# INTERVENTIONS TO INCREASE CLIMATE RESILIENT INVESTMENTS IN BARBADOS, JAMAICA AND TRINIDAD AND TOBAGO

## Identification of Hazards and Resilience Measures

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# Preface



This publication is a shortened version of an extensive study on the identification of hazards and resilience measures in Barbados, Jamaica and Trinidad and Tobago.

The extended study provides more comprehensive information on the methods employed to collect data, analysis and conclusions of the findings on SME and residential landscapes, identification and prioritization of climate hazards, resilience measures, investments and opportunities and market demand for climate resilience measures in Barbados, Jamaica and Trinidad and Tobago for both residential and SME sectors.

The report may be accessed at the following link: Identification of Hazards and Resilience Measures: Interventions to increase climate resilient investments in Barbados, Jamaica and Trinidad and Tobago

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## Acknowledgement

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**About IDB Invest**

IDB Invest, a member of the IDB Group, is a multilateral development bank committed to promoting the economic development of its member countries in Latin America and the Caribbean through the private sector. IDB Invest finances sustainable companies and projects to achieve financial results and maximize economic, social, and environmental development in the region. With a portfolio of $13.1 billion in asset management and 385 clients in 23 countries, IDB Invest provides innovative financial solutions and advisory services that meet the needs of it's clients in a variety of industries.

**About CEAC**

CEAC Solutions Limited, based in Kingston, Jamaica, is a regional leader in consulting, design, and operations, with a strong reputation for excellence. With expertise in several disciplines, the firm has successfully undertaken civil, environmental, and coastal studies to protect and enhance the hotel, transportation and energy sectors. Its involvement in development initiatives has led to innovations and improvements in housing, subdivisions, and commercial buildings. CEAC has also played a vital role in regional and global climate change adaptation and mitigation strategies, conducting assessments for facilities, housing, energy, and transportation projects in the face of extreme weather impacts. Working closely with Clients, the firm's engineers and climate scientists determine appropriate climate models and downscaling methods to ensure effective solutions.

# Introduction



Caribbean Islands are particularly vulnerable to climate-related risks due to their size and location. Droughts, hurricanes, floods, warmer temperatures, and sea level rise are some of the intensifying dangers that threaten the environment and economic sectors of the region. Therefore, climate adaptation in the form of climate-resilient infrastructure is crucial to endure the effects of climate change.

This document presents the business case outlook for the adoption of climate resiliency measures into designing and constructing residential and commercial structures and building capacity among construction companies in Barbados, Jamaica and Trinidad and Tobago. IDB Invest intends to expand the range of climate adaptive services currently provided by regional SMEs to reduce market inefficiencies.

The main objective is to develop a guide that identifies practicable measures for new and existing residential, commercial, and industrial building construction in Barbados, Jamaica, and Trinidad & Tobago. Added costs associated to the implementation of resiliency measures to typical residential and commercial buildings and the return on investment of such measures were also quantified to justify their incorporation in building design. This will also help educate the public, investors, building experts, and the insurance sector on the major drivers and benefits of taking climate-adaptive and resilient action.

An overview of the residential and SME landscapes, identification of the top four climate risks and corresponding resiliency measures with costs and returns on investment, and a market outlook for Barbados, Jamaica and Trinidad and Tobago are provided.

This was informed by the following activities in the three countries analyzed.

### Residential and SME Landscape

1. Research on the size of residential and SME sectors, broken down by demand and industry for each country.

### Climate Hazards

1. Identification of climate hazards for the built environment in Barbados, Jamaica and Trinidad and Tobago
2. Prioritisation of the top four climate hazards posing the most significant threats to the built environment, based on historical events, frequency/severity assessment and climate models.

### Resiliency Measures, Costs and Returns on Investment

1. Determination of the best resiliency measures and practices in construction based on international best practices and state-of-the-art measures for increasing the adaptability and resilience of commercial and residential buildings.
2. Estimation of cost premiums of these measures over traditional design and construction practices
3. Analysis of existing building codes to assess their compatibility with the proposed best resiliency practices.
4. Estimating return on investment for each benchmarked building resilience measure and the impact of adoption on operational costs.

### Market Outlook

1. Market demand study to assess the market size for climate-resilient properties in each island's residential and commercial sectors, as well as the readiness of people and companies to pay a premium for resilience measures.
2. Surveys to determine insurance products that account for climate-related events and the impact of resiliency measures on insurance premiums.



# Climate Risks



### Present and Projected Climatic conditions

This section examines the identification and prioritisation of climate hazards in the Caribbean.

**Rainfall:** Analysis of long-term climate data show drying trends in June and July across the three countries but show increasing trends in one-day (RX1) and five-day (RX5) extreme rainfall indices. Projections suggest a continuing of this trend of less annual precipitation but more extreme rainfall events likely leading to more severe floods.

**Drought:** Precipitation is projected to be reduced 6% to 12%. The projections suggest the likelihood of more drought events.

**Hurricane Winds:** In a world that is two degrees warmer than pre-industrial times (a 2-degree scenario), there is a 5% projected increase in average peak tropical cyclone wind speeds. Studies also show that the frequency of intense hurricanes will also increase.

**Heat:** Day and night temperature trends suggest an increase in day and nighttime temperatures since 1980 and underline both hotter days and hotter nights, with reduced diurnal range. This increasing trend is seen across all three countries with the changes more pronounced in Jamaica. This can have negative impact on both sectors but particularly residential.

**Sea Level Rise (SLR):** Global sea level rise (GSLR) is estimated at a current rate (2006 to 2015) of 3.6mm/year. This is expected to increase bringing sea levels to 0.28m, 0.29m and 0.36m for Barbados, Jamaica and Trinidad and Tobago respectively.

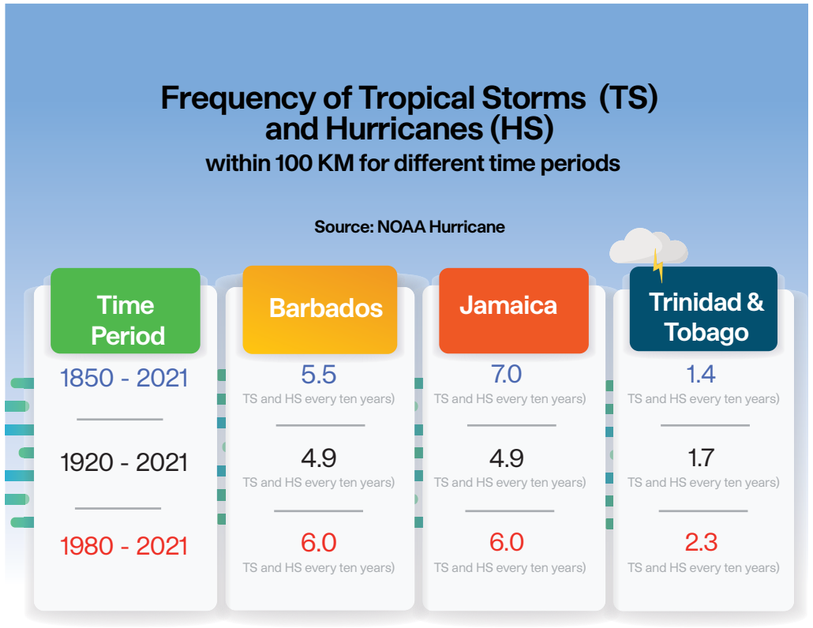
**AIR TEMPERATURE CLIMATOLOGY FOR THE CARIBBEAN SUGGESTS:**

**27°**

**24°**

Median monthly temperatures **range from 24°C during the coolest months (October to April)** and **27°C during the warmest months (May to September)** across all three countries.

