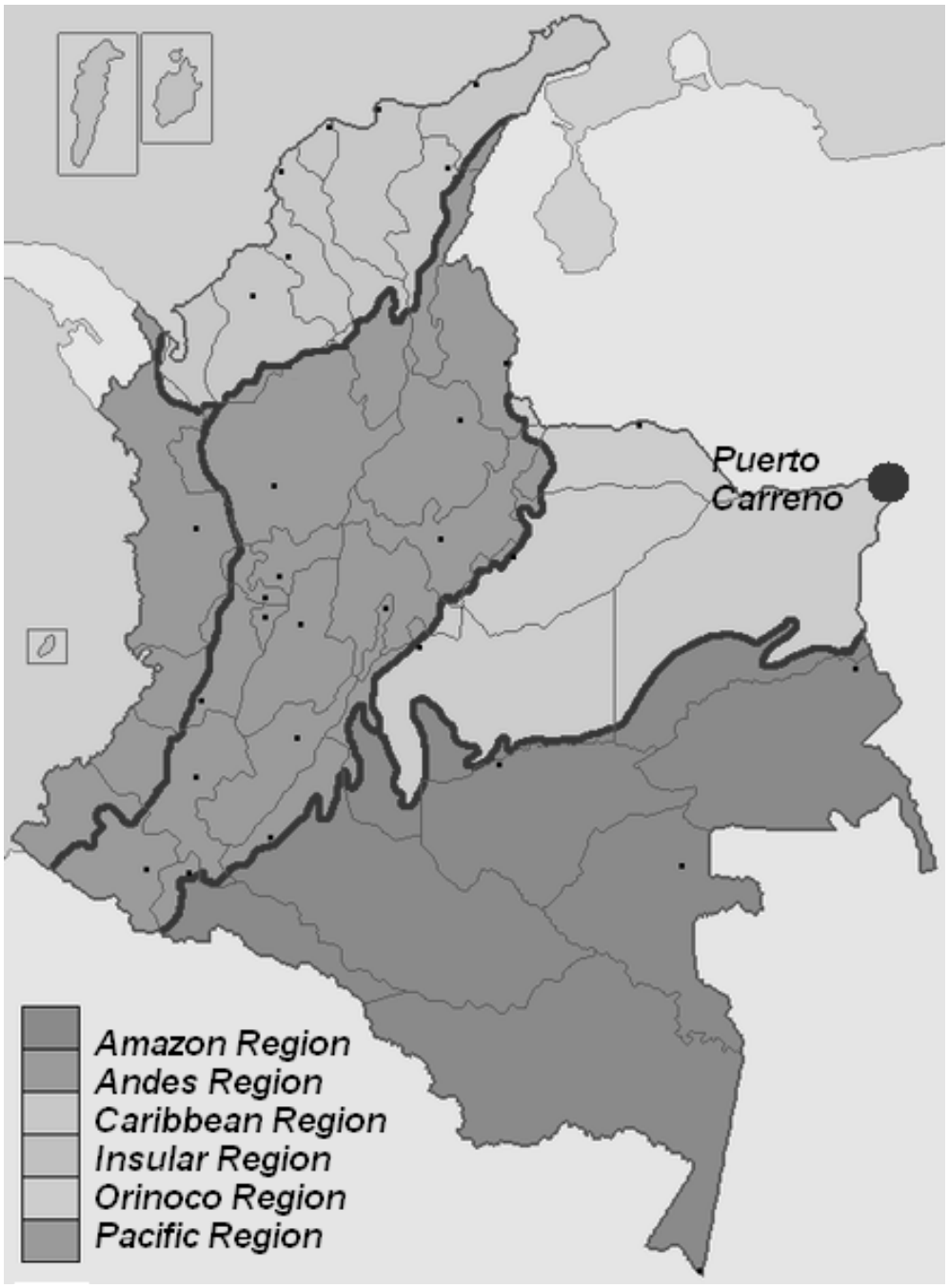

Figure 1-2: Natural regions of Colombia, including Puerto Carreño's location.
Source: http://en.wikipedia.org/wiki/File:Regionsofcolombia.png April 05, 2012. 14:41 WT

1.2. Puerto Carreño

1.2.1. Climate

Puerto Carreño has typical tropical weather, where the heat, humidity and rain are the most predominant factors of the climate. The annual total average rain is 2233 mm (IDEAM, 2012), with an average of 8 months with rain fall between 100 and 570 mm per month. The summer or dry season for this region is short, with 4 months that run from December until the end of March. However, April and November are considered to be a transition time between the rainy and the dry season.

The temperature ranges between 23 and 36 Celsius degrees with a media of 28. The meteorological station, as for most of the stations in Colombia, is located in the airport. Other factors measured in this station are relative humidity, 55% to 79%, speed and wind direction, and the solar radiation or daylight.

1.2.2. Economy

The most important economic activities in the region are livestock, fisheries, agriculture and mining. The main agricultural products are rice savanna, cotton, cassava and plantains. Also, there are exploited gold and silver mines in rudimentary form. The town offers tourist sights such as the coastal population of Casuarito, where leather goods and garments, textiles and traditional foods are produced. The town is supplied with goods from inside the country and sometimes in Puerto Paez, city of the

Venezuelan State on the border with Colombia (Alcaldia de Puerto Carreño, 2010). However, local farmers' production is for local consumption, except for cotton and cashew nuts, which are commercialized at the national level and most of the cotton is exported. On the other hand, recent economic activities are the forestry industry and oil and gas exploration in the region.

1.2.3. Population

According to the Puerto Carreño Municipal Government website, the total population is 14767, divided by those who are in urban and rural areas. Among these people, there are regular citizens, indigenous communities (Amorua, Sikuani, Guahibo, Saliba, and Piaroas), and a recent growing community of displaced people coming especially from inside Vichada and its surrounding departments.

Approximately 46.4% of the city population, or 6852 people, live in poverty. On the other hand, the education levels in Puerto Carreño are shown in table 1. In terms of utilities, some of the houses in Puerto Carreño possess power (78.3 %), wastewater pipe line systems (5.2%), drinking water (70.1%), and another smaller portion (20.5%) possess home phones.

Another characteristic of the population is the education level of the community which is not high compared to other cities in Colombia. In Puerto Carreño, only 7.7% of the 14767 people have attended university.

It could be as a result of the high level of poverty in the city. Table 1-1 shows details about the education levels in Puerto Carreño.

Education Level	Percentage	Number of Individuals
University	7,7	1137
Technical College/ Normal School	7,8	1152
High school	30,3	4474
Elementary	35,8	5287
Kindergarten	5,2	768
No Education	13,2	1949

Table 1-1: Levels of education in Puerto Carreño. Based on 2005 census. Adapted by the author.

1.3. Indigenous Communities in Colombia

Before the Spanish colonization of what is now Colombia, the territory was home to a significant number of indigenous peoples. Many of these were absorbed into the mestizo population, but the remainder currently represents over eighty-five distinct cultures[2]. Currently, five hundred sixty seven reserves (*resguardos*) established for indigenous peoples occupy 365.004 km^2 (over 30% of the country's total) and are inhabited by more than 800.000 people in over 67.000 families. The 1991 constitution established their native languages as official in their territories, and most of them have bilingual education (native and Spanish) (DANE, 2007). Some of the largest indigenous groups are the Wayuu, the Arhuacos, the Muisca, the Kuna, the Paez, the Tucano and the Guahibo. The departments of Cauca, La Guajira and Guainia have the largest indigenous populations.

[2] http://www.colombianbikejunkies.com/about-colombia.html

The Organización Nacional Indígena de Colombia (ONIC) is an organization representing the indigenous peoples of Colombia, who comprise some 1.380.000 people, or approximately 3.4 % of the population. The organization was founded at the first National Indigenous Congress in 1982 (ONIC, 2010).

1.3.1. Indigenous Communities in the Orinoco

The Indigenous' livelihood depends on what they get from nature through activities such as gardening, hunting and fishing. The indigenous communities present in the Orinoco region are as follows: Achagua, Amorua, Betoyes, Chiricoa, Kuiba, Guayabero, Guahibos, Hitnu, Masiguare, Piaroas, Saliba, Sikuani, and Tsiripu (DANE 2007). The Amorua and Sikuani communities are the most populous indigenous groups in Puerto Carreño's urban area (refer to section 1.3.3. for more details on current problems in the region).

The Orinoco region has some anti-government military activity such as guerrillas, which affect not only the economy, security, and culture of the region but also the security and stability of the indigenous communities: "The biggest concern of the indigenous communities is their extinction, of which 34 indigenous communities are at risk and therefore their culture, identity and knowledge" (Mario Alvarado, p. 5, 2010, translated by author).

1.3.2. The Indigenous Community in Puerto Carreño

In the case of Puerto Carreño and its rural area, indigenous communities located and identified living there are the Sikuanis, Guahibos, Piaroas, Amoruas, and Salibas. According to the Census DANE 2005, together they represent 22.9 % (2953) of the total population of Puerto Carreño.

1.3.3. Current Issues

Since the Spanish colonization, indigenous people in Colombia have been displaced, killed, and taken as slaves. These scary scenarios have been done by illegal anti-government groups in Colombia such as FARC, ELN, Paramilitaries, and in some cases, by the national army of Colombia (commanded by the government). These scenarios have strategic purposes, such as for the illegal groups to control territories, to grow illegal crops (to produce drugs) and for the government to give the land to companies to develop it for crop production (agribusiness):

> The territories inhabited by the indigenous communities, also have a value in the middle of the conflict, not only strategic for the illegal actors, but also for the extraction and exploitation of the natural resources "…water, minerals, biodiversity, the timber, and the forest; which have a strategic value for the so-called ***development*** (ONIC, 2008)…" by Colombian and international companies in the frame of megaprojects, have sparked interest in the territorial dispossession (Auto No. 004, 2009), affecting the sacred places of the ethnics groups, with the destructive impact on their cultural structure. Around 65% of the indigenous territories are ceded concessions to multinational companies, in most cases, without prior consultation. (Mario Alvarado, p. 3, 2010, translated by author)

Not only is it the indigenous community's concern but also the fact that with the implementation of the Free Trade Agreement (FTA) between Colombia and United States, the territory for their livelihood and practices is being infringed upon:

> Unfortunately, our voice was not heard and the agreement was approved. It was approved even though there is evidence, studies and realities of other regions, that show how nefarious these agreements to historically impoverished populations, including indigenous peoples, especially because it threatens the food security of the most vulnerable people, who end up depending on the products, food and seeds from large multinational corporations. It was not our voice heard, even institutions like the Constitutional Court have recognized that the current development model is strengthened trade treaties like FTA, is one of the structural causes of our silence and impunity extermination. (ONIC, 2011)[3]

1.4. The Farmers' Community in Puerto Carreño

Puerto Carreño is seeking development opportunities and projected as a potential economic strategic area for Colombia. Surrounded by many bodies of waters, the plains around the town are home to increasing farming activities in the area, changing from a savanna ecosystem to a developed place.

1.4.1. Main Activities

Based on previous information and supported by the field study, it was possible to identify the main activities developed by the farmers. These

[3] Original in Spanish. Translation by author.

activities include mining, cotton production, crops (yucca, cashew, and mango), forest industry, livestock, and fishing.

