



Climate Actions for Building Resilience in Coastal Communities (CABRIC) in the Caribbean EDA Facility

Annex 3b – Economic and Financial Analysis

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1. Introduction

1.1 Background

Caribbean Coastal communities face a multitude of climate impacts due to their positioning and proximity to the sea. In addition to hurricanes, storms, riverine flooding, landslides, heatwaves and the increasing unpredictability of precipitation; coastal communities are also affected by storm surges, coastal erosion and the long-term impact of sea surface temperature increases, and ocean acidification, affecting the distribution and productivity of fisheries. The effect of these impacts is complex and multifaceted: Ecosystem functioning is reduced, not only from the direct impact of such hazards, but also the need to derive livelihood income and food security. Social structures are challenged due to physical and psychological health impacts of these hazards, but also due to the impacts on education and livelihoods driving migration, and the resultant consequence of such pressures on women including grievous bodily harm (GBH) and psychological abuses. Livelihood resilience itself is dependent on both ecological and social resilience is impaired further with the impacts of climate hazards, particularly for the production sector of agriculture and fisheries. Where livelihoods are not adapted to such impacts, resilience is further destabilised. Without understanding and access to climate risk information to adapt livelihoods and social services, including accessible and appropriate education, adaptive capacity to climate disasters is undermined.

The CABRIC Caribbean (Climate Actions for Building Resilience in Coastal Communities in the Caribbean) EDA facility programme will operate in five countries of the Caribbean Community (CARICOM): **Bahamas, Belize, Grenada, Jamaica and St Lucia** and will support the built capacity and long-term empowerment of community level action to address climate adaptation needs and multi-dimensional vulnerability in coastal areas. The EDA facility will provide grants to CSOs and NGOs for activities that address livelihood and social vulnerability, with an emphasis on gender transformation and inclusion.

The CABRIC Caribbean will address the complexities that underpin the interaction of social-livelihood-ecological resilience through addressing the barriers to the institutional and technical capacity at the CSO and NGO level, whilst empowering communities to understand climate risk and gender equality, disability, and social inclusion (GEDSI) solutions in building gender transformative climate resilient livelihoods (including: climate smart agriculture, ecosystem based fisheries, coastal Nature based Solutions and circular economy) and inclusive social structures with climate risk integrated into their services (including last mile early warning systems (EWS), climate risk planning & monitoring into health services, climate related mental health supports, and inclusive climate disaster shelters & access. It will provide finance to those CSO and NGO grassroots organizations to implement community led solutions in coastal communities, whilst supporting the process including Monitoring, Evaluation and Learning. Knowledge sharing is a key component of CABRIC, building on existing structures, and setting up a lasting legacy of both in country, between country and regional knowledge sharing.

To achieve this, the programme is organised into three components:

Component 1: 1. Strengthened institutional and operational capacity for GEDSI integrated climate responsive planning

Component 2: Improved social and livelihood climate resilience through addressing multidimensional vulnerability to climate risks in coastal communities

Component 3: 3. Enhanced regional knowledge equity and transparent sharing of community-led climate risk information and adaptation lessons

The Caribbean Community Climate Change Centre (CCCCC) is the AE and an EE of the CABRIC programme and as mandated by the countries directly establish and manage an EDA facility for grassroots actors to address the repeated impacts of climate hazards to vulnerable coastal communities. CABRIC's overall impact will be improving the climate resilience of the most vulnerable people, through livelihood security, health, wellbeing, food and water security, and co-benefits for ecosystems and gender and social inequities.

Theory of Change statement: IF NGOs, CSOs, and LAs are empowered through strengthened institutional and operational capacity for climate-responsive GEDSI integrated planning, climate information and lessons learned are shared, and climate finance flows to the grassroots level are increased; **THEN** a paradigm shift is catalysed towards locally-led, gender-transformative climate action that secures long-term livelihood and ecosystem sustainability across the Caribbean; **BECAUSE** climate resilience for coastal communities in participating countries is improved and multidimensional vulnerability to climate risks is reduced through the implementation of accessible, community-driven adaptation initiatives.

1.2 Scope and objective

This annex (Annex 3) is the narrative presentation of the Economic and Financial Analysis (EFA) conducted for the programme.

The EFA assesses the economic and financial viability and returns of the CABRIC Caribbean EDA facility, the grant-making programme designed to channel climate adaptation finance directly to civil society organisations and non-governmental organisations across five target countries. The analysis examines the costs, benefits, and financial sustainability of community-led climate resilience interventions in coastal areas, with particular focus on gender-transformative livelihood security and inclusive health and social resilience.

1.3 Approach and methodological considerations

As an Enhanced Direct Access facility, CABRIC establishes a grant-making mechanism rather than implementing predetermined projects. The specific interventions to be funded will be determined through a competitive call-for-proposals process during programme implementation, with final project selection driven by community priorities, technical feasibility assessments, and alignment with national adaptation strategies. **This structure presents inherent challenges for ex-ante economic and financial modelling, as the exact portfolio composition cannot be known at the Funding Proposal stage.**

To address this analytical constraint, the EFA adopts a representative intervention approach. **Six illustrative interventions have been selected to be modelled**, three under Theme A (Gender Transformative Climate Resilient Livelihoods) and three under Theme B (Inclusive Health, Wellbeing and Social Resilience), that reflect the types of projects anticipated under the facility based on stakeholder consultations, discussions with the AE, and alignment with national priorities. These interventions are:

- A1: Climate-resilient agricultural package
- A2: Cold storage for artisanal fishers
- A3: Community-managed Marine Protected Areas (MPAs)
- B1: Community-based Early Warning Systems (EWS)
- B2: Mobile mental health support units for climate-related disaster support
- B3: Hurricane-proofing community buildings for shelter

The CABRIC facility will allocate USD 5 million per country across small grants (up to USD 150,000), medium grants (up to USD 300,000), and large grants (up to USD 500,000). **The actual distribution of grant sizes within each country will depend on the proposals received and approved through the facility's governance mechanisms.** For modelling purposes, the following representative scenario of grant allocation has been chosen within the CABRIC EDA Facility Grant Scenario Planner (Sheet 2 of Annex 3a).

This results in **132 grants** of all sizes distributed within the target countries in the six-year period of the programme (see Figure 1).

CABRIC EDA Facility Grant Scenario Planner

		Parameters			
Total countries	5				
Budget per country	\$ 5,000,000.00	Total funds	\$	25,000,000.00	
Small grant limit	\$ 150,000.00				
Medium grant limit	\$ 300,000.00		Variable		
Large grant limit	\$ 500,000.00		Calculation		
Programme duration	6 years			Click to expand	

Grant distribution by country								
Country	Small grants	Medium grants	Large grants	Total projects	Budget used	Under / over	Utilisation %	Status
Bahamas	10	5	4	19	\$ 5,000,000.00	\$ -	100%	OK
Belize	22	4	1	27	\$ 5,000,000.00	\$ -	100%	OK
Grenada	24	3	1	28	\$ 5,000,000.00	\$ -	100%	OK
Jamaica	6	7	4	17	\$ 5,000,000.00	\$ -	100%	OK
Saint Lucia	22	4	1	27	\$ 5,000,000.00	\$ -	100%	OK
Total	84	23	11	118	\$ 25,000,000.00			

Programme summary	
Total sub-projects	118
Total budget used	\$ 25,000,000.00
Total budget available	\$ 25,000,000.00
Programme utilisation	100.0%
Average project budget	\$ 211,864.41
Total budget remaining	-

Grant distribution methodology			
Country	Medium grants	Large grants	Assessment
Bahamas	5	4	Strong institutional sector: Bahamas National Trust, BREEF, Perry Institute for
Belize	4	1	Growing institutional NGO sector (TNC Belize, WCS Belize, Oceana, Belize Audubon)
Grenada	3	1	Vibrant community-engaged civil society. Organisations such as the Grenada Foundation
Jamaica	7	4	Most institutionally established civil society sector in the programme. Jamaica Environment Trust
Saint Lucia	4	1	Large and diverse CSO sector with a strong cooperative and fishermen's cooperatives

Small grants are the residual: calculated automatically as (Country budget – Large × Large limit – Medium × Medium limit) ÷ Small limit. Adjusting for small grants

Grant distribution across the three tiers (small ≤ \$150,000; medium ≤ \$300,000; large ≤ \$500,000) reflects a qualitative assessment of civil society

Timing of calls	
Startup phase (months)	7
Max project duration (months)	30
Programme end (months)	72
Final disbursement (month)	42 (Year 3.5 = 42nd month)
Total calls for proposal	6
Project limit per call	26

Calls for proposals	By end of month	Bahamas	Belize	Grenada	Jamaica	Saint Lucia	Total number	Funds disbursed	Cumulative
Call 1	12	4	6	6	4	6	26	\$ 6,550,000.00	\$ 6,550,000.00
Call 2	18	4	5	5	3	5	22	\$ 4,750,000.00	\$ 11,300,000.00
Call 3	24	4	5	5	3	5	22	\$ 4,750,000.00	\$ 16,050,000.00
Call 4	30	4	5	4	3	5	21	\$ 4,450,000.00	\$ 20,500,000.00
Call 5	36	2	3	4	2	3	14	\$ 2,400,000.00	\$ 22,900,000.00
Call 6	42	1	3	4	2	3	13	\$ 2,100,000.00	\$ 25,000,000.00
Totals	-	19	27	28	17	27	118	\$ 25,000,000.00	

Figure 1 Grant allocation scenario to be modelled by the EFA, and hypothetical grant distribution per call.

1.3.1 Grant distribution scenario rationale

The allocation of grants across the three tiers, small (up to USD 150,000), medium (up to USD 300,000) and large (up to USD 500,000), was determined through a two-part analytical process: first, a qualitative assessment of civil society absorptive capacity in each target country; and second, an arithmetic optimisation of the grant mix to achieve full utilisation of the USD 5 million country allocation. Both elements are documented in the Grant Scenario Planner (Sheet 2 of Annex 3a) and described in turn below.

Grant tier allocation across the five target countries reflects a qualitative assessment of each country's civil society sector, conducted through a desktop review of the stakeholder profiles of active civil society organisations (CSOs) and non-governmental organisations (NGOs) mapped during programme preparation. The assessment draws on CANARI's Civil Society Organisational Capacity Assessment Framework (2017) and the findings of CANARI's Green Climate Fund-funded project *Enhancing Caribbean Civil Society's Access and Readiness for Climate Finance* (2020–2022).

The assessment considers the proportion of mapped organisations that demonstrate the formal governance structures (e.g., registered legal status, a governing board, independently audited financial accounts, and procurement and safeguard policies) typically required to manage medium- and large-tier grants responsibly. Countries with a higher share of institutionally established organisations (see Annex 2) are allocated a greater proportion of medium grants, reflecting greater absorptive capacity across the civil society pipeline. Small grants, which constitute the majority of disbursements across all countries, are allocated as the residual, capturing the large number of community-based organisations, fishermen's cooperatives, youth groups, and grassroots associations that represent the primary target beneficiaries of the EDA facility.

The assessment findings per country are as follows:

- The **Bahamas** has a strong and formally governed institutional sector anchored by the Bahamas National Trust, the Bahamas Reef Environment Educational Foundation (BREEF), etc., supporting five medium grants and four large grants, the same large grant allocation as Jamaica. The Bahamas' unique archipelagic context, which demands capital-intensive

community investment across early warning systems, marine protected area management, shelter resilience, and artisanal fisheries, makes multiple large-tier grants a particularly appropriate instrument alongside its medium grant allocation.

- **Belize** has a growing NGO sector including WCS Belize, Oceana, and the Belize Audubon Society, alongside a substantial share of indigenous peoples' organisations and rural community-based organisations; it receives four medium grants and one large grant, the latter directed to the country's highest-priority large-scale intervention.
- **Grenada**, while having a vibrant and community-engaged civil society, is predominantly composed of community-based organisations, youth groups, and fishermen's cooperatives, warranting three medium grants, one anchor large grant, and the highest proportion of small grants in the programme.
- **Jamaica** presents the most institutionally established civil society sector among the five target countries, with organisations such as the Jamaica Environmental Trust, Environmental Foundation of Jamaica, demonstrating formal governance, audited financial accounts, and prior climate finance engagement. This depth of institutional capacity supports both the highest allocation of medium grants in the programme (seven) and the largest allocation of large grants (four), reflecting that Jamaica's established organisations are well-positioned to manage complex, multi-year, large-scale adaptation projects across the full range of CABRIC sub-themes.
- **Saint Lucia** has a large civil society sector but is characterised predominantly by fishermen's cooperatives, credit unions, and village-level associations with more limited formal governance structures, supporting four medium grants and one anchor large grant.

Each country is allocated at least one large-tier grant,¹ intended to anchor engagement with the most institutionally capable partner in each country, for instance, a national conservation trust, a leading environmental NGO. Across all five countries, small grants constitute the majority of disbursements by number, targeting community-based organisations, grassroots associations, and cooperatives that form the backbone of locally-led climate action.

The actual portfolio will be determined during implementation based on the quality and nature of proposals received, evolving country priorities, and adaptive management informed by implementation experience. The scenario presented is one plausible, analytically grounded baseline for the purposes of the EFA.

Within this grant size distribution, a hypothetical allocation of the **118 grants** across the six representative interventions have been modelled to generate cost and benefit estimates, in the Programme-level portfolio split (Sheet 3 of Annex 3a):

Hypothetical split of sub-projects between grant sizes	Small grants	Medium grants	Large grants	Total number of investments per sub-project
A1 - CRA package	43	7	0	971.59
A2 - Cold storage		7	3	14.40
A3 - Community MPAs			3	3.15
B1 - EWS			2	3.02
B2 - Mental health	41	9	0	59.00
B3 - Hurricane-proof shelters			3	3.13
Total number of sub-projects (must match EDA planner totals)	84	23	11	1054.28
EDA planner totals	84	23	11	

Figure 2 Split of interventions between different grants. Grey highlights mean the respective interventions are not applicable within that grant size, as the costs exceed the grant limit.

The number of investments per sub-project funded by each respective grant refers to the number derived from the maximum amount per grant divided by the cost of each respective investment.

¹ There is also an arithmetic constraint in this scenario planning exercise. With grant tier sizes of USD 150,000 (small), USD 300,000 (medium), and USD 500,000 (large), full utilisation of the USD 5,000,000 country allocation cannot be achieved with zero large grants: USD 5,000,000 is not evenly divisible by USD 150,000 (quotient 33.3), so a portfolio of small and medium grants alone leaves a residual of USD 50,000 uncommitted per country. Full utilisation is arithmetically achievable only when the number of large grants per country satisfies $L \equiv 1 \pmod{3}$ (i.e. $L = 1, 4, 7 \dots$) making one large grant per country the minimum viable value. With $L = 1$ fixed, the small grant count is the residual: $S = (5,000,000 - 500,000 - 300,000M) \div 150,000$, or equivalently $S = 20 - 2M$, and is implemented as a formula in the Grant Scenario Planner rather than a hardcoded value.

1.3.2 Country-level thematic allocation rationale

The proportional allocation of CABRIC's six sub-themes across the five target countries has been determined through a qualitative needs-based vulnerability assessment drawing on each country's most recently available nationally determined contribution (NDCs), national adaptation plans (NAPs), national communications to the UNFCCC, and other national sectoral policy instruments. For each sub-theme, countries are assessed against three criteria: (i) the prominence and specificity of the relevant sector within the country's NDC adaptation component and NAP priorities; (ii) the scale and severity of documented climate exposure in that sector, including quantified economic losses where available; and (iii) the degree of residual adaptation investment gap, reflecting the extent to which existing public expenditure or international climate finance has left identified needs unmet. Scores are normalised across the five target countries to derive a percentage allocation for each sub-theme, which determines what proportion of that sub-theme's modelled costs and benefits is attributed to each country in the portfolio-level economic analysis. The resulting allocation is presented in the portfolio split (Sheet 3 of Annex 3a); the evidential basis for each country's allocation is set out below, based on information presented in Annex 2: Feasibility study.

1.3.2.1 Summary

A1: Climate-resilient agriculture for smallholders

Country	Score	Rationale / country priority basis
Jamaica	5	17% of labour force in agriculture; 80% of farms rainfed; droughts and pests well-documented; CRA explicitly prioritised in NDC and NAP; RADA advisory infrastructure indicates active institutional demand
Belize	4	NDC targets climate-smart agriculture and food security; National Agriculture Sector Adaptation Strategy; indigenous and rural farming communities in Toledo and Cayo districts highly exposed
Saint Lucia	4	Agriculture listed as first-order NAP priority; dedicated Agriculture SASAP (2018–2028) with 11 project concept notes; Adaptation Fund USD 10M project for agricultural sector approved 2019
Grenada	3	NAP 2017–2021 prioritises CSA; Ministry of Agriculture workplan integrates CSA; crop failures from drought and flooding recognised risk; fisheries sector more prominent overall
Bahamas	2	Government target to expand domestic agriculture and reduce food import dependency; drought-resistant crop R&D cited in adaptation policy; smaller agricultural labour base relative to other countries

This results in a portfolio allocation of: Jamaica 28%, Belize 22%, Saint Lucia 22%, Grenada 17%, Bahamas 11% in the modelled scenario.

A2: Cold storage for artisanal fishers

Country	Score	Rationale / country priority basis
Grenada	5	Fisheries contribute 1–2% of GDP, employ 3,500 directly; post-harvest spoilage at 8% per landing site; climate-driven species scarcity forcing longer voyages; Hurricane Beryl caused USD 4M damage to processing infrastructure
Saint Lucia	4	Fisheries SASAP (2018–2028) with 10 project concept notes; strong fishermen's cooperative and landing site network; fisheries listed alongside agriculture as primary NAP sector
Belize	4	Artisanal fishing central to coastal indigenous livelihoods; GCF-funded Coastal Zone and Fisheries NAP consultations launched 2023; barrier reef ecosystem stress directly threatens fishing communities
Bahamas	3	Conch and lobster fisheries employ 9,000+ fishers; post-harvest cold chain challenges across remote family islands; marine resources central to food security in archipelago communities
Jamaica	2	Coastal fishing communities present but fisheries not a primary NDC or NAP adaptation sector; agricultural focus dominates livelihoods policy

This results in a portfolio allocation of: Grenada 28%, Saint Lucia 22%, Belize 22%, Bahamas 17%, Jamaica 11% in the modelled scenario.

A3: Community-managed MPAs

Country	Score	Rationale / country priority basis
Belize	5	UNESCO Barrier Reef Reserve System; NDC pledges 20% territorial waters in MPAs and 10% in community-managed replenishment zones; existing MPA system has documented weak management effectiveness and open-access fishing, which this type of intervention seeks to address
Bahamas	4	One-third of Caribbean coral reefs in Bahamian waters; spiny lobster and Queen Conch fisheries under documented overfishing pressure; Bahamas National Trust and TNC have active community reef management programmes
Grenada	3	Reef bleaching and coastal erosion priority in NDC; ICCAS project established community climate adaptation fund covering marine areas; GFC and Grenada Red Cross active in community-level coastal management
Saint Lucia	3	Resilient Ecosystems SASAP (REASAP); National Ocean Policy and Strategic Action Plan; mangrove and reef protection cited in NAP natural resource management sector
Jamaica	2	Marine Parks Regulations and Protected Areas System Master Plan establish legal framework; less prominent than agriculture and DRM in recent national climate policy

This results in a portfolio allocation of: Belize 30%, Bahamas 23%, Grenada 17%, Saint Lucia 18%, Jamaica 12% in the modelled scenario.

B1: Community-based Early Warning Systems

Country	Score	Rationale / country priority basis
Bahamas	5	Archipelago of 700 islands; USD 850M average annual hurricane loss (11–12% GDP); Hurricane Dorian USD 3.4B (2019); NDC and National Adaptation Policy identify EWS as critical; UNDP work documented disability inclusion gaps in existing EWS
Belize	4	Ranked 3rd globally for disaster risk (World Bank 2025); 60% of population in coastal or low-lying areas; indigenous and remote communities historically underserved by national forecasting systems
Saint Lucia	4	Hurricane belt exposure; Hurricane Tomas caused damage equivalent to 43.4% GDP; NAP infrastructure sector explicitly includes EWS strengthening; recurring flood and landslide events
Jamaica	3	Comprehensive Disaster Risk Management Policy and Strategy (2020–2040) embeds EWS; institutional DRM framework more developed than most CABRIC countries, moderating marginal need
Grenada	2	Hurricane exposure recognised in NDC community resilience component; smaller territory and population make national-level coverage more achievable; lower average annual losses relative to other countries

This results in a portfolio allocation of: Bahamas 28%, Belize 22%, Saint Lucia 22%, Jamaica 17%, Grenada 11% in the modelled scenario.

B2: Post-climate disaster mental health support

Country	Score	Rationale / country priority basis
Belize	5	10,000+ people displaced by weather disasters since 2008; National Mental Health Policy (2023–2028) explicitly mandates mobile clinic outreach and disaster mental health services; Toledo district case documented in peer-reviewed literature (Kirsch et al., 2025)
Bahamas	4	Hurricane Dorian triggered acute mass trauma across Grand Bahama and Abaco; Mental Health Bill (2022) enacted partly in response; UNDP documentation of mental health as under-addressed dimension of climate disaster response

Jamaica	3	National Mental Health Strategic Plan (2020–2025); mental health integrated into health and social sector climate adaptation planning
Saint Lucia	3	National Mental Health Policy; November 2022 trough system affected 300 households with documented trauma; recurring disaster cycle creates cumulative mental health burden
Grenada	2	Health Sector Strategic Plan (2015–2024) references mental health; lower documented rate of large-scale disaster displacement relative to other CABRIC countries

This results in a portfolio allocation of: Belize 29%, Bahamas 24%, Jamaica 18%, Saint Lucia 18%, Grenada 11% in the modelled scenario.

B3: Hurricane-proofing community buildings

Country	Score	Rationale / country priority basis
Saint Lucia	5	207 emergency shelters per national list (2024–25); Hurricane Tomas (2010) damaged housing and infrastructure equivalent to 43.4% GDP; November 2022 trough damaged 8 schools requiring EC\$2.4M repairs; NAP infrastructure sector explicitly targets shelter resilience
Jamaica	4	Comprehensive DRM Policy and Strategy (2020–2040) identifies climate-proofing of health centres and schools as a priority; schools and community buildings frequently serve as emergency shelters
Bahamas	4	Hurricane Dorian caused extensive destruction of community buildings in Abaco and Grand Bahama; Ministry of Disaster Preparedness, Management and Reconstruction established post-Dorian with shelter resilience mandate
Grenada	3	NAP infrastructure resilience objectives; Carriacou and Petite Martinique particularly exposed; NDC community resilience component references shelter
Belize	2	National Hazard Mitigation Policy covers critical facility resilience; lower documented shelter infrastructure deficit relative to hurricane-facing SIDS

This results in a portfolio allocation of: Saint Lucia 28%, Jamaica 22%, Bahamas 22%, Grenada 17%, Belize 11% % in the modelled scenario.

The overall summary for the portfolio allocation per country is as follows:

Country	A1 CRA	A2 Fisheries	A3 MPAs	B1 EWS	B2 Mental health	B3 Shelters
Bahamas	11%	17%	23%	28%	24%	22%
Belize	22%	22%	30%	22%	29%	11%
Grenada	17%	28%	17%	11%	11%	17%
Jamaica	28%	11%	12%	17%	18%	22%
Saint Lucia	22%	22%	18%	22%	18%	28%
Total	100%	100%	100%	100%	100%	100%

1.3.2.2 The Bahamas

The Bahamas' climate adaptation profile is defined above all by its extreme and recurring exposure to tropical cyclones and the acute vulnerability created by its archipelagic geography, comprising 700 islands and more than 2,400 cays spanning 250,000 km² of ocean territory. This geography is not merely a physical characteristic; it is the primary driver of adaptation cost and complexity, as the dispersed settlement pattern across family islands generates disproportionately high per capita costs for infrastructure,

emergency response, and the provision of public services under climate stress. Average annual losses from hurricanes are estimated at USD 850 million, equivalent to 11–12% of GDP or approximately USD 2,118 per person per year.² Hurricane Dorian (2019) caused an estimated USD 3.4 billion in damages (equivalent to one quarter of national GDP) destroying or severely damaging half of all buildings on Abaco and Grand Bahama, leaving over 29,500 people homeless or unemployed, and generating social sector damage of USD 1.6 billion concentrated overwhelmingly in housing and community infrastructure.³ The country's gross government debt burden of 71.9% of GDP in 2026, combined with its classification as a high-income country that restricts eligibility for many concessional development finance instruments, means that community-level adaptation investment is systematically underfunded relative to documented need.

