DOCUMENT OF THE INTER-AMERICAN DEVELOPMENT BANK

BELIZE

CLIMATE VULNERABILITY REDUCTION PROGRAM

(BL-L1028)

MONITORING AND EVALUATION PLAN

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Contents

ABBREVIATIONS

AOP	Annual Operations Plan
DRM	Disaster risk management
EA	Executing Agency
ESMR	Environmental and Social Management Report
GOB	Government of Belize
IDB	Inter-American Development Bank
MOW	Ministry of Works
M&E	Monitoring and evaluation
PCR	Project Completion Report
PEP	Project Execution Plan
PMR	Progress Monitoring Report
PMU	Program Management Unit
POM	Program Operating Manual
PP	Procurement Plan
PR	Progress Report
RM	Results Matrix

I. Introduction

1.1. This document presents the Monitoring and Evaluation (M&E) Plan of the Climate Vulnerability Reduction Program (BL-L1028) to ensure the achievement of results and compliance with the targets set in the Results Matrix. The Plan is divided into the Motoring Plan and Evaluation Plan. The Monitoring Plan includes: (i) indicators to monitor, its baseline and target; (ii) the critical path of monitoring of the accomplishment of activities and products during the execution of the program; (iii) a description, timeline and the agents responsible for the basic tools for monitoring, and; (iv) a methodology, specific activities and a budget for implementing the monitoring. The Evaluation Plan consists of the ex-post economic impact evaluation strategy. The strategy focuses on the methodology for the ex-post evaluation, coordination of activities and an indicative budget for implementing the strategy.

1.2. The objective of this intervention is to reduce Belize's climate vulnerability and risk through the implementation of climate resilient measures in the tourism sector and the improvement of Belize's disaster risk management (DRM) governance. The Climate Vulnerability Reduction Program's specific outcomes are (i) the mitigation of risk for residents; (ii) the enhancement of tourism in the intervention sites; and (iii) the improvement of government performance in disaster risk governance. Aligned with these objectives, the Climate Vulnerability Reduction Program consists of two components: (i) climate risk reduction in the tourism sector, to carry out flood reduction investments, beach shoreline stabilization works and management and monitoring plans for reef and coastal ecosystems; and (ii) governance for disaster risk management and climate change adaptation, to develop and disseminate the software to create a National Climate Risk information system, support the Central Building Authority in the design of a technical guidance for building in coastal areas, including nature-based solutions, and design a climate risk financing strategy for the tourism and agriculture sectors.

1.3. In the following section, the monitoring plan is presented. Next, the impact evaluation strategy is described and the empirical strategy to the evaluation is discussed at length. This plan closes with details of coordination and an indicative budget for the impact evaluation strategy.

II. Monitoring

2.1. This section describes the monitoring process of the loan program. The Inter-American Development Bank (IDB) and the Government of Belize (GOB) are in agreement that the activities specified herein are an integral part of the loan activities.

2.2. The main tools and reports for the monitoring, in addition to the present M&E Plan, are: (i) Results Matrix (RM); (ii) Project Execution Plan (PEP); (iii) Program Operating Manual (POM); (iii) detailed budget; (iv) Procurement Plan (PP); (v) Progress Monitoring Report (PMR); and (viii) Project Completion Report (PCR).

2.3. IDB and GOB have agreed on the use of the RM, which presents detailed information on the program's expected outcomes and outputs and their corresponding intermediate and end-of-project targets, as well as the activities defined in the PMR, as fundamental instruments to monitor this operation.

2.4. The Monitoring and Evaluation System will rely on three components:

2.4.1. Semi-annual monitoring reports prepared by a M&E specialist affiliated to the Program Management Unit (PMU) of the Ministry of Works (MOW), in its capacity as Executing Agency (EA), that describe: i) the physical progress of the program (i.e., in terms of output indicators); ii) the progress made in terms of outcomes and impacts, as stipulated in the Results Framework; iii) the status of applicable environmental and social mitigation measures; iv) lessons learned; and iv) any other issues related to the execution of the program, such as critical events and risks.

2.4.2. Mid-term and final independent evaluations (the latter will include an ex-post economic analysis of the program using the same methodology as the ex-ante economic analysis but with actual program data) focusing on the program's effectiveness, efficiency, sustainability, relevance and coherence.

2.4.3. An impact evaluation based on a quasi-experimental research design.

2.5. The PMU will be responsible for the operational monitoring of the program at all levels for both Components I and II. Consulting firms will be contracted by the PMU to carry out mid-term and final independent evaluations as well as for the implementation of the impact evaluation.

A. Indicators

2.6. Table 1 presents the information for specific sources and instruments to measure outputs.

Table 1. Output indicators

Output	Unit of measure	Frequency of measurement	Means of verification
Component 1: Climate risk reduction in the tourism sector			
Output 1.1: Flood reduction investment works in Belize City, executed	Project sites (#)	Biannual	Semiannual progress reports
Output 1.2: Coastal protection hybrid and nature-based infrastructure in Caye Caulker, implemented	Types of Structure measures (#)	Biannual	Semiannual progress reports
Output 1.3: Coastal protection intervention and tourism enhancement in Goff's Caye, implemented	Types of Structure measures (#)	Biannual	Semiannual progress reports
Output 1.4: Management plans approved	Plans (#) approved	Biannual	Semiannual progress reports
Component 2: Governance for disaster risk management and climate change adaptation			
Output 2.1: Climate Risk Information System, in operation	Accomplishment of milestone (#)	Biannual	Semiannual progress reports
Milestone 2.1.1.: Climate Risk Information System, designed	System design completion (%)	Biannual	Semiannual progress reports
Output 2.2: Communication plan for risk information accessibility, completed	Planning document (#)	Biannual	Semiannual progress reports
Output 2.3: Tourism and land use building codes incorporating nature-based solutions, approved	Proposal document submitted (#)	Biannual	Semiannual progress reports
Output 2.4.: Climate Risk Financial Strategy for the Agricultural and Tourist Sector	Proposal document and a 5-year operative plan submitted (#)	Biannual	Semiannual progress reports

B. Data Collection and Instruments

2.7. The PMU will be established within the MOW properly staffed with specialized personnel, including a program coordinator, a procurement specialist, a financial specialist, an environmental and social specialist, and a monitoring and evaluation specialist. The PMU will be responsible for ensuring the planning and implementation of the yearly operational plans in accordance with the PEP and this M&E plan. The monitoring and evaluation specialist will be responsible for collecting necessary data for monitoring the indicators.

