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# Conservation Analysis in the Municipality of Toa Baja

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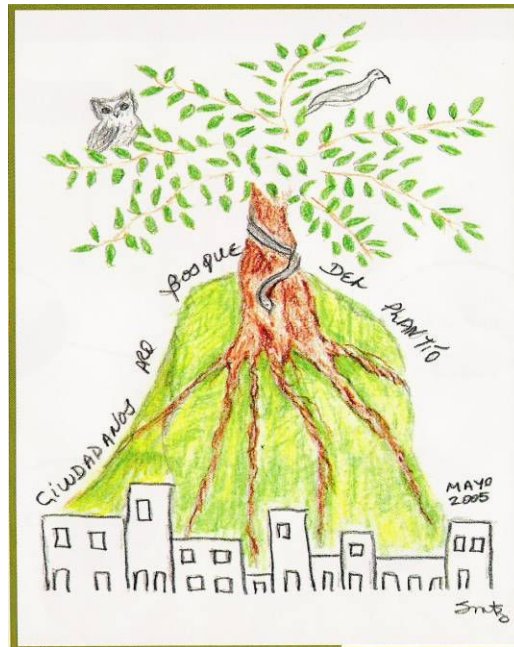
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# Conservation Analysis in the Municipality of Toa Baja, Puerto Rico



An Interactive Qualifying Project Report

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Alissa Paquette

May 3, 2006

# **Conservation Analysis in the Municipality of Toa Baja, Puerto Rico**

An Interactive Qualifying Project Report  
Submitted to the Faculty of  
Worcester Polytechnic Institute  
In partial fulfillment of the requirements for the  
Degree of Bachelor of Science

Sponsoring Agency: Department of Natural and Environmental Resources

Submitted to:

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Date: 3 May 2006

## **Abstract**

In Puerto Rico, ongoing economic and population growth is causing widespread urbanization at the expense of valuable forest ecosystems. The community of el Plantío faced this issue when a cherished range of forested hills was threatened by local developers. We assessed the situation through interviews, explored the area to compile scientific arguments for preservation, and surveyed local educators regarding use of the area for educational purposes. Our findings will help the community justify re-zoning the hills as a protected area and suggest educational uses as an alternative to development. With the assistance of the Department of Natural and Environmental Resources, we used the example of el Plantío to adapt the USFS Wildland-Urban Interface Assessment to a Puerto Rican context.

## Authorship

In the compilation of this report, each group member, Ian Levesque, Brendan McLaughlin, Christina Mezzone, and Alissa Paquette, has contributed his/her edits to our overall project and the chapters that follow. Listed below are the original authors of each section.

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## **Executive Summary**

In Puerto Rico, as in many other parts of the world, ongoing economic and population growth is causing widespread urbanization. With approximately 4 million people inhabiting an island just over 3,500 square miles in size, careful land management is absolutely essential to prevent the destruction of Puerto Rico's valuable natural resources. While recent efforts have been made to produce a comprehensive national land-use plan that addresses the issues of deforestation and the destruction of valuable karst aquifers, historically much of this burden has fallen - and will continue to fall - upon the shoulders of motivated community groups such as Casa Pueblo in Adjuntas, los Ciudadanos Pro Bosque del San Patricio in San Patricio, and now los Ciudadanos pro Bosque del Plantío in Toa Baja.

When the range of karst mogotes - or small forested hills - surrounding the community of el Plantío, Toa Baja, was threatened by multiple local developers, a group of citizens from the community banded together to look into ways to first protect the area, and then put it to environmentally friendly uses. Inexperienced in dealing with the complex issues surrounding conservation efforts, they enlisted the help of the Department of Natural and Environmental Resources. Over the last few years, they have made significant progress. With Toa Baja presently drafting a new municipal land-use plan, los Ciudadanos pro Bosque del Plantío has a unique opportunity to have the mogotes re-zoned as protected areas, and potentially to realize their vision of the karst mogotes being used for educational purposes.

It is at this critical phase of the conservation process that our project group was called in by the Department of Natural and Environmental Resources to assist the community group in:

- Arguing for the preservation of the mogotes during the critical public planning board reviews in June and September of 2006, and

- Assessing the interest level of local school teachers and administrators towards various educational use ideas for the area.

Additionally, the Department of Natural and Environmental Resources asked us to document various aspects of the project for use in assessing the applicability of the U.S. Forest Service's Southern United States Wildland-Urban Interface Assessment to Puerto Rico.

To accomplish these tasks, we conducted a series of interviews and focus groups with el Plantío community members, relevant politicians from the Municipality of Toa Baja, members of the community associations of both neighboring Macún and el Plantío, prominent members of the Casa Pueblo community group, and schoolteachers involved with the Casa Pueblo educational program. We conducted a survey of local schoolteachers and administrators to determine their level of interest in several proposed educational use plans. We also worked with field researchers from the Department of Natural and Environmental Resources, hiking through the mogotes to catalog plant and animal species and the GPS locations of important geographic features. All this information was compiled and analyzed to provide los Ciudadanos pro Bosque del Plantío with strong arguments to use during the land-use hearings, and a better sense of what area educators would like to use in their lessons.

Our key findings from these investigations were that the el Plantío mogotes hold important environmental value due to the following:

- The presence of the endangered Palo de Rosa tree and other rare or endemic species of plants.
- The karst formation's value as a source of clean water – presently being used by several freshwater wells in the surrounding area.
- The karst formation's value in preventing flooding - as exemplified by the findings of the U.S. Geological Survey in 1983.

We also discovered that the current mayor's administration is in full support of the conservation of the mogotes, and should prove to be a valuable ally during the ratification of the new municipal land-use plan. If conservation of the area is achieved, local schools do have a strong interest in using the area for educational purposes. In particular, a local flora and fauna exhibit and hands-on experiments would be most useful as a supplement to existing environmental programs.

Using these findings, we were able to make several recommendations for the community group in el Plantío. First, we recommended that the community group attend the two upcoming planning board reviews and use our findings to defend the conservation of the mogotes. Secondly, the community group should combine educational materials from the U.S. Fish & Wildlife Service, the U.S. Forest Service, and the Department of Natural and Environmental Resources, with the local flora information included in this report to put together lesson plan ideas for area schools. Also, if the community group is able to gain enough support - both within el Plantío and in the surrounding communities - an educational center with hands-on experiments would both be useful to students and help increase awareness of local environmental issues. Long-term management of the area will require the assistance of the Department of Natural and Environmental Resources to encourage the continued growth of the Palo de Rosa and maintain the health of the entire ecosystem.

Based upon our experiences with los Ciudadanos pro Bosque del Plantío, we decided that the guidelines contained within the Wildland-Urban Interface Assessment - with several key modifications - better address the environmental issues facing Puerto Rico than existing programs. Our report will help strengthen the community's argument for preservation and provide the Department of Natural and Environmental Resources with a case-study to use in similar efforts across all of Puerto Rico



## **1.0 Introduction**

Throughout the world, pressures including urban expansion, tourism, pollution, and deforestation are threatening ecosystems. During the twentieth century, approximately 40% of natural forest coverage was lost to agriculture, industrialization, and urbanization. Karst forests – which grow over a limestone base – are particularly sensitive to the effects of deforestation due to their unstable soil composition. Recently, communities near such valuable untouched land have been pressured to develop, making it difficult to preserve the land’s ecological diversity and natural functions. To combat these developmental pressures and preserve the environment, many community groups have adopted community-based natural resource management systems.

Puerto Rico has a particular need for community-based natural resource management systems to avoid overdevelopment and the destruction of natural ecosystems. Centered in the tropical environment of the Caribbean, Puerto Rico is home to many ecosystems that provide important natural functions. One such natural system is el Bosque del Plantío, a karst region located in the northern section of the island. El Bosque del Plantío presents a unique living environment for many Puerto Rican species and also acts as a natural water drainage system for the neighboring human settlements. These karst formations have remained undeveloped for much of the twentieth century, but modern economic interests now threaten both this forest and the rest of Toa Baja’s ecosystems.

The government organization responsible for the protection of such ecosystems in Puerto Rico is the Department of Natural and Environmental Resources (DNER). The DNER implements systems of management for the preservation of Puerto Rico’s public forests by working with local communities to effectively address the problem. Research conducted in nearby San Patricio, Puerto Rico, educated the DNER on the main issues involved in conserving an endangered area. Identifying the role of the ecosystems in relation to endemic plants and

animals, and developing a future use for the area were crucial steps to prevent development. The citizens of San Patricio showed that obtaining ownership rights to threatened land with the assistance of the DNER is an effective method to combat development attempts. In other areas of the world, the Nature Conservancy – a non-profit private organization focused on preserving natural ecosystems – developed other steps to protect habitats threatened by development. In East Kalimantan, Indonesia, the growing population's dependence on natural resources is threatening its rainforests and mangroves. By targeting critical areas, the Conservancy works with local community groups, industries, and the government to develop reasonable incentives that inspire landowners to conserve property rather than develop it. In the Municipality of Toa Baja, Puerto Rico, concerned residents formed los Ciudadanos pro Bosque del Plantío, to help manage and protect the unique karst forest present in their community from being developed.

The main problem los Ciudadanos pro Bosque del Plantío faces is that the land is not yet protected from development and a coherent strategy to achieve its long-term protection has not yet been articulated. The community group along with the DNER would like to see the area used for recreational and educational purposes in the future. Presently, a legal injunction is preventing immediate development. However, once this hold expires, the community and DNER will struggle to prevent developers from entering the area and permanently altering the environment.

For our project, we worked with both the local community group and the DNER to address their individual needs. For the community group, we aimed to develop possible solutions to maintain el Bosque del Plantío and use it for future educational purposes. We strove to understand the acceptable uses for this forest by conducting personal interviews and completing on-site analyses. Using the information acquired during the course of the project, we intended to make environmental, educational, managerial, and economic recommendations to the community members regarding the area. In addition to supporting the conservation of el Bosque del Plantío,

we aimed to use our project to evaluate the US Forest Service's Wildland-Urban Interface Assessment for the DNER to use for conservation efforts in other parts of Puerto Rico.

## **2.0 Background**

The effects of development and urban expansion have had major effects on the state of the environment throughout the world. While undisturbed land presents itself as a logical area for overcrowded societies to expand into, the consequences of deforestation can be devastating to the environment and detrimental to the well being of the people. Due to Puerto Rico's small size, many of its natural areas are being threatened by developers. In the Municipality of Toa Baja – the home of a karst tropical forest known as el Bosque del Plantío - developmental pressures have been growing and a conservation plan is desperately needed to prevent the destruction of its remaining forestland. This chapter discusses the functions of forests, their societal importance, and the reasoning behind conservation programs. It also describes the role that governments and communities have played in conservation efforts, and provides information regarding local Puerto Rican groups involved in various aspects of the protection process.

### **2.1 Importance of Tropical Forests**

By the end of the twentieth century, forested land comprised nearly twenty-seven percent of land suitable for human settlement throughout the world. Such forested lands include the tropical rain forests of the Amazon, the coastal mangroves of Southeast Asia, the frozen wilderness of Canada, the dry woodlands of southern Africa, and much more (Roper, 1999, Introduction). Indeed, forests are present in diverse forms and provide many important benefits and uses to both humans and the rest of nature. However, throughout the twentieth century, a large portion of forested land was lost to the world due to human intervention. In fact, of the estimated 6000 million hectares of original forest prior to major human intervention, only about 3,500 million hectares remained worldwide as of 1997 (Roper, 1999, p.1). Of the remaining

forests, about 2,000 million hectares can be classified as tropical forests, which are usually found in the developing countries in tropical and sub-tropical regions.

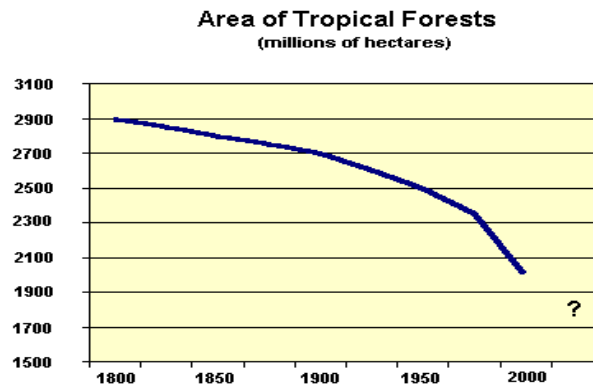


Figure 1: Tropical Forest Decline in the World (Roper, 1999, p.2)

Tropical forests have both environmental and socioeconomic importance. First of all, they are the natural habitat for nearly 70 percent of the world's plants and animals. This accounts for nearly thirteen million species worldwide (Roper, 1999, p.2). The natural systems of these forests also affect the local and global climate – more specifically air quality and other pollution levels. By maintaining atmospheric humidity, carbon levels, and oxygen levels, the forests serve a vital role in supplying breathable air to humans and other inhabitants. Also, tropical forests are important for managing rainfall and appropriately hold excess water in a manner that is most effective for the environment. This is important in preventing erosion damage to ecosystems, which is often the cause of dangerous sinkholes and landslides. In other words, forests serve as natural watersheds that absorb excess rainfall to minimize flooding and encourage the growth of trees, which enhances soil stability and prevents erosion caused by excessive winds or other means (Roper, 1999, p.2). This function of the forest proves to be very valuable in areas such as Puerto Rico, which can receive up to 200 inches of rainfall annually (Rivera, 2006, Climate).

Perhaps just as importantly, the forests serve a very important socioeconomic role, as nearly 500 million people live around tropical forests worldwide. While the lumber industry

thrives in such areas producing nearly \$100 billion in products, forests also serve as valuable centers for local food supply, medicine, and natural fibers and resins (Roper, 1999, p.2). Despite their environmental and socioeconomic importance, tropical forests continue to be permanently lost in many areas of the world.

## **2.2 Causes of Deforestation**

There are many explanations for the rapid rate of deforestation over the past century and its continuation today. Growing countries often depend on their extensive natural resources as means for economic development. In el Salvador, for example, an area with a similar tropical climate to Puerto Rico, nearly 50% of the forest coverage was destroyed since 1960 due to a rapidly growing agricultural industry. By 1991, only about 5% of the original tropical forest was undeveloped in el Salvador (Koop, 1997, p.2046). Such deforestation has had major negative environmental effects in the area. The country has soil erosion problems, is suffering from poor soil fertility, and has water pollution problems stemming from the destruction of natural watersheds. Such problems have caused nearly 75% of el Salvador's land to be degraded, and excess sediment runoff has further hindered already struggling hydroelectric energy production and irrigation systems. With a steady population growth rate of about 2% per year, el Salvador's demand for land for urbanization has made such deforestation nearly irreversible. El Salvador is a prime example of the dramatic impact of deforestation in developing tropical areas in the world.

The Food and Agriculture Organization of the United Nations reported in 1997 that from the period of 1980 to 1995 approximately 200 million hectares of land was deforested, at annual rates of up to 15.5 million hectares per year. Also, more land was lost to deforestation in Latin

America and the Caribbean than any other region – nearly 85 million hectares (Roper, 1999, p.3).

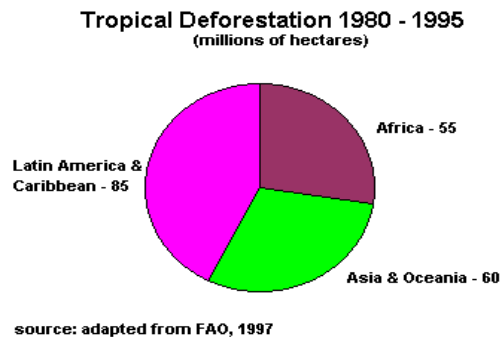


Figure 2: Tropical Deforestation by Location (Roper, 1999, p.3)

## 2.3 Karst Regions

The karst regions of Puerto Rico consist of only a small portion of the total tropical forests in the world but serve vital environmental functions. The growing threat presented by deforestation directly affects areas such as the karst regions of Puerto Rico and other tropical forests which hold environmental and cultural significance to their inhabitants.

### 2.3.1 Karst Regions Significance

Karst and pseudokarst regions are found all over the world, in places as diverse as the Waitomo region of New Zealand, the Ozark Plateau of Missouri, the Gunung Mulu National Park of Malaysia, the Apuseni Mountains in Romania, the Halong Bay in Vietnam, and of course the Karst forests of Puerto Rico (Karst, 2006, p.1). These regions vary greatly in topography and geographic placement, but all share some common characteristics. Karst regions are defined by large networks of underground drainages, formed through the erosive effects of rainwater, and are usually composed of limestone or dolomite, each of which is easily dissolved by mildly acidic rain (Karst, 2006, p.1). Pseudokarst is made up of basalt or granite, neither of which can be readily dissolved by rain. A third form of karst, known as thermokarst, is formed when

underground permafrost melts and drains away, leaving underground caves.

The caves found in karst regions are responsible for most of the karst's unique characteristics. Flooding is extremely unlikely in karst regions because rainwater drains very readily through the underground caves. Farming on a karst plain poses unique challenges because rainwater permeates the ground so quickly. If the region does not see frequent rainfall, the ground may dry out completely many times throughout the year. Sinkholes are also a common occurrence in karst regions. The continuous underground erosion creates large caves that occasionally become unstable and collapse, swallowing whatever or whoever is above them at the time. Without careful investigation of potential building sites, karst development can present a serious safety hazard. Karst groundwater can also be dangerous, because it is not filtered in the same way as traditional groundwater. It is entirely possible for pollution to travel extremely large distances underground. There have been many instances of karst sinkholes being used as landfills, without any regard for the environmental consequences.

Over time, karst sinkholes often coalesce into large depressions made up of the non-soluble remnants of prior erosion known as *poljen*. These areas are essentially large, flat sinkholes with walls as high as 100 meters (Karst, 2006, p. 1). Because they are made up of only non-soluble materials, *poljen* are stable and therefore readily developable. Soil from the valley walls surrounding *poljen* often flows downhill to cover the bottom of the depression (Rivera, 1998, p. 64). As such, *poljen* are often blanketed in nutrient-rich soil, which makes them particularly good for farming.

### **2.3.2 Karst Regions in Puerto Rico**

Puerto Rico's karst region covers almost 20% of the island. Puerto Rico's karst is primarily limestone and dotted with mogotes (small limestone hills) and alluvial terraces (a form



of poljen characterized by frequent flooding). At the height of Puerto Rico's agricultural development, almost all alluvial terraces were used for farming as pastures, space for rotating crops, or coffee plantations (Rivera, 1998, p. 65). Many of these were eventually abandoned as the economy changed and are now covered in re-growth. Former coffee plantations had large numbers of shade trees planted and as such are now dominated by shade-favoring species, such as the short leafy *Guarea guidonia*, commonly known as *chuchupate* or *cedro macho* (Center for Tropical Forest Services, 2004, p.1). Abandoned pastures are now dominated by the highly aggressive *Spathodea campanulata*, or African Tulip Tree, a problematic species that can impede the growth of many other types of plants (Invasive Species Specialist Group, 2005, p.1).

Karst regions are important for a number of reasons. They are home to many kinds of wildlife, including at least twenty-two species of plants and fifteen species of animals that are legally designated as threatened or endangered (Belson, 1999, p.1). Limestone karst aquifers, such as the two found in northern Puerto Rico, are important sources of fresh water for inhabitants. These two karst aquifers, located within the Miocene limestone of the Aymamón and Aguada Formations and beneath the Oligocene limestone of the Cibao and Lares Formations, are saturated with water that takes over a decade to fully circulate, and as such, they are very sensitive to any form of pollution or development. Even small quantities of contaminants will build up to dangerous levels in a short time, leaving the water unsuitable for human use and harmful to plants and animals (Jones, 2003, p.132).

El Bosque del Plantío is one particular karst region located in the northern section of Puerto Rico, west of the capital city, San Juan. Surrounded by communities in the Municipality of Toa Baja, the area holds



Figure 3: Toa Baja Location (University of Texas, 2005)

environmental significance for nearby aquifers. The forest is home to a variety of flora and animal species and two protected endangered species - the Palo de Rosa (tree), and the Boa Puertorriquena (snake).



