EXECUTIVE SUMMARY

The Role of Economic Valuation in Developing Adaptation Policy to Climate Change in the Caribbean.

The island nations of the Caribbean have a strong dependency on their natural resources. Their coastal zones are particularly valuable, with their beaches and coral reefs providing important revenues in the form of tourism activities, as well as providing their local population with recreational and cultural value, and their mangroves being a source for subsistence livelihood and replenishment of their fisheries. These key natural resources are also particularly vulnerable to climate change impacts, and are the key link in understanding the economic potential for damage that climate related events can bring.

The process of planning for mitigating these climate related impacts requires a careful consideration of the consequences of action and non-action. Being able to develop estimates of the comparative costs of action and non-action is an important tool in deciding whether to take action, and what kind of action is more appropriate, or even feasible. For this reason, it becomes important to develop and apply non-traditional economic tools for valuating the impacts of natural events along with estimating the costs of the actions required to mitigate these impacts.

This report explores the application of several of these non-traditional economic tools for estimating the costs of potential impacts of climate change and sea level rise in the Caribbean nations of Trinidad & Tobago, St. Lucia, and Dominica. The economic tools that are explored use several types of direct and indirect approaches, and both market and non-market values are considered. These approaches have been developed with the express interest in their replicability in other Caribbean nations and island nations around the world.

One of these non-traditional approaches is the use of related markets to value environmental impacts on key economic sectors, such as tourism and fisheries, in economic terms. In this study, the change in tourism expenditures in St Lucia along a period of several years is used to measure the economic impacts of hurricanes, events which are predicted to increase in frequency due to climate change. Through measuring the extent of economic loss and tying it to specific attributes such as infrastructure for tourism that have experimented climate-related damage, it becomes possible to measure the potential economic damage that may be caused by climate change, and direct efforts for mitigation toward those attributes that are deemed vulnerable. Another possibility is to link effects on ecosystems to decreases in productivity values. In this instance, a decrease in the productivity of shrimp fisheries (using the shrimp catch as a proxy) is related to the decrease in the area of neighboring mangroves in Trinidad, a coastal ecosystem highly vulnerable to climate change.

The value of climate impacts on local recreational activities can be estimated by using related activities whose cost can be measured. The study estimates the economic value of the recreational use of beaches in St. Lucia by its residents, and the potential impact of

climate change on these activities is valued through the simulated affectation of beaches, the vulnerable attribute. The related activity that is used for measurement of economic value of recreation is the comparative cost of transportation to these beaches. The measure of economic impact in this case is the change in cumulative welfare through the increase in costs incurred in modifying visitation patterns to the beaches, due to the loss of a subset of these beaches through climate change impacts.

The value of climate impacts on cultural resources and activities can also be estimated, and this is demonstrated through the measurement of the economic value of a cultural/aesthetic attribute, which has a non-use value as well as a use value, that is endangered by climate change. In this instance, the example is a religious temple in Trinidad, and the value of the services the temple provides is captured through direct questioning of the population on their willingness to pay for its preservation. This approach captures the economic value of an attribute by defining a hypothetical (contingent) market for it, in the absence of an actual market.

Following is a description of the techniques that were applied for measuring the economic impact of climate change on different sectors of the economy, as well as on cultural and recreational activities. For details concerning the studies that were conducted, please refer to the individual chapters of the report.

Measuring climate impacts on key sectors by using related markets.

Valuation of climate change impacts on the tourism sector.

In several cases, linking climate change impacts to losses in specific sectors depends, in the first place, on finding an indicator of economic loss and, in the second place, on linking the losses to damage to infrastructure. Data on changes in tourism expenditures due to climate events can be used as a crude measure of the economic damage they do. In order to obtain data on tourism expenditures, the study examines the impact of Hurricanes Allen, David, and Lenny on the number of visitors arriving in Saint Lucia. The data on the numbers of visitors between 1977 and 1982 show an upward trend for two different categories, cruise ship and stopover visitors. When compared across the years, the post-hurricane years show either a decrease or a leveling off. The number of visitor arrivals is then converted into number of visitation days. Hurricane Allen had a significant effect on the number of visitation days for both categories, David and Lenny affected mainly the number of stopover days.

Converting lost visitation days into monetary figures by using an estimated average visitor expenditure per day showed the effect of the hurricanes to be substantial: it is estimated that Hurricane Allen caused losses of over US$1 billion.

The major loss in income was from stopover visitors: tourism infrastructure for stopover visitors (in the form of hotels) was damaged by the storms, while the infrastructure required for day trippers (in the form of docks) was not affected as badly. Compared to

Dominica, which is mainly an ecotourism attraction, Saint Lucia, as a beach destination, is comparatively vulnerable to climate events, through the direct damage to its beaches. Conversely, this suggests that Dominica should protect its ecotourism qualities, as this enhances the resilience of its tourism market and, by extrapolation, its economy.

Measuring climate impact on the fisheries sector.

The loss of infrastructure is also used for the economic valuation of climate impacts in the fisheries sector. If a hurricane destroys fishing vessels, gear and equipment, then the expenditures by individual firms to replace losses in equipment represent a minimum expected net value of the fishing operation. These expenditures represent lost capital, and the cost of replacing the capital represents the lower bound of economic damage of the climate event. Additional economic damage would come from the fact that capital was destroyed and not replaced. It is no longer available to perform a function, and consequently there is a loss of the income associated with it. In this case, not enough data were available on the expected earnings from the fisheries to be able to estimate the additional economic cost.

Another way to value the economic impact of climate change is indirectly, by relating ecosystem changes to losses in markets that depend on the ecosystem. This is illustrated in the report by using the value of fisheries dependent on wetlands in Trinidad in order to obtain a value for the wetlands themselves.

The reason fisheries depend on wetlands is that the latter function as hatcheries and nurseries for the larval stages of many commercial species. By correlating the yield of one these species, shrimp, with the area of the nearby wetlands over time, the value of the shrimp catch is transferred on to the value of the wetlands.

The size of the shrimp catch is related to shrimp production, as there is a point above which the amount of fish caught affects the size of the following year´s catch; that is, shrimp is being fished unsustainably. Over a period of five years (1995-1996), the shrimp catch showed a marked decline. On the assumption that the decrease in the shrimp catch would be related to a reduction in the area of the wetlands over this period, an effort was made to quantify the reduction. Using a different study that showed a 1% change in mangrove area resulting in a 2.8% reduction in the shrimp catch, the authors estimated the percentage by which the wetlands would have had to decrease in order for the shrimp catch to be reduced by 41%, according to the data obtained. The estimate was 2.9%, which was similar to the 2.3% reduction estimated subjectively by local inhabitants. The 2.3% figure was reached by averaging out the estimates made by local inhabitants over the number of years they had lived in the area. Using the shrimp catch data, the gross value of the catch lost because of the loss of wetland area was estimated to be about US$9,115 a year.

This value estimate would be considered an indirect use value. However, the wetlands could be also have direct use and non-use values. Direct-use values would include food and biomass collection and recreational activities, and nonuse value would include

aesthetic appreciation of the wetlands by individuals. The estimation of direct-use values was performed through a survey intended to capture the uses the local inhabitants made of the wetlands. Through this survey, it was learned that the direct uses included making use of the wetlands for making a living, for obtaining household items, and for recreational opportunities.

The valuation of these uses was done through market valuation of the products and food items that were obtained from the wetlands, whether they were sold or consumed in place. The time invested in the collection of these products was valued at the unskilled labor rate for Trinidad and Tobago. Adding up the figures for value of products and labor invested in their collection provided the net rent from the wetland products.

Correlating the reduction in wetlands with the net yearly rent, a net loss of US$1,751 per hectare of wetland per year was estimated, or an absolute net loss of US$842,000 a year.

The results of this study show a significant linkage between the subsistence of the local population and the existence of the wetlands. The loss of wetland area and quality due to climate change could seriously affect the well-being of the inhabitants. In addition, there would be indirect effects down the line, as with the reduction in the shrimp catch described above.

Valuation of environmental impacts on land attributes such as property values and sea defenses.

Another way of measuring the economic effects of environmental impacts is estimating the value of the attributes of an area or good. In this case, the idea was to value the impact of climate by measuring the differences in market property value (the good) according to the location of the property with respect to the coast (the attribute).

Sea-level rise and climate-change impacts are expected to affect the price of waterfront property. In order to determine if that is the case, data were collected on parcel location through tax maps, and assessments of land property values were obtained from estate services and municipal sources. A regression was then performed of the distances to water vs the property values per square foot, and the results were analyzed for correlations.

The study found that there is a positive correlation between the value of a property and its distance from the water, up to a certain point: at the waterfront itself, the correlation becomes negative. That is, being on the water reduced the value of an average parcel by US$2,000. The results implied that people value being close to water, but not on the water itself, because of the possibility of damage from beach erosion and storm effects. In this manner, the value of the potential damage from climate is captured in the form of market valuation of the attribute "distance from the waterfront."

Additionally, it is crucial to measure the effects of climate impacts on expenditures for the construction of defensive infrastructure. In general, the capital costs of investing in this type of infrastructure are too high for any individual parcel owner in low-income areas to incur for the protection of private property; but, given that the value of the total property behind the defensive structures tends to be much higher, companies and public institutions may be willing to pay for this "public good" structure. A measure of this willingness to pay provides information on the value of climate impacts, and this information is sometimes available by observing the history of investment in sea defenses.

Estimating the value of climate change impacts on the recreational, cultural, and aesthetic use of resources.

Obtaining non-market (recreational) use values through indirect valuation methods.

When services are available to the public free of charge, the market cannot be used to measure potential economic impacts on the services due to climate events, and indirect methods need to be applied. In this instance, the example is a study that was performed on the recreational value of beaches in Saint Lucia. Through telephone and on-site interviews, beach use preferences among Saint Lucia´s population were determined. Inputting the data collected on the distance, time, and mode of transportation invested in travel to a particular beach in a GIS system yields an estimate of the costs incurred in traveling to the beaches. The change in the cost to receive comparable utility is what is considered to be the value of the beach.

To model the effect of a climate change scenario where the use of beach is lost, a comparison is made between the expected utility from the available beaches before and after the loss of a subset of beaches. The result can be converted to the loss of aggregate economic welfare by the beach users. In general, some beach users will need to spend more time or income in visiting an alternative beach if the choices are less. Lower and upper boundaries on the potential costs incurred by the loss of a beach are estimated in this manner, where the impact of climate change on beach loss can be quantified in economic terms. For example, the annual economic loss of one particular beach was estimated to range from a lower bound of US$1,000,000 to an upper bound of US$1,250,000. These studies reflect the importance of capturing the value local inhabitants place on their resources for estimating real potential economic impact from climate events.

Non-use (aesthetic and cultural) and total value estimation.

Aside from use values, resources may have non-use values associated with them (values that arise even without using the resource). Since there are no related markets that can be used to estimate these values, other methods must be used. In this case, resource value needs to be obtained through direct questioning of individuals who place this value on the resource.

This report applies a method of this kind in attempting to quantify the loss of a Hindu temple site that is threatened by sea-level rise. The temple has use value arising from the use of the site for religious and spiritual activities, and non-use value in that there are individuals who are willing to pay to preserve the site for its cultural and aesthetic value, although they do not use it.

To obtain estimates of these values, an intercept survey of users and a random telephone survey were conducted. The intercept survey took place at the site itself. It was mainly meant to capture information from users of the site on the number of times they visited the site each year and the cost of travel. Amongst the more interesting results of the survey, the fact that many users visited the site on work days meant that the visit represented an opportunity cost in the form of the value of their wage rate to them, in addition to the travel costs they incurred. The use value of the temple was calculated by developing a regression model that factored in the number of trips to the temple, the cost of the trips, and the number of trips to other similar sites.

The random telephone survey was performed in order to obtain an overall picture of the visitation pattern of the population, and to capture the value placed on the temple by non-users. A significant proportion of the population (72%) turned out to be willing to contribute to its preservation directly, and an even higher proportion (98%) thought it important that it be preserved. The willingness to pay this value was estimated through a logit model applied to data collected from response to a yes or no answer given to a suggested amount. The logit model relates population variables such as income, age, and education to the probability of paying for the preservation of the temple.

The total value of the services the temple provides was then estimated by adding up the resulting use and non-use values, with the non-use value from the users of the temple obtained by subtracting the results of the telephone survey from the use value obtained through the regression model as described above.

Conclusions

Several approaches are available for estimating the economic value of potential climate change impacts. These approaches can be applied to estimate these impacts on key economic sectors such as tourism and fisheries, or on activities that have not traditionally been valued in economic terms, such as local recreational and cultural endeavors. These approaches take into consideration that entire economic sectors are dependent on structures and attributes that are vulnerable to climate change related events. Therefore, the valuation of climate impacts takes the form of an exercise in finding the links between activities and vulnerable structures, and among the activities themselves.

Many of these approaches are relatively low in cost, and depend on gathering information that will be available locally. This includes data on economic activity or expenditures, or surveys of local inhabitants. In many instances, incomplete or partial data can still be

useful to extrapolate measures of total economic value, and related economic activities can be used to place value on climate impacts on structures or attributes that do not have a market value.

Through capacity-building and hands-on experience, it should be possible to train local consultants in the application of these methods. Placing economic value on natural resources represents an additional incentive for preserving and managing those resources, at the same time it provides good guidance on directing policy choices in deciding where and how much to invest in climate change adaptation measures.

Adaptation to Climate Change in the Caribbean:

The Role of Economic Valuation

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CHAPTER I

INTRODUCTION

Economic Valuation and Policy

Economics has played an important role in the analysis of policy alternatives for several hundred years. Currently, project analysts often are interested in comparing alternative policies on the basis of the society's welfare. Economic valuation is a process through which societal welfare is translated into economic terms. The societal welfare in economic terms then can be compared for various policies. It is not the sole determining factor in policy choice but often is an important factor in the ultimate choice of policies.

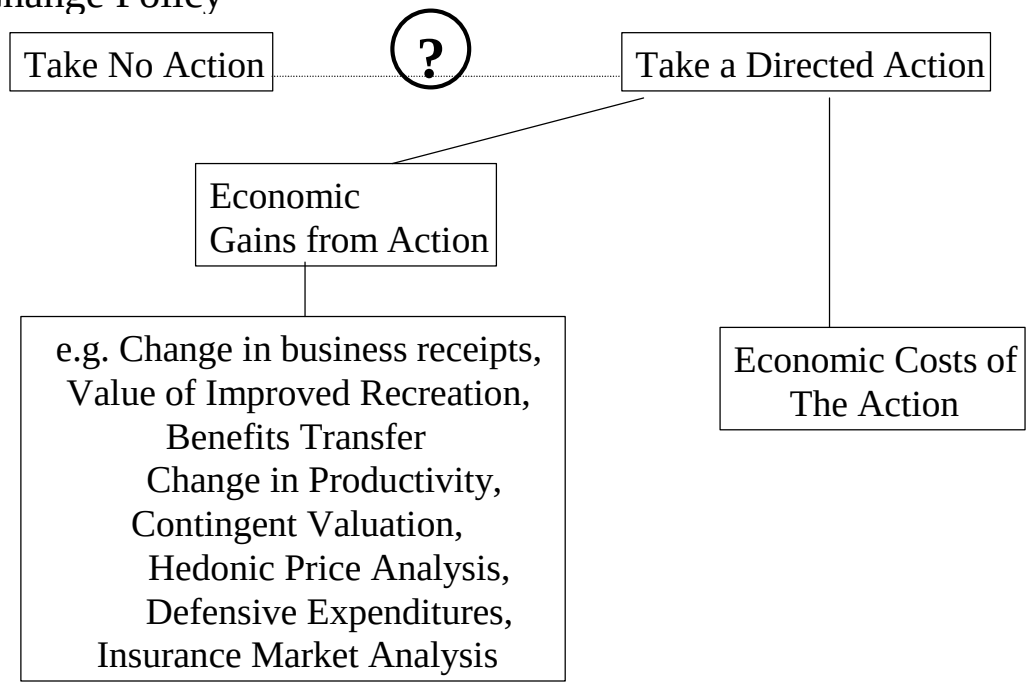
The classic economic framework for making comparisons between policy alternatives is benefit-cost analysis (references). It assures appropriate accounting of the gain and losses in economic terms from a policy change. In this sense, benefit cost analysis is much like the income statement in accounting. Economic valuation forms the rules and process for the determination of the economic values that go into the accounts. With the structure provided by benefit-cost and the tools of economic valuation, economic information concerning proposed regulations can yield meaningful information regarding societal welfare with and without a policy.

In the context of the current project Caribbean Planning for Adaptation to Climate Change (CPACC)[1], leaders in the Caribbean may find economic valuation and benefit-cost analysis useful in planning for adaptation to climate change. We are not considering the global issue of emission controls or other action to alter climate change but rather what policies are relevant to adapt to climate change given the likelihood for changes in climate and what economic information is useful to assess those policies. At the present time, a complete understanding of the long-term and even decadal trends in climate change is lacking and thus, we can only pick some potential changes and illustrate economic valuation for the potential events. Our perspective in determining the values is from the island point of view- i.e., what is lost or gained by the residents of the islands, not the tourists.

Yet the framework and the concepts will withstand any new information coming from the nature sciences regarding climate change. To illustrate, Figure 1.1 contains the accounting framework for a benefit-cost analysis along with the major methods used to determine the inputs into the framework. The "No action" scenario might be one in which no intervention to mitigate the effects of climate change was taken- sometimes this is referred to as the "without" scenario. The "Take Directed Action" box or "with" scenario

[1] CPACC is executed in the twelve countries of the English-speaking Caribbean, which also form the Caribbean Community or CARICOM. There are: Antigua and Barbuda, Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Jamaica, St. Kitts and Nevis, St. Lucia, Trinidad and Tobago and St. Vincent and the Grenadines.

Figure 1.1: Benefit Cost Analysis of An Adaptative Climate Change Policy



represents the policy action under consideration and the boxes under it represent the accounts that reflect the gains and losses from the policy action in comparison to the No Action scenario. In the boxes beneath the gains are different methods of determining the gains. The losses are defined as the opportunities lost in economic terms from using resources to undertake the policy. It is recognized that there are different "ways of knowing" and detecting these values. The method simply reflects different approaches to estimate the same conceptual value. Sometimes there is certain information or more commonly, lack of certain data that leads one to prefer one of the methods to another. Data availability, importance of the item, and the funds available to determine the value are among the critical factors that are considered by the analyst in choosing the approach.

The estimates of economic value can be used in many other ways. For example, many Caribbean nations place surcharges on visitor entry/exit and in many cases, the justification is the need for funds to protect Island natural resources. Determining a defensible and rational level of the surcharge can be assisted with information on the economic value of the resources. This concept is also relevant for local issues such as the protection of specific stretches of coast. Here surcharges on property values to pay for shore stabilization could be developed from estimates of willingness to pay to avoid erosion.

What makes economic valuation of climate change adaptation so difficult is that most of the important reactions of humans to adapt to climate change arise from natural resource-based goods and services that usually are not traded in the market. Waterfront erosion, wave action, and rainfall may change and the changes will affect humans. However, there

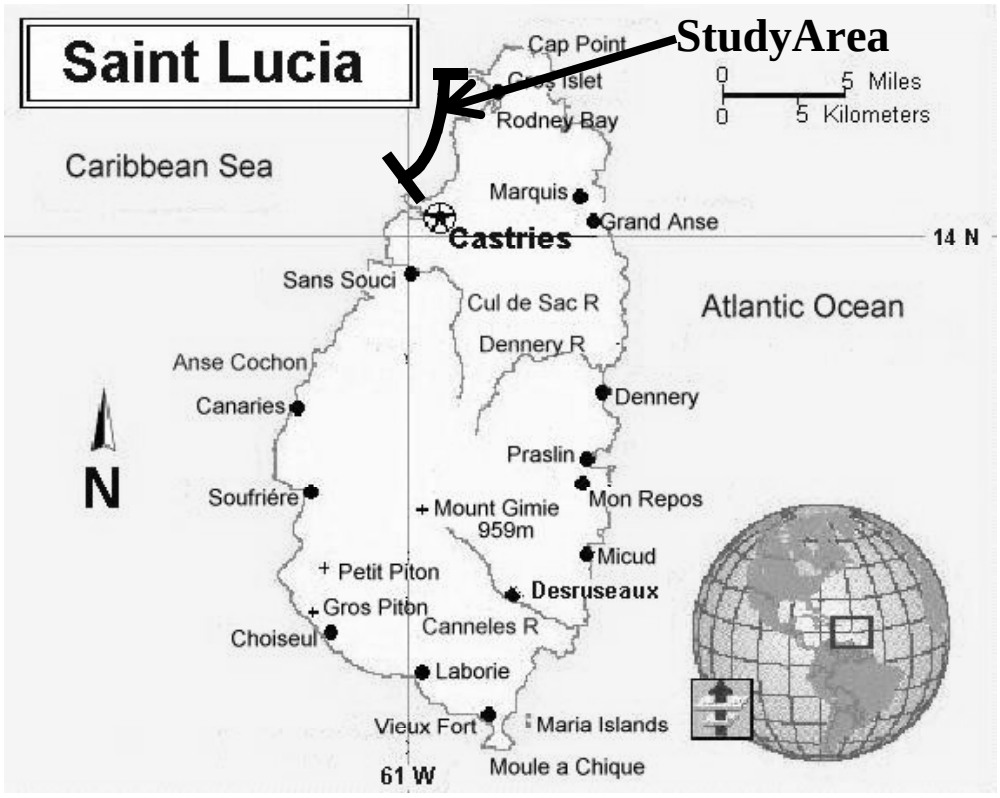
are no markets for these "goods". As a result, we must turn to non-traditional economic analysis to estimate the economic value or loss of their change.

In Figure 1.1, we have not shown methodologies for determining the opportunity costs of the policy action. The economic costs in most cases are the expenditures on the resources used to implement the policy. However, there are times when the opportunity cost cannot be treated with such expedience. For example, the existence of high unemployment in the construction industry might lower the opportunity cost of using labor to build sea defenses. Some of the cost of labor would not be representative of lost opportunities if some of the laborers were not able to work in an alternative job. For the purposes of this report, we focus on the methods to estimate gains from policy so as to highlight them with respect to climate change and the Caribbean. The problem of opportunity cost estimation is more troublesome and we do not explicitly treat it.

Chosen Study Areas

In demonstrating these methods, the designers of the study chose to focus on three different types of Islands in the Caribbean: a "sun and fun" tourist island, an "eco-tourism" island, and an "industrial" island. Although no Caribbean island can be defined so cleanly and most islands have each component represented in their economy, study areas in three islands, St. Lucia, Dominica, and Trinidad were chosen to reflect the different bases to the economy.

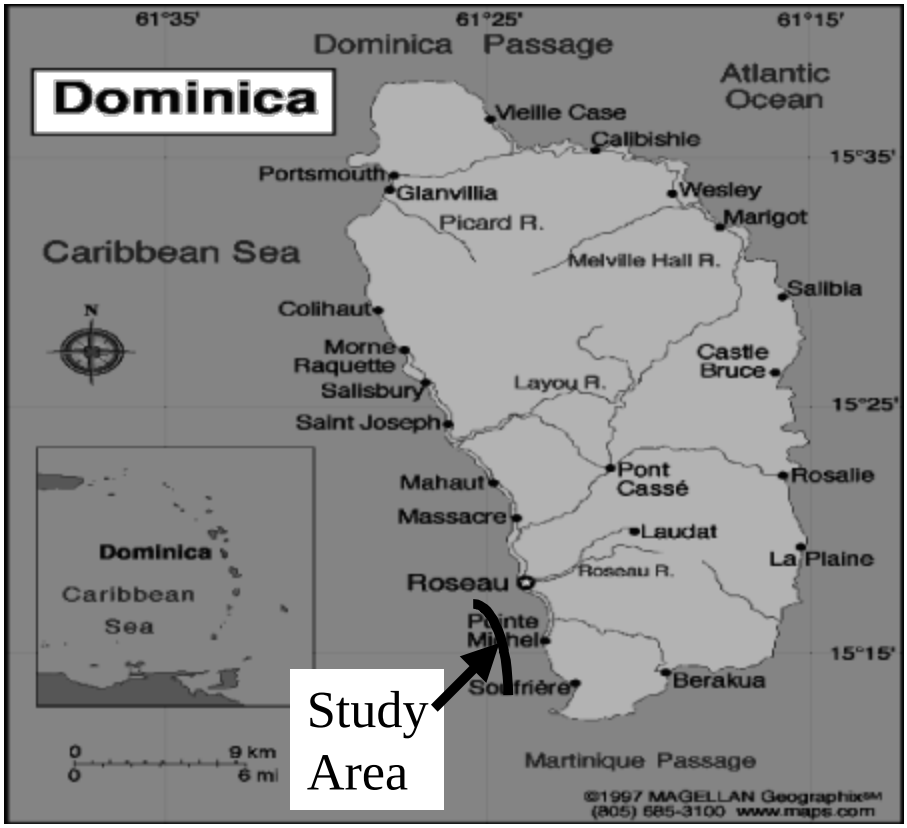
Figure 1.2: Map of St. Lucia and the Study Area



For St. Lucia, the study area beginning just north of Castries and running to Pigeon Point was chosen as the "sun and fun" based economy (Figure 1.2). In the most southern portion, it has Vigie Beach that is primarily used by local residents. Further north, there is a mangrove area, providing important nutrient and nursery areas for fish landed in the Castries and Gros Islet area. Still further north is an area with beaches primarily used by tourists but with some local participation. At the northernmost portion of the study area is Pigeon Point, a National Park providing an historic Fort as well as a beach. An annual Jazz Festival in May is held at Pigeon Point.