2.8. Monitoring data will be compiled from semiannual progress reports. Supplementary information will be obtained during on-site inspections, and/or from baseline and follow-up surveys for the ex-ante economic analysis and the impact evaluation of the program, as well as statistical datasets provided by the GOB or available on GOB's websites.

C. Reporting

2.9. To accommodate the reporting requirements of both the EA and the IDB, the PMU will prepare a detailed Annual Operations Plan (AOP) 60 days prior to the beginning of each calendar year. Semi-annual Progress Reports (PR) will be presented within 60 days after the end of each six-month period during program execution.

2.10. The AOP will be supported by the Project PP for the acquisition of goods and services; and a financial plan, based on estimated procurement costs and other program activities to be undertaken. The AOP and Progress Reports (PR) will be prepared following a template consistent with the Bank's PMR. The AOP for the following calendar year shall include: i) a forecast of disbursements; ii) an updated PP; iii) detail achievements in relation to planned activities, outputs and outcomes, among others; iv) budget analysis, disbursement and financial plan; v) Output Indicators and Costs – PMR Matrix.

2.11. The semi-annual PRs will focus on the fulfillment of output indicators and progress towards achieving the outcomes proposed in the Results Framework, analyze the problems encountered and propose corrective measures. The PR shall include: (a) physical progress; (b) financial progress in terms of commitments, payments and disbursements under the loan; (c) updated financial plan; (d) outputs and outcomes measured against program indicators; (e) work plan and related budgets for the next 6 months; (f) unaudited financial statements; (g) a description of actions taken to guarantee the operating conditions of equipment purchased by the loan; and (h) the output indicators and costs matrix required for the IDB PMR. The PR also includes the updated maintenance plans of the infrastructure works concluded and transferred to the participating institutions.

2.12. Within 60 days after the last disbursement date, the PMU will prepare a final report, summarizing all the PRs prepared during the program's life and will organize a closing workshop to present and discuss the PCR prepared by the Bank.

D. Monitoring Coordination, Work Plan and Budget

2.13. A comprehensive program monitoring will be performed by the Bank project team and the Bank's Country Office in Belize. The project team will conduct inspection visits to the program every six months during the operation's execution period. In addition, the team will conduct annual management missions to assess progress. For its part, the PMU will submit semiannual execution progress reports to the Bank within 60 days following the end of each six-month calendar period, as described in the monitoring and evaluation plan, including action taken to comply with the Bank's environment and safeguards policies. These reports will include at a minimum, the following: (i) executive summary, analyzing the program's physical and financial execution; (ii) monitoring report; (iii) updated PEP and AOP; (iv) risk matrix update; (v) Environmental and Social Management Report (ESMR); and (v) PP.

2.14. MOW will submit to IDB: (i) a midterm, independent evaluation report no later than 36 months after the date of entry into force of the loan agreement; and (ii) a final independent evaluation report, within 90 days after the date on which 90% of the loan proceeds have been disbursed or after the Bank's official request. The final evaluation report shall include a preliminary analysis of the program's impact evaluation.

2.15. Table 2 provides details on the responsible entities for the implementation of the monitoring plan, monitoring activities, budgetary allocations for each activities and sources of funding. Project costs, as established in the PEP, are disaggregated by output (Table 3) and by year (Table 4).

Table 2. Timeline of activities, agent responsible, cost and source of funding

Activity	**Year 1**				**Year 2**				**Year 3**				**Year 4**				**Resp.**	**Cost (USD)**	**Source of Funding**
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4			
RM, Risk Matrix, semi-annual PRs and PEP																	M&E specialist	0	N/A
Mid-term evaluation																	EA	15,000	BL-L1028
Final evaluation																	EA	20,000	BL-L1028
Inspection visits																	IDB	25,000	IDB Transactional Budget
Administrative missions																	IDB	20,000	IDB Transactional Budget
Day-to-day project monitoring																	EA/ IDB	12,000	IDB Transactional Budget
External audits																	EA	100,000	BL-L1028
Total cost																		222,000	

Table 3. Costs per output, USD

Output		Total IDB (USD)	%
	Component 1: Climate risk reduction in the tourism sector	8,539,641	85
1.1	Flood reduction investment works in Belize City, executed	6,960,720	69
1.2	Coastal protection hybrid and nature-based infrastructure in Caye Caulker, implemented	360,000	4
1.3	Coastal protection intervention and tourism enhancement in Goff's Caye, implemented	601,400	6
1.4	Management plans approved	403,691	1
	Component 2: Governance for disaster risk management and climate change adaptation	618,241	6
2.1	Climate Risk Information System, in operation	418,241	4
2.2	Communication plan for risk information accessibility, completed	60,000	1
2.3	Tourism and land use building codes incorporating nature-based solutions, approved	70,000	1
2.4	Climate Risk Financial Strategy for the Agricultural and Tourist Sector	70,000	1
	Project management	842,298	8
	Project Administration Unit	627,298	6
	Evaluations	115,000	1
	Audits	100,000	1
	Total	10,000,000	100.0%

