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Establishing TDR Credit Values in the Karst Region of Puerto Rico

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On-Site Liaisons: Sra. Irmgard Gonzalez Segarra, Sra. Lourdes Fernández-Valencia

Project Advisor: Aarti Madan, Ph.D., WPI Professor

Project Co-advisor: R. Creighton Peet, Ph.D., WPI Professor

Submitted by:

Christopher Dunn

Jeffrey Peters

Alberto Phillips

Dale Spencer

Date: May 2, 2012

Abstract

The Puerto Rico Planning Board wants to create a Transfer of Development Rights (TDR) program that would send land development away from ecologically sensitive areas such as karst zones. In this project we determined the amount of land that one TDR credit would represent, using criteria from successful TDR programs elsewhere and from existing zoning laws in Puerto Rico that identify the amount of land needed to construct one house unit.

Acknowledgments

Our team would like to extend a special thanks to our liaisons, Sra. Irmgard Gonzalez Segarra and Sra. Lourdes Fernández-Valencia. Sra. Segarra was our main contact as soon as we arrived at the Puerto Rico Planning Board. Her help though the many changes of our project's focus, as well as the guidance she provided through the shuffling of liaisons, was invaluable. We were introduced to Sra. Lourdes two weeks into our time with the Planning Board. Her guidance offered our project the direction it needed to start really making progress. Both Sra. Irmgard Gonzalez Segarra and Sra. Lourdes Fernández-Valencia contributed greatly to our success. We could not have done this without them.

We would like to thank our advisors, Professor Aarti Madan and Professor Creighton Peet from Worcester Polytechnic Institute, for all of the hours spent helping us with our report and presentation. Their guidance and direction really helped shape the project. We would also like to thank them for the many emergency meetings that they held with us when our project statement continually changed.

Lastly, we would like to thank the Puerto Rico Planning Board and its employees for their hospitality and for offering us our own room in which to complete our work. We would also like to thank the Planning Board and Worcester Polytechnic Institute for collaborating to make our trip to Puerto Rico and our project possible.

Authorship

In this section we will state our writing process for completing our report. Once we gathered the data, our general writing process involved dividing up the sections of each chapter. We agreed upon these divisions either prior to gathering data in an attempt for each of us to gain a specific focus, or after the data was gathered depending on who gathered the information. Once we wrote the sections, we took turns individually editing each others writing and then submitted the sections to our advisors. After receiving their comments, one of us would make the appropriate revisions, and the group would read over the sections again. This exchange of revisions between ourselves and the advisors continued until we felt that our sections were finished. The final compilation and formatting of our report was performed by Jeffrey Peters. Below is a breakdown of who wrote each section. For the sake of efficiency, a legend is provided below:

Legend:

Christopher Dunn = CD

Jeffrey Peters = JP

Alberto Phillips = AP

Dale Spencer = DS

Acknowledgements – DS

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Executive Summary

As a nation's population grows and moves into cities, one result can be urban sprawl, which can lead to an inefficient living environment. When land development is not regulated, there is a possibility that developers will build on land that, when developed, has a high risk of polluting the environment. In Puerto Rico, urban sprawl has become a problem because there exists significant areas of land with a mainly limestone karst base, which is very porous. Developing on this land can lead to an increase in pollution reaching the water table and aquifers located under the limestone. These underground water resources account for roughly half of the drinking water for those regions. Currently there is no island-wide policy to prevent development on land that, if developed, would lead to higher rates of pollution in Puerto Rico.

One such method to manage land development is the use of a Transfer of Development Rights (TDR) program. A TDR program allows landowners to sell the rights to develop on their land either to the government, or directly to a developer. This land is known as a sending area. The government then identifies areas known as receiving areas, where developers can use the credits to build housing and other infrastructure. This leads to planned development that not only protects sensitive land but is advantageous to everyone involved.

The goal of our project was to help the Planning Board in the creation of their island-wide TDR program by determining the value for Transfer of Development Rights (TDR) credits in the karst areas of Puerto Rico. We did not determine the financial value of each credit, but rather its land value. We determined how many *cuerdas* (3930.39 m^2 – a unit of land measurement unique to Puerto Rico) of land are worth one credit for development rights. We also recommended steps that can be taken to promote community involvement in the program. The final project resulted in a recommendation to the Puerto Rico Planning Board on how to determine the credit value of the karst land, as well as recommendations

on how to avoid rejection of this program by the public.

As with any research project, the most prudent thing you can do is to look at past attempts at achieving similar, if not the same research objectives. A vast majority of our time was spent doing research that went above and beyond the scope of our background chapter. During this research on specific TDR programs and their methods, we repeatedly came across literature concerning two specific examples. Those programs were in Montgomery County, MD, and the state of New Jersey. Because these examples were uniformly regarded as two of the most successful examples of TDR programs, we interviewed representatives from each of these programs.

Leslie Saville, a Senior Planner in Area 3 in Montgomery County, MD, explained to us how their program arrived at the credit representation that they did. One of the first things she said was, "The TDR allowance was one of many things that came out of a large advisory group that negotiated about it for several years" (Leslie Saville, personal communication, April 11, 2012). In that same interview she said that the credit representation was based on a zoning law that stated that, in order to build a property which consisted of one dwelling unit, the landowner needed to own five acres of land. She went on to say that basing the TDR credit on existing zoning regulations was "by far the cleanest, simplest way to do it." We decided to follow this model for the main reason that, by basing one credit on how much land someone needs to own to build one dwelling unit, we were able to expand on existing laws regarding land preservation, rather than possibly overlapping with or infringing on those laws.

The next logical step was to find the zoning laws for the different classifications of land in the karst regions of Puerto Rico. For this, we used the *Reglamento Conjunto de Permisos para Obras de Contsruction y Usos de Terrenos*, which we referred to as the comprehensive plan. Chapter 19 of this document states the zoning laws of all of the different land classifications. We consulted our liaisons about the land classifications that exist within the karst

region and found that there are five different categories. Within these laws, we specifically found the number of *cuerdas* of land required to build one basic house unit on a property. Below are the five classifications with the minimum number of *cuerdas* needed to build one basic house unit:

- General Agriculture (25 *cuerdas*)
- Agricultural Production (50 *cuerdas*)
- Forest (25 *cuerdas*)
- Resource Conservation (25 *cuerdas*)
- Resource Preservation (25 *cuerdas*)

Once we discovered the zoning laws in each of the land classifications and decided that our credit value system would be based around those laws, we were able to start brainstorming ideas for an equation that would calculate the amount of credits a landowner would deserve when he/she decided to participate in the Transfer of Development Rights (TDR) program. The equation we developed first looks at the number of *cuerdas* of land a person owns. It divides that number by the number of *cuerdas* of land one needs to build one basic living unit. Next, the equation subtracts the number of basic living units from the original division, thus resulting in the number of credits allotted to the landowner. The mathematical form of the equation can be seen below.

$$\frac{\textit{Number of}\,\text{Cuerdas}\,\textit{Owned}}{\textit{Number of}\,\text{Cuerdas}\,\textit{Needed to Build 1 UBV}} - \textit{Number of UBV Already on the Property}$$

The best way of using this equation was through an Excel program. We developed a simple spreadsheet that shows the five land classifications found in the karst regions of Puerto Rico. Next, there is a column listing the number of *cuerdas* of land one would need to own

to qualify for one credit. The program only requires that the user inputs three key pieces of information. First, the user inputs how many *cuerdas* of land is owned in each type of land classification(s). Then, the user enters how many houses they own on the property. Next, the user lists how many bedrooms currently exist on the properties. Once the information has been entered, the program calculates the number of basic living units the landowner has on his/her property, as well as how many credits are due to the landowner.

Due to the complexity of Transfer of Development Rights (TDR) Programs, public education plays a critical role in implementing the program into law and its continued success. In an attempt to give the Planning Board suggestions, we researched and analyzed both the current educational programs the Planning Board has and the educational campaigns other successful TDR programs currently practice.

We discovered that the Planning Board currently does not have any significant education program on the TDR program with the exception of the one town hall meeting in each Municipio which allowed by law. The first thing we recommend involves ten key talking points that cover advantages citizens would get in exchange for zoning regulations. After discussing the key points, community involvement becomes critical. One strategy we recommend is educating agents about the TDR programs and then having them educate the remainder of the community. These agents are usually active members and/or special interest groups in the community. To further community involvement the agents educate citizens, and should ask for feedback on the program, which would be reported back to the Planning Board so that they could improve the program.

Through the research that we conducted, we found that websites are a widely used tool in educating the public on Transfer of Development Rights (TDR) programs. Since the Planning Board does not currently have any information regarding their program on its website, we suggested that they create a separate TDR website. We recommend that the website be simple, with resources and information about the incentives that make the TDR

program attractive. The incentives that we have suggested include tax breaks and land-use training in the creation of agriculture and forestry programs for those who participate in the program so that they can learn how to use their newly restricted land in appropriate ways that could earn them economic benefits.

1 Introduction

As a nation's population grows and moves into cities, one result can be urban sprawl, which can lead to an inefficient and challenging living environment. This sprawl has the potential to create unfavorable environmental, social, and economic conditions. When one compares cities such as New York City and London, one can see that the former obviously has a planned layout, whereas the latter was, at least in its infancy, allowed to grow organically. In addition, when land development is not regulated, there is a possibility that developers will build on land that, when developed, has a high risk of polluting the environment.

In Puerto Rico, the government is facing the problem of unregulated urban sprawl. This growth has become a problem because the island consists of significant areas of land with a mainly limestone karst base that is known for its porosity. Development on this land would lead to an increase in pollution of the water table and aquifers located under the limestone. These underground water resources account for roughly half of the drinking water for the island. In addition to this concern, there are also land areas such as rain forests, wetlands, and farms. While some of these valuable ecological areas are already protected land areas, there are some that are not. Currently, the government of Puerto Rico, except for within the city of San Juan, does not have any tools with which to generally regulate which land can be developed, except for officially classifying the land as a protected area. In fact, at present there is no island-wide policy to prevent development on land that, if developed on, would lead to higher rates of pollution in Puerto Rico.

The Planning Board of Puerto Rico would like to create an island-wide, government run Transfer of Development Rights (TDR) program to address unplanned development. Excellent examples of TDR programs exist in New Jersey and Montgomery County, Maryland. The New Jersey TDR program is widely regarded as the most successful such program in the United States, saving both farm land and forests, while centering development in the

most desirable locations. In Montgomery County, Maryland, the TDR program serves as a worldwide example of how to conduct such a program, specifically providing a framework for how development credits can prove to be very valuable to landowners who can sell their land to developers.

The most difficult part of a TDR Program is determining how to value the land. While there are excellent examples of successful TDR programs, each nation, state, or county is unique in its requirements for setting up such a program. Because of these differences, there is a dearth of research specific to the situation in Puerto Rico that is immediately useful for developing a TDR program on an island-wide basis. Therefore, the Puerto Rico Planning Board has been working on gathering the necessary data to accomplish this endeavor. They have divided the island into eleven regions and are currently working to analyze each region for a TDR program.

The goal of this project was to determine the value for Transfer of Development Rights (TDR) credits in the karst areas of Puerto Rico. We did not determine the financial value of credits, but rather the land value of credits. We determined how many *cuerdas* (3930.39 m^2 – a unit of land measurement unique to Puerto Rico) of land is worth a credit for development rights. We also determined why certain lands ought to be valued more highly than others, and therefore why they should be assigned more credits per *cuerda*. We found correlations and similarities among the issues that other successful TDR programs have focused on and have already solved, and the problems the Planning Board faces in doing so. We used the maps that the Planning Board has of the karst regions of Puerto Rico to suggest a way to facilitate this process. Finally, we have recommended steps that can be taken to promote community involvement in the program. In the completion of this project, we provide a recommendation to the Puerto Rico Planning Board on how to determine the credit value of the karst land, as well as recommendations on how to avoid rejection of the plan from the public.

2 Literature Review

Urban sprawl is a common problem in all areas with growing populations, and Puerto Rico is no exception. Apart from San Juan, Puerto Rico does not have any regulations in place to control urban growth and development. Unregulated urban sprawl can cause environmental, social, and economic problems. A common method of dealing with this issue in other countries is the creation of a Transfer of Development Rights (TDR) program (Gottlieb, 2012). Mandated and organized by the government, a TDR program allows municipalities to purchase the development rights to land and strategically redistribute these rights to developers, thereby guiding urban growth. This chapter describes the history of urban growth in Puerto Rico, the areas of the island that must be protected, and the regulations currently in place in San Juan to control urban growth. This chapter also introduces the Geographic Information System (GIS) software that we will use to analyze the data needed to create a well-functioning TDR program. We also present information about other TDR programs currently succeeding in different areas of the world. Finally, this chapter describes the regulations currently active in Puerto Rico that provide a framework for a TDR program.

2.1 Transfer of Development Rights

A Transfer of Development Rights (TDR) program allows landowners to give up the rights to build on a piece of land and sell them to developers in the form of credits (Greve, 2011). If a government purchases these rights, it can guide urban growth by controlling the price of the land needed for development and the locations where developers can build. In this section, we will further explain the general logistics of creating a TDR program, as well as give examples of successful programs.