Accelerating trend of 0.2°C per decade from 1980 to 2020



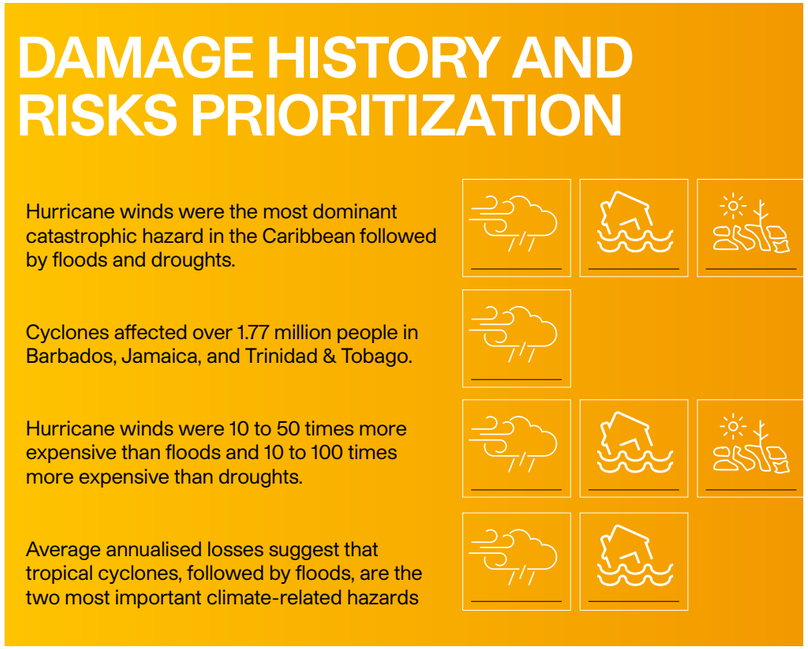

### Hazards: Damage History and Risks

The Caribbean and Pacific regions have been exposed to severe climate hazards causing damage which resulted in financial and economic losses. Data on damage history was sourced from EM-DAT International Disaster Database, ECLAC study, and Energy Transitions Initiative (ETI) Energy Snapshots. Next, catastrophic events between 1955 and 2021 were studied, and two primary data sources were available in EM-DAT and ECLAC reports.

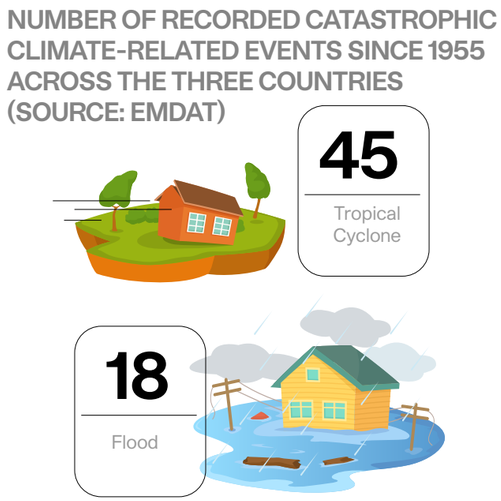
Finally, the five major hazards were explored:

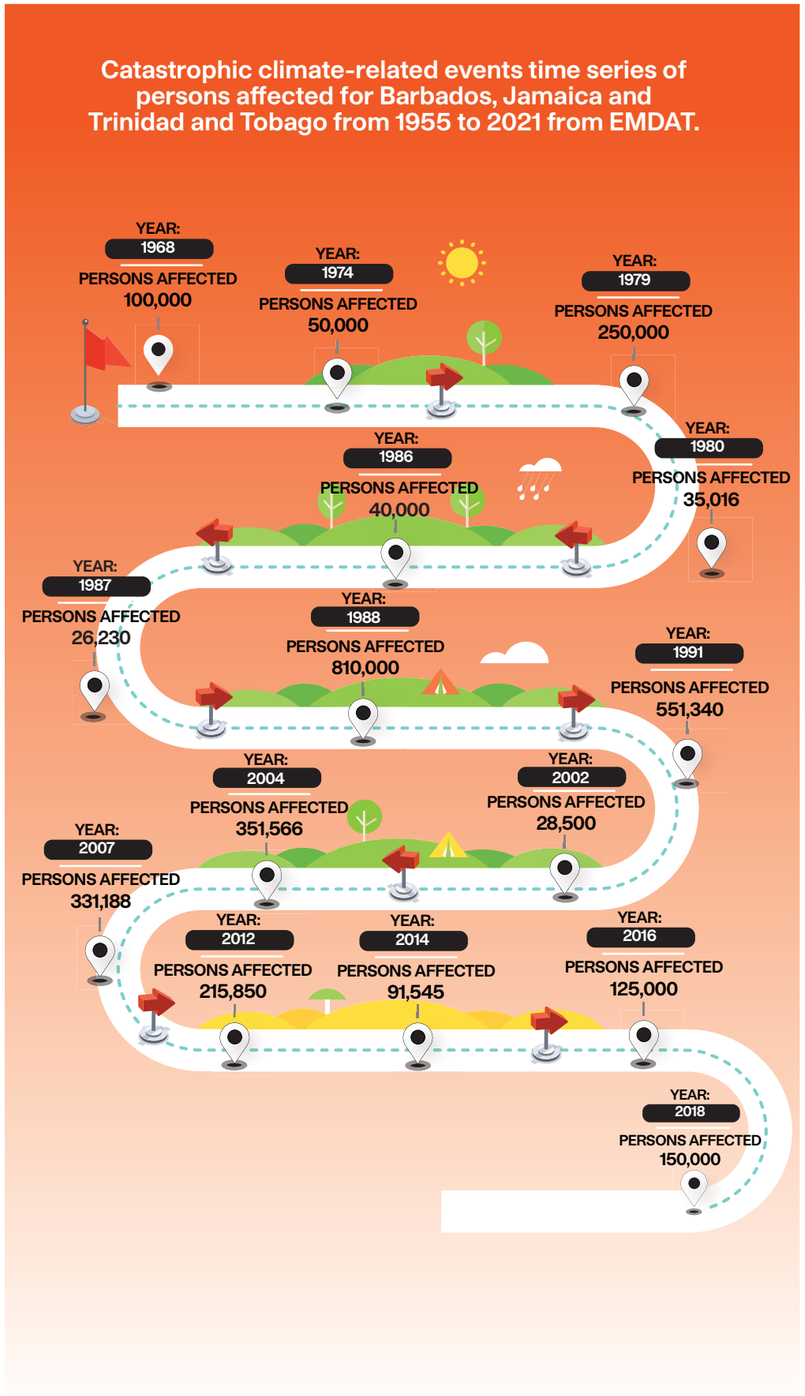




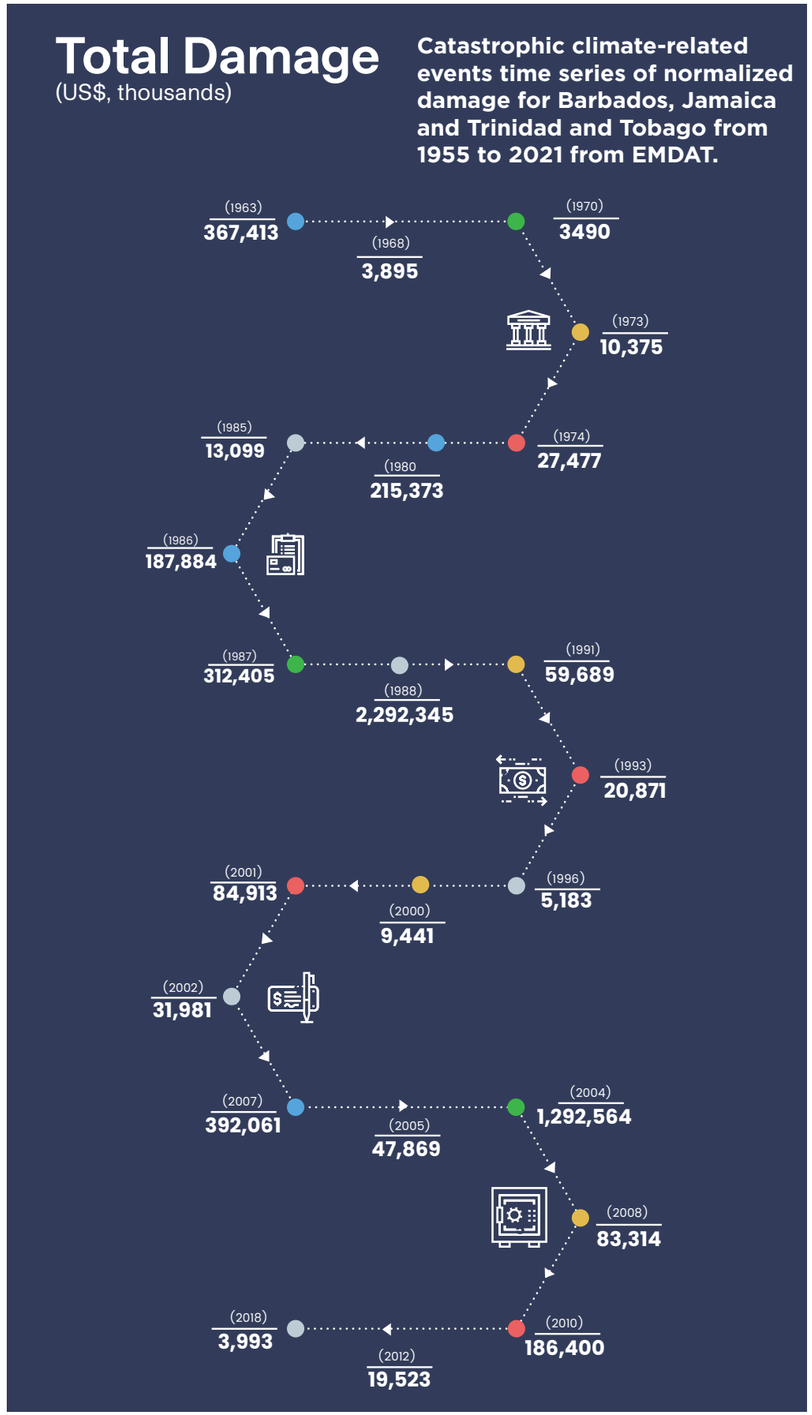

The section concludes that consideration of the impacts of both hurricane winds and floods should be prioritised. Coastal flooding and heatwaves have occurred across the three countries, but the costs are considerably less and events relatively infrequent in comparison to cyclones, floods, and droughts.




Catastrophic climate-related events time series of persons affected for Barbados, Jamaica and Trinidad and Tobago from 1955 to 2021 from EMDAT.
YEAR: 1968
PERSONS AFFECTED 100,000
YEAR: 1974
PERSONS AFFECTED 50,000
YEAR: 1979
PERSONS AFFECTED 250,000
YEAR: 1980
PERSONS AFFECTED 35,016
YEAR: 1986
PERSONS AFFECTED 40,000
YEAR: 1987
PERSONS AFFECTED 26,230
YEAR: 1988
PERSONS AFFECTED 810,000
YEAR: 1991
PERSONS AFFECTED 551,340
YEAR: 2004
PERSONS AFFECTED 351,566
YEAR: 2002
PERSONS AFFECTED 28,500
YEAR: 2007
PERSONS AFFECTED 331,188
YEAR: 2012
PERSONS AFFECTED 215,850
YEAR: 2014
PERSONS AFFECTED 91,545
YEAR: 2016
PERSONS AFFECTED 125,000
YEAR: 2018
PERSONS AFFECTED 150,000