Table 4. Program disbursement projections, USD 1,000

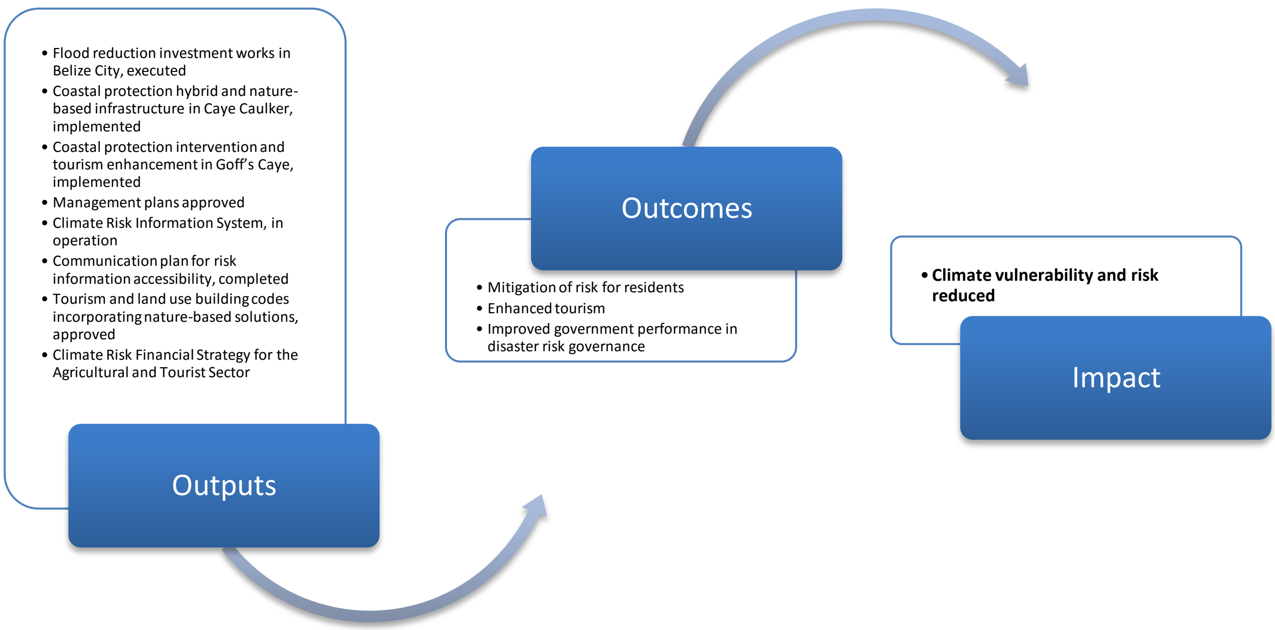
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Total**
BID and Total	1,533	1,500	1,936	5,031	10,000
% Total	15%	15%	20%	50%	100%

III. Evaluation

A. Logic of Intervention and Main Hypotheses

3.1. The Climate Vulnerability Reduction Program (BL-L1028) consists of two components: (i) climate risk reduction in the tourism sector; and (ii) governance for disaster risk management and climate change adaptation. Through these components, the program seeks to reduce Belize's climate vulnerability and risk through the implementation of climate resilient measures in the tourism sector and the improvement of Belize's DRM governance. The Climate Vulnerability Reduction Program's specific outcomes are (i) the mitigation of risk for residents; (ii) the enhancement of tourism in the intervention sites; and (iii) the improvement of government performance in disaster risk governance. The impact to be measured is the effect of the intervention on the reduction in the economic losses (including reduced income from tourism) caused by floods in Belize City's Orange St. Area and in Caye Caulker, as well as tourism enhancement in Goff's Caye. The theory of change through which we expect to attain the abovementioned outcomes is shown in Figure 1 below.

Figure 1. BL-L1028 Theory of Change



3.2. Component I will finance (i) implementation of climate resilient flood control measures that consider climate change scenarios to protect public and private infrastructure in tourism and residential areas of downtown Belize City; and (ii) shoreline stabilization measures on public land in public tourism areas in Caye Caulker and Goff's Caye. Component II will finance (i) studies and the procurement of goods and services for the development and dissemination of a National Climate Risk information system; a web platform to share the existing climate risk information that will be hosted in the National Climate Change Office under the Ministry of Forestry, Fisheries and Sustainable Development, and (ii) the design of a technical guide for building in coastal areas, including nature-based solutions, produced by the Central Building Authority; and (iii) the design of a climate risk financing strategy for the tourism and agriculture sectors.

3.3. Reduced vulnerability to climate risks stems from an increased capacity to absorb the negative impact of a disaster, which is reflected in reduced economic losses caused by floods as a result of the implementation of the program. Such avoided losses can be direct (physical damage to infrastructure and assets) or indirect (loss of trade, loss of income, increased health expenses due to the disaster and fatalities).

3.4. The main hypothesis to be tested with this evaluation is that flood prevention works reduce the likelihood of loss as a consequence of a flood in the intervention areas. Furthermore, a complementary hypothesis is that flood reduction works reduce health expenses due to a disaster. It is also hypothesized that the project reduces the poverty levels of the beneficiary population, since a lower flood risk leads not only to further accumulation of capital but also to an increase in property values. Finally, it will be tested whether flood risk reduction improves tourism activity.

B. Key Outcome and Impact Indicators

3.5. The outcome and impact indicators to be measured as part of the evaluation strategy, as well as their formula, frequency of measurement and means of verification are presented in Tables 5 and 6.

Table 5. Expected outcome indicators

Outcome	Indicator and formula	Frequency of measurement	Means of verification
Component 1: Climate risk reduction in the tourism sector			
Mitigation of risk for residents	Reduction of people affected by recurrent floods in the Orange St area and Caye Caulker (*F*), where *F* = people with reduced flood exposure in Belize City + people with reduced flood exposure in Caye Caulker	2017, 2022	Risk assessment model and analysis for Belize City and Caye Caulker, adjusted with baseline and follow-up surveys information for ex ante economic analysis and impact evaluation
Enhanced tourism	Tourist satisfaction (*TS*) in Palapa Beach (Caye Caulker) and Goff's Caye, where *TS* is the percentage of survey respondents who answered that their overall satisfaction of the site/reef is high $= \frac{T_{CC}}{T_{CC}+T_{GC}}(\overline{TS_{CC}}) + \frac{T_{GC}}{T_{CC}+T_{GC}}(\overline{TS_{GC}})$ and *T* is the annual number of visitors.	2017, 2022	Baseline and follow up surveys for the ex ante economic analysis and impact evaluation and Goff's Caye Visitor Satisfaction Survey Report
Component 2: Governance for disaster risk management and climate change adaptation			
Improved government performance in disaster risk governance	Government agencies (*GA*) benefited by projects that strengthen technological and managerial tools to improve public service delivery, where *GA* = {1,2,3,4,5}	2017, 2022	Semiannual progress reports.
Component 2: Governance for disaster risk management and climate change adaptation			

Improvement in iGOPP's Financial Protection component	iGOPP's Financial Protection (PF) component score, where $PF = [0,100] = \{x \in \mathbb{R} \mid 0 \leq x \leq 100\}$	2017, 2022	iGOPP report for Belize; follow-up iGOPP estimation after completion of the program
Improvement in iGOPP's Risk Identification component	iGOPP's Risk Identification (RI) component score, where $RI = [0,100] = \{x \in \mathbb{R} \mid 0 \leq x \leq 100\}$	2017, 2022	iGOPP report for Belize; follow-up iGOPP estimation after completion of the program