**Figure 4: El Bosque del Plantío in Toa Baja (Los Ciudadanos pro Bosque del Plantío, 2005)**

### **2.3.3 Puerto Rican Karst Aquifers**

In Puerto Rico, karst regions are particularly important due to their function as aquifers, or clean fresh water supplies. All domestic, commercial, and industrial water is supplied by either surface water sources, such as lakes and rivers, or groundwater sources like karst aquifers. In Puerto Rico, over 25 percent of all water is supplied by groundwater sources (USDA, 2001, p.68) – a much higher portion than in the United States and other countries. This high dependence on groundwater makes careful management and conservation of aquifers essential.

The most important source of groundwater is the north coast limestone aquifer. This karst aquifer alone supplies 33 to 35 percent of all groundwater used in Puerto Rico. Every day over 20 million gallons flow northward through this aquifer from the mountainous center of

Puerto Rico towards the ocean (USDA, 2002, p.68). This course passes beneath many municipalities, including Toa Baja. This path provides convenient access to fresh water, but also ample opportunities for it to become polluted. The most effective conservation and management policies take into account the entire watershed, from headwaters to the ocean.

## **2.4 Deforestation in Puerto Rico**

As described, karst regions are particularly sensitive to the effects of development. As a result of deforestation and urban expansion, both the karst ecosystems and their natural functions can be destroyed in just a short time. As Puerto Rico has developed into a powerful economy, it has endured many of the effects of deforestation, and the important ecosystems, including karst regions, are now being threatened.

Puerto Rico's economy has changed significantly from the early 20<sup>th</sup> century. In 1934, about 43 percent of the Gross National product was agriculturally based. Under the Puerto Rican policy, Operation Bootstrap, Puerto Rico began its change from an agrarian to an industrial economy. The shift began in the late 1940's, and by 1960 new factories were growing at a rate of five per week. Between 1945 and 1965 alone, 1,027 new manufacturing plants were constructed. Although Operation Bootstrap brought growth, there were disadvantages to industrialization including a decline in employment of 18.8%, and an increase in poverty due to the lack of jobs and low wages being offered. By 1979 the main companies in Puerto Rico were involved in petrochemicals, pharmaceuticals, and electronics (Johnson, 1980, pp.39-41). Specialized industries did not expand the job market for the general population, and the majority of people were forced to live in expanding poor urban communities.

Puerto Rico's major agricultural exports – coffee, sugar, and tobacco – have decreased by 13%, 87%, and 100% respectively since 1960 (Koop, 1997, p.2046). The karst regions of Puerto

Rico, which were primarily used as coffee plantations in the early to mid twentieth century, have since been abandoned and have recovered almost completely (Aide, 1997, p.64). Such areas have become very valuable natural ecosystems once again. In fact, due to the shift in its economy, Puerto Rico has actually experienced a rise in the amount of natural forest since 1960. By 1994, natural forest cover in Puerto Rico rose to 34% from the low of only 5% in the 1930s to 1950s (Thomlinson, 1999, pp.15-16). This level, however, has been noted as the “peak” of forest coverage in Puerto Rico. Panchromatic Satellite imagery data have shown that expanding urban and suburban centers have begun to encroach on forested land once again.

Figure 3. Distribution of urban areas in Puerto Rico in 1977 and 1994.

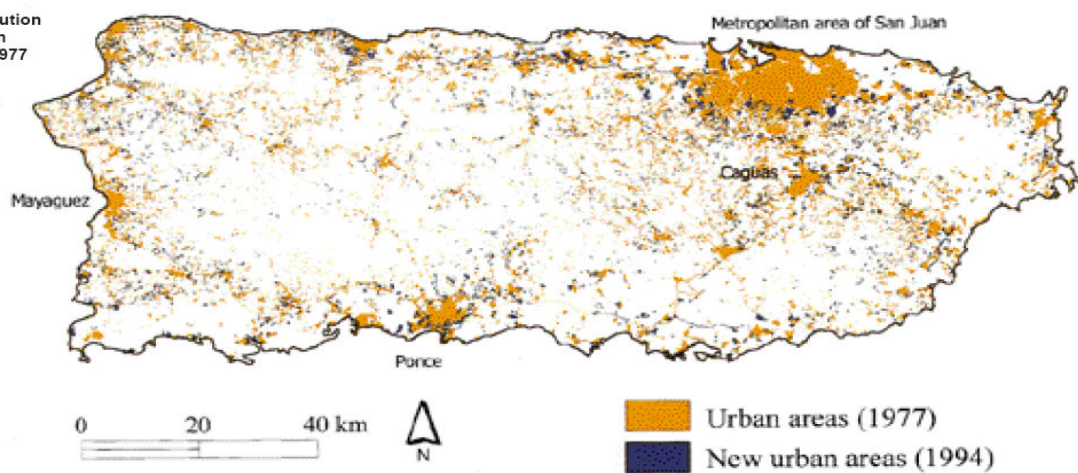
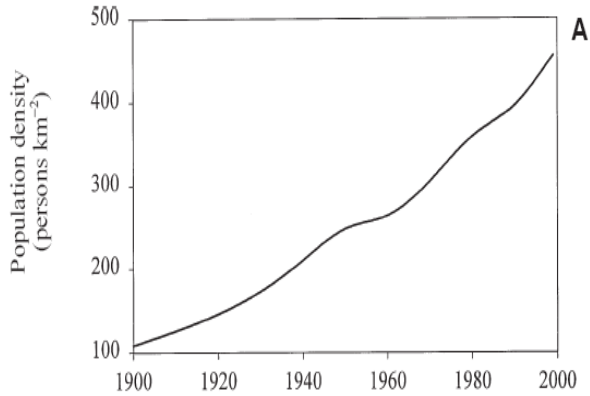


Figure 5: Urban Expansion Satellite Imagery (Aide, 2001, p. 51)

## 2.5 Urbanization and Its Results in Luquillo, Puerto Rico

During this time, populations shifted to major urban centers including the metropolitan areas of San Juan, Caguas, Ponce, and Mayaguez. Areas defined as urban covered about 11.3% of land in 1977 and have since increased to 14.4% of land in 1994, or a 27.4% increase in total urban areas (Aide, 2001, p.51). Population migration to the four major urban centers along with population growth has caused an increase in suburban development and population density.

Thus, areas that recovered over the years from the agriculture industry are once again becoming threatened by urban development and expansion.



**Figure 6: Population Growth in Puerto Rico (Aide, 2001, p. 50)**

Table 1. Urban and nonurban areas (km <sup>2</sup> ) in Puerto Rico in 1977 and 1994, and the percent change of each class during the study period. Values in parentheses are the percent cover for each class on the island.		
Year	Urban	Nonurban
1977	984 (11.3)	7725 (88.7)
1994	1252 (14.4)	7457 (85.6)
% change	+ 27.4	- 3.5

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**Figure 7: Urban/Nonurban Land Area (Aide, 2001, p. 51)**

One example of the modern impact of deforestation can be seen through a study conducted at the Municipality of Luquillo, Puerto Rico. This expanding urban center in Northeast Puerto Rico has seen a shift from major agricultural development, and today supports thriving electronic and clothing manufacturers. Also, residential construction has increased to support the population migrating from nearby San Juan. The area has experienced a 218% population growth and a 2000% increase in the amount of land encompassed by urban settlements from 1936 to 1988 – mainly a result of expanding beyond the main town of Barrio Pueblo (Thomlinson, 1999, p.16). Luquillo is classified as subtropical moist and wet forests, areas which have ecosystems supporting a wide variety of plants and animals. As population growth has accelerated in recent years, natural land coverage has been negatively affected. The dense forest (over 80% canopy coverage) of Luquillo was most affected by the development of low and high density areas, according to a study carried out from 1988 to 1993. About 83% of the land that experienced a transformation to an urban environment was previously classified as dense forest.

The pattern of development in Luquillo is similar to areas around the world where natural resources are being exploited. The haphazard style of development – where urban areas grow in patches rather than planned growth – is known as “urban sprawl” (Robinson, 2005, pp.51-52). Roads and technology have made such expansion possible. In Luquillo, road density is among the highest in Puerto Rico. Road development, while connecting communities and enhancing urban growth, has major negative effects on the environment. Roads and the development alongside them fragment the natural ecosystems and habitats they pass through. After times of natural disaster, such as hurricanes, species are not able to move to less impacted areas to find food sources. This has been particularly devastating to native Puerto Rican species such as the Puerto Rican boa (*Epicrates inornatus*), which is now recognized as an endangered species.



**Figure 8: Road Development (Roper, 1999, p. 5)**

As populations are continuing to grow and people are developing a preference for low density urban areas, deforestation is once again becoming a major problem for urbanizing areas. In Puerto Rico, both governmental and local planning boards responded to this growth. The Puerto Rico Planning Board, for example, created a policy which advocates compact community development instead of the urban sprawl that destroys natural systems. In fact, the Planning Board placed zoning restrictions on environmentally important lands in Luquillo to minimize the effects of development. However, according to Koop (1997, pp.2053-2054), not all zoning laws

are being adhered to, and development is continuing at a pace that is not sustainable for sensitive environments.

While Luquillo consists of a more diverse ecosystem – both karst (semi-tropical moist forests) and wet tropical forests – than the karst region in Toa Baja, it is an important example to show the devastating effects of overdevelopment (Rivera, 1998, p.72). Uncontrolled urban sprawl effectively destroys natural ecosystems to an extent that they cannot recover.

With so many complex economic and political issues to work through, conservation efforts can be very difficult. Thankfully, much work has already been done in this area that our project and others can leverage. In particular, our project evaluated a model put together by the US Forest Service known as the “Wildland-Urban Interface Assessment” (Macie, 2002, p.1).

## 2.6 Wildland-Urban Interface

In 1998, after a series of Florida wildfires, the United States Department of Agriculture Forest Service developed the Wildland-Urban Interface Assessment to analyze the effects of urbanization, land use patterns, and management of the environment in thirteen southern states.



**Figure 9: States of Interest for Wildland Urban Interface Assessment (Macie, 2002, p. 3)**

This interface exists on several different levels according to the configuration of the land. Classic wildland-urban interface is defined by areas of urban sprawl, or areas where development approaches public and private wilderness (Macie, 2002, p.2). More specifically, the wildland-

urban intermix describes areas that are experiencing a transition from agriculture and forest uses to urban land uses. Typically these areas are a combination of urban and rural settlement, with the boundaries of urban development encroaching on the rural areas. Isolated wildland-urban interface consists of remote structures surrounded by large areas of untouched land – commonly in the form of summer homes or ranches and farms. As urban areas grow larger and closer together they create remnant forests surrounded by urban settlements, known as wildland-urban interface islands. These areas often lack species diversity and are not suitable for development due to topographical unsuitability (Macie, 2002, p.3).

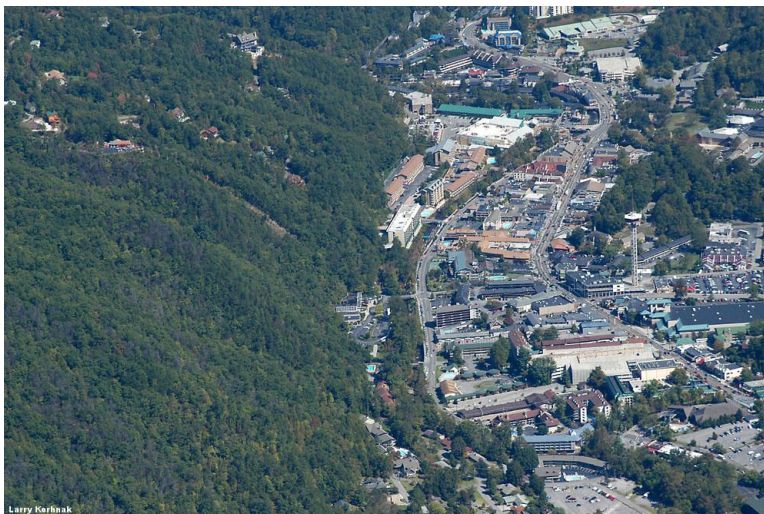
The Wildland-Urban Interface Assessment was also established to address the sociopolitical issues present with development. Due to the different attitudes people have about the management of natural resources, conflicting values about natural land exist amongst opposing groups. For example, while some people may value maintaining an area with natural water resources, others may value its developmental potential. The interface also addresses the biological diversity of forested areas, and addresses possible changes in forest ecosystems and water quality that can result from increased urbanization. Lastly, for the southern United States, the interface was established to allow fire managers to identify and manage areas of development that are nearby areas prone to wildfire (Macie, 2002, p.5).

The main goals of the Forest Service's Assessment were to examine factors causing change in the interface including land use planning, to explore their consequences on natural resources and forest management, and to identify research gaps and promote public awareness of interface issues.



### 2.6.1 Factors Driving Change in the Wildland-Urban Interface

As identified by the USDA, the main sources motivating change of the southern wildland-urban interface are population growth, social composition, shifts in the economy, rural land ownership, and individual lifestyles. The south is experiencing a net population rise of 6.3 people per 1,000-population per year – increasing the population by approximately 600,000 people per year (Macie, 2002, p.12). In addition, the levels of immigration and migration from other states to the south are greater than all other U.S. regions combined. This factor, along with a higher median age and life expectancy, affects forest ecosystems by increasing development of retirement communities and recreation facilities.



**Figure 10: Example of Wildland-Urban Interface Area (Macie, 2006)**

Consequently, between 1992 and 1997 nearly 16 million acres of rural land were converted to urban land uses. Over the next twenty years the urban and rural populations in the United States are expected to grow 18.8% and 12.4% respectively thus expanding the wildland-urban interface by increasing demands for development, timber harvesting, and recreation (Macie, 2002, pp.14-17). Also, the development of major interstate highways is contributing to the expansion of the interface, as rural areas are becoming more accessible to urban populations.

The changing economy in the south is another factor affecting change in the wildland-urban interface. Between 1975 and 1995, farming employment dropped by 7% while agricultural service industries, construction, and retail services all increased. This shift to a service economy is linked directly to urban expansion as the demand for shopping malls and manufacturing plants increase (Macie, 2002, p. 19). Also, the majority of southern rural land – approximately 432 million acres – is corporately and privately owned. The status of rural ownership is important to the land’s future and the advancement of the wildland-urban interface. Private ownership allows landowners to develop manufacturing and residential projects with greater ease resulting in greater fragmentation of the landscape. Also, private landowners are facing property damage from public uses, rising property taxes, and increasing pressure to transfer property rights to encroaching developers (Macie, 2002, p.22). These pressures have resulted in changing trends of forest management policy and preservation.



Figure 11: Developmental Pressure in Wildland-Urban Interface (Macie, 2006)

Another important factor affecting the change in the wildland-urban interface is the lifestyle of individuals within the interface. The knowledge gained by understanding the recreational activities and the choices people make helps to reveal the attitudes toward natural

resources and suggests appropriate programs for interface education and involvement. The most popular recreational activities in the south, such as walking for pleasure, outdoor family gatherings, visiting nature centers, and sightseeing, are each drivers for rural settlement and development patterns (Macie, 2002, p.24)

### **2.6.2 Land Use Policy and the Wildland-Urban Interface**

The Federal Government has taken several steps to encourage management and stewardship of forested lands within the United States. For example, landowners of forested land are subject to a ten percent investment tax-credit and up to a \$10,000 annual tax write-off (up to 8 years) for reforestation expenses. Also, landowners who sell natural resources can recover their initial investment through tax deductions (Macie, 2002, p.43). However, tax deductions are not enough to effectively protect rural areas from being developed as the economic pressures are far greater than the government's incentive programs. The Wildland-Urban Interface Assessment notes the importance of identifying methods to reclaim abandoned urban areas and discourage the unnecessary development of untouched land. It recommends educational programs to alert residents in the interface area (including local officials and city councils) of the economic conditions that will result from urbanization and programs to encourage policymakers to create land-use policies that minimize the tax burdens of holding undeveloped land.

During focus group studies conducted in the southern United States, a majority of private landowners recognized the importance of environmental protection over property rights of individuals. The public is becoming more aware of the effects that individual landowners can have on the welfare of rural areas and communities despite zoning ordinances (Macie, 2002, p.60). Current zoning laws were not created with environmental protection in mind, but rather to protect private property values by restricting uses of land that decrease value or add cost to the

community. This system influences landowners to make decisions for their short term economic interest rather than for the good of the community. In comparison, the Wildland-Urban Interface Assessment provides recommendations that emphasize the long term significance of the environment. Geographical Information Systems (GIS) such as CITYgreen can be used to help map land-use plans that effectively integrate natural resources and development by projecting the impact of population growth. Also, policies such as the Purchase of developmental rights, Conservation Easements, and Land Trusts, limit developmental options (Macie, 2002, p.63). In order to find the most effective programs, the USDA recommends identifying the weaknesses in current land use policies and determining the public support and willingness to pay for land protection.

The Wildland-Urban Interface Assessment is a valuable resource for conservation and management techniques for urbanizing areas in the southern United States but also presents broad themes and lessons that can be applied to other areas of the world – such as Puerto Rico. By understanding these issues, environmental agencies will be able to more effectively communicate the environmental significance with community members, planners, and developers to promote conservation.

## **2.7 Government Regulations and Policies**

In order to control the rate of development and conserve the natural ecosystems and functions of areas such as the Bosque del Plantío, it is necessary to create and implement management systems in coordination with governmental agencies and local communities. Governmental policies can have a large impact on the course of development and the impact development will have on the environment.

### **2.7.1 Puerto Rican Governmental Structure**

Puerto Rico is a commonwealth of the United States and organizes its government in a similar structure to the United States. There are three main branches: The Legislative, Judicial, and Executive. The Governor heads the executive branch, and there are six offices that operate under him. Among those are the Planning Board, the Regulations and Permits Administration, and the Environmental Quality Board, each of which are vital to Puerto Rico's environmental status. With the Executive Reorganization Act of 1993, eight "umbrella" departments were created; one being the DNER. This government based organization considers proposals from communities in Puerto Rico in an effort to help them conserve land and natural resources within their communities (Business Registrar, 2006, p.1). For example, the community group from el Plantío obtained an injunction against an apartment complex construction to temporarily halt further development on the area. Also, a law presented by the Puerto Rican Senate, known as P. del S. 83, called for the protection of undeveloped parts of the Municipality of Toa Baja. (Puerto Rican Senate, 2005). The law protects all caves, wildlife and weather refuge, large rocks, hills, and other features of the community's karst region. With the cooperation of the community of el Plantío, the DNER has the ability to preserve and coordinate the management of the area, as well as designate the use of its natural resources. This law will be helpful in maintaining the area, but *non-autonomous municipalities* (as discussed below) have limited control over the development of their land (Puerto Rican Senate, 2005).

### **2.7.2 Municipality Power and the Puerto Rican Planning Board**

Puerto Rico is organized into 78 municipalities, each of which is comprised of different communities, and has its own political standing and local flag (similar to individual states in America).



**Figure 12: Municipalities of Puerto Rico (CCSU, 2006)**

In 1991, the Municipal Reform Act moved many of the decision making responsibilities from the central government to the municipalities. In particular, once a municipality gains autonomy it has the right to make its own land use plans. Furthermore, each municipality is allowed a Community Board of 50,000 representatives from that specific municipality for the purpose of self-government (Business Registrar, 2006, p.1). The municipality’s power is not absolute. Land use plans must be reviewed by the Central government’s Planning Board, which ensures that the municipality’s plans comply with environmental policy and coincide with its overall vision for the island (Junta de Planificación, 2003, p.1).

Since land use is becoming an issue in various non-autonomous municipalities, such as Toa Baja, those municipalities are now required to prepare a Land Use Plan under Chapter XIII of the Autonomous Municipalities Act (Law 81) (Business Registrar, 2006, p.1). Chapter XIII, called Territorial Ordinance, describes the rules and regulations autonomous municipalities have in order to maintain their territory. Each municipality must divide its land into three main categories: urban, urbanizable (can develop), or nonurbanizable (cannot develop). Areas that are classified nonurbanizable should be specifically protected to preserve their forests and natural

resources (Puerto Rican Senate, 1991). After the plan is reviewed by the Planning Board and the Governor, it is sent to the Permits and Regulations Administration for final approval.