2.1.1 Economics of Transfer of Development Rights

In order to establish a well-functioning TDR program, an economic agreement must be reached between the developers and the landowners (Greve, 2011). This relationship is determined from the developers' Willingness to Pay (WTP) and the landowners' Willingness to Sell (WTS). The WTP is influenced by the revenue potential of the real estate in question, the social and environmental constraints at the development site, and the cost of land and infrastructure. Similarly, the WTS is determined by the landowners' site constraints, financial situation, and the location of the property they own. An appropriate ratio between the WTP and WTS must be reached to create a successful TDR program.

A common strategy of TDR programs is to create a "TDR Bank" (King County Government, 2012). The TDR Bank has three key roles:

1. Facilitate the private TDR market by bridging the time gap between willing sellers and buyers of TDRs;

2. Act as a revolving fund for continued land protection through buying, holding, and selling TDRs (proceeds from TDR sales are used for future land protection); and

3. Catalyze city-county TDR agreements by strategically acquiring development rights from high priority conservation rural / resource lands in the County that governments would like to see protected (Para. 1).

A TDR Bank also acts as a seller of last resort, which ensures a readily available supply of TDRs in the market (Gottlieb, 2012). One possible way to manage a TDR Bank is to divide the proceeds from every sale among the landowners. This way, all sellers share the risks equally and receive a small amount of whatever money comes in from developers. Alternatively, the State may purchase all of the development rights and hold them in the bank until buyers can be found. However, with this system the State would need to dedicate

significant funds to the TDR bank and would be at serious risk of losing money if the land market collapsed.

2.1.2 Geographic Information System

Since its origins over twenty years ago, "geographic information science" has become an important field of study in many industries (Goodchild, 2010). The computer software, Geographic Information System (GIS), has become an integral tool for spatial analysis and modern mapping projects. Many Transfer of Development Rights (TDR) programs utilize GIS software in the development and implementation of the program. Figure 1 shows an example of GIS software being used to distinguish sending and receiving areas in the King County, WA TDR program. More layers can be added to these maps to indicate urban growth, protected land areas, and other categories the TDR planners deem useful. These layers can be easily added or removed.

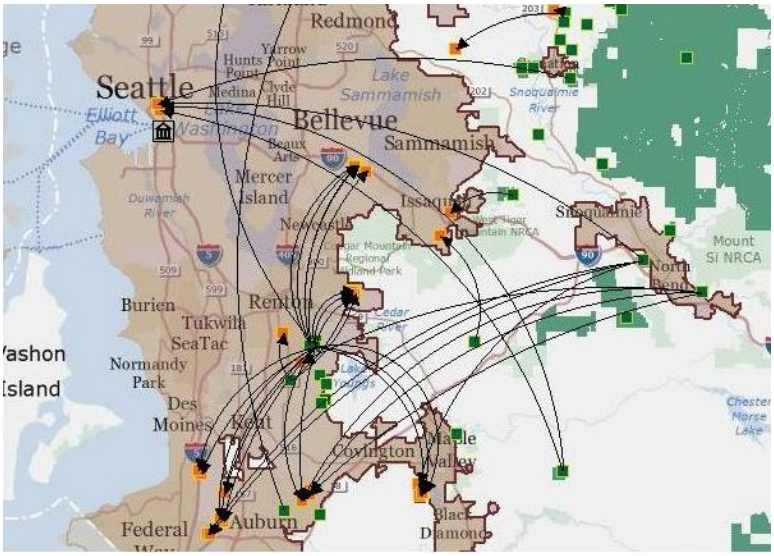


Figure 1: TDR Program Map for King County, Washington (Greve, 2011, pg. 1)

2.1.3 Land Acquisition

Land acquisition refers to the acquisition of land by the government, or a government agency, for some public purpose as authorized by the law. This land is acquired from the individual landowner(s) after paying a government-fixed compensation in lieu of the losses incurred (PRSIndia, 2007). There are many cases in which land acquisition is vital to maintaining natural resources and regulating optimal population density. The following section looks at an example of a government acquiring land for a distinct reason. In the case of Massachusetts, it was for the purpose of preserving and enhancing state forests and parks.

2.1.4 Land Acquisition Strategy - Massachusetts

In 1997, the Massachusetts Department of Environmental Management (DEM) (1997) was charged with the care and oversight of the natural resources of the Commonwealth of Massachusetts. The state program aimed to provide a framework for:

- Proactive planning for land acquisition and protection efforts
- Evaluation of specific land acquisition proposals
- Prioritization for long-term and annual land acquisition planning
- Provision of information to others about DEM's land acquisition program
- Identification of the implications of acquisition for land management and planning

To tackle these goals, the DEM (1997) solicited input from a variety of sources, including a survey that sought the perspectives of all DEM employees and statewide, non-profit environmental organizations. The results of this survey showed that the protection of Massachusetts natural resources should continue to be the primary purpose for which the DEM should acquire land over the following five years.

This example is useful when looking at the situation in Puerto Rico because it focuses on land acquisition for the purpose of preserving natural resources. It identifies criteria for evaluating individual projects or parcels within each resource protection area of focus (DEM, 1997). Also, it importantly notes that for their strategy it was not necessary for all criteria to be met, but rather that the more criteria that were satisfied, the higher a project would rank in importance. Currently, Massachusetts is developing a TDR program to help protect their natural resources.

2.1.5 New Jersey

The Transfer of Development Rights (TDR) program in New Jersey is widely regarded as the most successful TDR program in the country, saving farm and forested land while centering development in the most desirable locations (New Jersey Government, 2006). The objective of the New Jersey Pine Land Development Credit program (PDR, the name of this TDR program) was to save the rural farm lands and its famous pine forests from destruction due to urban sprawl. Since its inception in 1981, the PDR program has preserved almost 50,000 acres of pinelands. The protection of farmlands with the TDR program in New Jersey only started in the 1990's in some regions, and there is less comprehensive data on how much farmland has been saved in these regions. In 2004 this program was enacted statewide, making New Jersey the first state to have a statewide, inter and intra county TDR program. Through these various programs thousands of acres of pine and farmlands have been preserved, with an economic benefit accruing to the landowners of these properties.

For successful implementation of a Transfer of Development Rights (TDR) program, the first task is to distinguish the sending and receiving zones. Chesterfield County in New Jersey strategically chose to protect its rural, farm-based community (New Jersey Government, 2006). The goal in this county was to preserve the farming heritage while increasing its population. Since nearly the entire county was farmland, any location could be a receiving

area, so an ideal receiving area had to be determined. The plan was to establish a residential area for approximately 1,200 homes with a centralized school, park and community center. The TDR planners decided the ideal location was a 560 acre parcel of land in the northeast corner of the County. They chose this location because of an existing water treatment facility located on the border of a neighboring town that could also serve this receiving area's residents. Also, this area was located close to I-295 and Route 30, allowing potential residents quick access to employment options in the city of Trenton. The remainder of the county became sending areas. This essentially gave the landowners in the sending zone money for maintaining their farms. In addition, it raised the value of the receiving areas property because it was the only allowed location available for urban growth in the county.

After establishing the sending and receiving zones, the next crucial step was to ensure that all land owners were properly compensated (New Jersey Government, 2006). Because their property was the only location permitted for development, landowners in the receiving zones were automatically compensated. The challenge was to guarantee that landowners in the sending zones were compensated for losing the ability to sell their land to developers.

The Pine Lands Development Credit Program (PDC) accomplished its goal by setting up optional applications for a Transfer of Development Rights (TDC) credit (New Jersey Government, 2006). The PDC determined that two credits were distributed for 39 acres of farmland, one credit for every 39 acres of pineland and two-tenths of a credit for every 39 acres of wetlands. Landowners then applied for these credits, which were initially valued at $10,000 dollars but are currently worth between $15,000 and $16,000 each. The landowners gave up the right to develop on these lands in return for the valuable credits. The PDC determined, as do most TDR programs, that the price of these credits should be determined by the free market. However, the PDC will buy and sell credits, if need be, to maintain the credits value.

The Transfer of Development Credit (TDC) program in New Jersey is well known, par-

ticularly because the program was carefully and logically planned (New Jersey Government, 2006). First, they determined what was being protected and then what the development goals of the program should be. Then they strategically located sending and receiving zones and maintained an open market for the value of TDC credits. These steps allowed New Jersey to create a successful TDR program.

2.1.6 Montgomery County, Maryland

Montgomery County, Marylands Transfer of Development Rights (TDR) program is considered one of the most successful TDR programs for preserving agricultural land in the nation (Siemon, Larsen, & Marsh, 2012). Local government's efforts to protect the rural character of a large portion of the county and to fully educate all the parties likely involved in a TDR program were critical elements in the programs success. These governmental efforts, combined with development pressures strong enough to support a market for transferable development rights, gave rise to a mix of private and public forces that have sustained the success of Montgomery Countys TDR program.

Montgomery County is a highly populated county in Maryland with an important agricultural sector and history (American Farmland Trust, 2001). This county was one of the first in America during the 1900's to be subject to significant urban sprawl due to its proximity to the Nation's capital. During the 1950's the population exploded from 164,000 to 340,000 people. This urban sprawl resulted in the county creating many different land regulations over the next 20 years. The first regulation passed was in 1969, which designated particular areas for the sole purpose of farming. Being one of the first regulations of its kind, this initiative was moderately successful and saved a considerable amount of farmland. The new regulation introduced in 1973 was not so successful. This new regulation stated that every new residential property had to be located on five acres of land. The idea behind this was that people would neither want to, nor have the money to buy five acres of land to

develop. Unfortunately for Montgomery County, this strategy did not work because of the many affluent people working in Washington, DC, who liked the idea of living in a lightly populated community. These regulations led to Montgomery County's version of a Transfer of Development Rights program.

The goal of the Montgomery County Transfer of Development Rights (TDR) program is to preserve the county's prime agricultural areas and other rural open space in the face of strong suburban growth pressure in the Washington metropolitan area (Siemon, Larsen, & Marsh, 2012). Throughout the 1970's, preparatory studies and task force reports established the necessity to go beyond traditional zoning and land use techniques to preserve agricultural land and rural open space. This laid the foundation and provided justification for the implementation of a TDR program. In 1980, these efforts culminated in the adoption of the County's Functional Master Plan for Preservation of Agriculture and Rural Open Space. The TDR program was then adopted through an amendment to Montgomery County's zoning ordinance.

The Transfer of Development Rights (TDR) credits became valuable commodities for those who applied for them. In return for giving up the right to develop on their land, these landowners received TDR credits (American Farmland Trust, 2001). In 1983 the TDR credit's value was $3,500 dollars when the first sale took place. However, those prices peaked at $11,000 dollars per credit in 1996. It is important to remember that Montgomery County allowed the price of the TDR credits to be determined on the free market. Nevertheless, there was a market minimum of $3,500 per credit to ensure that those who received TDR credits would not lose on their investments by giving up the right to develop their property.

The Montgomery County Transfer of Development Rights (TDR) program is one of the most successful TDR programs in the country (American Farmland Trust, 2001). Because this TDR saved thousands of acres of farmland, many TDRs forming today use the Montgomery County program as a model, including the Massachusetts TDR program currently

in development.

2.1.7 San Juan, Puerto Rico

The Transfer of Development Rights (TDR) program in San Juan, Puerto Rico, was enacted on May 12, 2008 (Quiniones, 2008). The goals of this TDR program are to:

- Preserve permanent structures and properties of great historic value such as buildings with historic architecture, or with cultural and symbolic meaning.
- Preserve open space for the use of agriculture or as a natural reserve.
- Distribute the sending and receiving zones to different property owners throughout the area that are in accordance with the Transfer of Development.

The government maintains control over the San Juan, Puerto Rico TDR program (Quiniones, 2008). This means that instead of letting the TDR credits be bought and sold in the free market, the government regulates each transfer to ensure that it abides by the goal of the program.

The TDR program also tries to encourage builders to develop high density housing (Quiniones, 2008). This is accomplished by requiring more credits to build multi-bedroom complexes, thereby encouraging development of apartment complexes and multifamily housing that utilize all of the available space to its fullest potential. In addition, this strategy aids the poor because it is preferable for developers to build many smaller, cheaper housing units in a lot than build only a few large houses. This should make housing more affordable for the poor.

A concern for the Transfer of Development Rights (TDR) Program in San Juan is how they established their TDR Bank (Alsina, 2012). To purchase credits, a developer pays the value of the desired number of credits to the Municipio of San Juan, which will grant credits even if none are available to be transferred to the developer. After receiving this money the

municipio uses it as for its employees rather than saving it in a reserve (TDR) bank to pay for credits in the future. This could potentially lead to an economic collapse in San Juan because there is a large sum of potentially unclaimed credits, and if all the owners of credits were to demand their money at once in exchange for their development rights, San Juan would not be able to afford paying everyone.

2.1.8 Resistance to Transfer of Development Rights Programs

It is not a rare occurrence that Transfer of Development Rights (TDR) programs are looked upon with suspicion (Siemon, Larsen, & Marsh, 2012). For example, opponents of TDR programs routinely allege that the credits transferred in TDRs are valueless. This is only true if the program does not have any viable receiving areas, which can happen because of a lack of a market for increased density. However, it is also undoubtedly true that where demand for development is strong and existing zoning limits density, additional density does, and always will, have value. As long as the cost of purchasing additional density is reasonable in light of the profit to be made, there can be no serious claim that TDR credits do not have value.