Within **Theme 1**, the Bahamas receives its highest allocation under A3 (community-managed MPAs), reflecting the exceptional scale and economic significance of its marine ecosystems. Approximately one third of all Caribbean coral reefs are found in Bahamian waters, supporting the country's most important fisheries, spiny lobster and Queen Conch, which employ over 9,000 fishers and contribute an estimated USD 3–4 million annually to the national economy, in addition to coral reef-dependent dive tourism valued at USD 671 million per year.⁴ These ecosystems are under documented and intensifying pressure from overfishing, ocean acidification, rising sea surface temperatures, and coral disease, with the Bahamas' National Policy for the Adaptation to Climate Change identifying the protection of coastal and marine resources as a central national adaptation priority. The Bahamas receives a 17% allocation under A2 (cold storage for artisanal fishers), reflecting the particular cold chain challenges faced by fishing communities on remote family islands, where geographic isolation compounds post-harvest loss in the absence of accessible refrigeration and processing infrastructure. The A1 (CRA) allocation of 11% is consistent with the Bahamas' comparatively smaller agricultural labour force, though the country's National Adaptation Policy identifies the expansion of domestic food production and the development of drought-resistant crop varieties as medium-term priorities to reduce the country's high food import dependency.

Within **Theme 2**, the Bahamas receives its highest programme-wide allocation under B1 (community-based EWS) at 28%, commensurate with its position as the most hurricane-exposed CABRIC country in per capita economic loss terms. The country operates a tiered national evacuation system, but the dispersed geography of the family islands has consistently left remote communities inadequately served by national forecasting and early warning infrastructure, a gap explicitly identified in UNDP documentation of the country's EWS limitations. Critically, existing EWS mechanisms in the Bahamas have been found to inadequately serve persons with disabilities; for instance, SMS-based mass warning systems are inaccessible to persons with visual impairments, gap documented as requiring targeted community-based and inclusive EWS design.⁵ The B2 (mental health) allocation of 24% reflects the acute and sustained psychological impact of Hurricane Dorian on the populations of Abaco and Grand Bahama, where the scale of destruction, including the complete devastation of entire districts, produced population-level trauma documented in peer-reviewed clinical literature. The passage of the Mental Health Bill (2022) represents a formal legislative acknowledgement of this gap and provides the policy basis for community-level mental health investment. The B3 (hurricane-proofing community buildings) allocation of 22% is grounded in the IADB post-Dorian damage assessment, which found that 93% of social sector damage was concentrated in housing and community infrastructure,⁶ and in the Disaster Risk Management Act (2022), which mandates the development of resilient reconstruction standards for community facilities. The IFRC has additionally documented the absence of adequate safeguarding measures in existing emergency shelters,⁷ identifying structural and governance gaps that the B3 sub-theme directly addresses.

1.3.2.3 Belize

Belize presents one of the most multidimensional climate vulnerability profiles among the CABRIC target countries, ranked third globally for disaster risk and fifth for climate change risk by the World Bank (2025). With 60% of its population residing in coastal or low-lying areas, the country is simultaneously exposed to intensifying hurricane activity, coastal erosion and flooding, coral reef degradation, and the compound livelihood effects of climate stress on its agriculture and fisheries sectors. Its gross government debt burden of 63.2% of GDP in 2026 and estimated climate adaptation financing need of USD 1.15–1.3 billion by 2030, against

² https://publications.iadb.org/publications/english/document/Impact_of_Hurricane_Dorian_in_The_Bahamas_A_View_from_the_Sky.pdf

³ <https://reliefweb.int/report/bahamas/facts-hurricane-dorian-s-devastating-effect-bahamas>

⁴ <https://www.nature.org/en-us/about-us/where-we-work/caribbean/bahamas/stories-in-the-bahamas/sustainable-fisheries/>

⁵ <https://www.undp.org/geneva/blog/we-can-replace-things-we-cant-replace-people-protecting-lives-through-inclusive-early-warning-systems-bahamas>

⁶ <https://publications.iadb.org/publications/english/document/Hurricane-Dorian-%E2%80%99CAT-A-GLANCE%E2%80%99D-Assessment-of-the-Effects-and-Impacts--DALA-Visualization.pdf>

⁷ https://disasterlaw.ifrc.org/sites/default/files/media/disaster_law/2023-03/IFRC%20-%20Disaster%20Law%20Programme%20-%20Bahamas-REVISE.pdf

approximately USD 150 million received to date, reflect a structural financing gap that makes EDA-channelled grant finance among the few accessible instruments for community-level adaptation. Belize's updated NDC (2021) identifies adaptation priorities across coastal zones and marine resources, agriculture and food security, fisheries and aquaculture, human health, water, and human settlements, reflecting the breadth of the country's climate exposure.

Within **Theme 1**, Belize receives its highest allocation under A3 (community-managed MPAs) at 30%, reflecting the primacy of marine ecosystem protection within Belize's national adaptation framework. The Belize Barrier Reef Reserve System, a UNESCO World Heritage Site since 1996 and the largest barrier reef in the Northern Hemisphere, has experienced a documented decline of over 50% in both commercial and herbivorous fish populations, a trend linked in part to open-access fishing regulations and the inadequacy of community-level enforcement within existing protected areas. Belize currently maintains 18 MPAs, yet the IUCN and national assessments consistently document weak management effectiveness across the system. Belize's updated NDC explicitly targets the placement of 20% of territorial waters within marine protected areas and a further 10% within community-managed marine replenishment zones, the latter category by definition requiring active community co-management of no-take areas. This policy commitment, combined with the specific governance gap between formal MPA designation and effective community stewardship, makes Belize the highest-priority recipient of A3 investment. Belize receives equal 22% allocations under both A1 (CRA) and A2 (cold storage). The National Agriculture Sector Adaptation Strategy and Action Plan, alongside the NDC's explicit targeting of climate-smart agriculture and food security, identify rural and indigenous farming communities, particularly in the Toledo, Cayo, and Stann Creek districts, as highly exposed to drought, erratic rainfall, and heat stress. On fisheries, GCF-supported National Adaptation Plan consultations for the coastal zone and fisheries sector were formally launched in 2023, with the government explicitly identifying artisanal fishing communities, including indigenous coastal populations, as requiring targeted adaptation support to address climate-driven stock depletion and habitat degradation.

Within **Theme 2**, Belize receives the highest programme-wide allocation under B2 (mental health) at 29%. Since 2008, weather-related disasters have displaced more than 10,000 people, generating a well-documented burden of post-traumatic stress disorder, climate anxiety, and depression at the community level. Belize's National Mental Health Policy (2023–2028) explicitly identifies insufficient mental health service provision as a systemic gap and mandates the establishment of mobile clinic outreach for communities exposed to climate-related disasters, a direct policy mandate corresponding to the B2 sub-theme. Peer-reviewed research by Kirsch et al. (2025) further documents the absence of dedicated mental health practitioners from the existing mobile health clinic operating in the Toledo district, where referred cases are forwarded to the Ministry of Health rather than addressed in situ, illustrating both the scale of the gap and its geographical concentration in the most climate-vulnerable communities. Belize's B1 (EWS) allocation of 22% reflects its disaster risk ranking and the structural difficulty of providing effective national-level early warning to remote indigenous communities in the interior districts and to coastal settlements across the country's dispersed *cayes* and atolls. Its lower B3 (shelters) allocation of 11% acknowledges the National Hazard Mitigation Policy's provisions for critical facility resilience but reflects that Belize's documented shelter infrastructure deficit is comparatively less acute than that of the hurricane-facing SIDS that receive higher B3 allocations.

1.3.2.4 Grenada

Grenada's climate adaptation profile is centred on the intersection of a heavily fisheries-dependent coastal economy, accelerating marine ecosystem degradation, and the physical exposure of its small island geography to hurricanes, coastal erosion, sargassum influx, and sea surface temperature increases that are disrupting marine productivity and livelihoods. Grenada's second NDC (2020) targets adaptation under five priority areas: coastal resilience, water resource management, community resilience, institutional arrangements, and health, and establishes a total adaptation financing need of up to USD 1 billion by 2030. The country's gross government debt burden of 69% of GDP and its high dependence on international grant financing, which the NDC explicitly identifies as a prerequisite for implementing its adaptation commitments, frame EDA-channelled investment as structurally necessary for community-level implementation.

Within **Theme 1**, Grenada receives its highest allocation under A2 (cold storage for artisanal fishers) at 28%, reflecting the disproportionate economic and social importance of the fisheries sector to the country's coastal communities. The sector contributes approximately 1–2% of national GDP and directly employs around 3,500 people, with a further 400 employed indirectly in processing and value chain activities. The sector faces compounding climate stressors: rising sea surface temperatures are shifting the migration and spawning patterns of the 17 fish species that provide 43% of total national catch; sargassum influxes frequently entangle gear and block harbour access; and coral bleaching is degrading the reef habitat on which nearshore species depend for larval survival and breeding. Fishers report increasing scarcity of pelagic species and are being compelled to travel longer distances to secure catch, raising operational costs and exposure to open-ocean weather risk. Against this backdrop, business-as-usual post-harvest spoilage losses of 8% per landing site, representing an annual economic loss of USD 26,728 per site,

constitute a directly addressable vulnerability whose resolution requires cold chain investment. Hurricane Beryl (2024) caused over USD 4 million in damage to boats, jetties, and fish processing infrastructure, further eroding the capital base of an already-stressed sector. Grenada receives a 17% allocation under both A1 (CRA) and A3 (MPAs), reflecting that climate-smart agriculture is integrated into the Ministry of Agriculture's corporate workplan and the NAP's priority actions, and that reef bleaching and community coastal conservation are identified as priorities in both the NDC and through existing programmes such as the ICCAS-funded Community Climate Change Adaptation Fund, which has supported over 160 community groups with adaptation grants including marine and coastal management activities.

Within **Theme 2**, Grenada's allocations are more modest across all three sub-themes, reflecting lower documented investment gaps relative to its CABRIC counterparts. The B1 (EWS) allocation of 11% is the lowest in the programme, consistent with the country's smaller territory and population, factors that make national-level forecasting and early warning more accessible than in archipelago or larger-territory contexts, and its comparatively lower average annual hurricane losses. The B2 (mental health) allocation of 11% reflects that while Grenada's Health Sector Strategic Plan (2015–2024) and NDC community resilience component reference mental health within their broader frameworks, the country has the lowest documented rate of large-scale weather-related displacement and associated trauma burden among the five CABRIC countries. The B3 (hurricane-proofing shelters) allocation of 17% reflects infrastructure resilience objectives identified in the NAP and the particular exposure of Grenada's dependency islands, Carriacou and Petite Martinique, which are geographically isolated, have older community building stock with limited hurricane resistance, and face elevated access constraints during and after extreme weather events.

1.3.2.5 Jamaica

Jamaica's climate adaptation landscape is shaped by the intersection of high sectoral vulnerability in agriculture, an established disaster risk management framework that nonetheless faces significant implementation financing gaps, and a structural constraint in accessing concessional international climate finance arising from its upper-middle-income country classification. The country's estimated climate adaptation financing need of USD 6.5 billion by 2030 is the largest in absolute terms among the five CABRIC target countries, while its gross government debt burden of 65.8% of GDP in 2026 severely limits domestic fiscal capacity to address it. Jamaica's third national communication to the UNFCCC (2018), its NDC, and the Jamaica Vision 2030 National Development Plan identify agriculture, coastal communities, water resources, and health as the principal sectors requiring adaptation investment, with the Jamaica Gender and Climate Change Strategy and Action Plan integrating gender-transformative approaches across sectoral priorities.

Within **Theme 1**, Jamaica receives the highest programme-wide allocation under A1 (climate-resilient agriculture) at 28%. Agriculture employs approximately 17% of the national labour force, but the sector is structurally fragile: less than 10% of agricultural land is irrigated, leaving 80% of farmers entirely dependent on rainfed production and highly exposed to the prolonged droughts, erratic rainfall, and temperature extremes projected to intensify under all climate scenarios for the region. The 2014 drought reduced yam and coffee production by 20%, while rising temperatures have driven invasions by whiteflies, aphids, plant-hoppers, mites, and thrips that have devastated local production across multiple crop types. Hurricane Beryl (2024) caused an estimated USD 5.7 billion in damage to Jamaica's agriculture and fisheries sectors, directly affecting over 48,850 farmers and demonstrating the catastrophic single-event exposure of the sector. Jamaica's NDC adaptation component and national adaptation policy both explicitly identify climate-smart agriculture, drought-resistant crop varieties, and micro-dam water storage as priority investments, with these commitments reflected in RADA's advisory programmes. Jamaica's A2 (fisheries) and A3 (MPAs) allocations are the lowest in the programme at 11% and 12% respectively, consistent with the relative lower prominence of fisheries livelihood security and marine conservation as primary adaptation priorities in Jamaica's current NDC and NAP compared to agriculture and disaster risk management.

Within **Theme 2**, Jamaica receives a 22% allocation under B3 (hurricane-proofing community buildings), grounded in the Comprehensive Disaster Risk Management Policy and Strategy (2020–2040), which explicitly identifies the climate-proofing of community buildings — including health centres and schools that routinely serve as emergency shelters, as a priority action within its six-year implementation horizon. Jamaica's B1 (EWS) allocation of 17% reflects a moderate hurricane exposure profile combined with a more institutionally developed disaster management framework than most CABRIC counterparts, maintained through the Office of Disaster Preparedness and Emergency Management (ODPEM), which moderates the marginal need for community EWS investment relative to countries with less established national systems. The B2 (mental health) allocation of 18% is grounded in the Jamaica National Mental Health Strategic Plan (2020–2025), which integrates mental health services with climate-related disaster response and identifies community-level psychological support as a component of the country's broader social resilience agenda.

1.3.2.6 Saint Lucia

Saint Lucia's adaptation profile is characterised by the breadth and relative maturity of its national adaptation planning architecture and by the documented severity of its physical exposure to hurricane-intensity events and their cascading impacts on shelter infrastructure, agriculture, fisheries, and health. The NAP (2018–2028) identifies eight priority sectors for adaptation action: water, agriculture, fisheries, infrastructure and spatial planning, natural resource management, education, health, and tourism, and is complemented by a suite of Sectoral Adaptation Strategies and Action Plans (SASAPs) covering water, agriculture, fisheries, and resilient ecosystems. This policy architecture reflects both the breadth of sectoral vulnerability and a sustained national commitment to adaptation planning. Saint Lucia's gross government debt burden of approximately 77.5% of GDP in 2026 and estimated adaptation financing need of USD 400 million by 2030, equivalent to 25% of GDP, place the country among the most financing-constrained CABRIC participants relative to its income level, reinforcing the case for EDA-channelled investment across multiple thematic areas.

Within **Theme 1**, Saint Lucia receives equal 22% allocations under A1 (CRA) and A2 (cold storage), reflecting the co-equal status of agriculture and fisheries as the two primary NAP adaptation priorities with the most fully developed sectoral action plans. The Agriculture SASAP (2018–2028) is supported by eleven project concept notes and was preceded by an Adaptation Fund-approved project of USD 10 million for the agricultural sector, confirming both the scale of investment need and the country's institutional readiness to absorb and implement agricultural adaptation finance. The Fisheries SASAP (2018–2028) identifies ten adaptation project concept notes, grounded in the central role of the fishermen's cooperative network and landing site infrastructure in coastal community livelihoods and food security. The A3 (MPAs) allocation of 18% reflects the Resilient Ecosystems SASAP (REASAP) and the National Ocean Policy and Strategic Action Plan, which place marine and coastal ecosystem management, including mangrove, reef, and seagrass restoration, within the NAP's natural resource management priority sector, alongside the identified need for community co-management approaches to support marine ecosystem recovery.

Within **Theme 2**, Saint Lucia receives its highest programme-wide allocation under B3 (hurricane-proofing community buildings) at 28%, directly reflecting the severity and recurrence of its shelter infrastructure deficit. The national emergency shelter list for 2024–2025 identifies 207 shelters across the island's districts, the majority of which are school buildings. Hurricane Tomas (2010) caused total damages equivalent to 43.4% of national GDP, between USD 336 million and USD 350 million, with 92% of social sector damage concentrated in housing and critical infrastructure, including USD 2 million in damage to health facilities and the destruction of road access to communities including Soufrière. A trough system in November 2022 subsequently damaged eight schools requiring EC\$2.4 million in repairs, among them Dame Pearlette Louisy Primary School, illustrating the compounding cycle of infrastructure damage and reconstruction that the B3 sub-theme directly addresses. Saint Lucia's NAP infrastructure and spatial planning sector explicitly identifies the strengthening of physical structures to withstand climate impacts as a priority outcome. The B1 (EWS) allocation of 22% reflects Saint Lucia's position in the hurricane belt, its history of recurring flood and landslide events, and the identification of EWS as a component of the NAP's infrastructure and health sector outcomes. The B2 (mental health) allocation of 18% acknowledges the documented cumulative psychological burden of repeated climate disasters on Saint Lucia coastal communities, anchored in the National Mental Health Policy and the recurrent trauma associated with Hurricane Tomas and subsequent flooding events including the November 2022 trough system.

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1.3.2.7 Note on the limitations of ex-ante modelling

It should be emphasised that **this portfolio composition represents one plausible ex-ante scenario for illustrative purposes**. The actual portfolio will be determined during implementation based on the quality and nature of proposals received, evolving country priorities, and adaptive management based on implementation experiences.

However, the interventions that have been modelled are sufficiently representative of anticipated project types that the aggregate financial and economic results provide a robust basis for assessing the CABRIC facility's value proposition and expected returns on investment.

1.3.3 EFA methodology

This EFA was conducted in the form of an integrated Cost-Benefit Analysis (CBA). The CBA incorporates financial assessments, including the assessment of the investments, operational and maintenance costs, revenue generation, and, critically, includes economic consideration of non-marketable benefits that are directly linked to the investment and the interventions of the project.

The assessment utilises key financial metrics for the selected project interventions, i.e. the financial Internal Rate of Return (IRR) and Net-Present Value (NPV). As the analysis incorporates non-marketable societal benefits the relevant economic measures are presented as Economic Internal Rate of Return (EIRR) and Economic Net-Present Value (ENPV) to signify their consideration of societal factors.

The CBA is based on a counterfactual analysis and assesses the avoided negative impacts of climate-related events. The counterfactual for each measure assumes that the investment would most likely not occur and therefore the associated costs would take place. The figure below is a schematic overview of the counterfactual costs (Climate change impacts without adaptation) and the project scenario (investment costs and residual climate change impacts).

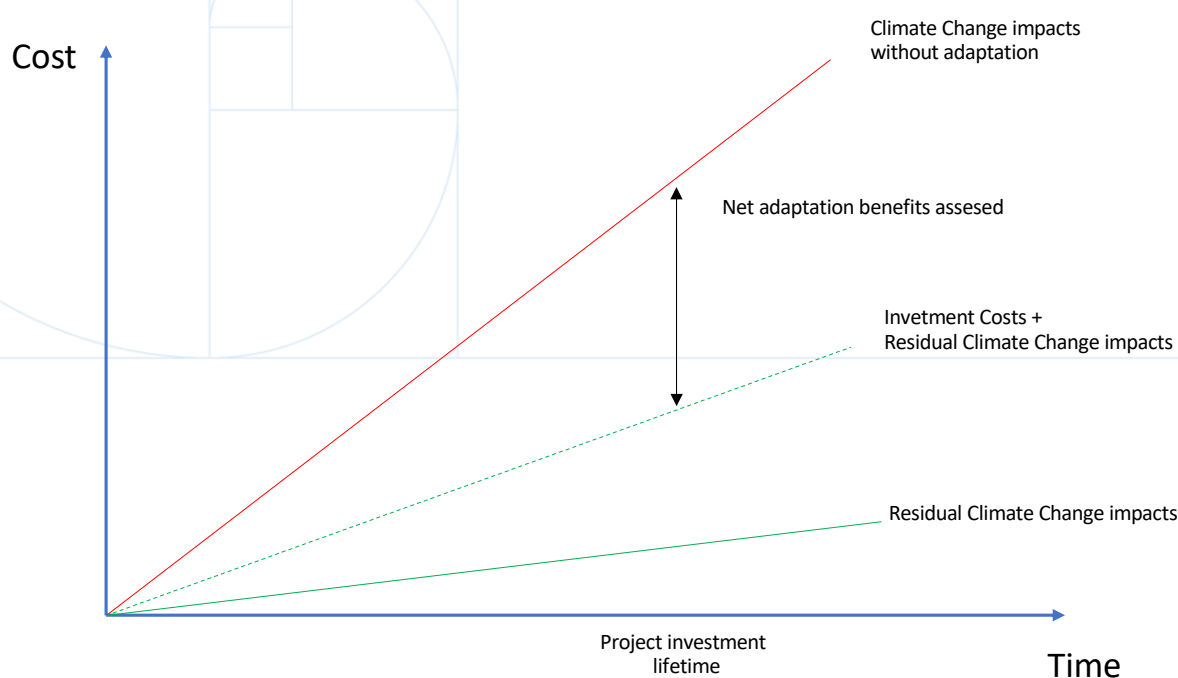


Figure 3: Schematic overview of the adaptation benefits assessed in the CBA

In the economic analysis, the economic net present value (ENPV) and the economic internal rate of return (EIRR) of the project interventions and the project as a whole are assessed. When the $ENPV > 0$ for an appropriate discount rate the intervention/sub-project is considered viable. The EIRR is defined as the discount rate (r) that produces a zero ENPV. Therefore, it represents the threshold interest rate in order for the intervention/ project to be profitable.

For the economic analysis, a **12% social discount rate** is employed, which is consistent with international development finance benchmarks.⁸ This rate is derived using the social opportunity cost of capital approach, which reflects the return that public resources would generate in their next-best alternative use within the Caribbean economic context. In capital-scarce small island economies characterised by thin domestic financial markets, limited fiscal space, and high sovereign borrowing costs, the social opportunity cost of capital is genuinely elevated relative to advanced economies. The 12% rate is consistent with guidance from the Caribbean Development Bank and with GCF project-level economic analysis practice for upper-middle income developing countries.

⁸ Ben Groom et al., 'The Future, Now: A Review of Social Discounting', *Annual Review of Resource Economics* 14, no. 1 (2022): 467–91, <https://doi.org/10.1146/annurev-resource-111920-020721>.

Sensitivity analyses, test social discount rates of 5%, 10%, 15%, and 20% across all six intervention models and at the portfolio level to test the economic case under lower-rate assumptions. The 12% baseline rate should therefore be understood as a conservative choice that understates the economic returns of long-lived adaptation investments with intergenerational benefits.

All of the interventions produce outputs and outcomes that meet the classical definition of public goods ((non-rivalrous and non-excludable);⁹ therefore, the focus has been put on the economic analysis of the programme. Two of the modelled interventions (A1 and A2) are revenue-generating, and therefore also contain a financial analysis. The financial analysis reviews the costs and revenues seen from the financial agent's perspective of investments in climate-resilient activities.

To account for the scarcity of available data and provide robust results a sensitivity analysis is conducted for both the NPV and the IRR. The sensitivity analysis takes into consideration reductions and increases of the investment costs and benefits for each measure assessed and for the project as a whole.

Lastly, to enhance the contextual relevance of the EFA, each of the six representative interventions has been modelled using data, parameters, and assumptions for costs and benefits from a specific CABRIC target country. Where country-specific data was available, it was prioritised to ensure the analysis reflects actual on-the-ground conditions rather than regional averages that may not accurately represent any single country context. The country assignments are as follows:

- A1: Jamaica
- A2: Grenada
- A3: Belize
- B1: Bahamas
- B2: Belize
- B3: Saint Lucia

1.3.3.1 Methodological note on economic values

Economic analysis values resources at their opportunity cost to society rather than at observed market prices, which are distorted by indirect taxes, tariffs and subsidies. Where an item is internationally traded, it is valued at its border-price equivalent (CIF for imports, FOB for exports); where a good or service is non-traded and no item-specific factor is available, a **Standard Conversion Factor (SCF)** is applied to convert the domestic market price to its border-price equivalent.

