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Estimating benefits of investing in resilience of coastal infrastructure in small island developing states: An application to Barbados

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ABSTRACT

Small Island Developing States (SIDS) are the least responsible for climate change, though they bear a disproportionate burden in terms of vulnerability to climate-induced disasters. The economies of many SIDS are also highly dependent on tourism, much of which occurs in potentially hazardous coastal areas and are closely linked to environmental quality. Despite the importance of catalyzing investment in coastal infrastructure to reduce vulnerability and enhance resilience, there is a paucity of research exploring the economic returns to investment to substantiate a business case for this investment. This paper addresses this research gap and develops a model for estimating the economic benefits of shoreline stabilization and illustrates the approach with an application to a US$24.2 million coastal infrastructure investment in Barbados. Results show that the investment generated significant benefits for both tourists and residents, as well as reduced beach erosion and property damage. The approach is versatile facing data constraints, provides evidence to support decisions to scale-up existing investments, and can support and inform the design of new investments.

1. Introduction

Small Island Developing States (SIDS) are the least responsible for climate change (1% of total emissions), though they bear a disproportionate burden in terms of vulnerability to climate-induced disasters [41,43]. The physical attributes of SIDS expose them to the effects of sea level rise and hurricanes. In addition to their physical vulnerability, the economies of many SIDS are highly dependent on tourism which relies on coastal areas and environmental quality. With one in every two tourists visiting a coastal region, tourism has become the main economic activity for many SIDS, which given their location as well as environmental and cultural resources, provides them with an important competitive advantage [43].

Considering the Caribbean Region, the total contribution of tourism to gross domestic product (GDP) was US$53.1 billion or 14.8% of GDP in 2015. Tourism was responsible for over 2.2 million jobs which is equivalent to 13.3% of total employment in the Caribbean [48]. With a significant proportion of tourism activities occurring in the potentially hazardous coastal areas, tourism is particularly vulnerable to climate change, and there is a clear need to reduce vulnerability and risk, manage hazards and enhance resilience in SIDS [27,39,40]. There is increasing recognition that to maintain the environmental features that

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tourists are attracted to, these investments in coastal infrastructure, management and the safeguarding of oceans are critical [39,43].

Enhancing the adaptive capacity of SIDS is a global priority however adaptation measures can be costly, particularly as they relate to shoreline stabilization measures. The mobilization of public investment to enhance shoreline stabilization can be challenging given competing public-sector priorities and increasingly scarce budget allocations. Catalyzing private investment in shoreline stabilization can make up for public investment shortfalls. Demonstrating the economic benefits of shoreline stabilization can make a strong case to support policy decisions in favor of investment in enhancing coastal resilience and can also serve to 'crowd in' private investment, particularly where tourism interests are concerned.

Despite the importance of investing in reducing vulnerability to climate change in SIDS, there is a paucity of research that explores the economic benefits of investments in shoreline stabilization. As such, the business case for these investments is thin from both a public and private investment perspective. Research in this area has tended toward understanding what characteristics of a shoreline are important to visitors [24,32,41], ex-ante estimation of consumer surplus of investments in shoreline improvements, and property valuations related to beach characteristics [22,23,28,37].

This paper addresses this gap in the literature and develops a retrospective ecosystem-based stated preferences model for estimating benefits of shoreline stabilization and coastal resilience, illustrating the approach with an application to Barbados' Coastal Infrastructure Program (CIP). CIP was a US$24.2 million (constant 2002 USD) investment to enhance shoreline stability, coastal resilience and the amenity values of key beaches on Barbados' south coast. This paper is structured as follows. Section two provides an overview of CIP and its key components. Section three presents the study methodology and its implementation, and section four discusses the key findings of the study. Section five concludes the paper with a discussion of the versatility of the approach for assessing investments in coastal infrastructure and resilience and suggests improvements for future applications.

2. Barbados' coastal infrastructure program

The mainstay of Barbados' economy is tourism which in 2014 contributed 36.1% of GDP and over 35% of the island's employment [47]. As a SIDS, Barbados' tourism industry is particularly vulnerable to climate change. Indeed, seventy percent of the hotels in Barbados are located within 250 m of the high-water mark, with many hotels at risk of major structural damage due to climate change [42].

Recognizing the nation's vulnerability to climate change, since the 1980s, the Government of Barbados has been active in integrated coastal zone management (ICZM) to increase coastal resilience. In 1996, the Coastal Zone Management Unit (CZMU) was established as the country's permanent provider of coastal zone management services. Since then, the CZMU has been monitoring and managing complex physical processes that shape Barbados' shoreline and contribute to the country's cultural and aesthetic ecosystem service values. Because of these efforts, Barbados has pioneered the most comprehensive coastal and marine management programs in the Caribbean and is a recognized best practice model and regional leader [36].

Between 2002 and 2010, the Government of Barbados implemented CIP with support from the Inter-American Development Bank. The principle goal of CIP is to enhance shoreline stability, coastal resilience, safe access, and the amenity values for locals and tourists of key beaches on Barbados' south coast. CIP is comprised of three core infrastructure projects, the first two of which are the focus of this study, namely: (i) the Rockley to Coconut Court Waterfront Improvement Project; and (ii) the Holetown Beach Improvement Project. The Rockley to Coconut Court Project included the construction of five landscaped headlands, 1.2 km of boardwalk, revetment and steps, 10,677 m^3 of beach sand recharging, and 38 m of breakwater. The Holetown Beach Improvement Project comprised the construction of two headlands, a new walkway protected by boulder revetment and 2698 m^3 of beach sand recharge.