However, municipalities must undergo many steps to gain autonomy and the powers associated with that status. Because of the complexity of the process, most municipalities remain non-autonomous and face further challenges when fighting for conservation (Business Registrar, 2006, p.1). For example, a municipality without autonomy might not have the power or funding to reclassify valuable land for conservation. The community group in el Plantío faces this issue because they lack a source of income with which to acquire land. As an alternative, the municipality could offer to trade land zoned for development for protected land. Another problem for non-autonomous municipalities is a lack of local environmental management expertise. In these cases, the DNER may be able to work with the community groups to establish management programs tailored to the area (Rebecca Rivera-Torres, Director of Toa Baja Planning Board, March 21, 2006, Personal Communication).

## **2.8 Community-Based Conservation**

While government agencies and policies play a major role in the prevention of deforestation, the conservation process is more effective with community involvement. In Rincón, for example, community members met to discuss methods for protecting their environment in the future (Surfrider, 2006, p.1). Issues of land use planning and management, as well as economic development were discussed in response to the rapid growth of the local economy. A community development workshop was conducted with the hosting foundation, Surfrider, as well as members of the DNER. This workshop devised a system of management to protect community interests. With communities, such as Rincón, taking the initiative to focus on their environmental future, a precedent is being set that could easily spread throughout other

communities of Puerto Rico. However, local communities often lack clear systems of community management to regulate the extent of development, and thus quickly lose control of expansion. In order to most effectively conserve natural resources, a management system can be developed through local community organizations with the help of governmental policy and regulation.

### **2.8.1 Management Techniques**

Community-based conservation incorporates the cooperation and involvement of community members and governmental agencies to aid them in the creation and implementation of future plans affecting their development. A community consists of a variety of people from different backgrounds, each with personal views, opinions, and agendas. Besides the individual households, the surrounding environment – forests, water, and animals – plays a key role in defining a community. This lays the foundation for community-based conservation that “the coexistence of people and nature...is its central precept” (Western, 1994, p.8). The main goal of community-based conservation is to utilize the connection between the local people and their surrounding ecosystem to benefit both nature and people.

Community-based management was developed to help protect natural resources in a manner that benefits society. Government bureaus and other organizations are continuously working to develop a system that prevents the environment from being overused and allows damaged ecosystems to recover. At times, community members are reluctant to trust governmental agencies when they propose regulatory policies for the community’s land. “Landowners traditionally react suspiciously to any (perceived or real) designs on their land by a government agency or a private organization. Such landowners may be more likely to take up a cause for conservation if the cause is place-based” (Babylon, 2003, p.7). To reduce tension, government agencies and private organizations often work with affected residents to include



them in the planning, implementation, and maintenance for a particular environmental project. This cooperation is important to the agencies as well because it allows them to understand the community viewpoint prior to executing a plan for a threatened area. “A cross-scale approach to conservation is necessary, addressing governance and ‘community’ at the various scales appropriate for the conservation problem in question” (Berkes, 2003, pp.635-636). Together, government and non-governmental organizations can realize the potential impacts of various proposals and evaluate which would offer the greatest social, environmental, and economic benefits for the area.

### **2.8.2 Effects of Community-Based Management**

Evidently, community-based management systems are valuable to limit the effects of deforestation within diverse ecosystems across the world. This form of conservation can also bring long term economic benefits. For example, villagers from a community in Bengal benefited from community-based management by both regulating the local forestry industry, and developing a supplemental form of income to serve as an “economic incentive” by working with the government (see Appendix M). Governmental agencies commonly offer such incentive programs to communities involved in the conservation of an area. It is important that, “conservation organizations...illustrate that the achievement of a healthy environment often actually contributes to a robust economy” (Babylon, 2003, p.7). Effective conservation of land does not require the land to be completely closed for human usage, but limits the acceptable uses for the land. This allows people to still benefit from the land as a source of income, while maintaining the environment for future generations and allowing them to benefit as well. In addition to money raised by exploiting natural resources, communities can also raise income by using land for recreational and educational purposes.

The ties between the community and the government are another benefit of community-based conservation. The government and the community are able to work together to develop plans for an endangered area, each bringing forth different views and powers to the process. By working with the government, community groups know what is expected of them and the legal issues involved in the land. Meanwhile, the government can gain local expertise and input to improve their decision and evaluate its impact on the community (Western, 1994, p.330).

Although there are many positives to community-based conservation, there are some challenges associated with it. In areas that resist governmental intervention, sometimes it is difficult to initially establish community-based conservation programs without incentives and compensation.

Several case studies apparently assume that if a conservation activity is situated locally and involves local populations, then it is participatory. The presence of a national park or protected reserve administered by a central government entity almost inevitably means that participatory CBC will be highly constrained if not impossible and that strong monetary or other types of compensation will be required to offset losses in land or income (Western, 1994, p. 355).

People are not always eager to become involved in this type of conservation. Often local individuals concerned about their own finances view government and businesses as a threat to their personal welfare. Also, another problem may arise; namely, that the government may overlook the community as a whole. In past instances, the government considered only selected individuals who have expressed interest in preserving local threatened land, rather than the interests of the entire community. Without proper consideration of the attitudes of the entire community, some people may be overlooked and plans may be placed into action that do not reflect the area's interest (Babylon, 2003, p.8). Conflicting ideas for land usage between the government and community members is a major problem that often hinders progress of land conservation projects. (Western, 1994, p.429).

### **2.8.3 Community Efforts in Puerto Rico**

There are several successful community-based preservation efforts in Puerto Rico. Their experiences helped us develop an effective preservation strategy and management plan for los Ciudadanos pro Bosque del Plantío to use.

#### **2.8.3.1 Ciudadanos pro Bosque del San Patricio**

Within Puerto Rico, community-based management has been used in order to increase protection for natural ecosystems. El Bosque del San Patricio is a forested area located near San Juan, in the northeast section of Puerto Rico. It is home to a variety of exotic animals and unique plants native to the area. After businesses expressed interest in developing the area for manufacturing purposes, los Ciudadanos pro Bosque San Patricio, a group of concerned community members, formed to protect the important natural habitat (Almeyda, 1998, Citizens pro San Patricio). The area now offers educational and recreational opportunities including a system of hiking trails and a park. They are currently developing a bird sanctuary to educate the community about the unique environment that surrounds them. The group has researched the native animals, plants, and the unique landscape to show its important role in the natural ecosystem. The group worked with the Department of Natural and Environmental Resources (DNER) to develop a law that allows them to co-manage the land, thus providing them with more control over acceptable uses for the area. The success of this group has served as a model for other communities in Puerto Rico, including the Municipality of Toa Baja in their fight to protect el Bosque del Plantío.

### **2.8.3.2 Casa Pueblo**

Other important lessons can be learned from the experiences of the Casa Pueblo group. Casa Pueblo formed in response to a plan to begin open pit mining in the mountains of central Puerto Rico. This group faced tremendous opposition from both the governmental and commercial sectors and still managed to both stop the mining effort and turn the area into a useful resource for the community, providing educational benefits in addition to its natural value as a source of clean water.

Casa Pueblo's approach was radically different from all previous preservation efforts in Puerto Rico. They fought for a system of forest management that gave the responsibility for maintaining and utilizing the forest to the community instead of the government. This approach was difficult but ensured that the effort would faithfully serve the interests of the community. Casa Pueblo's experiences taught them the following lessons that are widely applicable (Gonzalez, 2006, p.27):

1. Focus on human development, such as quality of life issues and community self-reliance.
2. Highlight environmental services, like clean water, that the forest provides.
3. Concentrate on learning and personal growth.
4. Offer new economic opportunities.
5. Make it easy to become part of the process.
6. Prepare scrupulously, with academic and technical expertise.
7. Demonstrate public backing.
8. Have a trustworthy and effective governmental intermediary.
9. Give management agreements the time and flexibility to evolve.

10. Make effective use of limited resources, attracting volunteers by offering everyone an equal share in decision-making.

11. Continue to bring in new stakeholders to widen the circle of participation. These lessons will help other communities run successful preservation campaigns and management efforts of their own.



**Figure 13: Casa Pueblo Community Group**

### **2.8.3.3 Ciudadanos pro Bosque del Plantío**

The Karst forest, el Bosque del Plantío, consists of privately owned lots throughout the seven communities of Toa Baja. After two landowners expressed interest in developing their lots nearby the community of el Plantío, residents formed los Ciudadanos pro Bosque del Plantío to combat this developmental pressure and protect the area's valuable environmental resources. The group approached the Planning Board of Toa Baja where they were assured the area would not be developed. After a new mayor took office, the appointed planning board granted the landowners the right to pursue their developmental projects. Through a legal hearing, an injunction was placed on the forest that ceased any development of the area for a maximum of eight years, during which time developmental alternatives could be presented to the Planning Board. Looking for sources of funding to possibly purchase the land and develop practical

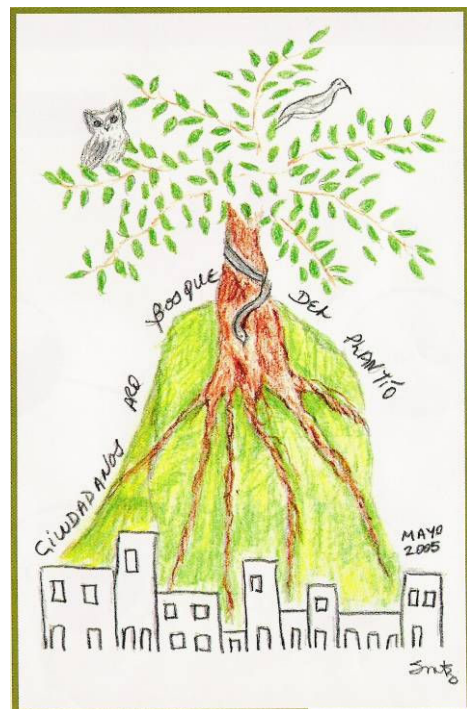
alternative uses, the community group approached the Department of Natural and Environmental Resources. At a market price of nearly \$800,000 for one four acre lot of land, the direct purchase of the land is not feasible for the DNER. However, with the resources of the DNER, the community is looking for another alternative that will guarantee the conservation of the area.

Presently, the Municipality of Toa Baja is in the process of proposing a new land-use plan under which all land will be reclassified. Under the Municipality's proposed zoning plans, el Bosque del Plantío is classified as a protected area restricting all development. Also, as part of the central government's (Planning Board) zoning plan –

which is also under review – the forest is marked to be conserved. The support of the planning board is very important to help ensure protection into the future. The Municipality's plan is in the fifth and final stage for approval and is now subject to public hearings. These hearings, which will take place in June and September 2006, allow the public to voice support or criticism for the proposals in an effort to help finalize the land-use plans for Toa Baja. If able to preserve this area, the

community of el Plantío would like to maintain the area to educate local students about the unique flora,

species, and karst characteristics and the importance of preserving natural ecosystems.



**Figure 14: Los Ciudadanos pro Bosque del Plantío (Los Ciudadanos pro Bosque del Plantío, 2005)**

### **3.0 Methodology**

The main goals of our project were to detail environmental and educational reasons to conserve el Bosque del Plantío, and – using the area as a model – develop an effective series of steps based on the USDA’s Wildland-Urban Interface Assessment that other areas in Puerto Rico can use to prevent undesired development. In order to reach our goals, we met a series of objectives, including understanding the community members’ attitudes and goals for the area, identifying developmental pressures and environmental concerns, and evaluating the educational alternative uses for the area. This chapter outlines the methods used to achieve our specific objectives in order to reach our goals.

#### **3.1 Identify Regional Plans, Goals, and Developmental Pressures**

To identify the regional plans and goals for el Bosque del Plantío, as well as determine the developmental pressures the forest is facing, we held interviews with the community group from el Plantío and the Director of the Toa Baja Planning Board. These interviews revealed the attitudes of both the community group and the Planning Board towards the forest and its possible future uses.

##### **3.1.1 Interview los Ciudadanos pro Bosque del Plantío**

We interviewed los Ciudadanos pro Bosque del Plantío to understand why the group is working to conserve el Bosque del Plantío. We were also able to determine what previous work had been completed by the group regarding the forest, and acquire contacts within the Municipality. The interview was conducted informally to allow for greater personal communication, encourage involvement from the whole group, and allow for open-ended responses. The questions were asked in an unbiased manner, solely to learn about the community group’s history, the work they have been doing, and what they would like to see the area used for

if the forest is preserved. We also identified the developers that are currently interested in the area.

### **3.1.2 Interview Toa Baja Planning Board**

We conducted a personal interview with Rebecca Rivera Torres, the Toa Baja Planning Board Director, to determine the status of the proposed zoning plan for Bosque del Plantío, and learn more about the roles the government and municipalities play in deciding land usage. Questions regarding the Municipality and the forest were asked in an unbiased manner, so that we could gauge the Director's true attitude towards the area. We acquired the proposed land-use plan for the Municipality of Toa Baja, and learned how it will affect el Bosque del Plantío if it is approved (See Appendix B).

### **3.1.3 Interview the Human Resources Director of Toa Baja**

We met informally with Elías F. Sanchez-Sifonte, the Director of Human Resources in Toa Baja, both to show outside support for the agenda of los Ciudadanos pro Bosque del Plantío, and to determine whether or not the Mayor of the Municipality was in general agreement with the proposed land-use plan for Toa Baja. As a confidant and close partner with the Mayor, we decided that his answers would truthfully reflect the Mayor's attitude towards the Municipality as well. If the Municipal government agreed with the community group, their goals for the area would be much easier to achieve (See Appendix C).

## **3.2 Identify Environmental Concerns that Would Preclude Development**

It was important to identify the major environmental concerns that that can be used as an argument against development. As described by Worcester Polytechnic Institute's professor Roger Gottlieb, a professor of environmental philosophy and an established author, (personal



communication, February 7, 2006), areas that hold an important environmental purpose are much more likely to be conserved than areas that cannot make a strong environmental claim (see Appendix O). To determine the functions el Bosque del Plantío serves, we reviewed previous academic research done on or in the forest, investigated the mogotes ourselves with the help of local experts, and analyzed the area's characteristics using GIS data from the Department of Natural and Environmental Resources.

### **3.2.1 Review Previous Academic Work**

Graduate students from the University of Puerto Rico have completed research in the area to identify local endangered species and their role in the ecosystem. Also, some information regarding the connection of karst regions and natural aquifers was prepared during past studies of the area. Through our contact with Wanda Crespo, a graduate student working with los Ciudadanos pro Bosque del Plantío, we were able to obtain the results of the community group's investigations and use them to strengthen our own findings.

### **3.2.2 Field Research Species Identification**

With the help of local community members and researchers from the DNER, we hiked through the mogotes to determine several important qualities of the land:

1. What are the characteristics of the terrain? Is it suitable for hiking, building, or neither?
2. What is the vegetation like? Is there fallen wood that could be used by the municipality?
3. What unique geographic attractions, such as caves, exist in the area and where?
4. What endangered species can we locate ourselves during a simple day-hike?

Throughout the hike we kept photographic documentation of our findings, logged species names in a notebook, and recorded GPS waypoints documenting both our path through the mogotes and the precise locations of important findings.

### **3.2.3 GIS Analysis for Karst Characteristics and Aquifers**

With our field GPS data, we used GIS to analyze our findings. Using data collected by the Department of Natural and Environmental Resources and the US Geological Survey, we plotted our findings on aerial and topographical maps of the area to show the proximity of endangered species and unique geographical features to proposed and current developments.

While the ecosystems and specific endangered local species are a valuable argument for the conservation of the forest, it was also important to stress the environmental value the area offers to the community. This argument was made by comparing the location of the el Plantío mogotes to existing GIS maps of the aquifer networks in northern Puerto Rico and local fresh groundwater well locations. If we were able to demonstrate a link between el Bosque del Plantío and larger aquifer networks, this information would help defend the proposed zoning plan for the conservation of Bosque del Plantío.

### **3.3 Identify Educational Value to Community**

Because the community group wanted to specifically maintain the mogotes as an educational center for the surrounding schools to visit, we investigated Casa Pueblo's successful environmental education program to use as a possible model for a similar program in Toa Baja. We also worked with local school administrators and teachers to evaluate feasible educational topics and determine their level of interest in using el Bosque del Plantío's resources for lessons and field trips.

### **3.3.1 Casa Pueblo's Community Value**

In order to understand how forest education could be implemented in schools, our group conducted a personal interview with a teacher from the educational center of Casa Pueblo, an established and successful community-based land preservation group. Casa Pueblo has a collaborative program with fourth and fifth grade classes at the Adjuntas Middle School. We also interviewed the director of the Adjuntas Middle School, Elín Cintrón along with an English teacher, Lillian Nieves. Through these interviews, we determined the steps Casa Pueblo took to implement an educational program at that school. We documented some of the educational services and opportunities that Casa Pueblo provides to the students at the Adjuntas Middle School. We also asked questions about the attitude of the students and other teachers towards the program (See Appendix D). The success stories of Casa Pueblo are a helpful reference for making suggestions to the el Plantío community group for educational programs in their specific area.

### **3.3.2 Educator Interest Survey**

After learning about the effect that Casa Pueblo had on their community and deciding to use their methods as an example for el Plantío, we needed to see if local educators incorporated information regarding el Bosque del Plantío or environmental issues into their lesson plans or had a future interest in doing so. We developed a survey for the teachers and administrators of schools within the Municipality that are close to el Plantío: Pajáros, Macún, and Candelaria (See Appendix E). We used this survey to find out what aspects of el Bosque del Plantío would be most applicable to the subjects taught at their schools.

The survey was conducted at six different schools - five at elementary schools, and one at a junior high school. At each of the six schools, questionnaires were given to the director,

science teachers, and social studies teachers. Our sampling frame included the fifth and sixth grade level teachers and directors at the elementary school and seventh grade at the junior high school because students at Casa Pueblo were most receptive at these age groups. A total of twenty-eight questionnaires were distributed to the six schools.

### **3.3.3 Educational Valuation Method**

Within each questionnaire, respondents were given options that they would like to see incorporated into the el Plantío educational program. Each option consisted of a ranking system from 1 to 5 to allow the respondents to rank how interested they were in a particular topic. These ranking results were analyzed by comparing all possible educational options using the contingent rating system (Riera and Penin, 1997). Each option's ranking was totaled and compared to the best possible score of 90 (maximum of 5 points x number of respondents [18]). The option with the score closest to 90 was considered the best choice for the el Plantío educational program.

### **3.4 Application of the Wildland-Urban Interface Assessment**

Working with Edgardo González of the Department of Natural and Environmental Resources, we evaluated the United States Department of Agriculture's Wildland-Urban Interface Assessment (WUI), to see ways that it could provide suitable conservation plans to communities in Puerto Rico. Using our work at el Plantío and research about other Puerto Rican communities as case studies, we modified the Wildland-Urban Interface to apply to the unique environmental and societal issues present in Puerto Rico. We identified sections of the plan that would be useful to implement in Puerto Rico and documented potential drawbacks and gaps that arose in the transition. The following topics were addressed:

- 1) Major themes and needs for the program

- 2) Population and demographic importance
- 3) Economic issues
- 4) Land-use policy
- 5) Urban and social influences on forests
- 6) Forest resource management and conservation

The differences between Puerto Rico's diverse ecosystem and the southern United States studied in the original WUI Assessment were considered to determine different management approaches. In addition, the differences in the laws and social attitude toward environmental conservation were also considered while modifying the Wildland-Urban Interface to become a useful model for the conservation of threatened land throughout Puerto Rico.

### **3.5 Summary and Impact of Methods**

Through these methods, we developed project recommendations that effectively addressed our goals and objectives for both los Ciudadanos pro Bosque del Plantío and the Department of Natural and Environmental Resources. By evaluating the attitude of the regional inhabitants, particularly those of the community of el Plantío, identifying the developmental pressures and environmental concerns, and understanding the local regulations and policies we developed a solution that will help to conserve the forest for environmental and educational purposes to benefit future generations. Also, using our work as a case-study in the application of the Wildland-Urban Interface to Puerto Rico, the DNER will be able to provide guidelines and recommendations to other communities looking to protect natural resources from unwanted development.

