Natural Resource Valuation Considerations for the Negril Breakwater Project

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1 Introduction

Coastal ecosystems throughout Jamaica are threatened by climate change and expanding development associated with a growing population. Climate induced change in sea levels and hurricane intensities have led to eroding shorelines. Decreased quality and quantity of coral reefs and other near shore ecosystems have resulted in a reduction in their ability to provide valuable ecosystem services such as storm surge protection, sand production and recreational opportunities.

Jamaica is vulnerable to climate related hazards, in particular hurricanes, floods and storm surges due largely to its geographical location and the exposure of social and economic assets in coastal areas (Etkin 1999). This situation is made worse by the country's low adaptive capacity especially in the climate sensitive sectors of the economy.

Data from climate models have indicated that Jamaica will experience significant changes in sea-level rise (SLR) by 2050. Jamaica's Second National Communication (SNC) on Climate Change lists the main climate change hazards as follows: sea level rise; increase in extreme events – precipitation and drought; more intense storms and storm surge and increased temperature (Chen et al. 2008) and outlined that the Caribbean has experienced changes similar to that of the global mean.

While most tropical cyclones take an east to west track from the Atlantic into the Caribbean, systems that form in the central Caribbean during mid to late October through to December and move north, are a threat to Negril and the south-western beaches. The result over a number of years has been considerable erosion with less accretion after these events leading to progressive loss of shoreline width (McKenzie 2012). PIOJ in its application to Adaptation Fund is seeking to intervene in Negril.

The objective of this analysis is to provide a framework for making an informed trade off analysis between the values of losing living coral reef material along with the temporary loss of the recreational services from nearshore coastal ecosystem versus the construction of a hard engineering solution to mitigate the problem of beach sand loss in the study area. The trade-off analysis undertaken includes a discussion of the existing stream of ecosystem service benefits (including, where appropriate, estimates for economic value) potentially being provided by the study area in its present condition as well as the potential changes in ecosystem services as a result of the proposed development activity.

2 Background

Coral reef ecosystems hug tropical coastlines and offer protection from the pounding of waves and scouring currents on a daily basis but more importantly, protect against the worst ravages of storms and hurricanes. They are able to grow in high wave energy environments and reef growth gradually builds up huge limestone structures, which buffer and defend the coastline. In addition, reefs also provide the major source of sand, which builds land and replenishes beaches (Edwards 2002). Coral reef ecosystems are also important because they provide people with a source of livelihood, food, recreation, and medicinal compounds and protect the land on which they live.

For a small island developing state (SIDS) like Jamaica, the coastal tourism industry is an important economic activity. The Jamaican tourism industry accounts for 32% of total employment and 36% of the country's GDP (WTTC 2010) and is largely based on the sun, sea and sand. The last two of these attributes being dependent on healthy coral reef ecosystems and sea grass beds that provide habitat for the sand producing organisms (Robinson et al. 2012). Therefore the primary recreational activities of visitors include sun and sea bathing on the beaches. The recreational users of the coastal resources are primarily: beachgoers, snorkelers, scuba divers, and glass bottom boaters (Edwards 2009; Mitchell et al. 2000). Beaches are therefore critical component in the tourism product.

Coral reefs and their associated ecosystems are however threatened by natural and anthropogenic impacts such as: coastal pollution, rapid coastal development, overfishing and global warming. Mitigating the anthropogenic threats to these natural resources requires effective management and this in turn is dependent on funding which is often limited or absent in island nations such as Jamaica.

According to the Jamaica Tourist Board (JTB), the vast majority of tourist days are spent in one of the three major beach destinations in the country – Montego Bay, Ocho Rios, and Negril.

They account for roughly 72 percent of total overnight (non-cruise) visitors, and 93 percent of total bed-nights (i.e. nights spent in hotels in the country) recorded by the JTB from 2006 to 2009. The ports of Montego Bay and Ocho Rios also account for nearly 92 percent of cruise ship arrivals. Furthermore, these three destinations provide an important source of jobs, employing nearly 87 percent of the staff from the accommodation sector in 2009 (JTB, 2009).

2.1 Threats to Jamaica's Coral Reefs

Based on decades of research and anecdotal experiences, it can be shown that a combination of human-induced and natural stresses have contributed to the decline of Jamaica's reefs (Burke et al 2011). The Jamaican reality of limited employment opportunities, a large informal economy, densely populated coastal zones, and easy access to the narrow shelf areas (particularly on the north coast) has led to overfishing in nearshore areas. In addition to the anthropogenic influences, natural disturbances from hurricanes, coral bleaching prompted by warming seas, and diseases have contributed to coral mortality over the years. The period 1983-84, the Atlantic Caribbean region experienced one of the most devastating mortalities ever recorded in a marine animal. This specie, *Diadema antillarum*, the Caribbean long-spined sea urchin, plays a critical ecological role by grazing on algae, clearing areas of hard substrate so new corals can settle. Healthy populations of long-spined sea urchins are particularly important after mass bleaching events when corals are more susceptible to algal overgrowth (Mumby and Harborne 2011). As a result of the dramatic decline in *Diadema* abundance in the late 1980's, combined with persistent overfishing of herbivorous fish, this has resulted in a dramatic (phase) shift on Jamaica's reefs from coral cover to algal cover by the 1990s. Additionally pressure on the reefs from coral bleaching took place in Jamaica during 1987, 1989, and 1990, with widespread and severe bleaching occurring in 1998 (Woodley et al 2002). The combination of stresses from hurricanes, bleaching, disease and human pressures have all contributed to the overall decline in coral reef ecosystem health. As a result, all of Jamaica's coral reefs are considered threatened, with over 60 percent classified as highly threatened (Kushner et al 2011).

Despite their importance, these ecosystems are under threat. For example, more than 75 percent of the Caribbean's coral reefs are threatened by human activities, including overfishing, pollution, and climate-related threats such as coral bleaching and ocean acidification. Left unchecked, these pressures will degrade coastal ecosystems, leading to reduced benefits from these ecosystems in the future. These threats to reefs stem from both a lack of awareness of the benefits provided by reefs and of the costs of insufficient protection, as well as a lack of political will to protect and sustainably manage reef ecosystems (including enforcement of existing regulations)—leading to insufficient investment in coastal protection and management. Many of the activities that damage coastal ecosystems arise from short-sighted decisions that fail to take long-term ecosystem benefits into account

2.2 Negril: A case in point

Like the rest of Jamaica, Negril's coral reefs have experienced similar pressures over the years. One of the side effects of the abovementioned human induced and natural stressors on coral reefs is a reduction in the capacity to produce and protect the deposition of sand for the creation of beaches. These human pressures and other stresses and threats have led to the widespread degradation of Jamaica's coral reefs. To reverse the degradation of Jamaica's reefs, it will be essential to curb these threats. Reefs provide an important source of white sand for beaches and also dissipate wave energy to reduce erosion and lower inundation and wave damage during storms. Economic valuation, which assigns a monetary value to the goods and services provided by ecosystems, gives policy makers an important tool with which to set priorities and improve decision-making around natural resources management.

Several studies including the most recent EIA (CL Environmental 2014) have documented the gradual loss of beach over the past 40 years (Smith Warner 2007, Hudson 1996, Kusher et al. 2011, McKenzie 2012, Robinson et al 2012). It is clear, however, that Negril's beaches are eroding and that further degradation would probably result in accelerated rates of erosion. This report will also examine the potential negative effects of increased beach erosion rates on the local tourism economy. This analysis emphasizes the contribution of reefs to beach erosion control and the economic benefits derived from beach tourism, as white sand beaches represent an important draw and the primary focus of most international tourists to Jamaica.