1.4.2. Current Issues

Recent issues in the farmers' community are related to the change in the natural cycle of the rain, affecting crops that depend on a regular and constant period of rain. Evidence of this information is discussed by the participants (interviewees) in Chapter 4. A second factor is the flooding season resulting from the convergence of many rivers into the Orinoco River that shares borders with Puerto Carreño. Some farmers grow their crops where the river floods for shorter periods, but when the flooding remains for longer periods the crops can be lost. An example of this is cotton production, which was mentioned while conducting the interview.

A previous factor that was affecting the farming system in general in Vichada was the violence that took place from the mid-1950's when the guerrilla groups began operating in the country until the beginning of the millennium when the national army of Colombia regained control of the area. Currently, farmers are thankful that soldiers are present in the town and the surrounding areas of Puerto Carreño, making it one of the most peaceful places in Colombia.

1.5. Climate Change in Colombia

According to a study conducted by the Institute of Hydrology, Meteorology and Environmental Studies, IDEAM, some possible effects generated by climate change are occurring in this specific part of Colombia where the project is taking place as well as in other regions of the country. By assessing global climate models that best represent the climate support regional climate model of high spatial resolution climate change, scenarios were simulated for the Colombian territory for the coming decades of this century. Figure 1-3 shows the estimated variation of the temperature around the world (IPCC, report 95) which contributes to the increase or decrease of precipitation. Based on the foregoing, the following is the most likely climate change scenario for the country: increases in precipitation would be observed in Vaupés, Chocó, Guainía, Amazon and Vichada. Climate change could have possible effects and implications for thermal comfort, which is the change in the thermal comfort associated with changes described that could have a drastic impact on the population because the Colombian land area status, "uncomfortably warm," will increase in much of the Caribbean regions, Orinoco and Amazon and along the Magdalena valley in the Andean region. In mountain areas, the cold chill would be gradually reduced.

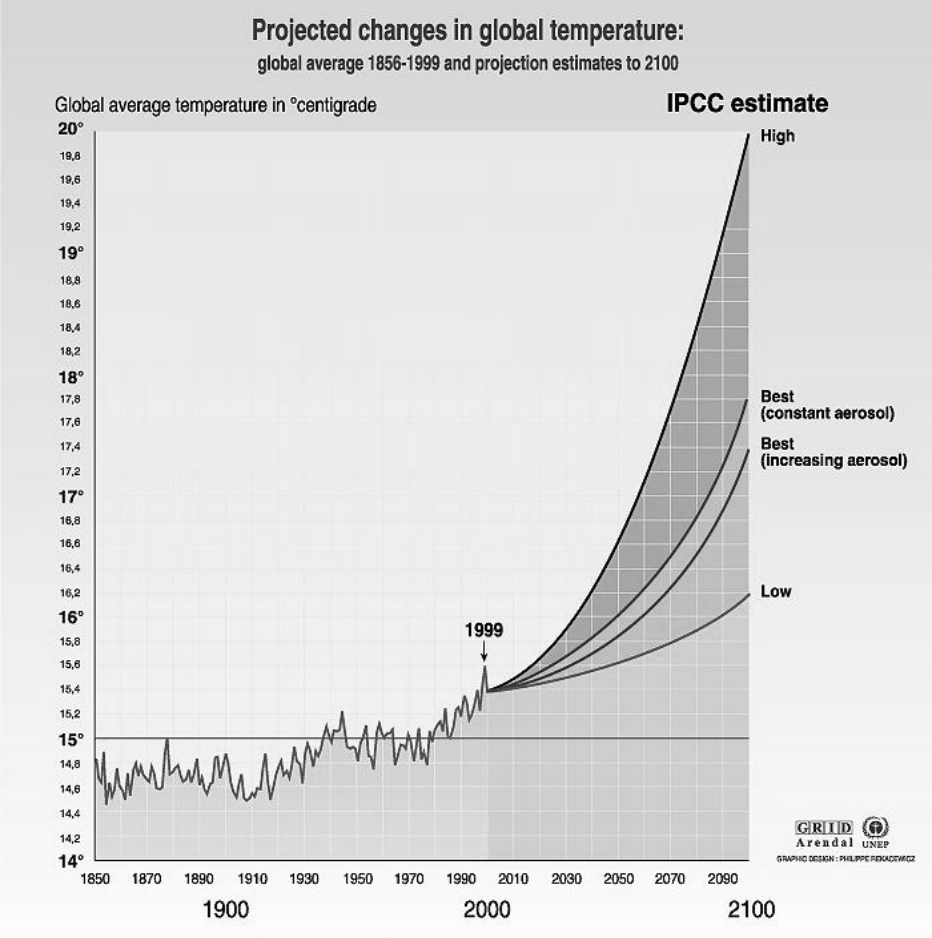

Figure 1-3: Projected changes in global temperatures for the last and next century.
Source: http://www.grida.no/publications/vg/climate/page/3076.aspx

1.5.1. Climate Change in Puerto Carreño

At the time of conducting the field research, there was little documentation specific about climate change in Puerto Carreño. Only the report presented in 2007 by IDEAM evaluates in general how the Orinoco region, including Puerto Carreño, will be affected by climate change (in terms of the weather). However, it does not mean there is lack of understanding in the community about what climate change means and/or if there are changes happening in the area: there is an awareness of the weather in the community.

2. LITERATURE REVIEW

2.1. Vulnerability

Turner et al. (2003) define vulnerability as “the degree to which a system, subsystem, or system component is likely to experience harm due to exposure to a hazard, either a perturbation or stress/stressor” (p. 8074). The perturbation may not be necessarily from a natural source. In other words, the perturbation might come from human activities, such as change in land use in susceptible ecosystems. Another perturbation may be the exploration and exploitation of natural resources, such as natural coal deposits. Adger (2006) defines vulnerability to climate change as a “characteristic of a system and as a function of exposure, sensitivity and adaptation capacity” (p. 273). This exposure will be created by humans in those cases where a potential hazard is foreseen.

Larger political-economic use of resources cannot be ignored in considering vulnerability to environmental change: “Vulnerability is driven by inadvertent or deliberate human action that reinforces self-interest and the distribution of power, in addition to interacting with physical and ecological systems” (Ribot J. 2010, p. 51). However, Hans-Martin Füssel (2006) describes a vulnerable situation when “vulnerability of a system’s feature(s) of concern to a hazard (in temporal reference), whereby the temporal reference can alternatively be stated as the first qualifier” (p. 157). Nevertheless, the political economy of resource use and the temporal space in a specific sector (e.g. agriculture sector) may combine

to cause vulnerability to the system. For example, the relocation and development of communities in areas already identified as vulnerable such as Florida where there are expected to be more and more intense hurricanes over the next 20 years or so (Tierney et al. 2006 and Lachlan et al. 2009)

Vulnerability to climate change, however, can be defined as the degree to which a person, ecosystem or a community is exposed to a natural hazard under weather conditions over a matter of time. Figure 2-1 represents a scenario where a family builds a house on the edge of a river not knowing the increase of precipitations in the upper area of the river. This hypothetical situation will occur in an area where an increase in rain will have happened as a result of climate change. Other factors that may be added to vulnerability are the economic condition of a community (Parkins & MacKendrick, 2007), system or a single person under natural phenomena threat.

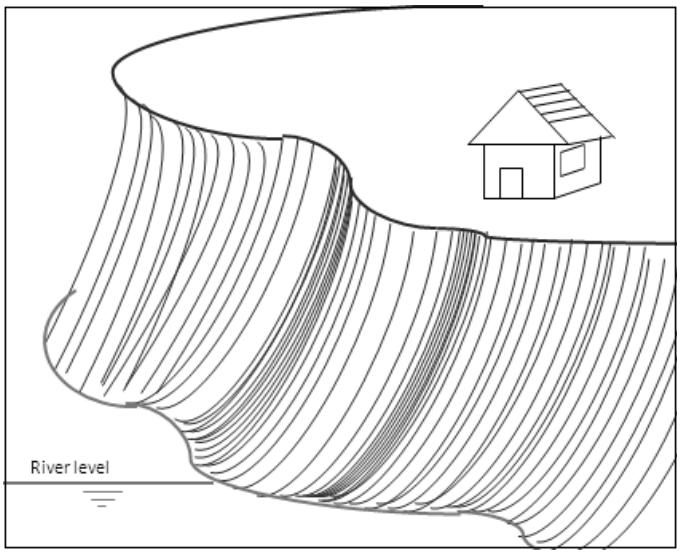

Figure 2-1: Risk of a landslide due to the increase of the river level by the rain.

In figure 2-1, the risk of a landslide caused by the increase of the rain will make the people living in the house vulnerable. However, the vulnerability will remain if the people in the house are not relocated to a safe area. The degree of the exposure to the natural hazard is evident; a landslide will result in a matter of time due to the rain and soil conditions (stability).

Finally, in an international prospective, Parkins and MacKendrick (2007) argued that average measures of development are considered as lawyers for vulnerability. These measurements can be poverty, food security, political stability, armed conflict, health, and as the most important to evaluate vulnerability from figure 2-1, the economic conditions of the community, which includes physical infrastructures as well.

2.1.1. Reducing Vulnerability

To reduce vulnerability, it is necessary to minimize and enhance those characteristics considered as measurements, which have been discussed in different papers as wealth, health, willingness to invest in adaptation, political commitments, and food security (Smit and Wandel, 2006; Parkins and MacKendrick, 2007; and Williamson, 2010). In some cases, these measurements are positive but in others are negative. For example, willingness to invest in adaptation is consider as a positive value (Adger, 2006), while food security is critical and crucial in the process of reducing vulnerability to a system.

Agrawal (2008) argues closer and deeper attention from institutions (government and non-government) to the poor and most vulnerable communities is necessary in order to increase or to address their adaptive capacity to climate change. This is because of the fact that these communities are at higher risk of increasing vulnerability to climate change.

Moreover, reducing vulnerability to climate change is going to depend on the connection among social dynamics and socio-ecological systems. These dynamics are related to the decrease of vulnerability because of the ability to present diversification in the systems. For example, diversification in land uses mitigates the over stress of the soil structure in agriculture activities, especially where capital investment in technology is low (Adger, 2006). Perhaps integrating resilience with adaptation capacity is one of the multiple ways to assess reduction of the vulnerability of a system, community, or ecosystem under the threat of climate change.

2.2. Adaptive Capacity

There are many definitions regarding adaptive capacity to climate change, but most refer in some way to the ability to adjust in form and/or function in a manner that increases the resilience of the system in response to changing conditions. For the Intergovernmental Panel on Climate Change, adaptive capacity is defined as “the degree to which adjustments in practices, processes, or structures can moderate or offset

the potential for damage or take advantage of opportunities created by a given change in climate" (IPPC, 2001).

Smit and Wandel (2006) suggested that "some determinants of adaptive capacity function at a local level (e.g. the presence of a strong kinship network which will absorb stress), while others reflect more general socio-economic and political systems (e.g. the availability of state-subsidized crop insurance)" (p. 287). In addition, the adaptation of/to a system is considered as a sign of adaptive capacity. These transformations in a system reflect the ability to reduce vulnerability, transforming it into an adaptive capacity tool.