Both the Government of Barbados and the Inter-American Development Bank have an interest in assessing the economic impact of CIP to demonstrate value for the investment dollar and to substantiate the business case for scaling up current investments and undertaking new ones. The design and integration of an economic impact evaluation strategy within an investment program, however, was much less common in the early 2000's when CIP was implemented than it is nowadays. While monitoring and ongoing evaluation of CIP activities were built into the design of the program, a formal economic impact evaluation strategy was not and therefore, limited baseline information is available. In the absence of baseline data, an alternative to experimental and quasi-experimental economic impact evaluation methods was required and is developed here.

3. Methodology

An ecosystem services approach provides a comprehensive organizational framework for cataloguing, prioritizing and estimating ecosystem service supply [2]. This is the approach taken in this evaluation of CIP. Ecosystem services contribute to human well-being and are classified as provisioning, regulating, cultural and aesthetic and supporting services [16,20,3,28,34,38,39].

The starting point for the quantification of CIP benefits is the prioritization and selection of the ecosystem services to be quantified [12,35,39]. The selection of ecosystem services was undertaken in collaboration with the CZMU, government officials and local experts through a deliberative process. Given the importance of the tourism sector to Barbados' economy, the quantification of cultural and aesthetic ecosystem services was given the highest priority. Next, considering the country's vulnerability to extreme weather events and climate change, storm surge and flooding mitigation were considered the next highest in priority ranking. These two ecosystem services were found to be weighed considerably more than other ecosystem services and therefore were selected as the subject of the evaluation. Beneficiaries of ecosystem service flows were then logically categorized as tourists, residents and local business owners.

To understand how beneficiary groups perceived changes in the flow of cultural and aesthetic and regulating ecosystem service benefits, a stated preference, contingent valuation (CV) approach is used to capture total value which is composed of use and non-use value [11,28,33]. A stated preference methodology is the only technique that captures non-use values [18].

A willingness to pay approach was used to estimate respondents' mean value to maintain the beaches in their current condition. This type of retrospective study faces the 'time traveler' challenge, where respondents cannot be reasonably expected to behave or respond as though the CIP beach projects had not occurred. Thus, the valuation scenario is a program to maintain the improvements and flows of ecosystem service benefits that were generated through CIP.

A single-bounded dichotomous choice format was used since it is an incentive-compatible elicitation format [10] and is the approach recommended by the National Oceanic and Atmospheric Administration (NOAA) Blue Ribbon Panel [1]. The bid values were chosen based on observed values in the literature, consultation with local experts and the survey specialist, and results from the pilot study.

In addition to the questions formulated to estimate economic values, auxiliary questions were included in the survey instrument to understand which characteristics of the CIP beaches beneficiaries value. This information is important to help inform the design of future coastal infrastructure investments.

The Barbados Coastal Zone Management Unit has invested in projects to improve the quality of Rockley (Hastings) Beach and other Barbados beaches and the stability of the coast in general.

Rockley (Hastings) is the beach you are on today.

Please look at the photos of Rockley (Hastings) Beach in the handout.

These photos show the beach **before** and **after** the improvements.

The improvements include:

- maintaining a wide sand beach
- providing connectivity so people can walk from one beach to another
- planting vegetation along the beach
- placing steps from roadway to improve access
- building a sidewalk and benches for sitting

The project also protects the shoreline and properties near the shore from beach erosion and damage from storms.

Fig. 1. Description of Beach Improvements.

3.1. Surveys

Both tourists and residents were surveyed at the Rockley to Coconut Court Waterfront Improvement Project and the Holetown Beach Improvement Project.[1] For tourist and resident surveys, given budget constraints, a minimum of 200 observations each were sought. An on-site interview protocol which involved random interception of beach users at different times of the day and different days of the week was adhered to at each beach [14].

3.2. Survey design

The design of tourist and resident surveys was undertaken in accordance with the principles outlined in Champ et al. [11]. Four versions of the surveys were administered. First, separate surveys were designed for tourists and residents to allow for differences in these two beneficiary groups. Second, separate surveys were designed for Holetown Beach and Rockley Beach so that the surveys could refer to these beaches by name and the CV question could be customized to each beach. Respondents were first informed about the beach resilience projects (Fig. 1) and the survey narrative was accompanied by images showing the beach before and after the beach improvements (Fig. 2).

Tourists and residents were presented the same information and images of the before and after conditions of the beaches, and; both tourist and resident surveys contained a CV question and questions designed to elicit information on respondent beach use, preferences for beach features and respondent personal characteristics.

The issue of consequentiality was placed front and center in the survey design process. A well-designed CV study ensures that respondents believe their decisions are consequential and that policy makers will make decisions in a way that is consistent with respondents' stated preferences [9,40,44]. To emphasize consequentiality of a payment being made, subjects were told:

- "Your answers are very important and will help to make decisions about beach improvement projects."
- They were subsequently told: "The Barbados Coastal Zone Management Unit has invested in projects to improve the quality of Holetown/Rockley Beach and other Barbados beaches and the stability of the coast in general." (Wording varied by survey beach version.)
- Just before the CV question, subjects were told: "To make decisions about maintaining beach improvements the Barbados Coastal Zone Management Unit would like to know how important these improvements are to beach users like you."
- And it was subsequently stated: "If the fee to be paid as you pass through Customs is approved, it will maintain Rockley Beach in the After-Improvement conditions shown in the photographs."