Table 6. Impact indicators

Indicators	Unit	Baseline		Goals		Means of verification Observations
		Value	Year	Value	Year	
IMPACT: Climate vulnerability and risk reduced						
Reduction of household annual economic losses caused by floods in the Orange St area.	% change	0	2015-2017	100%	2023	Means of verification: Baseline and follow-up surveys for ex ante economic analysis and impact evaluation. Observations: Economic losses caused by floods represent the economic vulnerability to floods. They include the disaster effects on physical assets and economic flows and consider comparable recurrent events (1-5 years)..
Reduction of household annual economic losses caused by floods in Caye Caulker.	% change	0	2015-2017	100%	2023	
Reduction of projected losses of overnight visitor expenditures in the Orange St. area.	% change	0	2017	12	2021	Means of verification: Risk assessment model for Belize City, adjusted with baseline and follow-up survey data for ex ante economic analysis and impact evaluation, and data from The Belize Tourism Board. Observations: The intervention will result in avoided visitor expenditure losses.
Reduction of projected losses of overnight visitor expenditures in Caye Caulker.	% change	0	2017	12	2021	Means of verification: Risk assessment model for Caye Caulker, adjusted with baseline and follow-up survey data for ex ante economic analysis and impact evaluation, and data from The Belize Tourism Board. Observations: The intervention will result in avoided visitor expenditure losses.
Decrease in the annual disaster mortality rate in Belize City	% change	0	2017	3	2021	Means of verification: Data from the Statistical Institute of Belize and National Emergency Management Office. Observations: Expected decrease based on estimates by Guerrero Compeán et al. (2017).

C. Existing Knowledge

3.6. In DRM projects, estimates of benefits focus on avoided losses or damage. That is, the project benefits are evaluated considering what could happen to public and private assets and economic flows in the occurrence of catastrophic events such as floods. Given the occurrence of a flood, one has to compare the extent of losses in a situation with and without project, so that estimates of avoided economic losses can be obtained. Since DRM project benefits can be materialized only after the occurrence of a disaster, which has a probability of occurrence, a type of economic assessment known as "probabilistic cost-benefit analysis" is often used to assess economic viability (Kull, Mechler and Hocharainer-Stigler 2013). The factors that are typically evaluated in the literature to evaluate DRM projects are (a) direct benefits (i.e., avoided direct losses, avoided indirect losses, and avoided non-economic losses), (b) extended benefits (i.e., improvements in living standards, food security, environmental sustainability), and (c) intervention costs (i.e., planning, construction, labor, materials, maintenance and opportunity costs) (Vorhies 2012).

3.7. Shreve and Kelman (2014) compile and compare estimates of cost-benefit analysis of flood risk reduction projects and conclude that, in general, these types of projects are economically viable, with benefit-cost ratios above 14. A similar ratio (14.5) is found by Kunreuther and Michel-Kerjan (2012) for flood mitigation works carried out in 34 countries with high exposure to floods. Mechler (2005) evaluates the economic viability of the construction of dykes, polders and other flood risk mitigation works in Piura, Peru, concluding that the cost-benefit ratio of such works exceeds 2.2. Burton and Venton (2009) and Multihazard Mitigation Council (2005) conduct cost-benefit analysis of dyke construction in heavily exposed settlements in the Philippines and the United States, respectively, and both studies find that small-scale mitigation projects are economically viable, with benefits being almost five times larger than the cost of investment. A meta-analysis by Mechler (2016) comprising 21 studies concludes that flood mitigation projects have a cost-benefit ratio of 4.6. The construction of gabion boxes and other risk reduction works in Nepal has cost-benefit ratios between 14.8 and 18.6 (Nepal Red Cross 2008). For the specific case of Belize, IH Cantabria (2017) carried out feasibility studies for the design of flood control works in Belize City, including a pumping station, four gates, dredging works, and a protection wall, suggesting their economic viability, with cost-benefit ratios greater than one.

3.8. The link between disaster risk management and economic development is particularly evident in the tourism industry. Primary beneficiaries of coastal protection projects are businesses and local residents who rely on tourism activity for income and/or who are exposed to natural hazards and the adverse effect of a changing climate, directly benefitting from infrastructure that provides a protective buffer from floods and storm surge. Coastal infrastructure that prevents beach degradation is expected to mitigate its negative economic effects as a result. Corral et al. (2016) argue that if the demand of tourists (and local residents) for time spent at the beach increases due to infrastructure works that stabilize and improve the coastline, it can be expected that this stimulates the local tourism industry and results in higher revenues for hotels, restaurants, and other beach-adjacent businesses. Similarly, these authors posit that an additional positive effect may be a rise in employment opportunities at such businesses for local residents. Coastal infrastructure is a determinant of economic development through its impact on tourism activity, in that coastal tourism demand is a function of beach features and quality (Bell and Leeworthy 1990). If beach erosion leads to a degradation of overall beach quality by diminishing space availability or the overall physical appearance of the beach, this would result in a decreasing demand for recreational activities by tourists there (Kragt, Roebeling and Rujis 2009). A previous cost-benefit analysis of an IDB-funded disaster risk management program in Barbados (BA-L1014) use Monte Carlo simulations to assess the amount of avoided damages over a 50-year period as a result of the intervention. The authors find a net present value of US$$89.6 million (90%

confidence interval of \$85.1-\$98.4 million) and an internal rate of return of 29% (95% confidence interval of 28%-32%). Proper impact evaluations of disaster risk management and coastal protection projects on economic development are scarce in the literature. Two exceptions appear to be the analyses by Cordes and Yezer (1998) and Corral et al. (2016). Cordes and Yezer (1998) use panel data on coastal communities in the United States between 1960 and 1992 to assess how exposure to beach erosion control programs affects economic development. They conclude that economic growth in beachfront communities resulted from rising incomes and employment rather than public investment in shoreline protection. However, they failed to take into account the potential increases in tourism demand that are likely to occur. Based on a comprehensive GIS dataset that contains information on beach characteristics, as well as beach-adjacent infrastructure and real estate activity, Corral et al. (2016) employ synthetic controls to assess the impact of a shoreline stabilization program on local economic growth in Rockley Beach, Barbados. The authors estimate that the effect of the program on economic activity accumulates to approximately 9% in three years post-treatment.