The study area in Dominica lies just south of the capital, Roseau. It begins at the Fort Young on Victoria Street and extends southward to the tip of Scotts Head (see Figure 1.3 below). The area has two "eco-tourist" points of interest, the Soufriere-Scotts Head Marine Reserve and the Sulphur Springs Park. In addition, there is critical infrastructure in the form of the road leading along the steeping banked shoreline to reach Soufriere and Scotts Head. The final asset considered in the study area is the residential property on the seaward side of Victoria Street. It is property whose value and very existence is sensitive to changes in storm activity and sea-level rise.

Figure 1.3: Map of Dominica and the Study Area



The study area in Trinidad, shown in Figure 1.4, lies along the west coast and is south of the capital city of Port of Spain. Its northern boundary is Waterloo, a community that has fishing activity as well as a national shrine, a Hindu temple that has become more water-bound as its nearby beach has slowly eroded into the Bay of Paria and the causeway leading to it has been extended. There are several other fishing sites south of Waterloo as well as farmland owned by the Government and infrastructure associated with the industrial park to the south. The industrial park lying between Couva and Point Lisas is an enormous facility housing chemical companies, fertilizer companies as well as a port for moving the products to market. In the middle of the study area is a beach that is surrounded by mangroves. The beach is readily accessible to nearby communities and also has some fishing activities. The mangroves offer nutrients and nursery grounds to the fisheries resources in the Gulf of Paria. They are also home to the national bird, the Scarlet Ibis.

Figure 1.4: Map of Northwest Trinidad and The Study Area

An Outline of the Report

In the subsequent chapters of this report, many of the natural and man-made assets of these study areas are assessed for the economic value that they bring the citizens of the countries. The purpose of the assessment is to provide a basis for economic valuation in the Caribbean for assets that are vulnerable to changes in the climate. The report is organized along the lines of the methodologies shown under the economic gains in Figure 1.1.

Chapter 2 begins by examining the use of expenditure changes in related markets as a means of estimating economic value. The first section examines the potential changes in tourism associated with major storm events such as hurricanes. Because a significant portion of the St. Lucian and Dominican study areas' economies depend on the tourist trade, changes in that trade after major hurricane events are examined. The change in tourism expenditures and local business receipts as a result of the tourist trade change is examined. This is more of a "macro-economic" evaluation, not necessarily targeting any specific site. To give a "micro-economic" evaluation, we look at one site in Dominica and assess the losses associated with Hurricane Lenny. Specifically, the changes in tourism in St. Lucia following Hurricanes Allen, David and Lenny are examined. Also, the effects of Hurricane Lenny on visitation at the Marine Reserve (snorkeling and diving) in Dominica are examined. We also show the value of lost capital (or wealth) associated with Lenny in Dominica.

Another expenditure change is used in the defensive expenditure method. This method is explained and demonstrated for St. Lucia and Dominica. The defensive expenditures undertaken by the government in Dominica are shown for the area that protects the highway leading from Roseau to Scotts Head. Finally, the expenditures necessary to protect both residential and commercial areas in St. Lucia are presented.

In Chapter 3, a more formal estimation approach, the random utility model (RUM) is applied. To determine economic value, the effect of travel costs on residential use of beaches in St, Lucia is explored. In this case, the related market is the market for travel and it is used to obtain the economic value of beach use. A formal model of economic value of beach loss is set up and used to estimate the effects and economic losses of potential beach damage due to hurricanes or water pollution.

Chapter 4 demonstrates how to use a contingent (hypothetical) market to obtain economic value directly from the response of citizens about the resource for which there is no market. The demonstration of the contingent valuation approach focuses on a cultural heritage in Trinidad. Because the Hindu temple at Waterloo may have value to individuals who do not use it but still value it, the contingent valuation approach can be used to obtain the total value, use and non-use, of the Temple. The respondents state their willingness to pay to have it preserved from potential changes associated with sea level rise. Unlike the previous methods, the users of the resource are not the only ones being observed.

Chapter 5 presents the next methodology, referred to as the change in productivity method. Here, we return to using related markets but using on both commercial and subsistence markets. A time series of commercial fishing activities and a cross section of subsistence/commercial fishers are used to show how fisheries production might be influenced by the existence of mangroves. Fisheries production in the study area in Trinidad is examined and related to mangroves in the area. In both cases, obtaining values of mangroves is difficult because of the limited historical data and a benefits transfer alternative is explored. We use information from other mangrove studies to give

a sense of the benefits transfer method of analysis. Also, stated perceptions are used to obtain the wetland values.

In Chapter 6, we demonstrate another common related market method as the effect on property values of being on a vulnerable coastline is examined. The hedonic price model can be used as a lower bound on the protection of shoreline. The residential and commercial area south of Roseau is used to demonstrate how property values, after controlling for effects like closeness to the city, are affected by being on the shore. The analysis also serves to demonstrate possible socio-economic losses if land-use planning and risk management are not effectively integrated into development planning.

To the degree possible, the report is written in a manual style, trying to explain the method, the steps taken to implement it and the results within the obvious limits that exist. At the beginning of each Chapter, a “Problem Statement” is provided to give the reader guidance as to the general nature of the methodology used in the chapter. The nature of the type of problems in estimation and the typical setting in the Islands will be discussed. We will highlight why this particular method is sometimes used, its strengths and weaknesses. There are many “ways of knowing” and the most appropriate one is determined within the context of the problem and the institutions in which the problem arises. Determining the appropriate method and steps to implement it comes with training, experience and luck. The reader is not guaranteed of a successful project simply by following our examples. We give a range of possible ways to approach the valuation problems and some examples against the Caribbean setting and our budgetary constraints.

Appendix 1A: The Theoretical Underpinnings of Economic Value

In many instances, a policy could have negative (or positive) effects on individuals. The effect in economists' jargon is termed a decrease (or increase) in the individual's utility. What we are attempting to do with three measures (EV, CV, CS) is to determine a "defensible" money measure of the change in utility arising from the different circumstance associated with the policy. "Defensible" means that the measure is consistent with the rest of the economic model of behavior (i.e., the individual is thought to know what is best for themselves, to have a particular set of information and to maximize their utility). Obtaining these "values" is known as economic valuation. We only will scratch the surface of the field. For greater depth see Johannson, P.: An Introduction to Modern Welfare Economics, Cambridge University Press, 1991.

In all valuation situations, there is a baseline against which the post-policy situation is being compared. If you answer a question such as "What's your ring worth to you?, the worth or value is measured with two situations in mind- one where you have the ring and one where you don't. Our three definitions vary in the baseline against which the policy situation is compared.

The importance of the different definitions relates to whether the individual has the right either to be bribed to stop a change for the worse or to be paid not to receive a change for the better. In each of these cases, the value represents a payment to the individual. On the other hand, if the individual must pay for a stoppage of a bad change or purchase of a good change, then the payment goes from the individual. Because a payment to the individual is not bound by the individual's income, it may be different from a payment that the individual must make. Thus the difference in definitions relate to the rights of the individual.

Equivalent variation: The income change that keeps the individual at the subsequent utility with the original environmental conditions. The base situation (against which the change is measured) is the subsequent (after policy) utility. Definition: $EV=E(b^0,U^1)-E(b^1,U^1)$ where $E(b^1,U^1.)$ is the expenditures necessary under a set of environmental conditions b1 necessary to achieve U^1.

> For an environmental improvement, the amount of the minimum income that we would have to give the individual leave them at the same utility as when they obtained the environmental improvement:
>
> For a worsening of the environment, it is the income that would have to be taken from the individual and leave them just as impoverished (i.e. lower utility) as the environmental degradation left them. As you can see, this definition has the individual paying for the right to stop the environmental degradation.

Compensating variation: The income loss (or gain) that compensates an individual for a change in utility, where the situation against which the change is measured is the initial (before policy) utility. Definition: $CV=E(b^1, U^0)-E(b^0,U^0)$.

> For an environmental degradation, this is the minimum payment to the individual necessary to return them to the same level of utility that they experienced before the environmental degradation. Hence the individual has the rights.
>
> For an environmental improvement, this is the maximum that the individual would pay to have the improved environment. Hence, this represents the case where the individual does not have the rights.

In the following chapters, these definitions underpin the various methodologies used to determine value. In some cases we can only achieve approximations and in other case we can only place bounds on the values. However, we should not lose sight of the fundamental objective of our measurement.

CHAPTER 2

USING CHANGES IN EXPENDITURES AS ECONOMIC VALUE: TOURISM AND INFRA-STRUCTURE CHANGES FROM HURRICANE EVENTS

PROBLEM STATEMENT:

As a general rule, one should be loath to use changes in expenditures as a measure of welfare change primarily because one person's expenditure is another person's receipt. Regardless of how expenditures change the net effect, considering both people, is zero. However, there are circumstances in which the change may be meaningful. In one case, the tourist's expenditure can be ignored from the perspective of an Island manager and only the receipts are considered. Changes in them, adjusted for opportunity costs, may be reflective of Islanders' welfare gains and losses from climate change. Similarly, there are circumstances in which the change in "defensive" expenditures to avoid a negative effect from the climate change may represent welfare change. In this chapter, those two circumstances are developed for St. Lucia and Dominica.

CHANGED TOURIST EXPENDITURES AND HURRICANE EVENTS

The effect of climate change on hurricanes, both in quantity and quality, is not known with any degree of certainty at this time but there are some indications that effects may exist. We are aware that the Caribbean islands have experienced a clear downward trend in precipitation over the 20th century, a rise in temperature from 1900 to 1950, and a relatively stable average temperature since 1950 (Intergovernmental Panel on Climate Change, 2000). There have been a significant number of intense hurricanes in the Atlantic/Caribbean since 1988 (see Table 2.1). Recently, the observed eastwardly movement of Hurricane Lenny in 1999 was unusual, hurricanes in the Caribbean nearly always move from East to West. The eastwardly motion exposed the leeward side of many of the Caribbean Islands to direct wind and wave action. Because most beaches and infrastructure are located on the western portion of the islands, many beaches and some infrastructure in St. Lucia and Dominica were damaged.

Tourism, whether it is sun/fun or eco-tourism, is an important component of the economies and livelihood's of many Caribbean Islands. In Dominica, for example, expenditures in 1998 were approximately US$ 50 million, representing about one-fifth of Dominica's US$ 250 million Gross Domestic Product. Tourist expenditures in St. Lucia, on the other hand were estimated at US$ 200 million or about one-third of the US$ 600 million Gross Domestic Product.[2] The ancillary industries based around tourism employs many otherwise unemployed resources. The degree to which hurricane events influence tourism is important to understand if only to predict what might happen following a hurricane event.

[2] These percentages are approximations based on the Caribbean Tourism Organization expenditure figures and on the World Bank's Gross Domestic Product figures.

Table 2.1: Intense Hurricanes since Gilbert of 1988

Year	Name	Maximum sustained wind speed		Central Pressure (Millibars)	Category, Saffir-Simpson Scale
		Knots	Miles per hour		
1988	Gilbert	160	184	888	5
1988	Helene	125	144	938	4
1988	Joan	125	144	932	4
1989	Gabrielle	125	144	941	4
1989	Hugo	140	161	918	5
1991	Claudette	115	132	956	4
1992	Andrew	135	155	922	5
1995	Felix	120	138	929	4
1995	Luis	130	150	940	4
1995	Opal	130	150	919	4
1996	Edouard	125	144	933	4
1996	Hortense	120	138	935	4
1998	Georges	135	155	937	5
1998	Mitch	155	178	905	5
1999	Floyd	134	154	927	4
1999	Gert	131	150	930	4

Source: Address by Professor Oliver Headley, CERMES/UWI at the Fifth Annual Conference of Head of State of CARICOM, 10-15th October 1999, Sherbourne Convention Centre. [LP seeking a direct reference]

In the context of valuation, the change in tourism expenditures can be viewed as a change in the value to the tourist-based resources in St. Lucia under very restrictive circumstances[3]. Three obvious conditions are that:

(1) the welfare of the tourist is not a consideration;
(2) the resources used to provide the goods and services to the tourists have no alternative uses that are valued by St. Lucians;
(3) the tourist expenditures must stay within St. Lucia and are not transferred to other locations such as Europe and North America.

As a general rule, one should be loathe to use expenditures as a measure of welfare change simply because one person's expense is another's receipts. The net always is zero regardless of the level of expenditure. For tourists who are not residents of an island, the island manager does not worry about the expenditures from the tourists and only is concerned with the receipts. Thus, a receipt is not offset by expenditures and thus in a social accounting sense, changes in "welfare" arise from changes in expenditures. This is what the first condition means.

The next two conditions state that inputs used to provide goods for tourists cannot be reallocated to other productive purposes. If they can, then the island does not lose the service that the input can provide when idled by lost tourism. The third condition relates to the perspective that the welfare of concern is the residents of the islands. If the receipts from tourist expenditures flow to individuals not on the island, it should not be counted in the welfare account of islanders. Because both of these conditions are not likely to hold perfectly, the change in tourist expenditures reflect upper bounds on the value of the resources in St. Lucia.

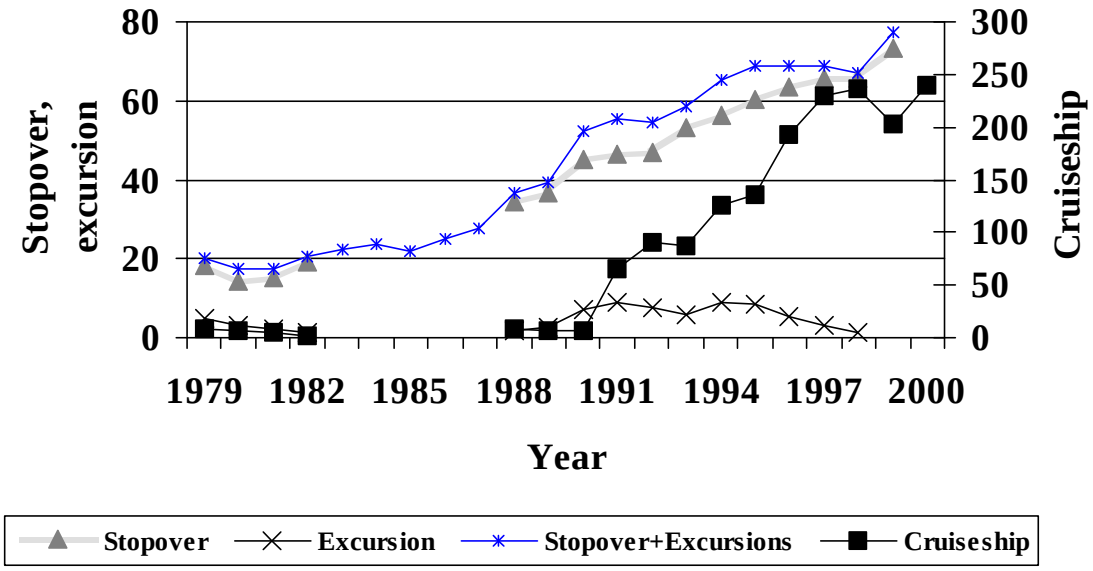
In this chapter, we go back to the late 1970's and explore the relationship between tourism and hurricane events for the two islands, Dominica and St. Lucia. We compare that situation to a recent storm event, Hurricane Lenny. The reason for selecting two islands so close to one another is that Dominica is more of an eco-tourism based island than St. Lucia, which is more dominated by "sun/fun" tourism. We hope that examining the two situations might illustrate the difference in response to hurricane events.

Types of and Trends in Tourism

Tourism in the Caribbean is normally classified into three groups, stopover (sometimes called stay-over), excursion, and cruise ship. The first category, the stopover visitor or tourist, is defined as a visitor that arrives by air or sea, but not cruise ship, and stays for longer than one day. As individuals, the tourists have a higher economic impact. They stay longer and spend considerably more than the other two categories. The excursionist comes for one day from another island and does not arrive on a cruise ship. The cruise ship passenger arrives by cruise ship and will normally arrive in the morning, spends the

[3] For example, the profits to a hotel owner will fall with cancellations of reservations when hurricanes hit. Likewise, labor's wages that are received because of the lack of tourists is also a loss in the value of the labor resource.

Fig. 2.1: Cruiseship, Stopover and Excursion Arrivals (000's) in Dominica, 1979-1999.



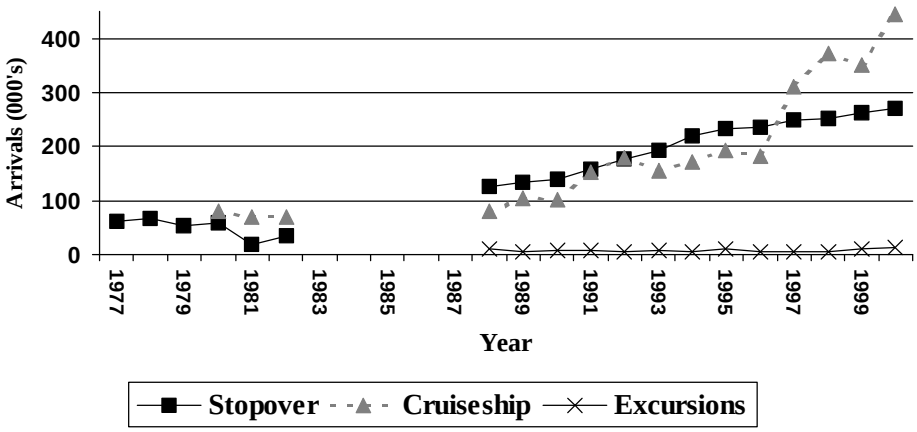
Source: Caribbean Tourism Office and Mr. Mark John.

day on the island and leave at the end of the day. Each of these groups has distinct characteristics, and engages in different activities. We will review trends in each group's visitation in St. Lucia and Dominica.

Figure 2.1 shows arrivals in Dominica for the three classes of visitors over the period 1979 through 1999. In 1979, stopover arrivals were approximately 18,000, cruise ship arrivals about 8,000 and excursion arrivals about 5,000. Whereas the stopover arrivals rose steadily but slowly throughout the period to reach about 60,000 arrivals, the cruise ship arrivals remained steady until 1990 when they rapidly increased to nearly 250,000. The excursion arrivals have remained reasonably small, peaking in 1994 at nearly 9,000.

The economic importance of the categories should not be judged on arrivals solely. In 1998, the average expenditure per day for cruise ship passengers arriving in Dominica ranged from US$43 for a French tourist to US$ 3 for a tourist from another eastern Caribbean island. While the average stay for a cruise ship visitor is one day, the average stay for a stopover visitor was 8.3 days with an average expenditure of US$ 68/day for an average expenditure per trip of US$ 564 per person. Thus, even a French cruise ship visitor will on average spend only one-thirteenth of the average stopover visitor to Dominica. Consequently, although the cruise ship arrivals were over four times the stopover arrivals in 1998, the total expenditures from cruise ship passengers were only about one-quarter of the stopover visitors' total expenditures in 1998.

Fig. 2.2: Cruiseship, Stopover, and Excursion Arrivals in St. Lucia, 1977-2000



Source: Caribbean Tourism Organiszation

If one examines the same information for St. Lucia (Figure 2.2), a slightly different pattern emerges. The number of cruise ship and tourist arrivals in the late 1970's was much higher than in Dominica. The cruise ship arrivals averaged over 50,000 for the 1978 through 1980 period while the stopover and excursion arrivals together[4] averaged over 80,000. The growth rate in cruise ship and stopover arrivals since the mid-1980s has been quite similar so that by the mid-1990s, arrivals in both categories were around 200,000. Clearly the difference is in the growth of stopover arrivals. In St. Lucia in 1998, the average stopover visitor spent $64 per day and stayed an average of 11.5 days.

It is apparent that both the number of visitors and the expenditures by tourists in St. Lucia are far greater than those in Dominica. Cruise ship arrivals in St. Lucia are approximately twice those in Dominica and stayover arrivals are about four to five times greater. Any kind of interruption in tourist flow affecting the coastal environment in both islands,will likely cause a greater absolute effect in St. Lucia.

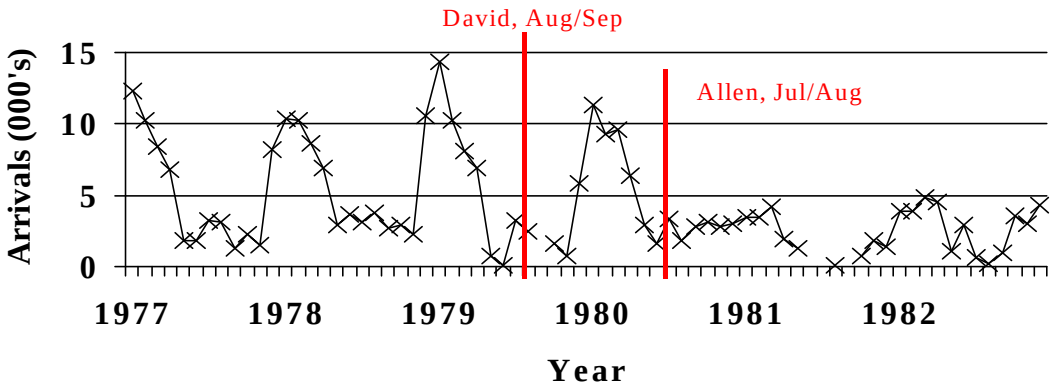
The Effect of Major Hurricanes on Tourism in St. Lucia

Hurricanes Allen and David

Examination of the effect of major hurricanes on tourism is limited by available data. In St. Lucia, however, monthly data for 1977 through 1982 (Figure 2.3), a period during which Hurricanes Allen and David occurred, and for 1999-2000, the period during which

[4] Separating the excurisionists and stopover arrivals was not possible.

Fig. 2.3: Monthly Cruiseship Arrivals in St. Lucia, 1977-1982



Source: Caribbean Tourism Office.

Hurricane Lenny occurred was available. Unfortunately, data were not available for the stopover and excursion visits in the earlier period.

Looking to the early period (Figures 2.3 and 2.4), Hurricane David's damages were not sufficient to cause a dramatic decline in cruise ship arrivals in 1979. The hurricane occurred late in the year and, although arrivals from September through December were down substantially (at least 50%), the following January-through-June arrivals had returned to normal. Data on the stop-over visitors was not available for 1979 and thus the effects of David on this segment are hard to determine.

We can calculate the average monthly visits before and after these hurricanes. For the stopover visitors, the average in 1978 was 8293 stopover visits and 5666 cruise ship visitors in St. Lucia. This fell to 7581 stopover and 3856 cruise ship visits in the recorded months after Hurricane David. In percentage terms, the greatest losses were in St. Lucia cruise ship visits. In Dominica, the average monthly stopover visitation was actually greater after Hurricane David than before (2932 versus 3758).

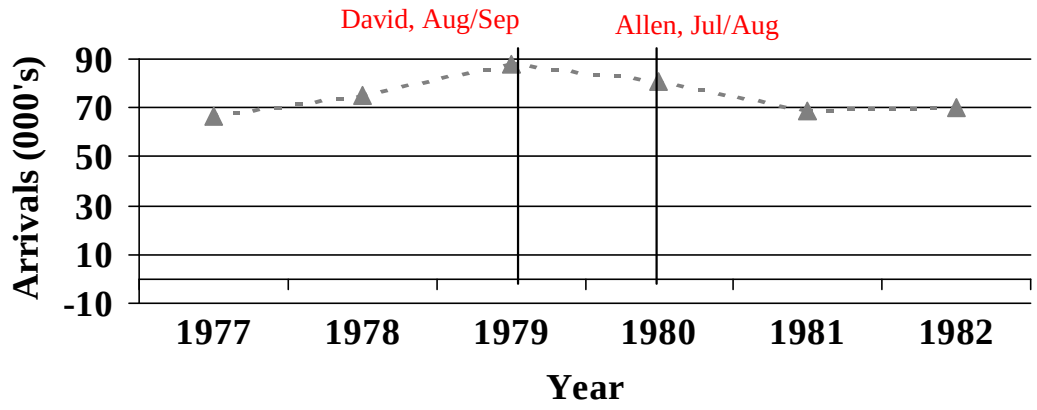
Thus we can infer a link between tourist numbers and weather conditions. Also, the return of tourists to the spot is a proxy indicator that the damage was either not that significant or that it had been effectively repaired.

However, Hurricane Allen's effects were more severe and long lasting. Even though Allen occurred in July 1980, cruise ships arrivals in St. Lucia were still down by 50% two and one-half years later (Figure 2.3). Monthly cruise ship visits in St. Lucia averaged 2500 for the two and one-half years following Hurricane Allen. While not as severe as

the cruise ship losses, stopover visits fell down to around 5700 per month. The degree to which these losses can be contributed to infrastructure loss, changed demand, and the cumulative effects of two large back-to-back events is difficult to ascertain but there is a link, nonetheless.

The two hurricanes had a similar effect on the visitation to Dominica. Annual cruise ship passenger arrivals fell from 7770 passengers in 1977 to a low of 2362 visitors in 1982. The stopover and excursion visitation was not affected as strongly (in percentage terms),

Fig. 2.4:Stopover Arrivals and Major Hurricanes in St. Lucia, 1977-1982



Source: Caribbean Tourism Office.

falling from about 20,000 in 1979 to 17,000 in both 1980 and 1981. It rose back to 20,000 in 1982.

Hurricane Lenny

Hurricane Lenny provides an illustration of the effects of one recent hurricane on the tourist trade in St. Lucia. Figures 2.5 and 2.6 show stopover and cruise ship arrivals by month for the years 1990, 1995, 1999 and 2000. Hurricane Lenny lasted from about the 13th of November, 1999 until about the 21st of November. It originated off of the Yucatan peninsula and moved westward, crossing over the Virgin Islands.