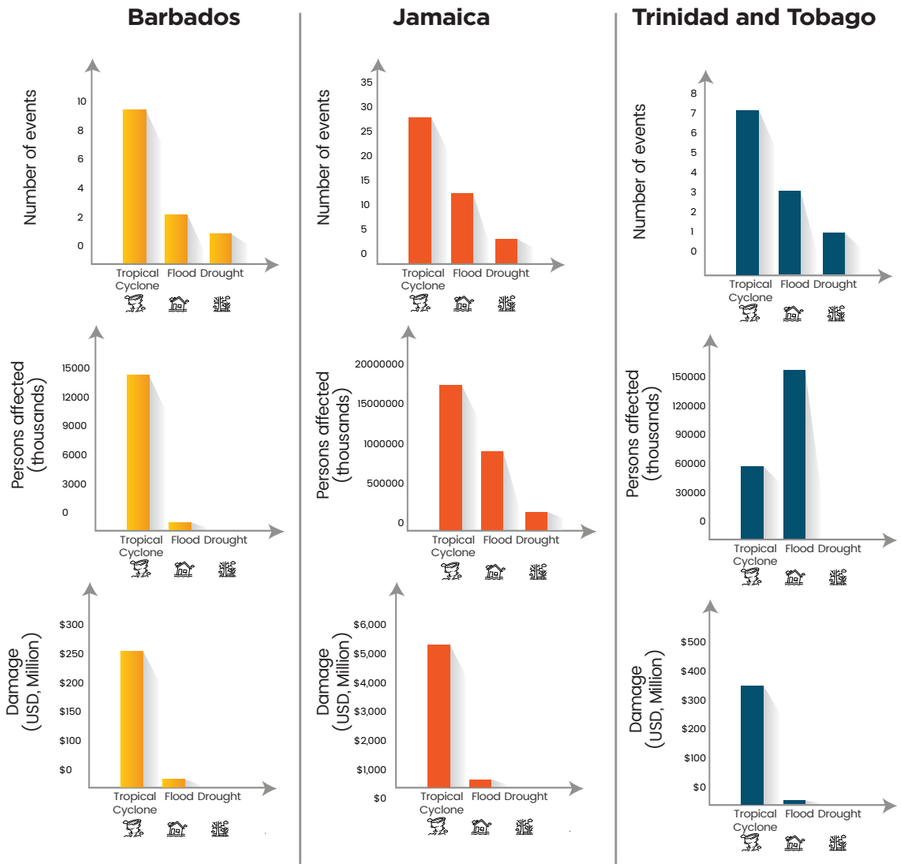

Total Damage
(US$, thousands)
Catastrophic climate-related events time series of normalized damage for Barbados, Jamaica and Trinidad and Tobago from 1955 to 2021 from EMDAT.
(1963) 367,413
(1968) 3,895
(1970) 3490
(1973) 10,375
(1974) 27,477
(1980) 215,373
(1985) 13,099
(1986) 187,884
(1987) 312,405
(1988) 2,292,345
(1991) 59,689
(1993) 20,871
(1996) 5,183
(2000) 9,441
(2001) 84,913
(2002) 31,981
(2004) 1,292,564
(2005) 47,869
(2007) 392,061
(2008) 83,314
(2010) 186,400
(2012) 19,523
(2018) 3,993

## Prioritisations

Climate related risks were identified for residential and SME sector in Barbados, Jamaica, and Trinidad and Tobago. The approach involved reviewing and analysing climate information, damage history, and risk assessments, with prioritisation based on a combination of individuals affected and average annual losses (AAL).

Hazards were prioritized as follows: Hurricane winds, floods, extreme heat, drought.

**The following shows the climate change impacts for Barbados, Jamaica and Trinidad and Tobago based on climate and damage assessments.**




*Source: EM-DAT International Disaster Database*

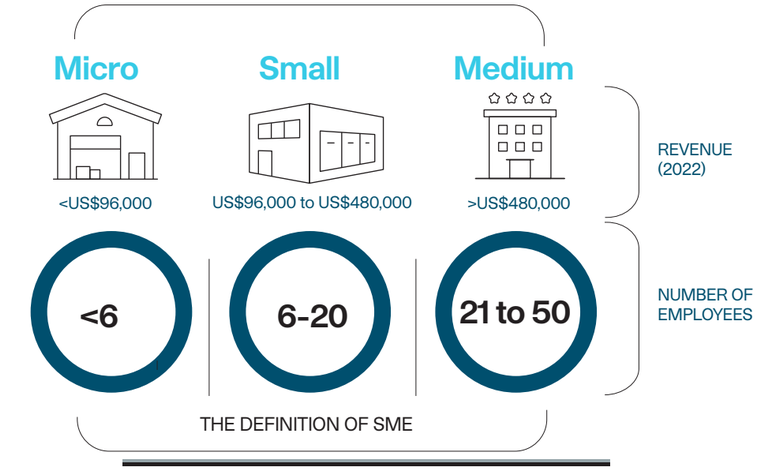


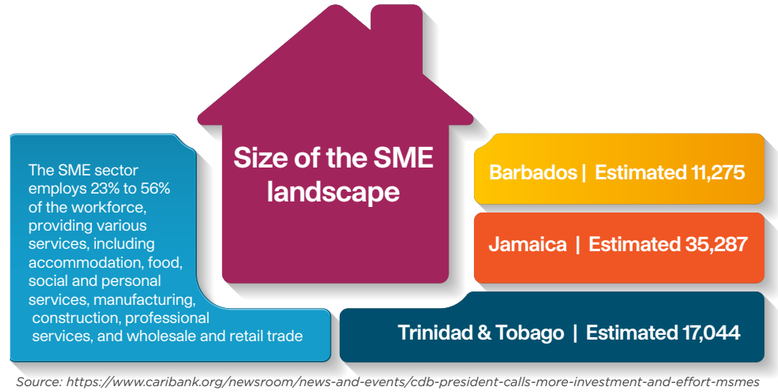
# Small and Medium Enterprise (SME) and Residential Landscapes



## Small and Medium Enterprise (SME) Landscape

The applied definition of what may be considered as an SME varies by country. For the purpose of this project, the definition from The Ministry of Industry Commerce, Agriculture and Fisheries Jamaica, MICAF (2017) revised policy and is outlined below:




*Source: https://www.caribank.org/newsroom/news-and-events/cdb-president-calls-more-investment-and-effort-msmes*

**Data Sources:**

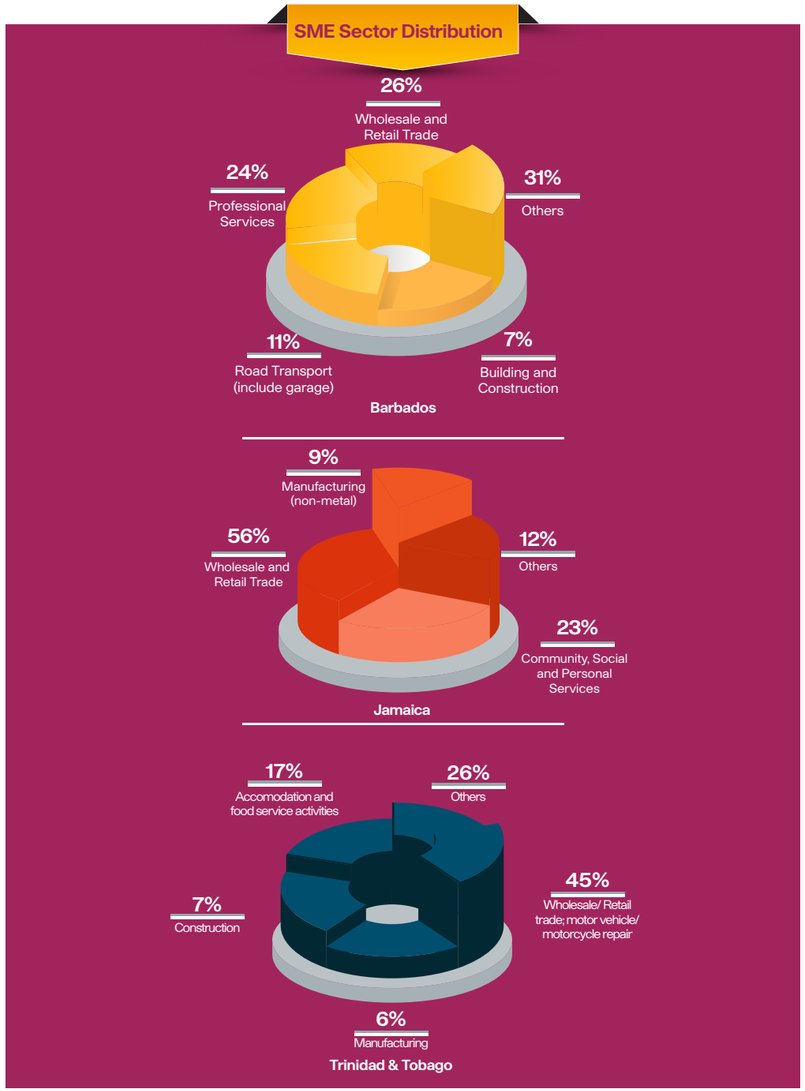
1. Ministry of Industry, Commerce, Agriculture and Fisheries (MICAF). (2017). Micro, Small and Medium Enterprises (MSME) & Entrepreneurship Policy.