A CV study requires that survey respondents are informed of the mechanism by which a hypothetical change would occur, and the payment vehicle for that change. In this study, the change had already occurred so respondents were asked about their willingness to maintain the current, post-improved condition. Respondents were informed of the need to actively maintain the beaches in their improved conditions and that without maintenance, the site would degrade and eventually revert to their pre-improvement conditions.

Tourists were asked if they would pay a beach fee at customs each time they arrived in Barbados (Fig. 3a). The beach fee for tourists makes the payment mandatory and linking the payment to the actions to maintain the improved beaches addresses consequentiality to elicit truthful responses to the valuation question [9,10,40,42] We used the customs fee because it was the only realistic binding payment vehicle that we and knowledgeable locals could identify, but this payment vehicle is potentially endogenous as respondents could affect payments by adjusting the number of trips they make to the island. However, there is a practical reason why this might not be a concern; the payment amount is small relative to the travel costs (airline fares plus lodging, and cruise fees) required to travel to Barbados.

The beach fee is not feasible for residents and any question that discussed raising taxes on residents was likely to engender significant protest responses. The Barbados government had failed to pay tax refunds for several years and was fining residents for late payment of taxes. No payment vehicle that had a tax component would be accepted by residents. A beach access fee was not practical to implement as beaches are open to public streets. Thus, the payment was posed as an annual, reoccurring reallocation of a portion of taxes residents already pay to the government toward a special fund for beach maintenance and coastal resilience projects (Fig. 3b). This payment vehicle was posed as binding and consequential, but the challenge is that it is not explicit what respondents are giving up if they indicate a positive willingness to pay.[2]

A tax reallocation has been explored previously as a payment vehicle [21,29,31,5], and these studies find that the tax reallocation

[1] See CZMU [15] for detailed site descriptions.

[2] We and others have noted in focus groups that there are some respondents who say they do not believe costs will increase, but that the government budget will be reallocated. This is not an unrealistic assumption even though the valuation scenario says costs will increase. When queried about this assumption, these respondents say their responses reflect the value they place on the improvement whether or not cost increases do indeed materialize.