3 Project Summary

The Negril Beach, located on Jamaica's West coast and shared by both Hanover and Westmoreland parishes, has two carbonate beaches known as Long Bay and Bloody Bay that stretch a total of 9.1 km (5.6 miles). Long Bay has a total length of 7 km (4.3 miles) and an average width of 15 m, with beach width ranging from as low as 1 m to as wide as 43 m sections in the central section on Long Bay beach. In general, the beach is shallow with a mild slope at an average of 10 percent. Large all-inclusive resorts are, for the most part, found on the northern end of Long Bay, while smaller locally owned restaurants and hotels occupy the southern section of the Bay. According to a 2007 Reef Check assessment, Negril reefs average 15 percent coral coverage. The fringing reef is not known to contribute significantly to any sediment deposition, but likely plays a role in reducing wave energy.

Negril's beach is extremely dynamic, as beach width has been recorded to fluctuate more than 30 m in a single year (SWIL 2007). A study by Smith-Warner reports a 40 m loss of beach in certain areas over the past forty years, providing an average rate of beach erosion of 1 m per year (SWIL 2007). The University of West Indies' Marine Geology Unit found a net average shoreline recession of 8.4 m for Long Bay from 1971 to 2008 or 0.23 m per year (Khan et al 2010). Although these averages vary, it is concluded by both studies that overall the beach width has been diminishing. This loss of beach has not occurred gradually over time, but rather sporadically through periods of accretion, recession and relative stability.

In response to the abovementioned problem of long-term beach erosion, the Government of Jamaica has embarked on an integrated management approach to address the erosion. This aspect sees the implementation of the larger umbrella project "Enhancing the Resilience of the Agriculture Sector and Coastal Areas to Protect Livelihoods and Improve Food Security" with funding sought by the Planning Institute of Jamaica (PIOJ). As part of this overall effort the subproject "Construction of Break Water Structures Offshore Negril (Negril Breakwaters)" is being executed by the PIOJ and is being managed by the National Works Agency (NWA).

The project involves the construction of two breakwaters which will be located 1,500 - 1,600 m offshore the Negril coastline in Long Bay (CL Environmental, 2014):

- Northern breakwater - 516 metres long in 3.0 to 4.0 m of water depth (MSL) that is partially emergent and submerged in some sections.
- Southern breakwater - 422 metres long in 3.7 to 4.1 m of water depth that is partially emergent.

However this activity while it is expected to provide medium to long-term benefits by way of shoreline protection and mitigating beach erosion comes with some costs, environmental and economic. This is not unusual in projects such as this however it is important to assess the trade-offs between these costs and the expected benefits. One tool for assisting with this decision making process is natural resource economic valuation.

4 Economic Valuation of Ecosystem Services

4.1 Ecosystem Services

Ecosystem services are the contributions that a biological community and its habitat provide to the day-to-day lives of human beings or society. Some ecosystem services are not easily exchanged in markets. These *Public Goods* may provide significant value to society but because they cannot be traded in traditional markets they require "nonmarket" valuation methods to estimate their economic worth. Examples of these goods include biodiversity, unique creatures and places such as whales or culturally significant sites, wildlife viewing, or snorkeling on a coral reef. Some of these goods do not have easily observable monetary values and, determining which method to use to value them require careful assessment of the type of services being provided and their relative worth.

Ecosystem services can be categorized in different ways. The Millennium Ecosystem Assessment (MEA 2005) describes 23 categories of ecosystem services. For the purposes of this evaluation we will discuss some of the services associated with Negril's coral reefs in four functional groups: Regulating Services, Habitat Services, Provisioning Services and Information Services. This approach is consistent with the MEA, as well as much of the scientific and economic literature. The four categories of ecosystem services are described below.

- Provisioning services - provide basic goods including food, water and materials. For example coral reefs are a source of fish and shellfish and other products.
- Regulating services are benefits obtained from the natural control of ecosystem processes. For example intact coral reef ecosystems provide regulation of the impacts of high wave energy from storms (erosion regulation).
- Habitat services - provide refuge and reproduction (nursery) habitat to aquatic plants and animals and thereby contribute to the (in situ) conservation of biological and genetic diversity.

- Information/Cultural services - provide humans with meaningful interaction with nature. These services include aesthetic, spiritual, recreational, educational and cultural values derived from important species, natural areas, places and experiences. The tourism product is directly linked to this component of ecosystem services.

Some of these services can be described in the context of economic value. It is not always easy but this report will discuss ways to describe ecosystem service benefit streams sometimes in terms of monetary values. By describing ecosystem service benefits in this manner it is hoped that this can contribute to improved natural resource policy and decision-making.

However, development pressures, natural and human induced disasters and environmental accidents can lead to degradation of ecological functions which result in losses in ecosystem services. In some instances conservation efforts are not enough to restore coastal habitats to their normal functioning. In these cases restoration actions are often employed to mitigate losses and restore or maintain suitable environmental conditions. Restoration actions can range from “soft” engineering solutions such as seagrass bed replanting, coral replanting from nurseries, mangrove seedling replacement. There may be solutions that employ a mixture of “hard” and “soft” engineering approaches for example recreation of oyster reefs, construction of artificial reefs (reef balls, tires etc) and use of heavy equipment to restore hydrological connections (e.g. salt marsh rehabilitation). On the other end of the restoration spectrum are techniques that can be considered “hard” engineering solutions. The Negril breakwater project could be considered to be typical of this type of approach. Another example would be beach nourishment and sea wall construction type activities.

As is to be expected there are differences between hard and soft ecosystem restoration, both approaches have pros and cons. The success of soft ecosystem engineering solutions is often heavily reliant on concerted management efforts to reduce other anthropogenic impacts (nutrient pollution, improper shoreline construction, over fishing) to achieve the desired outcomes. In addition the expected results tend to accrue over long time periods. However approaches such as this, if done correctly may have a few negative environmental impacts during the implementation phase and should result in an overall increase in marine biodiversity with the resultant ecosystem benefits. However competing economic factors and general human development pressures often render these approaches less effective than they ought to be.

By comparison, hard engineering solutions, such as breakwaters, usually reduce erosion more rapidly (start to finish) if done correctly as the expected benefits accrue over a shorter period of time. However these approaches typically come with negative environmental impacts (sedimentation, loss of marine life etc) in the short term. Another significant impact is to the cultural ecosystem services associated with the coral reefs in the area. Namely visual dis-amenities and loss of recreational services during the construction phase. It is important therefore to examine the trade offs between these two types of approaches.

As a result of the chronic beach erosion being experienced in Negril this project could be viewed as the last resort. Some of the soft engineering approaches along with environmental management have been attempted but arguably (as in the case of beach erosion and reef health) have had limited success. All things being equal, the best option for addressing this current problem would be to employ a mixture of approaches.