2. Subcommittee for the Development of a National Policy Framework for Micro, Small and Medium Sized Enterprises (MSMEs) in Barbados. (2019). A National Policy Framework for Micro, Small and Medium Sized Enterprises (MSMEs) in Barbados. Ministry of Industry, International Business, Commerce and Small Business Development.

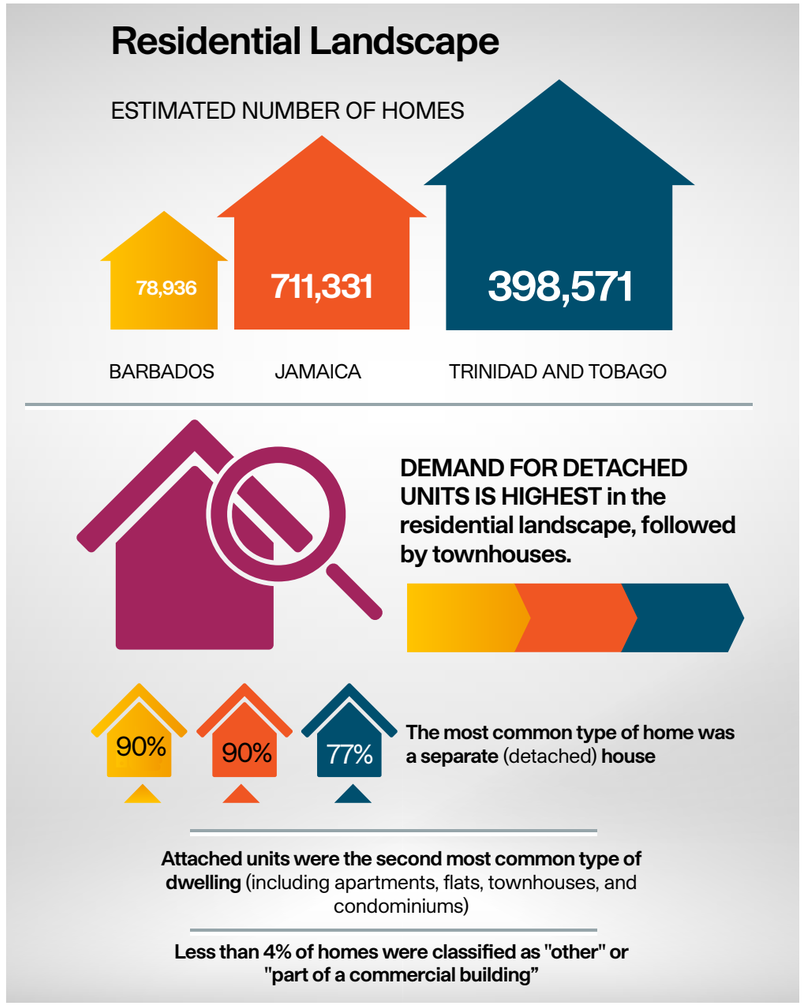
3. Central Statistical Office of Trinidad and Tobago (2018). Number of Business Establishments by Size and Industry. CSO. https://cso.gov.tt/subjects/business-and-industry-2/

A long-term solution to increasing climate adaptation in the region must include support to local SMEs. Investments into SMEs will build resilience of local economies and communities, and enable the region to address the challenges of climate change.

Due to extreme climate-related events, business continuity impact varies across the SME landscape based on years in business and vulnerability. For instance, 25% of SMEs in the USA do not reopen after extreme events. In addition, unregistered SMEs with less control over improvements and implementing resilience measures may be more vulnerable than those with that are established. Previous studies show that SMEs have difficulty fully recovering from disasters, ie their operations and finances may be affected for a long time afterwards.




Small and Medium
Enterprise (SME) and Residential Landscapes




## Residential Landscape

The annual demands for residential buildings in all three countries is greater than the market supply by 500, 15,000 and 10,000 for Barbados, Jamaica and Trinidad and Tobago, respectively.

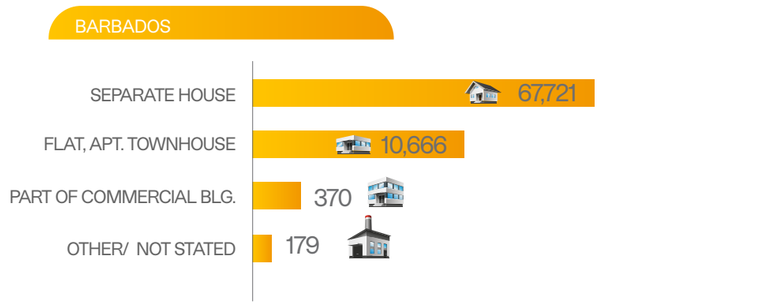
**DATA SOURCES:**

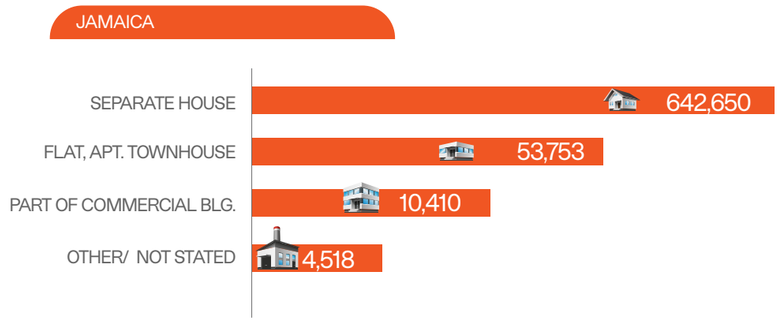
**Barbados**:
Barbados Statistical Service. (2010). Population and Demography Statistics. BSS. https://stats.gov.bb/subjects/social-demographic-statistics/population-demography-statistics/

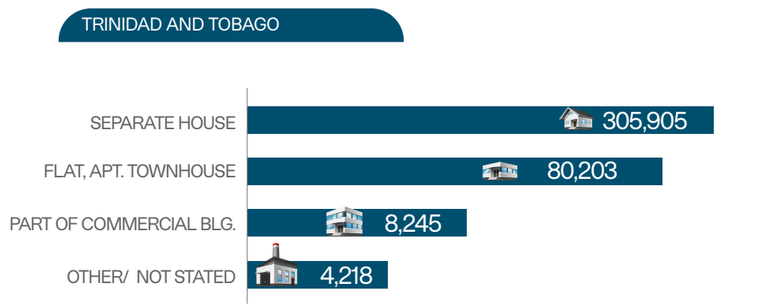
**Jamaica:**
Statistical Institute of Jamaica. (2011). Number of Dwelling Units by Parish: 2001 and 2011. STATIN. https://statinja.gov.jm/Census/PopCensus/Completed/NumberofDwellingUnitsbyParish.aspx

**Trinidad and Tobago:**
Central Statistical Office. (2011). Trinidad and Tobago Households. CSO. https://cso.gov.tt/subjects/population-and-vital-statistics/population/#Household-Stock-and-Intercensal-Growth

# Distribution of Types of Dwelling Units by Country



The methodology to determine international best practices for residential and SME structures included desktop research for the hazards to gather information on recommended international best practices for mitigation measures. A review of past studies on flooding and hurricanes also assisted in identifying mitigation measures that could apply to Trinidad, Jamaica and Barbados. In addition, drought and high temperatures were analysed using energy models.