## **4.0 Results and Analysis**

The results presented in this section provide the Department of Natural and Environmental Resources and los Ciudadanos pro Bosque del Plantío with information to support the community group's conservation effort of el Bosque del Plantío and provide useful ideas for the forest's future. Through research, interviews, and technical analysis, we determined the different goals of the community group and developmental pressures facing el Bosque del Plantío, generated data to reflect the environmental issues that would preclude development, and surveyed educators to determine the value of the karst forest for educational purposes. In addition to our results for los Ciudadanos pro Bosque del Plantío, we evaluated the Department of Agriculture's Southern Wildland-Urban Interface Assessment to determine how the DNER could adapt it to Puerto Rico.

### **4.1 Goals for the use of el Bosque del Plantío**

The regional goals for the use of el Bosque del Plantío were determined through a series of interviews. Group leaders of los Ciudadanos pro Bosque del Plantío, the director of the Toa Baja Planning Board, and the Municipality Human Resources Director provided us with their individual opinions. Through the interviews we gained multiple points of view on the mogotes of el Plantío and future uses for the forest.

#### **4.1.1 Los Ciudadanos pro Bosque del Plantío**

Los Ciudadanos pro Bosque del Plantío members want the mogotes surrounding their gated community to be fully conserved and protected for several reasons (See Appendix A). They expressed that the forest provides protection from dust and air pollution produced by neighboring industrial centers and helps regulate access to their community by outsiders. The group fought to cease all existing development that required the destruction of the mogotes and

is now fighting for the permanent protection of the land. This is important in order to maintain the biodiversity in the area, the habitats within the mogotes, and the overall appeal of the community of el Plantío. They would also like to renovate an existing abandoned house and offer it as an educational center for educators and schools to learn about the karst forests of the Municipality. Los Ciudadanos pro Bosque del Plantío want the ownership rights of the mogotes transferred from the private owner to either the community or an organization that can help manage and protect the area to benefit el Plantío and the surrounding communities. Currently, the el Plantío community group lacks a source of income and budget for purchasing and maintaining the area. They hope that through help from outside organizations, such as the DNER, they can obtain the funds needed to maintain the forest, and keep it from future development. For now, los Ciudadanos pro Bosque del Plantío members remain dedicated to fighting a hard battle in order to preserve the land.

#### **4.1.2 Planning Board**

The Municipality of Toa Baja Planning Board, headed by director Rebecca Rivera Torres, has proposed a land-use plan that designates the mogotes surrounding el Plantío as conservation areas, specifically called *tierra especial protegido* or specially protected land. However, the new zoning plan is still in progress – in the fifth and final stage of obtaining approval – and is subject to revision during public hearings in June and September 2006. If the plan is accepted and implemented, then no further commercial, residential, or industrial development will be allowed in the mogotes (See Appendix B). It would ensure that a permit for development will be prohibitively difficult if not outright impossible to obtain. The support of the Planning Board of Toa Baja is important to the conservation effort of los Ciudadanos pro

Bosque del Plantío, and if the new zoning plan is accepted and enforced, it will ensure the mogotes remain undeveloped.

#### **4.1.3 Human Resources Director of the Municipality of Toa Baja**

By interviewing Elias F. Sanchez-Sifonte, the Human Resources Director of Toa Baja, we learned about the Mayor of Toa Baja's stance on preserving the land of the Municipality, and what power the Municipality has in governing and owning land (See Appendix C). As a confidant of the Mayor of Toa Baja, Sr. Sanchez-Sifonte stated that one of the Mayor's main focuses is to protect the karst region. When he learned of the efforts of los Ciudadanos pro Bosque del Plantío, the Mayor took a stand alongside the community. Although for many years the Toa Baja area was neglected and there was over-development, the Municipal government has made efforts to preserve environmentally important lands in recent years. As an example, when the car dealership (see 4.2.2) began expansion – destroying sections of the mogotes in the process – the Mayor intervened and a cease and desist order was issued. The community group can take comfort in the fact that the Mayor presiding during the development of the land-use plan strongly supports the protection of the mogotes.

However, having the support of the Mayor does not mean that los Ciudadanos pro Bosque del Plantío will see the mogotes protected immediately. The government of the Municipality does not have the power to step in and claim ownership of the land. The 33 acres of mogotes surrounding el Plantío belong to a single private landowner. The Mayor and the Planning Board are currently negotiating with this private landowner to grant him ownership of lands designated for development in exchange for the environmentally important mogotes – a tactic that would help to ensure the immediate preservation of the forests while the land-use plan is under review, and place the land in safer hands for the future. The Municipality also stated that



it does not intend to retain possession of the land, as that could potentially place it in jeopardy during future administrations. The municipal government intends to entrust the land to a competent community-based conservation group.

The Director also stated that before the government would provide community groups, such as los Ciudadanos pro Bosque del Plantío, with the resources and tools for implementing and managing programs (such as educational centers or hiking trails), the full commitment and support of the community must be apparent to the Mayor. For now, both the Municipality government and los Ciudadanos pro Bosque del Plantío want the mogotes to be preserved in their current state, and the preservation effort is moving forward.

## 4.2 Developmental Pressures

It was important to establish the developmental pressures threatening the mogotes so we could offer feasible recommendations for the future maintenance and use of the area. By interviews with the community group, los Ciudadanos pro Bosque del Plantío, and through personal field work, we were able to establish three present threats: an apartment complex, car dealership, and a cell phone tower (Figure 15 – Larger version in Appendix F).



**Figure 15 (Appendix F) Proposed Developments (DNER, 2006)**

### 4.2.1 Apartments

A private owner of the 33 acres of the mogotes surrounding el Plantío has requested to construct between 57 – 67 apartments, a 100 car parking lot, swimming pool, and other facilities on a 1.5 acre lot. When asked to sell his land, he asked for a significantly larger amount than his

purchasing price (see Appendix B). The area he owns borders the mogotes, and any development would cause destruction of the land and important ecosystems. The development of the apartment complex would increase traffic through el Plantío and introduce a new demographic of residents, both of which the association members of el Plantío strongly oppose (see Appendix N).

#### **4.2.2 Car Dealership**

A car dealership located in Candelaria, on the opposite side of the mogotes and outside the gates of el Plantío, began excavating a significant portion of the mogotes to expand its capacity. The company destroyed more than their permit allowed, and they were forced to stop construction. This developed area upset community members of el Plantío because it has ruined that area's karst formation, and many trees and plants were disturbed in the process.

#### **4.2.3 Cell Phone Tower**

A cell phone tower exists on the side of the mogotes closer to Candelaria. There is an access road from a main street leading to the tower, and it is adjacent to the destruction of the mogotes from the car dealership. The community group recognizes the street as a future access point to the mogotes, especially if it becomes an educational area, but the construction of the tower disturbed the surrounding land similar to the car dealership development.

### **4.3 Environmental Findings**

This section provides the data we collected to identify environmental concerns that would preclude development of el Bosque del Plantío. Our results indicated that there are sound scientific reasons to conserve the forest.

### 4.3.1 GIS Map of Area

During our hike to identify the plant species and geographic features in the mogotes of el Plantío, we took GPS readings to record the route we took through the mogotes and the locations of important landmarks. These data were combined with



**Figure 16 (Appendix G): GIS Exploration Route and Fresh Water Wells Map (DNER, 2006)**

satellite imagery from the DNER to form an overview map of Bosque del Plantío (Figure 16 / Appendix G). This map clearly depicts the location of the Palo de Rosa seedlings and adult tree, the largest cave-like formation, and the area cleared for a cell phone tower. The map also shows the location of seven fresh water wells in close proximity to the mogotes. These wells draw upon clean groundwater provided by the karst formations of which Bosque del Plantío is a part.

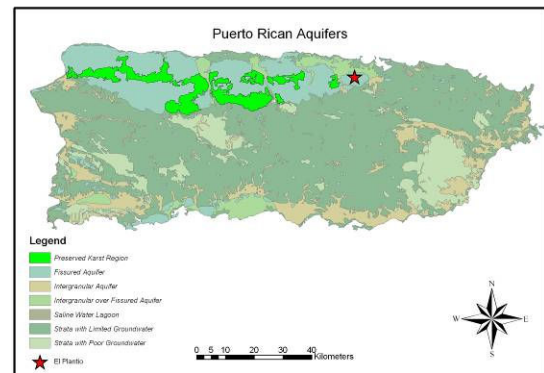
### 4.3.2 List of Species with Photos

After mapping the points of interest in the mogotes using GIS, a catalog was compiled with the various forms of vegetation seen on our hike within the mogotes (See Appendix H). This catalog included pictures and scientific information of the various plants found on the hike. The most important plants discovered were the Palo de Rosa and the Palo de Cruz. Palo de Rosa is an endangered species, while Palo de Cruz is endemic to Puerto Rico. There were also two rare species seen within the forest, specifically the Nigua and the Negra lora. Since we explored only this small section of the mogotes, there is a possibility that other endangered or threatened species remain to be discovered.

The catalog that we compiled contained only about a third of the actual species in the area. With the assistance of Victor Rodriguez, a research forester of the DNER, an expanded list of the plants that reside within this section of el Plantío mogotes was developed in order to give the community group information about the natural vegetation in the area (see Appendix I). All of this information can be used to help the community group of el Plantío make their case stronger by providing specific information to the planning board about the flora and fauna of the mogotes.

### 4.3.3 GIS Aquifer Map

The GPS location of Bosque del Plantío was also overlain with aquifer data from the United States Geological Survey to determine what type of aquifer it is (Figure 17 / Appendix J). As seen in the resulting aquifer map, Bosque del Plantío is classified as a “Fissured Aquifer (Including Karst and Volcanic Aquifers).”



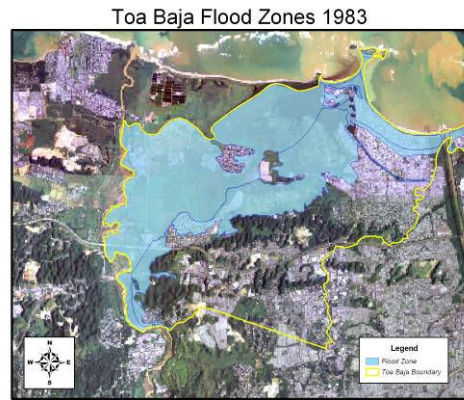
**Figure 17 (Appendix J): Aquifers Map of Puerto Rico (with protected karst highlighted) (DNER, 2006)**

Large areas of this same type of formation have already been designated as protected areas all across the northern coast of Puerto Rico (as seen in the map). This further affirms the value of this type of formation as a contributor to clean water.

### 4.3.4 Proximity Analysis

At the request of los Ciudadanos pro Bosque del Plantío, and with the help of the DNER, we performed a proximity analysis to determine the extent to which Bosque del Plantío contributes to clean air and water for communities outside el Plantío. During this process several additional maps were created to show changes in the land area of the Toa Baja mogotes over the

last thirty years and their relative location to industrial, residential, and commercial areas, and areas prone to (or protected from) flooding. In short, the proximity analysis showed that Bosque del Plantío is not large enough in land coverage area by itself to provide a benefit to Toa Baja as a whole. However, when combined with the larger karst mogotes found elsewhere in Toa Baja, the mogotes collectively provide a valuable service to Toa Baja by preventing flooding and contributing to cleaner air.



**Figure 18 (Appendix K): Toa Baja Flood Zones (DNER, 2006)**

The floodplains map shows a clear demarcation line between flood-prone and flood-safe areas running directly along the large range of mogotes (Figure 18 / Appendix K).

#### **4.3.5 Developmental Suitability**

Through a series of interviews and case studies, we determined the developmental suitability of karst regions – in particular the karst mogotes of el Bosque del Plantío. The karst belt of Puerto Rico has experienced many developmental problems due to its instability and porous characteristics. Sections of PR-10, a major highway that links Arecibo in the north and Ponce in the south, were developed over karst regions (Figure 19). Through a study of PR-10 we determined that developing karst regions is unreliable, dangerous, and much more expensive to maintain over a period of time than developing on stable ground. In a 1.7 mile stretch of highway construction through the Río Abajo State Forest, the



**Figure 19: PR-10 Developmental problems (Puerto Rico Herald, 2004)**

highway has experienced sudden collapses due to karst characteristics such as natural sinkholes and underground cavities of water. In fact, a biological assessment completed by the U.S. Department of Transportation revealed that thirteen sinkholes exist along the highway over this stretch (DOT, 1994, p.9). As a result, this stretch of the highway is constantly maintained and monitored to protect against a disastrous collapse that could harm civilians or close the highway. Due to the extra precautions and engineering efforts taken to maintain the highway, PR-10 is among the most expensive roadway projects in the history of Puerto Rico. The final segment, from Utuado to Adjuntas is expected to cost over \$100 million alone by its completion in 2007 (Puerto Rico Herald, 2004). This case study shows the inherent instability of karst regions and demonstrates the unsuitability of such regions for developmental purposes.

To determine the developmental suitability of el Bosque del Plantío, we conducted a series of interviews with the community groups from el Plantío and a neighboring village, Macún. The community group from el Plantío revealed that minimal flooding occurs within their community due to the surrounding karst's natural drainage system. To support their claim, we met with the community group from Macún, los Vecinos Unidos en pro de Macún. After the development of the PR-22 highway destroyed parts of the mogotes protecting Macún, the community experienced several negative environmental effects. Representatives from their community group mentioned that the highway contributes to an increase in temperature and flooding in sections of the community. Areas on the opposite side of the highway from Macún – former mogotes used by the community for farming and recreational purposes leveled for the highway construction – are now highly susceptible to flooding and not suitable for development. In comparison, there is little flooding in the other areas of Macún that are still protected by the karst forests of el Bosque del Plantío. These results show that el Bosque del Plantío serves an

important natural function to its neighboring communities and that the forest is not suitable for development.

#### **4.4 Educational Benefit**

In addition to serving important natural functions, el Bosque del Plantío can potentially offer educational and social benefits to surrounding communities. In order to identify the most feasible uses for the forest, we evaluated the efforts of Casa Pueblo in Adjuntas and surveyed local educators to determine what educational uses they would prefer.

##### **4.4.1 Casa Pueblo as a Case Study**

Casa Pueblo's educational program was designed to educate students about the importance of preserving their forested area and provided us with a model that could be adapted to help el Plantío become involved in schools within the Toa Baja area. First, Casa Pueblo worked with the University of Puerto Rico to develop an educational program for the neighboring Adjuntas elementary school. Once the curriculum was developed, members of Casa Pueblo presented their proposal to the director of the Adjuntas school. Their plan was to supply an additional classroom and teacher to work with 4<sup>th</sup> and 5<sup>th</sup> grade students on both managerial and scientific projects. These grade levels were selected because students at that age are typically open to trying new programs and are capable of being given some responsibility. The director reviewed the project and agreed to implement it into the Adjuntas curriculum. Since then, students involved with the Casa Pueblo program have improved in both leadership skills and grades.

The Casa Pueblo program provides the students with many activities to learn about the protected area and what it has to offer. Students tend to butterfly gardens, transplant trees, and learn about various management techniques to maintain the forested area. They also learn about

what services the forest provides, such as cleaner air and water. Field trips are made to both the forest and the University of Puerto Rico for students to work with the people of Casa Pueblo and professors in order to conduct experiments and collect data. When Casa Pueblo hosts awareness events, students act as tour guides and help describe exhibits. These types of programs were used as examples to give the people of el Plantío an idea of what types of activities they could offer at their site.

All people involved in the Adjuntas program had very positive attitudes about the opportunities it provides to the students. Different aspects of the Casa Pueblo class have even been incorporated into other subjects at the Adjuntas school. Many children participate more and take more interest in school since the inclusion of the Casa Pueblo program in their education. The community has been very happy to work with the people of Casa Pueblo and supports their children's involvement in the program. Newspaper articles are used to inform the people within the school district of upcoming activities and to inform the community about ways that they can participate. This type of information keeps the community actively involved in the program.

#### **4.4.2 Survey Results**

Replies were obtained from five out of the six schools in the el Bosque del Plantío area that we surveyed. We believe that the last school did not reply because there was no previous communication between the school and the el Plantío community group. The raw data that were collected can be found in Appendix L. These data were used to learn about what educational programs existed within the schools already and what future educational programs were of interest to the schools if el Plantío provided the schools with an educational center. We received eighteen responses (out of twenty-eight original questionnaires) from directors, teachers and (to



our surprise) students. Most of the teachers surveyed taught Science or Social Studies. Each individual's career length at their respective school ranged from three to thirty years. This broad response gave us many perspectives on the topic. An analysis of the data provided by the responses to the questionnaire found that in the opinion of the educators the average interest of students in the environment to be 3.9 on a scale of 1 to 5, with 5 being "very interested". This indicates that there is a significant interest in the environment among the students. At the same time, however, not many people were knowledgeable about the Los Ciudadanos pro Bosque del Plantío's work to protect el Bosque del Plantío.

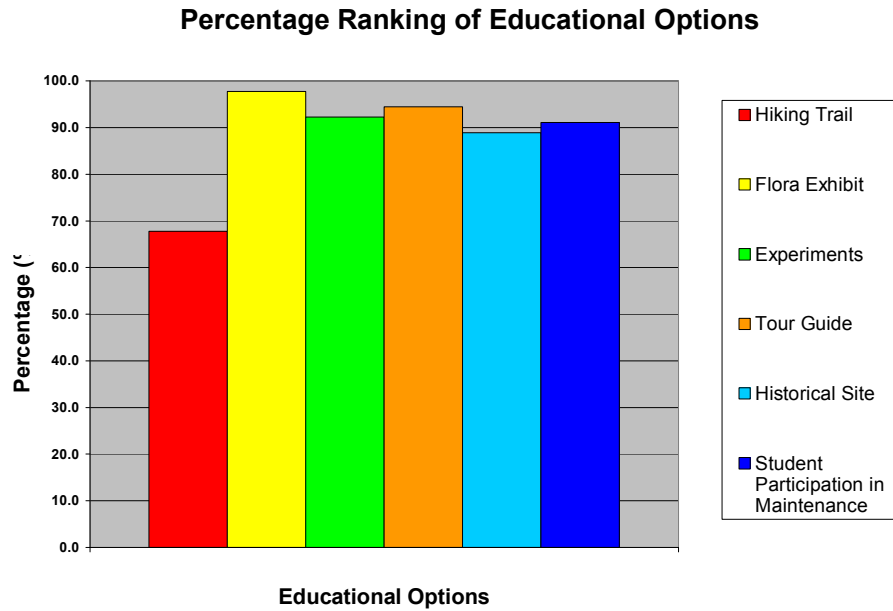
After the educators were supplied with basic information about the area surrounding el Plantío and the efforts of the community group, there was a unanimous interest in learning more about the Bosque del Plantío preservation effort and about seeing a future educational center constructed in the area. One fourth-to-sixth grade Science teacher surveyed mentioned that there is already a student organization that he/she works with in developing environmental protection plans. This teacher stated that this issue is personally important, and thinks some of the alternatives we have identified would provide excellent opportunities for students.

A majority of the schools' teachers and administrators showed a significant interest in incorporating a type of educational program within their own schools about el Plantío and would like to work with other schools as well in the process. There has also been some previous work done between a few of the schools that surround el Plantío. From the questionnaires we determined that the area schools do not participate in educational programs with each other, but they already collaborate on sports competitions between the schools. Although there is no existing academic link between the schools, the existing cooperation for sports programs suggests that further collaborative efforts – such as an environmental program – may be possible.

Some environmental studies, spanning fourth through ninth grade levels, are already established within these schools. Teachers convey the importance of the environment through lectures, projects, movies, and experiments. While almost all students learn about the importance of the environment, a smaller number learn about ecosystems, environmental conservation, contamination of natural resources, and endangered species. The teachers mentioned that if a program were developed by el Plantío, they would be receptive to teaching the students about the endangered and endemic plant species of the area.