3.9. An economic evaluation was conducted to assess the viability of flood mitigation infrastructure (pumped flood-reduction scheme) in the Orange St area of Belize City, shore stabilization measures in Caye Caulker (nature-based and hybrid coastal-protection tourism-enhancing interventions) and Goff’s Caye (soft coastal-protection strategies for climate-resilient tourist amenities), considering a discount rate of 12%. Overall, the Net Present Value (NPV) of BL-L1028 is greater than US\$5.6 million. The Internal Rate of Return (IRR) is robust at 18.5%. For the proposed investments in the Orange St area of Belize City, the NPV of BL-L1028 amounts to US\$3.4 million, with an IRR of 17.7%. With regard to the proposed investments in Caye Caulker, the NPV of BL-L1028 is US\$1.6 million, with an IRR of 33.2%. As for the proposed investments in Goff’s Caye, the NPV of BL-L1028 equals US\$0.7 million, with an IRR of 15.5%. Sensitivity analyses were also conducted and, under the most conservative assumptions, the NPV of benefits for the Orange St area of Belize City is US\$177,515 with an IRR of 12.3%; the NPV of benefits for Caye Caulker is US\$711,623 with an IRR of 24.9%; and the NPV of benefits for Goff’s Caye is US\$55,780 with an IRR of 12.4%, reflecting that BL-L1028 is a viable investment from an economic standpoint.

D. Technical Aspects of the Evaluation Methodology

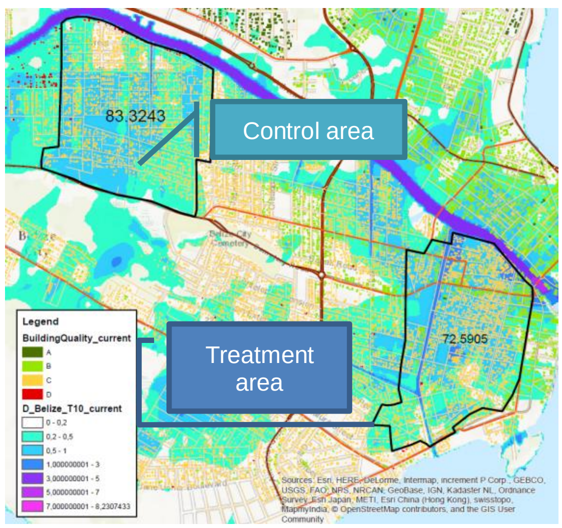
3.10. The Program is aimed at reducing or eliminating economic losses of households in the treatment areas through flood mitigation works. The central objective of the Program's impact evaluation is to measure changes in flood-related economic losses attributable to the intervention.

a. Unit of Analysis, Treatment Group and Identification of Comparison Group

3.11. A two-pronged approach will be employed for the impact evaluation of the program. A first evaluation will focus on Belize City, where most of the program beneficiaries are located and most of the investments will take place. The evaluation will consist of two sections, estimating impacts for households and business separately. The unit of analysis for the first (second) section of the evaluation is the household (business establishment). In terms of the business section of the impact evaluation, and considering the strong tourism aspect of the program, a sub-sample of tourism business (e.g., hotels, accommodation, restaurants, recreation, travel agencies) in Belize City will be analyzed in order to learn about business expenditures and economic losses of the tourism sector. Other types of business, however, such as retail, entertainment, professional services, manufacturing, transportation, construction and finance, are included in the sample. The evaluation methodology requires generating groups of beneficiary households/business establishments (treatment) and non-beneficiary households/business establishments (control). The methodological approach will be quasi-experimental. A second evaluation will focus on tourism expenditures, hotel revenue and satisfaction in Caye Caulker. For tourist satisfaction, the methodological approach will be reflexive, whereas for tourist expenditures and hotel revenue, we will assess impact by examining any change in the post-intervention period given the trend in the pre-intervention period. In this second evaluation, the unit of analysis will be the caye. These methodologies are described in more detail below.

3.12. For Belize City, we will generate a control group in a non-intervened zone that is as comparable as possible to the area under treatment. A hazard model of floods helped the IDB evaluation team identify comparison areas that share general geographic, demographic and risk attributes that make them comparable and are in spatial proximity to the area of intervention (see Figure 2).

Figure 2. Treatment and control areas



Source: IH Cantabria (2017).

3.13. The main challenge of evaluating the impact of the program is to identify a valid comparison group that has similar characteristics to those of the treatment group in the absence of the program. The validity of the identified comparison group is based on three criteria: (i) physical similarity—both the treatment and comparison areas share similar housing and infrastructure characteristics, are of similar size within the same jurisdiction, and exhibit comparable levels of flood exposure; (ii) no spillover effects—the treatment does not affect the comparison group either directly or indirectly, since the flood mitigation works to be carried out in the intervention area will not have any effect on the risk dimensions of the comparison area; and (iii) common trends—outcomes in the comparison group should change in the same way as in the treatment group, if both groups were treated (or not). The latter criterion implies that the treatment and comparison groups would have to react to the program in the same way. For example, if the economic losses caused by floods in treated households are reduced by 1,000 Belizean dollars as a result of the program, the economic losses of households in the comparison group would also have to be reduced by approximately the same amount if they were to benefit directly from a similar intervention.

3.14. A similar strategy is not feasible to evaluate the tourism impact of the project in Caye Caulker, given that no comparison group can be excluded from the effects of the tourism treatment. In addition, it would be extremely difficult to prevent tourists from visiting any given selected sites but not others, especially in a site that is as small as Caye Caulker. Even if it were possible to create a tourism treatment and comparison group, market linkages would make it impossible to avoid control-group contamination. Alternative economy-wide simulation approaches or computable general equilibrium models cannot be employed in this instance given Caye Caulker's sectoral data constraints and dated information. As a result, program impact attribution is not achievable. However, the impact evaluation strategy for BL-L1028 in Caye Caulker will be accompanied by beneficiary assessment reports, systematic client consultation and causal contribution analyses (Mayne 2001) to address attribution. Given that there is potential of exposure to internal validity threats, the before-and-after research designs proposed will be supplemented with complementary qualitative information that involves systematically identifying and investigating alternative explanations for observed impacts.

b. Research Design for the Impact Evaluation in Belize City

3.15. The empirical strategy is based on the difference-in-differences method combined with entropy balancing. Since the work by Ashenfelter and Card (1985), the use of difference-in-differences methods has become very widespread. Survey data that will be collected as part of this evaluation will allow to observe outcomes for the treatment and comparison groups for two time periods. The treatment group is exposed to treatment in the second period but not in the first period. The second group is not exposed to the treatment during either period.