Moreover, there are other authors that suggest that the access to economic resources, technological options, infrastructure, institutions, wealth, inequality, educational commitment, isolation of rural communities, quality of basic infrastructure, political influence, willingness to invest in adaptation, and environmental sustainability measures are key determinants, indicators and measures of adaptive capacity (Williamson, 2010). Meanwhile, if these previous aspects or tools are not identified, there is a possibility that vulnerability to climate change will be greater than the community-ecosystem's adaptive capacity.

Wall and Marzall (2006) connect these measurements as social, human, institutional, natural and economic. Each measurement has its own definition and could have different variables. For example, the social component is defined as communication capacity and people's

relationship with each other. For the social component, its variables are considered by the authors as community attachment and social cohesion.

In order to identify adaptive capacity, indicators discussed by Wall and Marzall (2006) are connected according to a variable in function of each measurement. Some of these indicators are listed in the table below:

Measurement	Variable	Indicator
Social	Place attachment	Hostels scale
Human	Level of Education Productive Population	Availability of schools and institutions Tendency in dependency relation
Institutional	Infrastructure Health care Communication	Condition and characteristics Services accessible Availability of local media
Natural	Drinking water Soil conditions Forest reserve	Rate of infectivity Erosion and diversity Diversity
Economic	Employment opportunities Economic resources	Trends in employment rates Income levels, home ownership rates, local business

Table 2-1: Possible indicators for adaptive capacity.

As indicated in table 2-1, the identification of these indicators could be demonstrating the level in which a community is building adaptive capacity. However, it is important to identify the measurements in order to have the right identification of what kind of indicators a community possesses to identify their ability for adaptive capacity in facing climate change.

2.2.1. Indigenous Knowledge

Some literature demonstrates that indigenous knowledge is a key element to reduce climate change, but little has been done to incorporate this as a mitigation and adaptation strategy. Adaptation is an option to reduce the vulnerability associated with the negative impacts of climate

change no matter where the strategies of mitigation come from. However, according to Nyong et al. (2007), incorporating indigenous knowledge into climate change concerns should not be done at the expense of modern/western scientific knowledge. Instead, indigenous knowledge should be considered as complement, rather than competing with global knowledge systems.

In Nyong et al.'s (2007) study, some of the mitigation strategies coming from the indigenous knowledge in the African Sahel where their study was conducted are the use of natural mulches which moderate and help to control soil temperatures and moisture, similar to moderating the reproduction of pests. Nevertheless, local knowledge is important for preserving biodiversity since native indigenous have had to follow and study the natural cycles and manners in which natural resources acts. Ifejika Speranza et al. (2009) discuss that data collected from different studies that argue that indigenous knowledge and science can complement each other. It might not be a methodology approved by science, but the results in some cases are similar to evaluated data and the results after analyzing the data .

However, recent studies demonstrated that, on the other side of the world in South America, the disturbing and disordered changes in the natural agricultural process are causing unique changes in the periods of drought, rain, and frost. In their discussion of traditional leaders, Kronik and Verner (2010) suggest that when it becomes difficult to predict

climatic conditions, such leaders who are normally seen as experts lose their authority and respect.

2.3. Local Institutions

As defined by Agrawal (2008), the adaptation of any community to climate change is, from beginning to end, mostly local, and the efficacy of its adjustments is going to rely on local institutions for which individual and collective action are planned. In addition, the author discussed the extent to which the adaptation practices among the rural poor are successful depends crucially on the nature of prevailing formal and informal institutions.

On the other hand, “institutional adaptation, such as federal subsidies, disaster-relief efforts, and crop-insurance programs, have buffered modern farmers to the point where they may feel only marginally vulnerable as climatic risk shifts from the individual farmer to a higher order of institutional support” (Vasquez, 2009, p. 289). However, there is an interest in understanding how social capital is used by individuals and communities to increase adaptive capacity in order to reduce vulnerability episodes from extreme weather conditions (Vasquez, 2009). As discussed before, the access to social capital or financial resources increase the level of adaptation from individuals through entire communities.

Combined with exposure to disease factors, approaches such as community health lay emphasis on the extensive social determinants that

add in both cases (directly or indirectly) to health and wellbeing, shaping the nature of health outcomes: “From health studies, a rich vein of social science research has emphasized in parallel fashion how health outcomes are generated by a complex raft of social and environmental factors” (Few and Tran, 2010, p. 530). Factors such as education, literacy, income, employment, working conditions, food security, housing conditions, social support networks, gender relations and cultural norms are part of the social determinants (Few and Tran, 2010).

In these terms, this research tries to offer an expanded concept of adaptive capacity in the Orinoco region (for the specific area of Puerto Carreño), starting with local perception of climate change followed by an accurate range of possible strategies built by locals in order to adapt to the climate hazards expected to be found in the research area, covering themes such as land management/use, community health, adaptation capacity, and vulnerability to natural episodes. This in-depth research has confirmed that this Orinoco region is valued and recognized by national and international environmental agencies as an important and unique grassland ecosystem.

3. METHODOLOGY

3.1. Methods

This research study used a case study research as methodology. This method was chosen because it is a qualitative approach in which multiple cases over time through detailed, in-depth data collection involved multiple sources of information, such as interviews, visual evidence, reports, and documents such as census (Creswell et al. 2007). This methodology is open to new ideas that will allow the opportunity to enrich social science in the Orinoco region. Currently, there is not enough information or studies of a similar nature for the region, which gives opportunities to add new strategies of assessment in Colombia, regarding the adaptive capacity in the face of climate change.

3.2. Personal Goals

I decided to use qualitative data analysis for my project because I found it to be a helpful tool to convey information that numbers cannot. Communicating with the local people provided me with another type of data which I transformed into codes with the use of Nvivo 9 (below in section 3.4. is provided a general description of this software) that made the results easy to understand. Ultimately this finally solved my research questions and the objectives outlined from the beginning. These codes will be useful in building climate change scenes from both the indigenous

peoples' and the farmers' points of view. These perspectives will be explored further in Chapter 4.

3.3. Collecting Data

Gathering data from interviews was one of the types or kinds of data collection applied in order to gather the field information/data. Interviews took place in the rural area of Puerto Carreño, Colombia. Conducting interviews permits access to certain types of information that is only palpable in the field. The population interviewed included six leaders from the native communities in the area and also ten local farmers from different economic activities (crops, livestock, forest) around the county of Puerto Carreño.

3.3.1. Preliminary Data

During summer 2010, an exchange of information with government and academic institutions was conducted using internet and phone calls. This provided a foundation for the research team to develop an optimal project plan for the Colombian Orinoco region.

3.3.2. Field Work

As a complement of the research, field work took place from April 30, 2011 until May 25, 2011. I had the opportunity to be in Puerto Carreño, a city that I never imagined I was going to know. As long as I remember, I

have always seen the east of Colombia as a place dominated by guerrilla forces. However, this town, repossessed by the Colombian government with its army during the administration of the ex-president Alvaro Uribe, is becoming one of the safest places in Colombia to go, invest, visit, and stay and live a quiet life there. The day for me to fly to Puerto Carreño came, and my excitedness to be in an unexplored place for me was limited by my nervousness. Once I got to the city, my first impression was, thank God the army is all over this town. Over a number of days, I discovered by talking with locals and experiencing myself that this town had a different profile than the one that existed in my mind. I had the opportunity to go to forest plantations, to cotton farms, livestock farms, and also to discuss and share opinions with the community, including different meetings with some of the indigenous leaders located in Puerto Carreño.

In addition to this, I had the opportunity to learn to ride a motorcycle by myself. This blue motorcycle served to move me around the town and also to go to those farms where I made connections to hold some of my interviews. However, I visited five farms, each developing different crops. The rest of my interviews I conducted in different places around the town, including open cafeterias with loud music.

3.3.3. Interviews

The process of collecting data from interviews and observation took place in May 2011 in the capital city of the Vichada department: Puerto Carreño. These interviews were conducted with indigenous leaders and farmers who are currently using the land (a factor that allows them to have a point of view about climate change). The interview guide (Appendix A) was structured in order to answer the research questions listed in the introductory section.

The design of the interview was open and very open to new comments, where new questions were conducted according to the level of knowledge and experience that each interviewee presented. The main 15 questions were generated in agreement and discussion with the supervisor, Dr. Debra Davidson. These questions were structure according to the objectives and research questions established on this research project. Some characteristics of the community were evaluated as well in order to generate the interview guide.

3.3.4. Visual Evidence

As an additional type of data collection, photographs were taken in order to have visual evidence to support the data gathered with the interviews. The use of a visual method “allows us to extend our research to incorporate knowledge that is not accessible verbally” (Pink, 2004, p. 361). However, visual evidence is a backup of the information provided

during the interviews by the interviewees. Also, visual evidence is another form of gathering information.

According to Gibson & Brown (2009), an observation analysis is different from a field note (in this case, the visual evidence) as it concerns observations that are recorded about the data (about the field notes) in a separate document.

3.4. Sampling Methods

The sampling method used to collect the data was referral sampling, known as snowball sampling (Trochim, 2005). However, a first and key contact for this project was Alejandro Siblezs, from Omacha Foundation. His relationship with natural conservation allowed him to identify the potential participants that were needed for this project. Once Alejandro was identified, the first five potential interviewees were referred by him. After entering in contact with the first five participants, the second round of participants were referred not only by the first participants, but also by new contacts from Alejandro Siblezs. His rule on establishing contacts for the project was crucial and proactive during the development and after the interviews.

3.5. The Interviews

From the interviews collected, most of the people showed a special interest in contributing to the research. Also, in some cases, some

interviewees had conversations after we were done, allowing me to understand and know more about the weather and, in general, about the natural cycles in Puerto Carreño.

Interviews with indigenous were conducted inside Puerto Carreño (some of these in ORPIBO, others at Etnollanos foundation). It was necessary at different occasions to travel a couple of hours and more by motorcycle to be able to collect data from some farmers. At the same time, the opportunity to go to the field allowed me to take some visual evidence (pictures) of the forest plantations, native species, foreign species, soil characteristics, and, in general, pictures of the landscape of the basin around Puerto Carreño.

3.6. Description of the Data Analysis

Collected data was analyzed using Nvivo 9, software that helps to analyze both qualitative and quantitative data and organize the information using a coding methodology. This tool was chosen because it helps organize documents such as interviews and photographs, facilitating the coding process of the 16 interviews conducted.

4. FINDINGS

Climate change has become one of the most significant and important topics of discussion for governments and scientists around the world, and also a big concern of many citizens around the globe, especially those who already suffer from the changes that this phenomena brings. Some recent observations in Puerto Carreño are consistent with climate change impacts that have been forecast for the Orinoco, including flooding, alteration of the rainy season, uncomfortably high temperatures in some places and cold temperatures in others, and other changes at a global perspective such as new epidemics or diseases--not only at the human level, but also at the fauna and flora levels.