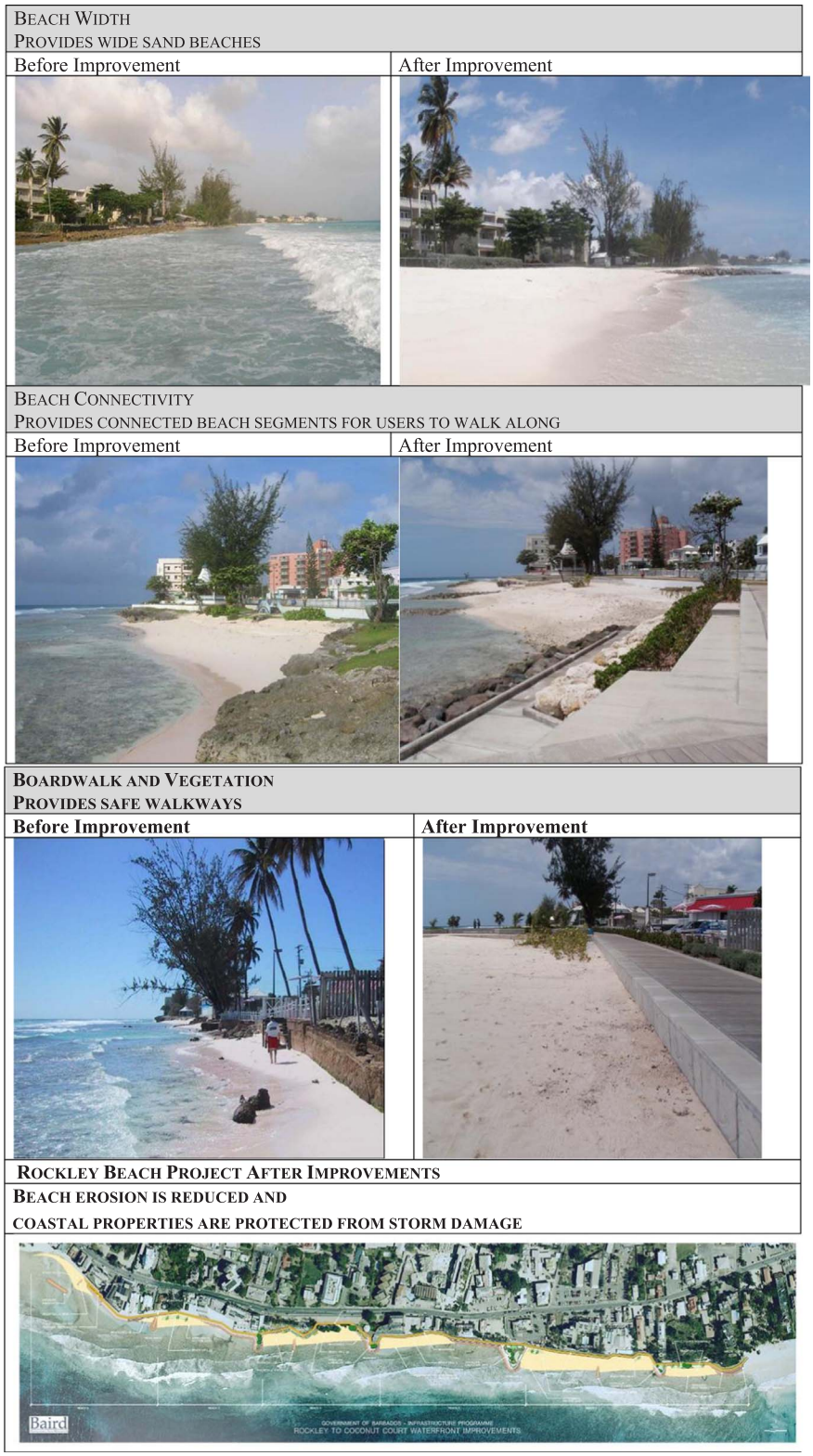

Fig. 2. Before and after images of the Rockley Beach Improvement Project.
Source: Coastal Zone Management Unit, Barbados.

provides higher values than tax payment vehicles. While tax reallocations may not be constrained by income, which can lead to overestimation, rejection of tax payment vehicles may lead to underestimation of the counterfactual in these convergent-validity comparisons [17,30]. This is a fundamental issue with these tests where the truth is not known [6].

Thus, both payment vehicles have complications and there is no ideal payment vehicle [7]. The issue with the entrance fee is that it could lead to under reporting of values and there is evidence that suggests a tax reallocation might lead to over estimation. The local conditions in Barbados limited the choice of payment vehicles that would be credible and these limitations should be considered when evaluating the reported value estimates. That being said, the survey pretesting indicated that subjects found the payment vehicles credible and that they would not engender rejection.

The next step in the survey is to ask the CV question (tourists

A

VOTING ON A TOURIST ENTRANCE FEE TO SUPPORT BEACH MAINTENANCE

To make decisions about maintaining beach improvements the Barbados Coastal Zone Management Unit would like to know how important these improvements are to beach users like you.

If the fee to be paid as you pass through Customs is approved, it will maintain Rockley Beach in the **After Improvement** conditions shown in the photographs.

We are conducting surveys like this on other beaches in Barbados and these surveys will be used to decide how much money to allocate to each beach.

Since you are being surveyed on Rockley Beach, **your vote will be used to allocate funds to Rockley Beach**.

Do you vote for or against a fee of $____BBD where your payment would be used to maintain the Rockley Beach improvements shown in the photographs? (Please circle one number)

1 FOR

2 AGAINST

B

VOTING ON A FUND TO SUPPORT BEACH MAINTENANCE

To make decisions about beach maintenance the Barbados Coastal Zone Management Unit would like to know how important maintaining beach improvements are to beach users like you.

If the fund is approved, it will maintain Rockley (Hastings) Beach in the **After Improvement** conditions shown in the photographs.

We are conducting surveys like this on all of the improved beaches in Barbados.

Since you are being surveyed on Rockley (Hastings) Beach, **your vote will be used to allocate funds only to Rockley (Hastings)**.

This means, when you vote, you should assume your entire tax amount you approve for the fund will be allocated to Rockley (Hastings) Beach.

Do you vote for or against creating a fund where $____BBD from the taxes you already pay would be used to maintain the Rockley (Hastings) Beach improvements shown in the photographs? (Please circle one number)

1 FOR

2 AGAINST

Fig. 3. a. Contingent valuation question- tourist survey. b. Contingent valuation question- resident survey.

Fig. 3a, residents Fig. 3b). The only difference in the CV questions between the tourist and resident surveys is the payment vehicle. The CV questions were the same for Holetown Beach and Rockley Beach. Dichotomous-choice CV questions were used that included one of the following monetary amounts: $12, $24, $39, $64 or $82 BBD.[3] The dollar amounts were randomly assigned to each survey.[4] If respondents answer yes to the CV question, they are revealing a value to maintain the current improved conditions so that they do not revert to the pre-improvement conditions. Thus, the average value computed is the value of the Holetown Beach and Rockley Beach improvements to tourists and residents.

3.3. Survey implementation

Draft tourist and resident surveys were pretested in June 2015. The survey pretesting yielded 58 usable responses, 27 for the tourist survey and 31 for the resident survey. The pilot did not generate any evidence to suggest that respondents had any issue related to the credibility of the scenario [14]. The experience with the pilot led to three types of changes to the survey. First, for some questions, a "Do Not Know" response category was added. Second, for questions with multiple categories of responses, categories that were unlikely to be chosen were eliminated to reduce the complexity of these questions. And third, the text explaining the payment vehicle was clarified.