#### **4.4.3 Valuation of Responses**

Using the questionnaires collected, we compared each of the possible el Plantío educational options using the contingency ranking method. The total possible score for each option was 90. The total raw score for each option was summed and compared to the total possible score, then converted into percentage form. These percentages represent the absolute interest level for a particular option. The flora and fauna exhibit was shown to have the highest interest at 97.8%. All the other options – except the hiking trail – appeared to have approximately the same high level of interest (Figure 20).



**Figure 20: Percentage Ranking of Educational Options**

In the percentage analysis, no solid conclusions about what activity was most favorable could be drawn. The hiking trail was the least favored option, although still holding about a two-thirds favorability rating, but no single activity was ranked significantly higher than the others. To gain a better sense of the respondents' opinions, we also compared the options to each other using a grouped chart (Figure 21). In this chart, each option's fives – or most interested – responses were counted and plotted. For comparison, other scores were included as well. This chart shows that the largest *number of people* were *most interested* in the flora and fauna exhibit. This distinguishes it as a clear choice for the first activity or facility to be implemented.

### Comparison of Percentage Ranked for Education Options

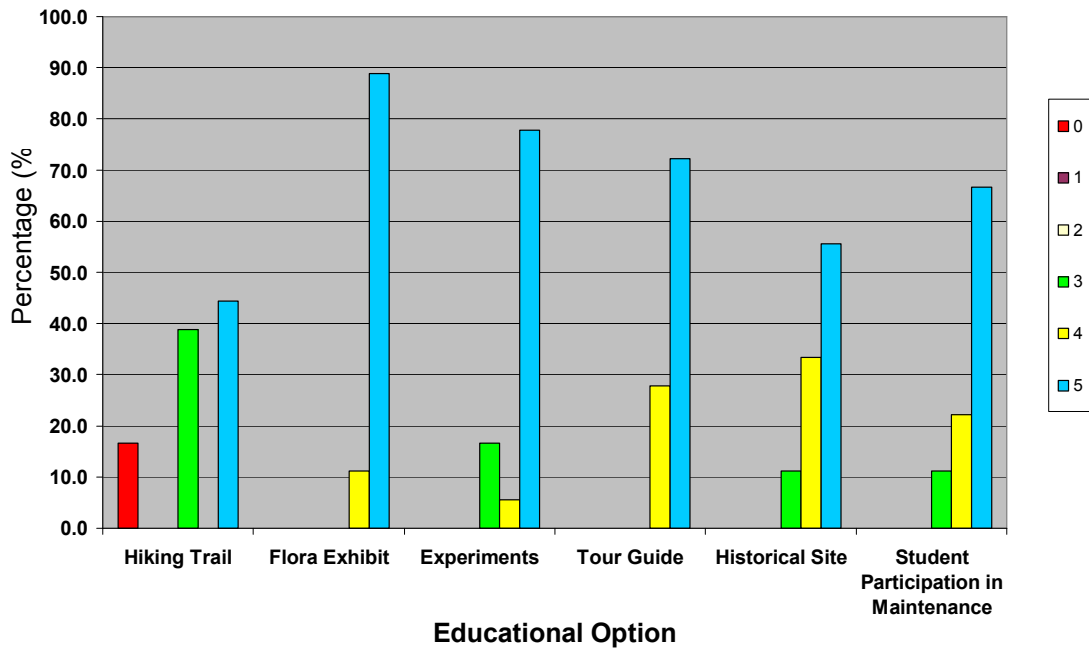


Figure 21: Comparison of Educational Options

Our last question simply asked for additional suggestions. One person suggested a virtual tour or video of what the mogotes had to offer (that would allow all visitors to see the area even if they are unable to hike into the mogotes). Another person suggested that we include information about the naval base near the mogotes. All of these data show the various interests that the schools have in different aspects and gives the community group ideas on what will draw educators to the area. It provides them with a starting point for ideas to incorporate within the educational center, with only more ideas to come in the future.

#### 4.5 Wildland-Urban Interface Assessment

To provide the Department of Natural and Environmental Resources with a set of guidelines and recommendations for conserving forested areas threatened by development in Puerto Rico, we evaluated the U.S. Department of Agriculture’s Southern Wildland-Urban

Interface Assessment. We used information gathered from the conservation effort to preserve el Bosque del Plantío to support our analysis.

#### **4.5.1 Application to Puerto Rico**

We modified the Southern Wildland-Urban Interface Assessment to take into account the difference in social, economic, geographic and environmental backgrounds between the southern United States and Puerto Rico. In order to provide the DNER with the most effective guidelines to promote environmental conservation throughout the island, we considered the unique characteristics of Puerto Rico including its social and ecological diversity, legal issues, and available resources learned through our research regarding el Plantío. Also, we compared the assessment to the current forest conservation program of the Puerto Rico Forest Service. While the current program provides separate procedures for areas classified as either urban or rural, it does not effectively provide management tactics for the interface areas where forests overlap urban areas.

##### **4.5.1.1 Major themes and needs for the program**

The Wildland-Urban Interface Assessment developed four major themes relevant to the Southern United States. First, in order to successfully manage and conserve wildland-urban interface areas, one must realize that interface areas concern people. Secondly, public policy also plays a major role both in creating and solving problems. Third, interface problems are rarely one sided, but often are interdisciplinary and affect many different viewpoints. Lastly, the wildland-urban interface exists over different scales, and sometimes involves multiple landowners and jurisdictions.

Puerto Rico's wildland-urban interface areas are subject to very similar themes. Wildland-urban interface areas in Puerto Rico often border local communities that are

experiencing population and economic growth – such as the communities of Toa Baja surrounding el Bosque del Plantío, San Patricio, and Casa Pueblo. As a result, the population’s attitude toward the wildland-urban interface in Puerto Rico is still the underlying issue toward its conservation or expansion. Puerto Rican public policy is also an important factor in creating and solving problems, as in the United States. New policies – such as Land Use Plans – passed by municipalities are often the subject of controversy among many opposing groups. In Toa Baja, for example, a large portion of Candelaria’s population is focused on industrial development, while communities such as el Plantío, Pajaros, and Macún favor community conservation efforts.

The Wildland-Urban Interface Assessment also suggested major areas to research when addressing interface problems. One must understand the human influences – including public policies and management systems – and threats to ecosystems in wildland-urban interface areas. Also, the assessment stressed that understanding and communicating public attitudes is important to solve problems effectively. These research areas are just as important in Puerto Rico.

#### **4.5.1.2 Population and demographic trends**

The assessment identified population and demographic trends as an important factor affecting conservation and development efforts in the wildland-urban interface. Changes in the population level and demographics in the South have altered people’s attitudes and priorities toward land-use (Macie, 2002, p.153). Puerto Rico is currently experiencing similar population growth trends. Because of this, most of this section’s interpretations are still relevant, but the exact figures must be updated to reflect Puerto Rico’s population growth rates and changing demographics.

#### **4.5.1.3 Economic issues**

The Wildland-Urban Interface Assessment addressed the importance of economic trends in the south. The development of new industries was identified as a catalyst for urbanization and deforestation. Tax rates and incentives for landownership also affected the attitude toward conservation in the south. The personal objectives of landowners – whether they are interested in making profit or maintaining land – was identified as a driving force for the status of an interface area. By determining what factors lead to economic and urban expansion in the municipalities of Puerto Rico, management of wildland-urban interface areas can be more effective. In addition, Puerto Rico’s historic widespread deforestation to create agricultural land – and subsequent partial regrowth – should be taken into consideration.

#### **4.5.1.4 Land-use policy**

Public land-use policies were also identified as factors that affect natural resource management and conservation. In the Wildland-Urban Interface Assessment, federal, state, and local land use policies have effects on the amount of land available for development. While the Federal and State policies offer broad land-use provisions, the local governments use policies such as conservation easements, land trusts, transfer/purchase of development rights, or incentive zones to manage growth. Puerto Rico is also subject to a similar land-use policy structure and the United States Federal environmental regulations apply to U.S. territories in the same way that they apply to states. In addition, the Puerto Rican Central Planning Board creates land-use plans for the entire island by working with local municipalities’ land-use plans. The individual municipalities also have planning boards that act in similar ways to town governments’ boards in the US, and use similar management tactics. The programs used in Puerto Rico are not as extensive, as land trusts and conservation easements are rarely implemented. A stronger

emphasis on the usefulness of conservation easements and trusts is needed to determine how they can be more widely used in Puerto Rico.

Historically, Toa Baja was not autonomous and did not have the power to make its own zoning plans. Without the use of this relatively straightforward mechanism to control land use, and a lack of public awareness of environmental issues, almost nothing was done to preserve valuable land. However, now that Toa Baja is in the final stages of gaining autonomy and is drafting their own land-use plan, they are using their power to designate important areas as conservation zones. Better information on what non-autonomous municipalities can do to encourage conservation may have helped to move the preservation process along years ago.

#### **4.5.1.5 Urban and social influences on forests**

The Wildland-Urban Interface Assessment provides a list of ecosystem goods and services that are affected by urbanization. Such goods included food products, plants, animals, tourism, and recreation, among others. Some of the ecosystem services provided are the maintenance of hydrologic cycles, regulation of climate, the cleaning of water and air, and providing natural beauty and research opportunities. El Plantío and its neighboring communities are examples of areas that would be negatively affected by development. El Bosque del Plantío is a source of a wide variety of native plants and animals, and provides recreational uses to the surrounding communities. The forest's natural beauty is also aesthetically pleasing and highly valued by the neighboring communities of el Plantío, Pajaros, and Macún, and serves as a visual barrier to nearby industrial centers. In addition, the forest provides natural protection to el Plantío by preventing access to the community by non-residents.

Social influences, such as forest industry growth, political and regulatory influence, recreational activities, and community and landowner attitudes are also identified as causes of



forest reduction. While the forest industry is not as strong in Puerto Rico, as demonstrated in Toa Baja, political and regulatory influence along with community and landowner attitudes toward land usage are still major factors in conservation and development.

#### **4.5.1.6 Forest management and conservation**

Several different areas for managing forests experiencing change are discussed in the assessment including: water resources, traditional forest products, fire, recreation, and wildlife. The assessment recommends educational programs for environmental managers to provide them with more effective methods for harnessing natural resources while maintaining the environment. Similarly, they recommend programs to increase the general public's awareness about the effects an expanding urban area has on natural resources. In Puerto Rico, there is also a lack of public awareness about the importance of protecting the environment. In areas of Toa Baja, some of the natural functions of the karst regions were affected by development projects such as highways, factories, and housing development, causing poor air and water quality, and increased flooding. In addition, Puerto Rico lacks a defined watershed management policy. The absence of a clear water management strategy combined with increasing population density and land-use pressure has historically caused rampant watershed mismanagement in Puerto Rico. Casa Pueblo was able to use the importance of managing forests for clean water to raise awareness of broader environmental issues. Because of the historical success of this strategy in Puerto Rico, it deserves special mention in this section.

#### 4.5.1.7 Wildland-Urban Interface Summary

Existing WUI Assessment Section	Southern United States	Puerto Rico (El Plantío, Toa Baja)
Population and Demographic Trends	<ul style="list-style-type: none"> <li>• Growing populations cause conflicts over land usage</li> </ul>	<ul style="list-style-type: none"> <li>• Similar to the United States</li> <li>• Limited land area causes conflicts</li> </ul>
Economic Issues	<ul style="list-style-type: none"> <li>• Economic conditions determine need for industrialization/development</li> <li>• Making profit vs. preserving land causes conflict of interest</li> </ul>	<ul style="list-style-type: none"> <li>• Economic motives of Municipality and land owners need to be identified</li> <li>• El Plantío has a mix of industrial, residential and rural land areas.</li> </ul>
Land-use Policy	<ul style="list-style-type: none"> <li>• Policies should minimize conflict               <ul style="list-style-type: none"> <li>• Long time residents/ Newcomers</li> <li>• Public and private land management needs</li> </ul> </li> <li>• Governmental roles in land-use:               <ul style="list-style-type: none"> <li>• Federal and State – determine available land</li> <li>• Local government – manage growth</li> </ul> </li> <li>• Use of conservation easements and land trusts</li> </ul>	<ul style="list-style-type: none"> <li>• Puerto Rico: Planning board land-use plan</li> <li>• Municipalities work on specific land-use plan</li> <li>• Needs more emphasis on easements and land trusts</li> <li>• Toa Baja land-use plan currently being reassessed.</li> </ul>
Urban and Social Influences on Forests	<ul style="list-style-type: none"> <li>• Logging Industry, recreational uses, and landowner attitudes affect rate of development</li> <li>• Urban and social influences threaten forest’s natural functions including: hydrologic cycles, regulation of climate, the cleaning of water and air, and natural beauty and research opportunities</li> </ul>	<ul style="list-style-type: none"> <li>• El Plantío provides natural protection, natural beauty, recreational uses, habitat to plants and animals, and educational opportunities.</li> <li>• Threatened by expanding bordering industries.</li> </ul>
Forest Management and Conservation	<ul style="list-style-type: none"> <li>• Federal programs for forest education               <ul style="list-style-type: none"> <li>▪ Educate environmental managers</li> <li>▪ Educate general public</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Community groups and government need co-management</li> <li>• More effective than federal efforts</li> </ul>

#### 4.6 Summary

Overall, through interviews, hikes, visits to surrounding and distant communities, GIS analyses, and a small survey, we have amassed scientific, social, and anecdotal information relevant to the efforts of los Ciudadanos pro Bosque del Plantío. In addition, this information provided us with the local experience necessary to evaluate the Wildland-Urban Interface in the context of Puerto Rico. Our results have indicated that there are sound scientific and social

reasons to preserve el Bosque del Plantío, and that the municipal government both agrees with the views of los Ciudadanos pro Bosque del Plantío and is uniquely poised to classify the forest as a protected area. Furthermore, local educators do in fact have an interest in using the area for educational purposes and have provided us with useful feedback regarding what they would like to see emphasized in any proposed educational use. With this information in hand, we are now able to provide conclusions and recommendations for future work.

## **5.0 Conclusions and Recommendations**

Our conclusions and recommendations are divided into two separate sections: one detailing environmental recommendations for Los Ciudadanos pro Bosque del Plantío, and one outlining our Wildland-Urban Interface recommendations for the Department of Natural and Environmental Resources.

### **5.1 Community Recommendations**

Using the information and results obtained through our work with Los Ciudadanos pro Bosque del Plantío we formed several conclusions and recommendations that will assist in the community group's effort to conserve Bosque del Plantío and maintain it in the future. This section contains our conclusions regarding the environmental significance of the forest, and recommendations for educational options, management strategies, and economic opportunities for the area.

#### **5.1.1 Environmental Conclusions & Recommendations**

The results of our investigations indicate that the area surrounding El Bosque del Plantío is environmentally valuable for several reasons, including: its value as an aquifer, the presence of the endangered Palo de Rosa, and the flood-preventative drainage characteristics of the karst. In the upcoming Land Use Plan hearings, the results section of this report and the associated appendices should be consulted to defend the proposed zoning plan from opposition. In particular, the Toa Baja Flood Plain Assessment (Appendix K) and the Map of Freshwater Wells (Appendix G) provide a strong practical argument for the conservation of the mogotes.

The proximity analysis did not show that Bosque del Plantío alone significantly affects the air quality of the surrounding area, however, the larger range of Toa Baja mogotes (of which

Bosque del Plantío is a part) indisputably provides a significant benefit to the municipality. Politically, it is wise to consider el Bosque del Plantío part of the larger range of mogotes.

The plant species catalog is not an authoritative assessment of the area because it covered only a limited area, but the confirmed presence of Palo de Rosa is an important consideration in future management of the area. The Department of Natural and Environmental Resources should be consulted regarding the proper care of the area immediately surrounding the Palo de Rosa seedlings, and department personnel should be brought in to thin the competing vegetation so that the seedlings have a better chance of long-term survival. The plant species catalog should also be useful in the development of educational materials or lesson plans. High-resolution versions of the vegetation photographs are included with this report and may be freely used for these purposes.

### **5.1.2 Educational Incorporation**

Preserving the Bosque del Plantío is important for environmental reasons, but the area can also serve as an educational asset for local students. The forest – readily accessible to nearby schools – can provide historical, cultural and scientific information to enrich the students’ education. After conducting our questionnaires, we found that some environmental work has already been done with students from the fifth and sixth grades, but none of it was specific to el Bosque del Plantío or karst mogotes. The educators demonstrated an interest in using resources from el Bosque del Plantío – specifically a flora and fauna exhibit and hands-on experiments for students – in their environmental curriculum. Because of this, we recommend that an educational center be developed and operated by the people of el Plantío and surrounding communities. This center would provide students, educators, and residents the opportunity to learn about both the

forest ecosystems present within their municipality, and the processes required to conserve and maintain them.

The center could include the following:

- Photographs with detailed captions documenting local flora and fauna.
- An area where students can learn how to plant and care for unique local species, such as the Palo de Rosa.
- A virtual tour of the mogotes, in the form of a film that would allow visitors to see the vegetation of the forest without increasing foot traffic in the mogotes or disturbing endangered species. It would also allow any visitor – such as young children, the elderly, or the disabled – to see more of the area without hiking through the difficult terrain.
- A hands-on exhibit on karst regions that demonstrates their important characteristics. For example, a piece of porous karst rock could be included in the exhibit, with captions explaining the manner in which it prevents flooding and provides clean water.
- An exhibit documenting the steps los Ciudadanos pro Bosque del Plantío took to protect the forest, and the detrimental effects development would have had on the area. Casa Pueblo, for example, created a model of their mountain range with areas removed to show the negative effect mining would have had on the region.

However, the establishment of such a center would be difficult without first incorporating el Bosque del Plantío into environmental lessons in the classroom. Using existing lesson plans and ideas available from the US Fish and Wildlife Service, Casa Pueblo, and other organizations as a starting point, a number of classroom activities tailored to Bosque del Plantío could be developed. The DNER has copies of a number of these lesson plan collections in printed form.

We recommend that los Ciudadanos pro Bosque del Plantío contact the DNER for more information and to review the potential plans themselves.

### **5.1.3 Management Options**

We formed three recommendations to help los Ciudadanos pro Bosque del Plantío effectively maintain the mogotes surrounding the community of el Plantío. They involve the government of Toa Baja, the Department of Natural and Environmental Resources, and the community group from Macún, respectively. If the community can demonstrate widespread support for a proposal, such as the establishment of an educational center, then the Toa Baja municipal government can provide some financial support for the project. The Toa Baja government expressed conditional interest in such a project, and therefore we encourage los Ciudadanos pro Bosque del Plantío to determine specifically what portion of surrounding communities would support their plans.

Secondly, the Department of Natural and Environmental Resources must have a role in the management of the Bosque del Plantío. During our hike through the mogotes we encountered a large number of Palo de Rosa seedlings located within thick undergrowth. The Department of Natural and Environmental Resources could help to carefully thin the undergrowth in the area to encourage the continued growth of the Palo de Rosa. Long term co-management with the DNER would be beneficial to maintain the species. Specifically, we recommend developing a Palo de Rosa recovery nursery. The DNER can provide resources needed to train members of the community as well as students from surrounding schools how to properly care for the species. A Palo de Rosa recovery nursery would allow el Plantío to gain recognition as a community that successfully protected an endangered species. This would be an accomplishment that the entire community and municipality could take pride in and could serve

as a symbol of their effort. The GIS files included with this report contain the GPS location of the endangered tree within the mogotes that the DNER will need to locate the species.

Finally, we encourage the community group in el Plantío involve the surrounding communities – to an even greater extent – in their efforts to conserve and maintain the forest. The forest is beneficial not only to el Plantío, but to the surrounding communities in Toa Baja as well. In Macún, los Vecinos Unidos en pro de Macún (a non-profit community organization that defends the interests of Macún) is also concerned about the future of the mogotes. They witnessed the consequences of deforestation when the PR-22 highway was constructed, and fear that flooding and similar problems would occur if the remaining mogotes were developed. Los Vecinos Unidos en pro de Macún expressed that they are very willing to work with other communities to support the preservation of the mogotes and promote alternative uses. Macún also shares a side of the forest with el Plantío, and by working together, there could be access to the mogotes for an educational center from a non-gated community, minimizing the security issues with which the community association of el Plantío is concerned. We recommend that los Ciudadanos pro Bosque del Plantío meet with Macún leaders in the near future to discuss possibilities for an educational center.