Following standard practice (e.g., Asian Development Bank, *Guidelines for the Economic Analysis of Projects*; European Commission, *Guide to Cost-Benefit Analysis of Investment Projects*), the SCF is defined as $SCF = (M + X) / (M + X + TM)$, where M and X are the values of imports and exports at border prices and TM is the total value of import duties. No country-specific SCF is published or maintained for the CARICOM member states covered by the programme; the factor is therefore derived from trade-tax incidence. Dividing through, the expression reduces to $SCF = 1 / (1 + t)$, where t is duties as a proportion of the traded base — i.e. the average tariff distortion between domestic and border prices. This is proxied by the applied, weighted-mean tariff across all products reported in the World Bank's World Integrated Trade Solution,¹⁰ which for the programme's CARICOM economies is of the order of 9% (for example, Jamaica's weighted-mean applied tariff was 9.24% in 2022), consistent with the CARICOM Common External Tariff bands of 0–20%.

Imported capital equipment is entered at domestic delivered prices inclusive of duty and local margin, and the SCF converts these to their border-price equivalent; genuinely tradeable benefit streams (notably avoided food imports, valued at import-parity prices) and benefits already expressed in economic terms (social cost of carbon, statistical value of life, disability-adjusted life years, ecosystem-service and avoided-damage values) are not further adjusted.

⁹ Non-rivalrous goods are public goods that are consumed by people but whose supply is not affected by people's consumption. In other words, when an individual or a group of individuals use a particular good, the supply left for other people to use remains unchanged. Therefore, non-rivalrous goods can be consumed over and over again without the fear of depletion of supply.

¹⁰ <https://data.worldbank.org/indicator/TM.TAX.MRCH.WM.AR.ZS>

Additionally, market wages may exceed the true opportunity cost of labour where the labour drawn into a project is otherwise underemployed, so that its foregone output is below the wage paid. A **Shadow Wage Rate Factor** (i.e., the ratio of the shadow wage to the market wage) is applied to the labour element of costs to reflect this.

The factor is applied in the models where labour is a material, separable cost input. For instance, in the climate-resilient agriculture model (A1), labour is estimated to constitute approximately half of crop production costs, and is drawn largely from a seasonal, underemployed smallholder pool, for which a shadow wage below the market wage is well founded; an SWRF of 0.75 is applied to the labour share, combined with the SCF on non-labour inputs to give a blended cost conversion factor of 0.825. In the cold-storage model (A2), the labour element is the embedded operation-and-maintenance labour of the facility (estimated at 30% of annual O&M expenditure); an SWRF is applied to this component while the imported equipment is converted at the SCF.

Where project labour is skilled or formal, the shadow wage approximates the market wage and no reduction is applied; those models' benefits are already expressed in economic terms, so only the price basis of cost inputs is stated and a Standard Conversion Factor applied. Because a sub-unity shadow wage reduces measured economic costs, this treatment is deliberately conservative in scope: labour is shadow-priced only where the underemployment premise genuinely holds.

1.3.4 Rationale for representative countries in modelled interventions

Jamaica was specifically selected as the representative country to assess the costs and benefits for Theme A1: Climate-resilient agricultural packages due to its agricultural vulnerability. The agriculture sector is a cornerstone of the Jamaican economy, employing approximately 17% of the labour force, however, despite this, the sector is structurally fragile because less than 10% of agricultural land is irrigated, leaving 80% of farmers completely reliant on rainfed agriculture.^{11&12} This reliance leaves farmers highly exposed to prolonged droughts and erratic rainfall which was evident from the 2014 drought reduced yam and coffee production by 20%.¹³ Furthermore, rising temperatures have triggered severe agricultural pest invasions, notable species include whiteflies, aphids, plant hoppers, mites, and thrips which have decimated local production.¹⁴ Frequent extreme weather events like storms, floods and hurricanes consistently devastate agricultural outputs which was the case during Hurricane Beryl in 2024 which caused over USD 5.7 billion in damages to the agriculture and fisheries sectors, affecting more than 48,850 farmers.¹⁵

At the macroeconomic level, Jamaica has the highest estimated climate finance need among the participating CABRIC nations, requiring an estimated \$6.5 billion by 2030 to achieve climate resilience. Despite this, Jamaica's classification as an upper-middle-income country restricts its access to necessary international concessional finance, while a gross governmental debt burden of 65.8% (2026) severely limits the government's fiscal capacity to fund these adaptation measures independently.¹⁶ To combat this, Jamaica's NDC as well as national climate policies such as the Adaptation Communication for Jamaica, strongly prioritises and encourages investments in climate-smart agriculture, drought-resistant crops, and micro-dam water storage, perfectly justifying a need for increased A1 grant funding.

Concerning Grenada, the country was selected as the representative country to assess the costs and benefits for Theme A2: Cold storage for coastal artisanal fishermen because its fisheries sector is a critical pillar of food security and the local economy, contributing roughly 1-2% to the national GDP and directly employing around 3,500 people, with an additional 400 employed indirectly.¹⁷ The sector, which heavily targets both coastal and offshore pelagic species (yellowfin tuna, billfish, deepwater snapper and parrotfish), is exceptionally vulnerable to climate change impacts such as rising sea surface temperatures, shifting currents and severe coral bleaching that disrupts fish migration, spawning, and larval survival. Furthermore, climate-induced influxes of sargassum seaweed frequently entangle fishing gear and block harbour access, while fisherfolk increasingly report a scarcity of pelagic fish and the need to travel longer distances to secure their catches. Additionally, widespread overfishing and illegal, unregulated, and unreported (IUU) fishing by large international vessels have significantly depleted vital stocks like yellowfin tuna and red snapper which, consequently, have caused local fishermen to venture farther from shore. This has increased their

¹¹ Food and Agriculture Organization. (2023). Jamaica Agricultural Profile.

¹² Food and Agriculture Organization. (2021). [The state of food security and nutrition in the world 2021](#)

¹³ Food and Agriculture Organization. (2023). Jamaica Agricultural Profile.

¹⁴ Rural Agricultural Development Authority, Government of Jamaica. (2023). Advisory to farmers.

¹⁵ Jamaica Observer. (2024). [\\$5.7 billion in losses for agri, fisheries sectors – Green](#).

¹⁶ IMF. (2026). Jamaica - [General government Gross Debt](#).

¹⁷ FAO. (2024). Fisheries and Aquaculture Country Profiles. Grenada, 2018. Country Profile Fact Sheets. In: Fisheries and Aquaculture.

operational costs for fuel and time while suffering from diminishing catch returns.¹⁸ The sector is also highly vulnerable to extreme weather events, as evidenced by Hurricane Beryl in 2024, which caused over USD 4 million in damages to boats, jetties, and fish processors. As noted in this EFA, compounding these climate stressors is underdeveloped cold chain infrastructure, resulting in business-as-usual post-harvest spoilage losses of 8%, which translates to an economic loss of USD 26,728 annually per landing site.

Grenada faces a gross debt burden of 69% of GDP and remains highly vulnerable to external economic and environmental shocks, which severely restricts its fiscal capacity for resilience investments, particularly relating to fishery production.¹⁹ Recognising these constraints, Grenada's second NDC estimates that fully implementing its climate measures will require up to USD 1 billion by 2030, explicitly stating that the country must rely on multilateral grants and concessional finance from entities such as the GCF. Overall, by preserving the quality of increasingly scarce catches and ensuring a reliable cold chain, proper storage maximises the economic value of the fishing effort and helps to sustain the financial viability and food security of Grenada's highly vulnerable coastal communities.

Belize was selected as the representative country to assess the costs and benefits for two themes: Theme A3: Community-managed Marine Protected Areas (MPAs) and Theme B2: Post-disaster mobile mental health services due to its vulnerability to climate hazards and the critical necessity to protect its foundational marine ecosystems and marginalized populations. As a Small Island Developing State (SIDS) located in the Caribbean hurricane belt, Belize is ranked 3rd for disaster risk and 5th for climate change risk, and the nation is continuing to be increasingly exposed to hurricanes, floods, and coastal erosion.²⁰ Nearly 60% of the population lives near the coast, and over a third reside in low-lying areas, making them especially vulnerable.²¹ Economically, Belize is constrained by a high gross debt burden, which stood at 63.2% of its GDP in 2026 and requires an estimated USD 1.15 to USD 1.3 billion by 2030 to achieve its climate action goals (the country has only received approximately \$150 million in international climate finance to date). This massive funding gap, compounded by the country's debt constraints, dictates that Belize requires grant financing to fund adaptation initiatives, particularly because both A3 and B2 are classic "public goods" interventions that generate immense societal and environmental benefits but produce zero direct financial returns for private actors.

The reasoning behind implementing community-managed MPAs (A3) in Belize centres on the protection of the Belize Barrier Reef Reserve System (a UNESCO World Heritage Site since 1996), which is the largest barrier reef in the Northern Hemisphere and a cornerstone of the national economy, supporting the tourism and fisheries sectors.²² However, the reef's health recently suffered a "poor" rating due to severe coral bleaching from rising sea surface temperatures as well as being exposed to overfishing.²³ It has been made clear that out of the four countries where the barrier reef dwells, Belize's coral reefs experienced the most decline, with a reduction of over 50% in both commercial and herbivorous fish populations, likely due to COVID-19 and weak climate enforcement measures. With regards to the overharvesting of marine life, Belize has open-access fishing regulations, and it has been noted that recreational fly-fishing in shallow mangrove areas is especially popular amongst fishermen and women.²⁴ Overfishing depletes fish populations, disrupts marine ecosystems, and threatens the livelihoods of those who rely on fishing for food and income. Operationally, MPAs struggle with inadequate capacity and financial resources, highlighting a crucial need for sustainable financing to maintain effective enforcement and potentially acquire larger patrol vessels. Belize's Updated NDC directly targets these vulnerabilities by pledging to protect 20% of its territorial waters in marine protected areas and 10% in marine replenishment zones to build coastal resilience.²⁵ Similarly, the National Protected Areas System Act aims to safeguard ecologically viable areas and promote the sustainable use of Belize's biodiversity.²⁶ With that in mind, it is important to emphasise that because MPAs are non-revenue generating interventions, market mechanisms fail to generate adequate conservation investments.

The selection of Belize for post-disaster mobile mental health services (B2) addresses a critical and often overlooked gap in disaster response. Since 2008, weather-related disasters have displaced over 10,000 people in Belize, triggering psychological impacts such as climate-anxiety (particularly on young people), post-traumatic stress disorder, and depression.²⁷ Belize's National Mental Health Policy (2023-2028) explicitly identifies that current mental health services are insufficient to meet population demands and are

¹⁸ Teck Deck. (2024). [Grenada's Fishing Industry: Challenges Facing Local Fishermen and Policy Solutions](#)

¹⁹ IMF. (2026). [Grenada - General government Gross Debt](#).

²⁰ World bank. (2025). [Belize Bolsters Climate and Disaster Resilience with the World Bank's Support](#).

²¹ Ibid.

²² UNESCO. (2026). [Belize Barrier Reef Reserve System](#).

²³ ICRI. (2023). [Mesoamerican Reef 2022 health report – poor reef health and fish decline](#).

²⁴ Global Mangrove Alliance. 2024. [The State of the World's Mangroves](#).

²⁵ Belize Updated NDC.

²⁶ National Assembly of Belize. (2015). [Act-No.-17-of-2015-National-Protected-Areas-System-Act-2015](#)

²⁷ Climate Resilient Food System Alliance. (2022.) Belize.

hindered by inadequate financial resources.²⁸ The policy underscores the necessity of establishing services for persons exposed to life-threatening disasters and mandates mobile clinic implementation and outreach services to underserved areas.²⁹ In the Toledo district for example, there operates a mobile clinic to serve various remote villages, however, this clinic does not have any dedicated mental health practitioners on staff; instead, any mental health concerns encountered during its operations are referred to the Ministry of Health.³⁰ As with MPAs, mobile mental health units produce no direct financial revenue and rely entirely on grant-based funding to cover capital costs like specialised curriculum development and telehealth communications equipment.

Regarding the Bahamas, the nation was selected as the representative country to assess the costs and benefits for Theme B1: Community-based Early Warning Systems (EWS) because of its exposure to tropical cyclones and its geographical vulnerability as a low-lying archipelago of 700 islands and over 2,400 cays. Located directly in the Atlantic hurricane belt, the country experiences an average annual loss from hurricanes of USD 850 million, equating to 11-12% of its GDP or USD 2,118 per person annually. The severity of this exposure was demonstrated by Hurricane Dorian in 2019, a Category 5 storm that caused an estimated USD 3.4 billion in damages—equivalent to a quarter of the national GDP—and triggered the creation of the Ministry of Disaster Preparedness, Management and Reconstruction to enhance future resilience.³¹ Given the country's expansive geographical area, relying solely on national forecasts has historically left vulnerable communities without adequate warning.³² Also, in relation to those with disabilities, EWS that use SMS to target a population en masse does not often consider the need for different formats and features such as how a text message warning may not be accessible for those with a visual impairment.³³ It is important to stress that community-based EWS are critical, as communication networks can empower local decision-making and enable protective actions like evacuations to be followed through effectively.

The need for requiring grants to fund these EWS interventions is rooted in the economic nature of disaster risk reduction and the macroeconomic realities of the Bahamas. The Bahamas requires an estimated USD 300 to USD 450 million annually (2-3% of GDP) to meet its adaptation needs, yet its classification as a high-income country severely restricts its access to international concessional finance from major entities like the EU and Canada. This structural barrier is compounded by a high gross debt burden, which stands at 71.9% of GDP in 2026.³⁴ Consequently, alignment with national frameworks such as the National Policy for the Adaptation to Climate Change underscores that international grant support is essential to establish these life-saving EWS and protect the nation's highly exposed populations and economy.

Lastly, Saint Lucia was selected as the representative country to assess the costs and benefits for Theme B3: Hurricane-proofing community buildings for shelter due to its geographic exposure within the Atlantic hurricane belt, and as such according to the 2024-2025 emergency shelter list, the nation had approximately 207 emergency shelters per district.³⁵ Regarding school facilities, they are frequently doubled as emergency shelters to protect vulnerable populations during climate-related disasters such as storms and hurricanes, however, when educational infrastructure is located in high-risk areas, it is more vulnerable to extreme weather events and may become unsafe to use as a public refuge.³⁶ Not only that, but school facilities often lack the capacity to house a large number of residents placing strain on water and sanitation services. Hurricane Tomas (2010) was one of the most devastating storms to hit Saint Lucia, causing extensive landslides, severe flooding, and total damages equivalent to 43.4% of the island's GDP (between USD 336 million and USD 350 million).^{37&38} Notably, 92% of these costs were attributed to housing and critical infrastructure damages, including USD 2 million in damage to health facilities and the destruction of roads that isolated communities such as Soufriere.^{39&40} Furthermore, a November 2022 Trough System produced severe flash flooding and land slippage that heavily damaged both public infrastructure and private property. Around 300 households were affected, with losses of 80-90% of household items, preliminary damage to residential properties exceeded EC\$1.8 million and public infrastructure costs reached EC\$854,180. Eight schools, including Dame Pearlette Louisy Primary,

²⁸ Ministry of Health and Wellness. (2023). Belize national Mental Health Policy

²⁹ Ibid.

³⁰ Kirsch, J et al. (2025). Current state of mental health and substance use in Toledo, Belize: A mixed methods study in *Cambridge Prisms: Global Mental Health*. 12 (e53), 1-9.

³¹ Othering & Belonging. (2026). *Climate Crisis, Displacement, and the Rights to Stay*.

³² VAISALA. Weather Resiliency and Early warnings in the Bahamas.

³³ UNDP. (2023). *We can replace things, but we can't replace people: protecting lives through inclusive early warning systems in the Bahamas*.

³⁴ IMF. (2026). *The Bahamas - General government Gross Debt*.

³⁵ Government of Saint Lucia. (2024). *New List of Emergency Shelters Per District for 2024-2025*.

³⁶ Government of Saint Lucia. (2018). Saint Lucia's National Adaptation Plan 2018-2028.

³⁷ Government of Saint Lucia. (2018). Saint Lucia's National Adaptation Plan 2018-2028.

³⁸ United Nations' Economic Commission for Latin America and the Caribbean (ECLAC). (2010). Macro Socio-Economic Damage Assessment report.

³⁹ Government of Saint Lucia. (2018). Saint Lucia's National Adaptation Plan 2018-2028.

⁴⁰ United Nations' Economic Commission for Latin America and the Caribbean (ECLAC). (2010). Macro Socio-Economic Damage Assessment report.

suffered extensive damage, requiring EC\$2.4 million for repairs.⁴¹ Despite this recurring threat, many of Saint Lucia's existing community buildings, such as schools and health centres, lack the structural integrity required to withstand Category 4 or 5 hurricanes, requiring infrastructure upgrades **that** can include the installation of hurricane straps, impact-resistant windows, wheelchair access ramp, and power resilience such as solar photovoltaic (PV) technology. As of 2026, Saint Lucia faces a gross debt burden of nearly 77.5% of its GDP⁴² and requires an estimated USD 400 million by 2030 (25% of its GDP) to meet its adaptation targets.

⁴¹ Government of Saint Lucia. (2025). [Loss and damage cost estimates underway](#).

⁴² IMF. (2026). [Saint Lucia - General government gross debt](#).

2. Financial analysis

2.1 A1: Climate-resilient agriculture (CRA) packages

2.1.1 Assumptions

The financial analysis for climate resilient agricultural packages examines the costs and returns from the perspective of smallholder farmers in coastal Jamaica implementing adapted agricultural practices to address climate risks including drought, unpredictable rainfall, and water scarcity. For the purpose of the analysis, a representative 1-hectare farm has been chosen as the average smallholder representative size as per the RADA ABIS (Agricultural Business Information System) database.

The modelled crop composition of a typical 1-hectare smallholder farm is as follows:

Table 1 Smallholder crop breakdown per 1 hectare of cultivated areas (assumption of typical crop mix based on RADA ABIS database and Rhiney, 2025)

Crop	Cultivated area (ha)
Sweet potato	0.3
Yam	0.25
Cassava	0.2
Tomato	0.15
Onion	0.1

Root and tuber crops (sweet potato, yam, and cassava) comprise 75% of the cultivated area, consistent with their importance in Jamaican food security and their inherent drought tolerance characteristics that make them suitable for climate adaptation strategies. These crops are well-established in Jamaica's agricultural systems and provide stable yields under water stress conditions when combined with improved soil management and rainwater harvesting techniques. The inclusion of high-value vegetables (tomato and onion) at 25% of cultivated area reflects the economic imperative for smallholders to generate cash income while diversifying production to spread climate risk.

The financial analysis compares the following scenarios:

Scenario	Description
Business as usual (BAU)	Farmers continue traditional agricultural practices which are increasingly vulnerable to climate variability, exposing farmers to progressive yield declines as climate impacts intensify, particularly during drought periods and irregular rainfall patterns.
Adaptation with commercial loans	Implementation of the climate resilient package without GCF grant support, assuming farmers must finance all upfront investments through personal savings or high-cost lending
Adaptation with concessional loans	Implementation of the climate resilient package without GCF grant support, assuming farmers must finance all upfront investments through lending at concessional rates
Adaptation with GCF grants	Implementation with GCF grant support covering infrastructure and equipment costs

A **financial discount rate of 12%** is used for BAU and grant scenarios, based on the Commercial Banks' Domestic Currency Loan Rates from the Bank of Jamaica.⁴³ This rate represents the actual cost of borrowing for businesses, including financially robust

⁴³ <https://boj.org.jm/statistics/interest-rates/commercial-banks-interest-rates/>

farmers, aligning with market-based lending conditions in Jamaica. For the commercial and concessional loan we utilise loan terms simulating the applicable terms in each case i.e. 25% discount rate with 3 years tenor and 6% discount rate for a 20-year tenor including a 5-year grace period respectively. Using a financial discount rate that reflects prevailing commercial loan rates ensures that the financial viability assessment accurately captures the challenges faced by the private sector in climate-resilient agriculture (CRA) and food loss and waste (FLW) reduction investments. Justification for the selection of the loan terms is provided in the scenario description.

The interventions lifetime is considered to be 10 years based on the supported capital and improved agricultural practices. We consider the lifetime of the solar pump as a limiting factor⁴⁴. **In the analysis no replacement or residual value assumed.**

2.1.2 Scenarios

2.1.2.1 Business-as-usual

Production data for crops is derived from the Ministry of Agriculture, Fisheries, and Mining's Cost of Production Estimates 2022.⁴⁵ The following tables summarise the business as usual (BAU) production costs and revenues.

Table 2 Sweet potato BAU production costs and revenues

Sweet potato					
Parameter	Value	Unit	Value	Unit	
Labour costs	J\$ 191,000.00	J\$/acre	J\$ 477,500.00	J\$/ha	
Material inputs	J\$ 58,250.00	J\$/acre	J\$ 145,625.00	J\$/ha	
Land lease	J\$ 6,000.00	J\$/acre	J\$ 15,000.00	J\$/ha	
Tools discounted for 5 years	J\$ 12,000.00	J\$/acre	J\$ 30,000.00	J\$/ha	
Transportation (10% of material costs)	J\$ 5,825.00	J\$/acre	J\$ 14,562.50	J\$/ha	
Production	6,984.00	kg/acre	17,460.00	kg/ha	
Price wholesale average (2025)	\$ 1.22	\$/kg			
Cycles per year	1.5	per year			
Cost per year BAU			\$ 6,392.52	\$/ha/year	
Revenues per year BAU			\$ 31,951.80	\$/ha/year	
Income per year BAU			\$ 25,559.28	\$/ha/year	

Under a BAU scenario, for sweet potato annual production costs per hectare amount to USD 6,392.53, while revenues reach USD 31,951.80 per hectare, resulting in a net income of USD 25,559.28 per hectare per year, making sweet potato highly profitable and viable agricultural model with promising returns.

Table 3 Yam BAU production costs and revenues

Yam					
Parameter	Value	Unit	Value	Unit	
Labour costs	J\$ 320,000.00	J\$/acre	J\$ 800,000.00	J\$/ha	
Material inputs	J\$ 483,100.00	J\$/acre	J\$ 1,207,750.00	J\$/ha	
Land lease	J\$ 12,500.00	J\$/acre	J\$ 31,250.00	J\$/ha	
Tools	J\$ 12,000.00	J\$/acre	J\$ 30,000.00	J\$/ha	
Transportation (10% of material costs)	J\$ 48,310.00	J\$/acre	J\$ 120,775.00	J\$/ha	

⁴⁴ Paudel, Padam & Adhikari, Subash. (2025). Technical feasibility and economic analysis of solar photovoltaic water pumping system for sustainable irrigation in Nepal: a case study. *International Journal of Sustainable Engineering*. 18. 2590115. 10.1080/1939

⁴⁵ <https://www.moa.gov.jm/document-categories/cost-production>

Production		7,794.00	kg/acre		19,485.00	kg/ha
Price wholesale average (2025)	\$	1.49	\$/kg			
Cycles per year		1	per year			
Cost per year BAU				\$	13,669.68	\$/ha/year
Revenues per year BAU				\$	28,935.23	\$/ha/year
Income per year BAU				\$	15,265.55	\$/ha/year

Under a BAU scenario, for yam annual production costs per hectare amount to USD 13,669.68, while revenues reach USD 28,935.23 per hectare, resulting in a net income of USD 15,265.55 per hectare per year, making yams fairly profitable and also a viable agricultural model with promising returns.

Table 4 Cassava BAU production costs and revenues

Cassava						
Parameter		Value	Unit		Value	Unit
Labour costs	J\$	228,000.00	J\$/acre	J\$	570,000.00	J\$/ha
Material inputs	J\$	66,325.00	J\$/acre	J\$	165,812.50	J\$/ha
Land lease	J\$	12,500.00	J\$/acre	J\$	31,250.00	J\$/ha
Tools	J\$	12,000.00	J\$/acre	J\$	30,000.00	J\$/ha
Transportation (10% of material costs)	J\$	6,632.50	J\$/acre	J\$	16,581.25	J\$/ha
Production		8,097.00	kg/acre		20,242.50	kg/ha
Price wholesale average (2025)	\$	1.26	\$/kg			
Cycles per year		0.9	per year			
Cost per year BAU				\$	4,571.26	\$/ha/year
Revenues per year BAU				\$	22,955.00	\$/ha/year
Income per year BAU				\$	18,383.74	\$/ha/year

Under a BAU scenario, for cassava annual production costs per hectare amount to USD 4,571.26, while revenues reach USD 22,955 per hectare, resulting in a net income of USD 18,383.74 per hectare per year, making cassava fairly profitable and also a viable agricultural model with promising returns.