There remains a large gap between the high levels of understanding and agreement among climate scientists and non-scientific groups, with large minorities in several regions who are either unclear about the causes and consequences of climate change and/or are skeptical of its human causes. In either case, the consequences are inaction in both mitigation and adaptation. In the case study of Puerto Carreño, both communities (indigenous people and farmers) expressed a diversity of interesting opinions about what is happening with the climate, how it is happening, who is responsible for these changes, and why it is happening. To analyze these different perspectives in depth, it is necessary to analyze the perspectives of members of each user group about climate change in

Puerto Carreño and about the new economic activities in the area, such as new carbon forest plantations. All the data presented below are derived from interviews and visual evidence collected in the field in the rural areas surrounding Puerto Carreño.

4.1. The participants

Sixteen participants were interviewed for this project, including males and females from two land user groups: indigenous peoples and farmers. Between the two groups, there were four women and 12 men. Most of the participants had university degrees, while others (only 2 of the 16 participants) had no education. According to the 2005 census, 7.7 % (1137 individuals) of the total population in Puerto Carreño attended university; thus our eight participants who possessed a university degree only represent 0.70% of the total university educated population in the area. On the other hand, 13.2 % (1949 individuals) of the total population had never attended any kind of education program. In other words, the two non-educated participants represent 0.10% of the non-educated people in the municipality of Puerto Carreño.

Table 4-1 summarizes current issues raised by the participants, what changes have they begun feeling, and what do these communities think about climate change, forest industry, and the effects of these on their lifestyle and culture.

Community	Farmers	Indigenous
Land Use	Forestation • Plantation with the use of technology • Use of local labor • Use of fertilizers • Composting processes • Burning inside the farms Cotton • Use of local labor • Use of vegas (places where the river floods and leaves nutrients once it is back to the regular flow) Natural Reserve • Preservation of native species (fauna and flora) • Protection of body waters Farmers in General (livestock, plantain, yucca, etc) • Use of vegas • Composting processes • Burning inside the farms • Access to technology	Forest livelihood • Use of vegas • Fishing and hunting from the natural environment • Composting processes • Burning of the forest inside their territories • Constraints on ability to migrate around the Orinoco basin in order to have access to different types of crops • Spirituality
Changes in the Region	• Last summer was shorter than previous summers • Stronger winds in previous year • Rainy season is currently longer • Rainy/dry seasons are not continuously on the same cycle as previous years • Loss of crops because of weather variation • Temperature has been increasing • New epidemics (thrips) appeared after introducing foreign plants	• Rainy season is currently longer • Rainy/dry seasons are not continuously on the same cycle as previous years • Loss of crops because of weather variation • Higher temperatures
Perceived Reasons for Climate Change	• Accumulation of gases in the atmosphere from industrialized countries • Natural process of the earth • Too much burning in the plains • Human activities such as burning fuel fossil	• Too much burning in the plains • God's punishment
Thoughts about Forest Plantations	• Good because are generating new soil • Good because animals migrate to these forested areas • Not good because there are no studies about the consequences of changing the landscape from plains to a forest area • Not good because these plantations bring new epidemics to the native species • The species introduced demand higher consumption of water, decreasing the water table in the region	• Not good because there are no studies about the consequences of changing the landscape from plains to forest area

Table 4-1: Summary of the participants' interviews from both farmers and indigenous communities.

The farmers and indigenous mostly perceive changes in the weather similarly. The increase of the temperature and the variation of the rainy/dry seasons are not on the same cycle as previous years. This is an important fact to highlight, as most of the farmers and indigenous people of Puerto Carreño do not possess enough knowledge to really know or understand what climate change really means. However, they are able to identify the local changes in the weather. Something curious and important to add is that people in Puerto Carreño expect a large flood every 10 to 12 years in the town, so flooding is not an abnormal event of the climate in this region in this period/cycle.

The next section will provide what climate change and forest plantations mean for these two communities. The end of this chapter will provide an overview of the adaptive capacity identified from the interviews and discussed by the participants.

4.2. Farmers' perspectives

The farmers' communication skills enabled them to express the community's concern about what is happening with the weather (separate from discussions of economic factors). Below are some of the farmers' thoughts and comments extracted from the interviews and filtered by Nvivo 9, the software used to analyze and organize the qualitative data in this research.

4.2.1. Climate change: impacts on the community, the environment and the economy

In Puerto Carreño, those inhabitants who are most sensitive to changes in weather and ecosystems that can be attributed to climate are those whose livelihood is derived from land use activities, primarily the farmers.

Changes in the regular periods of the rainy and dry seasons have begun as challenges for those farmers who directly depend on the regular cycle of these seasons. On the other hand, the inhabitants of Puerto Carreño are used to the floods caused by the Orinoco River every year, and they are always ready to face this natural phenomenon. Curiously though, they feel that the local and national governments do not do anything in response to this situation because people already know how to deal with these natural floods. The comment below is representative of what people in general think about the flooding episodes in the city:

> This is a quiet, low-key community. People here don't dwell a lot on the future. If you say to those who have houses on the edge of the river, "The river is going to flood," they will say "Just wait until it comes. We will get a canoe (interview 3).

To the extent that this sentiment is widely shared, community residents are unlikely to take pro-active steps to adapt to the impacts of climate change. As climate change progresses, the Orinoco River will flood more and more of the surrounding areas of Puerto Carreño, leaving behind

more vulnerable people every year (refer to chapter 1, section 1.5 to find out what the IDEAM estimates will be of the main impacts of climate change in the Orinoco region). Figure 4-1 illustrates a view of the Orinoco river in May 2011 where a local port is located. This port is key for the transportation of the communities around the Orinoco region.

Figure 4-1: Orinoco River at the Puerto Carreño's port.

In addition to this situation, the increase in the temperature is considered as a change in the weather in Puerto Carreño as well. Many native crops are sensitive to changes such as temperature, humidity, or precipitation. For local farmers who depend on their equilibrium, changing at least one of these meteorological variables will be a catastrophe for their economy and those people who are supported by the crops.

Some people have already noticed that the rainy and dry season are not the same anymore. Also, they have experienced an increase in the wind, making easier the invasion of non-native species to the natural

ecosystems of the region through seed dispersal. In addition, the change of regular cycles (dry and rainy season) means that the plants have to adapt to the new weather conditions, but this is not an adaptation of one year: it could take hundreds or thousands of years.

For example, the cashew tree is a native species of Vichada, specifically in Puerto Carreño. This crop is immune to most of the natural epidemics produced in the savanna's ecosystems and to the extreme weather of the region. However, there is a concern from the farmers who sow these trees. This is what one farmer said about his cashew crop:

> This year was bad for us because the humidity at the beginning of the summer was very high and we had unexpected rain. The rainy cycle affected our crops. But when we talk with the technicians, they tell us they can't predict the rainy cycle, whether next year the winter will be longer again, or whether there will be another unusual cycle (interview 78).

As mentioned, the weather in Puerto Carreño has already begun to change. There is a reality for the local farmers, but in addition to this, as a result of the changes present in the region come new issues to the community: diseases. It is not a secret that epidemics such as yellow fever, dengue, etc., are present in tropical regions. In this case, change in the weather means an increase in these diseases.

From the participants' and locals' points of view, communities such as indigenous, displaced and low income are more prone to getting tropical diseases. Unfortunately, these kinds of communities are located in high risk areas. According to the Major office of Puerto Carreño in a 2010

report, 46.6% of the city's inhabitants live under poor conditions (including Indigenous and displaced people):

> We can see that tropical illness such as dengue and malaria are expanding faster. According to the literature I read, this is because of climate changes caused by global warming. These communities here, such as the indigenous or displaced people, they are more vulnerable to these illnesses (dengue, yellow fever, and malaria) (interview 1).

On the other hand, climate change is not only affecting the natural ecosystems in the region and the communities but also the economy of those who depend directly on the weather to be able to produce or develop crops. However, it is important to recall that the flooding episodes in Puerto Carreño are not as a result of climate change but could be altered by it.

Puerto Carreño's economy depends on the agriculture and, for this reason, a significant change in the weather will affect crop productivity and the traditional ways people use to manage the land in the area. Also, there may be a significant change in the kind/type of crops that are suitable to the region (refer to chapter 4 for further discussion).

4.2.2. New economic activities: impacts on the community, the environment and the economy

Forests activities in Puerto Carreño are relatively new, becoming one of the high income activities for the town of Puerto Carreño and the department of Vichada. Behind this activity, there are other economic

activities in the immediate area, such as livestock, cotton crops, ornamental fishing, mining, and oil exploration (this last one is a new economic activity in the area). For these activities, different than forest plantations, there are many other concerns about the effects of introducing non-native species to the region. Nevertheless, the forest engineers working in the forest industry in Puerto Carreño know that foreign species may impact the soil, water table, underground water reservoirs, and also bring diseases such as fungus. However, many of these forest plantations have a clear objective: to contribute to the reduction of the greenhouse gases responsible for global warming and local climate change. Figure 4-2 shows some of the already afforested areas in Puerto Carreño.

Figure 4-2: Introduction of the Acacia to the Orinoco Plains.

At least one of the active forest engineers in Puerto Carreño expressed concern about the introduction of new species without having conducted research about the risk/benefits, such as the potential problems for native

species, especially those that are vulnerable to minimum changes in the immediate environment:

> Here, what is used the most is the Acacia Magnum and I think eucalyptus. We're talking about trees native to New Guinea and Australia, and about bringing them to an area like this, which is dominated by natural grasslands. The only problem is that the natural forest in this area is the gallery forest, which is made up of small bands of trees alongside the rivers and creeks, and not by non-native species, which might bring many pests to the native species (interview 10).

Forest engineers who participated in the project agreed that introducing non-native species into unique ecosystems will generate pest invasions for the native species.

In the case of the eucalyptus, some other farmers not related with forest plantations are convinced that this specie of tree deteriorates the soil structure. Also they argued that the eucalyptus demands high levels of water per day that then results in a lack of water for surrounding native species. There is also a concern about fungus and pests brought by the introduction of the non-native species, fungus for which, according to one of the participants, agronomists have not been able to find a cure. Some locals are quite concerned about the introduction of non-native species: “Even the acacia is a tree that sucks [consumes] a lot of land, and I've heard that the acacia produces a fungus that the agronomists haven’t figured out how to handle” (interview 2).

From the farmers’ point of view, the forestry plantations are mostly harmful to the native eco-system. The comment below presents a

particular thought about forest plantations coming from one of the farmers interviewed:

> They are growing, for example, acacia, pine, and eucalyptus. This is more profitable for the [short-term] economy, but [the farmers are] not thinking about the future. After the trees were planted and grew, people came with chainsaws, cut down the trees, and the whole process had to start again. The only thing I have to say is that after pine and eucalyptus trees have been planted, the land becomes weak and infertile" (interview 2).

For other participants, the idea of planting trees to reduce gas emissions (carbon sequestration) is no more than a commercial strategy to defend the industrial sector. In Colombia, forest plantations to reduce footprints are not legal yet. However, the forest industry is acting based on the commercialization of timber rather than selling carbon credits. As expressed by local farmers in Puerto Carreño, it is necessary to conduct research to find out the consequences of planting non-native species in the savannas of the Orinoco region:

> The Brazilians say, "Here the forest can have only eucalyptus and pine." The Spanish say, "Nature made the soil here for the acacia, so only acacia should be planted here." People say that in Australia, the acacia destroyed the soil. If this species destroyed the soil there, and we know those results, then knowing that it didn't work there, why would we do it here? If it was savannas, it was savannah for something, and jungle was jungle for something (interview 16).