#### **5.1.4 Economic Opportunities**

Currently los Ciudadanos pro Bosque del Plantío are a non-funded organization, but there are options for raising funds for the construction of an educational center. The forest surrounding el Plantío contains a wide variety of beautiful plants, animals and scenic vistas. Using photography from our hike and additional pictures (particularly close-ups of flowers or seedlings, animal species, and views from the top of the mogotes), several calendars could be designed with a different local photograph for each month. We believe that a calendar would be



an appropriate and creative way to display the beauty of the mogotes and its wildlife. It could potentially draw more attention to the area, and provide a modest source of funding for los Ciudadanos pro Bosque del Plantío's efforts.

## **5.2 Wildland-Urban Interface**

In addition to providing a strong argument for the conservation of el Bosque del Plantío in Toa Baja, we worked with the Department of Natural and Environmental Resources to address their particular needs. Through the data collected by working with the community of el Plantío and the case-studies of San Patricio and Casa Pueblo, we were able to analyze the United States Department of Agriculture's Southern Wildland-Urban Interface Assessment and determine its relevance to Puerto Rico. This section will present our conclusions and recommendations for ways to adapt the Assessment to Puerto Rico to allow it to be used in the future.

### **5.2.1 Implementing the Wildland-Urban Interface Assessment in Puerto Rico**

After analyzing the Wildland-Urban Interface Assessment, we learned that much of the information provided is applicable to our case study of el Plantío and other areas of Puerto Rico. The population and demographic trends, economic issues, land-use policies, urban and social influences on wildland, and possible conservation management techniques must be addressed for each area being threatened by development. In the case of el Plantío in Toa Baja, these issues each played a major role in the conservation effort of the local community group. The wildland-urban interface conflict in el Plantío also identified gaps in the assessment that must be added to provide Puerto Rico with a management system that government agencies such as the DNER can use to help other communities conserve land in the future.

### **5.2.2 Other Needs for the Wildland-Urban Interface**

While much of the Department of Agriculture's Assessment is applicable to Puerto Rico, there were several sections that need modification or additions. The ecological diversity of Puerto Rico is greater than the southern United States; therefore, it is important to recognize the sensitive environment when creating management policies and educational programs for the public. The interface assessment for the southern United States was initially established to provide methods to manage wildfire problems. In comparison, in Puerto Rico the focus of the wildland-urban interface rests on protecting the natural role and functions of the fragile and sensitive ecosystems.

Despite prior use of co-management systems between communities and governmental organizations to protect forested land, Puerto Rico's established co-management policy does not provide community groups with adequate information for the establishment of such systems. In Puerto Rico, community based management is an effective method of conservation that can decrease the strain placed on the resources of environmental agencies. The Wildland-Urban Interface Assessment should be adapted to emphasize the importance of co-management in Puerto Rico. We recommend that the Department of Natural Resource and the Environment expand community-based conservation efforts by educating the public about the steps needed to implement a co-management program and the possible benefits it brings. The DNER must establish relations with communities being threatened by development, determine possible goals/compromises for the use of the land, recommend the establishment of an official community group to head the efforts, and train community members in group communication and analysis. By working with el Plantío, we learned that within the community much confusion exists about the role municipalities have in implementing land-use plans and providing resources. To develop an effective management system, the community members must be

educated about the roles municipalities and the DNER hold for developing land-use strategies. The results from our contact with the municipal government of Toa Baja provide a basic overview of these roles. After this educational process is complete, community support for conservation efforts should increase and the DNER can train community members to properly manage their land with less government intervention.

Furthermore, the extremely fast regrowth rates experienced in abandoned areas of Puerto Rico places a special emphasis on the reclamation of cleared land. Abandoned areas in and around cities, including former military bases, can often be turned into valuable urban forests and serve the surrounding communities. This was not addressed in the Southern United States Wildland-Urban Interface Assessment and a section specific to Puerto Rico's tropical climate and plant species should be added.

Through our analysis of the Southern Wildland-Urban Interface Assessment, we recommend that the DNER reorganize its current forest management system to include the themes of the Wildland-Urban Interface. The important themes presented in the original assessment, in addition to our additional areas of recommendation specific to Puerto Rico, will provide the DNER with a comprehensive, organized conservation procedure for interface areas that were not addressed with the current rural and urban management systems.

### **5.3 Summary**

By following these recommendations and consulting the supporting results sections of our report, the community group should be well equipped for the remaining land-use hearings. If everything continues as planned, the municipality will handle the transfer of land-ownership and the area will be protected. At that point, with the support of the rest of El Plantío and the communities surrounding the mogotes, preparations for a local educational program and/or

center can commence. Long-term management of the area can be accomplished through the negotiation of management agreements with the municipality of Toa Baja and the Department of Natural and Environmental Resources.

The Wildland-Urban Interface assessment already provides a good general overview of the issues involved in preserving interface areas and much of it applies to Puerto Rico. It establishes a more thorough procedure for managing interface areas that were not addressed by the current forest management procedures. With the addition of the sections previously discussed, it can serve as a valuable political tool and starting point for future conservation efforts.

#### **5.4 Possible Future Interactive Qualifying Projects**

Throughout the course of our project, we identified several important aspects that can be expanded into future projects including the following:

- A Palo de Rosa recovery nursery in the mogotes of Toa Baja would include research into the lifecycle of the species to allow for more effective transplanting and the continued growth of the endangered plant. The project would also assess the positive influence that the nursery would have on neighboring communities and the entire municipality, and would allow for community participation.
- An educational program could be incorporated into the school systems surrounding the mogotes of Toa Baja. This project could work to develop possible lesson plans to portray the significance of the unique ecosystems in the nearby karst forests. The lesson plans must be evaluated to include reference to local flora and fauna species present in the mogotes.
- Another project could be developed if there is support for the construction of an environmental educational center in Toa Baja. This project could include researching

more important characteristics of the karst forests, and designing exhibits to highlight them most effectively – including a possible virtual tour of the forest. This center can be used to educate the general public about the importance of the mogotes, and can also be incorporated into the lesson plans of local schools. An educational center will provide an important use for the forest to help ensure their survival into the future.

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## **Appendix A: Interview Summary – Los Ciudadanos pro Bosque del Plantío**

On March 14, 2006, we visited el Plantío in the Municipality of Toa Baja. The interview was between our four team members, Edgardo González of the DNER, and eleven members of the community group. Wanda Crespo, our main contact within the community group, explained the goals of the group and the previous work that they have done prior to our arrival. She gave us a brief history of el Plantío community, stating that they were the first gated community in Puerto Rico. As a group they've made trips to the mogotes that surround them, and said they feel protected because the hills keep outsiders from entering the community. They provided us with a CD-ROM and printed copies of maps that showed the hydrology of the area and the location of the other communities. Wanda also explained the injunction that had been placed on an area where a private land owner hopes to build apartments. The proposed complex was for between 57-67 apartments, a 100 car parking lot, pool, and other facilities. The group was very opposed to this construction, and Wanda gave us a copy of the legal injunction, P. del S. 83. We were told that in the same area where there is proposed construction, they would like to see an educational center for schools to come and visit, to get children involved in their effort.

After hearing the community group's concerns and goals for the area, we were asked to explain what our thoughts on the project were, and what we have done so far. Ian explained to them our visions of the project, the research we have done, and what we would like to see happen in the area and with the project. The group responded, and again stressed their wants to have something educational come out of the project. Times were set up for us to visit the area, drive around to the other surrounding communities of Macún, Pajaros, and Candelaria, and to go on a hike through the mogotes.

## **Appendix B: Interview Summary – Toa Baja Planning Board**

### ***Questions:***

- 1) Could you explain the current land use plan being considered for Toa Baja?
- 2) How solidified is the plan that is being worked on and how much is still up for debate?
- 3) How will this affect el Plantío and other surrounding communities?
- 4) How close is the process to being completed?
- 5) What happens once it is re-zoned as a protected area? We have heard after the zoning process is complete the municipality has eight years to possibly purchase the land, could you explain this situation?
- 6) What is the current zoning for the area and how much is protected?

### ***Summary:***

On March 22, 2006, we completed an interview with the Director of Planificación for the Municipality of Toa Baja, Rebecca Rivera Torres. The main goals of the interview were to discuss the current zoning laws for Toa Baja and to review the new re-zoning plans for the area.

### **Project Goals:**

Brendan discussed the group's current plans for the project. He mentioned how currently we wanted to find out more information about the current land use plan along with the future plans for the area in order to help el Plantío use their area as a future educational center.

### **Re-Zoning Plan:**

Mrs. Rivera-Torres explained that the area of Toa Baja was going through re-zoning. Currently, the area of the mogotes is not protected. She explained how three public hearings were going to happen over the course of the next few months in order to discuss the new plans for Toa Baja. The municipality has developed their own plan for the area to be reviewed by the central government. This plan designates the mogotes surrounding el Plantío as a protected area. She also explained how the central government has its own zoning plan for the area. This plan

actually includes more of the areas within Toa Baja to be protected as “green areas”. Specifically, the karst area of el Plantío is protected in both versions of the re-zoning plan. It is labeled as suelo rustico especialmente protegido. This will keep the land protected “forever”; however, she mentioned that in the past land-use plans have been changed when new government administrations take office. Since this area is protected in both plans, Mrs. Rivera-Torres stated that it is very unlikely that the area would be categorized differently after the public hearings and not be protected.

### **Current Landowners**

Mrs. Rivera-Torres explained that the municipality is currently in conversation with the apartment developer. They were discussing the price for the land in order to possibly find a way to buy the property from the landowner. The municipality thought that the land would be approximately \$700,000, yet the land owner is asking for \$1 million. The central government is also working with other land owners in order to exchange their land for another area within Toa Baja that can be developed. This land interchange would allow the mogotes to also be protected and allow the land owners to still hold land elsewhere to develop.

## **Appendix C: Interview Summary – Human Resources Director of Toa Baja**

### ***Questions:***

1. Are you familiar with the community group Los Ciudadanos Pro Bosque del Plantío and their efforts?
2. We have noticed that Toa Baja has beautiful mogotes and wetlands. Does Toa Baja pride itself on these?
3. We also noticed that there is a karst belt within Toa Baja. Does the natural topography of the Toa Baja attract people to the area?
4. We visited a municipal park that is being developed in Caguas. Has Toa Baja thought about developing a park for the area?
5. We have heard a lot of controversy about the land-use plan, both nationally and within the municipality of Toa Baja. What land-uses do you want to see emphasized in Toa Baja?
6. Mogotes and industrial areas co-exist within el Plantío. This causes a conflict of interest between preservation and industrialization. The community group would like to see the remaining mogotes used to educate students about the area's environmental history and culture. Would you support a land-use plan that preserves this area for educational use?

### ***Summary:***

On April 11, 2006, we hoped to meet with the Mayor of the Municipality of Toa Baja to learn more about municipal government, as well as what he thinks about the mogotes, and his view on the efforts of los Ciudadanos pro Bosque del Plantío. The Mayor was occupied at the time of the interview, so we met with a close colleague of his, the Director of Human Resources, Elías F. Sanchez-Sifonte. First, we questioned whether Toa Baja prides the natural beauty of the system of mogotes. Mr. Sanchez-Sifonte explained that for many years, the mogotes were neglected, areas were developed that shouldn't have been, and much of the land was overused. Since the Mayor took office, however, his main focus has been to protect the karstic region. He also said that the Mayor fought this issue before hand, when he was a Senator. In the past, saving the mogotes was not a main focus unless the communities that were close to the mogotes brought the matter to attention, such has el Plantío. The Mayor has gone public with his efforts, and issued a cease and desist on an area where a car dealership was clearing the mogotes. The

intervention of the Mayor shows his dedication to the community group's efforts, because they were worried about the mogotes, and he took their concerns into consideration.

The Director later went to explain how the area can be designated protected under the Autonomous Municipalities Act, and that after a master plan created by the Land Use Plan Committee is passed, it will not be simple to develop on an area. We were curious as to what resources the Municipality has, and Mr. Sanchez-Sifonte said that the Municipality expresses full commitment to work with communities. As for now, the focus is to save the mogotes from further damage, and any other work with community groups, etc. will be handled only if there is uniform support within the community.

We were also able to gain information regarding the ownership issues regarding the mogotes surrounding el Plantío. The Director disclosed that all 33 acres of land are owned by a single person, and the Municipality is in the process of trying to trade his land for land suitable for development. If the municipality succeeds on acquiring the land, they intend to give ownership rights to a trustworthy conservation-minded private organization to prevent future administrations from reclassifying the land for other purposes. The Director, the Mayor, and the Municipality of Toa Baja, as a whole would like to see the land be protected from further development to ensure that the mogotes remain untouched.

## **Appendix D: Interview Summary – Casa Pueblo**

### **Questions:**

1. How big is the Casa Pueblo School?
2. What grades are incorporated into the Casa Pueblo Program?
3. How did you come to work with the Casa Pueblo community group?
4. How did Casa Pueblo develop?
5. What are some of the activities that are done with the students?
6. How do the students find the program?
7. What subjects incorporate Casa Pueblo into their curriculum?

### **Summary:**

On March 29, 2006, we visited Casa Pueblo in Ajuntas. During our visit we were able to speak to a teacher of a Casa Pueblo Class, a teacher within the Ajuntas school, and the Director of the school that works with Casa Pueblo. Each person was able to provide us with some information about the educational impact Casa Pueblo has had on the community.

### ***Interview 1: Glady Diaz - Teacher of Casa Pueblo Class***

The teacher of the fifth grade Casa Pueblo class, Glady Diaz, works directly with Casa Pueblo and was not hired by the school district. She explained to us the history of the educational system that Casa Pueblo has developed with the community's school. The program started as a pilot program with fourth grade students. Originally, professors from University of Puerto Rico Mayaguez and the Department of Natural Resources worked with people from Casa Pueblo to develop an educational plan for the students. This plan was then presented to the director of the school, Elín Cintrón, who approved to incorporate the importance of Casa Pueblo into the existing educational system. The current system has now been in use for two years with fourth and fifth graders. This program incorporates teaching the students about the history of Casa Pueblo along with management techniques of the area. The fourth graders usually focus more on the history and basic knowledge about the area while the fifth graders focus on learning

ways to manage and protect the area. The Casa Pueblo school consists of an auditorium, laboratory, class room and gallery for the students to use during their normal school hours. The students also take field trips to Bosque del Pueblo to collect scientific data as well as visit the University of Puerto Rico to work with professors.

The teacher then gave us a tour of the facilities, and noted that before she became a teacher within the program she worked for Casa Pueblo giving tours. She explained to us some of the hands-on activities the students can do while at school. One project the students work on is transplanting different varieties of plants. They are able to monitor the growth of these plants as well. They also get to participate in the growth of butterflies. They start watching the caterpillars grow and develop, care for the cocoons, and then once fully developed they transfer the butterflies to their butterfly garden, the newest attraction of Casa Pueblo. All of these attributes allow the students to become more active in school and expand their traditional education.

***Interview 2: Elín Cintrón, Director of Adjuntas School***

The director of the “Casa Pueblo” school gave us a better view of the process that took place between the community group and the school, which is adjacent to the main auditorium of Casa Pueblo. The director of Casa Pueblo approached Mr. Cintrón about the idea to incorporate the students in the preservation and management plan. He came with a full set of plans for the school director to review. The agreement was to be between Casa Pueblo and solely the collaborators of the school; the Central Government was to be in no way involved. Mr. Cintrón signed the contract with Casa Pueblo to show his full support and honor to collaborate with them. Through this program, he explained how the students have not only gained more knowledge about Casa Pueblo but how the program affects them on a much larger scale. The students involved in the program had higher grades in all of their classes and have increased their



leadership skills as well. The students find a joy and satisfaction from participating in the program and really look forward to attending the class. The parents of these students also participate and encourage the Casa Pueblo educational program. A newspaper is used to communicate the efforts of the students and Casa Pueblo as a whole, as well to make sure the community is aware of new activities Casa Pueblo can offer to them.

The director explained how this program is strictly between the community group of Casa Pueblo and the school. No government involvement was allowed. He explained how incorporating any legal aspects to the program would cause more problems. He is hoping to help Casa Pueblo expand their program to be able to accommodate the 326 students that attend the school. He would even like the Casa Pueblo program expand to other local schools as well.

***Interview 3: Lillian Nieves, Social Studies and English Teacher***

Mrs. Lillian Nieves gave us an “outsider” view on the Casa Pueblo program. She is teacher at the Adjuntas school and works with the students who are involved in the Casa Pueblo program. She feels that the Casa Pueblo program affects the students in a positive manner. She has seen more of the students participate in class and has seen their grades improve. She also said that the information from the Casa Pueblo class is often incorporated into the other classes the students are taking, such as Science and English. Often times, she will give the students a reading that relates to some information they have learned in the Casa Pueblo class. She appreciates the work of Casa Pueblo and encourages them to start to expand and incorporate more of the students into the program.

## Appendix E: Educator Interest Questionnaire

### Conservation Analysis of the Municipio de Toa Baja Educational Project Survey

*Hello, we are a student group from Massachusetts working on a project with the Department of Natural and Environmental Resources. We are conducting a survey to find out more information regarding the educational system of Puerto Rico and the schools interest in incorporating environmental education programs. If you could please take a few minutes to fill out this survey, it would be greatly appreciated. \*\*All information will be kept confidential.*

*Thanks.*

*Ian Levesque  
Brendan McLaughlin  
Christina Mezzone  
Alissa Paquette*

#### **Personal Information**

**1. Are you a citizen of el Municipio de Toa Baja?**

Yes

No

**If yes, which community do you reside in?**

\_\_\_\_\_

**2. What school are you affiliated with?**

\_\_\_\_\_

**3. Are you a Director or Teacher? (please circle one): Director  
Teacher**

**4. How long have you been a director/teacher?**

\_\_\_\_\_

**5. What subject(s) and grade(s) do you teach?**

\_\_\_\_\_

6. On a scale of 1 – 5, (1- No Interest, 5- High Interest), how would you rate your students interest in science and the environment?

1                      2                      3                      4                      5

7. On a scale of 1-5, (1 – No Knowledge, 5- Most Knowledge), how much do you know about Los Ciudadanos Pro Bosque del Plantío and their effort to preserve the karst area?

1                      2                      3                      4                      5

### Description of El Plantío



The forest that encompasses el Plantío contains karst forest formations that offer various functions to the area of Toa Baja. Karst forests are formed over a limestone base and have a composition similar to a coral reef structure that has risen and developed into mogotes. Also, the porous composition of karst acts as a natural water drainage system forming large caverns over

time. The unique characteristics of the area support a diverse ecosystem of plants and animals, including many endemic species and even the endangered Palo de Rosa tree.

Currently, the mogotes are in danger of being torn down and developed by private land owners. One of the communities, el Plantío, would be greatly affected by this development. Due to this threat, the Ciudadanos Pro Bosque del Plantío formed to help preserve this natural area to maintain the important natural resources, functions, and beauty it offers to neighboring communities. Their goal is to protect the forest and provide Toa Baja with an educational learning center. They hope to provide the students of the communities with an area where they can expand their scientific knowledge and learn about the importance of nature to society.