4.2 Economic Valuation of Ecosystem Services

Economic value considers benefits to the resource users and the wider society. These benefits are derived from the expected improvements in habitat quality and ecosystem services. Values may be described as individuals: appreciation and emotional value attached to the particular habitat (coral reefs and beaches), their values related to ecosystem resilience and health as well as their social values. It is important to note the economic value of coral reef habitats resides in the ecosystem functions that they contribute to human well-being. In economic terms "well-being" is also known as consumer or public welfare. The end goal of ecosystem service valuation is to be able to demonstrate the tradeoffs in ecosystem services resulting from policy decisions. This can include incorporation of a monetary metric into cost-benefit analyses or other quantitative or qualitative means of assessing the losses and/or gains of ecosystem services

The value of ecosystem services provided by a particular area (e.g. acre) of coral reef depends on the quantity and quality of the ecosystem functions and services provided, and the magnitude, the preferences, and demographic characteristics of the population receiving those services, typically the nearby population. In other words, not all coral reefs are created equal.

Estimating the public ecosystem services associated with the potential area to be impacted can be done following these steps: 1) The geographic/spatial, ecological and economic scope of the study site is identified; 2) The existing characteristics of the coral reef and potential changes in the flow and value of ecosystem services based on the proposed development action are assessed; 3) Existing data is used to estimate average economic values (including $ per unit area) for ecosystem service streams that are identified; 4) The economic values (losses or gains) associated with the development action will then be compared with the expected benefits (if any) from mitigating coastal erosion impact as a result of hard engineering solutions.

Economic valuation studies may attempt to quantify all or some of the use and non-use values of a resource. Although valuation is a useful and potentially powerful decision-making tool, users should always bear in mind the high degree of uncertainty in most economic valuation studies, and should pay attention to the methods used, assumptions made and the caveats attached to their results.

4.3 Economic Value vs Economic Impacts

It is important to distinguish between the concepts of economic value and economic impact. The economic valuation of natural resources, notably the primary purpose of this rapid analysis, falls within the “value” category. These two approaches have their pros and cons and the information generated through both processes can be useful for decision making. Providing information for environmental and coastal management decision making that supports cost benefit analysis economic valuation approach is theoretically the proper approach. Knapp (2001) provides some insight on the differences between economic value and economic impact.

Economic value (also referred to as "economic benefit," "net economic value," or "net economic benefit") measures how much an economic activity is worth to residents of a specified geographic area. Net economic value is calculated by subtracting total costs from total benefits. Total benefits can include both "market benefits" (which can be observed from market transactions) as well as "non-market benefits" (benefits which are received without having to pay for them).

Economic impacts are jobs, income or other measures of economic activity within a specified geographic area associated with or generated by an economic activity. In contrast to economic value, which has a very specific definition, there are many potential measures of economic impacts (for example total jobs, total full-time jobs, total full-time jobs for residents, etc.).

Economic value analysis is the appropriate technique to use if you are interested in the goal of "efficiency." For this reason, economists are likely to argue that economic value analysis is the "right" method to use in studying resource public policy issues (Knapp, 2001). By contrast, economic impact analysis is the appropriate technique to use if you are interested in goals such as "jobs" and "economic growth." For this reason, politicians and interest groups often are more interested in, or more inclined to seize upon the results of--economic impact analysis. It is therefore important to keep these fundamental differences in mind when interpreting the findings.

5 Other Socio-Economic Considerations

5.1 Economic Impact

As highlighted in the previous section, economic value is distinct from economic impact. Economic impacts can be defined as the economic activity generated by the use of resources. It is important to note that economic impact analyses are typically focused on a given region (for example Negril). Impact analyses do not measure the value to the primary users/beneficiaries (e.g. tourists) of the resource but rather the gains to those who are involved in supplying the primary users with goods and services (hotel owners, construction companies, merchants etc). Nonetheless regional economic impact studies provide useful information about the social and economic effects of proposed new projects and programs. Impact studies have included a study of the regional economic impact in the immediate vicinity of a project. Studies typically show the impact of the construction and operation of the proposed project and of the change in user consumption (e.g. tourists).

A regional impact study answers a different question than does a benefit-cost study. Policy makers and other stakeholders often confuse the two because the report results in dollars. However dollars from a regional impact study are a measure of effects on local businesses whereas dollars from a benefit cost analysis measures the effect on the visitors or main beneficiaries of the ecosystem services.

Economic Impacts and Contributions of Restoration

Restoration investments also have a short-term economic and employment stimulus, which can be measured through economic impact and contributions analyses. The stimulating effects of increases in spending, in any industry as well as in the public sector, are the result of interdependencies among industries, whereby changes in demand in one industry can have ripple effects for suppliers and related businesses. Short-term economic impacts are expected to be driven by construction activities during the project phase.

6 Methodology

Non-market valuation techniques are extensively applied over a wide range of goods and services and their use as a tool for natural resource management policy is now fairly common across many countries. Common to most of these studies is the estimation of consumer surplus or welfare, often expressed as willingness to pay (WTP). It is frequently applied in the context of public goods such as air and noise pollution. It is also used in damage assessments and cost benefit analyses for various types of development projects. There are a variety of techniques used to elicit non-market values for environmental amenities and these can be classified in general terms as stated preference (SP) or revealed preference (RP) techniques. Stated preference approaches, such as contingent valuation, which surveys the willingness to pay for a particular benefit. While revealed preference approaches, such as travel-cost modeling or hedonic pricing, which assess the actual amount paid for a benefit or its proxy. The challenge with these approaches is that they can be expensive and time consuming to implement.

There are other valuation approaches that can be considered as tools for improving resource management decisions and policy making. The damage cost avoided, replacement cost, and substitute cost methods are related methods that estimate values of ecosystem services, based on either the costs of avoiding damages due to lost services, the cost of replacing ecosystem services, or the cost of providing substitute services. It should be noted that these methods do not provide strict measures of economic values, which are based on peoples' willingness to pay for a product or service. Instead, they assume that the costs of avoiding damages or replacing ecosystems or their services provide useful estimates of the value of these ecosystems or services. These methods are most appropriately applied in cases where damage avoidance or replacement expenditures have actually been, or will actually be, made. For example, the value the erosion protection services of an offshore coral reef is estimated by measuring the cost of a groyne, breakwater construction or beach nourishing project. These methods rely heavily on literature from previously collected economic valuation studies on similar ecosystems.

6.1 Benefit and Value Transfer

Given that this effort requires a rapid turn-around time and there is not enough time or financial resources to conduct a full non-market valuation survey for this specific project, the economic valuation methodology that is proposed for this study is a **benefit transfer** approach for estimating the value of the coral reef at the study site. Benefit transfer or value transfer is a commonly-applied technique that involves adapting research found in the available literature and conducted for one purpose, to another purpose, to address the policy questions at hand. It should be noted that any benefit transfer application should take into consideration the possible differences across sites (geographies, countries) with respect to environmental quality as well as institutional frameworks governing environmental management and protection. Benefit transfer applications therefore rely on desktop analysis and where feasible model simulation for sensitivity analyses.

In developing benefit transfer approaches, key steps for valuing effects of changes on ecosystem services include: (1) describing the policy case, that is, the case for which value estimates are desired, (2) selection of the applicable studies from the available literature, and (3) transferring values to allow for trade off and policy analysis. This information should include estimates of the ecosystem benefit streams flowing from the existing study (coral reef) area as well the likely negative impacts from short term construction activities on cultural ecosystem services (such as tourism and recreation).