Determining the precise effect is difficult because the trend in arrivals, shown in Figures 2.1 and 2.2, had generally been upward. Looking at this more closely, Figure 2.5 shows that while there was a steady increase in visits each month from 1990 through 1999, the visits in 2000 did not grow appreciably and even fell in some months. If we were to simply compare the total 2000 stayover visits from January through October with the visitation over the previous year's first ten months, there would be a decline of 10,400 visitors. There is no similar effect on the cruise ship visitation in St. Lucia (Figure 2.6). Data on the effect of Hurricane Lenny on Dominica were not as evident. Stopover data by month for the period just before and after hurricane Lenny show an increase for December 1999, and relative little change for the first three months of 2000. The annual level of stopover tourists was approximately the same in 1999 as in 1998.

Cruise-ship arrivals, on the other hand, were down noticeably in 1999, falling from about 230,000 in 1998 to about 200,000 in 1999. However, the large decline could only be attributed to Hurricane Lenny if most of the cruise-ship arrivals in 2000 had not arrived.

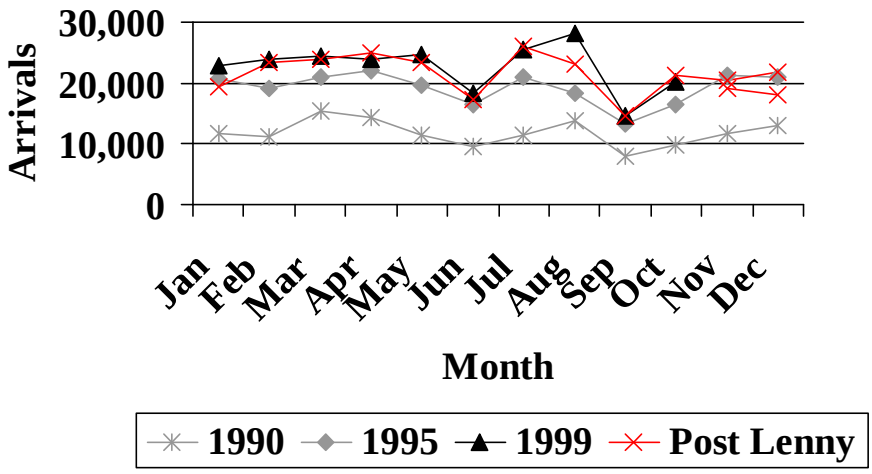
Economic Effects of Hurricanes on Tourist Expenditures in St. Lucia and Dominica

Using these figures and recognizing that the lost visitation estimates might be understated, we address the question of potential differential effects of hurricanes by considering the historical changes on the two islands and on the cruise ship expenditures. We do this by asking the question what would happen under different circumstances (i.e different levels of lost visitation) arising from different hurricane events. The two hurricane periods, 1979-1980 and 1999, serve as the basis for the comparison.

In order to obtain hypothetical expenditures under the varying physical changes, we use the average per day expenditures and average length of stay from the 1998 visitor surveys in St. Lucia and Dominica. While it is possible that the existence of hurricanes might influence the average expenditure, we do not have evidence of that.

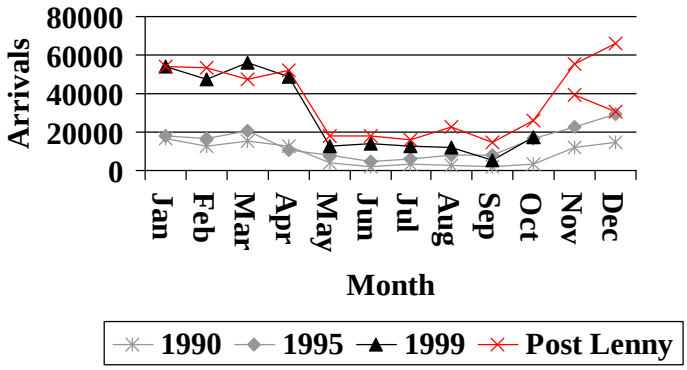
Table 2.2 shows the estimates of the lost tourism and tourism expenditures from previous hurricane events. For example, the third column in the table shows the estimated lost visitor days caused by hurricane events. Clearly the greatest effect was evident in St. Lucia following Hurricane Allen. It is estimated that nearly one million stayover visitor days in St. Lucia were lost following that event. Not only is this a huge absolute value, it also represented about 50% of the expected total stayover days during that period. Given that stayover visitation has grown rapidly since 1980, a 50% loss in stayover tourist days would mean a loss of about 25 million days. With an average expenditure of $64/day, the loss would be over a billion and a half dollars ($1, 500, 000, 000). Even given the relatively low tourism level in 1980, the losses are still estimated to be over $50 million (column 4).

Fig. 2.5: Effects of Hurricane Lenny on Stopover Arrivals in St. Lucia



Source: Caribbean Tourism Organization; Mr. Louis Lewis

Fig. 2.6: Effect of Hurricane Lenny on Cruiseship Arrivals in St. Lucia



Source: Caribbean Tourism Organization; Mr. Louis Lewis.

The observed effect of Hurricane Lenny on tourism in St. Lucia and even Dominica pales in comparison with Hurricane Allen. Even though the lost expenditures are over $5 million, they represent about one-tenth of those estimated for Allen (even accepting the low visitation rates of 1980). Perhaps these values place Lenny in perspective. Whether the low values are because of the relative size and strength of the hurricane or the improved infrastructure currently in the islands is not known. If it is the former, however, we can see the danger of climatic change that could trigger large storm events. This is particularly true under conditions where the sea-level is also rising.

Another feature of Table 2.2 is the relatively small losses associated with changes in cruise ship visitation. Maybe because cruise ships rely only on the docking infrastructure (and not the hotel infrastructure), the cruise ship visitation losses are much lower than the stayover visitation. When you combine this with the fact that the average cruise ship visitation expenditure per day is only two-thirds of the average stayover expenditure, the losses from cruise ship stops are relatively small.

Table 2.2: Estimated Tourist Expenditure Losses From Previous Hurricane Events

Island	**Hurricane Event**	**Lost Stopover Visitation (10^3 days)**	**Lost Stopover Expenditures (10^3 $)**	**Lost Cruise ship Visitation (10^3 days)**	**Lost Cruise ship Expenditures (10^3 $)**
St. Lucia	David (1979)	90	5764	20	896
	Allen (1980)	895	57250	95	4274
	Lenny (1999)	115	7360	Minor	Minor
Dominica	David (1979)	50	3386	11	487
	Allen (1980)				
	Lenny (1999)	Minor	Minor	20	900

*Estimate not available

The final feature of the Table is the relative size of the losses between the islands. One might expect this given the greater tourist market that St. Lucia commands. However, the result may also be the result of the "sun and fun" nature of the tourism in St. Lucia. The beaches and the hotel infrastructure must be of sufficient quality to compete. Hurricane events reduce that quality. Eco-tourism, on the other hand, is not as likely to be effected by those same qualities. As a result, it may be more resilient to the climatic changes.

One must be careful in taking the last argument too far. Hurricanes can have dramatic direct effects on the reefs. The losses to coral reefs in Barbados and Jamaica as the result of hurricanes illustrate the point.

Effects of Hurricane Lenny on Diving in Dominica

While the effect on the aggregate stay-over tourism in Dominica might have been minor, there were some segments of the tourism industry that were affected. One of the eco-tourism activities within our Dominican site is the Soufriere Marine Area, managed by the Local Area Management Authority. It is an area having approximately 21 dive sites. The moorings at the sites are used to tie up the local dive shop boats that carry divers and snorkelers who are observing the coral reefs. The dive sites are particularly spectacular because the island drops precipitously very close to shore, offering a rare view of dramatic elevation change in the coral. The damage to roads and waterfront property in this area from Hurricane Lenny was extensive.

As part of the study, Environmental Coordinating Unit personnel attempted to interview all dive shop operators that use the Soufriere Marine area. Questions were asked concerning the level of operation of the firms during 1999, the general trends in their business, the best months for their business, the pricing policies of the business, their assessment of damages from Hurricane Lenny and their impressions regarding the operation of the Marine Park. Nearly all operators cooperated with the survey and we are able to make some statements regarding the nature of diving in the Marine Area and the effect of Hurricane Lenny on the operators.

The dive shops that were interviewed are spatially distributed from being almost onsite (in Soufriere) to being north of Roseau (see Figure 1.3). The degree of reliance on the Marine Area depends on the location, with the more northern firms using reefs at the northern end of Dominica in addition to Soufriere. The clientele also vary across the firms, with some firms only offering dives and catering to stayover visitors only while others offer only snorkeling trips with clientele from cruise ships. The largest firms offer both types of activities and deal with both types of clientele.

From discussions with the operators, we estimated that there were roughly 3500 divers using the Soufriere Marine Area during 1999[5]. Of these, about 75-85% are on stay-over visits, 10-15% come from the cruise ships, and 1-10% are local residents. The divers are expected to take a total of about 25,000 dives. Prices vary across the type of dive and the firm providing the dive but a conservative estimate of the price of a dive is $50/dive. This means that about $US 1.25 million is spent to go on scuba dives in the Marine Area.

Snorkeling has greater numbers of participants but less total economic effect in Dominica. Based on our interviewS, we estimate about the same number of snorkelers as divers, about 20,000. However, each person who snorkels takes fewer trips (1-2 trips), making a total of about 30,000 trips. The cost of a snorkeling trip is about US $25 each, making the economic expenditures directly associated with snorkeling trips about US $ 750,000. Thus, a conservative estimate of the annual total direct expenditure on water-related activities in the Soufriere-Scottshead Marine Area is about US $2 million annually.

The fact that there was no noticeable change in the stopover passenger activity in Dominica in 1999 and there were losses to dive shop operators requires explanation. The Scottshead and Soufriere areas were particularly damaged by the storm, making it impossible for the larger dive operation (that were also hotels) to operate. One operator said that they lost 100% of their business from the last week of November 1999 through January 2000 and 50% of their business from February through April 2000. Another operator lost 100% of the business from the last week of November through December 1999 and then substantially less for three more months. This is particularly critical because the highest bookings usually occur from November 2000 through April 2001. However, these establishments represent a small portion of the total tourism in Dominica.

The Effects of Hurricane Lenny on Fishing Operations in the Study Area

Replacement costs for lost capital is another type of expenditure that can offer some guidance with regard to value. For example, if a hurricane destroys fishing vessels, gear and equipment, then the expenditures by individual firms to replace the equipment represent a minimum expected net value of the fishing operation. That is, if the fishermen did not expect to make profits sufficient to cover the cost of the equipment, then they would not purchase it. Thus, replacement costs represent a lower bound on their expected revenues from fishing. It is not extremely useful because it is the profits above the cost of capital that reflect the value of access to fishing.

Besides reflecting a lower bound on expected net revenues, the expenditures do represent the lost capital that the storm event created. We can think of net value as a flow, occurring over time. Wealth represents the accumulation of net value and part of wealth

[5] To check this estimate, the 1998 stayover visitor survey was obtained and the percentage of visitors stated that they went “scuba diving” was obtained. The estimate of 13.5% was multiplied by the total number of stayover visitors, 65,500, to obtain an estimate of 8810 scuba divers visiting Dominica in 1998.

is the capital stock. When a hurricane hits, Dominica may lose value from lost tourism, but they also lose accumulated capital.

A major portion of Hurricane Lenny's economic effect on Dominica was the destruction of capital in the form of destroyed residential housing, destroyed roads, and destroyed private capital. To illustrate these costs, the Department of Fisheries provided detailed information regarding the losses in the study area to fishermen from Lenny.

There are four main fish landing sites in the study area. They are from northernmost to southernmost Newtown, Pointe Michel, Soufriere, and Scotts Head. In terms of number of fishing vessels and fishermen, the Scotts Head/Soufriere area is the greatest, with over 300 fishermen. The vessels in Scotts Head/Soufriere are primarily canoes whereas the boats in Newtown are primarily keel boats (Table 2.3). Landings vary substantially across sites with Newtown having the greatest (245 thousand pounds) and Pointe Michel the least.

Figure 2.3: Number of Boats, Fishermen, and Landings in Study Area, by Landing site, 1999. (Source: Harold Guiste)

Landing Site	**Boat Types[1]**						**Fishermen[2]**	**Landings (000 lbs)**
	Canoe	**Keel Boat**	**Open Ply**	**Sloop**	**FRP**	**Total**		
Scotts Head/Soufriere	127	5	2	1	2	137	311	167.9
Newtown	23	40	5	1		69	207	245.2
Pointe Michel	6	10	-	-	1	17	45	62.2

[1]Canoes range in size from 16 to 18ft, keel boats from 16 to 22 ft, open ply from 18 to 25 ft, and fiber glass (FRP) from 20 to 25ft
[2] Fishermen are for 1998.

The fisheries consist of a coastal migratory operation, a coastal pelagic operation, a shallow reef operation, and an emerging Tuna Longline fishery. The species harvested include dolphinfish, jacks, flyfish, sprat, snapper, grouper, yellowfin tuna, skipjack tuna, Blackfin tuna, wahoo, king mackerel, and ballyhoo.

The Department of Fisheries also estimated the capital losses from Hurricane Lenny. The greatest losses occurred in Newtown whereas the greatest category of loss was in boats, with twelve being destroyed at a replacement cost of EC $359 thousand. In total, the estimated losses amounted to EC $767,400 (see Table 2.4).

Table 2.4: Estimated Capital Losses (EC$) from Hurricane Lenny (Source: Harold Guiste)

Landing site	**Scotts Head**		**Soufriere**		**Pointe Michel**		**Newtown**		**TOTAL**	
Type of Capital	# Lost	Estimated Cost	# Lost	Estimated Cost	# Lost	Estimated Cost	# Lost	Estimated Cost	# Lost	Estimated Cost
Boats	2	9,000	0	0	3	17,700	7	341,000	12	359,600
Engines	0	0	0	0	0	0	14	93,700	14	93,700
Fishpots	139	35,300	138	41,400	30	9,000	14	4,200	321	89,900
Sheds	1	2,000	4	9,500	0	0	7	19,200	12	30,700
Tuna Longlines	0	0	0	0	0		24	194,400	24	194,400
Fishing Tackle Cost								18,000		18,000
Total Estimated Cost		46,300		50,900		26,700		643,500		767,400

It would be beneficial to have these losses put into perspective by showing the annual earnings of fishermen. However, it is not possible to convert the weekly earnings into annual earnings. Many of the fisheries are seasonal and one must know how many weeks a year the fishery is operating. Vessels move between the fisheries and a more complete information source than is available would be needed to give this perspective. However, 10% of the fleet was lost in Newtown and about 15 - 20% in Pte. Michel.

The Effects of Hurricane Lenny on Defensive Expenditures

Another method used to determine economic value is to look at the change in defensive expenditures associated with a change in climate. Although this method likely provides a lower bound on the willingness to pay to avoid a harmful environmental change, it is often useful and is especially relevant with climate change. There are numerous defensive expenditures along the shore in the study area designed to protect the shoreline. Table 2.5 provides details of some of the defensive expenditures in the study area. One interesting feature of Table 2.5 is that the value of the land and property behind the sea defense is at least 6 times greater than the capital costs of the defense. Given the large capital

investment in sea defenses, they are unlikely to be taken by private individuals in low-income areas.

Unfortunately, the defensive expenditure method is difficult without knowing the changes that are occurring in the environment. The information that is available does not really lend itself to an application with a great deal of accuracy. We are aware that one defensive expenditure in Table 2.5 that can provide information indicative of how one would use defensive expenditures to ascertain a lower bound on the willingness to pay to avoid a change in climate.

Along Choc Beach there is an eating establishment known as the Wharf. It had been protected until Hurricane Lenny by a stone and mortar wall that cost about EC $100,000 to construct. During Hurricane Lenny, a good portion of the wall crumbled, requiring about EC $180,000 to reinforce. If you could say that a capital investment of EC $100,000 protected the Wharf until 1999 and that the climate change had cause events that rendered the wall ineffective, then the difference between the new protection and the old protection (180,000-100,000=80,000) represents a lower bound on how much the owner of the Wharf was willing to pay to avoid the climate change.

Table 2.5: Defensive Expenditures in St. Lucia Study Area (extracted from work by Crispin d'Auvergne)

Name/Location (from North to South)	**Type of Structure**	**Original/Estimated Structure**	**Maintenance/repair Costs**	**Estimated Lifespan**	**Value of Property Protected**	**Purpose of Structure**	**Effectiveness of Structure for Purposes Intended**
Pigeon island National Landmark	Rock armour & groynes	EC2,523,636	1% per year.	10 yrs	N/A It is a national historical landmark	Protection of southern coastline of pigeon island. Also beach protection and development and protection of British Cemetery	Washed away by wave action during tropical storms. National trust is seeking funding to reinstate.
Rodney Bay Marina and Boatyard, Rodney Bay	Sea wall , (170,000 ft^2) Retaining walls	US320,000 (EC854,000) in 1989 US200,00 (EC540,000) in 1989.	Estimated EC40,000/yr for last 6 yrs	25 yrs	US3.2 M	For full service marina shore protection	Seawall 80%. Some slope due to weak angle of repose. Retaining walls 60%. Some slope due to weak angle of repose.
Eagle's Inn Rodney Bay at entrance to marina	Rubble wall with rock-laid foundation	EC80,000	None	50 years	EC2.4M	Retain ground and contain water	Very good
St. Lucia Yacht Club	Steel piles 4ft above sea level	Not available	None	Currently 50 years old and still good	EC2.5 M	Built during the war along with the ramp for sea planes	Saved the property during last bad waves in October 2000.
Royal St. Lucian Hotel	sheet piles to end bearing….	480,000	1% year	1-100 years	EC18M	To protect beach property	No information.
Rex Hotel	Steel piles 4 ft. above sea-level.	Not available	0.5% per year	10 yrs providing no abnormal natural forces.	EC19M	To protect against heavy sea swells and protect property	This wall is constructed with total assurance that it will be effective against strong elements.

Table 2.5: Defensive Expenditures in St. Lucia Study Area (cont'd)

Name/Location (from North to South)	**Type of Structure**	**Original/Estimated Structure**	**Maintenance/repair Costs**	**Estimated Lifespan**	**Value of Property Protected**	**Purpose of Structure**	**Effectiveness of Structure for Purposes Intended**
Papillon Hotel	Sea wall 18" reinforced concrete block wall with concrete base precast	680,000	1% year	1-100 years	14M	To protect beach property	Has resisted all wave action over last 5 years- excellent performance
Wyndham Morgan Bay Hotel	Rip layer of 1-1.5 ton boulders along the front of the beach and 50m groyne.	US140,000 for groyne and US25,000 for boulders.	US15,000 to replace sand that is washed off the beach each year through wave action.	"Lifetime"	US17M	Groyne helps to trap sand and deposit it on the beach and the boulders help to protect the land from washing away with the heavy wave action and to break wave movements and reduce landslides, etc.	Groyne and boulders work very well.
The Wharf, Choc Bay	Outer Stone & Mortar Wall Inner concrete culvert with reinforced steel beam and sand felt retainer	100,000 EC 180,000 EC	N/A	Already Crumbling 15 years	EC2.2 M	Protect foundations " " Good	Poor
Sandals Halycon (Hotel)	Retaining wall	EC 1.2 M	EC 10,000	60 years	2 M	Prevent erosion	Very
Rendezvous Hotel	Offshore Breakwater	EC 2.4 M	EC 133,750	20 years	EC26 M	Beach restoration	Excellent

Conclusions

Extreme caution must be taken when using expenditures to infer anything about economic value. Expenditures in general represent a gain to one person and a loss to another. The two are "netted" out when the welfare of both people are considered. There are instances where both individuals are not considered and in these instances the change in expenditure can be a useful piece of information.

In this chapter, we began by showing how the loss of tourism expenditures from hurricanes can be informative regarding the loss of income to the island population. Specifically we showed the effects of Hurricane Lenny and how they varied between the two different types of tourism- the more "sun and fun" tourism of St. Lucia and the more "eco-toursim" of Dominica. During Hurricane Lenny, the stay-over visitation to Dominica was not affected whereas St. Lucia's stay-over visitation fell by about 100,000 visitor days causing a conservation loss in expenditures of US $10 million. The cruise ship visitation is likely not going to be influence greatly unless the infra-structure supporting docking and movement of visitors is damaged. In St. Lucia, there was no noticeable change.

Another comparison made related to the losses observed from Hurricane Lenny and those observed from Hurricanes David and Allen during 1979 and 1980. Despite the relatively low levels of visitation, the two hurricanes created far greater disruption and income lost.

The second form of economic information that must be used with caution is the price or value of assets. Property, building, and fishing vessels have a price that may be useful in determining economic value. The price of an asset is determined by the satisfaction or expected future profits is provides its owners. Lost asset values (and their replacement costs) and defensive expenditures on capital assets can provide information regarding the economic losses to a community from changes in the environment. The costs of replacing fishing gear and boats were provided. These replace values represent a minimum expected net future profit from fishing. If they exactly replace the damaged equipment, then they are a good measure of the lost value's lower bound.

Another estimate of the lower bound on economic value can be found in the change in defensive expenditures associated with a harmful environmental change. The cost of sea defenses in to protect valuable commercial property in St. Lucia provided some value information. Unfortunately, there is no clear cut environment change that these expenditures can be related to and hence their usefulness is limited.

Appendix 2a: Dive Shop Questionnaire

QUESTIONNAIRE FOR DIVE SHOPS

1 Name of Business_____

2 Date of inter d m yr
1 1 1

3 How many divers have you taken to Soufriere Reef over the last year?
(Jan.2000 thru Dec.)_____

4 About what percentage of these were

a) Cruise Ship visitors

b) Stay-over tourists

c) Local residents

5 Did the number of divers taken to Soufriere change from 1999?
(Please indicate % increase or decrease)

a) Increased

b) Decreased

c) About the same

6 What is your "best" month(s) for divers in Soufriere

Jan Feb Mar Apr May Jun
Jul Aug Sep Oct Nov Dec.

7 What is your worst month(s) for divers in Soufriere

Jan Feb Mar Apr May Jun
Jul Aug Sep Oct Nov Dec.

8 What is the current price of a trip to the Soufriere Reef?

$_____ Length of Time_____

$_____ Length of Time_____

$_____ Length of Time_____

9 Did you suffer damages from Hurricane Lenny? 1Yes 2No

Do you have an estimate of the value of the damages? $_____

10 Do you have any ideas for increasing the quality of diving at Soufriere?

_____

_____

_____

_____

_____

_____

11 Do you believe your clients would be willing to contribute to the up-keep of the Marine Park? 1Yes 2No

12 How much on average do you think they would be willing to pay US $_____/diving trip to the Reef?

13 What are the names of other dive shops that take clients to the Soufriere Reef

_____

_____

_____

_____

CHAPTER 3

USING RELATED MARKETS TO OBTAIN NONMARKET USE VALUES: RECREATION DEMAND IN ST. LUCIA

PROBLEM STATEMENT:

Many of the issues surrounding climate affect the recreational use of shoreline. Whether because of the changes in tropical storm patterns or prolonged sea level rise, the interface between the land and the sea is at the vanguard of change. Because many of the Caribbean nations' beaches are property of the Crown (i.e. owned by the nation), access to them is free and unimpeded. Citizens and tourist enjoy the beaches but the economic value of the enjoyment is not reflected directly in a market. In this chapter, we use a related market, transportation market, to determine the value of beach use and characteristics of the beaches. Everyone must travel to reach a beach and thus the travel cost to a beach (either in expenses or time or both) is incurred. One can use the travel costs and beach characteristics to determine a household's choice of site. From that information, an assessment of the economic loss can be made of closures of beaches, loss of beaches and changes in beach characteristics.

In this chapter we examine how the residents of St. Lucia use and value the beaches in the selected study area. These values, along with figures obtained from examining tourist behavior, will provide a benchmark against which cost of beach protection can be judged. The use and demand for beach use is explored for eleven sites in the study area. The patterns of use in 2001 are presented to provide a background for future use. The demand for the beaches is estimated so that the welfare effects of changes in climate can be assessed. The method used to estimate the demand is the random utility model, a model that is more statistically complex than other methods used up to this point. At the same time, it could be argued that it provides the closest estimate to the correct measure of welfare from use of a resource (see Appendix 1A for definitions).