Table 5 Tomato BAU production costs and revenues

Tomato						
Parameter		Value	Unit		Value	Unit
Labour costs	J\$	280,000.00	J\$/acre	J\$	700,000.00	J\$/ha
Material inputs	J\$	128,470.00	J\$/acre	J\$	321,175.00	J\$/ha
Land lease	J\$	4,000.00	J\$/acre	J\$	10,000.00	J\$/ha
Tools	J\$	12,000.00	J\$/acre	J\$	30,000.00	J\$/ha
Transportation (10% of material costs)	J\$	12,847.00	J\$/acre	J\$	32,117.50	J\$/ha
Production		7,553.00	kg/acre		18,882.50	kg/ha
Price wholesale average (2025)	\$	1.18	\$/kg			
Cycles per year		2.4	per year			
Cost per year BAU				\$	16,379.71	\$/ha/year
Revenues per year BAU				\$	53,475.24	\$/ha/year
Income per year BAU				\$	37,095.53	\$/ha/year

Under a BAU scenario, for tomato annual production costs per hectare amount to USD 16,379.71, while revenues reach USD 53,475.24 per hectare, resulting in a net income of USD 37,095.53 per hectare per year, making tomatoes highly profitable and also a viable agricultural model with promising returns.

Table 6 Onion BAU production costs and revenues

Onion					
Parameter	Value	Unit	Value	Unit	
Labour costs	J\$ 284,500.00	J\$/acre	J\$ 711,250.00	J\$/ha	
Material inputs	J\$ 436,900.00	J\$/acre	J\$ 1,092,250.00	J\$/ha	
Land lease	J\$ 3,360.00	J\$/acre	J\$ 8,400.00	J\$/ha	
Tools	J\$ 72,000.00	J\$/acre	J\$ 180,000.00	J\$/ha	
Transportation (10% of material costs)	J\$ 43,690.00	J\$/acre	J\$ 109,225.00	J\$/ha	
Production	4,150.00	kg/acre	10,375.00	kg/ha	
Price wholesale average (2025)	\$ 0.77	\$/kg			
Cycles per year	2.4	per year			
Cost per year BAU			\$ 31,479.07	\$/ha/year	
Revenues per year BAU			\$ 19,173.00	\$/ha/year	
Income per year BAU			\$ (12,306.07)	\$/ha/year	

Under a BAU scenario, for onion annual production costs per hectare amount to USD 31,479.07, while revenues reach USD 19,173 per hectare, resulting in a net loss of USD 12,306.07 per hectare per year. This financial shortfall highlights the unsustainable nature of current agricultural practices, reinforcing the need for efficiency improvements, cost reductions, or external financial support to enhance profitability and long-term viability.

The estimated costs and revenues for a representative smallholder farmer using the above crop breakdown per 1 ha are as follows:

Table 7 A1 BAU costs and revenues per 1 ha split between crops.

BAU costs per year			BAU revenues per year		
Sweet potato	\$	1,917.76	Sweet potato	\$	9,585.54
Yam	\$	3,417.42	Yam	\$	7,233.81
Cassava	\$	914.25	Cassava	\$	4,591.00
Tomato	\$	2,456.96	Tomato	\$	8,021.29
Onion	\$	3,147.91	Onion	\$	1,917.30
Total	\$	11,854.29	Total	\$	31,348.93

The financial indicators for the BAU scenario over 20 years are as follows:

NPV (20 years) - BAU	\$ 145,614.13
IRR (20 years) - BAU	N/A

2.1.2.2 Adaptation with commercial loans

The climate-resilient agriculture (CRA) adaptation package is defined as follows:

Table 8 A1 investment CAPEX and OPEX

Adaptation measures for smallholder farm unit (1 hectare)	Source / assumption	CAPEX	OPEX
Rhino water tank (1000 gal)	JSIF estimation	\$ 450.00	
Rainwater capture (e.g., gutters, downpipes, etc.)	JSIF estimation	\$ 800.00	
Efficient (solar-powered) irrigation systems (surface irrigation) (1 ha) (mainlines, laterals, drippers, filters, and pressure regulators, including installation)	JSIF estimation	\$ 3,000.00	
Solar pump and panels (2 HP pump with 1.5 kW solar panel system)	JSIF estimation	\$ 2,000.00	
Mulching and composting (including equipment) (100% of cultivated area) (per year)	JSIF estimation		\$ 500.00
Integrated pest management (IPM) (100% of cultivated area) (per year)	JSIF estimation		\$ 600.00
Integrated nutrient management and soil amendments (100% of cultivated area) (per year)	JSIF estimation		\$ 1,000.00
Intercropping and crop diversification (100% of cultivated area) (per season)	JSIF estimation		\$ 450.00
Total for whole package		\$ 6,250.00	\$ 2,550.00

The package includes investments in resilient crop varieties, soil and water conservation techniques, rainwater harvesting infrastructure, watershed management practices, and agroforestry systems that enhance both productivity and climate resilience. Experts from the Jamaica Social Investment Fund (JSIF) provided estimations on the Capital Expenditure (CAPEX) and operating costs (OPEX) of the measures. The assumed lifecycle of the investment is 20 years.

The climate resilient agricultural package is **assumed to increase yields by 10%** compared to business-as-usual practices through a combination of improved water management, soil conservation, and climate-appropriate crop management techniques. This conservative productivity estimate is based on expert judgment by the project formulation team, as well as literature review. The increase reflects benefits from rainwater harvesting systems that provide supplementary irrigation during dry spells, agroforestry shade management that reduces heat stress on crops, and improved soil moisture retention from mulching and organic matter additions.

The adaptation measures are also assumed to reduce input costs by approximately 5%, primarily through decreased reliance on synthetic fertilisers. The integration of composting systems, mulching practices, and nitrogen-fixing agroforestry species builds soil organic matter and nutrient cycling capacity, allowing farmers to reduce fertiliser applications while maintaining or improving soil fertility.

A conservative ramp-up time is modelled into all scenarios, assuming 0% benefits (additional revenues from increased CRA productivity) in Year 1, 60% in Year 2, 70% in Year 3, 80% in Year 4, 90% in Year 5, with 100% of the benefits attained from Year 6 onwards.

These benefits come with increased operational costs of USD 2,550 per hectare annually, representing investments in system maintenance and additional labour for composting and mulching activities.

The estimated costs and revenues for a representative smallholder farmer using the above crop breakdown per 1 ha with the CRA package are as follows:

Table 9 A1 costs and revenues with adaptation package per 1 ha split between crops.

CRA package costs per year			CRA package revenues per year		
Sweet potato	\$	1,826.43	Sweet potato	\$	10,544.09
Yam	\$	3,254.68	Yam	\$	7,957.19
Cassava	\$	870.72	Cassava	\$	5,050.10
Tomato	\$	2,339.96	Tomato	\$	8,823.41

Onion	\$	2,998.01	Onion	\$	2,109.03
CRA OPEX	\$	2,550.00			
Total	\$	13,839.80	Total	\$	34,483.82

This counterfactual scenario assumes that the smallholder farmer will take a loan based on the available market for them i.e. from a microfinance institution, at a **25% interest rate with a 3-year tenor**⁴⁶. This represents an average interest rate for smallholder farmers, based on consultations with representatives from the Development Bank of Jamaica.

The financial indicators for the commercial loan scenario are as follows:

NPV (20 years) - commercial loans	\$	138,379.40
IRR (20 years) - commercial loans		N/A
Payback time		4
Incremental NPV (20 years) - commercial loans	\$	(7,234.73)
Incremental IRR (20 years) - commercial loans		2%

The 20-year NPV and IRR based on the incremental net revenue compared to the BAU scenario are shown in the table above, suggesting that the investment under this scenario would not be financially feasible.

2.1.2.3 Adaptation with concessional loans

As with the above counterfactual scenario, the smallholder farmer would implement the same CRA package, but is assumed to take out a loan with improved conditions, at a **6% interest** rate with a 20-year tenor, and a 5-year grace period.

This scenario assumes a two-step flow of funds:

- **Step 1:** GCF provides a low-concessional public-sector loan at 0.75% interest, 5-year grace period, 20-year tenor, to a suitably accredited intermediary, such as the Development Bank of Jamaica
- **Step 2:** The intermediary on-lends to a downstream entity (cooperative or MFI-administered sub-facility) for final disbursement to sub-project beneficiaries.

The all-in The all-in interest rate at beneficiary level is estimated at 6% per annum, derived from the following cumulative margin stack: GCF cost of capital + country risk / FX premium + upstream intermediary margin and admin + downstream intermediation to beneficiary level + credit assessment, monitoring and recovery costs.

The financial indicators for the concessional loan scenario are as follows:

NPV (20 years) - concessional loans	\$	145,080.70
IRR (20 years) - concessional loans		N/A
Payback time		Not repaid
Incremental NPV (20 years) - concessional loans	\$	(0.01)
Incremental IRR (20 years) - concessional loans		9%

The payback time exceeds the modelled 20-year intervention period. Additionally, the 20-year NPV and IRR based on the incremental net revenue compared to the BAU scenario are shown in the table above, suggesting that the investment under this scenario would not be financially feasible.

⁴⁶ Source: Development Bank of Jamaica consultation and [JAMAICA | Agriculture Strangled by Punishing Interest Rates as Afreximbank Offers Lifeline Says Fulton](#)

2.1.2.4 Adaptation with GCF grants

This counterfactual scenario assumes that GCF grants will support all investments, and the first year of OPEX.

The financial indicators for the adaptation with GCF grants scenario are as follows:

NPV (20 years) - BAU	\$	149,884.53
IRR (20 years) - BAU		N/A
Incremental NPV (20 years) - grants	\$	4,270.40
Incremental IRR (20 years) - grants		N/A

2.1.2.5 Summary

While the CRA package generates positive net present value under all scenarios, the debt-financed options (commercial loans and concessional loans) produce lower NPV than the business-as-usual scenario. The debt service obligations, even at concessional rates, erode the financial benefits of productivity improvements for smallholder farmers operating on thin margins.

Only the GCF grants scenario generates higher returns than business-as-usual. This finding underscores that grant financing is the most appropriate modality for smallholder adaptation investments in the Caribbean context, where farmers' limited cash flow and vulnerability to climate shocks make debt repayment obligations financially burdensome.

Table 10 Financial indicators summary – A1

Parameter	5 Years	10 Years	20 Years
NPV - BAU	\$ 70,273.82	\$ 110,149.07	\$ 145,614.13
IRR - BAU	N/A	N/A	N/A
NPV - commercial loans	\$ 58,597.11	\$ 100,823.36	\$ 138,379.40
IRR - commercial loans	N/A	N/A	N/A
NPV - concessional loans	\$ 67,825.45	\$ 108,714.22	\$ 145,080.70
IRR - concessional loans	N/A	N/A	N/A
NPV - GCF grants	\$ 70,102.24	\$ 112,328.50	\$ 149,884.53
IRR - GCF grants	N/A	N/A	N/A
NPV - incremental net revenue vs BAU - GCF grants	\$ (171.58)	\$ 2,179.42	\$ 4,270.40
IRR - incremental net revenue vs BAU - GCF grants	-14%	N/A	N/A

2.1.3 Sensitivity analysis

A sensitivity analysis was performed to evaluate how the financial returns of the investment are affected by changes in key parameters. The sensitivity analysis examines two variables: 1) the discount rate used to calculate NPV, and (2) reductions in the expected flow of net revenues from the intervention.

The sensitivity analyses demonstrate that the investment generates positive financial returns under a wide range of plausible scenarios. The intervention remains financially viable even when stress-tested with unfavourable discount rates (up to 20%) and substantial revenue reductions (down to 60% of expected levels).

Table 11 Financial sensitivity dashboard – A1

Discount rate	NPV (10 years) - commercial loans	NPV (10 years) - concessional loans	NPV (10 years) - GCF grants	NPV (20 years) - commercial loans	NPV (20 years) - concessional loans	NPV (20 years) - GCF grants
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12% (baseline)	\$	100,823.36	\$	108,714.22	\$	112,328.50	\$	138,379.40	\$	145,080.70	\$	149,884.53
5%	\$	141,362.71	\$	149,607.87	\$	154,254.58	\$	239,225.21	\$	244,370.64	\$	252,117.08
10%	\$	110,443.69	\$	118,459.61	\$	122,316.89	\$	159,349.32	\$	165,816.18	\$	171,222.51
15%	\$	88,599.25	\$	96,282.12	\$	99,589.28	\$	114,209.46	\$	121,081.14	\$	125,199.49
20%	\$	72,741.40	\$	80,049.07	\$	82,959.95	\$	86,719.63	\$	93,584.55	\$	96,938.18

Change in net revenue / income	NPV (10 years) - commercial loans	NPV (10 years) - concessional loans	NPV (10 years) - GCF grants	NPV (20 years) - commercial loans	NPV (20 years) - concessional loans	NPV (20 years) - GCF grants
100%	\$ 100,823.36	\$ 108,714.22	\$ 112,328.50	\$ 138,379.40	\$ 145,080.70	\$ 149,884.53
90%	\$ 90,741.03	\$ 97,842.80	\$ 101,095.65	\$ 124,541.46	\$ 130,572.63	\$ 134,896.08
80%	\$ 80,658.69	\$ 86,971.38	\$ 89,862.80	\$ 110,703.52	\$ 116,064.56	\$ 119,907.62
70%	\$ 70,576.35	\$ 76,099.96	\$ 78,629.95	\$ 96,865.58	\$ 101,556.49	\$ 104,919.17
60%	\$ 60,494.02	\$ 65,228.53	\$ 67,397.10	\$ 83,027.64	\$ 87,048.42	\$ 89,930.72

2.1.4 Conclusions

The financial analysis shows that both the commercial and the concessional loan scenarios are not bankable in purely financial terms as incremental IRRs remain well below the respective discount rates. This is further exacerbated by the lack of appropriate financial documentation of smallholder farmers, land tenure issues, and the absence of collateral that make such investments even more precarious. Furthermore, as expected the GCF grants mechanism consistently delivers superior outcomes compared to commercial financing across all scenarios tested, validating the programme design's emphasis on grant-based support to overcome capital access barriers and maximize benefits for smallholder farmers.

2.2 A2: Cold storage for coastal artisanal fishermen

2.2.1 Assumptions

The financial analysis for cold storage infrastructure examines the costs and returns from the perspective of artisanal fishing communities in coastal Grenada implementing post-harvest storage facilities to address climate-related fish spoilage, reduce post-harvest losses, and capitalise on seasonal price variations.

For the purpose of the analysis, a financial agent is defined as an artisanal fisher's (i.e., non-subsistence and non-deep-sea commercial) cooperative in one landing site.

It is assumed that the catch composition of artisanal fishers is comprised of coastal pelagic and shallow shelf fish. The 8% post-harvest loss estimate is conservative compared to regional studies and reflects losses from spoilage during landing, processing, and transport to markets under BAU conditions without cold storage.

The full list of assumptions is given below:

Table 12 Assumptions for A2

Parameter	Source / assumption	Unit	Value	Unit	Value
Number of (primary) landing sites in Grenada	https://unctad.org/system/files/official-document/tcsditcinf2022d4_en.pdf	Nr	7		

Total annual production of small coastal pelagic and shallow shelf fish across all landing sites	https://www.crfm.int/images/documents/CRFM%20Statistics%20and%20Information%20Report%202020_Final_Published.pdf	tons/year	383.4		
Total annual production per landing site	Average across sites	tons/year	54.77		
In-season wholesale value per kg of fish (average across coastal pelagic and shallow shelf species)	https://www.selinawamucii.com/insights/prices/grenada/fish/	USD/kg	\$ 5.50		
Off-season wholesale value per kg of fish (average across coastal pelagic and shallow shelf species)	https://www.selinawamucii.com/insights/prices/grenada/fish/	USD/kg	\$ 7.50		
Post-harvest losses	Conservative assumption based on SAP053 Feasibility Study https://www.greenclimate.fund/project/sap053	%	8		
Total annual value (in-season wholesale) per landing site	Calculated, October-May			USD	\$ 194,000.40
Total annual value (off-season wholesale) per landing site	Calculated, June-September			USD	\$ 113,376.86
	-				
Total number of fishers In Grenada	Assumption based on https://www.crfm.int/images/documents/CRFM%20Statistics%20and%20Information%20Report%202020_Final_Published.pdf	Nr	2,550		
Percentage of artisanal fishermen (non-commercial, non-subsistence)	https://www.seaaroundus.org/doc/publications/wp/2015/Mohammed-and-Lindop-Grenada.pdf	%	70		
Number of artisanal fishermen per landing site	Calculated average	Nr	255		
Average operating costs per trip (e.g., fuel, ice, bait) (divided between avg. 4 fishermen per vessel)	Assumption based on https://data.jncc.gov.uk/data/8bb4527c-31d6-48eb-b7c2-98a35aa8c52f/ot-nca-sup-cbn-09-mst-thesis-fisheries-oda.pdf	XCD	\$ 20.00	USD/trip	\$ 1.85
Number of fishing trips per year	Accounting for lost days due to weather, equipment maintenance, time off, seasonal variations	Nr/year	200		
Annual maintenance costs (vessel maintenance, replacement of nets, lines, fishing pots, etc) (divided between avg. 4 fishermen per vessel)	Assumption based on https://data.jncc.gov.uk/data/8bb4527c-31d6-48eb-b7c2-98a35aa8c52f/ot-nca-sup-cbn-09-mst-thesis-fisheries-oda.pdf	XCD	\$ 500.00	USD/year	\$ 46.17

The financial analysis compares the following scenarios:

Scenario	Description
Business as usual (BAU)	Current fishing operations without cold storage infrastructure
Adaptation with commercial loan	Cold storage investment financed entirely through a commercial loan at market rates
Adaptation with concessional loan	Cold storage investment financed through a GCF-intermediated concessional loan at below-market rates
Adaptation with GCF grants	Full grant support for cold storage infrastructure

A financial discount rate of 12% is used, based on Grenada's Commercial Banks Selected Interest Rates.⁴⁷

The interventions lifetime is considered to be 15 years based on the supported capital. We consider the lifetime of the battery as a limiting factor⁴⁸. **In the analysis no replacement or residual value assumed.**

2.2.2 Scenarios

2.2.2.1 Business-as-usual

Under a BAU scenario, annual operating costs per landing site amount to USD 105,962.83, while revenues reach USD 307,377.26, resulting in a net income of USD 201,414.42 per year. This represents the baseline against which the cold storage intervention's incremental benefits are measured. Operating costs reflect typical expenses for fuel, ice purchased from external sources, bait, and routine vessel and gear maintenance divided among an average of four fishermen per small fishing vessel. The 200 fishing trips per year accounts for days lost to weather, equipment maintenance, seasonal variations, and personal time off.

Table 13 A2 BAU costs and revenues

Parameter	Source / assumption	Unit	Value
Total operating costs per landing site per year BAU	Calculated	USD/year \$	105,962.83
Total revenues per landing site per year BAU	Calculated	USD/year \$	307,377.26
Total income per landing site per year BAU	Calculated	USD/year \$	201,414.42

The financial indicators for the BAU scenario are as follows:

NPV (15 years) - BAU	\$ 1,371,806.35
IRR (15 years) - BAU	N/A

2.2.2.2 Adaptation with commercial loan

One cold storage adaptation package for one landing site includes investments in ice-making capacity to preserve catch quality immediately post-harvest, cold storage infrastructure for temporary holding of fish to capitalise on price differentials between peak and off-peak seasons, and renewable energy infrastructure to ensure reliable and cost-effective operation in coastal areas where grid reliability may be compromised.

One cold storage adaptation package is defined as follows:

Table 14 A2 investment CAPEX and OPEX

Adaptation measures	Source / assumption	CAPEX	OPEX
Ice plant (1 ton per day production capacity)	Assumption based on https://openjicareport.jica.go.jp/pdf/12148664.pdf	\$ 45,250.00	\$ 2,250.00
Cold storage room (10 ton capacity)	Assumption based on https://openjicareport.jica.go.jp/pdf/12148664.pdf	\$ 130,000.00	\$ 3,000.00
Off-grid solar PV system (15kW) with storage	Assumption based on https://openjicareport.jica.go.jp/pdf/12148664.pdf	\$ 67,000.00	\$ 2,500.00
Total		\$ 242,250.00	\$ 7,750.00

⁴⁷ <https://stats.gov.gd/subjects/economic-statistics/commercial-banks-selected-interest-rates/>

⁴⁸ [Luerksen, Christoph & Verbois, Hadrien & Gandhi, Oktoviano & Reindl, Thomas & Sekhar, Chandra & Cheong, K.W.D. \(2021\). Global sensitivity and uncertainty analysis of the levelised cost of storage \(LCOS\) for solar-PV-powered cooling. Applied Energy. 286. 1](#)

The cold storage infrastructure is assumed to generate benefits through two primary mechanisms: (1) elimination of the 8% post-harvest losses through improved preservation, and (2) value enhancement through market timing, allowing fishermen to store catch during peak season gluts and sell during off-season scarcity periods when prices command a premium.

The combined value enhancement factor is conservatively estimated at **10%**, reflecting:

- 4% increase from eliminated post-harvest losses (8% losses reduced to 4% losses, food loss cannot be completely eliminated)
- 6% average price increase from strategic market timing

This conservative estimate assumes that only a portion of the catch can be strategically timed to off-season markets, with the majority still sold fresh or within short storage periods. The 6% market timing premium reflects the price differential between in-season wholesale prices and off-season prices (applied to the estimated proportion of catch that can be strategically stored).

These benefits come with increased operational costs of USD 7,750 per landing site annually, representing investments in system operation, maintenance, and energy costs (though partially offset by avoided grid energy costs through solar power).

A ramp-up time is modelled into all scenarios, assuming 60% effectiveness of the cold storage in Year 1, 70% in Year 2, 80% in Year 3, and 100% from Year 4 onwards.

Under this scenario, the cooperative is assumed to finance the full capital investment of USD 242,250 through a commercial loan. We consider a conservative scenario for a loan with an interest rate of 12% per annum over a 4-year tenor, with no grace period. Annual loan repayments amount to approximately USD 79,757.04, which represent a significant but time-limited debt service burden that is extinguished by year 4, after which the cooperative retains the full incremental income from the cold storage system.

Table 15 A2 adaptation costs and revenues

Parameter	Source / assumption	Unit	Value
Total operating costs per landing site per year w/ cold storage	Calculated	USD/year	\$ 113,712.83
Total revenues per landing site per year w/ cold storage	Calculated	USD/year	\$ 338,114.98
Total revenues per landing site per year w/ cold storage	Calculated	USD/year	\$ 224,402.15

The financial indicators for the adaptation with commercial loan scenario are as follows:

NPV (15 years) - commercial loans	\$ 1,263,418.00
IRR (15 years) - commercial loans	N/A
Payback time	5
Incremental NPV (15 years) - commercial loan	\$ (108,388.35)
Incremental IRR (15 years) - commercial loan	0%

This indicates that while the cold storage system generates positive absolute returns, the debt service obligations of commercial financing at 12% per annum are sufficient to render the investment value-destructive relative to the business-as-usual baseline. The cooperative would be financially worse off adopting the technology under commercial loan terms than continuing current operations without cold storage.

2.2.2.3 Adaptation with concessional loan

As with the commercial loan scenario above, the fishing cooperative implements the same cold storage package (ice plant, cold storage room, and off-grid solar PV system, total CAPEX USD 242,250), but finances it under significantly improved terms through a GCF-intermediated concessional lending facility.

The cooperative is assumed to take out a loan with an all-in interest rate of 6% per annum over a 10-year tenor, with no grace period. Annual loan repayments amount to approximately USD 32,914, a substantially lower debt service burden than under the

commercial loan scenario and one more compatible with the cash flow realities of artisanal fishing cooperatives in small island settings.

This scenario assumes a two-step flow of funds:

- **Step 1:** GCF provides a low-concessional public-sector loan at 0.75% interest, 10-year tenor, to a suitably accredited intermediary, such as the Grenada Development Bank or a designated regional financial institution.
- **Step 2:** The intermediary on-lends to a downstream entity (fishing cooperative or MFI-administered sub-facility) for final disbursement to the landing site cooperative.