The tourist and resident surveys were conducted by enumerators walking along Holetown Beach and Rockley Beach. The enumerators covered the extent of these beaches associated with the CIP intervention and the extent of the beaches south and north of the CIP areas up to an impediment that precluded beach users from easily walking any further along the beaches. All individuals who were on the beach, but not in the water were eligible for inclusion in the sample and were approached to participate in the survey.[5] The enumerators conducted surveys between 6 a.m. and 5 p.m. on survey dates. The Holetown Beach surveys were administered from July 19–25, 2015 and August 7–9, 2015.[6] Two hundred tourist surveys and 200 resident surveys were completed. The Rockley Beach surveys were administered from July 22–28, 2015. Rockley is one of the more popular beaches on the island and therefore there was no difficulty obtaining a minimum 200 completed surveys for the tourist and resident surveys [13]. The number of completed surveys is documented in Table 1.

[3] 1 USD is equivalent to 2 BBD.

[4] The survey pretest indicated that these bid amounts were reasonable; there was no indication that the largest bid amount was too high or too low.

[5] By walking back and forth along the beach, enumerators attempted to contact all beach users when they were not in the water. The enumerators used a randomization process to select one person from each party to intercept. Those intercepted were asked to respond for themselves, not for all adults in the party.

[6] The tourism peak season in Barbados runs from December to March. Given the timeline of this study, surveys were implemented in the off-peak period. Ideally, surveys would be repeated in the peak season since it is possible that the type of tourists that visit during the off-peak season differ from those that visit in the peak season, and therefore their willingness to pay may also differ somewhat. Due to time and resource constraints, however, this was not possible in the present study.

Table 1
Number of survey respondents.

	Tourist Survey	Resident Survey	Totals
Holetown Beach	210	203	413
Rockley Beach	415	406	821
Totals	625	609	1234

Beach users that were approached could either agree or decline to participate in the survey. Some respondents declined to reveal whether they were tourists or residents, which is an implicit refusal since the enumerator would not know which survey to administer. Overall, 47% of the beach users approached agreed to participate in the survey; 51% for Holetown Beach and 46% for Rockley Beach [13].

3.3.1. Representativeness of survey data

Due to the short time period over which the surveys were administered, and based on the available information, it is not possible to confirm with certainty that the data collected are representative of tourist and resident beach goers in Barbados, though there is no compelling case suggesting that it does not. Tourism data shows that Barbados has a high volume of monthly tourist visits throughout the year rather than the large peaks and dips characteristic of seasonal tourism destinations [8]. Therefore, the period over which the surveys were implemented is relatively average in terms of arrivals. As another check of representativeness, regarding country of origin, the largest number of respondents was from the United Kingdom, followed by the United States and then Canada. This is consistent with annual tourist arrivals data for Barbados [4].

3.4. Analysis

To test for difference in means, the Pearson chi-square test and the F-test were used. Nonparametric, lower-bound estimates of willingness to pay are reported. The equation is a logit model.

4. Results

4.1. Tourist survey results

About two thirds of the respondents at Rockley and Holetown beaches had visited Barbados previously and slightly more than 50% of those had visited the island more than five times. About two thirds of respondents were on visits of two weeks or less and were typically traveling with their family for recreation. The largest percentages of respondents at both beaches were staying at hotels or rental houses on the beach (39% for Holetown and 47% for Rockley) with the rest staying in hotels or rental houses not on the beach or in other forms of accommodations. Nearly two-thirds of all respondents were visiting Holetown Beach or Rockley beach because these beaches were near where they were staying. In addition, 23% of Holetown Beach respondents and 30% of Rockley Beach respondents said they chose these beaches due to the improved conditions. This finding suggests that as additional coastal resilience projects are completed, tourists that stay at or near beaches will benefit, as should businesses also located in proximity to these sites.

For all tourist respondents, a sandy beach was the most important characteristic informing their choice of beach to visit. This was followed by the presence of nearby restaurants and bars, and then by the number of beach amenities. When asked if they would continue to visit the beaches if they were not maintained and returned to pre-improvement conditions, 60% of Holetown and 63% of Rockley resident visitors said they were “much less likely” or “somewhat less likely” to visit these beaches. These results indicate that the beach improvements are important and valuable to visitors and that interventions that restore and maintain sand on the beaches are particularly important, the impacts of which will have positive spill-overs to nearby businesses catering to tourists.

Table 2 shows the percentage of respondent votes for and against payment of the fee. As the fee increases, tourist respondents’ willingness to pay tends to decline for both Holetown and Rockley Beaches as may be expected.[7]

We use what has become known as the Lewbel-Watanabe estimator to compute willingness to pay to maintain the beach improvements [25,26,38,45,46]. This is a consistent estimator that is an advance over the Turnbull approach [19] with the primary advantage being the ability to compute error bounds on value estimates. Based on responses to the CV question, the estimated value for Holetown Beach is $51 BBD per visitor with a range of $45 to $56 BBD per visitor (95% confidence). The comparable result for Rockley Beach is $43 BBD per visitor with a range of $38 to $46 BBD per visitor (95% confidence). The per visitor value for Holetown Beach is $8 BBD higher, and these two estimates are statistically different at the 5% level.

A logit model (yes = 1, no-0) was estimated to evaluate how a tourist's characteristics influence their responses to the CV question (Table 3). The results show that as the tourist fee increases, tourists are less likely to answer “yes” to the CV question, which is the expected relationship. The significant, negative coefficient for the Rockley Beach variable indicates that tourists place a higher value on Holetown Beach compared with Rockley Beach. Respondents who would not return if the improvements were not maintained, have a higher willingness to pay. Those who said that a sandy beach or a boardwalk was not important to them have lower willingness to pay and this same relationship holds for respondents who said that parking is important. Those who were visiting Barbados with work associates have lower willingness to pay for the beach improvements.