Another misconception regarding Transfer of Development Rights programs is that they create a "windfall" for parcels of land designated as receiver sites (Siemon, Larsen, & Marsh, 2012). The theory is that a developer will have to pay for the additional density twice. When developing in a TDR program, those participating have permission to develop past existing zoning regulations that limit population density. Sellers of vacant land know this and will price their land based upon the expected development densities, and not the existing zoning regulations. However, the reality does not support the allegation. Developers, who ultimately set the market for vacant land, price it according to anticipated costs and revenues from development. For example, if the probability of rezoning is high, then the developer will be willing to pay for the land at the rezoned value. If there is little chance of

rezoning, then the developer will be unwilling to pay for anything more than existing zoning prices.

Another claim that must be addressed is the contention that Transfer of Development Rights programs increase housing costs by increasing land costs (Siemon, Larsen, & Marsh, 2012). This, however, is not the case. By making development rights transferable the government maintains the supply of development rights and thereby avoids an increase in housing costs as a result of limited supply of dwelling units.

2.1.9 Education in a TDR Program

Transfer of Development Rights (TDR) programs are extremely complicated and takes years of study to understand all of its components and aspects. This makes it difficult for the general public to understand and support the program, making public education one of the most important aspects of a TDR program.

A well-structured website is a key component for a Transfer of Development Rights (TDR) program (Collins & Goetz, 2006). This is a crucial educational aspect because it is a cheap educational tool that can be accessed by anyone with Internet access.

When advertising a Transfer of Development Rights (TDR) program to the general public, there are 10 key points to discuss, as described by "A Systems Approach to Community Land Use Education, Planning, and Action" (Collins & Goetz, 2006).

- Mix Land Uses
- Take Advantage of Compact Building Design
- Create a Range of Housing Opportunities and Choices
- Create Walkable Neighborhoods
- Foster Distinctive, Attractive Communities with a Strong Sense of Place

- Preserve Open Space, Farmland, Natural Beauty, and Critical Environmental Areas
- Strengthen and Direct Development towards Existing Communities
- Provide a Variety of Transportation Choices
- Make Development Decisions Predictable, Fair, and Cost Effective
- Encourage Community and Stakeholder Collaboration in Development Decisions

Mixed land uses are important to explain because residents should be assured that while certain locations might have regulations that will impede development, there will still be a multitude of potential uses for their land (Collins & Goetz, 2006). Taking advantage of compact building will allow for cheaper more affordable housing for the citizens and increased profits for developers. However, while compact housing will be available, so will a variety of other housing options. It is also important to emphasize that smart development strategies will create walkable communities that are safe and attractive. This is because increasing the safety and appearance of a community are appealing attributes

Preserving open space, farmlands, and the environment by concentrating development near existing communities is important to emphasize because logical planning helps assure the community will benefit (Collins & Goetz, 2006). Also, compacting development will make cheap public transportation a viable option in communities.

Lastly, it is important to reassure the community that the government will make predictable and fair development decisions and will allow community involvement these decisions (Collins & Goetz, 2006). If the community is involved in creating regulations, the sense of involvement will increase support of the program.

Gaining community involvement can be achieved by seeking out community feedback on various issues (Collins & Goetz, 2006). Citizens may even research and learn what about Transfer of Development Rights (TDR) programs because their community is involved in

it. Other methods of involving the community are needs assessments and evaluations of the program by members of the community.

"A Systems Approach to Community Land Use Education, Planning, and Action" indicates that to have a comprehensive educational campaign that includes community involvement, "ordinary" citizens should be encouraged to become community leaders (Collins & Goetz, 2006). The strategy they suggest is to make interested citizens and special interest groups "agents" of the program. The Planning Board then conducts a Transfer of Development Rights (TDR) special educational program for the "agent." This person is then required to educate the community about TDR programs and report the community's questions and feedback to the government.

Community educational is an integral part of creating and sustaining a successful Transfer of Development Rights (TDR) program (Collins & Goetz, 2006). Websites discussing key talking points and the promotion of community involvement are important aspects to address in achieving success.

2.2 History of Urban Growth in Puerto Rico

Since the sociopolitical changes brought on by the 20th century shift from agriculture to industry, Puerto Rico has experienced an increase in urbanization at the expense of agricultural lands (Mar Lopez, Aide, & Thomlinson, 2001). The population of Puerto Rico has more than tripled over the last century, resulting in one of the highest population densities in the world. While nearly 3.9 million people live in Puerto Rico, they only populate 9000 km^2, giving Puerto Rico a population density of 438 persons per km^2 (Martinuzzi, Gould, & Gonzalez, 2006). Without guided growth, Puerto Rico has been subject to unregulated urban sprawl, mainly across the coastal plain areas (which are also the most fertile lands). In 1997, roughly eleven percent of the island was considered "urban", but with the exponentially growing industrial economy, urban development had reached twenty-four percent of

the land after only 17 years. Development of urban areas has encroached upon agricultural land, with a forty-two percent increase of development on farmlands. Puerto Rico has lost six percent of its potential agricultural fields to development. The increase of population, along with the growth in urban areas, has put pressure on many aspects of the island, requiring immediate attention and better urban planning.

2.2.1 Urban Sprawl in Puerto Rico

Extensive road networks that were built during the agricultural phase of the island's economy have facilitated urban sprawl in Puerto Rico (Martinuzzi, Gould, & Gonzalez, 2006). This network of roads and highways was greatly influenced by American automobile companies, pressuring existing public transportation so that it would not diminish the market for private transportation (Alsina, 2012). The development and spread of metropolitan areas is neither sporadic nor random, rather it is a horizontal spread of low density development from the existing residential and commercial core areas along roads, flat lowlands, and coastal regions (Martinuzzi, Gould, & Gonzalez, 2006). Traffic jams in Puerto Rico occur regularly, due to congested residential areas and a high ratio of cars per person, equal to 0.54. The increased use of private cars for transportation and the increase of industry have put energy demands on the island. Industrial electrical costs are seventy-three percent higher in Puerto Rico than for other counties with more developed economies. To relieve traffic congestion and high energy consumption, the United States government has invested two billion dollars on an "Urban Train" as an alternative mode of transportation in the San Juan Metropolitan Area.

Urban sprawl in Puerto Rico has also affected the environment. Because the geological makeup of Puerto Rico has large regions of limestone (karst) based land structure, pollution from urban centers has leaked into the ground. This endangers the aquifers less than 300 feet below which are used for a large portion of the island's drinking water (US Geological Ser-

vices, 1985). Even protected lands, such as the Caribbean National Forest, have experienced environmental problems because of the low "ruggedness" of the land (Martinuzzi, Gould, & Gonzalez, 2006). Although it is expected that with more industrialization, deforestation will occur, Puerto Rico has been an exception. It seems that with more concentration on industry and development, the shift away from the use of agricultural fields has allowed the rainforest to recover. The peak of agricultural activity, which occurred between 1930 and 1950, had reduced forest areas in Puerto Rico down to only six percent of the total land area, but with less focus on agriculture, forest cover had grown to thirty-four percent of the land by 1985.

2.2.2 Economic Change in Puerto Rico

The economy in Puerto Rico is reliant on its duty-free access to the United States (Magaly, 2011). This has led to profitable industrial business that has surpassed sugar production as the main source of income for Puerto Rico. The duty-free access allows high tech industry and pharmaceutical companies to thrive. The products are expensive, and a profit can be made while still maintaining the U.S. enforced minimum wage. Agriculture, however, remains important to Puerto Rico as about fifty-two percent of the land and two percent of the workforce are dedicated to farming.

While agriculture and industry provide the majority of the GDP for the island, seventy-nine percent of the island's labor force works in the service sector, demonstrating the importance of tourism in Puerto Rico (Magaly, 2011). Because of industry and tourism, Puerto Rico's economy is highly reliant on the United States. Yet, as of 2010 the typical Puerto Rican citizen earned on average $16,300 per year, which is significantly less than the U.S. average of about $48,000 per year.

2.3 Protected Land Areas

Puerto Rico is an island rich in ecological locations that are imperative to preserve for future generations. Aquifers provide a substantial amount of fresh water to the island's inhabitants, but they are endangered due to chemical and saline contamination (US Geological Services, 1985). The El Yunque rainforest is one of Puerto Rico's most identifiable locations. Wetlands, while not abundant, provide refuge to many endangered species in Puerto Rico. Urban sprawl and industrialization have played a significant role in depleting the resources that Puerto Rico has, and it is currently part of the government's focus to help preserve these important lands. In the following sections, we will discuss the land areas that the Puerto Rican government would most like to preserve.

2.3.1 Aquifers

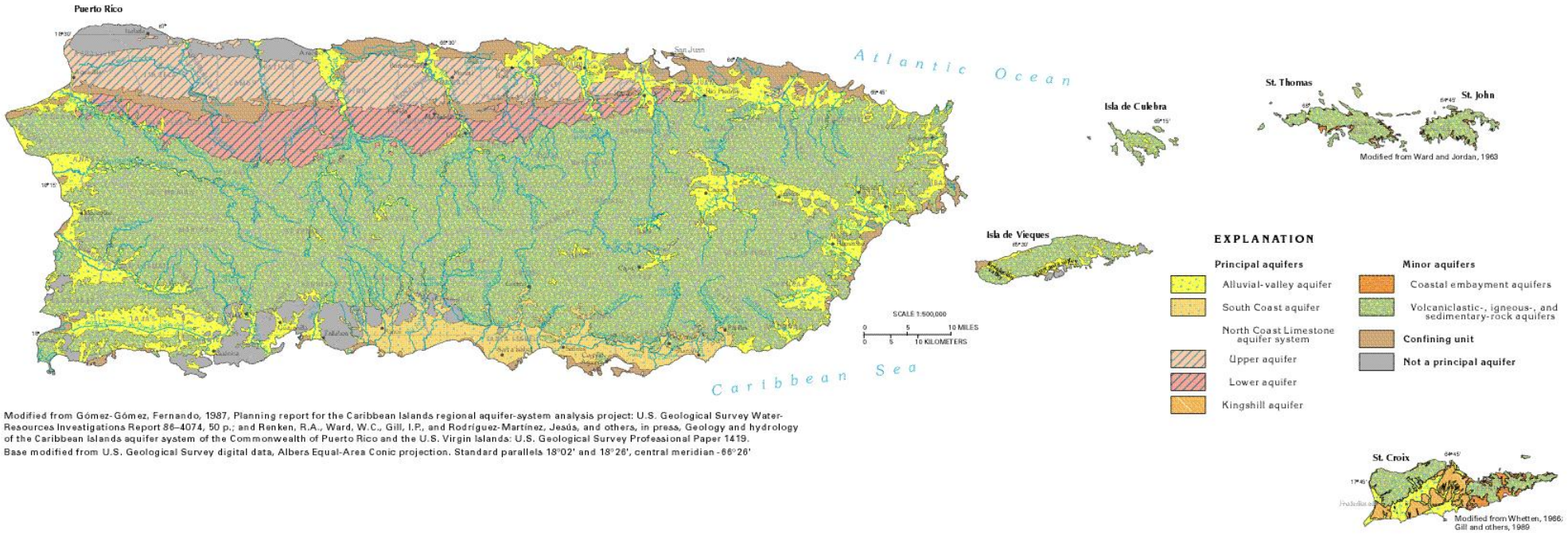
Aquifers in Puerto Rico are providing essential fresh water throughout the island; however, pollution from development threatens them. While a majority of the population relies on surface-water reservoirs, the people in the southern portion of the island rely on aquifers for up to 50 percent of their fresh water supply (US Geological Services, 1985). This is even more dramatic in the "dry season" between August and May when many ephemeral rivers dry up. Due to the lack of rain in some months, and the small size of the island, aquifers are an important resource for the local population.

The volcanic and limestone makeup of the island makes the aquifers susceptible to pollution (US Geological Services, 1985). Limestone found in nature is porous from weathering, which means that chemicals and pollutants from cars, household items, and industrial plants can reach the aquifers underneath the limestone, which can be less than 300 feet below the surface. Although the aquifers located in volcanic rock are smaller in comparison to the ones under limestone, there is an abundance of them due to the large amount of igneous and sedimentary rock in the center of island. These aquifers are created because the volcanic rocks

have large holes in them, allowing significant rainfall, stream, and river water to be trapped inside. These areas are referred to as alluvial valleys, meaning they have sedimentary runoff. Similar to the aquifers under the limestone, the weathered nature of the volcanic aquifers causes them to be susceptible to pollution.

Certain aquifer regions are more important to the future of development in Puerto Rico than others because of current pollution (US Geological Services, 1985). While manmade pollution has contaminated some of them, the majority of contaminated aquifers are a result of saline intrusion from the ocean. Saline contamination is defined as 1,000 milligrams of dissolved solids per liter of water. Coastal aquifers have been ruined as a result of rapid fresh water withdrawal inducing saline intrusion from the ocean and thus contamination. As a result of saline contamination, the North Coast Limestone aquifer and alluvial aquifers near the ocean are contaminated with salts (Ground Water Atlas, 1985). The location of these can be noted in Figure 2. The figure also clearly depicts the abundance of aquifers around the island.