The all-in interest rate at beneficiary level is estimated at 6% per annum, derived from the following cumulative margin stack: GCF cost of capital + country risk / FX premium + upstream intermediary margin and administration + downstream intermediation to beneficiary level + credit assessment, monitoring and recovery costs.

The financial indicators for the adaptation with concessional loan scenario are as follows:

NPV (15 years) - concessional loans	\$ 1,319,696.49
IRR (15 years) - concessional loans	N/A
Payback time	10
Incremental NPV (15 years) - concessional loan	\$ (52,109.87)
Incremental IRR (15 years) - concessional loan	-1%

The incremental NPV relative to BAU is **USD 52,109.87**, with an incremental IRR of **-1%**. While the concessional loan improves the bankability of the project remains unbankable, with an IRR that is below and therefore is still insufficient to make the intervention clearly value-additive relative to BAU over the 10-year horizon.

2.2.2.4 Adaptation with GCF grant

This scenario assumes that GCF grants will support all capital investments (USD 242,250) and the first year of operating expenses (USD 7,750), providing full grant-based financing to remove upfront capital barriers for coastal fishing communities.

The financial indicators for the adaptation with GCF grant scenario are as follows:

NPV (15 years) – GCF grants	\$ 1,505,668.00
IRR (15 years) – GCF grants	N/A
Incremental NPV (15 years) – GCF grants	\$ 133,861.65
Incremental IRR (15 years) – GCF grants	N/A

The incremental NPV relative to BAU is **USD 133,861.65**. Unlike the loan-financed scenarios, grant support eliminates debt service entirely, allowing the cooperative to capture the full financial benefit of the cold storage system, generating clear positive value above the BAU counterfactual from the outset.

2.2.2.5 Summary

All adaptation scenarios generate positive net present value, with returns increasing as the cost of capital falls. The GCF grants scenario produces the highest returns to fishing communities by eliminating debt service altogether, while the concessional loan scenario substantially narrows the gap with grants compared to commercial financing.

Table 16 Financial indicators summary – A2

Parameter	5 Years		15 Years	
NPV - BAU	\$	726,053.93	\$	1,371,806.35
IRR - BAU		N/A		N/A
NPV - GCF grant + commercial loans	\$	543,964.89	\$	1,263,418.00
IRR - GCF grant + commercial loans		N/A		N/A
NPV - GCF grant only	\$	786,214.89	\$	1,505,668.00
IRR - GCF grant only		N/A		N/A
NPV - incremental net revenue vs BAU - GCF grants	\$	60,160.97	\$	133,861.65
IRR - incremental net revenue vs BAU - GCF grants		N/A		N/A

2.2.3 Sensitivity analysis

A sensitivity analysis was performed to evaluate how the financial returns of the investment are affected by changes in key parameters. The sensitivity analysis examines two variables: 1) the discount rate used to calculate NPV, and (2) reductions in the expected flow of net revenues from the intervention.

- 1) The sensitivity analysis tests discount rates ranging from 5% to 20% to capture the range of potential community time preferences, alternative investment opportunities, and economic conditions in Grenada. Across the entire range of discount rates tested (5% to 20%), the GCF grants scenario consistently outperforms the commercial loans scenario. This persistent differential demonstrates that the value proposition of GCF support is robust to variations in how communities value future versus present consumption and reflects the substantial burden of debt service in the mixed financing scenario.
- 2) The second dimension of sensitivity analysis examines the impact of variations in net revenue, which could result from lower-than-expected productivity gains, reduced market price premiums for stored fish, increased operational costs, or climate events affecting catch volumes. The analysis tests scenarios ranging from 60% to 100% of projected revenues.

The sensitivity analyses demonstrate that the cold storage investment generates positive financial returns under a wide range of plausible scenarios. The intervention remains financially viable even when stress-tested with unfavourable discount rates and substantial revenue reductions. The robustness of positive returns across sensitivity dimensions reflects the fundamental value proposition of cold storage in tropical coastal contexts: eliminating spoilage losses and capturing seasonal price premiums generates ongoing benefits that compound over time, even when conservative assumptions are applied. The persistent advantage of full grant support over mixed financing highlights that debt service obligations can erode early-year benefits and delay payback periods in ways that may be incompatible with the cash flow realities of artisanal fishing communities.

Table 17 Financial sensitivity analysis dashboard – A2

Discount rate	NPV (15 years) - commercial loans	NPV (15 years) - concessional loans	NPV (15 years) - GCF grants
12% (baseline)	\$ 1,263,418.00	\$ 1,319,696.49	\$ 1,505,668.00
5%	\$ 2,021,018.96	\$ 2,049,680.21	\$ 2,303,833.49
10%	\$ 1,430,584.49	\$ 1,481,161.22	\$ 1,683,403.58
15%	\$ 1,062,751.66	\$ 1,125,268.48	\$ 1,290,456.29
20%	\$ 822,509.10	\$ 890,987.83	\$ 1,028,978.91

Change in net revenue / income	NPV (15 years) - commercial loans	NPV (15 years) - concessional loans	NPV (15 years) - GCF grants
100%	\$ 1,263,418.00	\$ 1,319,696.49	\$ 1,505,668.00

90%	\$ 1,137,076.20	\$ 1,187,726.84	\$ 1,355,101.20
80%	\$ 1,010,734.40	\$ 1,055,757.19	\$ 1,204,534.40
70%	\$ 884,392.60	\$ 923,787.54	\$ 1,053,967.60
60%	\$ 758,050.80	\$ 791,817.89	\$ 903,400.80

2.2.4 Conclusions

The financial analysis shows that both the commercial and the concessional loan scenarios are not bankable in purely financial terms as incremental IRRs remain well below the respective discount rates. This is further exacerbated by the lack of access to commercial loans by the artisanal fishermen due to nonviable loan conditions including fragile cash flow, lack of financial infrastructure, exclusion of insurance markets, and gender limitations (as mentioned in annexes 2a, 7, and 8). Furthermore, as expected the GCF grants mechanism consistently delivers superior outcomes compared to commercial financing across all scenarios tested, validating the programme design's emphasis on grant-based support to overcome capital access barriers and maximize benefits for artisanal fishermen.

3. Economic analysis

3.1 A1: Climate-resilient agriculture (CRA) packages

3.1.1 Assumptions

The economic analysis for climate-resilient agricultural packages builds upon the financial analysis framework but adopts a broader societal perspective to capture the full economic value of the intervention. While the financial analysis assessed returns from the perspective of individual smallholder farmers, the economic analysis evaluates the intervention's contribution to national welfare, incorporating both market and non-market values. The economic analysis retains the core assumptions from the financial analysis, including:

- The modelled crop composition for a typical 1-hectare smallholder farm
- Production costs and revenues based on Ministry of Agriculture data
- The climate-resilient agriculture package composition (water harvesting, irrigation systems, soil amendments, and integrated pest management)
- Productivity increases of **10%** and input cost reductions of **5%** attributable to CRA practices

A 12% social discount rate is employed, consistent with international development finance benchmarks for Caribbean developing countries. This rate reflects society's time preference and the opportunity cost of public funds.

The economic analysis quantifies the value of import substitution resulting from increased domestic agricultural production. Jamaica imports significant quantities of food, creating foreign exchange costs and vulnerability to international price fluctuations and supply chain disruptions. The additional production generated by CRA packages contributes to national food security by reducing dependence on imports. Assumptions for import prices are as follows:

Table 18 A1 assumptions – crop import prices (USD/kg)

Crop	Source / assumption	Value
Sweet potato	https://www.selinawamucii.com/insights/prices/jamaica/sweet-potatoes/	\$ 2.89
Yam	https://www.selinawamucii.com/insights/prices/jamaica/yams/	\$ 2.83
Cassava	https://www.selinawamucii.com/insights/prices/jamaica/cassava/	\$ 3.00
Tomato	https://www.selinawamucii.com/insights/prices/jamaica/tomatoes/	\$ 2.10
Onion	https://www.selinawamucii.com/insights/prices/jamaica/onions/	\$ 9.01

The incremental production per crop from one hectare implementing CRA practices versus the BAU scenario is as follows:

Table 19 A1 assumptions – incremental production from CRA practices (1 hectare)

Business as usual (no CRA package)	Additional production from CRA package	Crop
5,238.00	523.80	Sweet potato
4,871.25	487.13	Yam
4,048.50	404.85	Cassava
2,832.38	283.24	Tomato
1,037.50	103.75	Onion

Which generates the following annual avoided import costs:

Crop	Value
Sweet potato	\$ 1,513.78
Yam	\$ 1,378.56
Cassava	\$ 1,214.55
Tomato	\$ 594.80
Onion	\$ 806.14

This results in total **avoided food import costs of USD 5,507.83** per hectare annually, representing a tangible economic benefit to the national economy through reduced foreign exchange outflows and enhanced food sovereignty.

As with the financial analysis, a conservative ramp-up time is modelled, assuming 0% benefits (additional revenues from increased CRA productivity) in Year 1, 60% in Year 2, 70% in Year 3, 80% in Year 4, 90% in Year 5, with 100% of the benefits attained from Year 6 onwards.

3.1.1.1 Economic values

Parameter	Source / assumption	Value
Jamaica tariff rate, applied, weighted mean, all products (%) (2022)	https://data.worldbank.org/indicator/TM.TAX.MRCH.WM.AR.ZS	9.24%
Standard conversion factor (SCF), market to economic prices	SCF = $1 / (1 + t)$, where t is duties as a proportion of the traded base, i.e. the average tariff distortion between domestic and border prices. This is proxied by the applied, weighted-mean tariff across all products.	0.915
Shadow wage rate factor (SWRF)	Seasonal, underemployed smallholder pool, for which a shadow wage below the market wage is well founded; an SWRF of 0.75 is assumed	0.75
Labour share of crop production costs (Jamaica MoA cost-of-production data)	Estimated average across identified priority crops	50%
Combined SCF and SWRF factor	(1-labour share)*SCF + labour share*SWRF	0.833

The economic analysis converts the financial (market) prices used in the financial analysis into economic values reflecting the opportunity cost of resources to the economy. Transfer payments (taxes, duties and subsidies) are removed, internationally traded items are valued at their border-price equivalents, and residual non-traded inputs are adjusted using a Standard Conversion Factor (SCF). The SCF is derived from the applied, weighted-mean tariff across all products reported by the World Bank (World Integrated Trade Solution), which proxies the average distortion between domestic and border prices; the resulting parameters are set out in the table above.

A Shadow Wage Rate Factor (SWRF) is applied to the labour element of costs to reflect that labour drawn from a seasonal, underemployed smallholder pool has an opportunity cost below the market wage; this is combined with the SCF, in proportion to the labour share of costs, to give the blended cost conversion factor shown. Benefit streams already expressed in economic terms (e.g., avoided food imports valued at import-parity prices, the social cost of avoided emissions, and avoided-damage values) are not further adjusted.

3.1.1.2 Counterfactual

The counterfactual scenario for the economic analysis assumes continuation of business-as-usual agricultural practices without the climate-resilient package. Under this scenario, smallholder farmers would continue current production methods, generating the baseline yields and incomes described in the financial analysis. From an economic perspective, this counterfactual implies:

- Continued vulnerability to climate variability and extreme weather events, with associated production losses
- Persistent dependence on food imports to meet domestic consumption needs

- Ongoing foreign exchange expenditures for imported food commodities
- Maintenance of current levels of climate risk exposure for farming communities

The economic analysis measures the incremental benefits of the CRA intervention against this counterfactual, quantifying the value created through enhanced productivity, reduced import dependence, and therefore strengthened climate resilience.

3.1.2 Results

The economic analysis demonstrates that climate-resilient agricultural packages generate substantial positive returns from a societal perspective. The intervention produces economic benefits through two primary channels: direct agricultural productivity improvements captured in farmer revenues, and broader macroeconomic benefits through import substitution.

For a representative 1-hectare farm implementing the full CRA package, the incremental economic costs amount to USD 1,653.35 annually. The economic benefits over a 20-year time horizon are as follows:

- Direct agricultural revenues from increased production: USD 8,377.56 annually (reflecting the **10% productivity increase and 5% cost savings**)
- Avoided food import costs: USD 5,507.83 annually

The incremental economic benefits total **USD 8,377.56 annually** from Year 6 onwards (at 100%), following the initial investment year.

The economic key performance indicators (KPIs) are as follows:

ENPV (20 years)	\$	38,221.87
EIRR (20 years)		N/A

The positive ENPV demonstrates that the climate-resilient agriculture intervention generates substantial net economic value to society.

3.1.3 Sensitivity analysis

A sensitivity analysis was performed to evaluate the robustness of economic returns under varying assumptions. The analysis examines three dimensions of uncertainty: 1) investment costs, 2) benefit levels, and 3) the social discount rate.

- 1) The analysis tests scenarios where investment costs vary from 60% to 140% of the baseline estimate. This range accounts for potential economies of scale, bulk procurement advantages, or conversely, cost overruns and site-specific complexities. The ENPV remains positive across all cost scenarios. Even with investment costs 40% higher than anticipated, the intervention maintains a positive economic return, demonstrating resilience to cost uncertainties.
- 2) The analysis also examines scenarios where total benefits (both agricultural revenues and avoided import costs) vary from 60% to 140% of baseline projections. This range captures uncertainty in productivity gains, market prices, and import substitution effects. The intervention remains economically viable even if actual benefits reach only 60% of projections, though returns are more sensitive to benefit reductions than cost increases, reflecting the importance of realising anticipated productivity improvements.
- 3) Lastly, the analysis tests social discount rates ranging from 5% to 20%, reflecting uncertainty in the appropriate rate for valuing long-term social investments and varying macroeconomic conditions. The ENPV remains positive across the full range of discount rates tested, including the extreme scenario of a 20% rate. This demonstrates that the economic case for CRA packages is robust even under conservative assumptions about the value of future benefits.

The sensitivity analysis confirms that climate-resilient agricultural packages generate positive economic returns under a wide range of plausible scenarios.

Table 20 Economic sensitivity analysis dashboard – A1

Investment cost	ENPV	Benefits	ENPV	Discount rate	ENPV
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60%	\$	42,571.23	60%	\$	18,583.76	5%	\$	70,149.15
80%	\$	40,396.55	80%	\$	28,402.82	10%	\$	44,811.81
100%	\$	38,221.87	100%	\$	38,221.87	12%	\$	38,221.87
120%	\$	36,047.19	120%	\$	48,040.92	15%	\$	30,681.07
140%	\$	33,872.51	140%	\$	57,859.98	20%	\$	22,214.34

3.1.4 Conclusion

The intervention maintains economic viability even with simultaneous adverse movements in multiple parameters, indicating that the economic benefits are substantial and reliable. This robustness is particularly important given the inherent uncertainties in climate adaptation investments and the challenge of precisely forecasting agricultural outcomes over multi-decade time horizons. Moreover, it should be mentioned that the analysis does not consider additional economic benefits such as improved hydrological conditions and soil retention, which were not specifically assessed due to the EDA character of the project. Therefore, it is safe to assume that the current analysis underestimates the intervention's total economic benefits. Taken all the above into consideration the intervention is justified in economic terms.

3.2 A2: Cold storage for coastal artisanal fishermen

3.2.1 Assumptions

The economic analysis for cold storage infrastructure builds upon the financial analysis framework but adopts a broader societal perspective to capture the full economic value of the intervention. While the financial analysis assessed returns from the perspective of artisanal fishing cooperatives, the economic analysis evaluates the intervention's contribution to national welfare, incorporating both market and non-market values.

The economic analysis retains the core assumptions from the financial analysis, including:

- One landing site serving 255 artisanal fishermen with annual production of 54.77 tons of coastal pelagic fish
- Business-as-usual post-harvest losses of 8% due to inadequate cold chain infrastructure
- Operating costs and revenues based on Grenada fisheries sector data
- The cold storage adaptation package composition (ice plant, cold storage room, off-grid solar PV system)
- Value enhancement of 14% from combined elimination of post-harvest losses (4%) and strategic market timing benefits (10% price premium)

However, the economic analysis introduces additional considerations specific to the societal perspective:

- The economic analysis quantifies the value of fish that would otherwise be lost to spoilage under business-as-usual conditions. Post-harvest losses of 8% represent not only foregone income to fishermen but also a waste of valuable protein resources and the inputs (fuel, labour, vessel maintenance) used to harvest that fish. By eliminating these losses through improved cold storage, the intervention creates economic value beyond what is captured in market transactions.
- The cold storage infrastructure incorporates off-grid solar photovoltaic systems that displace diesel-powered refrigeration, which would otherwise be the standard approach in small island developing states with limited grid reliability. This design choice generates climate mitigation co-benefits through avoided greenhouse gas emissions.

Under business-as-usual conditions, 8% of the 54.77 tons produced annually at each landing site is lost to spoilage. At prevailing market prices (weighted average of in-season and off-season wholesale prices of approximately USD 6.10 per kg), these losses represent an economic cost of **USD 13,364.23** annually per landing site. This value captures the social cost of wasted marine resources, squandered fishing effort, and reduced food security.

The cold storage assumptions are as follows:

Table 21 A2 assumptions – cold storage

Parameter	Source / assumption	Unit	Value
Annual energy consumption (120 square foot cold storage room)	Assuming 25kWh / sq ft / year https://esa-solar.com/cold-storage-energy-efficiency-solutions/	kWh/year	3000.00
Marginal cost of energy consumed by cold storage	https://docs.nrel.gov/docs/fy15osti/62699.pdf	USD/kWh	0.383
Avoided annual cost of energy consumption per year	Calculated	USD/year	\$ 1,149.00
Grenada energy emission factor	https://cdm.unfccc.int/sunsetcms/storage/contents/stored-file-20170117160359875/ASB0031_PSB0023.pdf	tCO2/MWh	0.634
Annual emissions avoided	Calculated	tCO2/year	1.902
Social price of carbon	https://www.oecd.org/env/cc/37321411.pdf	USD/tCO2e	35.00
Social cost of avoided GHG emissions	Calculated	USD/year	66.57
Reduced food losses per year	Calculated	tons/year	4.38
Economic value of lost fish per year	Calculated	USD/year	\$ 26,728.46

A 15kW solar PV system with storage meets the energy requirements of the cold storage facility (approximately 3,000 kWh annually for a 120 square foot cold storage room). Using Grenada's grid emission factor of 0.634 tCO2/MWh, the solar system avoids 1.90 tCO2 of emissions annually. Applying the social cost of carbon of USD 35 per tCO2e (based on OECD guidance for developing country project appraisal), the climate mitigation benefits amount to USD 66.57 per landing site per year. While this value is modest relative to the direct economic benefits of reduced food losses, it represents a genuine co-benefit that would not occur in the financial analysis from the fishing cooperative's perspective.

As with the financial analysis, a ramp-up time is modelled, assuming 60% effectiveness of the cold storage in Year 1, 70% in Year 2, 80% in Year 3, and 100% from Year 4 onwards.

3.2.1.1 Economic values

Parameter	Source / assumption	Value
Grenada tariff rate, applied, weighted mean, all products (%) (2022)	https://data.worldbank.org/indicator/TM.TAX.MRCH.WM.AR.ZS	13.00%
Standard conversion factor (SCF), market to economic prices	$SCF = 1 / (1 + t)$, where t is duties as a proportion of the traded base, i.e. the average tariff distortion between domestic and border prices. This is proxied by the applied, weighted-mean tariff across all products.	0.885
Shadow wage rate factor (SWRF)	Seasonal, underemployed artisanal fishermen pool, for which a shadow wage below the market wage is well founded; an SWRF of 0.75 is assumed	0.75
Assumed O&M labour share of cold storage OPEX	Assumption	30%
Combined SCF and SWRF factor	(1-labour share)*SCF + labour share*SWRF	0.844

The economic analysis converts the financial (market) prices used in the financial analysis into economic values reflecting the opportunity cost of resources to the economy. Transfer payments (taxes, duties and subsidies) are removed, internationally traded items are valued at their border-price equivalents, and residual non-traded inputs are adjusted using a Standard Conversion Factor (SCF). The SCF is derived from the applied, weighted-mean tariff across all products reported by the World Bank (World Integrated Trade Solution), which proxies the average distortion between domestic and border prices; the resulting parameters are set out in the table above.

A Shadow Wage Rate Factor (SWRF) is applied to the labour element of costs to reflect that labour drawn from a seasonal, underemployed artisanal fishermen pool has an opportunity cost below the market wage; this is combined with the SCF, in

proportion to the labour share of costs, to give the blended cost conversion factor shown. Benefit streams already expressed in economic terms (e.g., avoided food imports valued at import-parity prices, the social cost of avoided emissions, and avoided-damage values) are not further adjusted.

3.2.1.2 Counterfactual

The counterfactual scenario for the economic analysis assumes continuation of business-as-usual post-harvest handling practices without modern cold storage infrastructure. Under this scenario, artisanal fishing cooperatives would continue to rely on limited ice availability and inadequate cold chain facilities, with the associated post-harvest losses and marketing constraints described in the financial analysis. From an economic perspective, this counterfactual implies:

- Continued waste of 8% of harvested fish due to spoilage, representing inefficient use of marine resources and fishing effort
- Ongoing economic losses from inability to time market sales strategically, forcing fishermen to accept lower in-season prices
- Persistent dependence on diesel generators or unreliable grid electricity for limited refrigeration capacity, with associated carbon emissions
- Maintenance of current constraints on value addition and market access for artisanal fishing communities

The economic analysis measures the incremental benefits of the cold storage intervention against this counterfactual, quantifying the value created through eliminated food losses, improved market access, and environmental co-benefits.

3.2.2 Results

The economic analysis demonstrates that cold storage infrastructure generates substantial incremental positive returns from a societal perspective. The intervention produces incremental economic benefits through three primary channels: direct revenue improvements for fishing cooperatives, elimination of economically wasteful food losses, and climate mitigation co-benefits.

Economic costs amount to the incremental operating costs of maintaining the cold storage facility of USD 6,544.63.

Total economic benefits comprise three components:

- Direct revenues from fishing operations with cold storage: USD \$27,201.53 annually at full capacity.
- Economic value of avoided food losses: USD 26,728.46 annually (representing the social cost of fish that would have been wasted under business-as-usual conditions)
- Social cost of avoided greenhouse gas emissions: USD 66.57 annually (from solar-powered refrigeration displacing diesel generation)

The combined incremental economic benefits total **USD 47,451.92** annually throughout the equipment lifecycle, excluding the first 3 years of ramp-up.

The economic key performance indicators (KPIs) are as follows:

ENPV (15 years)	\$	111,684.80
EIRR (15 years)		24%

The positive ENPV demonstrates that the cold storage intervention generates substantial net economic value to society.

3.2.3 Sensitivity analysis

A sensitivity analysis was performed to evaluate the robustness of economic returns under varying assumptions. The analysis examines three dimensions of uncertainty: 1) investment costs, 2) benefit levels, and 3) the social discount rate.

- 1) The analysis tests scenarios where investment costs vary from 60% to 140% of the baseline estimate. This range accounts for potential economies of scale, bulk procurement advantages, or conversely, cost overruns and site-specific complexities. The ENPV turns negative when the costs reach 120% of the original estimation.

- 2) The analysis also examines scenarios where total benefits (including direct revenues, avoided food losses, and climate co-benefits) vary from 60% to 140% of baseline projections. This range captures uncertainty in productivity gains, market prices, and import substitution effects. The intervention's ENPV turns negative as 80% benefits and returns are more sensitive to benefit reductions than cost increases, reflecting the importance of realising anticipated productivity improvements.
- 3) Lastly, the analysis tests social discount rates ranging from 5% to 20%, reflecting uncertainty in the appropriate rate for valuing long-term social investments and varying macroeconomic conditions in small island developing states (SIDS). The ENPV remains positive across the full range of discount rates tested excluding the extreme scenario of a 20% rate.

The sensitivity analysis confirms that cold storage infrastructure for artisanal fisheries generates positive economic returns under virtually all plausible scenarios. The intervention maintains strong economic viability even with simultaneous adverse movements in multiple parameters, indicating that the economic benefits are substantial and reliable. This robustness is particularly important for climate adaptation investments in vulnerable coastal communities, where the combination of eliminated food waste, improved livelihoods, and environmental co-benefits creates multiple pathways to economic value creation.