- 1. Now after reading about this information, would you be interested in learning more about the area and its environmental significance?**

Yes                      No

- 2. Are there any existing classes that incorporate information about environmental protection?**

Yes                      No

**If Yes, please describe the lesson plan below:**

**If No, would you be interested in incorporating lessons on the environment into your classroom?**

Yes                      No

- 3. Does your school coordinate programs with other schools in the area?**

Yes                      No

**If Yes, please list schools and describe programs below:**

**If No, would you be interested in working with other schools?**

Yes                      No

- 4. If an educational trail and center were provided to schools by this area, would it be of interest to you/your school?**

Yes                      No

5. Please rank the type of educational uses you would like to see incorporated into a future educational center of El Bosque del Plantío (1-No interest in incorporating into educational center, 5 –Very interested into incorporating into educational center)

*Hiking Trail*

1                      2                      3                      4                      5

*Endangered Flora and Fauna Exhibit*

1                      2                      3                      4                      5

*Hands-On Experiments*

1                      2                      3                      4                      5

*Tour Guide*

1                      2                      3                      4                      5

*Historical Information Site*

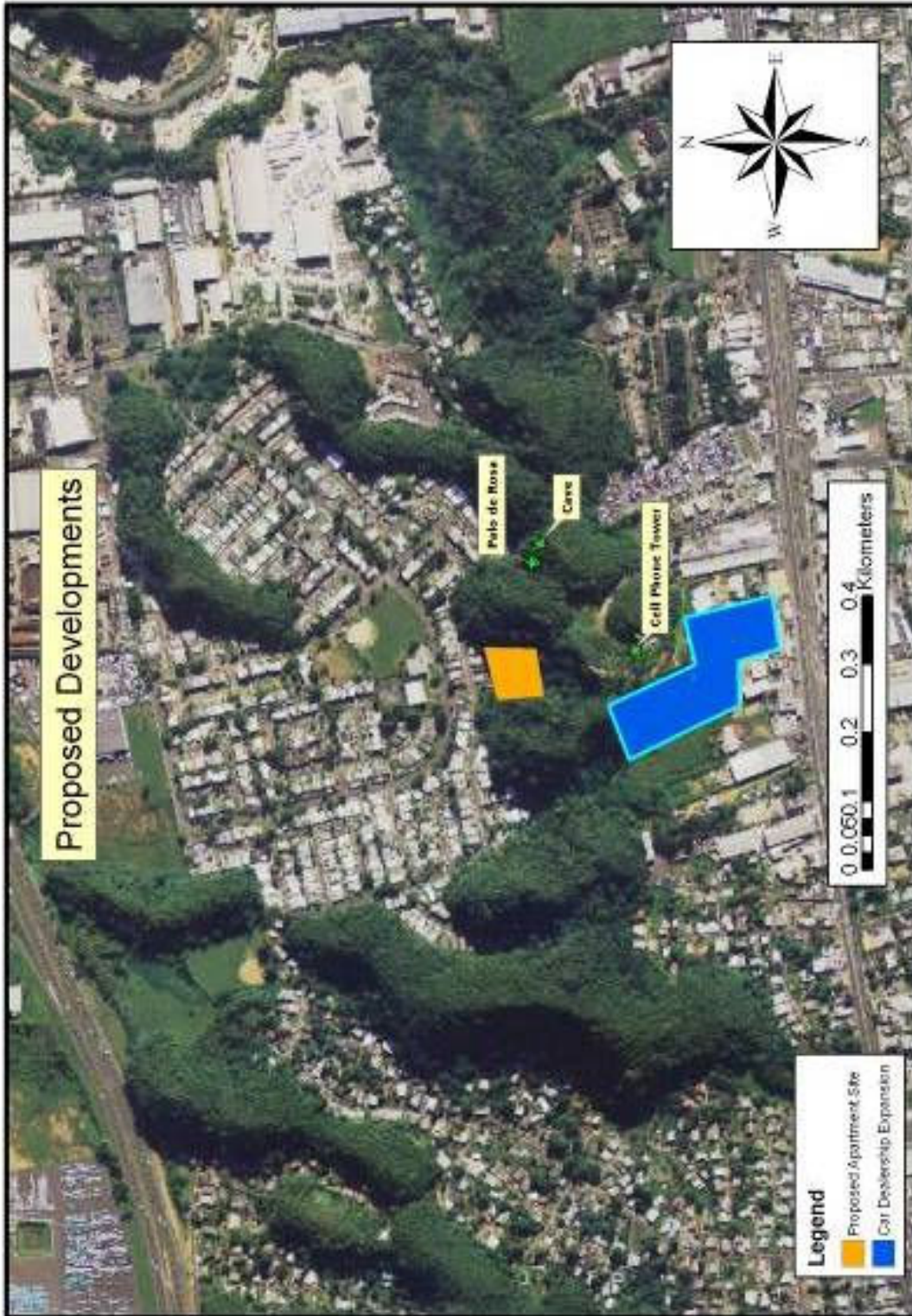
1                      2                      3                      4                      5

*Student Participation in Maintenance of Section of Land*

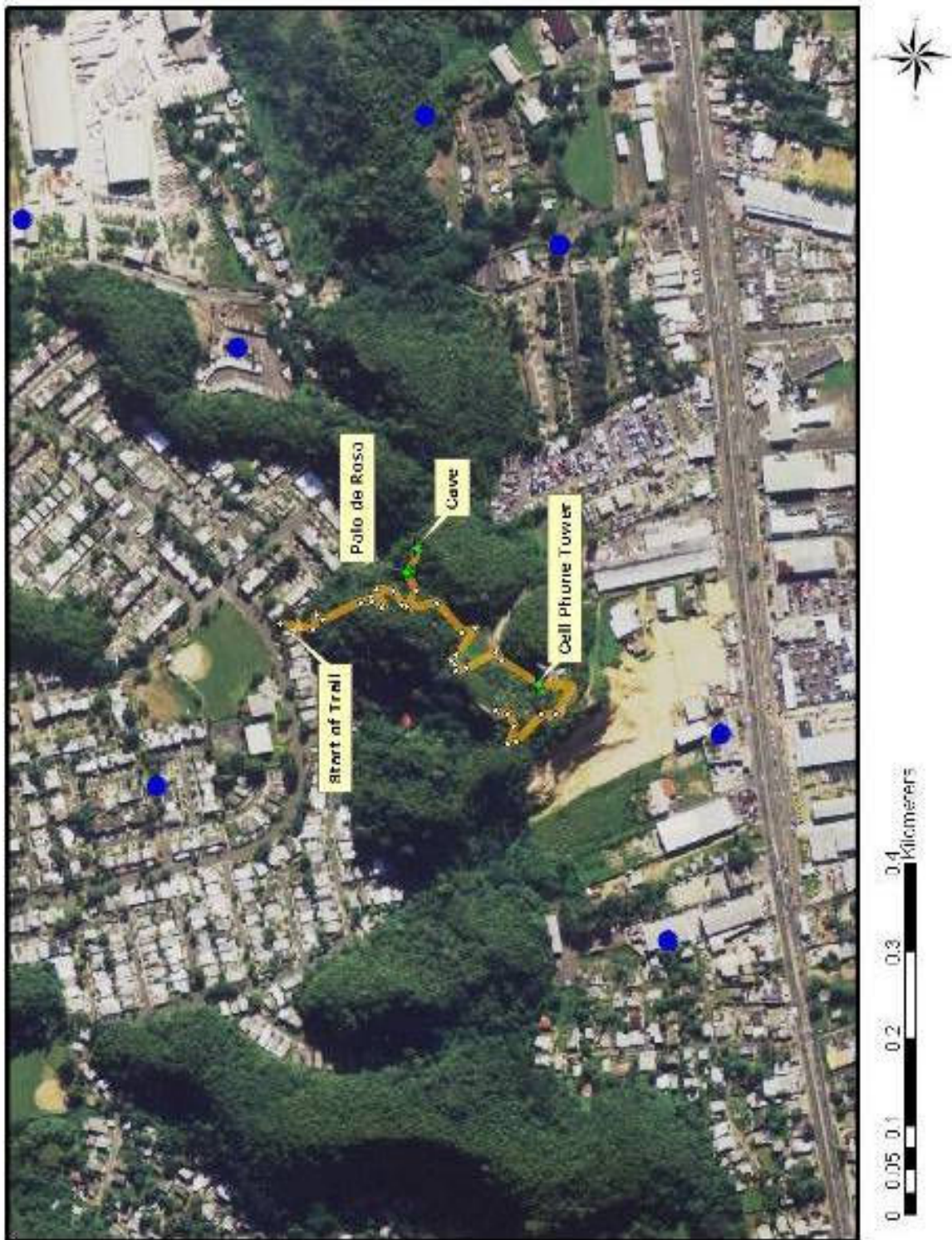
1                      2                      3                      4                      5

**Please state other suggestions/ideas for the area in the space provided below:**




# Appendix F: Proposed Development Areas



# Appendix G: GIS Exploration Route and Fresh Water Wells Map










## Appendix H: Photographic Flora Catalog

	Family	Scientific Name	Common Name	Type of Growth	Rarity
	Adiantaceae	Adiantum	Maidenhair fern	Fern	Common
	Araceae	Philodendron giganteum	Bejuco de calabazón	Herbaceous climbing plant	Exotic/ Common in cultivation
	Bombaceae	Ceiba pentandra	Ceiba	Tree	Common


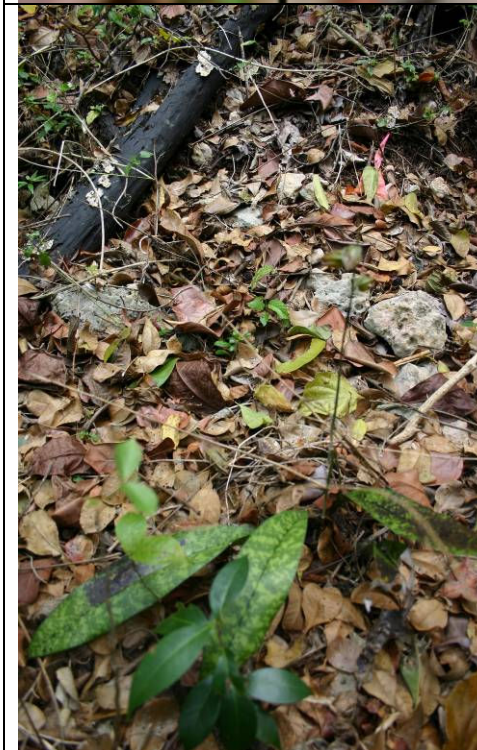





	Boraginaceae	Tournefortia filiflora	Nigua	Shrub	Rare/critical element/good for wildlife
	Celastraceae	Crossopetalum rhacoma	Maidenberry/ Coral	Shrub	Native/ Occasional
	Compositaceae	Emilia coccinea	Clavelito	Herbacious Growth	Exotic //Common in open areas
	Compositae	Bidens alba	Margarita/ Shephard's needle	Herbacious growth	Common
	Compositae	Eupatorium	Oreganillo	Shrub	Native



	Euphorbiaceae	Phyllanthus epiphyllanthus	Bayoneta/ Box-wood	Small Tree	Common in limestone
	Euphorbiaceae	Phyllanthus epiphyllanthus		Small Tree	Common in limestone
	Fabaceae	Rhynchosia reticulata	Frijolillo	Vine	Common

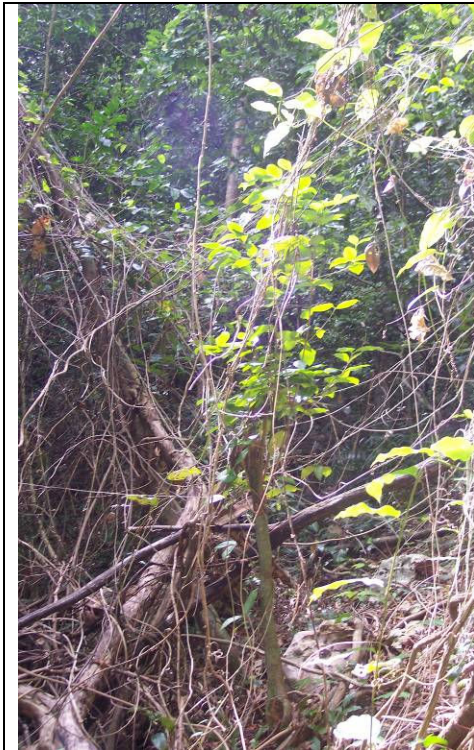


	Guttiferaceae	Rheedia portoricensis	Palo de Cruz	Tree	Endemic
	Guttiferaceae	Rheedia portoricensis	Palo de Cruz	Small Tree	Common/endemic to PR
	Guttiferaceae	Mammea Americana	Mamey apple	Large Tree	Common
	Guttiferaceae	Calophyllum calaba	Maria	Large Tree	Common

	Icacinaceae	Ottoschulzia rhodoxylon (seedling)	Palo de Rosa	Tree	Endangered species
	Icacinaceae	Ottoschulzia rhodoxylon	Palo de Rosa	Medium Tree	Endangered Species
	Leguminosae/ Caesalpinaceae	Hymenaea courbaril	Algarrobo/ West-Indian locust	Tree	Native/ Common
	Moraceae	Pseudolmedia spuria	Negra lora	Large Tree	Rare species in moist limestone hills
	Myrtaceae	Eugenia axilaris	White Stopper	Small Tree	Common in dry limestone and forest

	Orchidaceae	(seed capsule) Oececlades maculata	African Orchid	Orchid	Exotic/ Common
	Orchidaceae	Oececlades maculate	African Orchid	Orchid	Exotic/ Common
	Orchidaceae	Oececlades maculata	African Orchid	Orchid	Common

	Orchidaceae	<i>Vanilla poiteai</i>	Vanilla Orchid	Orchid	Common
	Polygonaceae	<i>Coccoloba diversifolia</i>	Uvilla	Tree	Native/ Common

	<p>Polygonaceae</p>	<p><i>Coccoloba diversifolia</i></p>	<p>Uvilla</p>	<p>Large Tree</p>	<p>Limestone</p>
	<p>Rubiaceae</p>	<p><i>Antirhea coriacea</i> (fruit)</p>	<p>Quina</p>	<p>Tree</p>	<p>Native</p>

	<p>Rubiaceae</p>	<p><i>Antirhea lucida</i></p>	<p>Palo Iloron</p>	<p>Small Tree</p>	<p>Common in moist limestone forest</p>
	<p>Rutaceae</p>	<p><i>Zanthoxylum martinicensis</i></p>	<p>Espino Rubial</p>	<p>Tree</p>	<p>Common</p>
	<p>Sapotaceae</p>	<p><i>Manilkara bidentata</i></p>	<p>Ausubo</p>	<p>Tree</p>	<p>Common</p>



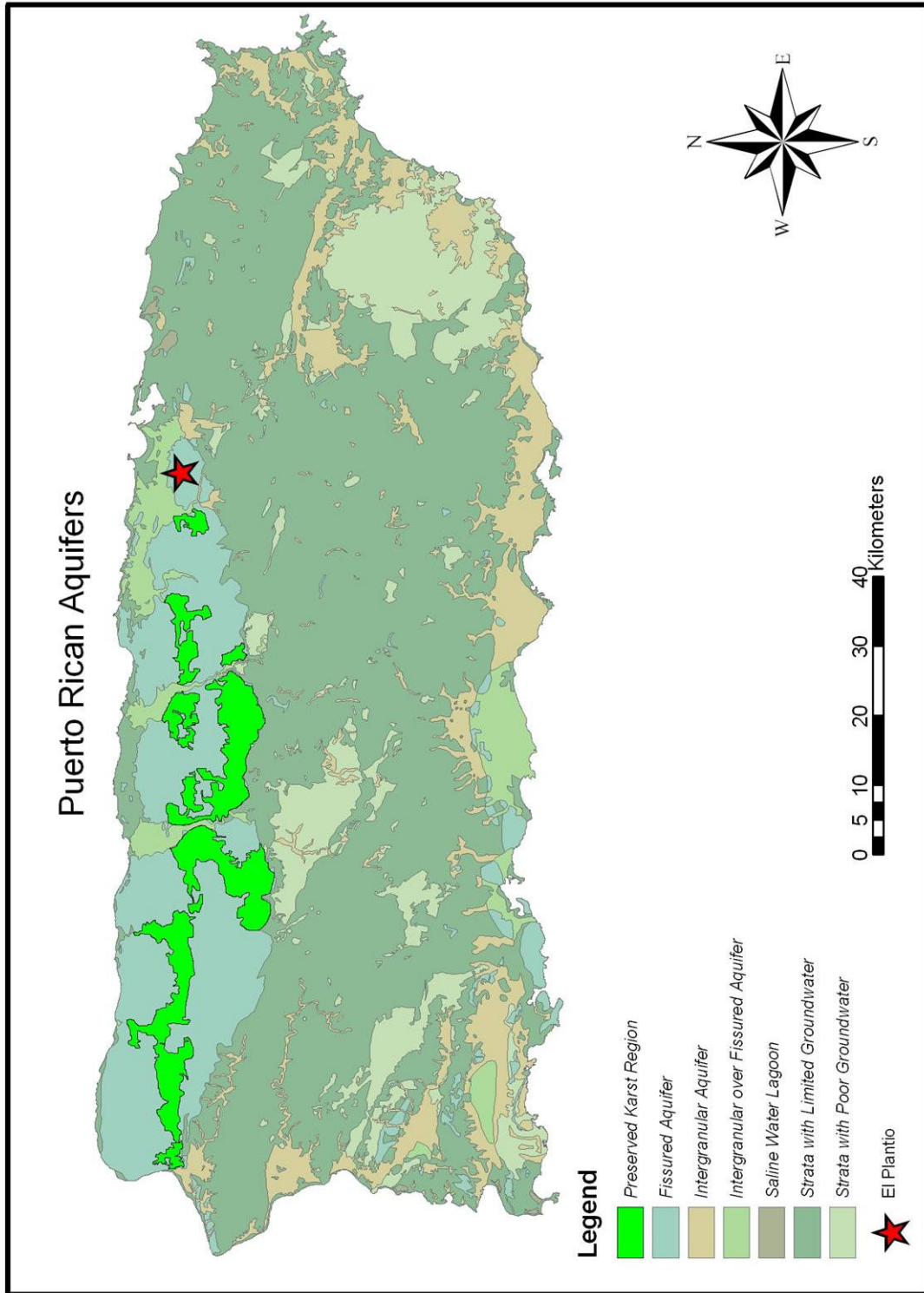
	<p>Zamiaceae</p>	<p>Zamia amblyphyllidia</p>	<p>Marunguey</p>	<p>Cycad</p>	<p>Common to mogotes and limestone</p>
	<p>Zamiaceae Cone</p>	<p>Zamia amblyphyllidia</p>	<p>Maruguey</p>	<p>Cycad</p>	<p>Common in mogotes and limestone</p>

## Appendix I: Extended Flora Inventory

Flora de los Mogotes Circundante a la Comunidad del Plantío en Toa Baja				
Familia	Nombre Científico	Nombre Común	Habito	Estatus
Acanthaceae	Oplonia spinosa	Espinosa	Arbusto	Nativo Poco Común
Anacardiaceae	Comocladia glabra	Carrasco	Arbusto	Nativo Común
Araceae	Epipremnum pinnatum	Bejuco de Agua	Bejuco	Exótico Naturalizado
Araceae	Syngonium podophyllum	Malanga trepadora	Bejuco	Exótico Naturalizado
Araceae	Philodendrom giganteum		Rastrero/trepador	Nativo
Araceae	Anthurium creantum	Hoja de costado		Nativo
Araliaceae	Dendropanax arboreus	Palo de Pollo	Árbol	Nativo Común
Arecaceae	Roystonea borinquena	Palma Real	Árbol	Nativo Común
Asteraceae	Chromolaena odorata	Christmas bush	Arbusto	Nativo
Asteraceae	Pluchea carolinensis	Salvia	Arbusto	Nativo
Bignonaceae	Tabebuia heterophylla	Roble Nativo	Árbol	Nativo Común
Bombaceae	Ochroma pyramidale	Balsa	Árbol	Nativo Común
Boraginaceae	Tournefortia filiflora	Nigua	Arbusto	Nativo Poco Común
Bromeliaceae				
Bromeliaceae	Pitcarina angustifolia	Piña cortadora	Bromelia terrestre	Nativo
Bromeliaceae	Tillandsia recurvata	Nido de Gungulen	Bromelia epifita	Nativo
Bromeliaceae	Tillandsia polystachya	Piñon	Bromelia epifita	Nativo
Burseraceae	Bursera simaruba	Almacigo	Árbol	Nativo Común
Celastraceae	Maytenus elongata	Cuero de Sapo	Árbol	Endémico Raro
Celastraceae	Gyminda latifolia	Coscorroncito	Árbol	Nativo Común
Celastraceae	Crossopetalum rhacoma	Coral	Arbusto	Nativo Común
Combretaceae	Bucida buseras	Ucar	Árbol	Nativo
Compositaceae	Bidens Alba	Margarita	Herbácea	Común
Compositaceae	Emilia fosbergii	Clavelito colorado	Herbácea	Común
Euphorbiaceae	Gymnanthes lucida	Yaití	Árbol	Nativo Común
Euphorbiaceae	Phyllanthus epiphllanthus	Bayoneta	Arbusto	Nativo
Gesneriaceae	Gesneria pedunculosa	Árbol de Navidad	Árbol	Endémico Común
Guttiferaceae	Rheedia portoricensis	Palo de Cruz	Árbol	Endémico
Guttiferaceae	Calophyllum calaba	María	Árbol	Nativo Común
Guttiferaceae	Mammea americana	Mamey	Árbol	Nativo
Icacinaceae	Ottoschulzia rhodoxylon	Palo de Rosa	Árbol	En Peligro de Extinción
Laureaceae	Licaria parvifolia	Canelilla	Árbol	Nativo
Malvaceae	Urena lobata	Cadillo	Arbusto	Exótico
Meliaceae	Trichillia pallida	Caracolillo	Árbol	Nativo Común
Mimosoideae	Inga laurina	Guama	Árbol	Nativo Común
Moraceae	Ficus citirfolia	Jagüey blanco	Árbol	Nativo
Moraceae	Pseudolmedia spuria	Negra Lora	Árbol	Nativo Poco Común
Myrsinaceae	Ardisia obovata	Mameyuelo	Árbol	Nativo Común
Myrtaceae	Eugenia biflora	Pitanguera	Árbol	Nativo Común
Myrtaceae	Eugenia axillaris	Grajo	Árbol	Nativo
Myrtaceae	Eugenia monticola	Birijí	Árbol	Nativo
Nyctaginaceae	Guapira fragans	Corcho	Árbol	Nativo Común
Oleaceae	Linociera domingensis	Hueso blanco	Árbol	Nativo Común