Figure 4-3: Typical grassland landscape of the Orinoco Plains.

Only one of the farmers interviewed agreed with the forest plantations in Puerto Carreño. Figure 4-3 illustrates how the landscape of the Orinoco region looked before intervention took place. According to this participant, forest plantations in the savannahs not only generate organic material for the soil but also generate life, bringing new species of animals (migration) from other parts, including deer, birds, and others:

> Forest plantations are better for animals because even though the weather is so hot in the summer, the animals have plenty of shade. Other species also migrate, for example, deer. For the soil, the forest plantations have to be like food for the soil. Yes, establishing these plantations would guarantee an increase in soil nutrients (interview 6).

It is important to highlight that this participant has been living in a farm environment all his life. He does not possess education, which limits the knowledge of the consequences of having invasive species in defined ecosystems (Refer to the beginning of this chapter in section 4.1 to find

more description of the participants). Figure 4-4 shows the topsoil in the region where the non-native species had begun growing.

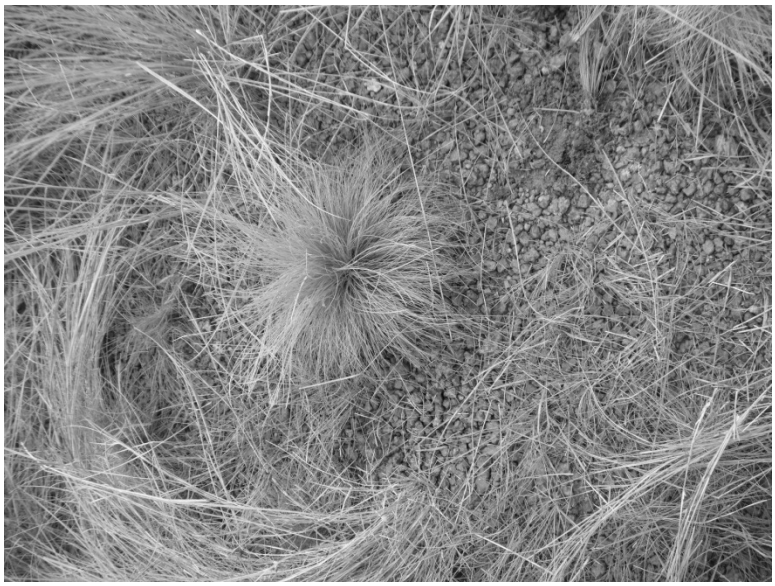

Figure 4-4: Topsoil and typical grass in the surrounding areas of Puerto Carreño.

On the other hand, in terms of the economic benefits for local inhabitants, these forest plantations became the solution for lots of families not only in the rural area of Puerto Carreño but also in the Vichada's department. Some farmers recognize that by opening these industries in the region, jobs and development finally came to this part of Colombia, which had been abandoned by the government and possessed by antigovernment army groups such as Farc, ELN, and Paramilitaries. Fortunately, the territory has been under the control of the Colombian Force Army since 2004, under the government of Alvaro Uribe Velez, who was the president of Colombia from August 7, 2002 to August 7, 2010.

In the case of the local and traditional farmers in the region, it is true that they are thankful because peace returned to the town. However, they disagree with the forest plantations no matter that these industries continue growing and bringing development to the region and are planned to be a solution to reduce greenhouse gases. Their biggest concern and what these traditional farmers are wanting is for the government to conduct research in order to find what kinds of species are good to introduce to the region. Some of these famers are concerned about the potential consequences of non-native species in the area:

> We are concerned about the impact that these plantations will have on riverbeds or forests if we do not regulate soon; they can become a breeding ground for pests. For example, we have yet to determine, if the population of **thrips** [forest pests] in the savannah is a result of the introduction of foreign plantations. We cannot know for sure because until last year, foreign plantations did not exist (interview 78).

However, the consequences of having foreign species in the Orinoco basin is not yet known, but for now, some of the land use farmers are sure that these plantations carry significant consequences for the region.

4.2.3. Adaptive capacity

As described in the Literature Review section, adaptive capacity is defined as the ability to adjust in form and/or function in a manner that increases the resilience of the system in response to changing conditions. For the farmers' community of Puerto Carreño an adequate resilience to climate change is measured by their accessibility to technology, which

relies on larger or easier access to investment capital. For the farmers, adaptive capacity relies on the tools offered by the region and by the government. To be able to identify the adaptive capacity for the local farmers in Puerto Carreño, it is important to recall what Wall and Marzall (2006) suggested which is to identify the variables and indicators for each measurement and after establish whether or not the community has potential for adaptive capacity.

4.2.3.1. Tools

Some of the farmers interviewed argued that in order to have greater success in agro-business, it is important for the government to create insurance that covers crops, harvest, and products in general from unexpected phenomenon, which follows what Smit and Wandel (2006), Wall and Marzall (2006), and Williamson (2010) suggested as key elements for adaptive capacity. In general, farmers described their adaptive capacity tools to face climate change as follows:

- The diversity, quality and quantity of ecosystems that are found in the Orinoco region
- The security that the government is offering in the region (safety)
- Access to loans such as “Agro Ingreso Seguro” to improve the crops and the economic assets growing in the region

- The strategic location that Puerto Carreño has, which allows local farmers to export the products in an easier way to other countries such as Venezuela
- The high level of awareness of climate change and its potential impacts

However, farmers in Puerto Carreño are concerned about what climate change is going to alter, how the crops are going to react to new weather conditions and how the government is going to help those who have small farms.

4.3. Indigenous communities' perspectives

The indigenous communities in Puerto Carreño are very friendly, but at the same time very hesitant to share some of their thoughts. However, according to the information extracted from the interviews, this community is more concerned about their security and their economy than what is happening with the weather, although they recognize something is happening with the climate.

4.3.1. Climate change: impacts on the community, the environment and the economy

One of the biggest changes that people around Puerto Carreño, and in general around the world, have begun feeling is in the temperature. For the indigenous that remain in the field, factors like the temperature, precipitation, and drought are the most important factors to sow and harvest their crops. Also, these factors are important for those groups who are still living under nomadic culture. They relate changes such as the temperature as God's punishment. This is because, according to them, there has been an abuse of the natural resources, especially by exploiting fossil fuels. However, they do identify other sources that might contribute to these changes in the temperature, such as the industrialization in developed countries and fossil fuel consumption. A key concept about how indigenous people have been able to identify these changes was presented in one interview:

> Indigenous people are conscious about everything. Why? Because indigenous people have their ecological cultural calendar, which accounts for everything. Each indigenous town, in its own idiosyncratic way, notices the cycle, the changes in the river, the animals. This means that these towns have spent millions of years observing nature and the environment and, therefore, they are obviously aware of any changes in the environment because of their knowledge and cultural practices (interview 5).

From this thought, any single change in the weather means a change in the indigenous people's calendar, which explains why this community is concerned and aware of the changes that have been happening in the weather.

As mentioned before, indigenous are concerned about their security; they are concerned about their safety in the rural areas; they are concerned about their rights.

On the other hand, episodes such as flooding of the river are considered as a blessing of nature because the soil is improved. According to the indigenous, after each flood, the river enriches the soil with nutrients, making the land "alive to develop crops." This methodology will start changing soon because episodes such as the change in the cycle of the rain will affect the way that indigenous use the land after the floods. The next statement shows why the rainy and dry seasons are important for them:

> For example, the crops are finished because the winter was stronger and the river is dragging everything along as it flows downstream. For example, this month, we had to sow the corn in the flooding areas, but we didn't. Why? Because winter (the

> rainy season) started early and the river is rising up and we can't sow now (interview 14).

This kind of situation not only affects the economy, food security and livelihood of these communities located in Puerto Carreño (Sikuani and Amorua) but also begins altering the social structure of the communities by making them change their traditional ways to develop their agriculture methods or their livelihood. Figure 4-5 shows a typical animal used in the diet of the indigenous people in Puerto Carreño, which could be under risk to migrate due to the reduction of this kind of specie's natural habitat.

In addition, it is clear that a change in the environment will be present too. For example, change in the air quality or pollution present in the rain in southern Colombia results from air carrying pollutants mixing with precipitation causing acid rain. Other natural events identified in the Orinoco region are related with this acid rain:

> From one day to the next, certain parts of the forest just dry out, as if an acid rain had dried out those sectors. We can still see it in Bojanawi,. That happened last year; it just dried out completely from one day to the next. You would say that there were susceptible species and that it was the forest that had gone completely (interview 4).

Information about this phenomenon was in particular difficult to find since the scientists that were in the area were displaced by an illegal army back in 2004. However, the participant who shared this information assured us that there are documents in the Jorge Tadeo Lozano University, located in the city of Bogota.

Figure 4-5: Chiguiro - Capybara -. A mammal found in the body waters and rivers across the Orinoco region.

It is important to know what technology means to the indigenous in terms of facing climate change. What role does western scientific and technological methods have in the adaptation process of climate change, and what role does the knowledge of these indigenous communities have in adaptation? It is a question that is not easy to answer since the ecosystems where the indigenous are located all over the world are different. An answer to this question could be:

> I always think that there are valid ideas as well as disastrous ideas. The indigenous connection to the earth is strong and the ones who grow crops and work the land have certain beliefs, practices, and established methodologies that are a strong part of their cultural knowledge. I can't say that they are less professional than an environmental engineer. Maybe, I don't know, they [have some ritual where they] light a candle, thinking that it will keep the rain from falling. Since I know them, I don't think they are less professional than the ones who come up with a hydraulic solution for the rain and implement it. I think it's all the superstition inside each person. I think the success is right there, in knowing how to connect any marvelous imposed solution to their culture. If

> the people who wash the clothes don't understand how to use the hydraulic solution, then it will just be a beautiful monument that worked a couple of times. (interview 5)

By taking this piece of interview as evidence, we will be able to reflect about how important and appropriate are the methodologies used by these groups: for the farmers, chemicals and machinery will increase the production; on the other hand, gathering food from the natural environment by not disturbing the soil and ecosystems, by praying and conducting rituals, as the indigenous do, nature will give better results and better opportunities to adapt. It could be a mystery, but after scientific knowledge, traditional knowledge is considered one of the most powerful tools to explain and address natural phenomena.

4.3.2. New economic activities: impacts on the community, the environment and the economy

After having the experience to visit Puerto Carreño, it is easy to identify that this city has a lot of people coming from all over Colombia, including the indigenous communities (especially the Sikuanis and Amoruas). These communities are located not only in the urban areas but also in the rural areas. Indigenous people are catalogued as the first settlers in the Colombian Orinoco, independent of being a nomadic or a sedentary group.

Indigenous' culture from Puerto Carreño is based on artisanal activities such as fishing, hunting, sowing, and, in some cases, mining. However,

these traditions have been losing importance because of other external factors rather than simply climate change: conflicts.