3.16. The program is expected to impact an outcome Y (economic losses resulting from a disaster, for example) in households/business establishments within the intervention areas. We define group "*b*" as the households/business establishments benefited by the project ("treatment" group) and group "*c*" as a group of comparison households/business establishments ("comparison" group). At the beginning of the project, both groups have an average value of Y_1 of the impact variable, i.e., Y_{1b} and Y_{1c} for the treatment and comparison groups, respectively. At the end of the project, the impact variable is measured again in both groups, i.e., Y_{2b} and Y_{2c}. The attributable impact of the project, ΔY, is estimated by:

$$\Delta Y = (Y_{2b} - Y_{1b}) - (Y_{2c} - Y_{1c})$$

3.17. In this case, where the same units within a group are observed in each time period, the average gain in the second (comparison) group is subtracted from the average gain in the first (treatment) group. This removes biases in second period comparisons between the treatment and control group that could be the result from permanent differences between those groups, as well as biases from comparisons over time in the treatment group that could be the result of trends.

3.18. Inference based on even moderate sample sizes in each of the groups is straightforward, and is easily made robust to different group/time period variances in the regression framework. With repeated cross sections, we can write the model for a generic member of any of groups as

$$Y_{it} = b_0 + b_1 * P_i + b_2 * t + b_3 * (P_i * t) + d * X_{it} + u_{it}$$

3.19. where Y_{it} is the outcome of interest, t is a dummy variable for the second time period. The dummy variable P_i captures possible differences between the treatment and comparison groups prior to the intervention. The time period dummy, t, captures aggregate factors that would cause changes in Y_{it} even in the absence of an intervention. The coefficient of interest, b_3, multiplies the interaction term, $(P_i * t)$, which is the same as a dummy variable equal to one for those observations in the treatment group in the second period. Formally, estimates of this model are:

$$\hat{b}_0 = (Y|t = 0, P = 0)$$

$$\hat{b}_1 = (Y|t = 0, P = 1) - (Y|t = 0, P = 0)$$

$$\hat{b}_2 = (Y|t = 1, P = 0) - (Y|t = 0, P = 0)$$

Where the impact of the program is:

$$\hat{b}_3 = [(Y|t = 1, P = 1) - (Y|t = 0, P = 1)] - [(Y|t = 1, P = 0) - (Y|t = 0, P = 0)]$$

c. Comparability between the Treatment and Comparison Groups in Belize City

3.20. Given that the assignment of households/business establishments between treatment and comparison groups is not random, there is a risk of selection bias and thus of having treatment and comparison groups that are not truly comparable to each other. Table 7 compares the means of relevant variables, based on pilot survey information, for the selected treatment and comparison areas. Standard t- and Pearson's chi-squared tests are used to compare covariates. Table 8 presents additional information obtained from the disaster risk assessment study of Belize City (IHCantabria & M&K 2016) and statistical information from the Belize City Council.

Table 7. Summary Statistics for Selected Treatment and Comparison Areas in the Original Unmatched Sample

Variable	Comparison (*n* = 94)	Treatment (*n* = 112)	*p*-value
Female head of household	40 (42.6%)	49 (43.8%)	0.86
Age of head of household	45.1 ± 15.5	49.4 ± 16.6	0.06*
Household size	4.1± 2.2	3.2 ± 2.1	0.002***
Household lives in a space made for dwelling	93 (98.9%)	108 (96.4%)	0.24
Household dwelling has finished walls	67 (71.3%)	86 (76.8%)	0.37
Household dwelling has finished floor	61 (64.9%)	78 (69.6%)	0.47
Average monthly income	433.8 ± 712.8	820.0 ± 2136.7	0.73

Variable	Comparison (*n* = 94)	Treatment (*n* = 112)	*p*-value
Flood intensity (1-4 scale)	2.6 ± 1.1	2.5 ± 1.0	0.30
Flood duration (hours)	31.8 ± 27.7	33.8 ± 33.4	0.65
Flood damage (1-4 scale)	2.0 ± 1.1	1.9 ± 1.1	0.27
Structural losses (BZD)	1712.4 ± 3100.4	1474.8 ± 4108.9	0.71
Asset losses (BZD)	2270.6 ± 3451.3	1787.6 ± 3789.4	0.50
Overall economic losses (BZD)	5014.2 ± 11244.3	5527.7 ± 15494.2	0.79

Notes: Continuous variables are reported as mean ± standard deviation. Dichotomous variables are reported as *n* (Per cent).

Table 8. Selected Treatment and Comparison Area Characterization

Variable	Comparison	Treatment
Population (#)	8,900	6,600
Households (#)	1,343	1,466
Licensed businesses (#)	457	89
Area (ha)	83.3	65.3
Population density (pop/ha)	106.8	95.6
Building stock (#)	2,120	1,969
Low-quality buildings (% of total)	85.0	79.7
Total building stock value (USD M)	140.0	152.2
Flood depth (T10) (m)	0.6	0.6
Flood depth (T100) (m)	1.2	1.2
Estimated annual losses (USD thousands)	126.0	136.9

3.21. Even though Tables 7 and 8 show that flood risk, sociodemographic and business characteristics present relatively comparable distributions pre-treatment for the selected treatment and comparison areas, the degree of overlap in the covariate distributions may not as similar as it would be in the setting of a randomized experiment. Matching techniques are employed in this context. They allow to estimate the probability of participating in the project (P=1) given a vector of observed characteristics X, that is $p(P)=p(P=1|X)$. A typical statistical matching technique is propensity score matching, which runs a logistic regression to obtain the propensity score $p(P)$ (Rosenbaum and Rubin 1983).

3.22. One disadvantage of propensity score matching is that it requires substantial overlap between treatment and comparison groups. In other words, an acceptable balance of X variables between treatment and comparison groups is seldom generated. Analysts carry out a range of estimates to make sure that low bias conditions are met across observables. In many cases, however, an equilibrium is not obtained and, even worse, the procedure increases bias in some variables after matching. Due to these problems, recent advancements in statistical techniques propose entropy balancing as a reweighting technique to ensure comparability of the treatment and the control group.