Table 22 Economic sensitivity analysis dashboard – A2

Investment cost	ENPV	Benefits	ENPV	Discount rate	ENPV
60%	\$ 206,079.13	60%	\$ (27,383.44)	5%	\$ 265,898.96
80%	\$ 158,881.97	80%	\$ 42,150.68	10%	\$ 145,308.65
100%	\$ 111,684.80	100%	\$ 111,684.80	12%	\$ 111,684.80
120%	\$ 64,487.64	120%	\$ 181,218.93	15%	\$ 71,842.11
140%	\$ 17,290.48	140%	\$ 250,753.05	20%	\$ 25,327.22

3.2.4 Conclusion

The intervention shows sensitivity in adverse movements of multiple parameters, though provides reassurance on the robustness of the intervention. Taken all the above into consideration the intervention is justified in economic terms.

3.3 A3: Community-managed Marine Protected areas (MPAs)

As community-managed MPAs are non-revenue generating interventions focused on public goods provision, this intervention does not include a financial analysis. The economic analysis directly evaluates the societal value created through ecosystem service preservation and enhancement.

3.3.1 Assumptions

The economic analysis for community-managed Marine Protected Areas evaluates the costs and benefits of establishing and maintaining coastal and marine conservation areas managed by local communities in Belize. These interventions represent classic public goods (non-excludable and non-rivalrous ecosystem services that generate broad societal benefits but limited private financial returns), making them particularly suitable for grant-based financing.

The analysis is based on an assumed community-managed MPA of 1,000 hectares, reflecting the typical scale of community-based marine conservation areas in the Caribbean. This size balances ecological effectiveness (sufficient area for species protection and habitat connectivity) with community management capacity (i.e., manageable monitoring requirements).

The assumptions for establishment costs of MPAs are as follows:

Table 23 Assumptions A3 – MPA CAPEX

Parameter	Source / assumption	Unit	Value
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Cost of establishing an additional 1% of total territorial waters of replenishment zone (19,139 hectares)				
Belize Marine Conservation and Climate Adaptation Initiative (AF) (2015-2020)	https://fifspubprd.azureedge.net/afdocuments/project/55/55_MCCAP-Completion-Summary_Final.pdf	USD/ha	\$	53.73
	https://documents1.worldbank.org/curated/en/099606007112433647/pdf/SECBOS11db89a20f31bcbf14e35c51b3bb2.pdf			
Conserving Biodiversity and Reducing Habitat Degradation in Protected Areas and their Buffer Zones in St Kitts and Nevis (GEF) (2014-2019)	Cost of establishing 3 new MPAs totalling 11,693 hectares	USD/ha	\$	215.87
	https://erc.undp.org/evaluation/documents/download/18150			
Saba Marine Park (2005)	Cost of establishing 870 ha MPA	USD/ha	\$	849.30
	https://www.sciencedirect.com/science/article/abs/pii/S0308597X10001338			
Bonaire National Marine Park (2005)	Cost of establishing 2,700 ha MPA	USD/ha	\$	562.36
	https://www.sciencedirect.com/science/article/abs/pii/S0308597X10001338			
Mean cost across past examples	Calculated	USD/ha	\$	420.31
Representative community-based MPA	Assumption	ha		1000
CAPEX per community-based MPA	Calculated	USD/year	\$	420,314.26

The capital costs for establishing one community-managed MPA are estimated at USD 420.31 per hectare. This estimate is derived from analysis of multiple Caribbean MPA establishment projects. While theoretical models (such as the McCrea-Strub model) suggest lower establishment costs of approximately USD 206 per hectare for a 1,000 ha MPA, the higher empirical average is used to provide a conservative cost estimate that reflects real-world implementation challenges including stakeholder consultation, boundary demarcation, legal designation, capacity building, and establishment of governance structures.

Establishment costs include activities such as:

- Community consultation and participatory planning processes
- Legal and administrative procedures for MPA designation
- Boundary surveying and marking
- Development of management plans and governance frameworks
- Initial capacity building and training for community managers
- Baseline ecological surveys and mapping

The assumptions for operating costs of MPAs are as follows:

Table 24 Assumptions A3 – MPA OPEX

Parameter	Source / assumption	Unit	Value
Glover's Reef Marine Reserve (35,067 ha)	https://www.wwf.fr/sites/default/files/doc-2017-10/1710_Rapport_Economic_benefits_of_the_Belize_Barrier_Reef_Reserve_System_World_Heritage_Site.pdf	\$	169,742.00
Blue Hole & Half Moon Caye Natural Monuments (4,340 ha)	https://www.wwf.fr/sites/default/files/doc-2017-10/1710_Rapport_Economic_benefits_of_the_Belize_Barrier_Reef_Reserve_System_World_Heritage_Site.pdf	\$	203,500.00
Laughing Bird Caye National Park (4,095 ha)	https://www.wwf.fr/sites/default/files/doc-2017-10/1710_Rapport_Economic_benefits_of_the_Belize_Barrier_Reef_Reserve_System_World_Heritage_Site.pdf	\$	37,338.00
Total area of example MPAs from Belize	Calculated	ha	43,502

Mean cost per hectare across MPAs in Belize	Calculated	USD/ha/year	\$	9.44
Median OPEX of Mexican community-based MPAs	https://www.frontiersin.org/journals/marine-science/articles/10.3389/fmars.2023.1180920/full	USD/ha/year	\$	57.31
Adjusted cost per hectare for Belize	Assumption to bring more in line with Mexican community-based MPAs example	USD/ha/year	\$	79.00
Representative community-based MPA	Assumption	ha		1000
Annual OPEX per community-based MPA	Calculated	USD/year	\$	79,000.00

Data from three established MPAs in Belize (Glover's Reef Marine Reserve, Blue Hole & Half Moon Caye Natural Monuments, and Laughing Bird Caye National Park) show a mean operating cost of USD 9.44 per hectare per year. However, these figures reflect extensive, low-intensity management of large, remote marine areas with minimal human pressure.

Community-based fishing MPAs typically require higher management intensity due to:

- Active fisheries pressure requiring regular enforcement and monitoring
- Coastal accessibility requiring more frequent patrols
- Intensive stakeholder engagement and participatory management processes
- Community capacity building and institutional development needs

A six-fold adjustment factor is applied to account for this higher management intensity, bringing the operating cost to USD 56.63 per hectare per year. This adjusted figure aligns with empirical data from community-managed MPAs in Mexico (median OPEX of USD 57.31 per hectare per year), providing external validation of the cost estimate. Notably, community-based management remains substantially more cost-effective than government-managed MPAs due to volunteer labour contributions, simplified administrative requirements, and community ownership reducing enforcement costs.

Annual operating costs cover:

- Community patrol and monitoring activities
- Management committee operations and coordination
- Ongoing stakeholder engagement and conflict resolution
- Basic equipment maintenance (boats, monitoring gear)
- Reporting and adaptive management processes
- Periodic training and capacity building

The economic value of MPAs derives from the ecosystem services they protect and enhance. Benefits are quantified using established ecosystem service valuation methodologies applied to Caribbean coral reef and coastal marine ecosystems. All values are drawn from the Ecosystem Services Valuation Database (ESVD) and reflect studies conducted in Caribbean contexts with similar ecological and socioeconomic conditions to Belize.

The analysis follows the Common International Classification of Ecosystem Services (CICES) framework to ensure mutual exclusivity of benefit categories, preventing double-counting. Six categories of ecosystem services are valued at USD 6,181.52 per hectare annually. The assumptions are as follows:

Table 25 Assumptions A3 – ecosystem service benefits of MPAs

Parameter	Source / assumption	Unit	Value
1.1.6.1 Wild fish and other natural aquatic biomass provisioning services	Burke et al. (2008) Coastal Capital: Economic Valuation of Coral Reefs in Tobago and St. Lucia	USD/ha/year	\$ 145.20
3.1.1.1 Recreation-related services	Ruiz de Gauna, I., Markandya, A., Onofri, L., Greño, F., Warman, J., Arce, N., ... & Hernández, M. (2021). Economic Valuation of the Ecosystem Services of the Mesoamerican Reef, and the Allocation and Distribution	USD/ha/year	\$ 1,368.77

[of these Values \(No. IDB-WP-01214\). IDB Working Paper Series.](#)

Total value of ecosystem services	Calculated	USD/ha/year	\$	1,513.97
Total benefits per representative community-based MPA	Calculated	USD	\$	1,513,970.00

Marine ecosystem recovery following MPA establishment is a gradual process. Fish populations rebuild, coral cover increases, and habitat complexity improves over time as fishing pressure is removed and destructive practices cease. The analysis incorporates a conservative benefit ramp-up reflecting ecological recovery dynamics, over a period of ten years:

- Year 1: 0% of full benefits (establishment phase, no recovery yet)
- Year 2: 10% of full benefits (initial recovery signs)
- Years 3-11: Linear increase from 20% to 100% (progressive ecosystem recovery)
- Years 12-20: 100% of full benefits (mature protected ecosystem)

3.3.1.1 Economic values

Parameter	Source / assumption	Value
Belize tariff rate, applied, weighted mean, all products (%) (2022)	https://data.worldbank.org/indicator/TM.TAX.MRCH.WM.AR.ZS	18.10%
Standard conversion factor (SCF), market to economic prices	SCF = $1 / (1 + t)$, where t is duties as a proportion of the traded base, i.e. the average tariff distortion between domestic and border prices. This is proxied by the applied, weighted-mean tariff across all products.	0.847
Shadow wage rate factor (SWRF)	An SWRF of 0.8 is assumed for hiring local community members as rangers, eco-guides, or monitors	0.8
Assumed labour share of OPEX for maintaining MPA	Assumption	80%
Combined SCF and SWRF factor	(1-labour share)*SCF + labour share*SWRF	0.809

The economic analysis converts the financial (market) prices used in the financial analysis into economic values reflecting the opportunity cost of resources to the economy. Transfer payments (taxes, duties and subsidies) are removed, internationally traded items are valued at their border-price equivalents, and residual non-traded inputs are adjusted using a Standard Conversion Factor (SCF). The SCF is derived from the applied, weighted-mean tariff across all products reported by the World Bank (World Integrated Trade Solution), which proxies the average distortion between domestic and border prices; the resulting parameters are set out in the table above.

A Shadow Wage Rate Factor (SWRF) is applied to the labour element of costs to reflect that labour drawn from underemployed local, rural communities, has an opportunity cost below the market wage; this is combined with the SCF, in proportion to the labour share of costs, to give the blended cost conversion factor shown. Benefit streams already expressed in economic terms (e.g., avoided food imports valued at import-parity prices, the social cost of avoided emissions, and avoided-damage values) are not further adjusted.

3.3.1.2 Counterfactual

The counterfactual scenario for the economic analysis assumes continuation of current trajectories without MPA establishment. Specifically, ongoing degradation of marine ecosystems under unregulated fishing pressure, habitat destruction, and climate stressors. Under this scenario, coastal marine areas would continue to experience:

- Declining fish stocks from overfishing, particularly of commercially valuable species
- Habitat degradation from destructive fishing practices (such as seine netting in sensitive areas)
- Reduced ecosystem resilience to climate impacts (bleaching, ocean acidification, storms)
- Progressive loss of ecosystem service flows as reef health declines

- Diminished coastal protection capacity as reef structures erode
- Declining tourism value as underwater environments degrade

This counterfactual represents the baseline against which the MPA intervention is measured. The benefits quantified in the economic analysis reflect the avoided ecosystem service losses and enhanced service flows resulting from effective marine protection. Without intervention, the region would experience continued erosion of natural capital and the valuable services it provides to coastal communities and the broader society.

3.3.2 Results

The economic analysis demonstrates that community-managed Marine Protected Areas generate exceptional returns from a societal perspective. Despite the substantial upfront investment required and the multi-year ecological recovery period, the value of preserved and enhanced ecosystem services far exceeds the costs of establishment and maintenance.

For a representative 1,000-hectare community-managed MPA, the economic costs and benefits over a 20-year time horizon are as follows:

Total economic costs amount to USD 419,835.41 in Year 1 (comprising USD 355,896.92 in capital investment for establishment and USD 63,938.49 in first-year operating costs), then USD 63,938.49 annually in subsequent years for ongoing management and maintenance.

Total economic benefits follow the ecosystem recovery ramp-up schedule described above. Benefits begin at zero in Year 1, reach USD 87,458.51 in Year 2 (10% of full ecosystem service value), and increase progressively through Year 11 when full ecosystem service delivery of USD 1,450,031.51 annually is achieved. This benefit level is maintained through Year 20 and beyond.

The cumulative benefits over 20 years total **USD 20,317,898.22**, representing the aggregate value of ecosystem services protected and enhanced by the MPA over two decades.

The key economic performance indicators are:

ENPV (20 years)	\$	5,025,303.62
EIRR (20 years)		71%

The high ENPV and EIRR reflect the extraordinary economic value created by marine ecosystem protection.

The relatively modest costs of community-based management, combined with the high value of ecosystem services protected, generate economic returns that exceed conventional infrastructure or productive investments.

The analysis also highlights the critical importance of grant financing for public goods like MPAs. Because ecosystem services are largely non-excludable (benefits accrue to society broadly rather than to identifiable private entities who could be charged), market mechanisms fail to generate adequate conservation investment. Grant-based financing overcomes this market failure by enabling society to invest in natural capital protection that generates broad, long-term benefits.

3.3.3 Sensitivity analysis

A sensitivity analysis was performed to evaluate the robustness of economic returns under varying assumptions. The analysis examines three dimensions of uncertainty: 1) investment costs, 2) benefit levels, and 3) the social discount rate.

- 1) The analysis tests scenarios where establishment and operating costs vary from 60% to 140% of baseline estimates. This range captures potential cost variations from economies of scale, site-specific conditions, or implementation challenges. The ENPV shows considerable stability across cost scenarios, ranging from 60% of baseline costs to 140. Even with costs 40% higher than anticipated, the ENPV remains positive and the EIRR remains well above the 12% social discount rate. This relative insensitivity to cost variations reflects the fact that establishment and operating costs represent a modest

fraction of total ecosystem service benefits; even substantial cost overruns have a limited effect on overall economic returns.

- 2) The analysis examines scenarios where total ecosystem service benefits vary from 60% to 140% of baseline valuations. This range captures uncertainties in ecosystem service quantification and ecological recovery rates. The intervention maintains positive economic returns across all benefit scenarios tested.. Even if actual ecosystem service values prove to be only 60% of baseline estimates, the ENPV remains positive. The benefit dimension is the most influential driver of ENPV in this analysis, reflecting the fact that ecosystem service flows dwarf investment costs in absolute terms.
- 3) Lastly, the analysis tests social discount rates ranging from 5% to 20%, reflecting uncertainty in the appropriate rate for valuing long-term social investments and varying macroeconomic conditions in small island developing states. The ENPV remains positive across the full range of discount rates tested. Even at 20%, a rate that heavily discounts future benefits and would render most long-term environmental investments economically unattractive, the MPA generates an ENPV of USD 2,368,251.75. The sensitivity to discount rates is more pronounced than for cost variations, reflecting the long-term nature of ecosystem service flows. At a 5% rate more consistent with intergenerational equity considerations, the ENPV reaches USD 10,833,198.26, more than double the baseline case.

The sensitivity analyses confirm that community-managed MPAs generate strong economic returns under a wide range of plausible scenarios. The intervention maintains positive net present value across all combinations of parameters tested, and the EIRR of 62% provides a substantial buffer above the cost of capital under any reasonable discount rate assumption. The robustness of returns across wide ranges of cost assumptions, benefit valuations, and discount rates provides high confidence that MPA investments represent sound use of public resources.

Table 26 Economic sensitivity analysis dashboard – A3

Investment cost		ENPV	Benefits		ENPV	Discount rate	ENPV
60%	\$	5,343,443.65	60%	\$	2,697,042.14	5%	\$ 10,833,198.26
80%	\$	5,184,373.64	80%	\$	3,861,172.88	10%	\$ 6,184,383.24
100%	\$	5,025,303.62	100%	\$	5,025,303.62	12%	\$ 5,025,303.62
120%	\$	4,866,233.60	120%	\$	6,189,434.36	15%	\$ 3,739,129.02
140%	\$	4,707,163.59	140%	\$	7,353,565.10	20%	\$ 2,368,251.75

3.4 B1: Community-based Early Warning Systems (EWS)

As community-based early warning systems are non-revenue generating interventions focused on disaster risk reduction and public safety, this intervention does not include a financial analysis. The economic analysis directly evaluates the societal value created through avoided disaster losses and enhanced community resilience.

3.4.1 Assumptions

The economic analysis for community-based early warning systems evaluates the costs and benefits of establishing localised disaster preparedness infrastructure in the Bahamas. These interventions represent critical public goods that generate substantial societal benefits through avoided disaster losses, yet produce no direct financial returns to private actors, making them particularly suitable for grant-based financing.

The analysis is based on a representative community-based EWS serving approximately 10% of the Bahamas' rural population. Rural communities represent approximately 19% of the total national population — roughly 76,000 people — of whom the representative investment is assumed to reach approximately 7,600. This targeting reflects the reality that rural and isolated island communities face the greatest last-mile warning dissemination gap: national meteorological services and centralised government systems are less effective at reaching dispersed coastal and island settlements, leaving these populations with weaker protective action capacity despite often facing comparable or higher physical exposure to hurricane impacts.

The Bahamas faces exceptional exposure to tropical cyclones, with the archipelago lying directly in the path of Atlantic hurricane tracks. The country experiences average annual losses (AAL) from hurricanes of USD 850 million,⁴⁹ representing approximately 11-12% of GDP, among the highest disaster risk burdens globally relative to economic size.

With a population of 401,283 (2024), this translates to an average annual loss of USD 2,118 per person from hurricane impacts. This figure represents the annualised cost of hurricane damage across all events, from frequent tropical storms to rare catastrophic hurricanes, accounting for both direct damage (infrastructure, housing, productive assets) and indirect losses (business interruption, displacement, recovery costs).

The high per-capita hurricane risk reflects the Bahamas' vulnerability profile: a dispersed island archipelago with extensive coastal exposure, high-value tourism infrastructure concentrated in coastal zones, limited economic diversification, and small absolute economic size that makes recovery from major events particularly challenging. This context makes disaster risk reduction investments, particularly early warning systems that enable protective action, exceptionally valuable.

The costs for establishing one community-based EWS are estimated at USD 331,500, comprising several integrated components, as follows:

Table 27 B1 cost assumptions

Parameter	Source / assumption	Unit		Value
Damage reduction potential of a well-functioning EWS	https://wmo.int/topics/early-warning-system	%		30.00%
Assumed population/area coverage per investment	Assumption	%		20.00%
Establishment costs of a community-based early warning system	Assumption based on FP171 Annex 3	USD	\$	260,000.00
Cost of a meteorological equipment package	Vantage Pro 2 Plus with Weather link console (USD 1,850) x10	USD	\$	18,500.00
	Stevens TB3 rain gauge (USD 1,650) x10	USD	\$	16,500.00
	Anemometer (USD 750) x10	USD	\$	7,500.00
	Stevens Steelhead (with 12-Watt Solar Panel & External Antenna) (USD 1,800) x10	USD	\$	18,000.00
	Other parts (temperature/humidity sensor, platform, WeatherLink) (USD 1,000) x10	USD	\$	10,000.00
OPEX (e.g. spare parts)	Assumption	USD/year	\$	1,000.00
Total costs of a representative EWS (less OPEX)	Calculated	USD	\$	330,500.00

The meteorological equipment provides localised monitoring capability essential for community-level early warning. While national meteorological services provide broad-scale forecasts, community-based monitoring enables detection of local weather developments, validates national warnings for specific communities, and empowers local decision-making about protective actions.

The USD 260,000 core establishment cost covers the non-hardware elements that transform monitoring equipment into an effective early warning system:

- Community risk assessment and hazard mapping
- Development of community-specific response protocols
- Establishment of communication trees and alert systems
- Training of community focal points and volunteer monitors
- Creation of evacuation plans and shelter arrangements
- Capacity building for local emergency committees

⁴⁹ <https://cdn.bahamas.gov.bs/tenant/tenantministryoffinance/documents/All%20Documents/BahamasClimateSpending202122-20240422080737.pdf>

- Integration with national disaster management systems
- Public awareness and education campaigns

Annual operating costs are estimated at USD 1,000 for ongoing maintenance, equipment calibration, spare parts, and system upkeep. This modest OPEX reflects the community-based operational model where volunteer labour provides monitoring and response coordination, rather than paid staff. The low operating costs are an advantage of community-based EWS compared to centralised government systems, enabling sustainable long-term operation with minimal recurrent financing.

The economic value of early warning systems derives from avoided losses through timely protective action. Well-functioning EWS enable communities to implement risk reduction measures before hazard impacts:

- Evacuation of people from at-risk areas to safe shelter
- Securing of movable assets (vehicles, equipment, valuable goods)
- Strengthening of structures (storm shutters, reinforcement)
- Pre-positioning of emergency supplies and response resources
- Protection of critical infrastructure (power systems, water supplies)
- Safeguarding of livelihoods (securing fishing vessels, agricultural protection)

Secondary literature (such as World Meteorological Organisation assessments) shows that well-functioning early warning systems can reduce disaster losses by 30%. For community-based systems targeting rural and isolated island populations, where existing national coverage is weakest, a more conservative **20% damage reduction potential** is applied. This reflects both the partial substitutability with existing national systems and the recognition that community-based EWS represent a marginal improvement above the current baseline rather than a replacement for all prior warning capacity.

An early warning system reduces disaster losses by enabling anticipatory action ahead of a hurricane's landfall (evacuation, and the securing or relocation of movable property, rather than by preventing physical damage itself). Its benefit is therefore confined to the share of expected losses that timely warning and response can realistically avert. The territory's hurricane Average Annual Loss (AAL) is dominated by damage to fixed assets, buildings, infrastructure and land, which sustain impact regardless of any warning issued and cannot be protected within the available lead time.

The avertible portion comprises loss of life together with movable and portable assets (vehicles, vessels, equipment, household goods and livestock) that can be evacuated or secured once adequate warning is received. Even within this portion, realisation is partial: the benefit depends on warning lead time, the reach of dissemination, and the proportion of the exposed population that receives and acts on the warning, none of which is complete in practice.

Therefore, reflecting both the predominance of non-avertible fixed-asset damage in total AAL and the partial effectiveness of warning-enabled response, the share of AAL treated as avertible by the system **is set conservatively at 15%**. Restricting the benefit to the mortality and movable-asset component also underpins the per-capita basis of the estimate, since exposure to these categories is spread across the population more evenly than the value of fixed structures. This ensures a more grounded assumption of the model.

Lastly, early warning system effectiveness develops progressively as communities build experience, trust, and response capacity. The analysis incorporates a conservative five-year ramp-up to full effectiveness, consistent with past approved GCF project examples:

- Year 1: 10% effectiveness (initial system establishment, learning phase)
- Year 2: 30% effectiveness (growing community confidence and coordination)
- Year 3: 60% effectiveness (established protocols, proven track record)
- Year 4: 70% effectiveness (mature community response capacity)
- Year 5 onwards: 100% effectiveness (fully operational system with sustained community engagement)

This graduated effectiveness profile reflects real-world implementation experience showing that technical EWS infrastructure alone does not guarantee effective community response. Building social capital, establishing trust in warning information, developing coordination mechanisms, and demonstrating system reliability through actual events all require time. Communities

become more responsive as they experience successful warnings and observe avoided losses, creating a positive feedback loop of increasing effectiveness.

3.4.1.1 Economic values

Parameter	Source / assumption	Value
Bahamas tariff rate, applied, weighted mean, all products (%) (2022)	https://data.worldbank.org/indicator/TM.TAX.MRCH.WM.AR.ZS	16.30 %
Standard conversion factor (SCF), market to economic prices	$SCF = 1 / (1 + t)$, where t is duties as a proportion of the traded base, i.e. the average tariff distortion between domestic and border prices. This is proxied by the applied, weighted-mean tariff across all products.	0.860
Shadow wage rate factor (SWRF)	An SWRF of 1 is assumed as maintaining EWS equipment is a specialised role	1.00

The economic analysis converts the financial (market) prices used in the financial analysis into economic values reflecting the opportunity cost of resources to the economy. Transfer payments (taxes, duties and subsidies) are removed, internationally traded items are valued at their border-price equivalents, and residual non-traded inputs are adjusted using a Standard Conversion Factor (SCF). The SCF is derived from the applied, weighted-mean tariff across all products reported by the World Bank (World Integrated Trade Solution), which proxies the average distortion between domestic and border prices; the resulting parameters are set out in the table above.