Today, indigenous people already displaced feel afraid to go back to their territories because of the fear of being killed by illegal groups that operate in Vichada. Also, these communities feel betrayed by the national government. It is true; forest companies have been gaining more and more territories in the last 6 years in Vichada, especially in the rural areas of its capital city, Puerto Carreño. However, the term “betrayed” is used in this chapter because the indigenous people say, “by the government providing more territory for the foreign companies, it means, less territory for our ancestral traditions” (refer to chapter 1, section 3.3. for information related about this allegation). As a result of these displacement modes (violence and forest plantations), some indigenous communities of the Orinoco decided to move to the urban area of Puerto Carreño:

> That is not our tradition. We are not used to seeing all those Gringos with guns, who don’t let us move around the land. We are not used to that, nor are we used to having guns pointed at us. (Interview 14)

This problem related to violence is not new. Before, landowners used to put too much pressure on the government to limit the indigenous access to their lands. This is because nomadic indigenous used to hunt and find their food in the areas that have changed from being a forest or savanna to farms. As a result of being in an isolated and remote area separated from civilization in Colombia, farmers started killing those indigenous that

used to go and hunt in the new territories made up of farms owned by non-indigenous (refer to Chapter 1, section 1.3.3. for information about this allegation). For the indigenous people of Puerto Carreño, “white people” are considered those people who are not “100%” indigenous.

However, the transformation of the natural ecosystems into farms or forest plantations does not have the approval or the consent of the indigenous communities in the Vichada. This is considered a weakness of the Colombian law in terms of defending the indigenous’ rights (based on the information collected from the interviews with the indigenous leaders). In discussions about forest plantations, it is clear that this kind of activity will change traditional ways of developing the cultures:

> I do not think that they are bad. However, if we talk about ancient cultural patterns, then they might be bad because they abruptly disrupt with a whole new culture surrounding those savannahs. It is not that we have to be against development in the country; it is just that, as I said before, those solutions are introduced before there is enough ecological knowledge about the area (interview 5).

According to this person, forest plantations are going to be not only a problem for the tradition of the indigenous in the region but also may alter other aspects in the area such as economy, education, or land use. This idea is supported by others, such as this indigenous leader:

> The impact is not just environmental, no! The impact is also felt in the ecological, social, and cultural parts because it is changing the traditional behavior constructed by a town. We are talking about hundreds of years, right! (interview 4).

In this sense, forest plantations are having an impact on our three components evaluated from the indigenous' point of view about the plantations: economic impact, social impact, and environmental impact. However, curiously, a participant said during the interviews that "later on, those plantations will affect the environment because they need a lot of chemicals. At the same time, the plantations will be magnificent because they will generate jobs for us" (interview 15).

When the indigenous were asked about the consequences of the forest plantations in their environment, all of them agreed that they will damage nature: the use of chemicals and the introduction of new species to the region are not going to be good to the environment, especially because they say "savanna is savanna and forest is forest" and, if God decided to have the landscapes how they were from the beginning, it is for a reason. This was expressed with energy by the President of ORPIBO: "The plantations are going to affect us because the trees are brought from other countries and also, the trees require minerals: they are not like the ones that God created in the natural forest" (interview 12). Figure 4-6 and 4-7 shows the Moriche Palm which is native to the region and also, the fruit of this palm is used by the indigenous people and locals for consumption. As a result of new economic activities, indigenous people have been finding it hard to get the fruit of this palm since the territory where they gather food has been reduced by new economic activities. In other cases, the indigenous people and the farmers showed concerns

about the impacts of the new economic activities such as the forestry for this kind of palm.

Figure 4-6: Perspective of the Moriche Palms on the Orinoco region

Figure 4-7: Having a closer look to the Moriche Palm's fruit. Left: Wayne Crosby. Right: Julio Arregoces

Many people believe that indigenous do not have any kind of knowledge and, in Colombia, as in other countries, indigenous are

synonymous with laziness and alcoholism (from general comments shared by local farmers and community in general). From this concept of the general population, true or not, it is clear for the indigenous people that transforming the natural landscape of the savannas into forest areas will affect the environment, the ecosystems, and will bring as they say “weird stuff,” leaving behind their traditional knowledge, traditional methods of livelihood and their potential for an adaptive capacity to climate change.

4.3.3. Conflicts

A third episode of vulnerability expressed by the indigenous people of Puerto Carreño is the fact that the conflicts generated by the illegal groups in the Orinoco region have displaced them from their aboriginal territories. The threat of violence forced them to migrate and set up in the urban area of Puerto Carreño (refer to chapter 1, section 1.3.3. for details on current issues of the indigenous communities in Colombia). At different times, indigenous people expressed their biggest concern about the conflicts and violence. They argue that, in most cases their capacity to reduce vulnerability is measure by the ability to interact with nature as they used to do. According to them, this interaction is no longer available for those who had been displaced to the urban area of Puerto Carreño. Figure 4-8 refers to the housing system of the indigenous and displaced people in the urban areas of Puerto Carreño. In this picture, it is evident that these displaced communities try to develop their own crops to gather as much

as possible their livelihood from it, but the space in which these communities try to keep their traditions is very limited.

Figure 4-8: Improved house used by displaced people in Puerto Carreno.

4.3.4. Traditional knowledge/culture

According to the indigenous leaders who agreed to participate in the research, the conflicts for the appropriation of land between the illegal or anti-government army groups, new economic activities and the national government (represented by the national army) have generated a decrease in the practice of their traditional knowledge, livelihood methods and culture, which are considered essential for their adaptive capacity (for example, A. Nyong et al. 2007 and Speranza et al. 2009.), not only for this community, but also for the farmers:

> If we go to the countryside, to the village where we used to live, we are not going to be the way we used to be. Why? Because you should know that there are too many illegal army groups. So if we see that out there, we are not going back to

> the countryside. That's why we look for solutions here inside the town (interview 13).

Such conflict with illegal army groups is the major concern for indigenous groups. In being displaced to the urban areas, they cannot practice traditional knowledge, reducing their ability to be able to adapt to climate change. In other words, the resilience that displaced indigenous people possess to adapt to climate change is breaking down.

4.3.5. Adaptive capacity

When the indigenous people who participated in the project were asked if they were doing something in terms of adapting to climate change, the general answer was no. They argue that changes in the weather conditions have become unusual for them only in the last year (between summer 2010 and summer 2011). Also, this community argues that new economic activities such as oil exploration and forest industry are still new, so they have not been able to measure the specific impact which could be good or bad for their communities:

> There, in the community where I am coming from, I went back after 12 years of being here in the town, and the other indigenous people that remain in that village, they are still using the same techniques, without chemicals. But it will start changing after this past year, since the dry season is not the same (interview 15).

So far, at this point it is easy to identify what kind of adaptation strategies have been adopted by the indigenous communities; these will be discussed in the next chapter.

Ideally, it is necessary an independent agency to assure the rights to the indigenous people and the farmers ground. At the moment, among the two groups, there is only one agency (ORPIBO) protecting the rights of the indigenous people, but as this group expressed during the interviews, their voice through this agency has not been listen by the local or national government. Their political influence is still under significant importance for the national government. Discussions about this issue are presented on section 5.2. (building adaptive capacity), where a recall to the national and local government support is made in order to reduce vulnerability in the face of climate change.

4.4. Land use innovation in both communities

Although the weather had already begun to change in the region by the time the field work was conducted, the farmers and indigenous people had not yet responded to the climate change with land use innovations. However, there is a potential for local farmers and maybe for the indigenous people to learn from the forest industry, which has been introducing new technologies in the region. Indigenous people and

farmers communities argued that the reason for not making an effort to adapt to the recent changes in the weather is because these extreme weather conditions have not been present in the region in pass years: “we haven’t done anything in terms of modifying our traditional land management because as I told you before, this is a new phenomena for us” (interview 12).

If changes in the region continue as estimated by IDEAM, then these two communities might be facing an adverse change in their traditional and current land use/management in order to succeed in the process of adaptive capacity.

4.5. Summary

Farmers and indigenous people have started to become aware of climate change. Its impacts are a concern to these two communities, the same as the impacts that the growing industries in the area might bring, especially the forest industry. Table 4-2 presents a summary of these impacts (where these communities feel vulnerable or not) that were taken from the interview analysis.

Community	Farmers	Indigenous Peoples
Climate Change	Instability of the weather • Affects the economy, food security, health and other risks in the region ie. strong flooding periods	Instability of the weather • Food security • Health problems ie. yellow fever
New Economic Activities	Forestry and mining industry • Impact on the soil structure, water table, the generations of pests, and emissions	Forestry and mining industry, farming • Threat to traditional knowledge and culture • Limit traditional ways to gather food
Conflicts	Low threat of violence • National army of Colombia repossessed the region	Displaced as a result of a decades of conflict • Do not feel safe in the natural environment • Established territory boundaries are against traditions
Adaptive Capacity	Tools for appropriate adaptive capacity • local and national regulations • research studies • local knowledge • security • financial resources (insurance)	Tools for appropriate adaptive capacity • local knowledge, aspects western science • community and the government acting in equilibrium with mother nature

Table 4-2: Summary of the vulnerability, impacts, and potential tools for adaptive capacity to face the impacts of climate change and new economic activities as perceived by the farmers' community and the indigenous people in Puerto Carreño.

5. DISCUSSION AND CONCLUSIONS

This last chapter integrates the defined theory with what the participants identified and defined as climate change, vulnerability to climate change and adaptive capacity to climate change. Discussion is based on what the participants' perspective is. However, I decided to integrated some of my own opinions to analyze what best describe the situation. At the end of this chapter, I will provide some conclusions and recommendations for future studies.

5.1. Climate Change and Vulnerability Episodes for the Participants

As discussed in section 3.1, Adger (2006) defines vulnerability to climate change as a characteristic of a system and as a function of exposure, sensitivity and adaptation capacity. Based on this theory, one of the biggest challenges for the two communities interviewed for this project (farmers and indigenous people) located in Puerto Carreño is the exposure to climate change since this has not been considered as a threat yet. Many consequences of this phenomena are unknown by most of the participants, especially by the indigenous people.

According to IDEAM (2007), an increase in the rain and in the temperature is expected for the Colombian territory, including the Orinoco region, leaving these two communities exposed to the changes mentioned before. As expressed during the interviews, most of the participants

identified and focused their biggest concern on the changes in the weather cycle. These cycles include the rainy and dry season.

Since the food security of the indigenous people (most of them) relies on gathering, hunting, fishing, etc, within on the natural environment of the Orinoco region, it could be possible that this community might be facing a transitory change in their traditional land use. However, how this community will improve their adaptive capacity to reduce their exposure and sensitivity to the climate change in their territories was not identified and/or expressed during the interviews.