Figure 71. The alluvial valley aquifers, South Coast aquifer, and the North Coast Limestone aquifer system of Puerto Rico, along with the Kingshill aquifer of St. Croix form the principal aquifers. The coastal embayment and the volcaniclastic-, igneous-, and sedimentary-rock aquifers are less important sources of water.



Modified from Gómez-Gómez, Fernando, 1987, Planning report for the Caribbean Islands regional aquifer-system analysis project: U.S. Geological Survey Water-Resources Investigations Report 86–4074, 50 p.; and Renken, R.A., Ward, W.C., Gill, I.P., and Rodríguez-Martínez, Jesús, and others, in press, Geology and hydrology of the Caribbean Islands aquifer system of the Commonwealth of Puerto Rico and the U.S. Virgin Islands: U.S. Geological Survey Professional Paper 1419.

Base modified from U.S. Geological Survey digital data, Albers Equal-Area Conic projection. Standard parallels 18°02' and 18°26', central meridian -66°26'

Figure 2: Aquifers in Puerto Rico (USGS, 1999)

Aquifers are an essential resource to Puerto Rico providing an estimated 100 million gallons of water per day (Ground Water Atlas, 1985). Protecting these aquifers from all types of pollution is imperative for Puerto Rico's fresh water supply. Further pollution can be avoided by properly guiding urban growth.

2.3.2 Rain Forests

Puerto Rico's rainforests are integral parts of its cultural identity, in particular the beautiful El Yunque National Forest, located on the Luquillo mountain range (El Yunque, 2012). All sub-tropical rainforests in Puerto Rico are located in El Yunque National Forest; however the actual size of the rainforest is quite small. It is located on a small strip of land on the windward and northeast side of the first mountain in the range, which receives approximately 3,400 millimeters of rain a year. The main plants in El Yunque rain forests are Sierra palms and epiphytes.

In the southern part of Puerto Rico there is a dry forest called Guanica, which consists of a flora that thrives in dry humid conditions (Vanderbilt, 2012). These areas receive little rainfall, and their flora cannot live in a tropical wet forest. The Guanica Reserve is located in the town of Guanica and protects much of the forest.

2.3.3 Wetlands

Puerto Rico has a variety of wetlands, from the rainforests to the coasts, in which many unique species of animals inhabit (NEEF, 2012). These wetlands range from high altitude fresh water wetlands to low altitude saline wetlands (USGS, 2012). These areas contain many endangered species of animals and plants that are being destroyed as urban development spreads. Figure 3 displays how the different types of wetlands are distributed.

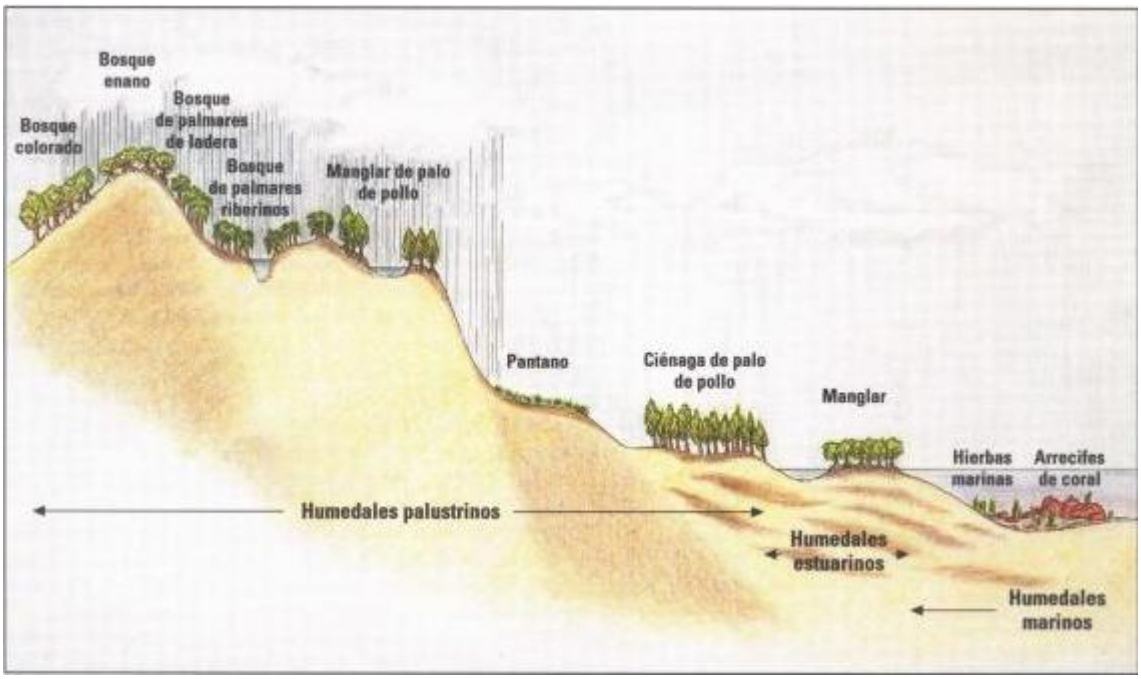


Figure 3: Wetlands at Various Altitudes (USGS, 2012)

The "Bosque de Palmares riberinos" and the "Mangular de palo pollo" are located in the center of Puerto Rico in the Luquillo mountain range (USGS, 2012). The "Bosque de Palmares riberinos" contains swampy areas with stagnant water from the runoff of the mountain. This area is rich in flora and is very humid. The "Mangular de palo pollo" is a mangrove forest with a plant that lives there called "el palo pollo", which is similar to the cypress tree in the southern United States. Though this type of tree is extremely common in countries in Central America, it is endangered in Puerto Rico due to deforestation.

The "Mangular" is a saline mangrove similar to those in the United States (USGS, 2012). It is threatened by pollutants and development because of its proximity to the coast. It is crucial to protect this area because many species of animals, including over a hundred species of birds, are reliant on the mangrove forests.

There are currently several agencies dedicated to protecting the various wetlands in Puerto Rico, including the Puerto Rico Planning Board and Fideicomiso (USGS, 2012).

2.3.4 Farmlands

The agricultural industry is an important part of Puerto Rican culture. The Municipio of San Juan Transfer of Development Rights program (TDR) protects farmlands, and a similar TDR is being established in the south coast region as well (Quiniones, 2008). Puerto Ricos main agricultural product is livestock, followed by a variety of crops (De Lahongrais, 2008). Sugar cane is the largest crop, having an annual production of 1,261,000 metric tons (Welcome to Puerto Rico, 2012).

The south coast of Puerto Rico is highly reliant on irrigation systems because it has semi-arid conditions as a result of only thirty to fifty inches of rain each year (Quiniones, 2008). Despite the dry conditions, the irrigation canals allow the farmers in the southern portion of the island to grow vegetables. However, starchier plants like plantains, bananas and potatoes need to be grown along the northern coast of Puerto Rico.

2.3.5 Summary

Being a small island, Puerto Rico has fewer resources compared to the United States and other larger countries. As resources are being depleted, it is becoming increasingly important to establish protection and conservation programs. Due to the ecological value of the locations described in this section, a Transfer of Development (TDR) program in Puerto Rico will have the task of preserving these areas while allowing for better planned urban growth. Although an island-wide TDR program has yet to be established in Puerto Rico, laws and regulations have been implemented that provide a framework for such a program.

2.4 Relevant Laws and Regulations in Puerto Rico

The Planning Board has passed and redacted many laws since it was founded in 1942. It has set into motion the goal of allowing each municipality in Puerto Rico to be able to create

its own land use plan, which it can subsequently manage. However, this requires many necessary boundaries to be in place so that the land on the island can be used in the most advantageous way possible.

2.4.1 Regulation 21

In addition to the Transfer of Development Rights program enacted in San Juan, Regulation Number 21 in Puerto Rico was instituted in order to gain better control over land use, Transfer of Development Rights (TDR), redistribution of land, and zoning laws by the Puerto Rico Planning Board (Junta de Planificacion, 1992). Regulation Number 21 aims to better develop land in such a way that public resources will not be affected adversely. The legal document states that in order to do this, the burden of economic and political programs will have to be equally shared amongst the involved areas. The agencies authorized to implement Regulation Number 21 are: La Junta de Planificacion, the Agencias Estatales, and the Municipios Cualificados. Communal areas will be designated in order to create areas that can be used according to the definition of the agency that implements it. In order to create communal land, land of equal value must be set aside for development purposes, and monetary compensation for the communal land will be given to the original owner(s) of the land. Regulation Number 21 explicitly lays out the requirements, procedures, and provisions for creating protected communal land and for monetary and land compensation. This regulation establishes the legislation that enables the development of a TDR program in Puerto Rico.

2.4.2 Land Use Planning in Puerto Rico

Land use planning in Puerto Rico began with the creation of the Puerto Rico Planning, Urbanizing, and Zoning Board (later changed to just Puerto Rico Planning Board) on May 12, 1942 (Fullana Corporation v. Puerto Rico Planning Board, 1958). The Planning Board

has had a long history of making frequent changes due to influences from socio-economic and political sources (UMET, 2009). The purpose of the Planning Board, created under Act No. 213 of 1942, was to centralize an effort to lead Puerto Rico's urban development in a direction of successful economic growth. Ten years after the creation of the Planning Board, Puerto Ricos Constitution called for sustainable urban and economic development, further emphasizing the need for a planned use of land, especially with the major economic shift from an agricultural-based to an industrial-based economy.

Many changes to the Puerto Rico Planning Board were realized during the 1970's (UMET, 2009). An important change in the structure of the Planning Board came about when the Planning Board was reorganized in 1975. The Puerto Rico Planning Board Organic Act of 1975, referred to as Law 75, was designed to better give the island and the government as a whole a more comprehensive direction, in regards to development of urban land. Moreover, the Planning Board adopted the Comprehensive Development Plan in 1979, giving the Board authority to guide government agencies in developing policies and programs. The Comprehensive Development Plan sought to expand on three key issues facing Puerto Rico: physical development, social development, and economic development. Although this document gave explicit guidelines for the development of government policies, it has not been updated, making its goals obsolete with regard to planning on the island today.

Law 81, The Commonwealth of Puerto Rico Autonomous Municipalities Act of 1991, marked the beginning of the decentralization of land use planning (UMET, 2009). This law allows municipalities to control the planning of their land. After the Planning Board and the governor approve specific strategies for a region, municipalities are then able to create and implement a land-use proposal, as long as they do not contradict regional and/or island-wide regulations made by the Puerto Rico Planning Board. There are also external agencies that influence the land development of Puerto Rico. These agencies include:

- Aqueduct and Sewer Authority

- Department of Natural and Environmental Resources
- Electric Power Authority
- Environmental Quality Board
- Highway and Transportation Authority
- Housing Department
- Solid Waste Management Authority

Presently, the Planning Board is developing land-use policies and zoning efforts for municipalities to classify land, with designations that include: Preservation Resources, Conservation Resources, Forest, Productive Agriculture, and General Agriculture (UMET, 2009). Although the Board has strived for an island-wide plan to promote ecological, economic and societal development, there is a lack of effort to implement these plans. Municipalities resist efforts made by the Planning Board and the set of responsibilities that public officials need to follow are unclear and have no legal repercussions if not followed. To date, the Puerto Rico Planning Board has had little impact on the actual land development of the island, even though there are various land management documents that give them the authority to implement such plans.

2.4.3 TU PLAN

The TU PLAN was developed by the Puerto Rico Planning Board (2011) in 2006 as an effort to develop the island wide Transfer of Developmental Rights Program (TDR). The TU PLAN in particular advises about the zoning strategies to be followed by each municipality

The TU PLAN consists of many goals, which the architects of new zoning regulations in municipalities try to achieve while creating the ordinances (Planning Board, 2011). The main goals are to:

- Promote public policies for uniform use of land adjustment vis-a-vis particular characteristics of each region.
- Promote participation of the municipios to create dynamic economic development in Puerto Rico.
- Promote a balanced Socio-Economic development that respects and protects the essential natural resources for the benefit of future generations.
- Consolidate the development of new territories for urban development for the protection of ecological systems
- Promote an improved quality of life for all of Puerto Rico by using a territorial plan for the wellbeing and security of the citizens and ecosystems.

The territorial plan previously stated is one of three classifications of plans used for zoning regions in Puerto Rico (Planning Board, 2011). These allow for simplified classification of what is being worked on.

1. The territorial Plan is an organizational plan that covers a municipality and uses political and public formulation for development and land use.
2. The Area plan is used to develop areas in municipalities that require special attention.
3. The Wide plan is used to develop ideal underdeveloped land for development

The TU PLAN also contains six major classifications for zoning. Classification 1 is Urban Land that has a long term focus on agriculture (Planning Board, 2011). Classification 2 is areas to be urbanized with in an eight year plan for development. Classification 2 is further subdivided to classifications 2A and 2B. Classification 2A consists of locations of planned urban development with four-year development plans. The primary objective is to develop in areas that aren't susceptible to destruction and areas that currently have, and are

improving upon infrastructure. In addition, Classification 2A looks to make sure there isn't any development on steep hills or mountainsides, which can be susceptible to erosion, and that there is no risk to damage high risk natural areas. Classification 2B is for land that is designated for development, but does not have immediate plans for development. A four to eight year plan for development is to be created.