Because the cost inputs in this model comprise imported equipment and materials rather than a material labour component, no separate shadow wage adjustment is applied; the Standard Conversion Factor is applied to non-traded, market-priced cost inputs, imported items are valued at border prices, and the price basis of each input is stated in the table above.

3.4.1.2 Counterfactual

The counterfactual scenario for the economic analysis assumes continuation of current early warning and disaster preparedness arrangements without enhanced community-based systems. Under this scenario, communities would continue to rely primarily on national meteorological services and government disaster management agencies for warnings and response coordination. The counterfactual implies:

- Continued reliance on generalised national warnings that may not reflect local conditions or community-specific risks
- Limited local monitoring capacity to track rapidly developing weather systems or validate national forecasts
- Absence of formalised community response mechanisms and coordination structures
- Gaps in last-mile warning dissemination to vulnerable populations without reliable communications
- Weak community preparedness and limited pre-event protective action
- Higher disaster losses from inadequate warning lead time and incomplete protective measures
- Reactive rather than anticipatory disaster response, with higher humanitarian costs

This counterfactual represents the baseline against which the community-based EWS intervention is measured. The benefits quantified in the economic analysis reflect the incremental avoided losses resulting from enhanced local preparedness capacity, improved warning dissemination, and strengthened community response coordination beyond the status quo.

It is important to note that the counterfactual is not "no early warning." Rather, it is "current early warning arrangements without enhanced community-based systems." The 20% damage reduction potential attributed to the intervention represents the marginal improvement beyond existing national systems, not the total value of early warning from zero baseline.

3.4.2 Results

The economic analysis demonstrates that community-based early warning systems generate exceptional returns from a societal perspective. Despite the modest establishment costs and minimal operating expenses, the value of avoided disaster losses far exceeds investment requirements, making EWS among the most cost-effective disaster risk reduction interventions available.

For a representative community-based EWS covering approximately 7,600 rural people (10% of Bahamas' rural population), the economic costs and benefits over a 10-year time horizon are as follows:

Total economic costs amount to USD 284,178.85 in Year 1 for system establishment, then USD 859.85 annually in subsequent years for maintenance and operation.

The cumulative net benefits over 10 years total **USD 3.29 million in avoided disaster losses**, representing the aggregate expected value of reduced damage across all potential hurricane scenarios over the period.

The key economic performance indicators are:

ENPV (10 years)	\$ 1,484,460.61
EIRR (10 years)	85%

The EIRR of 85% is exceptional and reflects the fundamental economics of disaster risk reduction in high-exposure contexts: modest upfront investments in warning capacity generate avoided losses that far exceed capital requirements.

These economic returns illustrate why early warning systems are widely recognised as among the most cost-effective disaster risk reduction investments. The minimal costs of establishing community-based monitoring and response capacity, combined with the enormous potential losses from hurricanes in vulnerable island contexts, generate exceptional benefit-cost ratios.

The analysis also highlights the critical importance of grant financing for disaster risk reduction. Because avoided losses are distributed across entire communities rather than accruing to specific private entities who could invest in EWS, market mechanisms fail to generate adequate investment despite the overwhelming social returns. Grant-based financing overcomes this market failure by enabling society to invest in risk reduction that protects broad populations and economic activities.

Furthermore, the benefits extend beyond the quantified avoided losses. Early warning systems generate important co-benefits that are difficult to value monetarily but contribute substantially to societal welfare:

- Reduced loss of life and injuries from timely evacuations
- Decreased psychological trauma and stress from disaster events
- Reduced humanitarian emergency costs through anticipatory action
- Enhanced community cohesion and social capital through collaborative preparedness
- Improved development planning through better risk information
- Reduced economic volatility from more predictable disaster impacts
- Strengthened institutional capacity for disaster risk management
- Demonstration effects encouraging broader risk reduction investments

These co-benefits, while not included in the quantitative analysis, reinforce the economic case for early warning system investments and suggest that the estimated returns may be conservative.

3.4.3 Sensitivity analysis

A sensitivity analysis was performed to evaluate the robustness of economic returns under varying assumptions. The analysis examines three dimensions of uncertainty: 1) investment costs, 2) benefit levels, and 3) the social discount rate.

- 1) The analysis tests scenarios where establishment and operating costs vary from 60% to 140% of baseline estimates. This range captures potential cost variations from equipment procurement efficiencies, differences in local implementation conditions, or unforeseen challenges. The ENPV shows remarkable stability across cost scenarios. This near-complete insensitivity to cost variations reflects the magnitude of avoided losses relative to establishment costs. Even with costs

40% above baseline, the ENPV remains above USD 1.3 million, underscoring that implementation cost uncertainty is not a material risk to the economic viability of this investment.

- 2) The analysis examines scenarios where avoided disaster losses vary from 60% to 140% of baseline estimates. This range captures uncertainties in the 20% damage reduction assumption, variations in how effectively warnings translate to protective action, and the inherent uncertainty in disaster risk quantification. The intervention maintains strongly positive economic returns across all benefit scenarios. Even if actual avoided losses prove to be only 60% of baseline estimates, implying substantially lower EWS effectiveness or an overestimate of baseline risk, the ENPV remains positive.. This sensitivity reflects the fact that avoided losses are the dominant value driver; however, even at the lower bound, returns remain strongly positive and well above any reasonable economic threshold.
- 3) The analysis tests social discount rates ranging from 5% to 20%, reflecting debates about appropriate discount rates for disaster risk reduction investments and variations in macroeconomic conditions in small island developing states. The ENPV remains strongly positive across the full range tested. The relatively limited sensitivity to discount rate variations reflects the short payback period of early warning systems: with benefits beginning in year 1 and reaching full effectiveness by year 5, much of the value is realised in the near term where discounting has a more limited dampening effect.

The sensitivity analysis confirms that community-based early warning systems generate exceptional economic returns under virtually all plausible scenarios. The intervention maintains extraordinarily high net present value and benefit-cost ratios even with simultaneous adverse movements in multiple parameters. The robustness of returns across wide ranges of cost assumptions, avoided loss estimates, and discount rates provides exceptional confidence that EWS investments represent sound use of public resources.

Table 28 Economic sensitivity analysis dashboard – B1

Investment cost		ENPV	Benefits	ENPV	Discount rate	ENPV
60%	\$	1,587,589.29	60%	\$ 787,547.68	5%	\$ 2,328,859.53
80%	\$	1,536,024.95	80%	\$ 1,136,004.14	10%	\$ 1,682,087.20
100%	\$	1,484,460.61	100%	\$ 1,484,460.61	12%	\$ 1,484,460.61
120%	\$	1,432,896.26	120%	\$ 1,832,917.07	15%	\$ 1,236,687.36
140%	\$	1,381,331.92	140%	\$ 2,181,373.53	20%	\$ 922,520.42

3.5 B2: Mobile mental health support units for climate-related disaster support

As mobile mental health support units are non-revenue generating interventions focused on public health and psychosocial resilience, this intervention does not include a financial analysis. The economic analysis directly evaluates the societal value created through reduced mental health burden and enhanced community well-being following climate-related disasters.

3.5.1 Assumptions

The economic analysis for mobile mental health support units evaluates the costs and benefits of establishing specialised mental health services targeting climate disaster-related psychological trauma, using Belize as a representative example country. These interventions represent critical public health investments that generate substantial societal benefits through reduced mental health burden, yet produce no direct financial returns, making them particularly suitable for grant-based financing.

Climate disasters impose not only physical and economic damages but also profound psychological impacts on affected populations. Hurricanes, floods, and extreme weather events trigger acute stress, anxiety, depression, post-traumatic stress disorder (PTSD), and other mental health conditions that can persist long after physical recovery. Yet mental health services, particularly those addressing climate-specific trauma, remain severely under-resourced in SIDS, creating a critical gap in disaster response and recovery.

The mobile mental health support unit represents an integrated intervention combining specialised curriculum development, capacity building for community health workers, and enabling technology for service delivery. The intervention specifically targets climate disaster-related mental health needs.

The intervention comprises three integrated components:

- 1) Development of comprehensive training materials and protocols specifically addressing climate-related mental health trauma. Unlike generic mental health curricula, this specialised program addresses the unique psychological impacts of climate disasters including eco-anxiety, climate grief, displacement trauma, livelihood loss, and prolonged uncertainty associated with slow-onset and compound climate hazards. The curriculum development process includes:
 - a. Adaptation of international best practices to Caribbean cultural contexts
 - b. Design of training modules for different cadres of health workers (community health workers, nurses, counsellors)
 - c. Development of peer support and community-based psychosocial support approaches
 - d. Integration with existing health systems and disaster response frameworks
 - e. Pilot testing and refinement based on community feedback

The relatively high cost of USD 120,000 reflects the specialised nature of curriculum development requiring expertise at the intersection of climate science, disaster psychology, public health, and Caribbean cultural competency. This investment creates a reusable knowledge asset that can be deployed across multiple communities and updated as climate mental health evidence evolves.

- 2) Hardware and communications equipment enabling mental health support workers to reach dispersed, disaster-affected populations across Belize's challenging geography. The telehealth package supports 10 community-based mental health workers with:
 - a. Laptops for secure telemedicine consultations and case documentation
 - b. Satellite phones for communication in areas with damaged telecommunications infrastructure
 - c. Satellite internet terminals for reliable connectivity in remote communities and post-disaster contexts
 - d. Software platforms for telecounseling, case management, and coordination

The mobile/telehealth approach is essential in the post-disaster context where transportation infrastructure may be damaged, populations may be temporarily displaced, and traditional facility-based mental health services are inaccessible. Satellite-based communications ensure continuity of mental health support even when terrestrial infrastructure fails—precisely when psychological support is most critical.

- 3) Additional resources for initial program establishment including training delivery costs, community sensitization, supervision and quality assurance systems, and unforeseen implementation needs.

Total capital costs amount to USD 150,000, representing a one-time investment to establish the mobile mental health support capacity. Annual operating costs of USD 500 cover telehealth hardware maintenance, software subscriptions, equipment replacement, and system upkeep.

The modest OPEX reflects that personnel costs (health workers) are covered through existing health system budgets, with this intervention providing specialised capacity enhancement rather than creating entirely new staffing.

To quantify the economic value of mental health interventions, the analysis employs the Disability-Adjusted Life Year (DALY) framework. DALYs measure disease burden by combining years of life lost to premature mortality and years lived with disability, providing a quantifiable metric for health impact assessment. The assumptions are as follows:

Table 29 Assumptions B2 - DALYs

Parameter	Source / assumption	Unit	Value
DALYs attributable to mental disorders, GBD Caribbean region (2019)	https://www.thelancet.com/journals/eclinm/article/PIIS2589-5370(22)00405-9/fulltext	Nr	1,700,000
Population of GBD Caribbean region (2019)	https://ghdx.healthdata.org/countries	Nr	41,879,736

Population of Belize (2019)	https://ghdx.healthdata.org/geography/belize	Nr	410,094
Belize's share of Caribbean DALYs attributable to mental disorders	Calculated	%	0.9792%
Number of DALYs attributable to mental disorders in Belize	Calculated	Nr	16,647
Share of mental health DALYs attributable to climate-related hazards	Conservative assumption based on: https://www.nature.com/articles/s41598-025-89298-1	%	10%
Climate-attributable mental health DALYs in Belize	Calculated	Nr	1,665
Belize GDP per capita (2019 USD)	https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?locations=BZ	USD	\$ 6,190.00
DALY reduction assumption from investment (% of climate-attributable mental health burden)	Conservative assumption	%	0.5%
Annual DALY reduction from investment	Calculated	Nr / year	8
Annual economic benefit from DALY reduction	Calculated	USD/ year	\$ 51,521.57

Based on the Global Burden of Disease (GBD) study for the Caribbean region (2019), mental disorders account for approximately 1.7 million DALYs across the region's 41.9 million population. Proportional to its population of 410,094, Belize accounts for approximately 16,647 DALYs attributable to mental disorders annually.

A critical question for this analysis is: what share of mental health burden is attributable to climate-related hazards. A study of coastal communities in Indonesia is used as a proxy, which finds that people who live in coastline hazard areas have 1.13 times higher odds to have depression than people who live outside those areas. Applying a conservative 10% attribution yields approximately 1,665 climate-attributable mental health DALYs in Belize annually. This represents the mental health burden specifically associated with climate hazards—the portion of Belize's total mental health burden that would not exist absent climate change impacts.

The economic value of reducing this burden is calculated using Belize's GDP per capita (USD 6,190 in 2019) as a proxy for the social cost of disability. This approach values each DALY at one year of per-capita economic output, reflecting both productivity losses and society's willingness to invest in health improvements.

The mobile mental health support unit is conservatively assumed to reduce climate-attributable mental health burden by 0.5%. This translates to approximately 8 DALYs averted annually.

This modest effectiveness assumption (0.5% of climate mental health burden) reflects several conservative choices:

- 10 trained workers cannot cover the entire national population
- Mental health stigma and access barriers limit utilisation
- The intervention primarily provides treatment rather than preventing all climate mental health impacts
- Mental health outcomes are difficult to quantify with precision
- Not all mental health improvements can be attributed solely to this intervention

Despite these conservative assumptions, averting 8 DALYs annually represents meaningful impact. At USD 6,190 per DALY, this yields annual economic benefits of approximately USD 51,521.57 from reduced mental health burden. Over the 10-year analysis period, cumulative benefits amount to approximately USD 474,000.

It should be noted that mental health interventions generate benefits beyond those captured in DALY metrics, including:

- Improved family and social functioning
- Enhanced economic productivity through better workplace performance
- Reduced healthcare costs from co-morbid physical health conditions
- Decreased substance abuse and associated social costs
- Lower suicide rates and self-harm incidents
- Strengthened community resilience and social cohesion

- Reduced caregiver burden and family stress
- Demonstration effects encouraging broader mental health service utilization

These co-benefits, while not quantified in the DALY-based analysis, suggest that the estimated economic returns may be conservative and the full social value of mental health interventions likely exceeds the quantified benefits.

A ramp-up time of effectiveness for the mental health unit is assumed, operating at 50% effectiveness in Year 1, 70% in Year 2, and 100% from Year 3 onwards.

3.5.1.1 Economic values

Parameter	Source / assumption	Value
Belize tariff rate, applied, weighted mean, all products (%) (2022)	https://data.worldbank.org/indicator/TM.TAX.MRCH.WM.AR.ZS	18.10%
Standard conversion factor (SCF), market to economic prices	SCF = $1 / (1 + t)$, where t is duties as a proportion of the traded base, i.e. the average tariff distortion between domestic and border prices. This is proxied by the applied, weighted-mean tariff across all products.	0.847

The economic analysis converts the financial (market) prices used in the financial analysis into economic values reflecting the opportunity cost of resources to the economy. Transfer payments (taxes, duties and subsidies) are removed, internationally traded items are valued at their border-price equivalents, and residual non-traded inputs are adjusted using a Standard Conversion Factor (SCF). The SCF is derived from the applied, weighted-mean tariff across all products reported by the World Bank (World Integrated Trade Solution), which proxies the average distortion between domestic and border prices; the resulting parameters are set out in the table above.

Because the cost inputs in this model comprise imported equipment and materials rather than a material labour component, no separate shadow wage adjustment is applied; the Standard Conversion Factor is applied to non-traded, market-priced cost inputs, imported items are valued at border prices, and the price basis of each input is stated in the table above.

3.5.1.2 Counterfactual

The counterfactual scenario for the economic analysis assumes continuation of current mental health service provision without specialised climate disaster capacity. Under this scenario, the healthcare system would maintain its existing mental health infrastructure, which is assumed to focus primarily on chronic mental illness and generic counselling services, without targeted interventions for climate-related psychological trauma. The counterfactual implies:

- Continued reliance on generic mental health protocols not tailored to climate disaster contexts
- Limited mental health worker capacity to recognise and treat climate-specific psychological conditions
- Absence of mobile/telehealth infrastructure to reach disaster-affected populations in remote areas
- Gaps in mental health service provision during and immediately after climate disasters when need is greatest
- Missed opportunities for early intervention preventing acute stress from developing into chronic conditions
- Persistent mental health burden from climate trauma without specialised treatment
- Higher long-term mental health costs as untreated acute conditions become chronic
- Reduced community resilience and recovery capacity from unaddressed psychological impacts

This counterfactual is particularly salient in the Caribbean context where mental health services are under-resourced and climate disaster mental health remains a gap in disaster response frameworks. While physical recovery receives attention and resources, psychological recovery often lacks specialised support, leading to persistent mental health burden that undermines long-term resilience.

The benefits quantified in the economic analysis reflect the incremental mental health burden reduction achievable through specialised climate disaster mental health capacity beyond the status quo of generic mental health services.

3.5.2 Results

The economic analysis demonstrates that mobile mental health support units generate positive returns from a societal perspective. Despite the modest scale of DALY reduction achievable by a single intervention, the relatively low establishment costs and sustained benefit stream create favourable economic returns over the project lifetime.

For a representative mobile mental health support unit covering Belize, the economic costs and benefits over a 10-year time horizon are as follows:

Total economic costs amount to USD 127,011.01 in Year 1 for curriculum development and telehealth infrastructure establishment, then USD 423.37 annually in subsequent years for equipment maintenance and system operation. T

Total economic benefits derive from reduced mental health burden as measured by DALYs averted. Benefits amount to USD 51,521.57 annually throughout the 10-year period (excluding the first two ramp-up years), reflecting the 8 DALYs averted per year valued at USD 6,190 per DALY. The consistent annual benefit stream reflects the ongoing nature of mental health service provision. Each year the intervention operates, it averts additional mental health burden.

The cumulative net benefits over 10 years total **USD 342,753.70**, representing the aggregate value of mental health burden reduction over the analysis period.

The key economic performance indicators are:

ENPV (10 years)	\$	139,991.02
EIRR (10 years)		44%

The positive ENPV and high EIRR demonstrates that specialised climate disaster mental health capacity generates net economic value to society.

While the economic returns for mental health interventions are relatively modest, they remain solidly positive and economically justified. This reflects the inherent challenges in mental health economics: benefits accrue gradually through improved quality of life rather than dramatic avoided losses, measurement is complex, and interventions reach limited populations.

As noted in the assumptions section, mental health interventions generate important co-benefits including enhanced economic productivity, reduced healthcare costs for co-morbid conditions, strengthened social cohesion, and improved family functioning. These effects, while difficult to monetise, contribute substantially to community well-being and resilience. The quantified returns should thus be understood as a lower bound on the full social value of climate disaster mental health services.

3.5.3 Sensitivity analysis

A sensitivity analysis was performed to evaluate the robustness of economic returns under varying assumptions. The analysis examines three dimensions of uncertainty: 1) investment costs, 2) benefit levels, and 3) the social discount rate.

- 1) The analysis tests scenarios where establishment and operating costs vary from 60% to 140% of baseline estimates. This range captures potential cost variations from curriculum development efficiencies, equipment procurement, or implementation challenges. The ENPV remains positive across all cost scenarios. This sensitivity to cost variations is more pronounced than for larger infrastructure interventions, reflecting the fact that costs represent a more material share of total benefits in this intervention. Nonetheless, positive returns are maintained across the full cost range tested.
- 2) The analysis examines scenarios where benefits (DALY reduction) vary from 60% to 140% of baseline estimates. This range captures substantial uncertainty in intervention effectiveness, climate mental health burden attribution, and DALY valuation. The intervention maintains positive economic returns across all benefit scenarios, though the margin narrows considerably at lower benefit realisations. At 60% of baseline, reflecting a scenario where intervention reach is more limited, climate mental health attribution is lower, or effectiveness is reduced, the ENPV is USD 37,676, remaining positive but indicating that benefit realisation is the most material driver of economic viability for this intervention. At 140% of baseline, the ENPV reaches USD 242,305. These results underscore the importance of robust monitoring and evaluation to track DALY outcomes and validate effectiveness assumptions during implementation.

- 3) The analysis tests social discount rates ranging from 5% to 20%, reflecting debates about appropriate rates for health investments and variations in macroeconomic conditions. The ENPV remains positive across the full range of discount rates tested. At the lower 5% rate, the ENPV reaches USD 235,051.51. At the 12% baseline rate, the ENPV is USD 139,991.02. Even at the high 20% rate, which heavily discounts future health benefits, the ENPV remains positive at USD 76,184.28. Mental health interventions generate relatively consistent annual benefits throughout their operational lifetime, making long-term discounting more consequential than for upfront-heavy interventions. However, positive returns across all discount rate scenarios confirm economic viability under diverse time preference assumptions.

The sensitivity analysis confirms that mobile mental health support units for climate disaster support generate positive economic returns across all scenarios examined. The results do highlight that benefit realisation, particularly the degree to which DALY reductions are achieved as modelled, is the key uncertainty that warrants monitoring during implementation. Cost overruns and discount rate variations, while influential, do not threaten the sign of economic returns within the ranges tested.

Table 30 Economic sensitivity analysis dashboard – B2

Investment cost		ENPV	Benefits	ENPV	Discount rate	ENPV
60%	\$	186,308.94	60%	\$	5%	\$ 235,050.31
80%	\$	163,149.98	80%	\$	10%	\$ 162,318.91
100%	\$	139,991.02	100%	\$	12%	\$ 139,991.02
120%	\$	116,832.05	120%	\$	15%	\$ 111,917.68
140%	\$	93,673.09	140%	\$	20%	\$ 76,184.28

3.6 B3: Hurricane-proofing community buildings for shelter

As hurricane-proofing of community buildings for emergency shelter is a non-revenue generating intervention focused on life safety and disaster resilience, this intervention does not include a financial analysis. The economic analysis directly evaluates the societal value created through avoided mortality, injuries, and health costs during hurricane events.

3.6.1 Assumptions

The economic analysis for hurricane-proofing community buildings evaluates the costs and benefits of retrofitting existing public infrastructure to serve as safe emergency shelters in Saint Lucia. These interventions represent critical life safety investments that generate substantial societal benefits through avoided casualties during hurricanes, yet produce no direct financial returns, making them particularly suitable for grant-based financing.

Hurricane shelter capacity represents a fundamental disaster risk reduction need in Caribbean SIDS. During major hurricanes, vulnerable populations require safe refuge from extreme winds, storm surge, and flooding. However, many existing community buildings such as schools, health centres, community halls lack the structural integrity to withstand Category 4-5 hurricanes, creating dangerous shelter capacity gaps that force populations to shelter in inadequate structures.

The hurricane-proofing intervention comprises structural retrofitting of existing community buildings to meet hurricane-resistant design standards. The analysis uses cost estimates from FP133 (Antigua and Barbuda Enhanced Direct Access pilot project), which provides detailed engineering assessments for similar Caribbean building stock, adapted to the Saint Lucia context.

Investment costs are estimated at USD 960 per square meter of building area, based on the FP133 building assessment report. For a representative 500 square meter building (typical of a health centre or large community facility), total investment costs amount to USD 480,000 per building. Hurricane-proofing measures could include:

- Strengthening foundations, walls, and load-bearing elements to withstand hurricane wind loads and lateral forces
- Installing hurricane-rated roofing systems with enhanced tie-down connections, impact-resistant materials, and proper drainage
- Fitting hurricane-resistant windows and doors, or installing permanent storm shutters
- Elevating critical systems, installing flood barriers, improving drainage

- Installing backup generators for electrical system resilience
- Emergency water storage and supply systems
- Ensuring safe access for vulnerable populations including elderly and persons with disabilities
- Installing emergency lighting, communications equipment, first aid facilities
- Structural assessment and engineering design
- Construction management and quality assurance

The relatively high cost per square meter reflects the complexity of retrofitting existing structures (typically more expensive than new construction due to working around existing systems), the demanding performance requirements for hurricane resistance, and the comprehensive nature of life safety improvements.

The analysis assumes a two-year construction timeline with costs split 50/50 between Year 1 and Year 2, reflecting realistic implementation schedules for major structural retrofitting that cannot be completed within a single construction season. Benefits begin accruing in Year 3 once the facility is operational as a certified hurricane shelter.

No ongoing operating costs are included as the retrofitted buildings continue to serve their primary functions (health centre, school, etc.) with hurricane shelter capacity as a secondary function activated only during storm events. Incremental operating costs for emergency supplies and shelter operations during activations are assumed minimal and covered through existing disaster response budgets.