When tourists were asked why they would pay to maintain the improved beaches, the primary reasons were to maintain current beach conditions or to preserve the greater benefits that the improved beaches provide (Table 4). The top reasons to oppose payment for maintaining

Table 2
Votes for and against payment of fee for maintenance of beach improvement.

Fee		Holetown			Rockley			
$ BBD	For	Against	No response	Don’t know	For	Against	No response	Don’t know
12	81%	17%	0%	2%	64%	34%	2%	0%
24	71%	24%	6%	0%	59%	39%	3%	0%
39	79%	21%	0%	0%	48%	48%	3%	0%
64	56%	41%	0%	3%	47%	47%	5%	2%
82	36%	62%	2%	0%	46%	50%	4%	0%

[7] The percent yes at the highest bid amount suggests that some people would have answered yes if higher bids were included in the design, but were not included in the design because higher bid amounts were not supported by the results from the survey pretest, and local experts felt that higher bid values would not be viewed as credible.

Table 3
Logit Models of Responses to CV Questions (1 = yes, 0 = no).

Variables	Coefficient Estimates	
	Tourists (Standard Errors)	Resident (Standard Errors)
Fee ($12, $24, $39, $64, $82 BBD)	−0.016*[a] (0.003)	−0.012* (0.004)
Rockley (1 Rockley Beach, 0 Holetown Beach)	−0.552* (0.206)	0.122 (0.241)
Sex (1 male, 0 female)	−0.079 (0.193)	−0.328 (0.237)
Age	0.003 (0.007)	0.025* (0.008)
Education (1 Preprimary, 2 Primary, 3 Secondary, 4 Senior/Composite, 5 Post Secondary, 6 Tertiary)	−0.189* (0.091)	0.039 (0.078)
Been to Beach (1 previously visited, 0 otherwise)	0.258 (0.210)	1.276* (0.623)
Before 2008 (1 visited beach before 2008, 0 otherwise)	NA	0.447* (0.246)
Beach Return (1 return if improvements not maintained, 0 otherwise)	0.249 (0.435)	0.667 (0.424)
Beach Not Return (1 not return if improvements not maintained, 0 otherwise)	0.591* (0.204)	0.627* (0.234)
VI-Sandy Beach (1 very important. 0 otherwise)	−0.140 (0.300)	0.136 (0.278)
VI-Wide Beach (1 very important. 0 otherwise)	0.115 (0.237)	0.190 (0.274)
VI-Long Beach (1 very important. 0 otherwise)	0.161 (0.241)	0.212 (0.293)
VI-Connected Beaches (1 very important. 0 otherwise)	0.285 (0.246)	0.176 (0.291)
VI-Beach Boardwalk (1 very important. 0 otherwise)	−0.073 (0.235)	0.021 (0.281)
VI-Flat Beach (1 very important. 0 otherwise)	0.300 (0.227)	−0.295 (0.261)
VI-Beach Benches (1 very important. 0 otherwise)	0.048 (0.235)	0.137 (0.283)
VI-Nearby Restaurants (1 very important. 0 otherwise)	−0.301 (0.285)	−0.447 (0.333)
VI-Nearby Bars (1 very important. 0 otherwise)	0.050 (0.292)	0.603* (0.343)
VI-Nearby Parking (1 very important. 0 otherwise)	−0.576* (0.254)	0.114 (0.281)
NI-Sandy Beach (1 not important. 0 otherwise)	−1.333* (0.722)	−0.244 (0.474)
NI-Wide Beach (1 not important. 0 otherwise)	0.257 (0.319)	0.216 (0.356)
NI-Long Beach (1 not important. 0 otherwise)	0.314 (0.308)	−0.484 (0.315)
NI-Connected Beaches (1 not important. 0 otherwise)	0.054 (0.237)	0.365 (0.275)
NI-Beach Boardwalk (1 not important. 0 otherwise)	−0.531* (0.288)	−0.003 (0.307)
NI-Flat Beach (1 not important. 0 otherwise)	−0.045 (0.278)	0.366 (0.304)
NI-Beach Benches (1 not important. 0 otherwise)	−0.262 (0.288)	0.104 (0.374)
NI-Nearby Restaurants (1 not important. 0 otherwise)	0.113 (0.396)	0.037 (0.393)
NI-Nearby Bars (1 not important. 0 otherwise)	0.174 (0.327)	−0.361 (0.355)
NI-Nearby Parking (1 not important. 0 otherwise)	−0.180 (0.262)	0.055 (0.385)
Beach near (1 visited because near lodging, 0 otherwise)	0.226 (0.211)	−0.467* (0.263)
Beach recommended (1 visited because recommended, 0 otherwise)	−0.057 (0.241)	−0.666* (0.361)
Beach improved (1 visited because of improvements, 0 otherwise)	0.199 (0.214)	0.332 (0.233)
By myself (1 visited Barbados by self, 0 otherwise)	−0.307 (0.427)	NA
With family (1 visited Barbados with family, 0 otherwise)	0.102 (0.331)	NA
With friends (1 visited Barbados with friends, 0 otherwise)	−0.209 (0.304)	NA
With work associates (1 visited Barbados with work associates, 0 otherwise)	−0.043 (0.586)	NA
Walk (1 walk to beach, 0 otherwise)	NA	0.469 (0.318)
Drive (1 drive to beach, 0 otherwise)	NA	−0.093 (0.304)
Bus (1 bus to beach, 0 otherwise)	NA	−0.130 (0.299)
Erosion (1 project reduced beach erosion, 0 otherwise)	NA	1.015* (0.289)
Damage (1 project reduced risk of storm damage to beach, 0 otherwise)	NA	−0.107 (0.249)
No effect (1 project had no effect on erosion or storm damage, 0 otherwise)	NA	−0.480 (0.417)
Other (1 project had other effect, 0 otherwise)	NA	0.743 (0.537)
Constant	1.821* (0.779)	−2.614* (1.000)
Log Likelihood	84.79*	9.78*
N	585	609