6.2 Review of the Literature

There have been a few non-maker economic valuation studies conducted in Jamaica. A recent literature review by WRI (2011) looked at 17 studies many of which were focused on Montego Bay, Negril, Portland Bight, Ocho Rios, and Discovery Bay. These locations were likely chosen due to their importance as tourism destinations. Many of the studies emphasized the benefits associated with marine protected areas, particularly their importance in marine conservation. Some of the other studies analyzed the value of the benefits provided by coastal ecosystems, and the costs associated with additional investments in environmental protection and ecosystem management. However one of the findings of this literature review was that even though there has been quite a few marine and coastal economic valuation studies conducted in Jamaica, few of them have had an impact on decision making.

The earliest recorded non-market valuation study was actually done on Negril. Wright (1995) attempted to estimate non-market values of coral reefs. He used both CV and zonal travel cost methods to estimate welfare for coral reefs in Negril. The travel cost estimate of welfare was US$121. Using an open-ended CV method Wright also estimated WTP values ranging from US$31-49 to pay to preserve the coral reefs in Negril. The payment vehicle was a one-time contribution to a reef improvement fund.

The largest study using a stated preference method in Jamaica was a World Bank funded project that looked at the values associated with the coral reef ecosystem in Montego Bay as well as a companion study in Curacao, Netherlands Antilles. The main focus of the study was to provide a valuation of biodiversity with respect to the potential for bioprospecting of coral reef resources (Ruitenbeek and Cartier, 1999). A number of articles have been published on various aspects of this study including the paper by Spash (2000) shown in Table 1. The World Bank study primarily examined the valuation of Montego Bay's coral reefs as a biotechnology resource (Gustavson, 1998; Bunce et al., 1999). As part of the larger study, a semi random intercept survey of visitors and residents was conducted, welfare values were assessed for the reefs in the Montego Bay Marine Park and a hypothetical marine park in Curacao. Street intercept, in-person interviews of locals and tourists were conducted using open-ended elicitation questions.

In Jamaica, respondents were asked for an annual contribution over a period of five years to a trust fund for the existing Montego Bay Marine Park. Respondents were informed that the marine environment was at 75% of its quality potential. They were also informed that if they contributed to the fund, managers would be able to fund initiatives that would raise quality to 100%, while a decline to 60% of quality potential would occur without the trust fund. Using

OLS techniques mean WTP was estimated at $25.89 per year, and there was no statistically significant difference between locals' and tourists' WTP. A comparative study was conducted in Curacao, using a similar payment vehicle (trust fund) and quality scenarios. Mean WTP was estimated to be $25.21 annually, again with no significant differences between locals and tourists.

A study by Dharmaratne et al., (2000) looked at tourism potentials for financing protected areas. They estimated use and non use values for the Montego Bay Marine Park and a proposed Barbados National Park. A payment card format was used and the payment vehicle was an entrance fee to enter the respective parks. For Jamaica, they estimated WTP for access to the resources of the Marine Park at $20 for first time users and $10 for repeat users. Non use value was estimated at $1.45. For Barbados they estimated WTP for access to the park at $109 for first timers and $66 for repeat users.

A study in 2001 by the Environmental Management Unit (EMU) of the University of the West Indies used a zonal travel cost model to estimate consumer surplus for the Ocho Rios Marine Park of US$132 per person who stayed for an average of 10.5 nights (EMU, 2001). The studies described above were either site specific (marine parks) and/or activity specific (scuba diving). It should also be noted that Scuba diving is not one of the primary recreational activities associated with a vacation in Jamaica.

The most recent non market valuation study of Jamaica's coral reefs was conducted by Edwards (2009). This study applied two types of stated preference techniques to provide estimates of the recreational values associated with quality changes to Jamaica's coastal ecosystem. Respondents were either faced with a contingent valuation (CV) scenario where half the respondents were asked their willingness to pay for a generic "Tourism Tax" and the other half were asked their willingness to pay an environmental tax that was to be used for conserving coral reef and beach resources. Other respondents were treated with the other type of stated preference approach, a contingent choice (or choice experiment - CE) survey. Respondents were asked their willingness to pay for preserving various combinations of environmental quality, namely beach, water, reef health and fish life.

The findings of the stated choice study (CE) confirm a priori expectations that a decline in present day beach, water and coral reef quality is least preferred while improvements to the existing environmental quality is most desired by respondents. For a hypothetical decline in quality from the status quo, that is, good beach and water quality and fair marine life, the mean welfare loss for each individual was calculated at US$97 (2008$). Mean welfare gain for an improvement in quality from the status quo was estimated at $22 per individual. Access value (welfare loss from removing Jamaica from respondent's choice set) calculations of $128 per-person also confirm that there is a significant consumer surplus associated with a typical coastal vacation in Jamaica. Both methods (CV and CE) showed that tourists have consumer surpluses (economic benefits) associated with a beach and coral reef vacation that greatly exceed the costs of coastal management (i.e. the costs of environmental protection and restoration).

6.3 Value of Beach Erosion in Negril

The WRI Study by Kushner et al utilized a bioeconomic approach where the analysis utilized two approaches. The authors attempted to quantify (1) the relationship between coral reef degradation and beach erosion in Jamaica; and (2) the relationship between beach erosion and potential losses of tourism revenue in Jamaica (Kushner et al 2011). This report demonstrated how continued coral reef degradation will result in economic losses for Jamaica's travel and tourism industry. The authors combined results from an erosion model and the contingent choice parameters from Edwards' study to produce estimates of economic losses from beach erosion in Negril. As expected the main findings and conclusions of this study made a compelling case for greater investment in reef protection and conservation in Jamaica, including managing coastal development, reducing watershed-based pollution and sedimentation, and promoting sustainable fishing practices.

This study focused on the three main beach tourist destinations in Jamaica—Negril, Montego Bay, and Ocho Rios—which are all impacted by coral reef degradation and associated beach erosion. An average current beach erosion rate of 0.3 m/yr was used for each of these beaches. They applied a model developed by Sheppard et al. (2007) to each of the three sites, to estimate how the further loss of live reef structure and the subsequent erosion of the reef substrate over 10 years would lead to increased wave heights and thus increased beach erosion. The study found that increased coral degradation would lead to significant increases in beach erosion in all three sites over 10 years—more than 50 percent for Montego Bay, 70 percent for Ocho Rios, and more than 100 percent for Negril compared to the current rate.

The abovementioned non-market economic valuation survey (Edwards, 2009), estimated the recreational value of coral reefs and their associated ecosystems (seagrass beds and beaches) in Jamaica. Using a contingent choice approach an annual economic value (to tourists) of US$217 Million was estimated. The study was based on the value of the coral reefs located on the northern coast of Jamaica in other words those reefs that directly and indirectly support the coastal tourism product. Accurate estimates of the area of north coast reef were not available. However for reference reef area in Montego Bay, including the Marine Park, are estimated at approximately 4,500 hectares. With more accurate assessments of reef area one could calculate per hectare per annum values for the value of coral reef ecosystem services. Another study that examined the value of coastal protection services of coral reefs demonstrated that as a result of coral reef decline and expected beach degradation would cause a loss in economic value. Table 1 below presents the consumer welfare loss of the simulation model, showing a decline in attribute quality per meter of beach loss.

Based on the model simulations conducted (Kushner et al) the loss in economic value due to erosion at three north coast beaches is estimated at US$19 million. Additional erosion caused by further reef degradation is estimated to increase this loss to US$33 million after 10 years. This represents an additional US$13.5 million loss of consumer welfare if the reef degrades further. The two studies referenced above demonstrate that there is significant value associated with coral reef and beach ecosystem services.