The assumptions for the beneficiary population and coverage are as follows:

Table 31 Assumptions B3 – beneficiary population and coverage

Parameter	Source / assumption	Unit	Value
Population of Saint Lucia (2024)	https://data.worldbank.org/indicator/SP.POP.TOTL?locations=LC	Nr	179,744
Number of hospitals and health centres in Saint Lucia	https://stats.gov.lc/subjects/society/health/number-of-hospitals-and-institutions-by-bed-capacity-1982-to-2020/	Nr	40
Number of beneficiaries per investment	Assumption based on average population served per hospital / health centre	Nr	4,493.60
Value of Statistical Life (VSL) - World Bank Upper middle income group	Assumption based on: https://gh.bmj.com/content/bmjgh/5/1/e001535/DC1/embed/inline-supplementary-material-1.pdf?download=true	USD	\$ 1,223,582.00
Number of deaths from hurricanes during 2000-2024 in Saint Lucia	EM-DAT, CRED / UCLouvain, Brussels, Belgium – www.emdat.be	Nr	16
Number of people affected by hurricanes 2000-2024 in Saint Lucia	EM-DAT, CRED / UCLouvain, Brussels, Belgium – www.emdat.be	Nr	179,744
Annual health expenditure per capita in Saint Lucia (2022)	https://data.worldbank.org/indicator/SH.XPD.CHEX.PC.CD?locations=LC	USD/year	\$ 644.80
Probability of death due to hurricanes	Calculated	%	3.71E-06
Probability of being affected by hurricanes	Calculated	%	100%
Probability of sustaining injury/illness due to hurricanes	Conservative assumption based on https://pmc.ncbi.nlm.nih.gov/articles/PMC7967478/	%	10%
Number of deaths avoided per investment	Calculated	People/year	0.02
Number of injuries avoided per investment	Calculated	People/year	449
VSL costs avoided per investment	Calculated	USD/year	\$ 2,995.73
Health costs avoided per investment	Calculated	USD/year	\$ 144,873.66
Total benefits per investment	Calculated	USD/year	\$ 147,869.40

Saint Lucia has approximately 40 hospitals and health centres distributed across the island. A representative building upgraded to hurricane shelter standards serves approximately 4,494 people, calculated as the average population served per health facility (179,744 total population divided by 40 facilities). While not all 4,494 people would necessarily shelter during every event, this represents the at-risk population served by the facility who would have access to safe shelter when needed.

Historical disaster data from EM-DAT (Emergency Events Database) provides the empirical foundation for quantifying hurricane risks in Saint Lucia. During 2000-2024, hurricanes caused 16 deaths and affected the entire population of 179,744 (noting that "affected" includes any impact from minor damage to major losses, not necessarily requiring evacuation).

These data yield the following risk parameters:

- Probability of death due to hurricanes: 3.71×10^{-6} per person per year (approximately 4 deaths per million people annually)
- Probability of being affected by hurricanes: 100% (the entire population experiences some impact from hurricanes during a 24-year period)
- Probability of sustaining injury or illness from hurricanes: 10% (conservative assumption based on disaster epidemiology studies showing injury rates typically 10-30 times higher than fatality rates)

The 10% injury probability is conservative, reflecting that most hurricane-related injuries are minor (cuts, sprains, stress-related conditions) rather than severe trauma. However, the aggregate health burden from hundreds of injuries during major events creates substantial healthcare costs and suffering.

The economic value of hurricane-proof shelters derives from three sources:

- 1) For the 4,494 people served by one upgraded facility, the annual expected fatalities avoided amount to 0.017 deaths per year ($4,494 \times 3.71 \times 10^{-6}$). While fractional, this represents the statistical expectation across all potential hurricane scenarios and probabilities.

Using the Value of Statistical Life (VSL) methodology, each avoided fatality is valued at USD 1,223,582 based on World Bank estimates for upper middle-income countries. This VSL reflects society's willingness to invest in risk reduction and is standard practice in cost-benefit analysis of life safety interventions. The annual value of avoided mortality amounts to USD 2,996 per facility.

- 2) With 10% of the beneficiary population (449 people) expected to sustain injuries or illness during hurricane events annually, and applying Saint Lucia's health expenditure of USD 645 per capita, the annual healthcare costs avoided amount to USD 144,874 per facility.

This calculation likely understates total injury costs as it captures only direct healthcare expenditures, not productivity losses, caregiver burden, or reduced quality of life. The USD 645 per capita figure represents average annual health spending, providing a conservative proxy for per-injury costs (which in reality would be higher for acute hurricane-related trauma).

- 3) Combining avoided mortality and injury costs yields total benefits of USD 147,869 per facility per year. Over a 25-year infrastructure lifetime, cumulative benefits exceed USD 3.4 million per facility.

It should be emphasised that these quantified benefits capture only a portion of total shelter value. Additional benefits not monetised in the analysis could include:

- Reduced psychological trauma from having secure shelter rather than sheltering in fear
- Avoided property losses when people can evacuate homes knowing they have safe refuge
- Community cohesion and social capital from collective emergency preparedness
- Resilience demonstration effects encouraging broader risk reduction investments
- Economic continuity through faster post-disaster recovery when casualties are minimized
- Improved disaster response effectiveness when safe facilities enable emergency operations
- Reduced humanitarian emergency costs through proactive shelter provision
- Enhanced community confidence and reduced climate-driven outmigration

These co-benefits, while difficult to quantify, substantially increase the total social value of hurricane shelter investments beyond the conservative mortality and injury cost estimates.

3.6.1.1 Economic values

Parameter	Source / assumption	Value
Saint Lucia tariff rate, applied, weighted mean, all products (%) (2022)	https://data.worldbank.org/indicator/TM.TAX.MRCH.WM.AR.ZS	9.10%
Standard conversion factor (SCF), market to economic prices	$SCF = 1 / (1 + t)$, where t is duties as a proportion of the traded base, i.e. the average tariff distortion between domestic and border prices. This is proxied by the applied, weighted-mean tariff across all products.	0.917
Shadow wage rate factor (SWRF)	An SWRF of 0.85 is assumed for labourers / construction workers plus other skilled roles like HVAC specialists	0.85
Assumed labour share of CAPEX	Assumption	40%
Combined SCF and SWRF factor	$(1 - \text{labour share}) * SCF + \text{labour share} * SWRF$	0.890

The economic analysis converts the financial (market) prices used in the financial analysis into economic values reflecting the opportunity cost of resources to the economy. Transfer payments (taxes, duties and subsidies) are removed, internationally traded items are valued at their border-price equivalents, and residual non-traded inputs are adjusted using a Standard Conversion Factor (SCF). The SCF is derived from the applied, weighted-mean tariff across all products reported by the World Bank (World Integrated Trade Solution), which proxies the average distortion between domestic and border prices; the resulting parameters are set out in the table above.

A Shadow Wage Rate Factor (SWRF) is applied to the labour element of costs to reflect that labour drawn from unskilled labour (but combined with some technically skilled persons in the retrofit), has an opportunity cost below the market wage; this is combined with the SCF, in proportion to the labour share of costs, to give the blended cost conversion factor shown. Benefit streams already expressed in economic terms (e.g., avoided food imports valued at import-parity prices, the social cost of avoided emissions, and avoided-damage values) are not further adjusted.

3.6.1.2 Counterfactual

The counterfactual scenario for the economic analysis assumes continuation of current hurricane shelter capacity without systematic building upgrades. Under this scenario, vulnerable populations would continue to shelter in non-engineered structures, private homes of variable construction quality, or inadequate public facilities not designed for hurricane resistance. The counterfactual implies:

- Continued reliance on aging community buildings with structural deficiencies and inadequate hurricane resistance
- Persistent shelter capacity gaps forcing populations into unsafe structures during major storms
- Ongoing hurricane casualties from structural failures, flying debris, and inadequate protection
- Healthcare system strain from preventable hurricane injuries
- Post-disaster humanitarian emergencies requiring external assistance
- Slower community recovery as casualties and trauma undermine social and economic functioning
- Erosion of community confidence and potential climate-driven outmigration
- Missed opportunities to leverage existing public infrastructure for dual-purpose disaster resilience

Historical evidence supports this counterfactual, notably during Hurricane Tomas (2010), where Saint Lucia experienced 14 deaths and widespread destruction with thousands sheltering in inadequate facilities.

The benefits quantified in the economic analysis reflect the incremental casualties and injuries avoided through systematic provision of hurricane-resistant shelter capacity, compared to continuation of current inadequate arrangements.

3.6.2 Results

The economic analysis demonstrates that hurricane-proofing community buildings for shelter generates positive returns from a societal perspective. Despite substantial upfront investment costs and modest annual benefits (reflecting the low probability of hurricane casualties in any single year), the long infrastructure lifetime and high value of avoided casualties create favourable economic returns.

For a representative 500 square meter community building upgraded to hurricane shelter standards, the economic costs and benefits over a 15-year infrastructure lifetime are as follows:

Total economic costs amount to USD 427,178 split across two years (USD 213,589 in Year 1 and USD 213,589 in Year 2) for comprehensive structural retrofitting. No ongoing operating costs are assumed as the building continues its primary function with shelter capacity as a secondary role.

Total economic benefits comprise avoided hurricane casualties and healthcare costs. Benefits begin in Year 3 following construction completion and amount to USD 147,869 annually throughout the 15-year infrastructure lifetime. The consistent annual benefit stream reflects the persistent protective value provided by hurricane-resistant infrastructure.

The cumulative net benefits over 15 years total **USD 1,495,124.16** representing the aggregate value of avoided mortality and injuries over the infrastructure's operational lifetime.

The key economic performance indicators are:

ENPV (15 years)	\$	396,235.29
EIRR (15 years)		29%

The positive ENPV demonstrates that hurricane shelter investments generate net economic value to society. The 29% EIRR substantially exceeds the 12% social discount rate, indicating the intervention is economically efficient.

As mentioned in the previous section, injury costs are proxied by healthcare expenditure, ignoring productivity losses, quality of life impacts, and psychological trauma. And numerous co-benefits (community cohesion, reduced outmigration, demonstration effects) remain unquantified. The quantified returns should thus be understood as a conservative lower bound on the full social value of hurricane shelter provision.

3.6.3 Sensitivity analysis

A sensitivity analysis was performed to evaluate the robustness of economic returns under varying assumptions. The analysis examines three dimensions of uncertainty: 1) investment costs, 2) benefit levels, and 3) the social discount rate.

- 1) The analysis tests scenarios where construction costs vary from 60% to 140% of baseline estimates. This range captures potential cost variations from procurement efficiencies, site-specific conditions, unforeseen structural challenges, or design changes. The ENPV remains positive across all cost scenarios, though with meaningful sensitivity given that construction costs represent a significant share of net present benefits. At 60% of baseline costs the ENPV reaches USD 540,626, and at 80% it is USD 468,431. Even with costs 40% higher than anticipated, for example, from unforeseen structural deficiencies requiring additional reinforcement, the ENPV remains positive at USD 251,845.
- 2) The analysis examines scenarios where casualty reduction benefits vary from 60% to 140% of baseline estimates. This range captures uncertainties in hurricane risk quantification, shelter utilisation rates, and VSL valuation. The intervention maintains positive economic returns across all benefit scenarios. Even if actual casualty reduction proves to be only 60% of baseline estimates, perhaps because shelter utilisation is lower than assumed, hurricane risk was overestimated, or VSL valuation is conservative, the ENPV remains positive at USD 93,351. The positive returns even in this pessimistic scenario provide confidence that hurricane shelter investments generate economic value despite measurement challenges. At the

upper end, if benefits reach 140% of baseline, from higher hurricane risk or better shelter utilisation, the ENPV approaches USD 699,120.

- 3) The analysis tests social discount rates ranging from 5% to 20%, reflecting debates about appropriate rates for long-lived infrastructure investments and variations in macroeconomic conditions. The ENPV remains positive across the full range of discount rates tested, though with substantial sensitivity reflecting the long-term nature of infrastructure benefits. At the 5% rate often advocated for public infrastructure with intergenerational benefits, the ENPV reaches USD 862,734, more than double the baseline case. Even at the extreme 20% discount rate, which heavily discounts future benefits and makes most long-term infrastructure economically unattractive, the hurricane shelter investment maintains a positive ENPV of USD 139,131. This demonstrates that life safety benefits, which begin accruing once the facility is operational and persist throughout its 15-year lifetime, generate sufficient near-term value to justify investment even under restrictive discounting assumptions.

The substantial discount rate sensitivity (ENPV ranging from USD 139,131 to USD 862,734) reflects the 15-year benefit stream. For hurricane shelter investments, the consistently positive returns across this wide range provide confidence that the intervention is economically sound regardless of specific discount rate philosophy. The positive NPV at 20% suggests that even conservative time preferences support hurricane-proofing investments.

Overall, the sensitivity analysis confirms that hurricane-proofing community buildings for shelter generates positive economic returns under most plausible scenarios. While the margins are tighter than other interventions (reflecting the fundamental economics of life safety infrastructure), the consistently positive returns across diverse assumptions provide confidence that these investments represent sound use of public resources.

Table 32 Economic sensitivity analysis dashboard – B3

Investment cost	ENPV	Benefits	ENPV	Discount rate	ENPV
60%	\$ 540,625.82	60%	\$ 93,350.65	5%	\$ 862,734.26
80%	\$ 468,430.55	80%	\$ 244,792.97	10%	\$ 497,381.90
100%	\$ 396,235.29	100%	\$ 396,235.29	12%	\$ 396,235.29
120%	\$ 324,040.03	120%	\$ 547,677.61	15%	\$ 277,020.96
140%	\$ 251,844.77	140%	\$ 699,119.93	20%	\$ 139,131.21

3.7 Portfolio-level analysis

The CABRIC EDA facility has a total budget of USD 25 million allocated across six intervention types over a 6-year implementation period. The portfolio is structured around three grant sizes: small grants (up to USD 150,000), medium grants (up to USD 300,000), and large grants (up to USD 500,000). The facility will conduct six competitive calls for proposals over 3.5 years, with the final disbursements occurring in Year 3.5 (month 42) of the programme.

As detailed in Section 1.3, the hypothetical scenario in this ex-ante modelling exercise assumes 118 sub-projects will be approved, reaching a total of 1,054 individual investments, with the following portfolio composition:

Table 33 Modelled portfolio split

Hypothetical portfolio split	Cost per investment sub-theme	Nr of sub-projects
A1 - CRA package	\$ 8,550,000.00	50
A2 - Cold storage	\$ 3,600,000.00	10
A3 - Community MPAs	\$ 1,500,000.00	3

Hypothetical portfolio split	Cost per investment sub-theme	Nr of sub-projects
B1 - EWS	\$ 1,000,000.00	2
B2 - Mental health	\$ 8,850,000.00	50
B3 - Hurricane-proof shelters	\$ 1,500,000.00	3
Total	\$ 25,000,000.00	118

The assumed portfolio is weighted toward two primary intervention types: climate-resilient agriculture packages (A1) and mental health support (B2), which together account for USD 17.4 million (70%) of the EDA facility budget. This weighting reflects both the prevalence of smallholder farming across the five countries and the scalability of both CRA and mental health interventions through small and medium grant mechanisms. Cold storage infrastructure for artisanal fishermen represents a smaller allocation compared to prior modelling, primarily delivered through medium and large grants. Community MPAs, early warning systems, and hurricane-proof shelters each receive a smaller share of the facility budget, delivered through large grants appropriate to their implementation costs.

In addition to the USD 25 million EDA facility budget, the programme includes **USD 19,426,681.00** for other activities and PMU and M&E costs. These costs are distributed over the 6-year implementation period, bringing the **total programme cost to USD 44,426,681.**

3.7.1 Results

The portfolio-level economic analysis aggregates the costs and benefits of the six intervention types based on the allocation scenario presented above. The analysis applies unit costs and benefits calculated in the individual intervention models (Sections 3.1-3.6), scaling them proportionally according to the number of sub-projects modelled for each intervention type.

The economic analysis was conducted over a 15-year time horizon using the same 12% social discount rate, consistent with the standard range applied for developing countries in climate finance projects. The results demonstrate strong economic performance across multiple metrics.

Table 34 Portfolio-level economic indicators

Indicator	6-year	10-year	20-year
Net costs / benefits	\$ (17,100,981.45)	\$ 33,804,241.57	\$ 142,621,527.89
EIRR			23%
ENPV			\$ 23,280,063.41
Net costs / benefits per year			\$ 7,131,076.39

The portfolio generates substantial economic benefits that exceed programme costs. Total benefits reach USD 187.0 million over the 20-year evaluation period against total programme costs of USD 44.4 million, yielding an undiscounted benefit-cost ratio of approximately 4.2:1. The ENPV of USD 23.3 million confirms positive returns when future benefits are discounted at 12%, and the EIRR of 23% substantially exceeds the 12% social discount rate, confirming economic efficiency.

The temporal distribution of benefits shows progressive growth over time, against costs that are concentrated in the first six years of deployment. During this implementation period the portfolio runs a cumulative net deficit of approximately USD 17.0 million, as grant disbursement precedes the maturation of benefits; cumulative net returns turn positive in Year 8. Cumulative benefits reach USD 27.3 million by Year 6, USD 78.2 million by Year 10, USD 134.8 million by Year 15, and USD 187.0 million by Year 20. This progressive increase reflects the ramp-up profiles embedded in the individual intervention models, particularly community-managed MPAs and early warning systems, which take several years to reach full effectiveness, and climate-resilient agriculture packages, whose benefits compound over time as farmers adopt new practices.

The average annual net benefits of approximately USD 7.1 million demonstrate the portfolio's capacity to deliver substantial economic value year-on-year once interventions are fully operational.

Portfolio benefits are distributed across intervention types as follows (20-year undiscounted totals):

- **Climate-resilient agriculture packages (A1)** generate USD 90.4 million (48% of total benefits), representing sustained productivity and resilience gains across a large number of smallholder farming households.
- **Community-managed MPAs (A3)** contribute USD 63.6 million (34% of total benefits), driven by enhanced fisheries productivity and ecosystem-service values that compound over the long term.
- **Mental health support (B2)** contributes USD 12.9 million (7% of total benefits).
- **Community-based early warning systems (B1)** generate USD 8.6 million (5% of total benefits).
- **Hurricane-proof shelters (B3)** and **cold storage (A2)** contribute USD 6.2 million (3%) and USD 5.2 million (3%) respectively, addressing critical adaptation needs across multiple dimensions.

It is worth noting again that **the economic results presented here are based on an ex-ante modelling scenario designed to illustrate the potential returns of the EDA facility under a very specific allocation of grants.** The actual composition of the portfolio will depend on the competitive selection process and the proposals received through the six calls for proposals. Different combinations of interventions, implementation contexts, and scale of operations will produce different economic outcomes.

3.7.2 Sensitivity analysis

As with all the individual interventions, the economic viability of the portfolio was tested through sensitivity analysis examining variations in investment costs, benefits realization, and discount rates. The results demonstrate that the portfolio maintains strong positive economic returns across all scenarios tested.

The portfolio remains economically viable under pessimistic benefit scenarios, though the margin narrows considerably at the lower bound. If only 60% of projected benefits materialise, the ENPV remains positive at USD 1.1 million; at 80% of projected benefits, the ENPV is USD 12.2 million. At the upper end, benefit realisation of 120% and 140% raises the ENPV to USD 34.4 million and USD 45.5 million respectively.

Investment cost variations have a more contained impact. Even if costs exceed baseline by 40%, the ENPV remains solidly positive at USD 10.4 million; if costs come in 40% below baseline, the ENPV improves to USD 36.2 million.

The discount-rate analysis confirms positive returns across the full range of social discount rates typically applied in developing-country contexts. At a 5% rate, the ENPV reaches USD 68.5 million; at 10% it is USD 32.3 million; and even at 20%, which heavily discounts future benefits, it remains positive at USD 3.4 million. The consistently positive returns across these extremes confirm the portfolio's robustness to uncertainty in discount-rate selection.

Table 35 Economic sensitivity analysis dashboard – whole programme

Investment cost		ENPV	Benefits		ENPV	Discount rate		ENPV
60%	\$	36,182,002.44	60%	\$	1,066,099.03	5%	\$	68,493,989.07
80%	\$	29,731,032.92	80%	\$	12,173,081.22	10%	\$	32,231,167.75
100%	\$	23,280,063.41	100%	\$	23,280,063.41	12%	\$	23,280,063.41
120%	\$	16,829,093.90	120%	\$	34,387,045.61	15%	\$	13,471,958.66
140%	\$	10,378,124.39	140%	\$	45,494,027.80	20%	\$	3,337,878.13

4. Summary and conclusion

This Economic and Financial Analysis has assessed the viability of the CABRIC EDA facility, a USD 25 million grant-making mechanism designed to support community-based climate adaptation across five Caribbean countries: The Bahamas, Belize, Grenada, Jamaica, and Saint Lucia.

Under the specific modelled scenario, the facility is assumed to deliver 118 sub-projects over a 6-year implementation period through competitive calls for proposals, offering small grants (up to USD 150,000), medium grants (up to USD 300,000), and large grants (up to USD 500,000), reaching a total of 1,054 individual investments across the five target countries.

The EFA models six distinct intervention types that represent the anticipated portfolio composition based on identified adaptation priorities and implementation contexts across the target countries. Each intervention demonstrates positive economic returns over a 10-, 15- and 20-year analysis period, with varying levels of performance reflecting differences in scale, implementation costs, and benefit streams.

- **Climate-resilient agriculture packages (A1)** generate USD 90.4 million (48% of total benefits), representing sustained productivity and resilience gains across a large number of smallholder farming households.
- **Community-managed MPAs (A3)** contribute USD 63.6 million (34% of total benefits), driven by enhanced fisheries productivity and ecosystem-service values that compound over the long term.
- **Mental health support (B2)** contributes USD 12.9 million (7% of total benefits).
- **Community-based early warning systems (B1)** generate USD 8.6 million (5% of total benefits).
- **Hurricane-proof shelters (B3)** and **cold storage (A2)** contribute USD 6.2 million (3%) and USD 5.2 million (3%) respectively, addressing critical adaptation needs across multiple dimensions.

The financial analysis across each intervention confirms the central role of financing modality in determining viability for beneficiaries. For both agricultural and fisheries interventions, the analysis shows that commercial loan financing, while generating positive absolute returns, produces negative or near-zero incremental net present value relative to the business-as-usual baseline, meaning that at prevailing Caribbean market rates, debt service obligations erode or eliminate the benefits of adaptation investment for smallholders and fishing cooperatives. Concessional lending substantially narrows this gap, while grant-based financing is the only modality that clearly and consistently delivers positive incremental returns to beneficiaries across all scenarios. This gradient provides a direct and quantified justification for the CABRIC EDA facility's grant-making design.

At the portfolio level, the combined economic analysis, conducted over a 20-year horizon at a 12% social discount rate, produces the following headline results: a 20-year **ENPV of USD 23.3 million**, an **EIRR of 23%**, and an undiscounted benefit-cost ratio of approximately **4.2:1**. Total 20-year benefits of USD 142.69 million are generated against a total programme cost of USD 44.3 million.

The sensitivity analyses conducted across all six intervention models, and at the aggregate portfolio level, confirm that positive economic returns are maintained under a wide range of adverse assumptions. The portfolio ENPV remains positive even if only 60% of projected benefits materialise, and at USD 3.3 million even at a 20% social discount rate. This robustness across both benefit and discount rate stress tests provides confidence that the facility's economic case is not contingent on optimistic assumptions.

With an ENPV of USD 23.3 million, an EIRR of 23% against a 12% hurdle rate, and consistently positive returns across sensitivity scenarios, the CABRIC EDA facility demonstrates sound economic viability. The programme provides a strong foundation for building climate resilience across The Bahamas, Belize, Grenada, Jamaica, and Saint Lucia, while establishing a replicable model for community-based adaptation financing in SIDS contexts globally. Its grant-making modality, competitive selection process, and diversified portfolio of evidence-based interventions collectively ensure that public climate finance is deployed efficiently, equitably, and in direct response to the adaptation priorities of some of the world's most climate-vulnerable communities.

The economic analysis demonstrates that climate adaptation in high-vulnerability contexts generates substantial returns, particularly when interventions address both chronic climate stresses and acute disaster risks. The facility's diversified portfolio balances transformative, high-return investments with scalable, broad-based interventions, creating a resilient programme structure capable of delivering adaptation benefits across multiple dimensions of vulnerability.