Classification 3 is classified as country common land protected from continued urban development (Planning Board, 2011). Classification 3 is subdivided into classifications 3A and 3B. Classification 3A is country common land that is used for agriculture and livestock unnecessary for the future urban growth and land lacking recreational and natural value. Classification 3B is specially protected country land which entails perceived indispensable natural or historic land in a region. Classification 4 is federal property that is to remain public and federal land forever. Classification 5 is the infrastructure in Puerto Rico, which includes general infrastructure such as electricity lines, water pipelines, and important roads and highways that can facilitate the maximum social and economic development in the municipalities. Classification 6 is the water classification for areas where there are bodies of water.

To have the TU PLAN established in each municipality, the Planning Board gave each of the 78 municipalities $250,000 to hire consultants and pay for the required resources to complete the TU PLAN (Gonzalez, 2012). However, due to either a lack of interest or capability, many municipalities have yet to create a land use plan which has forced the Planning Board to begin creating a land use plan for these municipalities where there are incomplete land use plans. The punishment for not utilizing the money and creating a municipality wide land use plan is that they forfeit the right to create one.

Varying levels of engagement by the municipios have led them being in different phases of completion of their land use planning processes. The TU PLAN outlines four phases in the completion of zoning (Planning Board, 2011).

- Phase 1: Access information of a municipio, create objectives, contact proper authorities in the Planning Board for advice, create benefits for the Transfer of Developmental rights program, and determine any other responsibilities of the future TDR program.

- Phase 2: Determine the characteristics of each municipio and determine the advantages and disadvantages of protecting each region. Determine two controllable and two uncontrollable factors and list the advantages and disadvantages of them. Create analyzable objectives including local and global effects. Discuss policies with local governments and analyze potential national effects. Find "guides" to show different characteristics of the municipio. Create potential zoning laws and determine the impact of the future program.

- Phase 3: Present plans with current and future benefits to the municipio, gain approval of plans in the Municipio and determine Super Region plans. Have strategies so that poor and small municipalities get strong and prosperous stimulation. Determine public space intended for general public use. Determine socio-economic effects of the TDR program. Investigate investment strategies about the TDR. Create classifications adopted in regional plans.

- Phase 4: Analyze implementation strategies, regional impact, super-regional impact, and the impact of new regulation. Also in phase 4 the plan has gone to voting for approval. The approval process starts with a town hall meeting and then is voted on by the municipio.

- Approved: The plan has been voted on and passed by the municipio.

Currently 4 of the 11 subdivided regions zoning regulations in Puerto Rico have been approved (Planning Board, 2012). The remaining regions have a deadline of completion by the end of December 2012. This will allow Puerto Rico to enact a national Transfer of Develop-

ment Rights Program.

The TU PLAN encompasses many goals to be accomplished such as stopping the unregulated urban sprawl occurring in Puerto Rico, protecting natural resources and delicate environmental locations, improving infrastructure, and improving education from the elementary level through the collegiate level while increasing graduation rates (Planning Board, 2011). The TU PLAN will rely on a symbiotic relationship between the public and private sector to work together in order to accomplish these goals throughout the island. An example of this is that the Planning Board wants to privatize waste management which would allow a reduction in government participation in daily activities of the citizens. Another difficult goal is to improve Internet bandwidth throughout the island. This will be challenging to accomplish because many municipios are poor and the citizens cannot pay for Internet. Therefore Internet companies lack incentive to expand there.

The difficulty in creating a working relationship between public and private sectors is that the private sector perceives the TU PLAN and other "symbiotic relationships" as a tax. In addition, many municipalities reject the TU PLAN for other various reasons. These obstacles will need to be overcome by the Planning Board in order to create a successful TDR program.

2.5 Summary

This chapter presents the concept of a Transfer of Development Rights program and examples of successful TDR programs outside of Puerto Rico. It also describes the ecological and social factors that will have to be considered when creating such a program in Puerto Rico. Furthermore, we describe the land use plans already established in Puerto Rico, and the laws and regulations guiding these plans. An important step in the creation of a TDR program that remains to be completed is the valuing of TDR credits.

3 Methodology

The goal of our project was to establish the value for Transfer of Development Rights (TDR) credits in the karst areas of Puerto Rico. We determined how many *cuerdas* (3930.39 m^2 – a unit of land measurement unique to Puerto Rico) of land is worth one credit in terms of development rights. We also determined why certain lands ought to be valued more highly than others, and therefore why they should be assigned more credits per *cuerda*. The final project resulted in recommendations to the Puerto Rico Planning Board on how to determine the credit value of the karst sections of land in Puerto Rico, as well as how to ensure long term sustainability and community participation. In this chapter we explain the research methods we used to complete our project, as well as our reasoning behind each step taken.

3.1 Identifying Effective Approaches to Implementing TDR Programs

When completing any research project, the most prudent thing you can do is to look at past attempts at achieving similar, if not the same, research objectives. It is important to note that a vast majority of our time used completing this project was spent doing research that went above and beyond the scope of our background chapter. During this research on specific Transfer of Development Rights (TDR) programs and their methods, we repeatedly came across literature concerning two specific examples. Those programs were in Montgomery County, Maryland, and the state of New Jersey. Because these examples were uniformly regarded as two of the most successful examples of TDR programs, we decided to contact and interview one or more people who either worked on the plans for developing and implementing these programs for a substantial amount of time or who were still working with them.

3.1.1 Montgomery County, Maryland

The first thing that we did was to go to the Montgomery County Planning website ("Montgomery planning," 2012). From there one group member contacted three employees via email. These people were chosen because they were the three people listed as contacts for further information regarding the program. The next day, we received a reply from Leslie Saville, a Senior Planner for Zone 3 in Montgomery County. She was immediately enthusiastic about helping us, and, when we asked about a phone interview, she offered to involve her supervisor, who has been working with the World Bank in Panama in setting up a program. We developed a short list of talking points, which can be found in Appendix B, and emailed it to Ms. Saville two days before the scheduled interview. The next day she replied to that email with the questions answered in great detail both by her and her colleagues. She also provided us with presentations that were put together for a previous seminar. With all of our questions answered above and beyond what we were expecting, we requested to postpone the phone interview until any further questions arose.

3.1.2 New Jersey

To gather information about the New Jersey TDR program, we first contacted the New Jersey Department of Agriculture and asked to be referred to someone with expertise in TDR programs. They referred us to Steven Bruder, who works with both the New Jersey State Agriculture Development Committee and the New Jersey State Transfer of Development Rights Bank. We contacted him via email with some general talking points and questions. It took roughly a week to receive a reply and when we did, our project focus had changed in such a way that the questions we had originally asked were not quite as relevant anymore. Because of this dilemma we scheduled a phone interview and sent him an updated list of questions a couple of days in advance. Due to some technical problems within the Planning Board, we were unable to complete the interview via phone, so we had to rely on his responses

to our emails. Our questions with his responses can be found in Appendix C.

3.1.3 Community Education and Participation

To determine how to gain public support for a TDR program, we studied other successful programs. When asked about public education in the New Jersey TDR program, Steven Bruder (personal communication, April 12, 2012) replied "Public education is a major factor in getting public support to enact a planning effort as complex as TDR. We have seen time and time again misconceptions about what TDR is and how it is used. It is a difficult concept for many non-planners to understand, so the more public education the better." He also provided us with links to the New Jersey websites so we could see how a public education section of a TDR website could be set up. A publication called "The TDR Handbook" (Nelson, Pruetz, Woodruff, 2011) was also a valuable resource for understanding how to construct a public education program.

3.2 Determine Changes in the Many Land Classifications

To properly determine the number of Transfer of Development Rights (TDR) credits that should be given for a specific plot of land, we first evaluated the different land classifications. These classifications, given to us by the Department of Natural and Environmental Resources (DNER), were evaluated and the criteria for each of the classifications were taken into account when creating the formula for receiving TDR credits. The categories for each of the sending areas reflect the type of land that resides in that specific plot. To more easily develop an Excel program that could calculate credits, each of the zoning classes were translated from Spanish to English. They were found in the Comprehensive Plan, (Planning Board, 2012) which is the document that contains all of the land use laws, regulations, and procedures.

3.3 Determine Karst Region Land Classification System

The Department of Natural and Environmental Recourses (DNER) of Puerto Rico is a vital partner of the Puerto Rico Planning Board in conserving natural resources on the island. We consulted the DNER to learn about their methodology and logic behind the different zoning classifications for land in Puerto Rico. In addition, the DNER staff took us on a field trip so we could make direct field observations of karst areas; viewing the region directly helped us to better understand the logic behind the creation of zoning regulations because we were given a firsthand view of how and why certain data, such as land characteristics and land use data, were collected.

3.3.1 Interviews for Identifying Land Use Planning Strategies

Along with Sra. Irmgard Gonzalez Segarra and Sra. Lourdes Fernández-Valencia, we met two representatives at the Department of Natural and Environmental Recourses (DNER) with the goal of gaining expertise on zoning and other regulations on the island. We had created an interview protocol for the meeting. The questions were determined by analyzing our background research and current understanding of the Planning Boards relationship with the DNER and their involvement with the Transfer of Development Rights (TDR) program. This meeting allowed us to ask questions that focused specifically on zoning and also developed into broader conversations that aided us in our conclusions and suggestions for the project. The interview transcript can be found in Appendix D.

3.3.2 Direct Field Observation of Land Value Assessment

We went to Morovis, a region west of San Juan, with our liaisons, Sra. Irmgard Gonzalez Segarra and Sra. Lourdes Ferández-Valencia, Sr. Vincente Quevedo Bonillo from the Department of Natural and Environmental Resources (DNER), and a biologist from the Municipio of Morovis. This trip allowed us to observe firsthand how zoning decisions are

accomplished in the field. We also observed the land formations in the karst region and discussed how protecting these formations are important to the ecosystem and the aquifers below.

3.4 Determine an Equation to Calculate the Credit Amount per Property

One specific request of the Puerto Rico Planning Board was to create an Excel program that could easily calculate how many credits an owner of karst land should be rewarded for taking part in the Transfer of Development Rights (TDR) program. To maximize efficiency, we decided that the program should work in such a way that the user need only to input a small amount of key information for the program to calculate the number of credits that the landowner would receive in return.

In order to create this Excel program, we first needed to develop an equation upon which it would be based. Before the equation could be made, we first needed to determine two critical elements. The first decision was made based upon the results of section 3.1, which allowed us to determine how much land one credit should represent. Second, the results from section 3.2 allowed us to compare our credit representation with the existing zoning laws for the different land classifications of Puerto Rico. With these key pieces of information, we developed the equation.

3.5 Summary

The goal of our project was to determine the value for Transfer of Development Rights (TDR) credits in the karst areas of Puerto Rico. We did this by researching successful TDR programs, specifically those found in Montgomery County, MD, and the state of New Jersey. We then analyzed the specific zoning laws of the karst regions in Puerto Rico. This was

done by translating legal documents provided to us by the Puerto Rico Planning Board, as well as by consulting specialists at the Department of Natural and Environmental Recourses (DNER). With that information, we were able to determine an equation for calculating the number of credits that would be due to landowners who gave up development rights to their land.

4 Results and Analysis

When we collected data, whether it was through research, interviews, or meetings, we needed to gain information regarding two key loci of attention. We focused on how land was evaluated and classified, and how we could represent protected lands in the form of credits. The first two sections of this chapter explain our results for these two categories. With those results we were able to formulate the equation upon which we based our Excel program for credit calculation. Finally, we outline our findings on how the Planning Board could ensure sustainability of the Transfer of Development Rights (TDR) program through community education.

4.1 Evaluating Land and Classifications

While developing the formula for calculation of credits, it was important to become familiar with the zoning laws and regulations in Puerto Rico. Land around the island is classified according to the specific geographical location, as well as soil quality and the inherent ecological value of the terrain. Specific land classifications that we considered due to their location on the Karst region are Developable Terrain (UR *Terrenos Urbanizables*), Forrest (B-Q *Bosque*), Resource Conservation (CR *Conservación de Recuros*), Resource Preservation (PR *Preservación de Recursos*), and General Agriculture (A-G *Agricultura General*) (Oficina del Gobernador, 2010). The Puerto Rico Planning Board published a book on the specific regulations regarding each type of land classification and allowed us to utilize these regulations when developing our recommendations to them. The Joint Regulation of Permits for Construction and Land Use (*Reglamento Conjunto de Permisos para Obras de Construcción y Usos de Terrenos*) gave the following permits and regulations for each plot class.