3.23. Entropy balancing assigns a weight to each observation of the comparison group directly so that the statistical moments of the control variables of the reweighted comparison group are equal to the statistical moments of the treated group (Hainmueller 2012). The weights are calculated so that a loss function using the directed Kullback (1959) entropy divergence as a distance metric is minimized under a set of pre-specified balance constraints imposed on the sample moments of the control variables. The control variables' first three statistical moments—namely the mean, variance and skewness—of the treatment and the comparison group are balanced. The main advantages of using entropy balancing rather than propensity matching techniques are an increase in balance quality, and the redundancy of potentially tedious balance checks since the covariate moments are automatically balanced by the algorithm (Hainmueller 2012).

3.24. Combining difference-in-differences and entropy balancing methods has several advantages over using one estimation method only. The basic idea of combining difference-in-differences with matching is to reduce bias due to unobservables, and bias due to different distributions of covariates in the treatment and comparison groups (Heckman et al. 1997; Blundell et al. 2004; Abadie 2005). In the context of this evaluation, we first use entropy balancing within groups so that treated households/business establishments are matched to comparison households/business establishments. The entropy balancing part of the estimator reduces bias due to differences in observables between the treatment and comparison groups. We then use the difference-in-differences part of the estimator to reduce bias due to unobservables that accompany the intervention, but should remain constant between the treatment and control groups.

d. Research Design for the Impact Evaluation in Caye Caulker

3.25. The proposed empirical strategy is a before-and-after study, in which impact indicators will be evaluated before and after program implementation. The main hypothesis of the proposed impact evaluation is that the program will increase tourist satisfaction and expenditures, as well as the revenue of hotels and other tourist-oriented businesses. Survey data that will be collected as part of this evaluation will allow to observe tourism satisfaction for two time periods. Univariate statistics will be calculated and factor and cluster analysis will be undertaken. To divide the sample into meaningful sub-groups, a K-means cluster analysis will be carried out and, once a cluster solution is identified, tourist satisfaction ratings will be analyzed. In order to pinpoint potential differences in data composition among clusters, ANOVA tests will be carried out. Cross tabulations with χ^2 tests will be used, and Cramer's V will be calculated in order to identify the strength of the relationship, as well as profile clusters socio-demographically, and to identify travel arrangement preferences and favorable behavioral intentions.

3.26. Another hypothesis is that the program will increase tourist expenditures as well as tourism-oriented business revenue. Given that the Belize Tourism Board does collect information on tourist expenditures and hotel revenue, it is possible to carry out a statistical comparison of time trends before and after the intervention using segmented time-series regression techniques to measure impact. By considering secular trends, the risk of impact overestimation caused by simply comparing the means before and after an intervention is likely to be reduced. The underlying trend in the outcome is established and proxies the counterfactual. The impact of the intervention is then assessed by examining any change in the post-intervention period given the trend in the pre-intervention period. The intervention may lead to a change in level, a change in slope or both. Data for the period 2012-2022 will be used. Data for the period 2012-2016 have already been produced and is publicly available for Caye Caulker.

3.27. The analysis estimates the effect of the intervention while taking account of time trend and autocorrelation among the observations. Estimates for regression coefficients corresponding to two standardized effect sizes will be obtained: a change in level (also called 'step change') and a change in trend before and after the intervention. According to Ramsay (2003), a change in level is defined as the difference between the observed level at the first intervention time point and that predicted by the pre-intervention time trend, and a change in trend is defined as the difference between post- and pre-intervention slopes. A negative change in level and slope would indicate a reduction in, for example, tourist expenditures. The primary model is:

$$Outcome = \beta_0 + \beta_1 time + \beta_2 phase + \beta_3 interact + e_t$$

3.28. Where, based on the model parameters, (i) the coefficient for 'time' gives us the slope of the regression line pre-intervention, (ii) the coefficient for 'phase' gives us the change in intercept, and (iii) the coefficient for 'interact' gives us the change in slope pre- and post-intervention. Notice that the variable *phase* takes a value of zero prior to the intervention and one post-intervention and that *interact* is the interaction between *time* and *phase*. Therefore, pre-intervention becomes $Outcome = \beta_0 + \beta_1 time$ and post-intervention becomes $Outcome = (\beta_0 + \beta_2) + (\beta_1 + \beta_3) time,$ as time and interact are the same post-intervention. Here, the pre-intervention slope of the regression line is β1, the difference in intercept pre- and post-intervention is β2 and the difference between the pre-slope and the post-slope is β3. When adding β1 + β3 we get the post-slope coefficient. Confidence intervals around the effect estimates will be estimated.

E. Sampling Strategy, Power Calculations, Data Collection and Other Technical Aspects of the Evaluation

a. Sampling Strategy

3.29. The sample design was carried out by the IDB project team between May and July 2017. The team sought coverage and representativeness of households and business establishments with elevated risk to floods. Exposure was estimated by IH Cantabria (2017), which analyzed rainfall data and flow gauges from the Belize National Meteorological Service for five stations in Belize. The sample was drawn from the areas that IH Cantabria categorized as risk-prone. In addition to identifying the project's area of influence (treatment area) IH Cantabria detected a non-intervention zone with similar levels of flood risk, geographical proximity and sociodemographic characteristics that will serve as comparison area to evaluate the impact of the program.

3.30. The National Electricity Grid database, which includes a list of all households in Belize, will be used as the household sampling frame for Belize City. This dataset is a good reflection of the number of households in the country since, by law, every home has to legally connect to the grid. The database has about 15,000 households. Similarly, the Trade License Registry, provided by the Belize City Council, includes all registered active businesses in Belize City, by zone and constituency. This database has information for more than 2,500 businesses in Belize City. In the case of Caye Caulker, the Caye Caulker Village Council provided the actual trade license figures for the 228 registered active business in the island. With regard to the tourist satisfaction survey, average three-month arrivals as reported by the Belize Tourist Board statistics were used as the sampling frame. With the exception of the tourist satisfaction survey, which will be carried out at departure points in Caye Caulker (i.e., purposive sampling), the other sampling frames enabled the IDB evaluation team to conduct systematic sampling, i.e., randomized sample selection using fixed intervals and sample homes and businesses by street location.

b. Power Calculations

3.31. Statistical power calculations were performed to establish the number of households and business establishments needed in the treatment and comparison groups. In the absence of disaster loss data, these calculations are based on the direct economic losses caused by floods in Belize City taken from the pilot survey for this evaluation. The survey conducted by the IDB team in July 2017 provides data on distinct types of economic losses caused by floods but the sample used was so small, and the variability in declared losses large enough, that the detectable effect is likely to be overestimated. As a result, it was decided to estimate a more conservative sample using overall economic losses as the main variable.