[a] Asterisks denote significance at the 10% level.

Table 4
Motivation for voting for or against paying to maintain beaches.

	Holetown	Rockley
Why pay to maintain beaches		
Maintain current beach conditions	25%	21%
Preserve beauty/economy/wildlife of island/beach	13%	12%
Small price for large benefit	12%	9%
Encourage tourism	8%	6%
Good cause	3%	3%
Why not pay to maintain beaches		
Too much money	14%	21%
Beaches should be free	8%	6%
Get money from elsewhere	3%	5%
Will hurt tourism	2%	3%
Don't use beach	1%	2%

Table 5
Resident perceptions of Beach Improvements.

	Holetown Beach	Rockley Beach
Visited before 2008?	74%	74%
Rating of beach quality change since 2008		
Substantial Improvement in Quality	81%	84%
Small Improvement in Quality	15%	10%
No Effect	2%	4%
Small Decrease in Quality	1%	1%
Effects of beach resilience projects		
Reduced beach erosion	74%	66%
Reduced risk of storm damage to properties	58%	49%
No effect	10%	16%

Table 6
Votes for and against reallocation of taxes for maintenance of beach improvement.

Tax allocation	Holetown			Rockley		
$ BBD	For	Against	No response	For	Against	No response
12	70%	20%	9%	82%	14%	4%
24	78%	17%	6%	61%	31%	9%
39	68%	25%	7%	65%	31%	4%
64	78%	19%	3%	81%	17%	1%
82	51%	42%	7%	57%	38%	5%

the improved beaches are that the fee was too high and the sentiment that well-maintained beaches should be free.

4.2. Resident survey results

Fifty-four percent of resident respondents visit the beaches daily or weekly. At Holetown Beach, the primary reason for visiting the beach is proximity to the respondent's home, while appealing beach conditions are the primary reason at Rockley Beach. At least two-thirds of all respondents also visit other beaches regularly. Approximately three out of four respondents had visited the beaches before 2008, which is before the completion of beach improvements (Table 5). Of those who had visited the beaches prior to 2008, over 80% think that the projects resulted in a substantial improvement in beach quality. Respondents think reduced beach erosion is the main impact and over half of all respondents think that improvements resulted in reduced property damage. This result is indicative of the value that residents place on regulating ecosystem services related to coastal resilience.

When asked if they would continue to visit the beaches if they were not maintained, and eventually returned to their pre-improvement conditions, 44% of Holetown and 60% of Rockley residents said they were “much less likely” or “somewhat less likely” to visit these beaches. These results indicate that the beach improvement projects are valuable to residents. Even those who did not say they were less likely to visit may have done so because the beaches are located near where they reside and are therefore convenient to visit. Due to this convenience, although they may not reduce their visitation if the beach were to return to pre-improvement conditions, these residents still benefit from the enhanced cultural and aesthetic ecosystem services the beaches provide.

As is the case for tourists, a sandy beach is the most important beach characteristic for residents, followed by the number of amenities such as availability of parking and benches. While restaurants and bars rank lower in terms of important characteristics for residents compared with tourists, the percentages are not substantially different; tourist percentages are slightly greater than 50% and resident percentages are less than 50%. This indicates that a substantial proportion of residents are customers of the restaurants and bars located near the study beaches and their increased visitation should result in positive spill-overs for local businesses.

Table 6 shows the votes for and against the reallocation of taxes for maintenance of beach improvement. There is a general trend toward willingness to pay as the amount of the reallocation increases, though for both Holetown and Rockley, there was a relatively high proportion of respondents that indicated a willingness to pay of $64 BBD for beach improvement.

The Lewbel-Watanabe estimator is again used to compute willingness to pay to maintain the beach improvements. Based on responses to the CV question, the estimated value for Holetown Beach is $57 BBD per resident with a range of $51 to $62 BBD per resident (95% confidence interval). The comparable result for Rockley Beach is the same when rounded to the nearest dollar at $57 BBD per resident with a slightly narrower range of $54 to $61 BBD per resident (95% confidence). The per resident value for Holetown Beach is less than $1 BBD different from the Rockley Beach per resident value, and this difference is not statistically significant at the 5% level.

Table 7
Motivation for voting for or against paying to maintain beaches.