Land under the "Developable Terrain" district is specifically zoned to optimize urban

growth and infrastructure expansion (Oficina del Gobernador, 2010). The UR districts will also include terrains previously classified as R-0, except land that contain valuable natural resources, land that is susceptible to landslides, and land that may be located over a sinkhole. Proper use of this land classification includes agricultural development, a single family dwelling unit, and other uses via consultation with the Planning Board. It is important to understand this land category in order to preserve the Karst beneath it, and keep urban expansion out of it. Land under the UR classification is also subject to procedures under the approved Territorial Plan set forth by the Planning Board. If a municipality has not yet been approved for the Territorial Plan at the time of the adoption of these regulations, there are guidelines for building on potential UR land. These guidelines include not building in flood risk zones, ensuring readily available infrastructure as well as the health and well-being of the inhabitants, and harmonizing land use with other existing terrain usage.

The PR classification of land primarily deals with preservation of mangroves and land that is considered unique, fragile, and in danger of extinction and which must be protected for scientific research (Oficina del Gobernador, 2010). Any land that has any of the five types of mangroves that exist in Puerto Rico will qualify to be in the "Preservation of Resources" terrain category. This land will be extremely restricted and the regulations explicitly declare that any land under the PR zoning cannot be separated into plots or divided for other uses, such as farming or construction.

Similar to the PR classification of land, the "Conservation of Resources" zoning is for the establishment of a district of conservation in which existing features should be protected i.e. lakes and other bodies of water, caverns, forests, rivers, etc (Oficina del Gobernador, 2010). Construction in the CR terrain is limited to recreational facilities, public facilities, agricultural usage (using Best Management Practices), and any building that will facilitate infrastructure services. If there is any agricultural usage, the housing is limited to two families maximum, occupying only two percent of the land. The primary area of interest in the

CR zoning is caves and caverns that formed over the Karst region. Any building that is approved through special permits must be fifty meters away from any cavern, unless it is for scientific research, but it may not damage or pollute the cave system.

The B-Q zoning deals primarily with forests and focuses on replanting trees in existing forestry areas and also calls for the reforestation in planned areas (Oficina del Gobernador, 2010). Any areas deemed to be classified under the "Forests" zoning must have a minimum of twenty-five cuerdas and plots cannot be separated from any general forest, unless land is turned over by the owner under a public deed. Construction in this area is permitted but limited to agricultural use, agro-forestry, raising livestock, agro-tourism, specialized lodging, and recreational facilities. If the land is used for agriculture or lodging, it is limited to a maximum of two families and the building footprint may not exceed four percent of the land.

An agricultural district is established to identify areas for potential agricultural and livestock activities, filed under the A-G regulations (Oficina del Gobernador, 2010). These were areas whose general pattern of agriculture and agricultural development was adversely affected with the introduction of urban uses, particularly residential housing. Construction in "General Agriculture" is for agricutural use, specialized lodging, windmills, veterinary hospitals, and agro-tourism and eco-tourism. Housing in this area has to meet certain requirements such as: construction in plots of one *cuerda* cannot exceed twenty percent of the total region, and in plots less than one *cuerda*, building footprints cannot exceed fifty percent of the total region. Housing is also limited to a maximum of two families in every twenty-five *cuerdas*, given that the land is used for farming and raising livestock.

4.2 Land Representation through Credits

We needed to determine what one credit will represent in terms of land in the karst regions of Puerto Rico. Naturally, the first question we asked those whom we interviewed was how their respective organizations conquered that hurdle. When our research through documents and

publications proved unfruitful, we decided to consult planners at successful TDR programs.

Leslie Saville, a Senior Planner in Area 3 in Montgomery County, MD, explained to us how the designers of their program created the credit representation they use. She first said, "The TDR allowance was one of many things that came out of a large advisory group that negotiated about it for several years." An appendix containing all of our questions and her answers can be found in Appendix B. This was rather discouraging, seeing as we were attempting to accomplish this feat in the matter of two months. However, in that same interview she said that the credit representation that was decided on in 1981 based on the zoning law that stated that, in order to build a property that consisted of one dwelling unit, one needed to own five acres of land. She went on to say that basing the TDR credit on existing zoning regulations was "by far the cleanest, simplest way to do it." The idea of basing TDR credits on existing zoning regulations greatly intrigued us. One of the original problems we had was to determine how to prioritize land conservation, and more specifically, how the credit representation would change among the different land classifications in the karst regions. By basing one credit on how much land someone needs to own to build one dwelling unit, we were able to expand on existing laws regarding land preservation, rather than possibly overlap or infringe on those laws. For example, if it takes fifteen *cuerdas* of land to build a house on one type of land, and twenty-five *cuerdas* of land to build in another classification, the land that requires twenty-five *cuerdas* to build on is a higher priority for protection. The credit system we are proposing reflects this priority.

4.3 Development of a Mathematical Solution

Once we discovered the zoning laws in each of the land classifications and decided that our credit value system would be based around those laws, we were able to start brainstorming ideas for an equation that would calculate the number of credits a landowner would have as a participant in the Transfer of Development Rights (TDR) program. One of the issues

we constantly kept in mind was that many landowners will not have enough land to earn even one credit in this system. However, it is important to note that in our interview with the representative from the Department of Natural and Environmental Resources (DNER), we learned that in order for anyone to develop in the karst regions of Puerto Rico, with or without a TDR program, they need permission from the DNER.

The equation we developed looks first at the amount of land one owns. It then divides the number of cuerdas of land needed to build one *Unidad Básica de Vivienda* (UBV). UBV translates into "basic living unit". One basic house unit is defined as a three bedroom house (Planning Board, 2010).The equation for determining how many basic house units exist in a house, as well as a table that describes it, are given below.

$$\textit{Number of Basic Living Units} = 0.4 + (0.2 \times \textit{Number of Bedrooms})$$

Figure 4: Equation of UBV Calculation (Planning Board, 2010)

Table 1: Basic Living Unit Chart (Planning Board, 2010)

Number of Bedrooms per Unit	**Basic Living Units**
0 (Studio)	0.4
1	0.6
2	0.8
3	1.0

The amount of land needed to build one UBV is determined by identifying which classification of land one owns, which is also explained in section 4.1. Next, the equation accounts for UBVs already existing on the property by subtracting the number of basic house units from the original division, thus resulting in the amount of credits owed to the

landowner. The mathematical form of the equation can be seen below, in Figure 5.

$$\frac{Number\ of \text{ Cuerdas } Owned}{Number\ of \text{ Cuerdas } Needed\ to\ Build\ 1\ UBV} - Number\ of\ UBV\ Already\ on\ the\ Property = Credits\ Allotted$$

Figure 5: TDR Credit Equation

Upon analysis of our equation, it quickly became apparent that in most cases the number of credits that the equation produces will not be a whole number. We decided that it was necessary to work in decimals for the simple fact that many landowners do not own large plots of land. Furthermore, the decision seemed even more obvious when one-tenth of a credit has the potential to equal five *cuerdas*, as in the case of land classified as "Productive Agriculture," where a landowner would receive one credit for every fifty *cuerdas* of land owned within this classification. The final decision that we made was to require that in order for landowners to participate in the TDR program, they would need to own at least one-tenth of a credit worth of land. By this we mean that those landowners in the "Productive Agriculture" classification (50 cuerdas = 1 credit) would need at least five cuerdas of land to be able to sell their development rights.

After we developed the equation, and the details were ironed out, we were able to begin work on our Excel program. A screenshot of the program can be seen in Figure 6.

Classification of Land	Cuerdas/UBV	Cuerdas Owned	Total # of Houses on Property	Total # of Bedrooms on Property	Exsisting # of UBV on Property	Credits Alloted
A-G - Agrícola General (General Agriculture)	25	0	0	0	0	0
A-P - Agrícola Productivo (Agricultural Production)	50	0	0	0	0	0
B-Q - Bosque (Forest)	25	0	0	0	0	0
CR - Conservación de Recursos (Resource Conservation)	25	0	0	0	0	0
PR - Preservacion de Recursos (Resources Preservation)	25	0	0	0	0	0

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Total Credits Alotted ----> 0.0

Figure 6: Excel Program for TDR Credit Calculation

As you can see, the five classifications found in the karst regions of Puerto Rico are explained on the left. Directly to the right of the classifications, there is a column defining the number of *cuerdas* of land one would need to own to qualify for one credit. The next three columns are the only ones that require the user to input information. The first column requires the user to input how many *cuerdas* of land owned in each of the five land classifications. Then, the user needs to enter the total number of houses on the property. Next, the user needs to input how many bedrooms currently exist on their property, between all houses. We ask for the number of bedrooms, instead of the number of houses, because one UBV (basic house unit) is equal to a house with three bedrooms, and we wanted to be as specific as possible. Once the information is entered, the next column produces the number of basic house units the landowner has on his/her property. Finally, the last column shows how many credits are due to the landowner. In the case that the landowner owns property in more than one of the classifications, the numbers in the final column are summed up in the black box, which can be seen in the lower right of the screenshot.

4.4 Community Education and Participation

Community involvement and support is an integral part of the establishment of a Transfer of Development Rights (TDR) Program. To pass the legislature to enact a TDR program, the community must understand the purpose of the program. After the TDR laws are passed, education leads to community involvement, which improves the program's success. Puerto Rico currently does not have a substantive educational program to achieve either of these goals.

The last part of our project required us to make recommendations to the Puerto Rico Planning Board on how to encourage the sustainability of the program through community education. In order to make these recommendations, we conducted an immense amount of background archival research. The following sections go through the results of the research we

performed to promote community involvement in the TDR through education and incentives.

4.4.1 Educating the Community about a TDR Program

One resource that contributed to a large portion of our research on community education was a paper by Timothy Collins and Stephen Goetz (2006) titled, "A Systems Approach to Community Land Use Education, Planning, and Action." This paper explains that the first step to educate the public is to describe the reasons for the Transfer of Development Rights (TDR) program. In the case of Puerto Rico, tourism constitutes the islands maximum potential financial gains and will therefore continue to stimulate development. For this trend to persist, however, the island must maintain pristine beaches, Puerto Rican culture, and a vibrant ecosystem that drives both regular tourism and eco-tourism. It is imperative to educate the public that a TDR program will aid in protecting these important resources without requiring significant government funding. In addition, the TDR program will promote smart development, allowing for improved infrastructure and quality of life for the average Puerto Rican.

The paper goes on to explain that in order to educate the public, it is important to define the community (Collins & Goetz, 2006). Those responsible for the education program need to understand why the community fears the Transfer of Development Rights (TDR) program in order to properly inform them. When defining the community, it is helpful to classify it into two categories. These groups are typically individuals, who are classified as self-interested citizens, and groups, which are classified as corporations, businesses, or special interest groups.

The same paper continues to explain that the most important tool to educate the public is the Internet (Collins & Goetz, 2006). In today's world, the Internet is the first place many people go to search for information. It is extremely important for a Transfer of Development Rights (TDR) program to properly maintain an informative website to inform

the citizens about the program. There are many important factors that determine if a TDR website is to be successful. The most important of these factors is ease of access. Also, the information should be clearly structured with topics that reflect the various land-use laws the program will put into effect. Finally, there should be links to general TDR information and other programs that utilize a similar TDR program.

We can personally vouch for the effectiveness of informative and educational websites. Websites such as the one for the Transfer of Development Rights (TDR) program in King County, WA, describes their current program in an easy to use website (King County, 2012). Visitors to this site will quickly find links that describes a TDR, how it works in King County, and incentives for partaking in the program. The New Jersey Pinelands website is another great example of a simple and easy to use resource with a focus on the education of how a TDR program works (New Jersey PDC, 2012). It is no coincidence that successful TDR programs also have very well planned, transparent, and accessible websites as a resource for the public. The Junta de Planificación website lacks a user friendly interface and does not have a TDR information site. Improving the website and creating a TDR website will help provide cheap and widespread public education for the program.

Our liaisons have made it very apparent that gaining the support of the Puerto Rican public has never been an easy task. One of the biggest issues we have surmised from our conversations with themSeñora Lourdes Fernández-Valencia, in particular, is that there is a general mistrust of the government. As such, it is difficult to gain public support and have bills passed into law. For the Transfer of Development Rights (TDR) program, law dictates that each region can only have one town hall style meeting on the issues. This prohibition significantly impairs the ability of the government to educate the citizens on the benefits of a TDR program so that they will be able to make an informed decision. In addition to only having one meeting, there also exist special interest groups who do not believe in the benefits of a TDR program and lobby against its passing.

The Department of Natural Environmental Resources (DNER) currently has educational programs to inform the public about their regulations. They utilize their website as a key resource for education as it is a cheap method to spread information. The DNER reaches out to those affected by new regulations one to two times per year in order to inform them of legal changes. Education at the school level is also a preferred method of outreach, such that members of the DNER go to schools upon request and teach students about the work done at the department.

4.4.2 Training as an Incentive to Participants in the Program

In our research of the King County, WA, Transfer of Development Rights (TDR) program, we found that they established a program that offers incentives to participating landowners (King County, 2012). The program provides training and other forms of technical assistance in farming and forestry to those who participate in the TDR program. Thus, landowners who give up their development rights still have the opportunity to use their land to generate revenue. One third of eligible citizens in King County participate in the land stewardship program indicating its effectiveness as an incentive. Puerto Rico, between the Department of Agriculture and the DNER, has similar farming and forestry education used as guidelines from the Farm Bill. These programs could easily be utilized by a Puerto Rico TDR program as well.