3.32. The data indicate that the average household economic losses caused by floods in Belize City is BZD 4,505, with a standard deviation of BZD 12,466. In addition, the business surveys show that the average economic losses caused by floods in business establishments in Belize City is BZD 3,585, with a standard deviation of BZD 7,560. Power calculations were done with a power of 0.80 and a 5% significance level, and based on the hypotheses of complete take-up up and no attrition.

3.33. The following equation is used to estimate the minimum detectable effect (MDE) (Duflo, Glennerster and Kremer 2007):

$$MDE = (t_{\alpha} + t_{1-k}) * \sqrt{\frac{1}{P(1-P)}} \sqrt{\frac{\sigma^2}{N}}$$

Where MDE is the minimum detectable effect measured as the change in the value of economic losses;
t_{α} is the critical value for the significance value of α, given by a standard *t*-distribution;
t_{1-k} is the critical value for the statistical power *k*, given by a standard *t*-distribution;
P is the portion of the sample allocated to the treatment group;
σ is the standard deviation; and
N is the effective sample size.

3.34. Based on this, a sample of 800 households (400 in both treatment and comparison groups) and 200 business establishments (140 in the treatment group and 60 in the comparison group, given the larger licensed business population in the treatment area) at baseline and the same number for the follow up will provide sufficient power to detect decreases in economic losses caused by floods of 57% and 81%, respectively. Thus, the total sample size will be 1,000 per survey wave. Considering that the expected impact of the project in terms of reducing economic losses caused by floods is over 90% (see impact indicators in the RM, which are based on estimates derived from the ex-ante economic analysis), this survey is powerful enough to detect expected reductions.

3.35. Given the nature of the methodological approach of the impact evaluation of the program in Caye Caulker, no power calculations were carried out to estimate a MDE. However, the Project Team determined, based on resource availability, that the actual sample size for the tourist satisfaction survey should be 400 per survey wave. In addition, 84 hotels and 86 registered active businesses will be surveyed in each of the two survey rounds.

c. Data Collection

3.36. The project's impacts will materialize progressively over the project's four years and will become most apparent at the end of its implementation. As a result, there will be two survey rounds, both in Belize City and Caye Caulker: a baseline survey, carried out in 2017, and one follow up (or endline) survey, to be administered two years after project completion, in 2024.

d. Questionnaires

3.37. The main data collection instruments for this evaluation will be (i) one household survey and (ii) one licensed business establishment survey with detailed information on relevant economic characteristics and losses due to floods in Belize City, as well as (iii) one tourist satisfaction survey and (iv) one licensed business establishment survey with detailed information on relevant economic characteristics and performance related to tourism. The structure of these surveys is presented in Tables 9-12 below.

Table 9. Household questionnaire measures (Belize City)

Section	Measures
HH – General Characteristics of Household	Demographic and household profiles
CD – General Characteristics of Dwelling	Dwellings construction type, amenities, and ownership
HA – Household Assets	Quantity and value of furniture, appliances, electronics, vehicles
FL – Floods in Households	Flood event(s), intensity, impact on structure and people, costs, flood mitigation practices
EA – Economic Activities of Household Members	Persons employed, occupation type, location, hours worked, income (fixed and supplementary), total annual earnings
SE – Self Employment (if applicable)	Occupation type, location, hours worked, annual income, trends and cause

Table 10. Business questionnaire measures (Belize City)

Section	Measures
BC – Business Characteristics	Business type, years' operating, ownership and gender of owner, legal and ownership status, management and staffing, markets served
BA – Business Assets	Building, land, equipment, vehicles, machinery, inventory, furniture
FL – Floods in business	Flood event(s) intensity, impact on structure, people, costs, flood mitigation practices
BP – Business Performance	Business performance in last 12 months, issues affecting performance, trends, sales income, and flood events and associated costs

Table 11. Tourist satisfaction questionnaire measures (Caye Caulker)

Section	Measures
TS – Tourist Satisfaction	First visit and frequency, advertisement medium, port of entry, duration of visit, level of importance placed on leisure and recreation factors, tourist satisfaction levels, likely to recommend, favorite beach resort, rating of Caye Caulker as tourist destination
RD – Respondent Data	Gender, type of accommodations, expenditure by category, size of group (if applicable), demographic

Table 12. Business questionnaire measures (Caye Caulker)

Section	Measures
BC – Business Characteristics	Business/services type(s), years' operating, ownership and gender, management and staff, full time and part time staff, market segments served
BO – Business Opinion	Reasons visitors' visit, rating of activities, rating of attractions, own rating of Caye Caulker as a destination, promotional efforts, risks associated with destination, rating of public and community driven policies, legislation, and regulations
FL – Floods in business	Flooding events, intensity, impact on business and people, associated costs, and mitigation efforts
BP – Business Performance	Business performance in last 12 months, issues affecting performance, trends, sales income, and flood events and associated costs

F. Evaluation Reporting and Budget

3.38. Budget necessary for the evaluation will be US$130,000, as detailed in Table 13. This includes (i) the questionnaire design and pilot survey; (ii) data collection for baseline surveys; (iii) data collection for follow-up surveys; and (iv) impact evaluation. This cost is included as the Administration Cost of the program. The PMU, specifically the monitoring and evaluation expert, will support the evaluation process. All procedures, results, key findings, challenges and lessons learned will be thoroughly documented as per IDB reporting requirements.

Table 13. Evaluation work plan and budget

Activity	Year 1				Year 2				Year 3				Year 4				Resp.	Cost (USD)	Source of Funding
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4			
Questionnaire design and pilot survey																	Consultant	5,000	BL-L1028
Data collection for baseline surveys																	Consultant	20,000	BL-T1090
Data collection for follow-up surveys																	Consultant	35,000	BL-L1028
Impact evaluation																	Consultant	40,000	BL-L1028
Total cost																		100,000	

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