	Holetown	Rockley
Why Pay to Maintain Beaches		
Maintain current beach conditions	25%	25%
Preserve beauty/economy/wildlife of island/beach	15%	16%
Small price for large benefit	12%	9%
Encourage tourism	15%	10%
Good cause	6%	5%
Why Not Pay to Maintain Beaches		
Too much money	11%	12%
Get money from elsewhere	4%	3%
Corruption	3%	3%
Taxes will eventually increase	2%	1%
Should support entire island, not just one area	1%	25

Noteworthy is that the highest fee amount of $82 BBD did not elicit negative vote responses under 50% at either beach. The interpretation of this result is that the median values for both beaches are greater than $82 BBD, and therefore, had fees higher than $82 BBD been included in the survey, more positive “for” responses would have been obtained and the willingness to pay estimates would have been higher than those presented here.

The logit equation analyzing resident responses to the CV question demonstrate a number of differences from the tourist results (Table 3). Again, the results show that as the amount of tax reallocation increases, residents are less likely to answer “yes” to the CV question. The Rockley Beach variable was not significant in this equation, which indicates that residents place a similar value on the improvements at Rockley and Holetown Beaches. Older residents and those who have a history of visiting the beaches have a higher willingness to pay. Residents who indicated that nearby bars are important also hold higher values for the beach improvements, which indicates that residents may visit bars concurrent with beach visits. Those visiting because the beaches were recommended hold lower values, while those who think the improvements reduce beach erosion hold higher values.

When asked why residents would agree to the reallocation of their taxes to maintain the beach improvements, the primary reasons were to maintain current beach conditions or to preserve the greater benefits that accrue from the improved beaches (Table 7). These same reasons were also the top reasons expressed by tourists. The top reason to oppose payment is that respondents felt it was too much to pay, which is also consistent with tourist responses (Table 8).

5. Conclusions

This study contributes to the literature by providing empirical evidence of the benefits of investing in coastal infrastructure and

Table 8
Motivation for voting for or against paying to maintain beaches.

	Holetown	Rockley
Why Pay to Maintain Beaches		
Maintain current beach conditions	25%	25%
Preserve beauty/economy/wildlife of island/beach	15%	16%
Small price for large benefit	12%	9%
Encourage tourism	15%	10%
Good cause	6%	5%
Why Not Pay to Maintain Beaches		
Too much money	11%	12%
Get money from elsewhere	4%	3%
Corruption	3%	3%
Taxes will eventually increase	2%	1%
Should support entire island, not just one area	1%	25

enhancing resilience for reducing climate vulnerability in SIDS which can be used to substantiate the business case for new investments and the scaling-up of existing investments. An ecosystem service-based retrospective stated preference approach was developed to examine the benefits that tourists and residents derived from the CIP investment to improve beaches.

Results show that CIP investments had a positive impact on enhancing cultural and aesthetic ecosystem services for both tourists and residents. Between 23% and 30% of tourists were drawn to the beaches because of the improved beach conditions. Resident visitors showed even stronger preferences for the improved conditions with over 60% stating that they were less likely to visit if the beach returned to its pre-improved condition. Eighty percent of residents indicated substantial improvements in beach quality, identifying the reduction in beach erosion as one of the main impacts. Over half of resident respondents stated that beach improvements reduced property damage caused by heavy storm events. These results provide evidence of the importance residents place on regulating ecosystem services.

Tourists were found to value the beach improvements at Holetown and Rockley beach at $51 BBD per visitor and $43 BBD per visitor, respectively, while residents valued the improvements at Holetown Beach and Rockley Beach similarly at $57 BBD per resident. Though tourist and resident visitation rates at the two beaches were unknown at the time of the study, should an estimate become available, the aggregate benefit tourists and residents derived from the beach improvements could also be estimated. The study would be further complemented with a second round of tourist and resident surveys undertaken in the peak tourism season.

The large percentage of subjects answering yes to the highest bid amounts among tourists and residents is a concern, which suggests higher bid amounts would have been desirable in the survey design. Unfortunately, this was not indicated by the pretest results. The Lewbel-Watanabe estimator trims the response distribution at the highest bid amount so that conservative estimates of value are reported.

The results of this analysis can be used to guide future investments in coastal infrastructure and resilience. For example, future investments should be careful not to inadvertently divert foot traffic from businesses because of new coastal infrastructure. In the case of investments targeting the enhancement of cultural and aesthetic ecosystem services for tourists, widening of sandy beaches is important. Certainly, any deterioration in conditions is likely to be perceived due to high repeat visitation in Barbados; two-thirds of beach tourists had visited Barbados before, 50% of which had visited the island 5 or more times. If residents are the target beneficiary group, increasing beach connectivity and length, areas that are apt for resident use and congregation, and enhancing regulating ecosystem services are important. The evidence generated on tourist and resident benefits coupled with a subsequent quantification of CIP investment impacts on reducing erosion and reducing property damage, communicated effectively, could be used to catalyze collective action around investments in coastal infrastructure and resilience, protection and maintenance.

As an approach to valuing the benefits of investments in coastal infrastructure and resilience, the methods developed here proved to be versatile and appropriate when: experimental and quasi-experimental methods are not feasible; baseline data is unavailable; it is not possible or desirable to select and separate a treatment and control group, and; treatment and control outcomes are not easily defined. This approach is transferable to other climate vulnerable SIDS with a high reliance on tourism as an economic development strategy.

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