4.4.3 Offering Tax Breaks

A possible method of gaining public support for a TDR program is to offer tax breaks to the landowners and developers. In Washington State, the Open Space Taxation Act allows a landowner to reclassify his/her land, and pay property taxes according to the new classification (Washington State Department, 2012). By taxing property less in ecologically sensitive areas, the government provides landowners with an incentive to classify (or re-

classify) their land as ecologically important and they must therefore abide by the laws governing such an area. In Georgia, the Tax Relief Act of 1997 changed the treatment of estate taxes by raising the exemption to $1.3 million (H.R. 2014—105th Congress, 1997). This is important to landowners with sizable estates and substantial real estate possessions. In Georgia, farmland worth between $600,000 and $1.3 million, depending on the year of death, is exempt from estate taxes when the owner dies. In addition, if a conservation easement is placed on land worth more than $1.3 million, the estate value will decrease, putting the value within the exemption range. A similar tax incentive could be offered as part of a TDR program so that people with large estates on protected land will not have to pay estate taxes.

The benefits of a TDR program will only become apparent if there is a "well organized auction" where the transaction costs are as low as possible between buyers and sellers (Field, 1975). A properly constructed TDR bank, as described in our Background section will help reduce transaction costs. However, another method of keeping transaction costs low is to keep TDR credits tax-free. If landowners and developers do not see TDR credits as a tax to them, they will be more likely to participate in the program.

4.5 Summary

Through archival research, a series of interviews, and on-site observations, our team collected and analyzed data that led to the creation of an Excel program that produces Transfer of Development Rights (TDR) values. We also performed an analysis of various educational programs. First we gathered the current land regulations, which allowed us to follow and analyze current zoning regulations while creating the Excel program. Then, we gained information on how other TDR programs valued credits, which allowed us to create an equation that calculates TDR values. We also analyzed educational and incentive programs and how they can be used by the Planning Board to help make a TDR program succeed

on Puerto Rico. This research and analysis has led to our recommendations chapter, which discusses how we believe the Planning Board can best benefit from and utilize our results.

5 Conclusions and Recommendations

The vast majority of our project has been based on archival and background research. The details of a Transfer of Development (TDR) program, or even the definition of one, are by no means common knowledge. We found and contacted representatives of successful TDR programs to gain insights into the processes they followed. We also spent a large amount of time understanding zoning laws so that we could better understand the regulations in the karst regions of Puerto Rico. Once we had a sufficient pool of knowledge, we were able to develop an equation that was used to create an Excel program for easy TDR credit calculations. This chapter presents our final recommendations to the Puerto Rico Planning Board. These recommendations focus on how to implement our credit value system and encourage its sustainability through community education and other incentives.

5.1 Implementing Our Credit System

We believe that the best method of implementing our credit system is to use make an Excel document because it is easy to use and edit. As our research of Transfer of Development Rights (TDR) program depicts, just creating an equation does not suffice to implement the program. Available public information and a successful TDR bank typically are keys to a well functioning TDR program, as our chapter 2 research explains.

5.1.1 Web Based Information

We believe that the first place people will go to learn about the new Transfer of Development Rights (TDR) program is the Internet, and more specifically, the Planning Board's website. Because of this, we recommend that the Excel spreadsheet be available on the website itself, or for download. This will allow a landowner to see for himself how many credits he would be allotted if he/she participated in the program. Putting the Excel program online and

making it available to the public also does two important things. First, it makes community members feel involved in the process. Second, it increases transparency. The second point is especially important because of the general mistrust of government in Puerto Rico, which our sponsors stressed to us during our meetings with them.

5.1.2 Establishing a TDR Bank

By establishing a TDR banking system, credits will be able to be transferred more easily between landowners and developers, as described in Chapter 2. People will be more likely to participate in the TDR program if they have an easily accessible method of selling and buying credits. A properly run TDR bank will also ensure that the price of a credit remains fair. From our research into other TDR programs, we have seen that the prices of TDR credits are nearly always determined on the open market. Therefore we suggest that government involvement in the determination of credit prices be limited. However, we have seen governments that set a minimum value for TDR credits, thereby ensuring that the landowners will receive a fair price for their development rights. We have also researched programs in which TDR credits are bought by the bank, and distributed when the market is struggling. By using these methods, the government can guide the transfer of credits without taking a controlling role. We recommend the Puerto Rico Planning Board set up a TDR bank to take on a similar role. By so doing citizens will be more likely to view the program as a benefit to them instead of a government mandated program. Also, this will help to ensure a fair and sustainable program.

5.2 Incentives to Create a Sustainable Program

A TDR program is a complex program that is often difficult for non-planners to understand. The program also requires a lot of work to maintain its functionality and effectiveness. Without a large group of landowners and developers participating in the program, the program

cannot function. In order to ensure the success of the program, the public must understand the purpose of the program and recognize the benefits of participation. Below, we have made a series of recommendations to create a successful and sustainable program.

5.2.1 Offering Tax Incentives

Through our research into other programs, we have seen the effects that tax incentives have on encouraging participation in a TDR program. Often times, landowners and developers see TDR credits as a tax burden on them. It is important to clearly demonstrate the financial benefits of the program. By offering tax breaks on property taxes and estate taxes, as described in section 4.4.3, participants in the program will begin to see how the TDR program can personally benefit them. Also, to prevent people from seeing TDR credits as a method of taxation, we suggest that the credits can be bought and sold tax free.

5.2.2 Agriculture and Forestry Programs

Our group recommends that the Planning Board utilize the existing programs in Puerto Rico that provide technical assistance for farming and agriculture. We suggest that all citizens who apply for their Transfer of Development Rights (TDR) Credits become eligible for these programs. Our research shows that this can be an effective incentive to partake in the TDR program because one third of eligible members in King County, Washington partake in a similar program. We believe the reason for the effectiveness of the agriculture and forestry programs are because it allows citizens to profit on their land without disturbing the environment.

5.3 Educating the Community

As described in Chapter 2, education is an integral part of a Transfer of Development Rights (TDR) Program. The following recommendations are based on our background research con-

ducted for the development of a TDR Program in Puerto Rico, as well as the results from our research on focused community education and involvement. During town hall meetings we suggest that the Planning Board discuss the ten key talking points described in Chapter 2.

We recommend the Planning Board find "agents" to aid it in educating and involving the community. These agents are usually involved members and/or activist groups in the community. The agents should participate in an education program about what a Transfer of Development Rights (TDR) Program is, as well as the specifics of the program in Puerto Rico.

Our team recommends that the agents of the Planning Board not only educate their communities about the program, but they also should involve the communities in the program. We recommend that the agents, after educating community members on the topic of Transfer of Development Rights (TDR) program, ask questions and gain feedback from the community members about the program and its implementation that can be sent back to the Planning Board. We recommend the Planning Board obtain recommendations from multiple communities and continuously improve the TDR Program because the community involvement fosters trust and education.

5.4 Online Education

Websites are a relatively cheap method of spreading ideas and information to a wide range of people in many different locations at once. It is our opinion is that the Planning Board has not promoted their new programs in an attractive, accessible way, which can discourage interested visitors to the website who are interested in self-education on the Planning Board's programs. In addition, the Transfer of Development Rights (TDR) Program, which is currently a major project by the Planning Board, is not mentioned on the website, or any other Puerto Rican government sponsored website. We suggest that the Junta de Planifi-

cación website add an attractive, easy-to-follow link to a separate and new website focused on the TDR program. There are a plethora of reasons why we believe that a website will significantly improve the educational process for the TDR program. One issue that this will address is the fact that currently only one town hall meeting can occur to educate Municipios about the program. A website will allow the Planning Board to provide the public with an additional way for them to educate themselves. Self-education by the interested public is valuable because a TDR program is complex and hard to explain. The following paragraphs describe our suggested content and benefits of a TDR program website.

We believe that the front page of a good Transfer of Development Rights (TDR) website should first clearly list the main objectives of the program being proposed in order to let the reader gain a sense of purpose for reading all or some of the documents on the page. The other information found on the home pages of successful TDR program is a concise description of what a TDR program is and how it can be beneficial. A good explanation is written in simple language so that the reader does not have to be an urban planner to understand the program. It is important that this page not contain project details but just a TDR overview so the reader can understand the basics of the program. Lastly, on the home page we recommend that there is contact information for knowledgeable members of the Planning Board so that citizens can either call or e-mail them to ask any questions and voice any concerns. These members of the Planning Board can then answer any questions or address any concerns. We suggest the remainder of the home page contain easy to use links appropriately titled with further information.

We suggest the website have a link that contains program specifics, with what the Puerto Rican TDR program is going to do, what and who it is going to affect along with a description of how it will do so. Again, keeping this in simple non-technical language is imperative. For those who would like to read the technical documents with specifics, we suggest there be another link for that information where it can be made available.

A vital section of most Transfer of Developmental Rights (TDR) programs has subjective analysis of other TDR programs outlining the successes and shortcomings of each of the other programs. We recommend the Planning Board do this as well because it can validate the Planning Board's beliefs that a TDR program can potentially improve the development occurring in Puerto Rico with evidence that is has worked elsewhere. From this page, we suggest that there be links to other TDR websites so that the visitor can read other program websites as well.

We also recommend links on the home page that lead to the previously described tax incentives information and special programs sections. These sections are important because they promote continued education in the community. Once a Transfer of Development Rights (TDR) program is passed, it is important to continue educating the public and to continue to gain public support for the program. This is important because if the public does not continuously support a TDR program, such a program has historically failed. We also recommend that the website contain current local successes of the program to show its effectiveness and maintain the public's support.

Our group strongly encourages that the Planning Board develop a website with the sole purpose of explaining the future Transfer of Development Rights (TDR) program. A simple website can greatly assist in the educational campaign the Planning Board plans to perform to pass the TDR program into law and to achieve its continued success.

5.5 Conclusion

We recommend that the Puerto Rico Planning Board adopt our credit value system along with web-based information and a free market based TDR bank. To make the program more appealing we believe the Planning Board should offer incentives, such as tax incentives and technical assistance in farming and forestry to those landowners participating in the TDR program. In order to have a successful TDR program, education is crucial. We believe

the Planning Board should increase the public's involvement in the program as well create a good TDR website. It is our group's opinion that the preceding recommendations will benefit Puerto Rico with the creation of a fair TDR calculation program and educational strategies.

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Appendix A: Sponsor Description

The Puerto Rico Planning Board (Junta de Planificaciòn de Puerto Rico) is a government organization that was created in May 12, 1942 to make Puerto Rico a more economically and socially effective democratic Commonwealth (Portal de la Junta, n.d.).

The Mission Statement of the Planning Board reads:

"*Planificar para el desarrollo de Puerto Rico basado en tres principios fundamentales: Economia Competitiva, Ambiente Sano y mejoramiento de Nuestra Calidad de Vida*" or

"Planning for the development of Puerto Rico is based on three fundamental principles: Competitive Economy, Healthy Environment and the improvement of Our Quality of Life."

The Board is headed by the Chairman (currently Rubén Flores Marzán) and four Associate Members all of whom are appointed by the Governor with consent of the Puerto Rico Senate. The organization has four main branches, overseen by the Chairman and the Members of the Board. They are the Information System Program, the Administration Program, the Economic and Social Planning Program, and the Physical Planning Program. The Physical Planning Program and the Information System Program will both be valuable resources in the completion of the IQP. The Planning Board has several ties to other organizations involved with the development of Puerto Rico. These agencies include:

- Administración de Reglamentos y Permisos (ARPE)
  - Provides administrative services for permits and regulations
- Administración de Valles Inundables (AVIPR)
  - Regulates and protects electronic data and information on the Internet
- El Tiempo (National Weather Service Forecast Office)
  - Provides an accurate weather forecast

- FEMA
  - Provides disaster services and emergency response
- Gobierno del Estado Libre Asociado de Puerto Rico
  - The Puerto Rican Government
- Información Geográfica (GIS)
  - Analyzes and interprets geographical data
- Junta de Calidad Ambiental (JCA)
  - Agency in charge of environmental standards
- Oficina de Ética Gubernamental
  - Oversees ethics and values in governmental operations
- Plan de Uso de Terrenos de Puerto Rico (OPUT)
  - Organization in charge of the planning of land in Puerto Rico
- Red Sísmica
  - Provides accurate seismic readings to warn of earthquakes and tsunamis

The Puerto Rico Planning Board has several departments under the four branches (Figure 7). Several maps, zoning ordinances, and laws created in conjunction with the agencies listed above are made available online. The Planning Board is engaged in analysis and development plans of several highways, nature reserves, and cities. Regulation Number 21, implemented in 1992, has had a significant impact on the policies and actions of the

Planning Board (Junta de Planificacion, 1992). It has enabled the Planning Board to better assess and develop urban growth in Puerto Rico.