6.4 *Dominican Republic – Hedonic Value of beach Erosion*

This study sought to estimate the long-term costs of reductions in beach width through beach erosion in the main tourism regions of the Dominican Republic. They investigated the contribution of beach width to the prices of hotel accommodations in the country by applying Hedonic price valuation technique (Wielgus et al 2010).

The hedonic-price valuation technique is based on the premise that the price of a housing unit is determined by the components—such as total size or number of rooms — of the unit (Rosen 1974). Although originally developed to study house prices, the method has also been applied to assessing the determinants of hotel-room prices (White and Mulligan 2002; Fleischer and Tchetchik 2005; Hamilton 2007). By estimating a "hedonic function"—with room prices as the dependent variable and accommodation amenities as independent variables—we can estimate the contribution of each amenity to room prices. We included beach width as an amenity to study its contribution to room prices.

To estimate a hedonic function, they gathered information on room prices and accommodation amenities, including location of the resort (latitude and longitude), size of the resort (number of rooms), beach width (meters), distance to the closest airport (kilometers), star rating (an objective system based on number of amenities, offered by the travel site Expedia®), value rating, and cleanliness rating. The authors also estimated average beach width in front of each resort in the sample using Google™ Earth. Findings from this study are discussed in the following chapter of this report.

7 Findings

7.1 Current Economic Value – Negril Reefs

As stated in previous sections, this analysis is primarily concerned with the economic value of the natural resources or ecosystem services of Negril's reefs and coastal environment. The dominant ecosystem service from the reefs can be classified (under the Millennium Ecosystem Services Framework) as "Cultural Services", that is, Tourism and Recreation. Thus the analysis in this study is heavily based on the recreational values associated with the reefs and nearshore areas. As a reminder, economic value is derived from the primary beneficiaries of the coral reef services (users). The other predominant ecosystem service can be defined as "Supporting Services", namely coastal stabilization/shoreline protection. It is this particular ecosystem service that has been severely degraded thus requiring the need for some kind of mitigation including as an option this particular breakwater construction project. Loss in the protective services of the reef implies that there is a negative loss in value of this ecosystem services. Therefore most of value that exists or has been lost (due to environmental degradation) is attributed to users of the resources including tourists (visitors and locals) and other related beneficiaries. One of the purposes of this rapid analysis is to examine the estimates of current value (status quo), expected loss in economic value under Business as Usual (BAU) scenario i.e. continued beach erosion, and the potential expected increase in value if the design of the breakwaters achieves its intended purpose (stabilization and accretion).

We can first look at estimates of value for the existing coral reef and beach ecosystem in Negril. Edwards (2009) conducted a stated preference survey of visitors to the island to estimate the recreational value visitors place on the presence of beaches and nearshore coastal waters. Using a contingent choice modeling approach, Edwards estimated that the average access (recreational) value for an overall coral reef and beach was US$128 per visitor. This amount represents the value of compensating tourists if they were to experience a total loss of the beach and coral reef recreational services at their destination. It can also be expressed as the tourist's willingness to pay (WTP) to avoid the decline. It is also possible to disaggregate the attributes of a coastal vacation in order to focus on the value the beach adds to visitors' enjoyment. The WRI study used increased erosion rates as inputs and then determined the loss in consumer welfare associated with a decline in beach quality due to erosion at each site based on the Edwards 2009 study. Using this approach they estimated that between 70 and 80 percent of tourists care strongly about the presence of beaches in their visits to Jamaica. It should also be noted that like the tourist board study, Edwards' survey respondents also indicated that beach and beach-related activities played a key role in them deciding to take their vacation in Jamaica.

Using this per person value of US$128 the aggregate value of Negril's beach and reefs can be estimated by multiplying the number of stopover visitors to Negril per annum. This is estimated at USD 45,984,128.00. This aggregate value is likely to decrease as the problem of erosion continues over time. Against this background it should be noted that the commercial value of Jamaica's dive sites and diving related tourism is not a key feature the Tourism Master Plan[1].

7.2 Value/Cost of Erosion

7.2.1 Findings - Value of Coastal Erosion in Negril

The WRI study used Edwards (2009) estimates of visitors' willingness to pay for environmental quality, as the basis to determine the welfare loss per meter loss of beach width. (Kushner et al 2011). The study estimated that at the end of 10 years, current erosion rates at the beaches in Negril, Montego Bay, and Ocho Rios will cause a US$19 million annual loss in value. If reefs

[1] "The JTB Corporate Plan also identifies the dive market as a potential segment to target. No doubt, the 1.8 million divers in the US with their very high incomes represent a potentially attractive market for Jamaica. However, Jamaica's reefs have suffered extensive damage and there are now only a few sites that would prove of interest to the serious diver. Bonaire and other countries offer more spectacular diving. The dive business has been declining and although better promotion would no doubt yield results, this is not as significant a market opportunity as the others."

degrade further, they estimated that the additional beach erosion would increase this loss to US$33 million that year. This represents an additional US$13.5 million, a 70 percent increase in the annual loss of value if the reef degrades further. This loss of value is projected to have knock-on impacts by reducing tourist visitation between 9,000 and 18,000 stopover visitors per year, costing an estimated US$9 million to US$19 million per year to the Jamaican tourism industry and US$11 million to US$23 million per year to the entire Jamaican economy.

Table 1 Annual loss in consumer surplus due to coral and beach degradation

Location	*Annual Welfare loss for status quo ($US Million)*	*Annual Welfare loss if reef erodes ($US Million)*	*Difference Due to reef degradation ($US Million)*
Negril	$5.5	$10.9	$5.3
Montego Bay	$7.1	$10.7	$3.6
Ocho Rios	$6.5	$11.1	$4.6
Total:	**$19.2 million**	**$32.7 million**	**$13.5 million**

Note: The welfare loss was calculated using a per meter value of $5.11 per visitor. (Adapted from Kushner et al 2011)

7.2.2 Findings – Dominican Republic Hedonic Study

A study of the economic values of beaches was conducted in the Dominican Republic by Weilgus et al (2010). The study looked at 87 all-inclusive seaside resorts in the Dominican Republic and found information on hedonic variables for 30 resorts with a combined total of more than 31,000 rooms. Our sample represents 34 percent of all-inclusive seaside resorts and 95 percent of all-inclusive hotel rooms in the country. The mean price (±SD) of accommodation for one person per night was $263 (±$75). They used a linear regression econometric approach, with per person room price as the dependent variable run against independent variables including beach width, room size, distance to the airport etc. Their results indicated that the implicit price of beach width is $1.57 per meter (Weilgus et al, 2010). This means each person has a value of US$1.57 per m width of beach, in other words wider the beach the more valuable. The results from the regression analysis were also used to estimate the potential loss in economic value based on a beach erosion rate of 0.5 m per year. It was shown that the potential annual loss of revenue to these resorts due to erosion was approximately US13.4M with a net present value of potential loss for 10 years of $52-100 million.

This analysis shows that beach erosion has a high potential negative impact on the gross revenue of seaside resorts in the Dominican Republic. Using a hedonic function, they found a statistically significant and positive relationship between beach width and accommodation prices in all-inclusive resorts. Although the effect that beach width had on prices was relatively small compared to that of other predictors of room prices (for example, star rating and perceived satisfaction per dollar spent), a loss of 0.5 meters in beach width would nevertheless potentially result in annual gross-revenue losses of approximately $160,000 for an average-size resort (480 rooms). Thus again confirming that beach erosion has a serious effect on tourism revenues in addition of general economic value.