Architypes were proposed for residential and commercial buildings to enable cost comparison of resilience measures. The Return on Investment (ROI) was used to determine the profitability by dividing the investment's cost-benefit by its initial cost. The ROI was computed from the aggregated current value of the benefits and the cost of the resilience measure, factoring in the prevailing market costs and a climate change factor for incremental climate-related costs.





## ELEVATING OF STRUCTURES

Completed single story unit elevated on sloping site in Trinidad and Tobago

**Elevating a structure to avoid floods can prevent property damage and prevent loss of life. This can be done using columns, piles, foundation perimeter walls or marl pads.**

**BUILDING CODES:**

The Jamaica and Trinidad and Tobago Building Codes guide the elevation of structures.

**HAZARD ADDRESSED: FLOODING**

Best Practice/Recommendation:

- A floodplain assessment informs the decision to use this measure.
- Options include stilts/piles and compacted marl pads depending on the soil types at the site
- Can also be used when building on uneven terrain

**OTHER CONSIDERATIONS:**

- Assessment of floodplain level
- Design of the structure to consider the forces of the water, wind and seismic forces.
- An additional staircase, ramp or elevator may be required to access the structure.
- Increase in cost of construction for an elevated structure.
- Additional cost for services such as plumbing and electrical to the structure

| ARCHITYPE | OPTION | BARBADOS | | JAMAICA | | TRINIDAD | |
|---|---|---|---|---|---|---|---|
| | | Capital Cost ($US) | ROI in 5 years | Capital Cost ($US) | ROI 5 years | Capital Cost ($US) | ROI 5 years |
| Residential | Building on piles | $9,800.00 | 0.3x | $9,800.00 | 1.6x | $9,800.00 | 0.3x |
| | Concrete pads | $4,000.00 | 2.1x | $2,000.00 | 20.1x | $4,000.00 | 2.1x |
| SME Warehouse | Concrete pads | $1,000.00 | 79.5x | $1,000.00 | 159.9x | $1,000.00 | 79.5x |

## FLOOD DOORS

Installation of flood door in New York, USA

Flood doors prevent water ingress from entering homes/buildings during flood events. This measure provides no disruption to day-to-day activities and does not need activation.

**HAZARD ADDRESSED: FLOODING**

Best Practice/Recommendation:

- A floodplain assessment informs the decision to use this measure.
- Useful for entrances of structures to prevent water intrusion.

**OTHER CONSIDERATIONS:**

- Proper installation of flood door to maximise its benefits.
- Increase in cost for installation and maintenance.

| ARCHITYPE | BARBADOS | | JAMAICA | | TRINIDAD | |
|---|---|---|---|---|---|---|
| | Capital Cost ($US) | ROI in 5 years | Capital Cost ($US) | ROI 5 years | Capital Cost ($US) | ROI 5 years |
| Residential | $1,800.00 | 0.1x | $1,800.00 | 1.2x | $1,800.00 | 0.1x |
| SME Warehouse | $7,100.00 | 0.8x | $7,100.00 | 2.6x | $7,100.00 | 0.8x |





## PERMANENT FLOOD BARRIERS


Permanent Flood Barrier installed at an SME in Trinidad and Tobago

Flood barriers prevent floods from infiltrating weak spots such as doors and windows, while also bearing the impact loads caused by flood waters. They can be used in tandem with flood doors or be placed in other areas and can be fixed or demountable.

**BUILDING CODES:**

The Jamaica Building Code recommends the use of flood barriers

**HAZARD ADDRESSED: FLOODING**

Best Practice/Recommendation:

- Assessment of Flood Plain
- Useful for entrances/ driveways of structures to prevent water intrusion.

**OTHER CONSIDERATIONS:**

- Proper installation of permanent flood barriers to maximise its benefits.
- Additional cost forpreparation, installation & maintenance
- Barriers may require activation during flooding activities

| ARCHITYPE | BARBADOS | | JAMAICA | | TRINIDAD | |
|---|---|---|---|---|---|---|
| | Capital Cost ($US) | ROI in 5 years | Capital Cost ($US) | ROI 5 years | Capital Cost ($US) | ROI 5 years |
| Residential | $2,300.00 | -0.1x | $2,300.00 | 1.9x | $2,300.00 | -0.1x |
| SME Warehouse | $8,900.00 | 0.4x | $8,900.00 | 1.9x | $8,900.00 | 0.4x |

## STORM WATER RETENTION & INFILTRATION BASINS

Storm Water Retention Pond, Church Village Green, Bridgetown

**Storm water retention and infiltration basins collect excess water during a rainfall event and recharging groundwater aquifers.**

**BUILDING CODES:**

**The Jamaica Building Code includes requirements for storm water retention.**

**HAZARD ADDRESSED: FLOODING**

**Best Practice/Recommendation:**

- **Requires urban planning expertise**
- **Has to be considered during design stages**
- **Engineering needed for optimal functionality**

**OTHER CONSIDERATIONS:**

- **Requires acquisition of large areas of land**
- **Increase in cost of construction and maintenance.**

| ARCHITYPE | BARBADOS | | JAMAICA | | TRINIDAD | |
|---|---|---|---|---|---|---|
| | Capital Cost ($US) | ROI in 5 years | Capital Cost ($US) | ROI 5 years | Capital Cost ($US) | ROI 5 years |
| SME Warehouse | $11,800.00 | 5.8x | $11,800.00 | 12.6x | $11,800.00 | 5.8x |





## HURRICANE/WIND ROOF ANCHORAGE TO WALL

Roof Clips and Ties on a Timber Roof

**Roof members can be anchored to the wall of a building by galvanized steel straps or threaded rods and plates. This measure is applicable to both residential and SME buildings**

**BUILDING CODES:**

**Barbados, Jamaica and Trinidad and Tobago Building Codes include hurricane clips and anchorage recommendations.**

**HAZARD ADDRESSED: HURRICANE**

**Best Practice/Recommendation:**

- **Helpful in strengthening the roof against high wind forces**
- **Different roof clips/ties for different sections and uses**

**OTHER CONSIDERATIONS:**

- **Proper installation is required.**
- **Retrofitting the straps/ties are costly.**

| ARCHITYPE | BARBADOS | | JAMAICA | | TRINIDAD | |
|---|---|---|---|---|---|---|
| | Capital Cost ($US) | ROI in 5 years | Capital Cost ($US) | ROI 5 years | Capital Cost ($US) | ROI 5 years |
| Residential | $180.00 | 60.3x | $180.00 | 489.2x | $9,800.00 | 121.5x |
| SME Warehouse | $1,200.00 | 34.3x | $1,200.00 | 69.7x | $1,000.00 | 34.3x |

## IMPACT RESISTANT DOORS AND WINDOWS

Glazing installed at Ministry of Works and Transport Office, Caroni, Trinidad and Tobago

**Impact resistant windows and doors are designed to withstand hurricane winds. These windows and doors help prevent wind borne debris and water intrusion from hurricanes and floods.**

**BUILDING CODES:**

The Jamaica Building and International Building codes recommend using impact-resistant doors and windows.