The Process of Estimating Recreational Demand

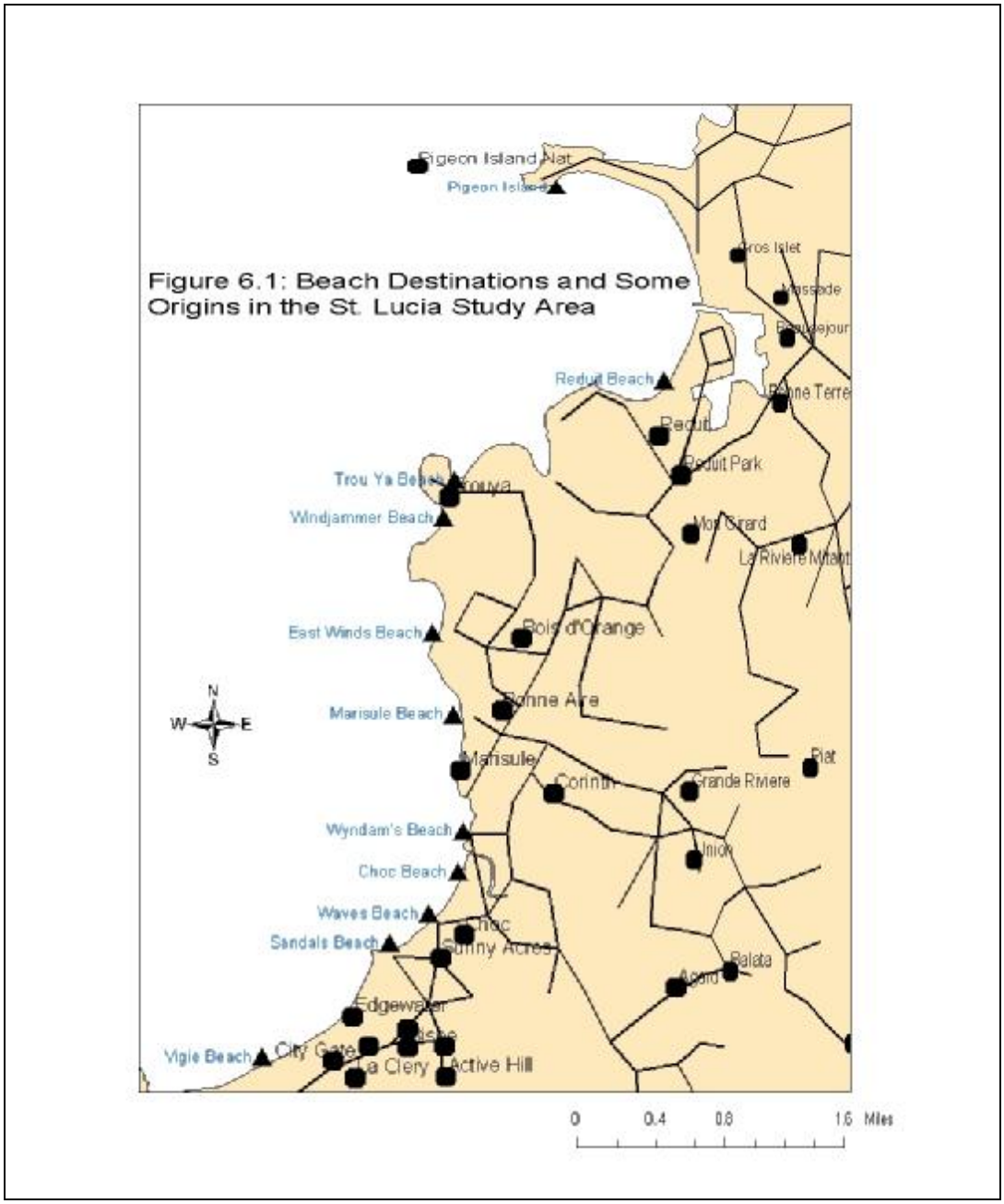
1. ***Scope the nature and extent of the demand for the beaches.*** Visiting the sites and talking with key informants is important to determine what information is important, what are reasonable methodologies to use to estimate preferences, and what methods are potential to collect the information.
2. *Design the study.* Select the appropriate methodology to estimate demand and the manner in which data are to be collected. Determine the type of information and the general size of the sample that needs to be collected.
3. *Make surveys and test them on persons.* The surveys should be designed to collect only information that is useful in order to keep the interview short. Problems of language differences (such as patois in areas of the Caribbean) need to be discussed with survey design personnel in the region.

4. *Contract a survey firm and interact with it whenever necessary, to eliminate problems of survey implementation.*
5. *Closely examine the data provided by the survey firm to assess the information and to eliminate obvious errors (such as in key-punching).* When the data comes from the survey firm, it inevitably has to be augmented and cleaned up before the researcher can proceed. Sometimes codes will be left out but always there will be clear errors in data entry. Most things can be addressed independently but occasionally the firm will have to be contacted. It is important to do this early while the firm still has the information.
6. *Create summary information about the sample.* Summary information gives useful insights how the sample is behaving. The statistical analysis permits a quantification of behavior but the summary statistics also are useful in understanding the behavior.
7. *Create the operational model.* In our situation, the model is a "linked" trip , site/mode choice model. This means that we predict site/mode choices. With the model of site/mode choice, we link its results to a model that predicts the number of trips to a sites in our study area.
8. *Determine the implied "values" of the sites and the characteristics.* If we properly specify and estimate the linked model, it can be used to determined the lost economic value to households from the elimination of sites. Likewise, the value of site characteristics can be computed.

The Study Design

The intent of the study was to examine the use and value of the eleven beaches in the study area (see Figure 3.1), both to the residents of St. Lucia. After visiting the sites and talking with people about who uses the beaches in the study area, it was decided that the random utility model (e.g. Hanemann, 1999) was likely the best method to obtain the values of the beaches. This choice was dictated by the reasonably large number of sites that residents could use and by the one-time nature of the surveying (i.e. the use of cross-sectional data).

It was further decided that two surveys would provide the essential information for the study- one that arose from a telephone survey to random household in the Castries and Gros Islet Quarters and one that arose from intercepted beach goers at eleven sites in the study area. The choice to survey a limited St. Lucian population was based on a limited budget that required focus on a group who represented the vast majority of users of the study area beaches. Having both the intercept and telephone survey permitted complementarity, with the analysis of daily beach use determining the value per day of the average user and the telephone survey showing the average days per user and the number of participants. The three components of total value (average value per user per day, average number of days per user, total users), when multiplied together yield the total use value of a beach to households with telephones. The intercept survey also was used to determine the percentage of beach users who had telephones within their household so that the previous figure could be expanded to the entire population. At the same time, the telephone survey complemented the user survey by providing information



on the relative usage of each beach to the representative household. With those features in mind, we designed two surveys, one for intercepted users of beaches in our study area (Appendix 6a) and one for the general population of the Castries and Gros Islet quarters (Appendix 6b).

Originally, the surveys were to be executed each two months to reduce the recall bias associated with the telephone survey. However, contracting and time constraints required that the telephone respondents be asked to recall activity based on a six-month basis, for January 1 to June 30, 2001 and from July 1 to December 31, 2000. Individuals were

asked to report their usage on a six-month basis. The intercepted respondents were asked for their entire activity at each beach in the study area over the six months.

The Statistics Department of St. Lucia worked with the consultants in developing the questionnaire and implemented the surveys using 25 experienced enumerators. The surveys were undertaken over a two-week period beginning at the end of July 2001. Table 3.1 contains the percentages of respondents who were intercepted at various

Table 3.1 Comparison of beach use by survey method

	Telephone Interviews	**On-Site Interviews**		
Beach	% Identifying Beach as Most Likely Visitation Spot	% of Total Beach Interviews	% Interviews Who Were Residents[1]	% of All Residents[1] Intercepted at Beach
Vigie	21.3	22.9	82.4	31.5
Sandal's	1.2	2.2	75.0	2.7
Waves	6.7	5.9	50.0	4.9
Choc	4.9	21.6	53.8	19.3
Marisule	4.9	3.2	100.0	5.3
Wyndham's	1.8	4.6	41.1	3.2
East Winds	1.8	3.5	61.5	3.7
Windjammer	.6	2.2	12.5	.5
Trouya	4.3	0.0	.	.
Reduit	9.1	22.6	40.4	15.1
Pigeon Island	42.1	11.3	73.8	13.8
Total Percent	100.0	100.0		100.0
Total Number	154	382	*	210

[1] Residents currently living in St. Lucia.

beaches and the percentages of residents who stated in the telephone interview that a particular beach was their destination on a "typical" trip. We are using the beach survey to obtain a value per trip and we require that the sample is a random selection of a household trip. Because it was impossible to design the beach survey to intercept a random household trip (i.e. no knowledge of the relative frequency of visits by household was known), a useful comparison is between the beach participation of telephone interviews and of the intercepted sites. The visitation of the random households for Vigie Beach was 21 % compared with the intercept survey percentage of 31.5%. Thus, the beach survey tended to over sample Vigie Beach and under sample Pigeon Island. When we use the beach interviews, we must weight them by the "true" household proportions as shown in column 2.

Because of the relatively low intercepted number of users of Sandal's Beach, Waves Beach, Wyndham's Beach, East Winds Beach, Windjammer and Trouya Beach, we decided to eliminate them from the potential sites that could be chosen. The low usage,

especially in light of the need to consider the mode of transportation, meant that we did not have sufficient information in order to determine why someone chose these beaches[6]. There was also limited information on the characteristics of some of these beaches.

Another important relationship between the intercept and the telephone survey is the percentage of intercepts that responded that their household had a telephone. If this percentage varied greatly across beaches, then using the telephone percentages as representative of the population of beach users from St. Lucia would be misleading. Table 3.2 shows that the percentages do not vary greatly and there were no statistically significant differences among telephone accessibility by beach. We proceed by assuming that the telephone survey proportions represent the true population proportions.

Table 3.2: Percentage of Respondents with Telephone Accessibility, by Beach

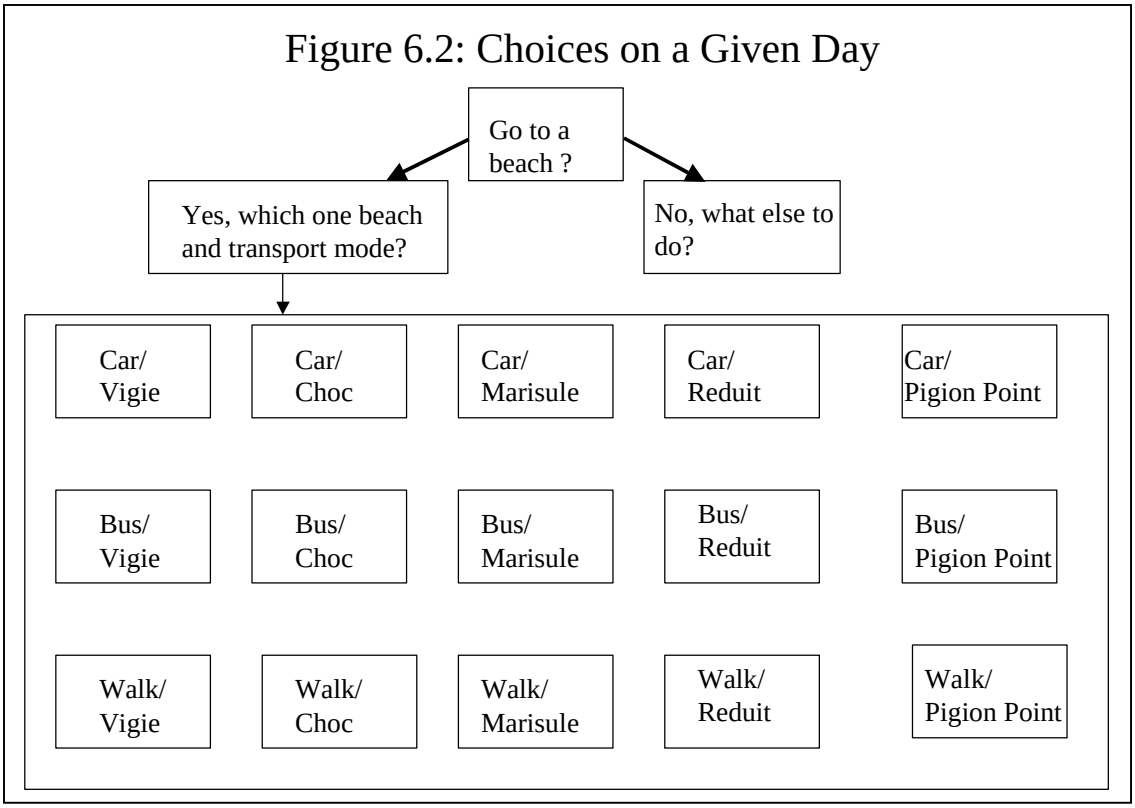
Beach (Intercepts)	Percentage of Respondents with Telephone Access	Beach (Intercepts)	Percentage of Respondents with Telephone Access
Vigie (63)	.76	Wyndham's (7)	1.00
Sandal's (6)	1.00	East Wind's (7)	1.00
Waves (9)	1.00	Windjammer (1)	1.00
Choc (40)	0.80	Trou Ya (0)	*
Marisule (12)	0.83	Reduit (34)	0.88
		Pigeon Island (31)	0.84

Beach Site, Transportation Mode Choices

To value beaches (i.e. current access to sites), we must observe individuals trading an asset (like money or time) to get to a site and to get to sites with desired attributes. The trade-off between the asset and the access to the beach is then used to determine the value of the representative user of the beach. In this analysis, the aforementioned sample is examined to determine the influence of travel costs and travel time in the household's selection of beaches (see Appendix 3C for a brief description of the details of the statistical model). Beach characteristics that may be important in determining beach attendance were also collected. The variation in characteristics among the beaches makes the consideration of many beach characteristics impossible. Because there are a relatively small number of beaches sampled and the variation in the characteristics of the beaches is small, only a few beach characteristics can be considered.

The intercept survey data are considered within a simplified or stylized model of a household's behaviour. The household is assumed to use their time and income so as to maximize their utility, given their preferences. We use the simple behavioural model and

[6] We did see whether including Wyndham's Beach and Sandal's Beach had a noticeable effect on the results. Their inclusion did not change the results markedly.



our sample to estimate preferences. That is, the sample's behaviour reveals their preferences through the implicit trades made among items such as travel costs and beach characteristics. We can test whether the model can be rejected with the data. If it is not rejected, the estimated preferences are used with a simulation model to predict changes in household activity from changes in policies associated with beaches, beach access and even roads. At the core of the research is the behavioral model. We are not stating that every household behaves in this manner but rather that the model captures the major tendencies of households. A sequence of decisions is assumed to take place.

A representation of how a household makes a decision (i.e. a decision tree) is shown in Figure3.2. On a given day (call it a choice occasion), the household is presumed to decide whether or not they want to take an outing to one of sites in our study area. They assess what type of transportation is available to them (i.e. car, bus, or walking) and they choose a site and a mode to visit it. The decision could be considered as one site/mode choice but also could be considered sequential in nature, with the choice of the site conditioned on the mode of transportation available. While it is possible to estimate[7] a sequential model, we allow the travel mode and site choice to be jointly determined.

The household is considered to make one discrete choice each day on whether or not to go to a beach. The participation decision, as it is known, is not examined in this research.

[7] We have estimated sequential models and fond the combined site/mode model to be superior. For a discussion of comparison of different models, see Kling and Thompson, 199).

Once having decided to go on a trip, they then decide what site and what mode of transportation to use. This is also considered a discrete choice, with the fifteen choices in Figure 3.2 being mutually exclusive. That is, one beach/mode choice is made on a given day. We hypothesize that a person chooses a particular site/mode because the utility of that site/mode combination is larger than any other site/mode combination. The utility on which the choice is made is considered determined by certain factors, among which are the cost of traveling to a site using a particular mode and the characteristics of the site. The difference between the utility of the site/mode choices determines the probability that a household chooses a sit/mode combination.

For example, suppose a person is considering going to Vigie beach using a car and Pigeon Island walking. We would say that the utility of first combination (U(Vigie, car)) is greater than the second (U(Pigeon Island,walking) if they chose the first. We define utility as $U = \boldsymbol{a}\ gascost + \boldsymbol{b}\ beach\ length$. Then the likelihood that someone will choose Vigie/car is given *as (U1-U2)= **a** (gascost to Vigie-gascost to Pigeon Island)+ **b** (beach length of Vigie-beach length of Pigeon Island*). Because we know whether our sample chose Vigie by car or Pigeon Island walking on our interview day, we know the realized probability (0 if they chose Pigeon Island/walk or 1 if they chose Vigie/car).

The realized probability is correlated (using a logistic regression model) with the utility differences so as to obtain an estimated value of ***a*** and ***b.*** In this case, the estimated value of the coefficient on gas costs is the marginal utility of income (money). Once we have the estimated, we can predict the expected utility of different situations (say the existence of certain sites/mode combinations) and we can convert the expected utility into economic values using our estimate of the marginal value of income.

In estimating the model, we specify factors that are believed to influence the decision, paying attention to the ones for which the government and its policies are likely to affect. We have mentioned the cost of travel and the length of beaches. We also look at the travel time to access the various sites. In addition, we examine whether the ownership of a car influences the car mode choice.

Measuring monetary and time costs

The measurement of travel distance and travel time are central to the analysis of recreation demand because these estimates are used to generate the "price" of a trip and are an important part of measuring the marginal utility of income. Several different approaches are used to generate estimates of travel times and distances and in turn monetary and time costs. We will use the term "route" to describe jointly the time and distance of a recreational outing.

1.) Routes to and from an origin and destination may be characterized in a descriptive fashion, relying entirely on respondent perceptions to assign distance and time as well as monetary and time costs.

2.) Alternatively, route characteristics may be delineated using maps and/or "canned" packages that measure the distance and sometimes the time between two points in space.

The former method is troublesome, especially in cases of RUM applications, where route characteristics are assigned to a host of substitutes. For example, if numerous recreation alternatives are available, the descriptive approach requires asking respondents not only to describe the route they actually took but also the routes they would likely take if visiting the alternatives. Given the steep data requirements of RUM and other recreation demand applications, the latter method (using maps and/or "canned" packages) has evolved quite understandably as the convention.

The development of geographic information system (GIS) programs (e.g., ESRI's ARC/INFO Network Module) and the increasing availability of GIS data present a unique opportunity for researchers to obtain improved information regarding distances and time costs associated with travel. GIS-based information and programs make the details of travel accessible to researchers and allow for research to be conducted in geographic areas where "canned" programs are not available as of yet. GIS methods allow for the location and attributes of roads and other parts of the transportation network to be directly accessible to researchers, along with improved location information on origins and destinations. In addition, when describing a route of travel, GIS packages such as ESRI's ARC/INFO enable the combination of time and distance to be minimized rather than just time or distance to be minimized. Because of these advantages, ARC/INFO is used to estimate the distance and time costs of travel for St. Lucia.

Three sets of distance and time calculations are generated using ESRI's ARC/INFO GIS, where each set corresponds to one of three modes used by the respondents: car, bus, and walking. While different approaches were used to estimate these sets and tailor the measurement to mode characteristics, all approaches rely to some extent on information on the location of the origins (neighborhoods) and destinations (sites) and characteristics of the transportation network.

Based on the survey responses, we designated 11 sites and 122 household origins. Sites are mapped as points and tend to be located at a central point of access. Origins are also mapped as points and are approximately located at the centroids of neighborhoods. The location of neighborhoods and sites were checked against a variety of available paper maps. Distance and time calculations are generated for 3 modes between 11 sites and 122 neighborhoods (3 * 1342 = 4026). The distance and time calculations are the sum of three components generated by ARC/INFO. Essentially, routes are divided into three parts. The first involves travel from the neighborhood to the relevant transportation network. The second and most important/significant represent the travel along the transportation network. Finally, the third component involves travel from the transportation network to the site. The third component was necessary because some beach and recreation areas are located at a substantial distance from parking areas or bus stops.

The Network module of ESRI's ARC/INFO was used to determine the primary part of the optimal routes from each neighborhood to each site. This module utilizes information on a specified transportation network, where a network is comprised of numerous segments or arcs. GIS coverages of the major roads of St. Lucia were created using available GIS data and paper maps. The road network is used as the basis for the car mode estimates. We allow footpaths in addition to roads in the walking mode. The bus routes are considered the same as the car routes except the speed is halved.

ARC/INFO generates information on the time of travel by assigning travel speeds to segments of the transportation network (e.g., road segments). Speed of travel information was added to the road and bus network coverages using the following rules of thumb. Travel time by car was computed by assigning the major highways an average speed of 45 mph and the secondary routes an average speed of 30 mph.

With the least cost routes selected from each origin-destination combination, we computed the cost of travel. The intercept survey asked respondents how much it cost them to travel to the site from their home. The average cost to residents of St. Lucia was $EC3.02. The individual costs were regressed against the distance that determined. The coefficient on the distance variable was $EC 0.45/km.

Sample Observations and Beach/Mode Results

The original survey by the Department of Statistics contained 382 respondents. The number of residents of St Lucia within the total sample was 210. Fourteen respondents did not report their neighborhood. After eliminating the small beaches and neighborhoods outside of the Gros Islet and Castries quarters, the sample size was reduced to 154. There were 36 respondents who did not report trips taken in the six-month period, reducing the sample 118. Finally, we decided to use only those respondents who stated that they would have gone to another beach if the one at which they were interviewed was closed. This left 88 households in our sample.

The model was estimated using the LIMDEP program. The results are shown in Table 3.3. The large reduction in the sample size did not impose the dire consequence that concerned us. The coefficients associated with travel time and gasoline cost variables that were expected to negatively affect a household choosing a particular beach were both negative and statistically significant. The estimate marginal utility of income was -0.14/$EC and the marginal utility of travel time was –0.15/hour. The implicit value of time was $EC 1.07/hour that appeared quite low. However, no one in our final sample responded that anyone in their party could trade their time taken going to the beach for income.

The other two variables had the expected affect. Households were more likely to go to larger beaches. The implicit tradeoff between traveling cost and the length of the beach was $EC .01 per 100 feet of beach. Households were also more likely to choose the car mode of transportation if the household owned at least one car.

Table 3.3: The Results of the Random Utility Model for Beach Site/Mode Choices in the St. Lucia Study Area.

Site/Mode Choice Estimates				
Variable	**Coefficient**	**Std. Error**	**T-ratio**	**Prob |t|> Critical Value**
Travel time (hours)	-0.153	0.032	-4.767	.0000
Gas Cost ($EC)	-0.141	0.025	-5.527	.0000
Beach Length (m)	0.001	0.00007	14.558	.0000
Car mode with car owners	1.887	0.235	8.016	.0000

Number of observations	88
Iterations completed	58
Log-L for Choice model =	-169.5633

R2=1-LogL/LogL*	No coefficients	Log-L fncn	R-sqrd	RsqAdj
		-238.30	.29	.29

The Number of Trips Decisions

There are not tractable and utility-theoretic methods to incorporate both the site/mode decision and the number of trips taken by the household[8]. However, it is clear that if we only allow household to adjust the behavior by changing where they go but not how often they go, we may be missing a large component of the human behavior of beach going. To address this problem, researchers have proposed and used a "linked" model. The discrete choice (in our case the beach site choice) is first estimated. With the results of that model, one can determine for each respondent an expected utility of going on a trip. The measure of expected utility is called the inclusive value. The inclusive value and other variables that might influence the number of trips that a household makes are then regressed against the number of household trips.

The intuition behind this approach is that the travel cost and time, as well as other factors influencing the site/mode choice, may also influence the number of trips people take. For example, households that reside far away from beaches will likely have a small inclusive value and, in all likelihood, take fewer trips to the beach. We use the previous analysis to compute inclusive values for our sample and use it to predict the number of trips taken by the household. In addition, we use the report relative income of the household and the number of children under 16 within the household.

[8] Phaneuf, Herriges, and Kling (1998) provide an excellent review of the various models that consider both a site/mode selection decision per choice occasion and the number of choice occasion decision.

It is critical to assure that we have a sample that is representative of households in the Gros Islet and Castries quarters. Because the intercept survey will contain households that are more likely to visit beaches, we use the telephone survey to estimate the trips model. The telephone survey was randomly executed and we can use the coefficients estimated in the RUM model from the intercept survey to develop our inclusive value. This is only possible because we asked the telephone respondents for their residence, the total number of trips taken to the study site, the mode of travel on a typical trip, and whether the household owned a car.

Table 3.4: The Results of the Number of Household Trips per Half Year

Dependent Variable: Number of Household Trips					
Variable	**Mean of Variable**	**Coefficient**	**Std. Error**	**T-ratio**	**Prob |t|> Critical Value**
Constant	1.00	1.342	0.214	6.258	0.000
Inclusive Value	3.711	0.172	0.050	3.426	0.001
Income, Well Below Average	0.011	-0.448	0.225	-1.993	0.046
Income, Below Average	0.182	0.058	0.113	0.513	0.608
Income, Average	0.102	0.402	0.094	4.268	0.000
Income, Above Average	0.409	0.052	0.091	0.564	0.573
# of Children less than 16	1.409	0.116	0.021	5.534	0.000
| Number of observations 134 | | Iterations completed 7 | | Log likelihood function -1319.482 | | Restricted log likelihood -1360.541 | | Chi-squared 82.11868					

The results of a truncated Poisson regression are reported in Table 3.4. The Poisson regression, discussed more technically in appendix 3D, takes account of the integer value of the trips variable whereas the truncated model accounts for the fact that no one can have less than one trip. The chi-squared statistic is highly significant and one can reject that all of the coefficients are zero.

The coefficient of the inclusive value has a positive sign is significantly different from zero at a high level of confidence. The coefficients on the income variable should be interpreted with respect to a household that responded that their

household income was well above average. The coefficient on the well below average income is -.1, indicating that the lowest income households took slightly less than one fewer beach trips in the study area than households in the highest income category. Except for the average income households, all other categories took a level not significantly different from the highest income households. The average income households took about one more trip.

The Value of Access to Beaches

The RUM model and linked models can serve as the basis for the economic assessment of various policy analyses and natural events. For example, the results could be used to determine the value of allowing free public access to specific beaches, an introduction of a new beach, or the cost of having to close a beach because of health reasons or oil spills. We develop values of access to the beaches in our study.

Because we have estimated a model that is not completely utility theoretic, we have chosen to report two values for compensating variation, one that acts as a lower bound (CV_1 equation (3C.4, appendix 3C) and another that is closer to an upper bound (CV_2, equation (3C.9).[9] In the former, the number of trips is not permitted to adjust to the policy change whereas the latter measure permits adjustment in the number of trips.