We can employ a value transfer approach by using this per person value estimate of $1.57 per m and apply it to the beaches in Negril. The Dominican Republic is a Caribbean island, with a very similar tourism product. That is, sun, sea and sand (beach) tourism with a significant compliment of all-inclusive hotels. As a result we can apply this per person implicit value of US$1.57 per meter of beach width. This implies that the wider the beach, the more valuable it is to beach goers and visitors to the island. If a primary hedonic analysis were conducted for Negril, similar results would be expected.

7.3 Current Economic Impact

The total current room numbers is 5,118 in 2012. This is a reduction of 1.6% from 2011. The direct employment is 9,365 persons and induced and indirect employment of 18,730 persons (CL Environmental 2014). Negril's average occupancy is 61.3%[2]. The average expenditure of tourists is USD117.23[3] per person per night. However it is important to note that the aggregate dollar value as a result of expenditures from visitors as measured by occupancy rates and visitor expenditures do not translate to net revenue to the local economy. The direct income for an area is the amount of tourist expenditure that remains locally after taxes, profits, and wages are paid outside the area and after imports are purchased; these subtracted amounts are called leakage (UNEP). In most all-inclusive package tours, about 80% of travelers' expenditures go to the airlines, hotels and other international companies (who often have their headquarters in the travelers' home countries), and not to local businesses or workers. In addition, significant amounts of income actually retained at destination level can leave again through leakage.

A common criticism of tourism is that a great proportion of the benefits derived from tourism leaks to foreign countries (Sandbrook, 2010), which leaves insignificant profits with the host community and only reaches a small number of people. As is to be expected there are very different opinions on tourism and its contribution to economic development. Tourism is criticized to involve a high level of external control and consequently, local communities lack influence on tourism development (Scheyvens, 1999; Tosun, 2000). There is also the fact that there are negative environmental impacts associated with both the development and operational phases of tourism operations. These impacts typically impinge upon the very same coastal resources these entities depend on for their economic viability.

Other economic impacts that need to be considered are the impacts to fishers and independent tour operators (glass bottom boats, Jet Ski operators etc). According to the Negril Breakwater

[2] Jamaica Tourist Board 2012 Annual Tourism Statistics

[3] Jamaica Tourist Board 2012 Annual Tourism Statistics

EIA (CL Environmental 2014) there are about 5 snorkel sites that are located within 100m of the proposed breakwater sites. During the construction phase this will have a negative impact on these operators as access to these sites would be eliminated in the short term. Similarly if individuals use these sites for fishing activities (spear fishing, hook, line and pots). The concerns of these groups need to be taken into consideration during the implementation phase of the project.

7.4 Expected Ecosystem Improvements

If the construction model calculations are correct then based on the coastal improvements and the resultant enhanced ecosystem services economic value is expected to increase. Using results from Edwards 2009 study where he conducted econometric analysis to disaggregate the components (or attributes) of value of coral reef ecosystems. Namely he was able to calculate implicit prices for changes in: Beach, Water, Reef and Fish (Quality and Quantity). Not surprisingly his results show that the highest component of value resides with the beach attribute.

Implicit price calculations from the mixed logit coefficient estimates are shown below (Table 2). These estimates indicate that respondents are willing to pay $60 for an improvement in the quality of the beaches (holding all other attributes constant). While if water quality were to be improved, holding all other attributes constant, respondents would be willing to pay an amount equivalent to $45. However if reef quality were to be improved holding all other attributes constant that respondents would have to be compensated with an amount equivalent to $24. The implicit price for fish abundance was the lowest at $9 and this suggests that if you were to hold all other attributes constant and increase fish abundance, respondents would have to be compensated by this amount. It should be noted that the estimated implicit prices for the reef and fish attributes are based on parameter estimates with low levels of statistical significance and for policy purposes would not carry much explanatory weight.

Table 2 Prices for each Attribute

Quality Attribute	Median	Mean (Std Dev)
Beach	$60.14	**$60.02**
Water	$44.61	**$45.18**
Reef	-$24.06	**-$24.05**
Fish	-$9.44	**-$8.79**

This analysis shows that if beach and water quality were improved there would be a significant increase in the overall economic value in Negril. Intact and restored environmental resources have an aesthetic value for which there is higher demand than for degraded resources. Numerous studies have estimated the marginal increase in property value attributable to restoration by the willingness to pay for a property nearer a restored environmental asset such as a beach (Ghermandi et al. 2010).

8 Discussion

Using Edwards per person value estimate of $128 Negril's beaches and reefs have a current economic value of USD 45,984,128.00. As a reminder, economic value here represents the "worth" of a beach and coral reef vacation to the average visitor. It does not represent costs and expenditures associated with the tourism industry. This (aggregate) value represents the amount over and above what each person has already spent on their beach related vacation.

If the current business as usual scenario continues (coastal erosion and other anthropogenic pressures) there are likely to be significant decreases in economic value of the natural resources in Negril (beaches and marine environment). These losses are estimated in the range of US$10.9 million per year at 2013 (Kushner et al 2011). Using a benefits transfer approach, it can be imputed that tourists on average value the beach at $1.57 per meter width of beach. This value would decrease as average beach width is reduced. This overall reduction in consumer surplus (economic value) that is likely to affect the primary beneficiaries (tourist/beach/coastal resource users) will likely result in a reduction in visitation to Negril as a result of the reduced beach quality. Thus the reduction in tourist expenditures will therefore have negative economic impacts to various key stakeholders and the Jamaican economy over all. The proposed breakwaters will permanently cover a pavement area valued approximately USD 143,700.40. However, the breakwaters will provide protection to USD 59,300,930.48 worth of land. This value is conservative and does not include the value of the buildings and other improvements.

The estimated construction cost of the project USD 5.4 million. This will provide two breakwaters that will shelter 4.95 kilometers of shoreline. This sheltering is projected by the coastal processes models to provide on average additional stabilized beach width of 13.5 meters to the current situation over a period of time (CL Environmental 2014).

Costs to commerce, tourism and loss of the reef in the breakwater footprint are estimated to be USD 528,590.25. This accounts for some potential loss of business in the work area due to increase in traffic flows and additional cleaning and sweeping services as a result of the construction activities. It is noted that the impact from the construction can be mitigated by scheduling off-peak delivery of boulders and thus this cost may not be realized.

There will be expected short-term beneficial economic impacts from the project. Namely with regards to added commerce during construction from: employment, food, fuel sales, haulage, other sales and services. This is valued at USD 1,057,585.

The long-term benefits of the breakwaters are the additional stabilized beach width predicted from the coastal processes models. An additional 13.5 meters of width over 4.95 kilometers is estimated to be valued USD 5,418,711.14 annually in offsetting current losses. This stabilized width also represents a gain in the first instances between the breakwaters being built and the final stabilized shoreline plan form being realized. A period of three years was assumed for this interval based on the historical occurrence of storms and swells. This value of beach is comparable to the estimated land value[4] of USD 6,671,354.68 for the additional area of beach that will be created.