**HAZARD ADDRESSED: HURRICANE, HEAT WAVES**

Best Practice/Recommendation:

- Helps to reduce heat gain on the building
- Helps to prevent uplift of roof by preventing wind pressures from entering the building
- May also hold back flood waters and minimize flood damage

**OTHER CONSIDERATIONS:**

- Proper installation is required to be effective.
- Costly

| ARCHITYPE | BARBADOS | | JAMAICA | | TRINIDAD | |
|---|---|---|---|---|---|---|
| | Capital Cost ($US) | ROI in 5 years | Capital Cost ($US) | ROI 5 years | Capital Cost ($US) | ROI 5 years |
| Residential | $3,800.00 | 6.5x | $3,800.00 | 14x | $3,800.00 | 6.5x |
| SME Warehouse | $1,800.00 | 22.6x | $1,800.00 | 46.1x | $1,800.00 | 22.6x |





## HURRICANE SHUTTERS

Rolling Shutters installed on the structure

**Hurricane shutters prevent hurricane winds and wind-borne debris from penetrating the doors and windows.**

**BUILDING CODES:**

The Jamaica Building Code recommends the use of shutters

**HAZARD ADDRESSED: HURRICANES**

Best Practice/Recommendation:

- Helpful in protecting against high wind forces

**OTHER CONSIDERATIONS:**

- Proper installation is required to be effective.
- Costly
- InstallVation/Activation required during an event.

| ARCHITYPE | BARBADOS | | JAMAICA | | TRINIDAD | |
|---|---|---|---|---|---|---|
| | Capital Cost ($US) | ROI in 5 years | Capital Cost ($US) | ROI 5 years | Capital Cost ($US) | ROI 5 years |
| Residential | $1,900.00 | 14x | $1,900.00 | 29x | $1,900.00 | 14x |
| SME Warehouse | $3,600.00 | 10.8x | $3,600.00 | 22.6x | $3,600.00 | 10.8x |

## CONCRETE ROOF STRUCTURES

Concrete Roof on SME,
Eastern Washington, USA

**Concrete roofs help prevent the roof from being uplifted durring a hurricane event as it can resist higher wind loads, while also preventing water infiltration.**

**HAZARD ADDRESSED:**
**HURRICANES, HEAT WAVES**

**Best Practice/Recommendation:**

- **Helpful in protecting against high wind forces.**

**OTHER CONSIDERATIONS:**

- **Design of structure to consider seismic forces and increase loads from the roof.**
- **Increase in cost of construction of roof and maintenance.**
- **Susceptible to leakage**
- **Increased heat gain on building**

| ARCHITYPE | BARBADOS | | JAMAICA | | TRINIDAD | |
|---|---|---|---|---|---|---|
| | Capital Cost ($US) | ROI in 5 years | Capital Cost ($US) | ROI 5 years | Capital Cost ($US) | ROI 5 years |
| Residential | $8,900.00 | 0.5x | $8,900.00 | 4.9x | $8,900.00 | 2x |
| SME Warehouse | $57,400.00 | 1.3x | $57,400.00 | 8.2x | $57,400.00 | 1.3x |





## MINIMUM EAVES ON BUILDING

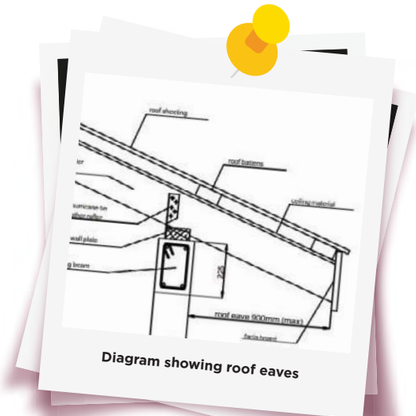


Diagram showing roof eaves

**The eaves on the building are subjected to high wind pressures on a structure. Keeping the eaves to a minimum helps to reduce the uplift forces on the roof by extreme winds.**

**HAZARD ADDRESSED:**
**HURRICANES**

**Best Practice/Recommendation:**

- **Helpful in protecting against high wind forces**

**OTHER CONSIDERATIONS:**

- **Increased heat inside the structure**

| Residential and SME | Barbados | Jamaica | Trinidad & Tobago |
|---|---|---|---|
| NO EXTRA COST | | | |

## REDUCING HEAT GAIN ON BUILDING ENVELOPES - ROOF

Installation of the fibre installation on a concrete roof

To reduce the heat gain, roofs can have an insulative layer or a reflective barrier. Alternative roofing materials can also be considered.

**BUILDING CODES:**

The CARICOM Regional Energy Efficient Building Code (CREEBC) provides guidelines for reducing heat gain in SME (Commercial) Buildings and Residential buildings

**HAZARD ADDRESSED: HEAT**

Best Practice/Recommendation:

- Use heat barriers such as fibreglass insulation, a layer of radiant barrier with 10 mm insulation, metal roof sheeting with an insulative ceiling, wooden roof tiles with waterproofing sealant and installation of a photovoltaic system on a metal roof

**OTHER CONSIDERATIONS:**

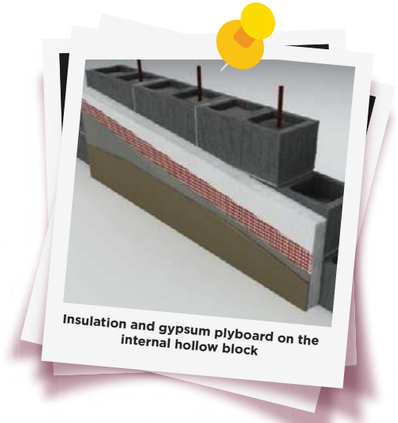
- Many different options are available.
- Increase in cost for installation.
- Maintenance may be required depending on the option selected.

| ARCHITYPE | OPTION | BARBADOS | | JAMAICA | | TRINIDAD | |
|---|---|---|---|---|---|---|---|
| | | Capital Cost ($US) | ROI in 5 years | Capital Cost ($US) | ROI 5 years | Capital Cost ($US) | ROI 5 years |
| Residential | Prodex 10mm insulation and radiant barrier | $450.00 | 7.1x | $450.00 | 3.7x | $450.00 | 0.3x |
| SME Warehouse | Prodex 10mm insulation and radiant barrier | $4,500.00 | 393.3x | $4,500.00 | 233.5x | $4,500.00 | 73.8x |





## REDUCING HEAT GAIN ON BUILDING ENVELOPES - WALL



Insulation and gypsum plyboard on the internal hollow block

Walls should possess a good insulative value to reduce heat transfer to inside the building. Composite walls with insulation or filling can be

**BUILDING CODES:**

The CARICOM Regional Energy Efficient Building Code (CREEBC) provides guidelines for reducing heat gain in SME (Commercial) Buildings and Residential buildings

**HAZARD ADDRESSED: HEAT**

Best Practice/Recommendation:

- Use insulation for walls with gypsum board attached to hollow blockwork, concrete-filled blocks instead of hollow clay blocks, natural shadings such as plants or radiant barrier with 10mm insulation.