Losses from Closure of Beaches

As the first example of the model's potential for policy analysis, we consider the loss of access to each of the beaches. This could arise from a catastrophic natural event such a direct "hit" from a hurricane moving in an easterly direction, like Hurricane Lenny did in 1999, or from a large oil spill. Specifically, we eliminate from the feasible choice set for all modes the beach sites ranging from Vigie Beach to Pigeon Point.

The process of determining aggregate welfare estimates involves obtaining from the sample a representative household's estimated value and then expanding the sample mean to the population. This is accomplished by using the values in Tables 3.3 and 3.4 as well as the information available from the telephone survey.

To determine a "value", one needs two situations: a baseline and a hypothetical situation. We show the value of beaches in the study site in Table 3.5. They are obtained by developing a baseline utility (the status quo) and determining a new utility associated with eliminating a beach from the choice set of the individual. Two measures are shown, one in which the individual does not change their number of trips and one in which the individual can respond to the absence of a site by changing both where they go and how often they go.

[9]We have not included a third, an estimated change in consumer surplus (CCS). We really have not treated the number of trips to each site in our model and therefore the relevance of using it is questionable.

Table 3.4: Use Value[10] to St. Lucia Residents from Six-Month Free Access to Beach, 2000 (EC$ 000,000).

	Lower Bound Economic Loss			Upper Bound Economic Loss		
Beach	Total Loss	Castries Quarter	Gros Islet Quarter	Total Loss	Castries Quarter	Gros Islet Quarter
Vigie	2.695	2.548	0.147	3.371	1.233	0.288
Choc	0.580	0.520	0.060	0.664	0.217	0.121
Marisule	0.168	0.143	0.025	0.212	0.064	0.052
Reduit	0.254	0.203	0.051	0.327	0.092	0.097
Pigeon Island	0.229	0.163	.066	0.311	.078	0.116

One interesting feature of the table is the relative importance of Vigie Beach in the study area. Its availability over a six-month period generates nearly four times as much value as any of the other beaches. This stems from its closeness to the center of the population, Castries. The nearby substitutes for it are small and households seem to prefer close, large beaches. This flies in the face of the high visitation rate that Pigeon Island gets (Table 3.1) from our telephone survey. Our model does not apparently capture the characteristics that make Pigeon Island so popular. One of them could be the Jazz Festival that draws about 20% of the households in the population surveyed. However, the Jazz Festival could be held elsewhere and it is debatable whether the beaches at Pigeon Point are a major contributing factor to the event. This is something that can be addressed in the future.

Conclusions

The purpose of this Chapter was to develop theoretically sound estimates of recreational values for the beaches in the study area. It required developing a telephone and beach survey. The two were used in concert to provide information on use of the beaches, to estimate the preferences of residents toward the various beaches and to assess the economic value of access to the different beaches. These purposes have been achieved and now we speculate on how this information might be used in the future.

There is much qualitative information buried in the results. For instance, the average income household's takes the greatest number of trips, all else equal. The lowest income group takes the fewest. Higher income groups take more than the low income but less than the average income group. People also appear to consider both time and more when deciding on which beach to visit. The nearer beaches are normally preferred. One interesting result is the importance of Vigie Beach vis-à-vis the other beaches. Given that it is closest to the densely populated areas, some interest should be made in assuring that pollution does not spoil the waters. Illnesses transmitted by water-borne organisms can reduce the welfare of St. Lucians, without them necessarily knowing the source. The

[10] These estimates are currently based on a population estimate of 50,000 households in the Castries quarter and 10,000 in the Gros Islet quarter.

larger beaches also will be more attractive to the beach user. Partial loss of a beach is therefore important- the entire beach does not have to disappear before beach users are harmed.

The quantitative information is also important. Knowing that Vigie Beach generates over EC $2.5 million each 6 months provides some guidance regarding the economic importance of protecting it from erosion. An oil spill could also close beaches and one would like some information regarding the cost to users of the beach from having no access to it. Another interesting issue is how the time and money costs influence beach use. If new highways are opened or public transportation costs change, then there is a tool for projecting the change in beach use and the value of the change.

The Chapter should also be recognized for providing a baseline of use and economic value information on which future studies can use in designing surveys, studying changes in beach use, or just finding out what people are doing at the beaches. To this point, little was known about the how people used the beaches.

A final comment should be made regarding the values shown in Table 3.4 - they are based on a six-month interval. Sea level could conceivably rise so as to destroy these beaches forever. The value of their existence, even to users, should not be mistaken for a six-month value. They are assets and their continued existence will lead to these values (and more given the rising population) being generated well into the future. The present value of the stream of returns could easily raise the use value by fifty fold.

Appendix 3A: Intercept Survey

SURVEY OF BEACH USE

Date	D	D	M	M	Y	Y
Time			H	H	M	M
Beach						

Good day. I am …… , a representative of the Caribbean Planning for Global Climate Change programme. We are conducting a survey of beach visits in this area. We want to interview an adult (18 years old or greater) in your household that made the decision to come to this beach.

Question 1. Is your principal residence in St. Lucia?

Yes=1, Go to Question 2
No=2

Ques. 1.a. Are you on vacation?

Yes=1,No=2

Ques. 1.b. With how many people (including children) are you travelling?

Ques. 1.c. How did you reach St. Lucia? (Cruise ship=1,Air=2,Other=3)

Ques. 1.d. At what hotel, if any, are you staying? (We'll need a code)

Ques. 1.e. How many days do you intend to be in St. Lucia?

Ques. 1.f. How many days do you intend to visit this beach during this trip?

Ques. 1.g. Did you or will you visit any other beaches during your stay in St. Lucia?

Yes=1, No=2

Ques. 1.h. If yes, which beach (name only one) ?

Stop here for tourists

Question 2. How many people from your household accompanied you to the beach today?

Question 3. Could any of them have worked for wages today if they had not gone on this trip?

Yes=1,No=2

If no, go to question 4

Question 3a. If yes, how many?.

Question 3b. What would the average wage per hour be in EC dollars?

Under 5 (1)	5-10 (2)	10-15 (3)	15-20 (4)	20-25 (5)	25-30 (6)	over 30 (7)

Question 4. If this beach were not available for use today for some reason, what would you have done?

1=Gone to another beach, 2= Worked, 3=Stayed home, 4=Done another recreational activity, 5=other

Question 5. Is this the beach you/your family usually visit?

Yes=1,No=2

Question 6. How many trips did your household take (that is, at least one person from your household went) to beaches along the coast stretching from Pigeon Island to Vigie Beach from January 1 to June 30, 2001 ? The beaches and codes (.) are Vigie Beach (1), Sandals Beach (2), Waves Beach (3), Choc Beach (4), Marisule Beach (5), Wyndham's Beach (6), East Winds Beach (7), Windjammer Beach (8), Trouya Beach (9), Reduit Beach (10), Pigeon Island Beach (11)

	This Beach 6.11 (CODE)	Other Beach 6.21 (CODE)	Other Beach 6.31 (CODE)	Other Beach 6.41(CODE)
Number of times	6.12 (XXX)	6.22 (XXX)	6.32 (XXX)	6.42 (XXX)

Question 7. What about the period July 1 to December 31, 2000 ? The beaches and codes (.) are Vigie Beach (1), Sandals Beach (2), Waves Beach (3), Choc Beach (4), Marisule Beach (5), Wyndham's Beach (6), East Winds Beach (7), Windjammer Beach (8), Trouya Beach (9), Reduit Beach (10), Pigeon Island Beach (11)

	This Beach 7.11 (CODE)	Other Beach 7.21 (CODE)	Other Beach 7.31 (CODE)	Other Beach 7.41(CODE)
Number of times	7.12 (XXX)	7.22 (XXX)	7.32 (XXX)	7.42 (XXX)

Question 8: On **today's** trip, how did you travel to the beach? Method of transport (Bus=1, Car=2, Walk=3, Other=4)

Question 9. How much did it cost you to travel to this beach **today**?

Question 10. What activities have you done today or will you do **today** on this beach?

Sit on beach Y=1 N=2	Swim/wade Y=1 N=2	Supervise children Y=1 N=2	Exercise Y=1 N=2	Picnic Y=1 N=2
Meet friends Y=1 N=2	Ball games Y=1 N=2	Other games Y=1 N=2	Other ----------	Other ----------

Please supply the following personal details:

Question 11. How old are you?

under 18 (1)	18-25 (2)	25-35 (3)	35-45 (4)	45-55 (5)	55-65 (6)	over 65 (7)

Question 12. What is your sex ? (male=1, female=2)

Question 13. How many people live in your household?

Question 14. How many are children under 16 years of age?

Question 15. Does anyone in your household own a car? (Yes=1,No=2)

Question 16 Is there a telephone that is connected in the house where you live?

Yes=1,No=2

Question 17. Relative to an annual income of EC$12,000, would you consider your household income:

Well below it=1, Below it=2, About the same=3, Above it=4, Well above it=5

Question 18. Did you attend the Jazz Festival at Pigeon Island this year?	
1=yes	2=no

Question 19. Did you attend the Jazz Festival at Pigeon Island last year?	
1=yes	2=no

Please give your address:

District		Community	

Thank you for your co-operation.

Appendix 3B: The Telephone Survey

Telephone Survey Draft for ST. LUCIA

Interview ID_____ DD___MM___ YY____

INTRODUCTION

I am …….. , a representative of the Caribbean Planning for Adaptation to Global Climate Change Programme. We are interested in the use by residents of St. Lucia of beaches in the Castries-Gros Islet area. I wish to interview an adult in your household who makes decisions about going or not going to the beach

Question 1. Since January 1, 2000 have you visited a beach for recreational purposes along the coast stretching from Pigeon Island to Vigie Beach?	
1=yes, go to **Question** 3.	2=no, go **Question** 2.

Question 2. What are the reasons for not going:

1. Physically unable
2. Did not have time
3. Did not have an interest in the beach
4. Did not have transportation available
5. Too many tourists
6. Water not clean
7. Other

Go to **Question 7.**

We will now ask some questions about visits over the course of the year.

Question 3. What is your best estimate of the number of times that someone in your household visited a beach in this area between **January 1, 2000 and June 30, 2000**?

Question 3.1. On a **typical trip**, which beach did you go to? The beaches and codes (.) are Vigie Beach (1), Sandals Beach (2), Waves Beach (3), Choc Beach (4), Marisule Beach (5), Wyndham's Beach (6), East Winds Beach (7), Windjammer Beach (8), Trouya Beach (9), Reduit Beach (10), Pigeon Island Beach (11)

Question 3.2. [On a **typical trip** during this period], what mode of transportation did you use to get there?

1 Automobile
2 Bus
3 Walk
4 Other

Question 3.3. [On a **typical trip** during this period], would you combine this trip with other purposes such as shopping, visiting relatives or sightseeing?

1=yes	2=no

Question 3.4. [On a **typical trip** during this period], would you participate in

1. Water contact - swimming, wading, fishing yes=1, no=2
2. Picnicking- yes=1 no=2

Question 3.5 . How many persons from your household would likely go on the **typical trip**?

Question 4.0 What is your best estimate of the number of times that someone in your household visited a beach in this area between **during last year (July 1-December 31, 2000)?**

Question 4.1. [On a typical trip during this period**]**, which beach did you go to? The beaches and codes (.) are Vigie Beach (1), Sandals Beach (2), Waves Beach (3), Choc Beach (4), Marisule Beach (5), Wyndham's Beach (6), East Winds Beach (7), Windjammer Beach (8), Trouya Beach (9), Reduit Beach (10), Pigeon Island Beach (11)

Question 4.2. [On a **typical trip** during this period], what mode of transportation did you use to get there?

1 Automobile
2 Bus
3 Walk
4 Other

Question 4.3. [On a **typical trip** during this period], would you combine this trip with other purposes such as shopping, visiting relatives or sightseeing?

1=yes	2=no

Question 4.4. [On a **typical trip** during this period], would you participate in

1. Water contact - swimming, wading, fishing yes=1, no=2
2. Picnicking- yes=1 no=2

Question 4.5. How many persons from your household would likely go on the **typical trip**?

DEMOGRAPHICS

Question 5. How many people live in your immediate household?

Question 6. How many children 16 years old or under live in your household?

Question 7. Does anyone in your household own a car?

1=yes	2=no

Question 8. How long (in minutes) does it take you to walk to the public bus stop?

Question 9. Where do you live on the Island?

District	Community

Question 10. Relative to EC $12,000, would you consider your household income to be:

Well Below	
1=yes	2=no
Below	
1=yes	2=no
Average	
1=yes	2=no
Above	

1=yes	2=no

Well Above

1=yes	2=no

Question 11. Did you attend the Jazz Festival at Pigeon Island this year?

1=yes	2=no

Question 12. Did you attend the Jazz Festival at Pigeon Island last year?

1=yes	2=no

Thank you

Appendix 3C: The Formal Nested Multinomial Logit Model

Applied welfare measurement in a standard discrete choice setting is well known and has been used in many applications of the Random Utility Model (RUM) (see Domencich and McFadden, 1975; Manski and McFadden, 1981). To review, an individual is assumed to choose from S possible sites, where the set, S, is assumed known by the researcher. The individual is assumed to choose the feasible alternative that yields the highest utility. The random component arises because from the researcher's perspective there are some portions of the respondent's utility which are unobservable. Let the individual's indirect utility function for alternative j be represented by:

$$U_j(q_j, y - p_j, \varepsilon_j) = V_j(q_j, y - p_j) + \varepsilon_j. \quad \text{(3C.1)}$$

Note that the indirect utility function has two components: $V_j(q_j, y - p_j)$ represents the deterministic portion of the individual's indirect utility function (with vector of quality characteristics q_j, income y, and price of accessing the site p_j) and an error, ε_j, which is the unobservable portion of the individual's indirect utility function.

Therefore, for a given choice occasion, the individual will choose j if

$$V_j(q_j, y - p_j) + \varepsilon_j \geq V_k(q_k, y - p_k) + \varepsilon_k \ , \ \ j \in S, \forall k \in S. \quad \text{(3C.2)}$$

From the researcher's perspective, the probability that the i^{th} individual chooses alternative j can be written:

$$P_i(j) = \frac{e^{V_j(q_j, y - p_j)}}{\sum_{k \in S} e^{V_k(q_k, y - p_k)}} \quad \text{(3C.3)}$$

if the ε are distributed as type 1 extreme value. Assuming that the specification of the deterministic portion of the indirect function is linear in income, Hanemann (1982) shows that a measure of improvement in well being, the compensating variation (CV), of a parameter change from q^0 to q^1 can be written as

$$CV = \frac{\ln\left(\sum_{k \in S} e^{V_k\left(q_k^1, p_k\right)}\right) - \ln\left(\sum_{k \in S} e^{V_k\left(q_k^0, p_k\right)}\right)}{\beta_Y} \quad \text{(3C.4)}$$

where β_Y is the marginal utility of income, obtained from the response to monetary costs in the choice.

Because we are interested in the tree structure approach to the travel mode and site choice decision, the simple model must be modified. Using the above standard logit discrete choice model at the lowest level of the decision tree, we can write the conditional probability of an individual choosing site j given that the travel mode choice m was undertaken

$$(6C.5)\quad P(j \mid m) = \frac{\exp(V_j^m(q_j^m, p_j^m))}{\sum_{j \in J^m} \exp(V_j^m(q_j^m, p_j^m))}$$

If we specify a linear form for V(.), we can obtain the associated parameter vector **b** by maximizing the log of the likelihood function for this conditional branch of the decision tree as

$$\log(L) = \log\left[\prod_{i=1}^{I}\prod_{j \in J} P(j)^{d_{j,m}}\right]$$

where $d_{j,m}$=1 if alternative j,m was chosen and zero otherwise.

Using the results of this model, we can calculate the inclusive value for each of the travel mode strategies at the highest level of the tree,

$$(6C.6)\qquad I_m = \log[\sum_{b \in A^m} \exp(V_j^m(q_j^m, p_j^m))]\ ,$$

which can be thought of as the average utility for an individual choosing the branch m of the decision tree. The inclusive value essentially collapses all of the information of the lower branch of the tree and transforms them into a scalar utility value. Using the inclusive value, we can write the unconditional probability that we observe an individual choosing a site j and travel mode strategy m as

$$(6C.7)\qquad P(j,m) = \frac{\exp(\alpha x_m + (1-\sigma)I_m)}{\sum_m \exp(\alpha x_m + (1-\sigma)I_m)}\ ,$$

where σ is a scale parameter. Using the above probability statement, we can then obtain parameter estimates by maximizing the log of the likelihood function

$$(3C.8)\qquad \text{Log}(L) = \log\left[\prod_{i=1}^{I}\prod_{m} P(j,m)^{dj_{a,m}}\right]\ .$$

When estimating a nested logit with a model that allows trips to respond, we have taken the CV measure used by several authors before us (e.g. Parsons and Kealy, 1996) that is represented as:

$$(3C.9) \qquad CV = \{E(T_k^1)I_k^1 - E(T_k^0)I_k^0\}/\beta_\gamma$$

where E(.) is the expected number of trips for the k^{th} person with the j^{th} situation (I=0,1) and I_k^j is the inclusive value for the final stage for the for the k^{th} person with the j^{th} situation.

Appendix 3D: The Poisson Regression

The approach used here was originally proposed by Hanemann (1978) and further developed in Bockstael, Hanemann and Strand (1986). It creates an overall inclusive value for a trip (t) by combining the m individual inclusive values derived in (4) along with variables Z_m in the following way:

$$\hat{I} = log[\sum_{m=1}^{M} \alpha_m \left[exp(\gamma Z_m + \theta_m \hat{I}_m)\right]^{\theta_m} \quad (6D.1)$$

The inclusive value for an overall trip during a quarter is now comprised of elements at the lower and upper stage and summed over all sites. Clearly if a household is near many "good" beaches, this value will be higher than one for a household that is in the interior of the Island. The inclusive value can be used as a factor to predict the total number of trips (T_i), irrespective of location, taken by the i[th] individual:

$$T_i = h_i(\hat{I}_i, W_i) \quad (6D.2)$$

where W_i is a vector of other household factors that might affect demand for trips.

There are many different specifications that are possible for equation (3D.2). One would like a single expenditure function from which both the number of trips and the site selection could be derived. However, such a model requires an explicit corner solution model that is impossible to estimate given the large number of sites. We have chosen the repeated discrete choice model proposed by Hellerstein and Mendelsohn (1993). They show that a series of discrete site choices, as described above, occurring over a period of time due to random "shocks" or errors can asymptotically converge to a Poisson process. The most important assumption underlying the model is that the random shocks are independent. This precludes the traditional model of consumer choice where consumers have diminishing marginal utility to the consumption of a good. That is, one might expect that if a shock arose that lead to someone to take a trip today, the marginal utility of taking another trip in the near future would fall. The second trip would be valued less than the first one. Hence a random future shock of equal size to the first one would not cause them to take a trip. This would cause a dependency between "effective" shocks.
Ignoring considerations of diminishing marginal utility and assuming identical, independent randomness across time, we have that the probability that the i[th] household takes a positive number of trips (T_i) in a quarter is given by:

$$p(T_i) = \frac{exp(-\lambda_i)\lambda_i^{T_i}}{T_i!}$$

where λ_i is the mean number of trips and usually specified as an exponential function demand or , in our case, as:

$$\lambda_i = exp(\gamma \hat{I} + \delta W_i).$$

Because our sample is comprised of respondents who had taken at least one trip, the expected value of the Poisson (truncated at 1) is:

$$E[T_i] = e^{\gamma \hat{I} + \delta W}.$$

CHAPTER 4
TOTAL VALUES USING A DIRECT QUESTIONING METHOD: THE WATERLOO TEMPLE AND ASSOCIATED SITES

PROBLEM STATEMENT:

In many situations, the entire value of a resource does not arise from the use of it. There could be non-use as well as use values attributable to the object. If this is the case, examining the behavior or resource users, as was done in Chapters 2 and 3, will not obtain the total value. Because there are no other related markets when it comes to non-use value, other techniques must be used. The contingent valuation method (CVM), or conjoint analysis as it has become known in some circles, uses direct questioning of individuals in an attempt to reveal the non-use and total value of access or change in attribute of an object with non-use values.

Introduction

The Waterloo Temple and Cremation site is an important cultural and heritage site for the Hindu community in Trinidad and Tobago. The site is located on the Northern boundary of the study area (see Figure 1.4). Valuation of this site is crucial in this study due to several reasons. Firstly, the site can be considered as a "high risk" site as a result of climate change and associated sea level rise. This is due to the fact that the site is located out in the sea, about 300 feet from the mainland. Also, a significant component of the total value of the site could be nonuse value.

Due to the history of the site and its importance to the Hindu community in Trinidad and Tobago, the site is expected to have a significant preservation value. Secondly, as the site is used for religious activities, it is possible that the same household makes multiple trips in a year. This will significantly impact the use value as well. Finally, valuation of this site provides an opportunity to apply the contingent valuation method, which is not used in any other pilot countries.

Site Description

The temple is officially known as the Siewdass Sadhu Mandir and Recreation Park. To the right of the Mandir is the serene ambience of Brickfield and the Shore Bird Sanctuary. The abundant bird life in the area serves as a lively backdrop to the Mandir, The Isaac Yankarran Cremation Site, and Fishing Depot. It is the Mandir (the temple) and Cremation Site that are the focus of this study.

The Siewdass Sadhu Shiv Mandir

Siewdass Sadhu was born in India in 1903. He came to the island of Trinidad and Tobago in 1907. During his first journey back to India, through the battle torn Pacific Ocean of the First World War, he made a pact that he would dedicate a temple to the

Gods, upon his safe return to Trinidad. In fulfillment of his promise, Sadhu started the temple on land in 1947, but a dispute ensued between the state-owned Caroni Ltd. and Sadhu. In 1952, he was jailed for 14 days during which time the temple was demolished. Intent upon keeping his promise, Sadhu resorted to the sea, where he re-built the temple, single-handedly carrying each foundation stone on his bicycle to the water's edge. Regrettably, Sadhu died in 1970 without having completed the entire structure. It was not until 1994, to coincide with the first annual Indian Arrival Day Celebrations that the temple was rebuilt in tribute to its creator. Today, the temple stands as a reminder of one's man total commitment to his personal dharma or truth.

The temple site (100 metres in diameter) extends 300 feet out to the sea. To this day, Hindus from around the country come to the temple in order to worship, perform special pujas or prayers and conduct ceremonies such marriage. However, the temple's doors may not be open to the public at all times, as its opening is restricted to services and special functions, purely as a precautionary measure to protect this holy ground from the heavy traffic from sight seers. However, the walkway entrance is always open, thereby allowing patrons to perform their personal religious activities. On the other hand, Hindus and non-Hindus, locals and tourists alike also come to the site to visit this spectacular wonder in the sea. Residents of the nearby villages come especially to relax and unwind from the pressures of the everyday world, while their children play in the park, both groups enjoying the atmosphere of the surroundings.

The Isaac Yankarran Cremation Site

At this site, it is not uncommon to see families offering pujas for departed loved ones along the seashore on a daily basis. Flowers and food are offered to the ocean for the spirit's safe journey and protection, as the mortal body is cremated in a wooden pyre. Further, users of this cremation site consider it to be one of the best and most organized facilities of this kind in Trinidad.

From the forgoing descriptions of the site as well as the type of activities that take place, it is clear that both the temple and cremation site are of extreme cultural and spiritual significance to the people of Trinidad and Tobago. Although, one would say that the site is only important for the Hindu community, the fact that about half of the population of Trinidad and Tobago is of East Indian origin, of whom most are Hindus, would render the total value of the site significant. On the other hand, it is quite possible that non-Hindu population in Trinidad and Tobago also value the existence of the site, although they may not use it.

METHODOLOGY

Since the types of economic values and their estimation are explained elsewhere in this project, they will not be described in detail again here. However, it is important to identify what types of economic values are associated with this site. The following economic values can be identified for this site:

- Use value – arising from the use of the site for religious and spiritual activities
- Users nonuse value – users who are willing to pay to preserve the site
- Pure nonuse value – willingness to pay by nonusers of the site to preserve it.
- Existence value – willingness to pay by all users to preserve the site if they believe that it is in danger of being destroyed.

It is clear that within the context of project objectives it is the existence value that is most relevant. However, from an estimation point of view it may be difficult to discern these different values. For instance, according to Freedman, ***existence value*** is the willingness to pay to keep the resource above a threshold existence level. While this definition may suit resources such as endangered species, whether it is relevant in this case is questionable. In the estimation process, we have attempted to estimate willingness to pay by users, nonusers and potential users. In practice the distinction among these groups may not be as clear-cut as one would expect them to be. Therefore, an appropriate average the preservation of all these groups will be reported as the preservation value.

To obtain estimates of use and nonuse values, two surveys were administered. They are,

- An intercept survey of users
- A random telephone survey to obtain nonuse value as well as frequency of visitation.

The intercept survey, 250 questionnaires were (Appendix I) administered on site through face-to-face interviews with users (see Appendix I). The survey was done during the hours between 1pm and 7pm on Mondays to Saturdays, and 10am to 12pm on Sundays, over a period of 14 days between 19 February and March 9th, 2001. This time frame captured a period of high intensity use, encompassing the special Hindu event of Shri Vatri, a Sunday morning service.

The telephone survey was administered on a sample of 280 residents of Trinidad and Tobago. Telephone numbers were selected randomly from the directory by picking up one number from every other page. Since the "willingness to pay" question was designed as a referendum choice (where an amount is presented to the respondent and his/her (not) willingness to pay is recorded) the total sample size was divided into forty (40) sub-samples. Each respondent in a sub-sample was presented with a fixed amount. The amounts used in this study were 5, 10, 15, 20 25, 50 and 75. The survey was done between 8pm and 9:30pm on weekdays and between 3pm and 8pm on weekends, over the period beginning Monday, 19 February, 2001 and ending Tuesday, 13 March, 2001.