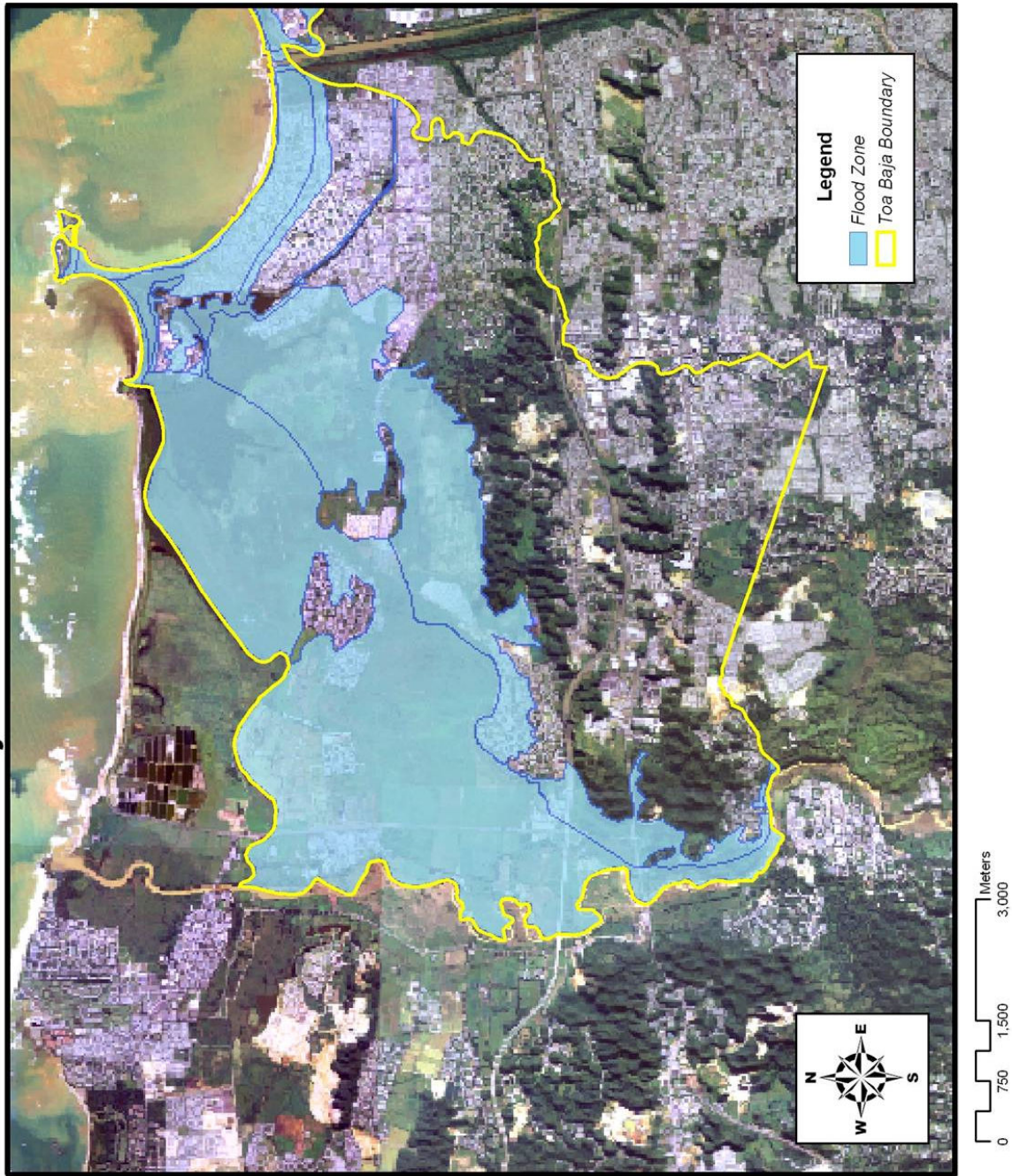
Orchidaceaea	Bletia patula	Flor de Pasma	Orquidia	Nativo
Orchidaceaea	Oceoclades maculata	Orquidia Africana	Orquidia	Exotico
Polygonanceaea	Coccoloba diversifolia	Uvilla	Árbol	Nativo Común
Rubiaceae	Chiococca alba	West Indian Snow Berries	Arbol	Nativo
Rubiaceae	Antirhea lucida	Palo Llorón	Árbol	Nativo
Rubiaceae	Guettarda ovalifolia	Cucubano	Árbol	Nativo Poco Común
Rubiaceae	Guettarda elliptica	Cucubano Liso	Árbol	Nativo Común
Rubiaceae	Antirhea coriacea	Quina	Árbol	Nativo Poco Común
Rubiaceae	Ixora ferrea	Cafeillo	Arbusto	Nativo
Rutaceae	Zanthoxylum martinicense	Espino Rubial	Árbol	Nativo Común
Sapotaceae	Sideroxylon foetidissimum	Tortugo Amarillo	Árbol Nativo	Nativo
Smilacaeae	Smilax domingensis	Bejuco de Membrillo	Bejuco	Nativo
Sterculiaceae	Melochia nodiflora	Malva Colorada	Arbusto	Nativo
Verbenaceae	Citharexylon fruticosum	Péndula	Árbol	Nativo Común
Zamiaceae	Zamia amblyphyllidia	Marungeuy	Cicada	Nativo Localmente Común

# Appendix J: GIS Aquifer Map



# Appendix K: Toa Baja Flood Plain Map

## Toa Baja Flood Zones 1983



## Appendix L: Raw Survey Result

Director/Teacher	Toa Baja	Area	School	Grade Level	Subject	Years	Student Interest in Environment	Knowledge of Community Group	Interest in Learning More about Area	Interest in Environmental Lessons	Interest in working with other Schools	Educational Trail and Center
D	N	Toa Alta	Antonia Saez Irizarry			3	3	3	Y	Y	N	Y
T	N		Antonia Saez Irizarry	5th - 6th	Science	7	3	2	Y	Y	Y	Y
T	N		Antonia Saez Irizarry	4th- 5th	Science	25	4	3	Y	Y	N	Y
T	N		Ernesto Juan Fonfrias		Social and Science	15	4	4	Y	Y	Y	Y
T	N		Ernesto Juan Fonfrias	4th-6th	Science	5	4	2	Y	Y	Y	Y
S	N		Ernesto Juan Fonfrias	3rd	Student		5	5	Y	Y	Y	Y
S	N	Companilla	Ernesto Juan Fonfrias	5th	Student		5	5	Y	Y	Y	Y
T	Y	Pajaros	Martin Garcia Giusti		Science	30	4	2	Y	Y	Y	Y
T	N	Bayamon	Martin Garcia Giusti		Social Studies	20	4	1	Y	Y	N	Y
T			Altinencia Valle Santana		Science and Social	6.5	4	1	Y	Y	Y	Y
T	Y	Levittown	Altinencia Valle Santana		Spanish, Social	15	2	1	Y	Y	Y	Y
D	Y	Candelaria	Altinencia Valle Santana			25	3	4	Y	N	Y	Y
T	Y	Levittown	Altinencia Valle Santana	4th	Social Studies	28	4	1	Y	Y	Y	Y
T	Y	Ingenio	Ernestina Bracero	5th	English	20	4	2	Y	Y	Y	Y
D	Y	Campanillas	Ernestina Bracero			14	5	4	Y	-	Y	Y
T	Y	Candelaria	Ernestina Bracero	6th	Social Studies	20	3	3	Y	Y	Y	Y
T	N		Ernestina Bracero		Science	13	5	1	Y	Y	Y	Y
T	N		Ernestina Bracero		Science	26	5	3	Y	Y	Y	Y

Topics	Number of People
Interest in Learning about Area	18
Interest in Environmental Lesson	18
Interest in working with Other Schools	16
Interest in Educational Center	18

### Raw Survey Data – Educational Option Ranking

Director/Teacher	Hiking Trail	Flora Exhibit	Experiments	Tour Guide	Historical Site	Student Participation in Maintenance
D	5	5	5	5	5	5
T	5	5	5	5	5	5
T	0	4	3	4	5	3
T	3	5	5	5	4	5
T	3	5	5	5	4	5
S	5	5	5	5	5	5
S	5	5	5	5	5	5
T	5	5	4	5	4	5
T	3	4	3	4	4	5
T	0	5	5	5	3	4
T	5	5	5	5	5	5
D	3	5	3	5	5	4
T	0	5	5	5	5	5
T	3	5	5	4	4	4
D	5	5	5	5	5	5
T	5	5	5	5	5	5
T	3	5	5	4	3	4
T	3	5	5	4	4	3
<b>Total Score</b>	<b>61</b>	<b>88</b>	<b>83</b>	<b>85</b>	<b>80</b>	<b>82</b>
	0.677777778	0.977777778	0.922222222	0.944444444	0.888888889	0.911111111
<b>Percentage</b>	<b>67.8</b>	<b>97.8</b>	<b>92.2</b>	<b>94.4</b>	<b>88.9</b>	<b>91.1</b>

Percentage of People Who Rated Each Educational Option a Given Number						
Ranked Number	Trail (%)	Flora Exhibit (%)	Experiments (%)	Tour Guide (%)	Historical Site (%)	Student Participation in Maintenance (%)
0	16.7	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0
3	38.9	0.0	16.7	0.0	11.1	11.1
4	0.0	11.1	5.6	27.8	33.3	22.2
5	44.4	88.9	77.8	72.2	55.6	66.7

## **Appendix M: Community-Based Management in Southwest Bengal**

The success of community-based management can be demonstrated throughout the world. For example, Western (1994) describes the community-based conservation effort of the village of Chandana in Southwest Bengal. The village developed an environmental management system that protected their once abused forest and allowed them to benefit from its natural resources. After obtaining ownership rights to sections of the land in the 1970's, the inhabitants of the village started intensively logging the area, causing severe ecological problems. Suffering from a low household income, the villagers depended on the forest's logging industry as their main source of income and abused their rights. Over-logging destroyed the natural water systems causing land to dry up and become useless, and limited the water supply to the village. With this problem only growing, intervention was necessary before forest destruction became irreversible.

Forest Manager Jyoti Naik visited the village and warned the villagers if they kept abusing the forest, future generations would be left with no resources (Western, 1994, p. 58). After meeting as a community several times, the villagers developed a final plan that required each area of the forest to regulate and safeguard against over-logging through a community managed forest protection watch. The Chandana Forest protection Committee set up an informal warning system which reported any intruders to the area, thus effectively regulating the logging industry. As a result, there has been a positive long term economic impact on the community, and ecological systems have been able to recover. "In villages near Chandana, after five years of protection, more than 214 species of flora and fauna were present in the forest. Of these, 189 were utilized by local people" (Western, 1994, p.61). Although the members of the community suffered an initial decrease in income, in the long run they guaranteed financial stability. If the area had suffered complete destruction, the loss of the logging industry combined with the



negative environmental impacts would have left the community with no source of income.

Also, the Bengalese government gave the villagers rights to nearby rice-land farms to provide them with a supplemental source of income to ease the blow caused by the decrease in logging.

Overall, this system of community management greatly benefited both the population and the environment.

## **Appendix N: Interview Summary - Asociación Recreativa Residentes el Plantío Inc.**

On April 19, 2006, we met with ARREPI, an association that works to maintain the safety of the community of el Plantío. We wanted to meet with them to learn of how many households there are in the community, as well as some of the things the group does for el Plantío. We were told that there are roughly 700 families, around 2,000 residents, within the gates of el Plantío, a number the Association does not want to see increased too greatly. Like the members of los Ciudadanos pro Bosque del Plantío, the Association members were against the construction of the apartment complex within their community, stating it would bring too many more inhabitants. As a group, the Association members developed services to protect the community and its residents, such as the 24 hour guarded access control entrance and street patrol. They stated that there is a low monthly maintenance fee of \$30 that the residents are asked to pay to upkeep these services, but their budget is small. The Association is headed by resident Lydia Gamancho, but no decisions can be made without the residents' cooperation and support.

It is clear that the Association wants to see the mogotes protected to maintain the security of their gated community, but implementing anything new would take full commitment and agreement from all of el Plantío's residents. This paralleled what we learned before with our interview at the Municipality, that working together will be the only way anything can happen within the mogotes that is aside from getting them protected.

## **Appendix O: Interview Summary – Professor Gottlieb**

The main goal of this interview with Professor Gottlieb – conducted at WPI on February 7, 2006 – was to gain the knowledge of an experienced environmentalist in relation to our project needs. We entered the interview hoping to gain information about the most effective conservation methods and possible examples of such efforts. Also, we wanted to use Professor Gottlieb as a source for other contact information of local groups and agencies which could provide further detail on our project.

### **1) Important Methods of Conservation:**

Professor Gottlieb discussed the most common methods for saving forested areas around the world:

- Does the area represent a cultural significance to a community or group?
- Does the area hold a specific environmental importance?
- Does the area have an educational purpose, or offer a possible educational use?
- Can the area be used for ecotourism purposes?
- Are there any traditional uses/resources for local communities such as food, plants, and other natural things?

If we can identify several of these possible uses for a threatened area, it is much easier to defend conservation over development.

### **2) Possible contacts and sources of information:**

We began to discuss possible examples and contacts in the United States that we could contact for further information.

- Forest Service Employees for Environmental Ethics: Offers viewpoints on the importance of saving forests, and provides alternative uses that are ethical and useful for forest preservation.
- Northern Forest Alliance: Focused on New England, particularly Maine. Involved with methods of sustainable management.
- Forest Stewards Guild
- Nature Conservatory: This group often buys plots of land to keep developers away legally.

Professor Gottlieb noted that often local groups are powerless by themselves because they don't have the resources to make an impact at a wider level. Making connections with large governmental/professional organizations is important for local groups because it provides them with professional opinions and resources. Therefore, he felt it would be important for us to get this professional knowledge in addition to solely the community group.

## **Appendix P: Sponsor Background Information**

### *Department of Natural and Environmental Resources*

The Department of Natural and Environmental Resources (DNER) is part of the government of the Commonwealth of Puerto Rico. It plays an influential role in both the judicial and cultural activities of the island in order “to protect, to conserve and to administer the natural and environmental resources of the Country” (Department of Natural and Environmental Resources [DNER], 2003, Mission). It uses both promotion and administration to inform the people of Puerto Rico about the importance of their surroundings. It aims to help inhabitants of Puerto Rico to live in an environmentally conscious manner in order to create a happier and healthier environment.

The DNER is comprised of three sectors: direction, programming and administration. The most influential group is the programming sector. The Department relies on this group “to guarantee the development, planning, coordination, direction and supervision of the functions of the agency and the implementation of the public policy of development, protection and conservation of the natural, environmental and power resources.”(DNER, 2003, Structure) The programming sector of the DNER includes, among others, the Body of Watchmen of Natural Resources, Information and Education on Protection of the Atmosphere, and the Reforestation and the Administration and Conservation of Living Resources. The agency is responsible for dealing with wild life, forests, natural reserves, bodies of water, fishing, hunting, public properties, natural resources and the effects of development on each of these areas. It is in charge of creating laws and regulations that sustain the development of the natural resources of Puerto Rico.

The DNER is a key player in the development of the forest area within Toa Baja. This project deals with the fight to maintain the forest surrounded by the seven communities within the area. Particularly, the importance the DNER places on forestation along with their ability to create regulations to protect the area, greatly influences the project. By working with this agency, the project group will be able to obtain laws that have been established dealing with other forests within Puerto Rico as well as what laws they could implement if this area were not developed. The DNER feels that forests truly improve the quality of life for people while maintaining the wildlife and ecosystems that reside within it. They add character to the town, reduce contamination, act as a source of water absorption, reduce sunlight in order to save electricity, provide food and create a peaceful atmosphere for residents (DNER, 2003). With this in mind, it is very clear to see that the destruction of a community forest will greatly affect the DNER.

#### *Los Ciudadanos pro Bosque del Plantío*

Los Ciudadanos pro Bosque del Plantío consists of a group of concerned local citizens in the municipality of Toa Baja, the towns adjacent to the Bosque del Plantío. They formed in response to the increased pressure to develop the natural forest in the area. The group has organized itself to protect the land enclosed by the seven communities, and has established several goals for the future. The community group hopes to gain the right to co-manage the land with the government and other environmentally geared groups (*Los Ciudadanos*, 2005). Already, they have gained the cooperation and support of various groups, including the Department of Natural and Environmental Resources. With a focused group effort, they hope to

minimize commercial development in the area to protect the environment and well-being of the local communities.

Members of the municipality of Toa Baja have identified several problems that would arise if the Bosque del Plantío were to succumb to developers. The area offers educational opportunities for its citizens, is home to a variety of recognized endangered species, provides protection against flooding from storms, and holds other cultural significance, such as local flora and fauna. The group has identified several other functions of the forest, including controlling emission levels and toxic contamination, and regulating temperature. (*Los Ciudadanos*, 2005). Since these issues directly affect the citizens of the area, the community group has made it their mission to fight the developers in their quest for the land. The group intends to develop recreational and educational activities for the area, and also create a system of co-management between the community and the government.

Los Ciudadanos pro Bosque del Plantío is a privately funded, community based organization. Therefore, they have limited resources and need the support of government agencies such as the DNER for help in dealing with legal issues and costs. On May 26, 2005, the group officially registered with the State Department of Puerto Rico, to further broaden their outreach (*Los Ciudadanos*, 2005).

Los Ciudadanos pro Bosque del Plantío has grown as an organization over time. The group is now headed by an executive committee; offices including the Director, President, Vice President, Treasurer, Secretary, Sub-Secretary, and a Legal advisor. There are a total of thirteen active members on the main committee (*Los Ciudadanos*, 2005). The organization offers local knowledge and an understanding of the history of the Bosque del Plantío. It is trying to grow further with the help of the central and local government, private businesses, other communities, and scientific and educational institutions. There has already been a large response by Puerto

Rican citizens to the mission of Los Ciudadanos pro Bosque del Plantío. Groups who have offered support include the Ciudadanos del Karso, Sociedad Omitologica de Puerto Rico, Ciudadanos Pro Bosque San Patricio, Casa Pueblo – Adjuntas, Fundacion Luis Munoz Marin, Comunidades del barrio Candelaria, and the University of Puerto Rico. Research studies have been completed by the University of Puerto Rico dealing with developing systems of co-management and alternative uses for the area.