Based on this analysis, it would appear that the trade-offs between the cost of the project, short term disruption and negative environmental impacts when compared to the potential long term economic benefits associated with a stabilized beach that the breakwater project would pass the benefit cost test (see table 1). Please note that because this is primarily a value transfer and desktop analysis, exact benefit cost ratios cannot be calculated. That would have required primary research (either hedonic analysis or a contingent choice survey) which is outside the remit of this analysis and would take considerable time and effort to complete in a timely manner.

[4] Per acre value derived from NLA land valuation, commercial asking prices for lots in the project area and known sale price for two large and recently developed lots in Negril

Table 3 Summary of Cost-benefit analysis for Negril, Jamaica breakwater project

	Costs (USD millions)	Benefits (USD millions)	Net Benefit (USD million)
Short-term (for first 9 nine months)	5.93 (construction = 5.4 + commerce, tourism and dive sites = 0.53)	0.194 (commercial value)	-5.736
Long-term	0.14 (pavement)	5.4	5.26 per annum
Net Internal Rate of Return 2nd year 5th year 10th years			 -26% 63% 73%

8.1 Other considerations

This rapid analysis does not allow for a comprehensive quantitative analysis of all the potential benefit streams that may be affected in the near and long term. For example, it would have been most beneficial if a comprehensive documentation of the level of other recreational activities such as number of snorkel tours to the affected sites as well as the number of fishing trips by local fishermen over some period of time (for example average trips per month) which could then be used to estimate impacts to earnings. These as indicated in previous sections would give some information on pecuniary economic impacts (not value) as a result of the project.

However it is also important to recognize that the construction phase will negatively impact recreational activities in the short term. In the absence of information on the current level of these activities there are some other key questions that should be considered during implementation and post implementation phases of this project. These questions include; How will vessel traffic be affected post construction? Will personal watercraft have unimpeded access around the structures once they have been constructed? Another consideration is the amount and locations of snorkel sites in the leeward side of the breakwaters. Among other things the breakwaters are designed to minimize the impact of high wave energy conditions. If the assumption is that the breakwaters were properly designed then the expectation is that the calmer conditions behind the structures (simulated "back reef" conditions) should provide more snorkel day opportunities, thus increasing the opportunities for income generation. The assumption here is that more stable conditions behind these structures should also provide increased opportunities for other activities such as (banana boats, jet skis, snorkeling etc.). This may represent in the long term improved revenue potential for the recreational sectors. These economic impacts are therefore linked to the improved supporting ecosystem services associated with constructed breakwaters.

Other ecosystem improvements that are likely from properly designed breakwaters are stable current and wave regimes that promote the establishment of seagrass beds and thus potentially increase nursery areas for juveniles of commercially important marine species (fin and shellfish). Thus leading to increased biodiversity and promoting ecosystem resilience with obvious benefits to improved fisheries and non-extractive uses of these areas (e.g. snorkeling). It should be noted that these expected improvements to seagrass beds and other back reef ecological units are dependent on improvements coastal management and other conservation measures. This will require addressing the other anthropogenic pressures such as nutrient loading, high fishing pressure, addressing invasive species, inappropriate coastal development and habitat loss due to swimming beach creation among other pressures.

It is also important to recognize the obvious concern and impact to aesthetics of the seascape as a result of the construction of a man made structure in the coastal waters. This response is not surprising and is an example of the "Not In My Backyard" response to large projects of this nature. These impacts to key stakeholders are important and require transparent and open communication from all stakeholders. It is important for all parties to examine the trade-offs associated with projects such as this. A result of the "Business as Usual" (BAU) scenario will result in the continued overall loss in economic value of the ecosystem services associated with the reefs and protection of back reef areas. This loss in economic value (consumer surplus) is likely to result in direct economic impacts such as reduced visitation and decreased earning potential from the dominant tourism product. Other impacts of BAU scenario is the loss and damage to coastal infrastructure (both private and public) from reduced protective services of the reefs and associated habitats.

Based on a review of the current policy context and applying the results from relevant studies the benefits of a properly implemented breakwater project seem to outweigh the short term negative impacts associated with the project.

9 Conclusions

As a result of decades of environmental neglect, Negril's reefs are in dire straits. Engineering is an unfortunate last resort. Continued environmental degradation is the result of a number of factors including; ignoring rules and regulations (e.g. constructing too close to the shoreline, over capacity of buildings etc) and lack of political will to enforce marine and coastal conservation laws. In this matter all stakeholders are culpable, the local residents, hotel operators and the Government of Jamaica.

The breakwater construction has therefore become a necessary "evil". In a perfect world the ideal option should be a combination of a breakwater and beach re-nourishment. This should be complimented by addressing the issues of coastal water pollution, coral reef rehabilitation and minimizing the removal of seagrass and other sub aquatic vegetation important to the stabilization of beaches and production of sand. For example the breakwater design should also be complemented by live coral transplantation onto hard surfaces if a viable and sustainable source of harvestable coral is available. The breakwater could serve as a basis for coral settling and other sessile reef life. However poor nutrient conditions and a paucity of herbivores (fish and urchins etc) may result in macro algal overgrowth.

With correct engineering designs, the environmental adverse impacts of the footprint of the breakwater should be offset by the long term benefits. Aggressive coral rehabilitation and co management of the Negril Marine Park should be a part of the project. The construction project as currently defined does not include a combined approach for arresting the problem of coastal erosion. This combined approach being a combination of the hard engineering solution (breakwater) done in conjunction with a somewhat softer solution of beach re-nourishment. This approach would probably be the most optimal as it is likely that beach nourishment on its own may have shorter life span and comes with its own disruption in coastal use and loss in aesthetics. One would have to consider the estimated time before sea level rise and erosion from high wave energy would return the beaches to their current state. However it is understood that the budget for this project does not allow for a combined approach. As mentioned previously, a combination of activities are required post breakwater construction to ensure that coastal erosion and coastal ecosystem degradation are halted.

Some other recommendations for consideration are; key stakeholders should have been engaged from the outset. All stakeholders (tourism and private sector, municipal, central government, public) must also recognize the role that they all have played in the overall degradation of the reefs of Negril. This should involve strategies such as public awareness campaigns which should have a combination of high quality signage that contain basic information such as diagrams and artists' renditions of what the final project will look like, including what it will appear like at 1.5 km from the shore. These diagrams and lay-person friendly information should also form part of an aggressive information campaign directed at locals and visitors alike (for example pamphlets and signage at affected properties). These public engagement strategies may serve to alleviate some of the fears of visitor anxiety and demonstrate transparency in the process.

For future studies it is recommended that proper primary socioeconomic data collection is done in advance of similar project implementation. For example the collection of non-market economic values using methods such as Hedonic Valuation (Revealed Preference) and Contingent Choice (Stated Preference) would provide more empirically robust value estimates from which to base decisions.

These approaches however are not inexpensive and require trained professionals to conduct these types of analyses. This approach could be applied to other tourism dependent locations in the island as well as assessing the economic value of coral reefs and beaches to local Jamaicans. Collection of this type of baseline economic information well in advance of these kinds of projects would be very useful for future planning contexts.

10 References

Bunce L, K. Gustavson, J. Williams and M. Miller, (1999). The human side of reef management: a case study analysis of the socioeconomic framework of Montego Bay Marine Park. Coral Reefs; 18:369-389.

Burke, L., K. Reytar, M. Spalding, and A. Perry. 2011. Reefs at Risk Revisited. Washington, DC: World Resources Institute.