When implementing both on site and telephone surveys, all cautionary practices were observed to ensure data accuracy, quality and fidelity.

Descriptive Statistics

Intercept Survey

Some selected characteristics of the sample are presented in Table 4.1. Since there is more than one person accompanying the respondent, it is clear that visit to the site is a family affair. The average number of trips per year is close to 35 indicating the aggregate value of the site for a household could be fairly high. The average cost of travel is fairly low (less than US $3 per trip). This may be an indication that the visitors are mainly from surrounding villages. The average size of the household is an indication that the site is popular with large households.

Table 4.1: Intercept Sample

Variable	*Mean*	*Standard Deviation*
Number of people accompanying to the site	1.29	1.51
Cost of Travel (TT$)	15.08	12.99
Number of trips last year	34.37	69.99
Number of people in the household	4.59	2.05
Age of respondent	38.31	11.45

Over 92% of the respondents were Trinidadian. This is not surprising, as it is the indigenous East Indian population which primarily uses the site for religious and spiritual activities. The most popular mode of transportation was private car as indicated by 83% of the respondents and the same percentage of respondents indicated they own a car. Nearly 70% of the sample had an average income at or above the national average. This is an indication that the visitors to the site are fairly well off. About 65% of respondents were male.

Site seeing and religious activities were mentioned as their main activities by 54% and 40% of the respondents, respectively. About 38% could have or would have worked if they had not visited the site on that day. Therefore, for over one third of the respondents the opportunity cost of time is their wage rate. This is an indication of the importance of the visit to the site for these respondents. Respondents have made 1 to 4 visits to the temple within the last three months (of the interview date). The weighted-average of the visits within the last three months is about 2.2 visits. Extrapolating these visits gives about 9 visits for the whole year. This number contrasts significantly with the number of visits indicated directly in response to the question of "how many visits in the last year? (Table 4.1)." About 61% of the respondents have not visited any other temple within the last 3 months. The weighted-average of the visits made to other temples within the last three months is less than 1.

Telephone Survey

The objective of the telephone survey was to obtain an overall picture of the visitation pattern of the population of Trinidad and Tobago to the site. By taking a random telephone survey, it is expected that some of the inherent biases in the onsite survey will be revealed. Therefore, to obtain value estimates for the overall population, information of the telephone survey is more appropriate than the onsite survey.

In the telephone survey about 67% indicated that they have heard about the site. While only 22% have visited the site, 69% indicated that they hope to visit. According to 82% the site is of natural importance and 98% indicated that it has to be preserved for future generations. When asked whether they would like to contribute to preservation of the site, 72% answered in the affirmative.

As can be seen by comparing Tables 4.1 and 4.2, there is a significant difference between the number of trips taken in the previous year between the onsite sample and the telephone sample. This clearly shows the bias that is in an intercept survey as opposed to a random survey. Since we are more likely to survey more frequent users in an intercept survey, it is not surprising that they indicate a high number of visits. However, for benefit estimation in a national context, the appropriate number of trips per household should be from the telephone survey. There appears to be no significant difference in the cost per trip between the two samples, especially in conjunction with the large standard error of the onsite sample.

Table 4.2: Telephone Sample

Variable	***Mean***	***Standard Deviation***
Number of people accompanying to the site	1.29	1.51
Cost of Travel (TT$)	11.81	5.18
Number of trips last year	3.12	4.65
Number of people in the household	3.20	4.67
Age of respondent	44.18	11.30

Estimation of Benefits of the Temple

From the surveys it is apparent that the temple has a user value for those who use it for religious and cultural purposes and a nonuse value (a preservation value) for those who see it as an important cultural/heritage site of Trinidad and Tobago. Therefore, the total value of the site is the combination of these two values. Also as mentioned earlier, the definition of nonuse value could differ. For the purpose of this study, three sources of nonuse values are identified. They are,

- Nonuse value of those who have visited the site (they may or may not return).
- Nonuse value of those who have heard about the site and hope to visit.
- Nonuse value of those who have heard about the site but do not intend to visit.

All these three groups were identified in the survey and information about their willingness to pay for the preservation of the temple was elicited (see the Appendix for the questionnaire). To estimate the expected willingness to pay, the following Logit model was estimated.

The logit model is popular in modeling the response of a discrete dependent variable. The dependent variable is expressed as a [0,1] variable representing the binary choice that can be made in the choice. The dependent variables are those variable that are hypothesized to influence the decision. The functional form of the Logit model is given below.

$$Log(Z_i) = \frac{1}{1+e^{-(\alpha+\beta X_i)}}$$

where, $Z_i = \frac{p_i}{1-p_i}$ and p_i is the probability that an individual make a certain choice given X. In the context of the problem under investigation, p_i is the probability of giving a positive response for the amount presented (as his willingness to pay) to individual i and X is the amount. However, X is in fact is a vector of variables, which include the amount, presented to the individual. As the respondent is required to give either a "yes" or "no" answer to the amount presented, in the empirical estimation the dependent variable is recorded as a 0, 1 variable where a 1 is coded for a "yes" response.

Visitation Patterns

The telephone survey revealed the visitation patterns of the respondents. About 9% (22) of the sample has not visited the site and does not hope to visit. Close to 22% (53) has visited the site while 69% (170) has not visited the site yet, but hope to visit. Therefore, it appears that about 22% of the population has a use value as well as potentially a nonuse value. Less than 10% potentially has a pure nonuse value and the rest has an option value (which is the expected consumer surplus). From a theoretical point of view the difference between the preservation value of potential users and the consumer surplus of users should reflect the risk premium that they are willing to pay to preserve the site to keep the option open to use the site in the future. Therefore, one should expect the preservation value of the potential users to be larger than the use value of the current users of the site. Table 4.3 gives the estimated coefficients of the models.

Only two of the pure nonusers responded positively to the stated amount. Therefore, there appears to be no significant pure nonuse value. As apparent from the estimated coefficients in Table 4.3, the amount has the expected negative sign and is highly significant in the models for current and potential users. Age has a negative coefficient implying that the probability of agreeing to pay the stated amount decreases with age. Although, education has a negative coefficient in the first and third models, it is not

significant even at the 10% level. It is highly significant and positive in the "hope to visit" category. More educated respondents can be expected to have a higher valuation of a site such as this site. However, the coefficient of the mode of transport variable (coded as 1 if use a car and 0 otherwise) is unexpectedly has a negative sign in his model. In the other model, mode of transport variable could not be included due to perfect collinearity with the constant term (for all respondents in these two models mode of transport is car).

Table 4.3. Estimates of Logit Model of WTP to Preserve the Temple

	Visited Site	Hope to Visit	Will not Visit
Constant	0.9801	0.7987	-
Amount	-0.0173**	-0.0098**	-
Age	-0.0284*	-0.0382*	-
Education	-0.1453	0.5316**	-
Transport (Car=1)	-	-3.9819**	-
E(WTP) in TT$	57.80	102.04	-

** significantly different from zero at least at 1% *significantly different from zero

between 10% and 5%. E(WTP) is estimated using the formula E(WTP) = - 1/X where X is the coefficient of the amount variable.

The "hope to visit" category has the highest E(WTP). This group has an expected consumer surplus as well as a option price as they hope to visit the site in the future. The user's nonuse value is the lowest as expected. Pure nonuse value (WTP by those who don't intend to visit the site) is close to that of users. This group does not have an expected consumer surplus.

Use Value

Use value is generated due to the fact that people visit the site from all over Trinidad and Tobago for religious, cultural and recreational purposes. Since a visit (come to the site and get back home) costs money and time, the value of the site can be derived through the demand for travel to the site. Therefore, the travel cost method can be potentially applied to estimate the use value of the site.

The discrepancy between the average of visits of the respondents surveyed onsite as compared to those who were interviewed over the phone was addressed earlier. It is obvious that an onsite survey would sample more frequent visitors as compared to a national telephone survey and therefore is subject to an inherent bias. Further investigation of the onsite sample revealed that those who are from the vicinity of the site make a substantially greater number of visits than those who come from further away. Since each respondent indicated the village/area where he/she is living, it was possible to identify the closest locations to the temple. Five major towns/areas were identified as closest to the temple. They are, Waterloo, Chauganas, Couva, Carapinchaima and

Freeport. The number of trips and cost per trip of these five areas (together) and rest of the island is presented in Table 4.4.

Table 4.4: Comparison of Number of Trips and Cost per Trip				
Area	Number of Trips		Cost of a Trip	
	Mean	Std. error	Mean	Std. error
Waterloo, Chauganas, Couva, Carapinchaima and Freeport	9.76	4.54	8.56	7.06
Rest of the Island	7.55	5.16	21.36	14.40

From Table 4.4 it is clear that those who are in the surrounding villages make about two more visits as compared to those from the rest of the island. Their average travel cost is also significantly less as compared to those from rest of the island. Differences in the number of trips and travel cost are significantly different at a significance level of 99%.

To estimate the demand for travel to the site the travel cost model was estimated. The survey collected information on the number of trips made in the last year and last three months, number of other (substitute) site, cost of travel, opportunity cost and other socio-economic variables. The estimated model is presented in Table 4.5.

Respondents were asked to give the total number of trips taken during the last year as well as the number of trips during the last three months. The total number of trips obtained by multiplying the number of trips within the last three months by 4 was significantly lower than the total number of trips given for the last year. Since it is more

Table 4. 5: Travel Cost Model			
Variable	**OLS Estimates**	**Tobit Estimates**	**Mean**
Constant	18.9369**	14.7705**	
Number of Trips	-0.3076**	-0.3732**	8.68
No. of Visits to Other Sites	-0.2655**	-0.3572**	16.13
Transport (Car =1)	5.7653**	11.6667**	0.83
Location Indicator	-11.0250**	-12.3459**	0.50
# of People Accompanying	0.8663*	1.0222**	1.29
Household Size	0.5033	0.6146*	4.59
Opportunity cost	0.0043	0.0049*	97.36
Adj. R^2	0.3146		
No. of Observations	252	252	

** significant at 95% level. * significant at 90% level.

likely that the respondents will remember the trips taken within the last three months more accurately, the number of trips within the last three months multiplied by 4 was use in the model. The number of visits to other sites was also determined in a similar manner.

Although, theoretically the dependent variable should be the number of trips, estimation can also be done in the inverse from that is, with cost of a trip as the dependent variable. In travel cost model, it is important to include the trips to other sites as an explanatory variable. Otherwise, the model will suffer from the excluded relevant variable bias. When the model is estimated as number of trips as the dependent variable, cost of travel to the substitute site (which is usually identified as the next best site) is included as a explanatory variable. However, in this study one such site could not be identified. The only measure of substitute sites available was the total number of trips to other site. Because of this reason it is necessary to use cost per trip as the dependent variable and number of trips to the temple as well as total number of trips to other sites as explanatory variables. Estimation in the inverse form also provided a better fit (produces coefficients that are more significant). Also, calculation of welfare estimates is easier with this specification as now the cost is on the Y-axis. However, with this specification interpretation of coefficients of independent variables becomes somewhat difficult, as marginal effects cannot be interpreted within the standard cause-effect relationship.

As mentioned earlier, the number of trips given for last year did not match with the number of trips within the last three months multiplied by four. Total number of trips given for the last year was significantly higher and also had a larger variance. Therefore, for the number of trips to the sites as well as to other sites was taken to be the number of trips within the last three months multiplied by four. However, we are mindful of the fact that the number of trips within the last three months may not reflect visitation patterns for all months. Especially during festival seasons there may be higher number of trips. However, we believe total number of trips for the year is unrealistically high.

An indicator variable was included to identify the method of transport. As about 83% of the respondents traveled by car (this about the same percentage that owned a car) this indicator variable was defined as 1 if the method of transport is private car and 0 otherwise.

As indicated in Table 4.4, respondents from Waterloo, Chauganas, Couva, Carapinchaima and Freeport, the towns and villages closer to the site made significantly higher number of trips as compared to those from other areas of the island. Therefore, another indicator variable was included to identify respondents from these areas (defined as 1 if the respondent from any of these areas and 0 otherwise).

Opportunity cost represents the foregone income that respondents mentioned they could have earned during the time they spent on visiting the site. This is only relevant for the people who indicated that they could have worked during that time.

The sign of the coefficient of the number of trips is negative indicating the expected inverse relationship between the price of a trip and the number of trips. All coefficients are significant at least at 10% level.
The net benefits for those who use the site were calculated at the mean value of all other variables. The mean value for each variable and multiplied by the corresponding regression coefficient (except for number of trips) yields the following equation for cost of a trip as a function of the number of trips.

Marginal value of a trip= Marginal Cost of a trip = 17.14 – 0.3732 * Trips

To demonstrate how benefits are estimated, the equation is graphed in Figure 4.2.

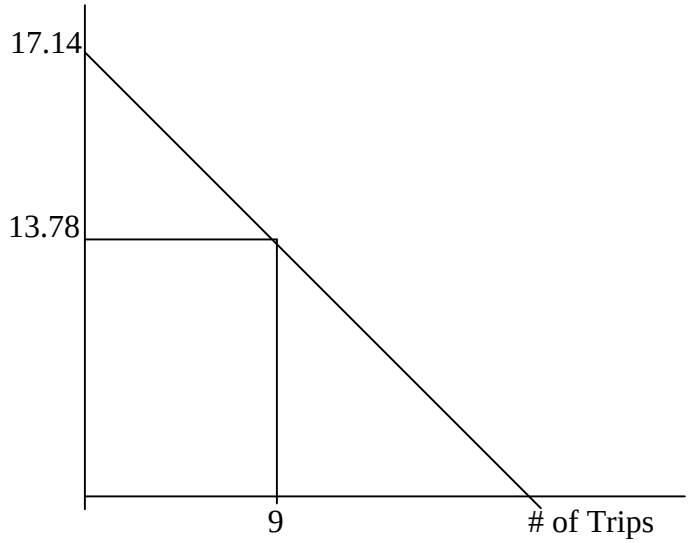


Figure 4.2: Demand Curve and Consumer Surplus Demonstration

If we approximate the average number of trips to be 9 for the whole sample (Table 5) then according the above equation, this many trips are taken when the cost of a trip is $13.78. Therefore, as explained in the methodology section, the consumer surplus (the triangular area above the price line ($13.78) and below the demand function) at this average number of trips is calculated as follows.

$$CS = \frac{(17.14 - 13.78) * 9}{2} = \$15.11$$

The interpretation of this consumer surplus (net benefit or net willingness to pay) is that the visitors to the site are willing to pay $15.11 over and above the actual cost of 9 trips (which is 9 x 13.78 = $124.02).

Since the number of trips between the five combined areas and rest of the island are significantly different, it is appropriate to estimate total benefits by area. When the number of trips are rounded-off to nearest whole value, we get 10 trips per year for

Waterloo, Chauganas, Couva, Carapinchaima and Freeport and 8 trips per year for rest of the island. Total economic benefits of 10 and 8 trips can be calculated as above.

For 10 trips total benefits are

$$CS = \frac{(17.14 - 13.41) * 10}{2} = \$18.66$$

For 8 trips total benefits are

$$CS = \frac{(17.14 - 14.15) * 8}{2} = \$11.94$$

Table 4.6: Comparison of Number of Trips and Cost per Trip		
Area	Zone 1	Zone 2
Average Number of trips	10	8
Total benefit of trips (per household)	$18.66	$11.94
% of those in the telephone sample who have visited the site	64%	14%
Population	26365	1075731
Number of Households (@ 4 persons per household)	659	268933
Total benefits to the area	$12297	$3,211,060

Nonuse Value

Table 4.6 gives the estimated willingness to pay by those who have visited the site and those who hope to visit. Out of the potential 269,628 households, 22% have visited the site (see Telephone Survey). The question that was asked from the households in the telephone survey is their willingness to pay to preserve the site. Since they are active users, to obtain the "pure" preservation value, use value should be subtracted from the this willingness to pay. On the assumption that those who intend to use the site in the future will have the same use value their "pure" preservation value could be obtained in a similar manner. These calculations are presented in Table 4.7.

Although it is possible to calculate the preservation value of those who are potential visitors, it is difficult to give credence to such estimates. Since these households have not yet seen the site or experienced its use, they may not be able to form a credible estimate of their willingness to pay. Therefore, to be conservative we are considering only the use value and nonuse value of those who have actually visited the site. As there is evidence to indicate that those who have visited to the site are likely to visit again in the future, their use and nonuse values can be considered credible.

Table 4.7: Nonuse Value		
	Region 1	Region 2
Type of Household –Visited Site		
I. Total WTP (Table 3)	57.80	57.80
II. Use Value (Table 4)	18.66	11.94
III. "Pure" Nonuse Value (I – II)	39.14	45.86
IV. % Visited	65%	14%
V. Number of Households	659	268,933
VI. Total Nonuse Value (III x IV x V)	16766	1,726,657
Type of Household – Hope to Visit		
I. Total WTP	102.04	102.04
II. Use Value	18.66	11.94
III. "Pure" Nonuse Value	83.38	90.10
IV. % Hope to Visit	35%	76%
V. Number of Households	659	268,933
VI. Total Nonuse Value	19,232	18,415,456

Overall estimates of the use and nonuse values of the site are given in Table 4.6.

Table 4.8		
Total Economic Value of the Site		
Type of Value	Region 1	Region 2
Use Value	12,297	3,211,060
Nonuse Value	16,766	1,726,657
Total	29,063	4,937,780

The total economic value therefore is nearly TT $5 million (taking into account only the current users). Based on the current exchange rate of about TT $6 to US $1, the total estimated annual economic value is about US $827,797.

Limitations

In conducting the surveys, the following problems were encountered.

- When using the telephone directory to acquire a random list of telephone numbers to be used for the telephone survey, there is a bias of excluding those residents whose telephone numbers are unlisted in the telephone book. This personal choice by the residents may have caused the exclusion of a certain economic and socio-cultural group

in the society from the entire original list, from which the telephone numbers were chosen. The alternative of attaining a random computerized listing from the telephone company was too timely and still would not have solved the bias occurring as a result of using the telephone directory.

- The weather constraint on certain days. This presented on site surveys from being conducted due to heavy rainfall, thus extending the time frame for the study.

- Further, due to the time of year in Trinidad and Tobago, more so, the Carnival season, there was a temporary suspension in performing both the telephone and on site surveys. The telephone survey was suspended from Thursday, 22 February, 2001 to Wednesday, 28 February, 2001 and the latter, suspended from Friday, 23 February, 2001 to Tuesday, 27 February, 2001. On the other hand, it is to be noted that the Carnival season also encouraged high visitor on site use for periods before and especially after the Carnival weekend itself.

- Lastly, while conducting the telephone survey, it was observed that most of the respondents were very hesitant, uncomfortable and unwilling to disclose information about their household income

Conclusions and Implications

One of the main criticisms against nonuse values and in fact the CVM method, is that these values do not reflect actual willingness-to-pay. Since WTP by individuals is rarely actually collected, it is generally not known whether they would actually pay, if they were asked to pay their stated WTP. This is one of the fundamental and early criticisms against CVM. Therefore, in resource management decisions it is not uncommon to skeptical about nonuse values, particularly in developing countries.

Provided that we have correctly estimated the nonuse value of the temple and associated sites, is this value of any relevance to resource management in Trinidad and Tobago? The Government of Trinidad and Tobago is the trustee for the national wealth of the country on behalf of its people. When there are direct users of a resource, it is not difficult to determine its value. However, when there are non-users who still may value the resource, such as the temple and associated sites investigated in this study, the value has to be elicited directly from the population. But how much weight should be given to such values? If the government is the trustee on behalf of the people of the country, then the total value of the temple reflects its worth to the nation. Therefore, it may be justified to use public funds, if necessary, to protect the temple regardless whether the users and nonusers pay directly.

The temple and associated sites have a significant use and nonuse value. Understandably, both the use and nonuse values primarily accrued to residents of surrounding villages (region 1). The limited number of households in these villages makes the total value

small. However, nonuse value in particular is important to all in Trinidad and Tobago as the temple is considered a national cultural icon. Even with the relatively low percentage of people who have visited the temple outside the surrounding villages, their nonuse value is nearly TT $2 million a year. When one considers the nonuse value of those who plan to visit the temple in the future, the total nonuse value is fairly substantial.

How can the values derived here be used for efficient management of this important site? First, it has to be noted that the value presented here is only for a year. It is likely, that if the temple is properly protected (for example, from climate change effects) it will continue to exist for many years. Considering an infinite time horizon and a discount rate of 10%, TT$5 million has about a TT$50 present value. This is considering that fact that a $5 million value per year will continue to exist infinitely into the future. However, it is likely that value will continue to increase (in constant prices) as the temple gets older (giving it more historic value) and as the population in Trinidad and Tobago gets larger and more affluent (aggregate WTP gets larger). On the other hand, expenses involved in protecting the temple will probably be only a one-time expense in a current period. Even without a proper cost-benefit analysis, it is safe to say that the benefits of preservation of the temple are very likely to exceed costs.

To frame the preservation decision in the context of climate change we can look at the options available to protect the temple. The fact that the temple is an off shore structure makes it extremely vulnerable to climate change. There are basically two options to protect the temple. It can be relocated to a safer site. In this case the cost of climate change would be the relocation cost provided that the users and nonusers of the temple consider the relocated temple an exact substitute for the current one. Also, preventive measures could be taken to protect the temple from anticipated effects of climate change. Due to the fact that the temple is a fairly small structure and the shallowness of the surrounding sea, use of defensive structures may be the more cost efficient option.

Although, not specifically an objective of this report, we outline some measures that could be used to recover cost of protection of the temple. Since this is a religious site it would not be appropriate to charge a user fee, especially given the cultural background of the users. However, it is more than likely that the users will make voluntary contributions to an NGO set up to protect the temple. It would be necessary to educate users of the perils that the temple faces if not protected from elements. People are more likely to contribute to a fund when they know that the proceeds will be used directly for the purpose and if there is minimum bureaucracy involved in the process. There are precedents in the Caribbean where such organizations have been successful in raising funds from the general public. The case of "Friends of Saba Marine Park" NGO and "Cruesto Society" in Trinidad and Tobago itself are two examples. A major drawback of this approach is that it would not be possible to determine beforehand how much will be actually collected as would be possible with user fees.

Appendix 4A: Telephone Survey

May I speak to the head of the house?

"I am conducting this survey on behalf of the Global Climate Change Project, which is sanctioned by the Ministry of the Environment. As you may be aware most coastal resources and structures are under threat of being destroyed due to effects of climate change and associated sea level rise. Some of these are structures and sites that are of cultural and religious importance to the citizens of Trinidad and Tobago."

(give a brief description of the Temple)

I. Have you heard about the ……. Temple in Waterloo Village? YES NO

II. Have you visited this temple? YES NO

III. Do you intend to visit this temple for religious and/or recreational purposes? YES NO

IV. In your opinion is this temple an important national/cultural site in Trinidad and Tobago? YES NO

V. Do you think this site should be preserved for future generations? YES NO

"*Due to the location and the proximity of this temple to the sea, it is in danger of being destroyed due to sea-level rise, hurricanes and other adverse climatic conditions that may be caused by global climate change. It is unlikely that the government will be able to give priority in preserving this temple from such damage given the other important priorities of the government. If a private organization was established to preserve and protect this temple and if such an organization was funded completely by private donations, would you be willing to contribute*?"

YES NO

VI. If yes, would you contribute $5 a year? YES NO

VII. For how many years would you continue to contribute this amount? ----- YRS.

The following questions are primarily for research purposes to estimate the validity of our over all results. They will not be given out to anyone outside the research team or will not be connected to any individual.

1. What is your age? ---- YRS
2. What is the highest educational level that you have attained?
    a. No formal education
    b. Primary education
    c. Secondary education.
    d. University education (Undergraduate degree).
    e. Graduate degree.
    f. Vocational training
3. What is your household's gross monthly income? $ ----------
4. In which area do you live?

CHAPTER 5
USING RELATED MARKETS TO VALUE WETLANDS IN ORANGE VALLEY, TRINIDAD

PROBLEM STATEMENT:

There are numerous instances in which the researcher is interested in valuing access to an object or attributes of an object but does not have sufficient data or sufficient funds to complete one of the methods outlined above. One approach in these instances is to use the benefits transfer method. Although one could use values from resources with similar characteristics, we have chosen to use a portion of one study and apply it within the analysis of a nearly complete analysis.

Coastal wetlands are an important resource lying at the interface between the islands and the sea. Their value is in part attributable to the nutrients and shelter that they provide fisheries resources. We use the value of fisheries dependent of the wetlands to develop a partial value for them. In the process of developing the value, we draw on research associated with wetland loss in Mexico.

Introduction

One of the indirect uses of the wetlands is its contribution to the commercial shrimp fishery in the nearby sea. According to the Ministry of Fisheries, the wetlands serve as a nursery and sanctuary for juvenile shrimp larvae. Mature shrimp migrate into the open sea where fishermen catch them.

This dependency between wetlands and the catch of fish and shrimp in the nearby open sea is well documented in the case of tropical wetlands. There are numerous biological studies documenting this dependency. Quantifying the relationship however is not straightforward, as both the quantity and quality of the wetland as well as many other environmental factors are crucial in determining the relationship.