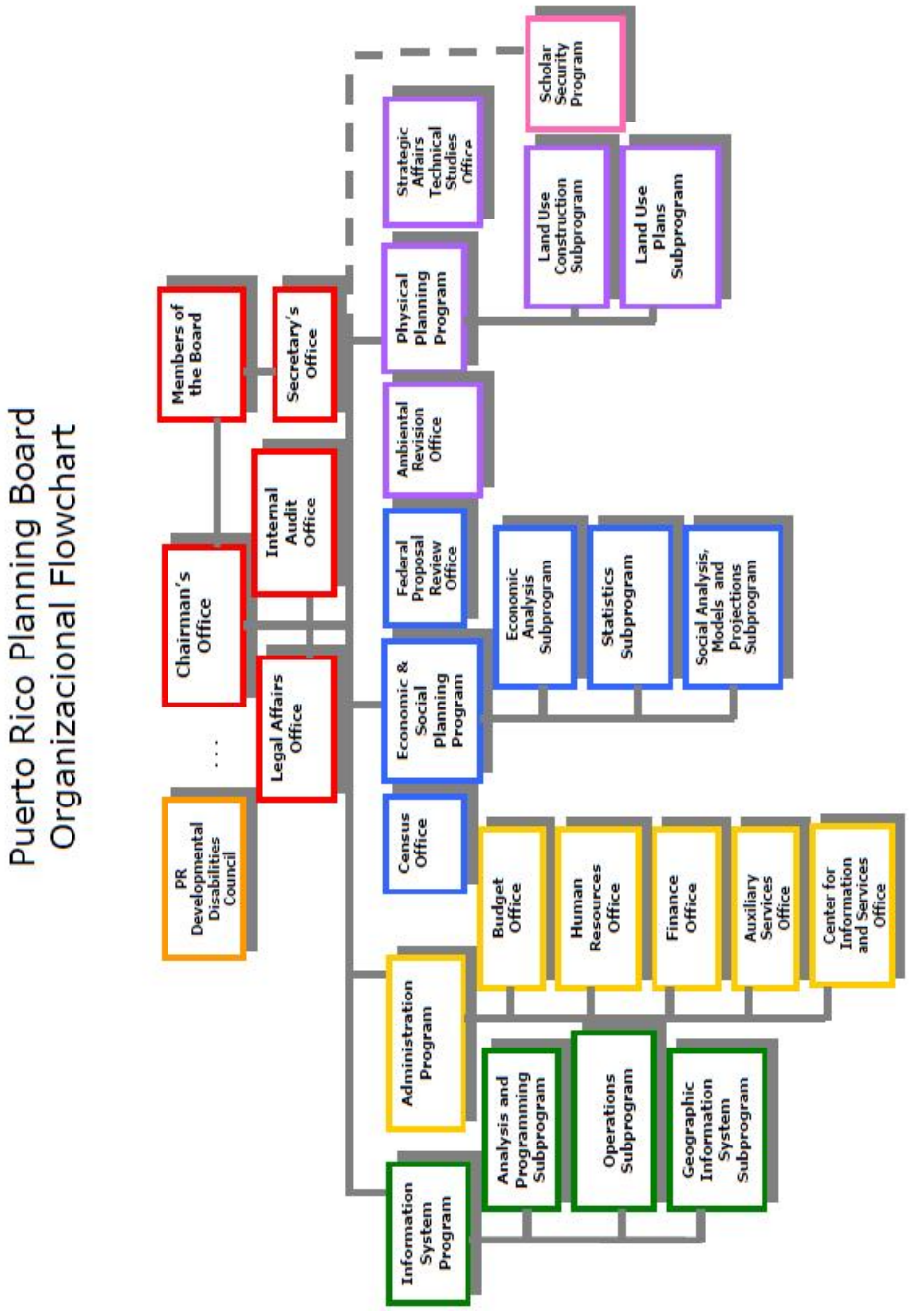

Figure 7: Organization Chart of the Puerto Rico Planning Board http://www.jp.gobierno.pr/

Appendix B: Interview with Leslie Saville

Date: April 4, 2012

Interviewer: Dale Spencer

Interviewee:

Leslie Saville, ASLA

Senior Planner, Area 3 (Montgomery County, MD)

(via email)

1. What criteria were used to determine what a single credit represents. For example, i was reading that in Montgomery County, 5 acres = 1 TDR credit

   Yes, in Montgomery County, 5 full acres = 1 TDR. That was based on the 1981 zoning that was in place at the time our TDR program went into effect. So, under the pre-1981 zoning, you had the right to build 1 house per 5 acres. Following the 1981 re-zoning, you needed 25 acres to build a house, but you could then sell the four "excess" TDRs.

2. In other TDR programs we have studied, TDR credits are scaled differently for different types of land (e.g. 80 acres of farmland is worth 1 credit whereas only 20 acres of forest is also worth 1 credit).
   - Is there something similar in the Montgomery County program?
   - If so, how was the scale determined?

   No, there's nothing like that here.

3. How does the target density of the receiving zones affect the calculation for allotted credits in the sending zones?

The sending areas were almost entirely established in 1981 (a small adjustment was done in 1994); the receiving areas are reviewed with each new master plan–we do approximately three per year. Until the markets went flat in 2008, we also did a tracking report every few years to see whether our sending and receiving areas were in balance.

4. Will the current credit scale eventually be reevaluated?
   - If so, what criteria will you use to determine the success of the current program?

   The credit scale for sending is not anticipated to change. The credit for receiving has evolved slightly–one TDR = one single family dwelling or two multi-family dwellings, or, in one transit-oriented zone, three multi-family dwellings

5. From our understanding Montgomery county TDR program solely focuses on the protection of farmlands.
   - Are there other ecological areas protected under the program?
   - If not, why was there only the goal of protecting farmland?

   Your understanding is correct–the Montgomery County TDR program focused on farmland protection. We have numerous policies, regulations and plans that provide environmental protection that cover forests, significant trees, stream valleys and steep slopes.

6. In the Montgomery County TDR program, all the farmland is essentially a sending and receiving zone.
   - How was that determined?

- Are there any locations that are strictly classified as receiving zones?

Slight correction–farmland is the sending area. Receiving areas are "down-county" areas where we have adequate public facilities (water, sewer, roads, schools, police, fire and rescue facilities, etc etc etc).

Appendix C: Interview with Stephen Bruder

Interviewee:

Steven M. Bruder PP, AICP

New Jersey State Agriculture Development Committee

New Jersey State Transfer of Development Rights Bank

Market & Warren Streets

2nd Floor, Room 202

PO Box 330

Trenton, New Jersey 08625

Date: April 12, 2012

Location: Interview conducted via email

1. We have read that in the New Jersey TDR program, 39 acres of pineland equals 1 credit whereas 39 acres of wetland only equals .2 credits. How was this scale determined? Why was 39 acres of pineland the base unit for 1 credit?

   The Pinelands Development Credit program allocation you reference is found in the Pinelands Comprehensive Master Plan (from 1981) starting on page 150. I am not exactly sure how this allocation was derived at the time, but the staff of the Pinelands Council may be able to give you that.
   http://www.nj.gov/pinelands/home/contact.html
   http://www.nj.gov/pinelands/cmp/CMP.pdf

2. Does the target density of the receiving zones affect the calculation for allotted credits in the sending zones? If so, how?

I'd like to discuss this with you more but the short answer is this. Typically, credits are allocated based on the development potential that existed prior to some restriction and/or enactment of TDR. The credits are used to provide compensation to landowners for some regulation that would prevent onsite development. The State TDR Act requires all sending area credits be accommodated in the receiving zone. Therefore some TDR programs design a receiving area based on the amount of credits they need to accommodate and others will base the size of their sending zone on how much receiving area development they are willing to accept.

3. We found an equation for Highland Development Credits: HDC = (Net Yield) x (Zoning Factor) x (Location Factor). How were each of these factors determined?

   The Highlands Development Credit allocation is explained here starting on page 27: http://www.highlands.state.nj.us/njhighlands/master/tr_tdr.pdf

4. Will the current credit scale eventually be reevaluated? If so, what criteria will you use to determine the success of the current program?

   There is certainly the need to continually reevaluate your TDR program so that you create and maintain a viable credit market. In New Jersey we require that a Real Estate Market Analysis be performed before program establishment. (http://www.nj.gov/state/planning/docs/tdrrules.pdf) The State TDR Act also has a review requirement at NJAC 40:55D-155 through 157 that allows for a periodic reassessment of the TDR program. These are parameters which prompt a reevaluation of the credit market, ultimately the governing body needs to look at the operation of the credit market and

decide whether or not it is working or what needs to be amended to make it work.

5. Is there a public education program in place to educate developers and landowners about the benefits of participating in a TDR program?

   The websites for the State TDR Bank, the State Office of Planning Advocacy, the Highlands Commission and the Pinelands Commission all have information on TDR. Our site does provide a bit on landowner benefits. Admittedly we need to do a better job of this. Public education is a major factor in getting public support to enact a planning effort as complex as TDR. We have seen time and time again misconceptions about what TDR is and how it is used. It is a difficult concept for many non-planners to understand so the more public education the better.
   http://www.state.nj.us/agriculture/sadc/tdr/
   http://www.nj.gov/state/planning/programs-tdr.html
   http://www.highlands.state.nj.us/njhighlands/hdcbank/
   http://www.nj.gov/pinelands/pdcbank/

Appendix D: Interview with the DNER

Interview Protocol with DNER Members Sr. Bonillo and Sra. Diaz

11:00 AM, 4-17-2012, DR. Cruz A. Matos Building

Attendance: Sra. Gonzalez, Sra. Fernandez-Valencia, Chris Dunn, Jeffrey Peters, Alberto Phillips and Dale Spencer.

1. How does the DNER determine zoning Regions?

   - **Characterization of habitats**
   - **Reports on areas and basing decisions on laws**
   - **Major natural resources of concern (coastal regions, karst formations etc...)**
   - **New methodology for identification of wetlands**
   - **Analyzing reports from the DNER, academia, and other organizations**

2. How were critical karst regions determined?

   Not all karst regions are considered critical or protected. The ones that are follow the criteria that they are enduring significant geomorphological evolution, hydrological changes, or have ecological value. If an active aquifer is in a karst formation, that region is protected by law.

3. What type of developments is acceptable on the karst region?

   The only commercial activities allowed on the karst are eco-touristic activities. However, any development on the karst region requires a special

permit from the director of the DNER which gives the agency veto power for any reason.

4. What type of factors does the director take into account when considering approving a permit?

   The director takes into consideration the regions pertinent geology such as cave and sinkholes systems (which are protected by law). The director also takes into consideration endangered species in the area.

5. What are current programs by the DNER in the karst region?

   Certain insular forests in the karst region are protected. There are many programs in place to enlarge the size of protected public forests. There are funds from the government for the purchasing of land for this reason. Non-government organizations (NGO) are also buying land for protection such as the conservation trust and the ciudadanos del karsto. This is a joint effort between the government and non-government organizations.

6. What is the DNER strategy for buying land? What do you look for?

   The DNER chooses land to buy for conservation based on technical knowledge from reports, such as critical habitats and critical species. Also if land owner does not want to sell imminent domain will be enacted. Also, if someone does not know the value of their land the DNER will take advantage of it and buy it for cheap.

7. One concept we are considering in the education process of the TDR program is giving free forestry and agricultural education to citizens who exchange development rights

for TDR credits. Would the DNER be able to aid in this education?

The DNER currently has a Forestry Bureau and auxiliary programs that already provide this information to those who exchange development rights for tax exemption. This program gives general knowledge to those who qualify about forestry as well as direct technical assistance and financial analysis of the potential forestry operation. This program could be utilized by a potential TDR program. As far as agriculture is concerned, if there is a similar program, it would be run by the Department of Agriculture.

8. Educating the public is a major concern in creating a TDR program. How does the DNER educate the public about their programs?

There is no regular education by the DNER but they do provide some public outreach about 1-2 times a year. The webpage has educational tools, as well having staff attend schools and teach students about available programs.

9. What are some methods that you believe could improve upon the DNER's public education program?

Increasing the outreach programs and widening the focus of education would improve public education. Also educating the public on a more regular basis would help the situation as well.

Appendix E: Tutorial for Using our Excel Program

The purpose of this Appendix is to give an in depth tutorial of how to use our Excel Program. The first column that the user will see is the five land classification found in the karst regions of Puerto Rico. (Seen below in Figure 8)

Figure 8: Land Classification Screenshot

Directly to the right of the classifications, there is a column outlining the number of *cuerdas* of land one would need to own to qualify for one credit. (Seen below in Figure 9)

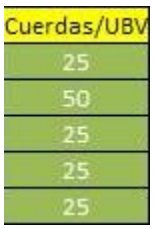

Figure 9: *Cuerdas* Needed to Build One UBV

The next three columns are the only ones that require the user to input information. The first column requires the user to input how many *cuerdas* of land they own in each of the five land classifications. Then, the user must enter the number of houses on the property. Finally, the user needs to input how many bedrooms currently exist on the property. These columns can be seen in below in Figure 10.

Cuerdas Owned	Total # of Houses on Property	Total # of Bedrooms on Property
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0

Figure 10: Input Columns

Once those three pieces of information are entered, the next column outputs the number of basic house units the landowner has on their property. Finally, the last column shows how many credits are due to the landowner. In the case that the landowner owns property in more than one of the classifications, the numbers in the final column are summed up in the black box in the lower right of the screenshot seen in Figure 11.

Exsisting # of UBV on Property	Credits Alloted
0	0
0	0
0	0
0	0
0	0

Total Credits Alotted ---->	0.0

Figure 11: Existing UBV and Credits Allotted