In addition to the fact that the weather has already begun changing in the region, as discussed before, in their discussion of traditional leaders, Kronik and Verner (2010) suggest that when it becomes difficult to predict climatic conditions, such leaders who are normally seen as experts lose their authority and respect. Another vulnerability factor for the indigenous is the fact that they have been displaced by the conflicts in the Orinoco region (as discussed early in chapter 1, section 1.3.3. in current issues for the indigenous). As discussed by the indigenous and supported in the Alvarado document (2010), this displacement and conflict is not only caused by the illegal army, but also by the introduction of new economic activities in the region such as the forest industry. It is a delicate situation present in this research, but the solution to this conflict will be the key of the indigenous' adaptive capacity to climate change for a single reason: being able to practice their traditional livelihood pursuits on the land. If the

indigenous people that have been displaced to the urban areas of Puerto Carreño lose their interaction with nature, then the traditional knowledge that is crucial to those livelihood practices will be lost to upcoming generations, further exacerbating these communities' vulnerability.

In the farmers' case, changes in the weather's cycles (which are considered as the instability of the weather) mean instability for their economy, and for all local residents, an increase of epidemics such as yellow fever and malaria, and also a decrease of their food security, which is related in some cases to what local farmers are able to produce on their lands. As mentioned by some participants and by Vasquez-Leon (2009), institutional adaptations such as federal subsidies, disaster-relief efforts, and crop-insurance programs have buffered modern farmers to the point where they may feel only marginally vulnerable to a higher order of institutional support. It is clear that once there is support by government institutions, the adaptive capacity to climate change will be higher. For Puerto Carreño's farmers, this kind of support from the national and local government is not fully developed in Colombia yet. They argued that there are programs to subsidize the crops, but these are accessible only for larger farms and not directed to the small farming communities, which are the communities that need it to build a strong adaptive capacity to face climate change. Meanwhile this is what is happening in the national territory of Colombia. Small farmers such as those who are in the rural areas of Puerto Carreño are concerned and at the same time aware of

how to react to the changes in the weather since they do not count on these institutional tools.

For instance there were some farmers who expressed their experience with the instability of the weather. In one case, the early rain during the flowering process of the cashew tree had the consequence of damaging the flowers resulting in no production of cashews for the farm's 200 hectares. In another case, the early raising level of the Orinoco River flooding the cotton crops resulted in being unable to harvest the product. After these two cases happened, both farmers confirmed they did not get any subsidy from the government and still had to pay high rates of interest to the banks, from whom they got money to update their technology. Still, this community has the ability to have access to financial support which is a highlighted tool for the process of building adaptive capacity.

Finally, another vulnerability episode identified by the community, which is related to climate change, is the illegal arm conflict that Colombia suffers, more specific at the south and southwest of the country. This situation is related to the force migration or displacement that indigenous communities in general are suffering, where the alternative have been to find refugee at the capital cities of Colombia. In Puerto Carreño, this situation is not any different. The indigenous communities displaced to this city had expressed their vulnerability to climate change because of the fact that they are no longer interacting in what their traditional territories used to be. In summary, the armed conflict between the government and the

illegal armed groups had created a controversy inside the national territory in who is violating the human rights of the indigenous, if the government for economic interest or the illegal army groups for their own purposes. More information about this allegation can be found in chapter 1 under current issues section.

5.2. Building Adaptive Capacity

Based on the interviews and the information collected for the project, a number of tangible elements or tools are needed for building adaptive capacity in the community. Not yet discovered or fully utilized, these tools need to be shared with those who have not been able to identify these tools.

Early in the literature review (section 2.2.), Williamson (2010) suggested that the access to economic resources, technological options, infrastructure, institutions, wealth, inequality, educational commitment, isolation of rural communities, quality of basic infrastructure, political influence, willingness to invest in adaptation, and environmental sustainability measures are key determinants, indicators and measures of adaptive capacity. Some of these tools are there in Puerto Carreño but not yet in operation. The commitment of the governmental institutions is the first and most important step in the process to share these tools with those who need them the most.

In the case of the forest industry, these tools are stronger compared to those used by the indigenous people and local farmers. This is because the financial capital of these forest industries comes, in most cases, from outside of the country. In other cases, these forestry companies are related with multinational companies which ensure a solid financial backer. These types of supports allow the community related to the forest industry to have a higher adaptive capacity, but it does not contribute to inhabitants such as indigenous people, displaced communities, or even to local farmers, who are not among the local peoples who become employed on the plantations.

It could be possible for forestry companies to share information about green land management (such as new land use practices with less impacts) with the locals who are currently using the land, but it is still a cultural difference between the aboriginal and non-aboriginal people. For example, farmers argue that indigenous people likely to burn the savanna, but at the same time, indigenous people say that they protect the land from burning because it is not good for the soil, even for the fauna and flora, pointing out that the burning in the savanna is caused by the farmers. Working with little things such as these different opinions is how those who possess the adequate tools for adaptive capacity (such as the forest industry) will share their information.

Lastly, it is important to mention some of the measurements that the participants identified as key elements they own in contributing to their

adaptive capacity such as their composting processes, reducing the use of chemicals, and no burning of the forest/plains inside their territories (for ex. Williamson et al. 2010; Adger, 2006.). These methods adopted by the participants demonstrate the interest in, concern for, and awareness of climate change coming to the Orinoco region.

5.3. The Forest Industry for the Participants

For the participants, there were three main positive perspectives on the forest industry coming into the region: first, this new economic activity provides reinforcement to the development of the region; second, it generates employment for the locals; and third, the incursion of forestation into the dominant grassland landscape of the Orinoco region will result in generating new soil. This last comment is seen from one of the participants as one major benefit of what this activity will offer to the region.

Although unconfirmed, some indigenous people assured us that forestry landowners threatened them about going inside the forested areas. With such allegations, it is going to be hard for the indigenous people to accept the incursion of such an activity in the region. At the same time, both indigenous people and the farmers' community argued that there is no evidence or research of what the risks and benefits of the forest plantations will be for the region. Although there are some theories that might be helpful for these communities to know, "climate change

mitigation proposals focused on forests concentrate on reducing greenhouse-gas emissions by reducing deforestation and forest degradation and by promoting afforestation" (White et al. 2008, p. 290.).

On the other hand, there is a lot of speculation about forest plantations in Colombia. However, these activities are not yet certified as carbon sequestration operations in the country, which is one of the reasons why inhabitants want research on the consequences of the massive introduction of non-native species in the region:

> Forest companies are necessary for the development of the Vichada. The Problem that I see is that all these species grown here are non-native to the region. There are 46 native species which seen to be under threat by the non-native species. From these forest companies, none of them are certified. So what is the point of having something here that is not certified? One problem for example; do you know what is the evapotranspiration of an eucalyptus tree under these weather conditions? It is 300 liters of water per day. Also these plantations have a high density of trees per hectare which is between 1000 and 1300 trees, so how many liters of water do you need per day? It is necessary to conduct research to measure the adaptive capacity of these non-native species to the region (interview 9.)

The fact that there are lots of concerns about the impacts of the forest plantation on the native ecosystems in the region is one potential point that suggests the necessity of urgent research in terms of the benefits of the forest plantations. Also, it is important to conduct focus groups to discuss with the community the approaches and perspectives of the forest industry in the region.

5.4. Limitations of the Project

During the development of this research project, a number of limitations appeared. First, the fact that the field work was located in another country limited the access to the preliminary information to what the internet could offer at the time. Secondly, once in the field, a better panorama of the research was discovered, finding some inconsistencies in the literature provided by some websites such as safety for the research team, the overstated presence of indigenous people, the limited education of the population, and agriculture characteristics of the region. Therefore, once in the town of Puerto Carreño, the first impression of the research team was how safe was the area, surrounded by army bases that have control and keep in peace this unknown part of Colombia. Inhabitants in Puerto Carreño are not only from indigenous' communities, but also there are other kinds of populations such as mestizo (A mix between European and Indigenous people from the times of the conquest), and also black communities (the latter dated to the XV century during the Spanish colonization of Colombia and are now, all around the national territory).

Another limitation, and maybe one of the most important of all, was the collection of data in Spanish which has to be translated into English. During this process, it is impossible to keep the same meaning from the original interviews, a reason why the translation of the interviews into English took more time than normal. Some of the interviewees had no education and a limited vocabulary to communicate for two reasons: first,

because of a lack of education or because Spanish is their second language (in the indigenous people's case). However, most of the interviewees showed an interest in participating in the research. This project is considered to be the first of its class to be done in conjunction with the community in Puerto Carreño. The last limitation was the access to conduct interviews with indigenous. Indigenous people in Puerto Carreño are very friendly, but are also very private in relation to their thoughts and how they care for their community. For these reasons it was only possible to have access to leaders located inside the town. They did not approve of conducting interviews in the nearest reserves within the vicinity of the town.

5.5. Conclusions

The farmers' community and indigenous people in Puerto Carreño have begun to be aware of changes in the temperature and rainy cycles, becoming vulnerable, as they argued in the interviews, to these changes since their livelihood, economy and health are under threat of the root of these evidential changes in the region: climate change. As discussed before, the farmers' community and indigenous people have been practicing some essential principles in order to reduce their footprint such as recycling, composting processes to develop the crops, reducing the use of chemicals inside the crops, and no burning of the forest/plains

inside their territories. These are important values in both communities that are needed for building adaptive capacity.

Compare to the IDEAM reports and based on what this institution had estimated for the weather in the region, the participants were able to identify the changes estimated. This perception of changes in the weather has been considered as a proof of climate change present in the Orinoco region, Vichada Department and for the city of Puerto Carreño. These changes are related to the variations of the rainy season, the increase of the temperature, wind speed, and humidity.

The recent changes in the weather are the reason why these two communities have not been active in looking for changes in their traditional ways of land use. However, at the time of the field work, the participants expressed that if the weather changed again for the next rainy and dry season, then they might start looking for some alternatives in order to keep their traditional methods of land use, or at least modify them to adapt to the new weather conditions.

A final conclusion suggests the forest industry can be defined as a development tool for Puerto Carreño, but it does not mean the natural ecosystems of the Orinoco and their functions have to change. However, this new economic activity is seen as a threat to current activities of the participants since they have identified potential impacts from these activities in the region such as changes in the water table, high

consumption of water, pests' epidemics, and displacement in the case of the indigenous.

5.6. Recommendations

It is important for the government to regulate and promote research to find the answer that the participants are looking for regarding the benefits and risks of having forest areas based on foreign species in the Orinoco ecosystems. Since the development of the forest industry is considered as a potential activity for the development of the economy in the region, it is important to establish guidelines and a practice policy in order to regulate the land uses in Puerto Carreño and in Vichada Department in general.

It is responsibility of the government to start using the tools that have been built in the Vichada department to face climate change. In case the local government has not developed any measures, it is necessary to recall the attention of national and local government institutions to start developing and sharing policy, and strategies to decrease the degree of vulnerability to climate change in the region, not only for the participants, but also for the 14.767 inhabitants present in Puerto Carreño and increase the degree of adaptive capacity to climate change.

Since the participants have potential tools to respond with appropriate adaptive capacity to climate change, it is important to review these tools and show them how to take advantage of them in order to succeed in the process of adaptation. It is necessary to conduct research in exploring the

current and potential adaptive capacity tools possessed by the inhabitants in Puerto Carreño and how to start practicing these principles.

Finally by conducting this research project, the author gained the experience of getting to know that indigenous people deserve respect and need to be included in national decisions made by the government. It is not right that communities with hundreds of years of living in the Orinoco's savannah have to leave or migrate because the industrialization found a new place to expand its businesses or because illegal army groups want the indigenous territories for their own purposes.