Due to the inability to model the ecological relationship, quantifying the benefits of the wetlands in terms of fish/shrimp catch in the open sea is also difficult. The way most economic studies have attempted to capture this dependency is by having the area of the wetland as an explanatory variable in explaining the yield of fish or shrimp. However, for such a model to be developed, a considerable data series on fish catch, fishing effort and the area of the wetland is necessary. Also, the area of the wetland should have changed within the time period. If there has been a change in the quality of the wetland as well as other relevant environmental factors, then measurements of those variables are also necessary to obtain the “pure” effect of wetland area on the fish catch. Generally such detailed information is not available, particularly in developing countries.

Wetland area and shrimp catch in the Study Area

It is well documented that shrimp larvae hatch and grow in coastal wetlands before they migrate to sea. The same cannot be said for other fish types. As a result of these facts, at a meeting with country team, representatives of the Ministry of Fisheries indicated that it is the shrimp yield that is more likely to be dependent on wetlands. Therefore, only the shrimp catch data was used to estimate the indirect value of wetlands. In ecological terms, shrimp was seen as a good indicator of the quality of the wetland.

The most up-to-date data available for the study area is the shrimp (and some other types of fish) catch for the Orange Valley Beach (see map) from 1995 to 1999. For these five years, the catch in kilograms, the number of trips, value and type of shrimp (large and medium) is available on a monthly basis, though not for all the months for all five years. Unfortunately however, the area of the wetland is not available for any of the five years. According to the Ministry of Agriculture, there has been no significant change in the wetland area during these five years. Although, there may have been changes in the quality of the wetland, there are no measurements on any quality variables or other environmental factors. Therefore, what can be done is to value the shrimp fishery in Orange Valley Beach landing site and investigate to which extent the value has changed (if in fact it has) within the five years.

The key variables of the shrimp fishery are described in Table 5.1. It is apparent that the monthly average of catch per trip is on the decline from 1995. This is typical of many fisheries that are over-fished or that have been affected by continuous environmental degradation. In the case of this fishery, it appears that the reason for decline in the catch per trip is most probably environmental factors (such as the health of the wetland) rather than over-fishing. This can be said because the average number of trips per month has virtually remained unchanged, except for a decline in 1996. Accordingly, the price of shrimp shows an upward trend. This could be due to general price inflation as well as due to reduced supply.

Table 5.1. Key Variables of the Orange Valley Beach Fishery

Year	Catch (kg)	Value ($)	Trips	Price($/kg)	Catch/Trip	Revenue/trip
1995	7769.45 (5277.87)	150086.49 (95769.62)	197.82 (75.88)	21.90 (8.47)	37.90 (17.00)	830
1996	3056.87 (1246.50)	69396.86 (32221.68)	156.13 (43.00)	24.98 (12.17)	24.73 (30.26)	717
1997	4697.28 (1049.32)	111043.53 (54107.34)	186.58 (19.84)	24.59 (12.26)	25.27 (5.37)	621
1998	4063.93 (915.56)	129491.34 (69779.96)	187.00 (9.06)	34.54 (21.72)	21.71 (4.62)	750
1999	4554.14 (3371.32)	152012.41 (98473.83)	193.36 (59.88)	35.74 (12.84)	22.15 (11.71)	792

Values are monthly average for the year for both types of shrimp. Standard errors are in parenthesis

Shrimp Production Function

One model that has been widely used in fisheries to model the yield is the surplus production function. The model estimates catch per trip as a function of number of trips.

$$\frac{C}{T} = a + bT$$

Where C is the total catch and T is the number of trips. This is the average product function. It is estimated by regressing catch per trip against the number of trips. For most mature fisheries, the sign of b is negative. The total production function is derived from the average production function by multiplying through by T (number of trips). This will yield the following total production function.

$$C = aT + bT^2$$

Environmental factors that are hypothesized to affect fish catch can be included in this production function as explanatory variables. For example, on the assumption of a linear relationship between the shrimp catch and the wetland area (WA), it could be included as an additional explanatory variable as follows.

$$C = aT + bT^2 + cWA$$

The marginal effect of the wetland area can be determined by taking the derivative of catch with respect to WA.

$$\frac{\partial C}{\partial WA} = c$$

Therefore, the level to which the shrimp harvest change due to a marginal change in the wetland area is given by c. As hypothesized, one would expect c to be positive.

If this function is graphed, it will be a parabola as given in Figure 5.1. The production function can be easily converted to the total value function by multiplying the production (catch) by the price of product ($/kg). Since the price is taken to be a constant, the shape of the function remains unchanged while it is now a function between trips and value of catch ($). The curve in the solid line could represent the initial production function. The straight line with a positive slope represents the total cost (TC) of fishing, which is the product of cost per trip (w) and the number of trips.

$$TC = wT$$

If the fishery is open access (as in the case of this fishery), fishing will take place up to the point where total cost is equal to total revenue. At this point each fisherman will be "breaking even," that is, they are not making a profit. Since the total revenue is the production function itself, the number of trips under open access is where the total cost and total revenue intersect (points x and y).

Another important location of the production function is its highest point. This is known as the Maximum Sustainable Yield (MSY), that is, it is the maximum yield that can be harvested from this fishery in a sustainable manner (without reducing the parent stock). Although, this point has little economic significance, it is an important biological concept as it is an indication of the "health" of the fishery. In a healthy and productive fishery one would expect the maximum point of the production function to be as high as possible and as much as possible to the right. This means at MSY, the catch will be larger and the fishery will support a higher level of fishing effort (fishing trips).

The broken line can be thought of as a production function under adverse environmental condition. For example, if the shrimp fishery is dependent on the wetland area, then this could be the production of shrimp under reduced wetland area (as compared to the production function represented by the solid line). Now as the fishery is not as productive, at the maximum sustainable yield and the level of effort that can be supported at MSY, is less. Also, for the same cost of fishing now there will be a lower level of fishing effort under open access ($T_2 < T_1$).

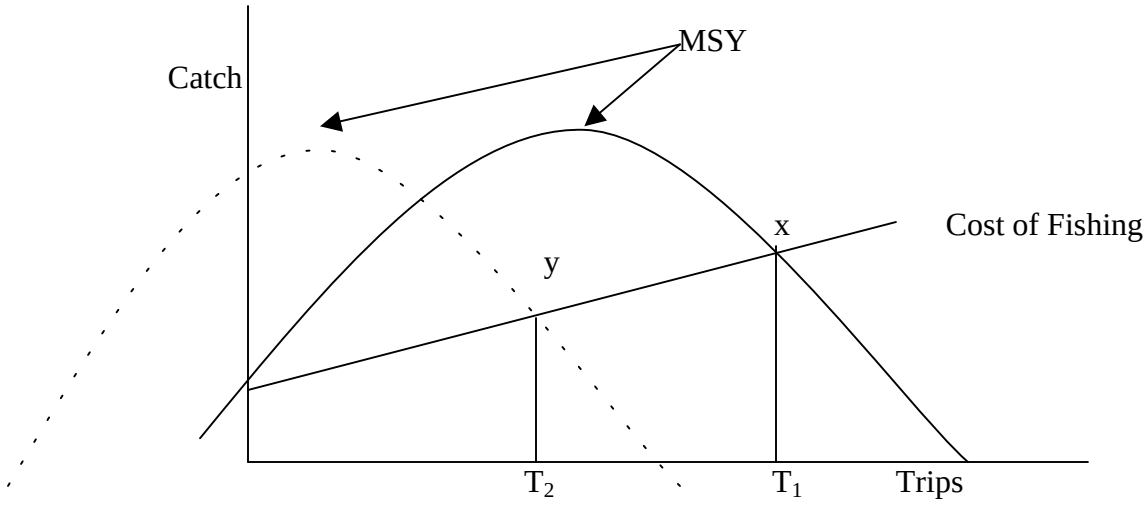


Figure 5.1. Shrimp Production Function

From Table 5.1 it is clear that the catch per trip has been decreasing from 1995. This implies that the production function has been contracting over the years. To examine whether it has also been shifting to the left, we estimated the production function for each of the five years using monthly catch effort data. Both types of shrimp were considered together primarily because lack of data for estimation on a yearly basis, but an indicator variable was used to identify the type of shrimp. Results are presented in Table 5.2.

Table 5.2. Shrimp Production Functions				
	Constant	Trips	Type	Trips at MSY (MSY)*
1995	46.6186 (18.1050)	-0.0758 (0.0725)	-3.2882 (10.3869)	296.67 (6671.19)
1996	30.1130 (6.9076)	-0.0519 (0.0401)	-6.2480 (2.6795)	260.01 (3506.27)
1997	42.6344 (9.6424)	-0.0917 (0.0527)	-0.5206 (1.1956)	231.05 (4895.22)
1998/99	46.9744 (16.8268)	-0.1595 (0.0954)	-11.8439 (1.5806)	121.27 (2635.47)

* MSY (in kg) was calculated by substituting the number of trips at MSY in to the production function.

The number of trips at MSY was determined by taking the first derivative of the production function and setting it equal to zero and then solving the equation for trips. This is because at the maximum point of the production function (at MSY) the slope is zero. As can be seen from Table 5.2, the number of trips at MSY has also been shifting to left. Also, MSY has been generally on a downward trend. This is evidence that the production function has been contracting as well as shifting to the left, indicating that the shrimp fishery has become progressively unproductive from 1995.

From Table 5.1 it is clear that revenue per trip has been on the decline since 1995, except of a small upsurge after 1997. This increase has been primarily due to a sharp increase in price of shrimp, probably caused by inflationary forces or due to increase in demand. Considering relatively high inflation rates in Trinidad, revenue in real terms is likely to be on the decline from 1995. Further evidence on the deterioration of the shrimp fishery is evident from Table 5.2. MSY has reduced by over 50% within 5 years.

On the assumption that this reduction in catch and effort is a result of degradation of the wetlands (in area and quality), the next step is to quantify this effect. However as mentioned earlier, it is not possible to establish the relationship between wetland and shrimp catch because we have no information on the wetland area and any other indicators of the condition of the wetland. Although, there has been no reduction in the area of the wetland according to the Ministry of Agriculture, wetland users who were surveyed indicated a reduction in the quantity and quality of the wetlands. Based on their subjective assessments, we estimated that there has been a yearly reduction in area of about 2.3% during the past 25 years (see direct value section). They also indicated a reduction in quality, primarily caused by industrial pollution. The extent of quality reduction, however, could not be quantified.

Any inferences on the effect of wetlands on the degradation of the shrimp fishery has to be based on circumstantial evidence on the reduction in the area and quality and scientific evidence on the dependency between wetlands and development of shrimp. However, it is still not possible to separate the effects of wetland quantity (area) and quality on the shrimp catch. As far as climate change is concerned, this separation may not be important. Climate change is expected to affect both the quality (such as salinity of water) and quantity (area and depth) of wetland. Therefore, climate change is likely to

affect shrimp production through changes in wetland quantity and quality, resulting in changes in indirect wetland productivity

Since we have no data on wetland area and quality, we are using the benefits transfer method for this purpose. As mentioned in the methodological section of this report, the benefits transfer method entails using results and findings from studies that are done on similar environments and issues. We used the results of a recent study done by Barbier and Strand (1997) on shrimp fishery in Mexico. In this study the authors attempted to investigate the relationship between the shrimp catch and the surrounding mangroves in the Campeche area in Mexico. This is one of the largest mangrove areas in the Gulf of Mexico. Since both are tropical mangrove systems, we believe the results of this study have significant relevance to the current study.

According to this study, the output elasticity of mangrove area is 2.80 (at the means). This implies that a 1% change in mangrove area causes a 2.8% change in shrimp catch. Both changes are in the same direction due to the positive effect of the mangrove area on the shrimp catch. Since catch data is not recorded for all months in all years, it is not possible to compare the total catch over the years. Therefore, we use average catch, which has decreased by about 41% from 1995 to 1999 (Table 5.1). This is about an 8% decrease per year. Using output elasticity, we can now determine by what percentage the wetland area has to decrease to cause a 41% reduction in shrimp catch.

$$\% \text{ change in wetland area} = \frac{41}{2.8} = 14.64\,\%$$

Therefore, during the five years from 1995 to 1999, the wetland area appears to have decreased by nearly 15%. The average change per year therefore is about 2.9%. This is very comparable with the estimate of 2.3% that was derived using the subjective assessments provided by the households in the survey.

Using 1999 shrimp catch data and on the assumption that a 1% decrease in wetland area will result a 2.8% reduction in shrimp catch, the gross value of shrimp catch lost due to a marginal reduction in wetland area is about US $9,115 per annum.[11]This comes to about 3% of the gross value of shrimp caught in 1999. It has to be noted that this loss is completely attributed to the change in wetland area. In reality, climate change could cause a change in area as well as quality. In that case the reduction in yield and income could be even greater than shown here.

[11] Yearly reduction in shrimp catch is 128.52 x 12=1530.19 kg. Market value is 35.74/kg. The total gross value is 1530.19 x 35.19=TT$54,689.03. At the rate of TT$6=US$1, this is equal to US$9115.

Direct Value of Wetlands: Value of Wetland Products

Introduction

The study area includes several wetlands. As mentioned in the methodological section, wetlands could potentially have direct use, indirect use and nonuse values. Wetlands within the study area are made up of several areas. The main wetlands are,

- Carlibay, South of Couva River
- North of Couva River behind Farmland Misschem
- Hydro agri/turning basin, Point Lisas Bay
- Orange Valley
- Other areas

Direct uses include food and biomass as well as activities such as recreation. Indirect use values are those services such as flood protection, fish nursery and fish sanctuary that are provided by the wetlands. There also may be individuals who like to see the wetlands exist even though they are unlikely to benefit from them either directly or indirectly. These are nonuse values.

At the team meeting with local experts, it emerged that the most important values of the wetlands are direct use values and indirect use values. The surrounding communities use the wetland for collection of wetland products such as crustaceans, shellfish and fish for household use as well as for sale. This is the primary direct use of the wetland. There are no significant recreational activities such as boating, swimming and recreational fishing in the wetlands.

According to fisheries officers from the Ministry of the Fisheries, there is evidence that the wetland also function as a nursery and a sanctuary for juvenile fish that are finally caught in the surrounding sea. This is a typical indirect value of wetlands. However, according to fisheries officers, this wetland is probably more likely to be a nursery and a sanctuary for shrimp larvae rather than fish. Therefore, only the shrimp catch recorded at the Orange Valley beach was considered as the indirect benefit of the wetlands.

Estimation of Direct Use Value

To estimate the direct use values a survey was conducted in the surrounding communities. Due to time and budget constraints a sample of 25 households were chosen at random from the surrounding communities and information was gathered from them on the extent of their dependency on the wetlands. The questionnaire that was used for this survey is given in Appendix II.

The communities that were surveyed are given in Table 5.3. About 44% households surveyed use the wetland for their livelihood and about 24% for collection of products for household use. For the remaining 32% wetland was primarily a source of recreational

opportunities. A majority (60%) of the households ranked the wetland area North of Couva River and behind farmland Misschem as the best. About the same number of households (52%) indicated this wetland is their primary wetland for collection of products, followed by Carlibay and South of Couva River (24%).

Table 5.3: Distribution of the sample among communities		
Community	Number of Households	%
St. Andrews/Pt. Lisas	2	8%
Waterloo	2	8%
Orange Valley	11	44%
Claxton Bay	1	4%
Couva	6	24%
Felicity Hall	2	8%
Caroni	1	4%

The most popular items collected are crabs (16%), crabs and fish (8%) and crab with any combination of shrimp, oysters and mixed fish (28%). Therefore, crab is collected by over 50% of the households either by itself or in combination of other products. Besides these items, various other types of fish and oysters are also collected. The most popular use of products is for household use (56%) followed by for sale (28%) and for both purposes (16%). The discrepancy between these figures and those mentioned above is due to the fact that those households that use the wetland for recreation also collect products for household use. Therefore, recreation here does not mean activities such as boating, swimming or recreational fishing. High percentage (83%) of the households indicated that they are unable to collect the same amount that they were used to collect. Only 8% said they collect the same amount and the remaining 8% indicated that the amount collected has increased.

There is a difference in opinion on the highs and lows in production during the year. However, in general most households seem to agree that the summer months, that is, the period from May to September, are the most productive (this coincides with the rainy season; extreme climate events could easily alter this seasonality). The general consensus was that the period from August to December gave the lowest production. Over 76% of the households had the opinion that the wetland area has changed by 50% or more during the time that they have been using them.

Most of the households (21%) in the sample have been using the wetland for 20-25 years. Some households have been depending on the wetlands even longer with 14% for 25-40 years and 8% for 45-50 years. Three households (14%) each have been using the wetlands for 15-20 years, 5-10 years and less then 5 years. Therefore, it is apparent that dependency of the wetlands is well-established and fairly long term. It does not appear to be something sporadic or incidental.

The amount of time spent in the wetlands cannot be summarized in a useful manner. This is because households do not spend a fixed amount of time each day or each period. Each household provided a different measure of the time that they spend collecting products.

Using their answers and converting them to a weekly basis, it appears that when the use of the wetland is for collection of products for sale the average amount of time spent is about 9.2 hours per week. When the collected products are used purely for household use, the average time is about 4.2 hours per week. When it is for both purposes, households spend on the average about 17 hours per week. However, it has to be noted that these figures are simply indicators and may not be representative for every week of the year. Some households use the wetlands only during certain periods of the year. But the observations that more intense the purpose of use, the greater the amount of time spent, is clear.

Valuing Products

Important for valuation of the wetlands for direct use are the quantity of production and the market prices of products. Both these proved to be the most challenging to quantify from the information provided by the households. Most quantities were described in non-standard units such as bags, buckets, or by descriptions such as "few" or "several" crabs, fish, etc. This is not surprising, as one would not expect households to keep a record of the weight or prices of products as such is not necessary, especially if the products are for household consumption. Only three households, who collect products exclusively for sale, provided any indication of prices. As shrimp/small fish and crabs appear to be the main items collected, we consider only these two products in valuation. Taking all information that have been provided on disparate quantities and prices, it can be deduced that the price of crabs is about $40 per pound and price of shrimp/small fish is about $10 per pound.

Although, reasonable prices can be determined for the products, as mentioned earlier, quantifying how much is collected within a period is not possible. Therefore, to put a value on products collected, we use an alternative approach.

Table 5.4 gives the dependency on the wetlands of the sample of 25 households that were surveyed.

Table 5.4: Distribution of households by use of (wetland)

Nature of Dependency	Number of Households (%)*
Income	
100% income from wetlands	4 (16.6%)
85%	3 (12.5%)
75%	2 (8.3%)
25%	1 (4.2%)
12%	1 (4.2%)
Household Use	5 (20.8%)
Recreational Purposes	8 (33.3%)

* Only 24 households answered the question

It is highly likely the households that use the wetland have a household income well below the average income for Trinidad and Tobago. Recent estimate of per capita income

of Trinidad and Tobago is about US $4,400 per year and according to most recent data available, about 21% of the population in Trinidad and Tobago is below the poverty line. On the assumption that per capita income is lognormally distributed, households that use the wetlands for livelihood are deemed to have an average per capita income of about US $3,000 (about TT $18,000) per year.

Using data from the survey, it appears that on the average about 5 lbs of crab/shrimp/small fish will be collected for household use per week. The composition of crab and shrimp/fish collected cannot be ascertained. As a conservative estimate we put the average price of products collected to be about TT$25 per pound at the market value. Based on these figures the market value of products collected for household use is about TT $500 per month. Some households that collect products for sale also use some of the collection for household use. Using all information that is provided the value of products collected for a representative household is presented in Table 5.5.

The weighted average of the value of products collected by a household therefore is about US $1,730 per year. The households that use the wetlands are most likely to be located in the Waterloo, Chauganas, Couva, Carapinchaima and Freeport as they are the villages surrounding the wetlands. As mentioned earlier, the number of households in these villages is about 659 of which 21% is expected to be below the poverty level and therefore dependent on the wetlands to some extent. Therefore in total, about 139 households are likely to use the wetlands for collection of products for sale and/or for household use. Based on these figures, the gross total value of products collected by these households is about US $240,470 per year.

Table 5.5: Weighted Average Income of a Representative Household

Type of Use	No. of Households	Income (US$)/year	Weighted Amount
Income			
100%	4 (16%)	3000	480
85%+household use	2 (8%)	3550	284
85%	1 (4%)	2550	102
75%+household use	1 (4%)	3250	130
75%	1 (4%)	2250	90
25%+household use	1 (4%)	1750	70
12%	1 (4%%)	360	14
Household Use*	14 (56%)	1000	560
Total	25		1730

Net Rent

Collection of products requires primarily labour and nothing else significant in terms of variable or fixed costs. As mentioned earlier, depending on the use of products, households spend different amounts of time in the collection process. This information is summarised in Table 5.6.

Table 5.6: Time spent collecting products by type of use.		
Type of Use	**Ave. # hours per week**	**Number of Households**
Sale	9.2	11
Household Use	4.2	5
Both	17.00	4

The weighted average of the number of hours spent in collecting products is 9.51 per week. The wage rate for unskilled labour in Trinidad and Tobago is about US $1.12/hr. The shadow wage rate is taken to be about 85% of the market wage rate. Therefore the economic cost of labour spent on collecting wetland products is about US $9.03 a week and the yearly cost is US $469.79. Thus the net rent from wetland products is US $1,260.27 per year per household. This gives a total net rent of US $175,178 per year for the 139 households that are dependent on the wetlands. Since the current wetland area is about 481 hectares, this implies that the net value of products from the wetlands is about US $364 per year per household.

Change in Wetland Area

Since the survey is cross-sectional it is not possible to estimate the change of production due to change in wetland area. According to the Ministry of Agriculture, the current wetland area, which is about 481 hectares, has remained relatively unchanged during recent years. However, according to the households surveyed, there is a reduction in the wetland area as well as other problems such as chemical and garbage pollution, and dying off of mangroves. Also, those households that indicated there is a reduction in wetland area also indicated that there is a reduction of wetland products. These subjective assessments of the households are presented in Table 5.7.

Table 5.7: Subjective assessment of Wetland Change			
Type of Change	**% Change**	**No. of Households**	**No. of years wetland use**
Area has decreased		19	
	76-99%	1	-
	75%	6	27
	51-74%	5	26
	50%	2	20
	26-49%	2	14
	25%	1	40
	0 < 25%	1	18
	No value	1	
Area has increased		2	
	51-74%	1	
	26-49%	1	
No change	-	2	
Don't know	-	2	

The weighted average of the percentage reduction of wetland area is about 57.31% and the weighted average of the number of year of wetland use is about 24.59 years. Therefore, based on subjective estimates provided by the households, there has been a yearly reduction of about 2.33% of the wetland area during the last 25 years. It is difficult to independently verify this figure, as there are no records on the wetland area over the years. Also, no assessment was provided on the extent of reduction in products. As a result, it is not possible to correlate the change in wetland area to change in products collected. For marginal changes, it is reasonable to assume that the average change is equal to marginal change. Based on this assumption, a 1% change in current wetland area for example, will result in a reduction of net value of about US $1,751 for all households per hectare.[12]

Conclusions and Implications

This study illustrates how fairly basic data and information could be effectively used to estimate direct use value of a natural resource. Especially, in the case of wetlands, use values constitute an important component of its total economic value. Since most of the direct users are from the lower end of the income distribution, benefits accrued to them are not often considered as important or significant. However, results from this study as well as from studies done in other parts of the developing world reveal that the dependency on natural resources for direct users could be substantial and sustained. For example, for the wetland that was investigated in this study, on the average a household gets a net value of over US$1,200 from products collected. But more importantly, the dependency on the wetland has been well established and sustained. On the average a household has been collecting products for over 25 years. About 16% of the households depend exclusively on the wetland for their livelihood while about 36% use it to derive 75% or more of their household income plus food for household use.

These social and economic implications of these findings are quite important. As these households are likely to be comprised of individuals with unskilled labor, if the wetland were to be unavailable (such as from flooding due to sea level rise), it is more than likely these households will be left without an alternative source of income. Since their unskilled labor will have very low demand in a labor market that already suffers from significant unemployment, they will have to either depend on the government or resort to other non-conventional sources of income. As a result, crime and related social problems would escalate. Therefore, the benefits of the wetland to the society as a whole goes much beyond the value of direct benefits to those households that depend on it for livelihood. If proper weights can be given to other "costs" the society as a whole will have to incur if these wetlands were no longer available, then even a stronger case for protecting wetlands can be put forward.

Indirect benefits calculated for the shrimp fishery sheds light on how important a wetland can be in their contribution to not so obvious benefits. Using basic fisheries data and the

[12] 1% of 481 ha = 4.81 ha x $364 ha = $1750.84

benefits transfer approach we have determined that a marginal reduction in the wetland area will incur an annual loss of nearly US$10,000 to the Orange Valley shrimp fishery. Like in the case of direct wetland users the cost of loss of shrimp fishery is likely to be much more than simply the loss of income from the fishing. Since these fishermen are subsistent fishermen, alternative income opportunities for them are limited. Therefore, there would be additional social costs due to the loss of fishery (as a result of degradation of the wetlands) on top of the economic cost of loss of income.

We believe this exercise is useful to resource managers and planners in the Caribbean in three important aspects. Firstly, it shows how important and significant direct and indirect benefits could be even with fairly low levels users. Policy makers and resource planners may not considered direct use benefits as important because they are usually accrued to low income households and therefore believe them to be insignificant. However, this study illustrates that aggregate benefits could be substantial even with fairly low levels of use. When taken into account the lack of alternative income generating opportunities as well as other social costs, estimation of direct benefits should not be neglected in developing countries.

There is no doubt that those involved in resource management and planning are well aware of the issues surrounding the environment and resource use in the Caribbean. However, they have been lacking in ways of quantifying benefits and costs of uses and degradation of natural resources and environmental goods. As a results their concerns and pleas have been given scant attention in national policy making decisions.