Chen, A. and Taylor, M. 2008. Enabling activities for the preparation of Jamaica's Second National Communication to the UNFCCC: Climate scenarios for vulnerability and adaptation. Report by the Climate Studies Group Mona (CSGM), University of the West Indies, August 2008, Kingston, Jamaica

CL Environmental. 2014. Environmental Impact Assessment Construction of Two Breakwaters at Long Bay, Negril, Westmoreland.

Dharmaratne, G.S., F. Yee Sang, L. Walling, (2000) Tourism potentials for financing protected areas. Annals of Tourism Research 27(3):590-610.

Edwards, P.E.T. Mangrove, Seagrass and Coral Reef Community Interactions of the Falmouth Coast, North West Jamaica. M.Phil. Thesis, University of the West Indies, Mona; 2002

Edwards P.E.T., (2009). Sustainable Financing for Ocean and Coastal Management in Jamaica: The Potential for Revenues from Tourist User Fees. Marine Policy 33:376-385

Edwards, P.E.T. 2009. Measuring the Recreational Value of Changes in Coral Reef Ecosystem Quality in Jamaica: The Application of Two Stated Preference Methods. Doctor of Philosophy in Marine Studies thesis, University of Delaware.

Environmental Management Unit, (2001). Socio-Economic Valuation Study of the Ocho Rios Marine Park. Department of Geology and Geography, University of the West Indies.

Etkin, David. "Risk transference and related trends: driving forces towards more mega-disasters." Global Environmental Change Part B: Environmental Hazards 1, no. 2 (1999): 69-75.

Fleischer, A., and A. Tchetchik. 2005. "Does rural tourism benefit from agriculture?" Tourism Manage. 26: 493–501.

Ghermandi, A, J van den Bergh, Brander, L. de Groot, H. and Nunes, P. 2010. Values of natural and human−made wetlands: A meta−analysis,. Water Resources Research 46, W12516, doi:10.1029/2010WR009071.

Gustavson, K., (1998). Values Associated with the Local Use of the Montego Bay Marine Park. Report Prepared for the Environmentally and Socially Sustainable Development Sector Department, Latin America and the Caribbean Region, (LCSES). World Bank, Washington, D. C.

Hamilton, J.M. 2007. "Coastal landscape and the hedonic price of accommodation." Ecol. Econ. 62: 594–602.

Hudson, Brian. 1996. "Paradise Lost: A Planner's View of Jamaican Tourist Development." Caribbean Quarterly (1996): 22-31.

Jamaica Tourism Board 2009. Annual Travel Statistics 2009. Jamaica Tourism Board, 2009.

Khan, S., E. Robinson, R. Coutou, and M. Johnson. 2010. Shoreline Changes and Sea-Level Rise at Long Bay, Negril, Western Jamaica. Kingston, Jamaica: University of the West Indies, Marine Geology Unit, Dept. of Geography & Geology.

Knapp G. 2001 Economics of Resources. Lecture notes for Economics 435. http://www.iser.uaa.alaska.edu/iser/people/Colt/econ435_s04/knappnotes_Impacts%20and%20Value.doc

Kushner, Benjamin, P Edwards, L Burke, and E Cooper. 2011. "Coastal Capital: Jamaica." Coral Reefs, Beach Erosion and Impacts to Tourism in Jamaica. Working Paper. Washington, DC: World Resources Institute.

McKenzie, A. "Beach Responses to Hurricane Impacts: A Case Study of Long Bay Beach, Negril, Jamaica." Caribbean Journal of Earth Science 43 (2012): 51-58.

Millennium Ecosystem Services Assessment. 2005. Guide to the Millennium Assessment Reports . http://www.unep.org/maweb/en/index.aspx

Mitchell, Simon, Shakira Khan, Ravidya Maharaj, and Edward Robinson. "Carbonate beach sediment composition at a tourist beach, Negril, Jamaica." Carbonate Beaches (2000): 204-217.

Mumby, P. J., and A. R. Harborne. 2010. "Marine Reserves Enhance the Recovery of Corals on Caribbean Reefs." PLoS ONE 5: e8657.

Robinson, Edward, Shakira Khan, Richard Coutou, And Monique Johnson. "Shoreline changes and sea-level rise at Long Bay, Negril, western Jamaica." Caribbean Journal of Earth Science 43 (2012): 35-49.

Rosen, S. 1974. "Hedonic prices and implicit markets: product differentiation in pure competition." J. Polit. Econ. 82: 34–55.

Ruitenbeek, H.J. and C.M. Cartier, (1999). Prospecting for marine biodiversity: a case study in Montego Bay, Jamaica (Chapter 13). In Turner K., Bateman I, Adger N (eds) Economics of Coastal and Water resources: Valuing Environmental Functions. Kluwer Academic Press, Dordrecht.

Sandbrook, C., 2010. Putting Leakage in its Place: The Significance of Retained Tourism Revenue in the Local Context in Rural Uganda. Journal of International Development, 22, pp.124-136.

Scheyvens, R., 1999. Ecotourism and the Empowerment of Local Communities. Tourism Management, 20(2), pp. 245-249

Sheppard, C., D. J. Dixon, M. Gourlay, A. Sheppard, and R. Payet. 2005. "Coral Mortality Increases Wave Energy Reaching Shores Protected by Reef Flats: Examples from the Seychelles." Estuarine, Coastal and Shelf Science 64: 223–234.

Spash, C.L. 2000. Assessing the benefits of improving coral reef biodiversity: The contingent valuation method. In Cesar, HSJ, ed. Collected Essays on the Economics of Coral Reefs. Cordio: Kalmar, Sweden. pp242.

Smith Warner International Limited. 2007 Preliminary Engineering Report for Beach Restoration Works at Negril. Smith Warner International Limited, July 2007

Tosun C. 2000. Limits to Community Participation in the Tourism Development Process in Developing Countries. Tourism Management, 21 (6), pp. 613–633.

UNEP – Accessed from the web (June 18, 2014) Negative Economic Impacts of Tourism. http://www.unep.org/resourceefficiency/Business/SectoralActivities/Tourism/FactsandFiguresaboutTourism/ImpactsofTourism/EconomicImpactsofTourism/NegativeEconomicImpactsofTourism/tabid/78784/Default.aspx

White, P.J., and G.F. Mulligan. 2002. Hedonic estimates of lodging rates in the Four Corners Region. Prof. Geogr. 54: 533–543.

Wielgus, J., E. Cooper, R. Torres, and L. Burke. 2010. Coastal Capital: Dominican Republic Case Studies on the Economic Value of Coastal Ecosystems in the Dominican Republic. Washington, DC: World Resources Institute.

Woodley, J. & et al. 2002. Status of Coral Reefs in the Northern Caribbean and Western Atlantic. 296. Australian Institute of Marine Science, Townsville, 2002

World Resources Institute 2011 Coastal Capital Literature Review: Economic Valuation of Coastal and Marine Resources in Jamaica.
http://www.wri.org/sites/default/files/Jam_Literature%20Review_Updated_final.pdf

World Travel and Tourism Council. 2010. Tourism Economic Impact: Jamaica. World Travel and Tourism Council, 2010

Wright M. 1995. An Economic Analysis of Coral Reef Protection in Negril, Jamaica. Working Paper, Series No. 11, Insights in Environment and Development: University of the West Indies, Centre for Environment and Development