6. REFERENCES

Adger, W. N., 2006. Vulnerability. Global environmental change 16: 268 – 281.

Agrawal, A. (2008). Local institutions and adaptation to climate change. Social Dimensions of Climate Change: equity and vulnerability in a warming world. 11: 173-197. Robin Mears and Andrew Norton, Editors. 2010.

Alcaldia de Puerto Carreño. Economy of Puerto Carreño. Wed site: http://puertocarreno-vichada.gov.co/nuestromunicipio.shtml?apc=myxx-1-&m=f. Last updated: July 21, 2010.

Charles L. Redman, J. Morgan Grove, and Lauren H. Kuby. 2004. Integrating social science into the Long-Term Ecological Research (LTER) network: social dimensions of ecological change and ecological dimensions of social change. Ecosystems 7: 161-171.

Creswell J, Hanson W, Clark Plano V, and Morales A, 2007. Qualitative research design: selection and implementation. The counseling Phychologist 2007 35: 236.

DANE – Departamento Administrativo Nacional de Estadísticas. 2005. Reporte censo 2005.

DANE – Departamento Administrativo Nacional de Estadísticas. 2007. Colombia, una nación multicultural: su diversidad ética.

Etkin D, Haque E, Bellisario L, Burton I (2004). An assessment of natural hazards and disasters in Canada. The Canadian natural hazard assessment project. Public safety and emergency preparedness Canada and environmental Canada, Ottawa.

Few R, and Tran P. 2010. Climate hazards, health risk and response in Vietnam: Case studies on social dimensions of vulnerability. Global environmental change 20: 529 – 538.

Füssel Hans-Martin, 2006. Vulnerability: a generally applicable conceptual framework for climate change research. Global environmental change 17: 155 – 167.

Gibson William J. & Brown, Andrew 2009. Working with Qualitative Data.

IDEAM – Instituto de Hidrología, Meteorología y Estudios Ambientales. José Franklyn Ruiz Murcia, main researcher 2007. Escenarios de cambio climático, algunos modelos y resultados de lluvia para Colombia bajo el escenario A1B.

Instituto de Investigacion de Recursos Biologicos Alexander Von Humboldt, 2009. Colombia, Diversa por Naturaleza.

Kremen, C., 2005. Managing ecosystem services: what do we need to know about their ecology. Ecol. Lett. 8, 468-479.

Kronik Jakob and Verner Dorte. 2010. The Role of Indigenous Knowledge in Crafting Adaptation and Mitigation Strategies for Climate Change in Lating America. Social Dimensions of Climate Change: equity and

vulnerability in a warming world. 11: 277-301. Robin Mears and Andrew Norton, Editors. 2010.

Lachland Kenneth, Burke Jennifer, Spence Patric, and Griffin Donyale, 2009. Risk perceptions, race, and hurricane Katrina. The howard journal of communications, 20: 295-309.

Montada, L., Kals, E., 2000. Political implications of psychological research on ecological justice and pro environmental behavior. Int. J. Psychol. 2, 168-176.

Nyong A, Adesina F, and Osman Elasha B, 2007. The value of indigenous knowledge in climate change mitigation and adaptation strategies in the African Sahel. Mitig adapt strat glob change 12: 787-797.

ONIC – Organización Nacional Indígena de Colombia. Web site: http://www.onic.org.co/. Last updated: August 2010.

Parkins, John and MacKendrick, Norah 2007. Assessing community vulnerability: A study of the mountain pine beetle outbreak in British Columbia, Canada. Global environmental change17: 460 – 471.

Peguero, Anthony A. 2006 Latino Disaster Vulnerability. Hispanic Journal of Behavioral Sciences 28: 5 – 22.

Pelling, Mark 1998 Participation, Social Capital and Vulnerability to Urban Flooding in Guyana. Journal of International Development 10: 469 – 486.

Pink, Sarah (2004) “Visual Methods” In Qualitative Research Practice, Clive Seale et al., eds. London: SAGE. P 361 - 376.

Redman C, Grove J, and Kuby L, 2004. Integrating social science into the long-term ecological research (LTER) network: Social dimensions of ecological change and ecological dimensions of social change. Ecosystems 7: 161 – 171.

Ricketts et al., 2008 T.H. Ricketts, J. Regetz, I. Steffan-Dewenter, S.A. Cunningham, C. Kremen, A. Bogdanski, B. Gemmill-Herren, S.S. Greenleaf, A.M. Klein, M.M. Mayfield, L.A. Morandin, A. Ochieng and B.F. Viana, Landscape effects on crop pollination services: are there general patterns?, Ecol. Lett 11 499 – 515.

Ribot, Jesse 2009. Vulnerability does not fall from the sky: toward multiscale, pro-poor climate policy. Social Dimensions of Climate Change: equity and vulnerability in a warming world. 47 - 74. Robin Mears and Andrew Norton, Editors. 2010.

Smit B, and Wandel J, 2006. Adaptation, adaptive capacity and vulnerability. Global environmental change 16: 282 – 292.

Sperenza Ifejika C, Kiteme B, Ambenje P, Wiesmann U, and Makali S, 2010. Indigenous knowledge related to climate variability and change: insights from droughts in semi-arid areas of former Makueni District, Kenya. Climatic change 100: 295 – 315.

Tierney Kathleen, Bevc Christine, and Kuligowski Erica, 2006. Metaphors matter: disaster myths, media frames, and their consequences in hurricane Katrina. The ANNALS of the American academy, AAPSS, 604: 57-81.

Turner BL II, Kasperson RE, Matson PA et al (2003). A framework for vulnerability analysis in sustainability science. Proc Nat Acad Sci USA 100: 8074 - 8079.

Vásquez-León Marcela, 2009. Hispanic Farmers and Farmworkers: Social Networks, Institutional Exclusion, and Climate Vulnerability in Southeastern Arizona. American Anthropologist 3: 289 – 301.

Wall, Ellen and Marzall, Katia 2006. Adaptive capacity for climate change in Canadian rural communities. Local environment 4: 373 – 397.

White, A., Jeffrey Hatcher, Arvind Khare, Megan Liddle, Augusta Molnar, and William D. Sunderlin. 2009. Seeing people through the trees and the carbon: mitigating and adapting to climate change without undermining rights and livelihoods. Social Dimensions of Climate Change: equity and vulnerability in a warming world. 11: 277-301. Robin Mears and Andrew Norton, Editors. 2010.

Willianson T, Hayley H, and Johnston M, 2010. Adaptive capacity deficits and adaptive capacity of economic systems in climate change vulnerability assessment. Forest policy and economics 15: 160 – 166.

7. APPENDIX

APPENDIX A: Interview Guide

Interview Questions for Land Users:

1. Can you tell me a little bit about yourself? How long have you lived in Puerto Carreño? Why have you chosen to live here?

1. How do you use the land/what are you doing on your farm?

2. Have you noticed any changes in the weather, the land, or plants and animals in this area?

3. Why do you think these changes are happening?

4. What do you know about climate change?

   a. What causes it?
   b. What are the expected impacts?
   c. How did you learn about it?

5. Do you think climate change has anything to do with these changes happening locally?

6. What sorts of impacts do you feel your community will experience, or are experiencing now?

   a. Are you concerned about these?

7. Are these episodes impacting directly the traditional ways that you manage or use the land?

8. Have you made any changes in your land use/management in response to these changes in your local environment?

9. Have you been seeking new information to help learn more about climate change and how best to respond to it in your land management practices? From where?

10. Are you getting support or training from anyone to assist you in adapting to climate change? If so, from whom?

11. Do you try to do what's best for the environment in your land mgt practices? How?

12. Some landowners around here have begun to grow trees on their land; what do you think about these operations?

13. Would you like to add anything?

14. Can you think of other people who are also farmers/land users who would be interested in participating in an interview?

Thank you for your time and for your valuable contribution to this project.

APPENDIX B: Information Sheet

Title of Project: Climate Change and Community Sustainability for Puerto Carreño, Colombia

Research Team:
Principle Investigator:
Dr. Debra Davidson, Department of Rural Economy, University of Alberta. email: debra.davidson@ualberta.ca Ph Canada: 780.492.4598 Ph Colombia: 780-668-2966

Research Assistants:
Julio Arregoces, MSc student, Department of Renewable Resources, University of Alberta. email: arregoce@ualberta.ca Ph Colombia:
Wayne Crosby, PhD student, Department of Rural Economy, University of Alberta. email: wcrosby@ualberta.ca. Ph Colombia:

Project Purpose
We are interested in exploring how climate change might impact the sustainability of the community of Puerto Carreño. Some communities are especially vulnerable to unexpected changes like those we may experience as a result of climate change. Other communities may have a high level of capacity to cope with and adapt to such changes. In this research project, we will be assessing the ways in which Puerto Carreño might be vulnerable to climate change, and what types of local resources and characteristics you have that might be valuable in adapting to climate change. We are especially interested in hearing what you think climate change means to you and your community, and if and how you and your community might already be taking steps that will help in climate change adaptation.

The Interview
You have been asked to participate in this study based on your role as a community leader or land user in the county of Puerto Carreño. You are invited to participate in an interview that will take about an hour. I would like to audio-record the interview, with your consent. Your interview (the audio-recording and transcribed text) will be kept **confidential**. You can also remain anonymous if you choose. In other words, no personal information or data will be attributed to you, and your interview will be assigned a number. Only the members of the research team listed above, the interpreter if present, and the transcriber will have access to the recording and transcription. If you like, I can supply you with a copy of the transcript, and provide you with a month to review it for accuracy and completeness. This information will be kept in a secure location at the University of Alberta. The results of this study will contribute to a Master's Thesis that will be deposited in the library at the University of Alberta. An executive summary in Spanish will be available upon request. In addition, several presentations and other publications and reports may be developed in which information from this study will be used, including the occasional use of directly quoted passages from the interviews. The data will be kept indefinitely for potential future analysis.

Risks and Benefits
We do not anticipate any risks to you as a result of participation in this study. Your participation may benefit your community, by providing information that can improve community sustainability by increasing adaptive capacity. Your participation will also benefit researchers who are trying to understand better the impacts of climate change on people, and how we can address these impacts.

Your Rights
You are not compelled to participate in any part of this research project. If you do choose to participate you are free to withdraw at any time during the interview or up to two weeks after the interview by contacting one of the researchers. If you choose not to participate, this information will also be maintained in confidence. You have the right to choose whether or not to have your name used in reports and presentations of this project. If you have any concerns about this study, you may contact any member of the research team as indicated in the contact information above. Further questions regarding your rights as a research participant can be directed to the University of Alberta Research Ethics Office at 780-492-2615.

APPENDIX C: Photo Consent

Photograph CONSENT Form

Hello, I am a researcher from the University of Alberta conducting a study in this area. I would like to be able to take your photograph for use on a web page and possibly in reports used to provide educational information about Puerto Carreño, in the context of a research project we are conducting about rural community sustainability and climate change.

I consent to being photographed Yes No

_____ _____

Name/Signature of Participant Date

_____ _____

Name/Signature of Researcher Date