The other important lesson that this study illustrates is how direct and indirect benefits could be calculated using readily available data and with some additional data and information using fairly straightforward calculations. An intermediate knowledge of microeconomics however would be necessary to interpret results. Calculation of benefits would significantly aid in bringing to attention the importance of resources to politicians and national policy planners.

Further, it is important that in routine data collection processes that "relevant" data is collected. For data to be relevant, one has to know what type of analysis would be done with collected data. If data is going to be used for calculation of economic benefits, then it is necessary to have specific information, such as prices, costs, quantities, frequencies, etc. This excise manifest what type of data should be routinely collected during normal data collection processes. Most data sets that exist in the Caribbean have not been collected specifically with economic analysis in mind. As such they cannot be used for economic analysis without additional data and information. This usually requires surveys that could be costly. Additional information that is necessary for through economic analyses can be done with minimum additional cost during a routine data collection process. For example, when information on fishing trips and catch is collected, it would be extremely useful to collect information on prices and costs as well. These two pieces of information is crucial to estimate a value of a fishery. Therefore, another use of this study is to help resource managers and planners to decide what type of economic

information should be collected if they intend to use such information for economic analyses.

Appendix 5A: Wetland Valuation Survey Questionnaire

Town and Country Planning Division

Ministry of Integrated Planning and Development

For Official Use Only:

Interviewer: ……..

Date: ……

Questionnaire #: ……..……..

Area:…..…….Ward: ……..…….ED#: ……..…….Building #:……...……..

Name:

1. In which community do you live?

……

…….

Please indicate on Table 1 provided, the following:

- Do you use any of these wetland/mangroves for your/family livelihood or for any other purpose? (***refer to attached map***)
- How would you rank your use of the various wetland areas based on frequency?
- What products do you obtain from each particular wetland?

Table 1

Wetland **(enter area code on map)**	***Use*** **(Livelihood/Other)**	***Rank*** **(by frequency)**	***Product*** **(shellfish, oysters, crab, tilapia, other)**
Other Area			

The following questions pertain only to the primary wetland that the respondent uses. (Rank 1)

Please indicate on ***Table 2*** attached, information on the wetland that you use most frequently (Rank 1) for livelihood, i.e. to collect products for household consumption or for sale.

2. What year did you first start using this wetland? **……..…….**
3. What quantity of each of these products is for sale? (Table 2)
4. How many hours/days do you spend, collecting the above-mentioned products during a week? (Table 2)
5. What quantity of each product do you collect from the wetland area? (Table 2)
6. Do you collect these products for

   Household use ◯ Sale ◯ Both ◯
7. What quantity of each of these products is for sale? How many are wholesaled or retailed? (Table 2)

8. What is the market price of these products? (Table 2)

9. Are you able to collect the same amount of the above mentioned products throughout the year?

Yes ◯ **No** ◯

10. If not, during which month do you experience high yield and which months do you get low yields. (Table 2)

11. What amount of your monthly income is from the sale of the products that you get from the wetland?

O <25% 25% 26-49% 50% 51-74% 75% 76-99% 100%

12. Has the supply of the products collected from the wetlands changed significantly since you first started using the Wetland area?

Increase ◯ **Decreased** ◯ **No Change** ◯

13. From the time you first started using these wetlands, in your opinion, has the area of the wetlands changed?

Increased ◯ **Decreased** ◯ **No change** ◯

14. To what extent has the wetland area changed?

O <25% 25% 26-49% 50% 51-74% 75% 76-99%

100%

15. Please describe the change to the wetlands.

……
……
…….

16. What in your opinion has caused the wetlands to change?

……

……

……

17. In your opinion, how many other households use the same wetlands that you use?

……
……
……
……
……
……

18. Is there anything else that you want to tell us about the wetlands in this area?

……
……
……
……

19. Please use the following space if you wish to further elaborate on any of the issues raised in the previous questions or to highlight any issues that were not covered.

.....

.....

.....

.....

.....

Thank you for your participation

CHAPTER 6

HEDONIC PRICE ANALYSIS : WATERFRONT EROSION IN DOMINICA

PROBLEM STATEMENT:

One of the most applied valuation techniques associated with attributes of land is hedonic price analysis. It is difficult to justify that values associated with it will be unbiased, but the nature of the bias will often be obvious. Thus, the approach is often used to give either conservative or liberal estimates of economic value. The upper and lower values may be important and sufficient information on which to based decisions. For example, if an installation eliminating erosion costs $5 million and a conservative estimate of the economic value of the erosion is $ 10 million, then the biased value estimate may be sufficient information on which to undertake the installation.

Introduction

Another method to reveal environmental values is the hedonic pricing model. The hedonic model has been used in economics for many years to capture the relationship between the bundle of characteristics a good has and its price. One of the first applications was to examine the effects of quality characteristics on the price of asparagus. The use of hedonics to estimate values of environmental goods is relative new, dating back to the mid 1970's. Its application to environmental goods and services depends on observing market prices for goods like land or housing that might be affected by the environmental quality or characteristic of interest. Studies of air quality in major metropolitan areas represent classic examples of this technique.

Hedonic models estimate the implicit price of the characteristics of a good. For example, the price of land and improvements on it could be influenced by the acreage, number of bedrooms, the square footage, the existence of a pool, the proximity to local schools, etc. A parcel's price also could be influenced by the proximity to and quality of environmental amenities or dis-amenities. Air quality has been found to be a determinant of housing prices in Los Angeles. Whether or not a property abuts the ocean may also matter. Where existing private residential property abuts an area affected by sea level rise, hedonic methods may be used to estimate the effect of this dis-amenity on the price of the land.

Most environmental incidents will have small, if any, effects on housing prices. Climate change, potential erosion and storm action could have more effect. Even where there are effects, it is usually difficult to estimate them using econometric methods because so many factors influence land and parcel prices, and many are correlated. However, even when implicit prices for environmental amenities can be estimated, it is usually very difficult to use them as precise measures of value. The connection between the implicit prices and the measurement of value is technically very complex and sometimes

empirically unobtainable. Only under restrictive assumptions can values be obtained directly from these estimated functions. A small environmental change offers the best case for using hedonic prices to measure value. More often than not, the value that is obtained from the hedonic price estimation represents the highest value of gaining an amenity and the lowest value of reducing a disamenity. In our case, we obtained a lower bound on the welfare loss from influences of the sea on waterfront properties.

This technique depends on observable data, and relies on the revelation of preferences through market behavior. Market data on property sales and characteristics are available through real estate services and municipal sources and can be readily linked with other secondary data sources such as assessed values. In many cases, the sales data is insufficient to obtain statistically valid estimates and property assessment of the land price is used. To the degree that the assessments reflect the actual market prices, the practice offers promise especially in areas like the Caribbean where the "land market" is "thin" and data on sales is lacking.

The Steps in the Hedonic Price Estimation Process

1. *Choice of an appropriate sample.* One must obtain a randomly chosen sample as well as assure that there is sufficient variation in the quality there is being "valued". A portion of the study area was selected that had numerous parcels of property, with many located on the water. Since sea-level rise and potential increased storm activity are possible, the value of the water front property is being used to determine if the "market" discounts property that is located in danger of these changes. Attempt to obtain an intuition of the important geographic characteristics that are important in the determination of price.

2. *Obtain data on the sample and entering the data into a data format for statistical analysis.* Obtaining information on the parcels can be difficult because one requires information on both the parcels and its geographic characteristics. The sample and information on the sample points was obtained through the Land Division in Dominica. The location of parcels was determined by walking the geographic area and "ground-truthing" the assessment data with the tax maps. After the data were provided, each parcel's characteristics were entered into an EXCEL spreadsheet. Although the analysis could have been carried out in EXCEL, the data were saved in an ASCII format and read into SAS.

3. *Regressing parcel and geographic characteristics on the "price".* As a first approximation, a linear relationship between the assessed parcel value and the various characteristics of parcels is run. One could use a Box-Cox transformation to see check whether the data fits a logarithmic relationship better than a linear one.

4. *Assess the structure of residuals (unexplained components of the model).* Assess whether the residuals exhibit an observable systematic variation and conform to the assumptions of the model regarding them.

5. *Interpret the estimated coefficients of interest and assess whether they match your the expectations regarding them.*

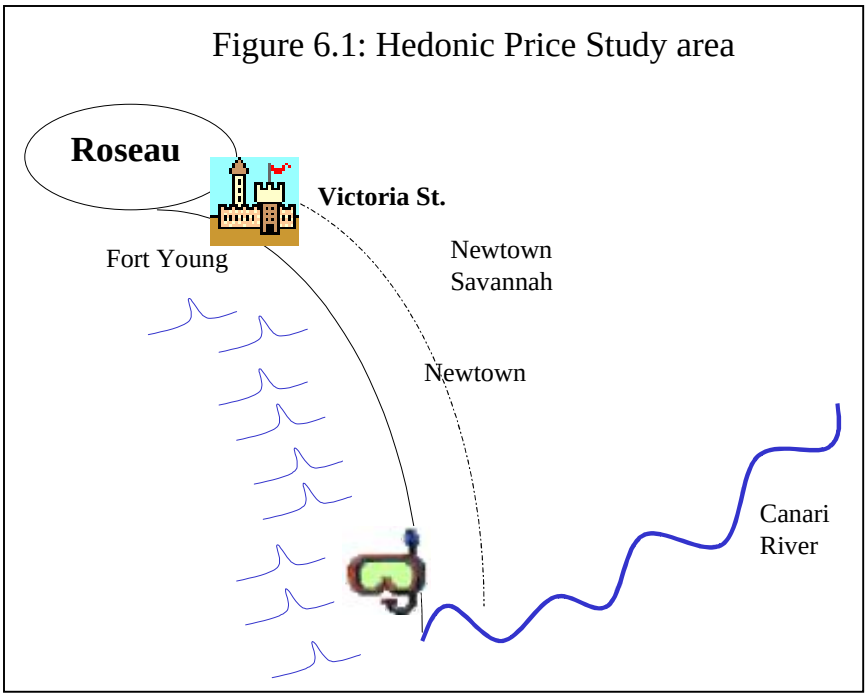
6. *If satisfied with the results, predict changes in parcel prices implied by changes in characteristics.*

The Study Site: South Roseau to the Canari River, Dominica

Rather than dwell on the theoretical issues involved in hedonic price estimation, let us apply the technique to an area in Dominica. Figure 6.1 shows the basics of the study area. It begins at Fort Young, an upscale hotel located at the southern edge of Roseau, continues through a densely developed area until passing past Newtown Savannah (and open area to the landside of Victoria St.) and through Newtown, a more densely populated area. At that point the housing density thins and the road becomes closer to the shore. The area continues that way until two hotels that service snorkeling and diving clientele are reached.

In the hedonic price model, we ideally would like to examine the effect of storms/erosion on the sales price of land. Unfortunately, the data on sales prices are unavailable and

Figure 6.1: Hedonic Price Study area



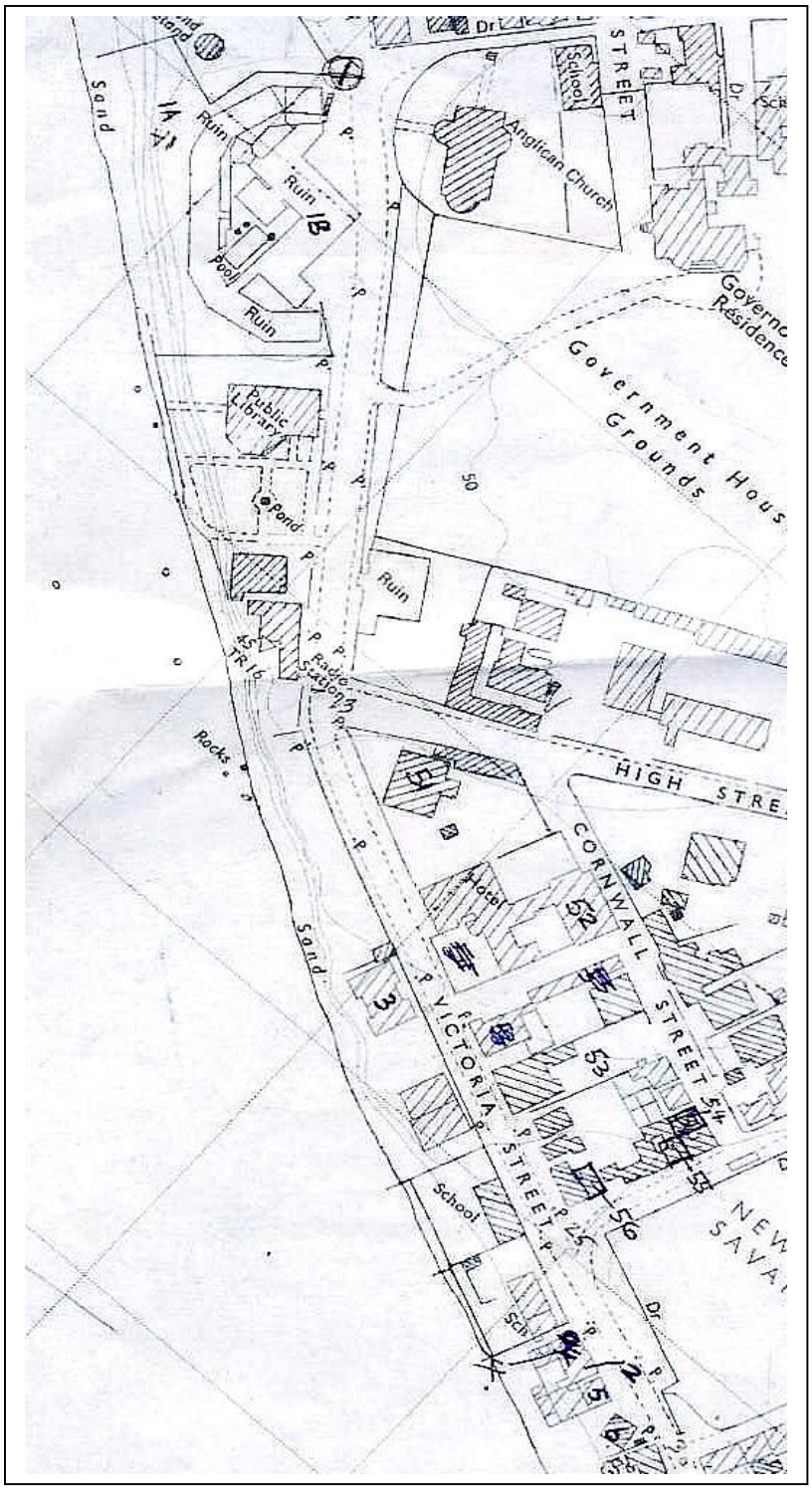


Figure 6.2: Detailed Map of the Beginning of the Study Area

likely too sparse to use in the model. There is also no data on the " before and after" aspects of an event that would allow an assessment of an event. However, data do exist on the assessed value of the land, independent of the structures on the land. This data

represents a cross-section of parcels that include land exposed to greater danger from the sea. With the help of Mr. Bernard Lloyd of Dominica's Land Assessment Division, fifty parcels on the seaside of Victoria St. and fifty parcels on the shore-side of Victoria St. were randomly selected. The assessment rates per square footage, the parcel's location, and the square footage of the parcels were obtained.

The study area was divided into several sections: i) the area from Roseau to the Newtown Savannah, ii) the Savannah to Newtown, iii) the beginning of Newtown until its end and finally iv) from the end of Newtown to the River Canari. Figure 6.2 shows some detail regarding the area from Fort Young to the Newtown Savannah and the parcels (numbers written in) selected for the sample.

Factors Deemed Important in Study Area Assessed Value

A multitude of factors are influential in determining the price of land but realtors often say that it is "Location, location, location" that is the most important factor. The model that is the basis of our hedonic price analysis emphasizes location, partly because we do not have good information on erosion rates and damages along the waterfront in our study area. The variables that are considered are whether or not the parcel is located on the waterfront side of Victoria Street, whether or not the property is fronting on Victoria Street, the square footage of the property, the distance of non-waterfront property from the water. In addition, the distance from Roseau is considered. Everything else being equal, one expects that the further from the major employment center of Roseau, the lower will be the value of the property. Because this factor may have a highly non-linear effect, we consider segments of the study area based on the four areas described in the last paragraph. We have combined the first segment and the last because when considered separately, there was no significant difference between them.

Ideally, one would like to have more detail regarding the characteristics of the land. Factors such as the slope of land, elevation, or water view may contribute to the value of the parcel. Unfortunately, time and budget constraints precluded going to each site and collecting this data.

Model Estimation and Results

We estimated the hedonic price model using SAS, although SPSS could have been used as easily. Over three-quarters of the total variation in the assessment value of a property could be explained by the factors that we considered (Table 6.1). All of the variables included in the model were statistically significant at the 5% level of confidence. The error structure did not have a noticeable location component to it. There were no signs of the prediction errors being correlated over space.

The most important factors for our consideration are the ones that are associated with waterfront parcels. The average assessment rate on the 87 parcels of land in our sample was EC \$21.05 per ft^2. The estimated waterfront coefficient indicates, that all else being

equal, a waterfront parcel will be assessed at a rate that is EC $19.63 per ft^2 less than a non-waterfront property.

Table 6.1: Estimated Effects of Factors Influencing Assessment Rates, By Study Area Segment

	Estimated Effect			
Factor in Determining Assessment Rate	**Mean of Variable (all parcels)**	**For Pre-Savannah and South of Newtown**	**For Savannah to Newtown**	**For Newtown**
Assessment rate	EC$21.44	EC$35.45	EC$21.52	EC$19.51
Independent Variable	**Coefficient Estimatess**			
Waterfront	0.37	-19.63 (-4.81)	Same as Column 2.	Same as Column 2.
Victoria Street Frontage	0.65	5.21 (6.39)	Same as Column 2.	Same as Column 2.
Square Footage	3793 ft^2	.00023 (2.51)	Same as Column 2.	Same as Column 2.
Distance Inshore from Water ($EC/ft)	280 ft	-.010 (-6.71)	Same as Column 2.	Same as Column 2.
Distance from Roseau (All lots) ($EC/ft)	6508 ft	-0.0044 (-11.78)	-.0032 (-7.95)	-.0011 (-4.08)
Distance from Roseau*(Waterfront lot ($ECft)	2846 ft	0.0017 (6.41)	0.0033 (6.81)	0.00084 (1.88)
Intercept		55.90 (17.90)	Same as Column 2.	Same as Column 2.
Adjusted R^2=.75 Durbin-Watson=1.95, Observations=87				

The estimated intercept, EC $55.98/sq.ft, indicates the expected assessment rate if all variables (especially the distance to Roseau) were set to 0. In other words, one expects that the assessment rate for the first square foot of a parcel located at the edge of Roseau (near Fort Young) to be around EC $50/ ft^2. If it were on the waterfront, the rate would drop to about EC $35/$ft^2$.

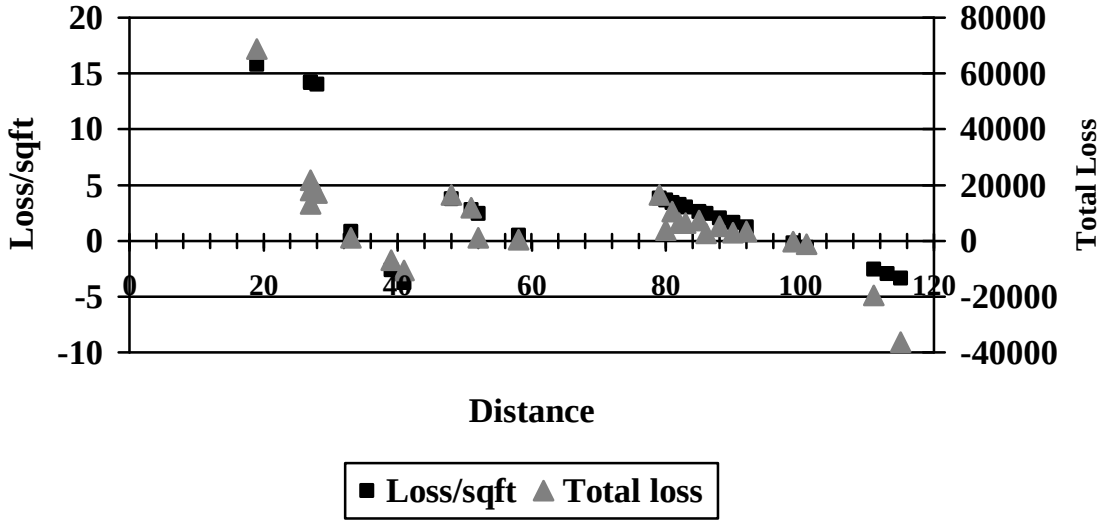
However, we also considered that assessment rates could vary depending on the distance from Roseau, on the segment of our study area and on the waterfront nature of the parcel. The distance to Roseau has a negative and statistically significant effect on the assessed value. However, the effect of distance appeared to vary according to whether the parcel was on the waterfront and on the specific location in the study area Our estimates do show that, relative to a non-waterfront property, there is a less negative effect of waterfront property as one moves further from Roseau. Assessment rates with these

characteristics dropped at a rate of EC $0.5/100-feet distance from the origin near Fort Young. Waterfront property fell at a rate about two-thirds of that figure. The parcel assessment rate dropped quickest for parcels in the Newtown-Savannah through Newtown area. In these areas, the rate fell at a rate near EC $0.75/100-feet from shore.

The most important secondary finding is that the assessed rate falls as the distance to the water increases. This suggests that people value being close to the water (for the cooler atmosphere and view) but apparently not on the water. The reason for this may be the erosion and constant potential of a damaging storm.

To take all factors into account, we considered all study area waterfront parcels with Victoria Street frontage and projected the loss from being on the waterfront, both as an assessed rate and as a total loss for the entire parcel. The projected losses are shown in Figure 6.3 for each of the study area parcels. The values take both the waterfront factor as well as the waterfront/distance from Roseau factor into account. As one moves away from Roseau, the losses from being on the waterfront decline. In terms of assessment rates, the losses range from EC $15.00/ft^2 down to a gain (shown in the figure as a minus value) of about EC $6.00/ft^2. The average loss per square foot across all parcels is about EC $6.61.

Figure 6.2: Predicted Loss ($EC) in Property Value from Being on the Waterfront,By Distance from Roseau



Costs of Waterfront Location

While the economic losses per square foot are not extraordinarily high, when the total effect on the parcel is considered, the values become larger. The largest loss is in the order of EC $70,000 whereas the average loss is about EC $5,500. The gains occur mostly south of Newtown as one gets closer to Soufriere and Scottshead. These tend to have mostly residential properties and hotels.

It is difficult to say with certainty that the losses calculated are associated with the potential damages of being on the water. There could be other factors such as commercial establishments or areas with noise that we have not considered. However, the results are consistent with the hypothesis that the economic system does "discount" for the problems associated with being near to the water. The average parcel on the waterfront is "valued" at nearly EC $5,500 less than its counterpart off the waterfront. A more complete analysis that takes into account the actual erosion rates effect on sales prices would be better but the data do not exist. We have demonstrated what information can be developed without perfect data.

Conclusions

This chapter has demonstrated the use of the hedonic price model to "value" climate. Because there is no historic information on erosion rates, the erosion occurs in an episodic manner (with hurricanes), and no historic series on property prices (or assessment values), we were left to use a cross-section of properties in our study area. We used waterfront location to reflect the effect of weather on the value. We found that the market decreased properties on the waterfront by EC $6.61 per ft^2. Based on the average size a parcel, the loss to a property owner was approximately EC $5,500. The value varied along the coastline, with the greatest losses being near Roseau and the smallest near the Canari River.

These market discounts for being on the waterfront should be placed in perspective. That is, several other methods have been mentioned as ways of valuing the climate change. The defensive expenditure method was discussed as a way to obtain a minimum value for an adverse change in the climate in Chapter 2. The government subsequent to Hurricane Lenny has placed 2.8 kilometers of seawall and Gabian baskets (stones in meshed wire) to protect the coastline, especially segments of road damaged by Hurricane Lenny (B. Mark John, personal correspondence). The costs to the government to construct sea walls was EC $6,000 per meter and to place Gabian baskets EC $1,000[13]. Because the government undertook the investment to protect certain infrastructure, it is unlikely that they represent the same private economic values that the hedonic prices of property

[13] To obtain the lower bound of economic value using the defensive expenditure method, one would have to determine the cost of the sea defenses that were in place before Hurricane Lenny. The difference between them and the new defense would determine the lower bound. Remember, however, that these are government expenditures to protect infrastructure such as roads. Comparing them with private values would require a leap of faith.

owners reflect. However, one can see why the personal property is not being protected against erosion losses. The average estimated value of the property on the waterfront in our study was EC$56,000. If that property had a 60-foot sea frontage, then protection using the cheapest method (Gabian baskets) would cost more than the value of the property[14].

Given these results, it is not clear that property owners will be able to "defend" themselves against a situation of rising sea level. The costs of the defenses are large in comparison with the property gains from having them. The large properties near Roseau might find it profitable to undertake these defensive expenditures, whereas the smaller ones are unlikely to have the capital or the incentive to do so. Without some government involvement and with sea-level rise, the properties will probably continue to depreciate.

Although hampered by not having a time series of data, the analysis does provide a baseline against which subsequent analysis can be compared. That is, climate change is gradual. Twenty years from now it is likely that a study along lines of this one will be undertaken. We have provided a snapshot as of 2001 that can be used well into the future. At the same time, we have demonstrated that there are current costs to being on the waterfront.

[14] Obviously the property's value would rise because of the protection. However, the protected property away from the shore only had an average assessed value of EC$94,000.

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