**OTHER CONSIDERATIONS:**

- Many different options are available.
- Increase in cost for installation.
- Maintenance may be required depending on the option selected.

| ARCHITYPE | OPTION | BARBADOS | | JAMAICA | | TRINIDAD | |
|---|---|---|---|---|---|---|---|
| | | Capital Cost ($US) | ROI in 5 years | Capital Cost ($US) | ROI 5 years | Capital Cost ($US) | ROI 5 year |
| Residential | Use concrete filling to block wall | $1,100.00 | 24.7x | $1,100.00 | 13.8x | $30.00 | -0.9x |
| SME Warehouse | 3/4" gypsum board lining | $17,700.00 | 27.8x | $17,700.00 | 17x | $17,700.00 | 6.2x |

## REDUCING HEAT GAIN ON BUILDING ENVELOPES - WINDOWS

Internal blinds for windows

Windows should also possess a good insulation value and can be double glazed to reduce heat transfer to the internal space. Window overhangs/shadings can also be introduced to reduce the window's direct exposure to the sun.

**BUILDING CODES:**

The CARICOM Regional Energy Efficient Building Code (CREEBC) provides guidelines for reducing heat gain in SME (Commercial) Buildings and Residential buildings.

**HAZARD ADDRESSED: HEAT**

Best Practice/Recommendation:

- Use internal blinds, external shading overhangs and blinds, and Low-E double-glazed windows.

**OTHER CONSIDERATIONS:**

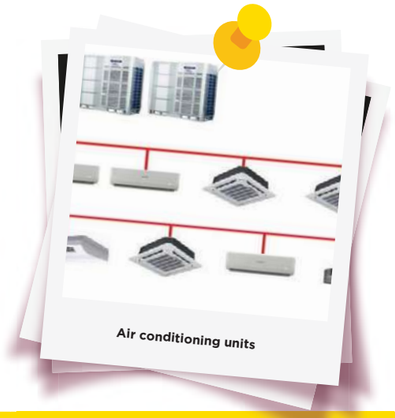
- Many different options are available.
- Increase in cost for installation.
- Maintenance may be required depending on the option selected.
- Aesthetics of the

| ARCHITYPE | OPTION | BARBADOS | | JAMAICA | | TRINIDAD | |
|---|---|---|---|---|---|---|---|
| | | Capital Cost ($US) | ROI in 5 years | Capital Cost ($US) | ROI 5 years | Capital Cost ($US) | ROI 5 year |
| Residential | Install double glazed windows | $3,800.00 | 26.7x | $1,100.00 | 15.5x | $3,800.00 | 4.3x |
| SME Warehouse | Install double glazed windows | $7,100.00 | 14x | $17,700.00 | 7.9x | $7,100.00 | 1.8x |





## ENERGY-EFFICIENT AIR CONDITIONING UNITS



Air conditioning units

Energy efficient Air conditioning often creates ideal thermal conditions within a space. Inverter or solar options help to reduce emissions and manage costs.

**BUILDING CODES:**

CARICOM Regional Standard CRS 59 Energy Labelling – Air Conditioners

**HAZARD ADDRESSED: HEAT**

Best Practice/Recommendation:

- Useful for residential and SME
- Cooling equipment should be labelled as energy efficient
- Inverter units to be used where possible
- Expert recommended to calculate cooling load for correct sizing of equipment

**OTHER CONSIDERATIONS:**

- Increase in cost for installation and maintenance.
- Additional electrical requirements
- Many options available

| ARCHITYPE | OPTION | BARBADOS | | JAMAICA | | TRINIDAD | |
|---|---|---|---|---|---|---|---|
| | | Capital Cost ($US) | ROI in 5 years | Capital Cost ($US) | ROI 5 years | Capital Cost ($US) | ROI 5 years |
| Residential | | $890.00 | 61.8x | $890.00 | 35.3x | $890.00 | 8.7x |
| SME Warehouse | VRF Inverter AC units | $12,300.00 | 50.8x | $12,300.00 | 31.3x | $12,300.00 | 11.8x |

## PASSIVE COOLINNG

Orientation of the buildings

**Windows and doors should be facing the direction of the flowing winds to allow for natural ventilation. The solar heat gained from windows and doors can be reduced by facing them away from the rising and setting sun directions.**

**HAZARD ADDRESSED: HEAT**

**Best Practice/Recommendation:**
- **Helpful in reducing heat**
- **To be considered during design stages to account for additional weight on the structure.**

**OTHER CONSIDERATIONS:**

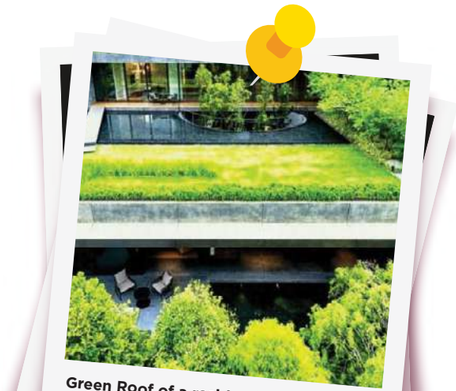
- **Increase in cost of construction.**
- **Aesthetics of the structure**

| Residential and SME | Barbados | Jamaica | Trinidad & Tobago |
|---|---|---|---|
| NO EXTRA COST | | | |





## GREEN ROOFS



Green Roof of a residential facility in Singapore

**A green roof/living roof refers to a layer of vegetation atop a building and may include drainage and irrigation systems. Green Roofs aid in reducing the amount of water in the runoff due to its ability to store water in the soil substrate.**

**HAZARD ADDRESSED: FLOODING, HEAT WAVES**

**Best Practice/Recommendation:**
- **Assessment of Flood Plain.**
- **To be considered during design stages toa account for additional weight on the structure.**
- **Needs professional expertise**

**OTHER CONSIDERATIONS:**

- **Design of structure to consider seismic and wind forces.**
- **Increase in cost of construction of a roof.**
- **Access to the roof is required.**
- **Increase in maintenance.**

| Residential and SME | Barbados | Jamaica | Trinidad & Tobago |
|---|---|---|---|
| VARIED | | | |

## UTILISE EFFICIENT WATER FIXTURES

Water efficient faucet

Water efficient fixtures reduce the consumption of water by including aerators, flow restrictors and operating with less volume of water.

**HAZARD ADDRESSED: DROUGHT**

**Best Practice/Recommendation:**
- Helpful in reducing water consumption
- Public sensitization campaigns by local and regional bodies can be useful

**OTHER CONSIDERATIONS:**
- Increase in cost for installation and maintenance.
- May require additional electrical and plumbing
- Can also be done using social media to reduce costs and wastage

| ARCHITYPE | OPTION | BARBADOS | | JAMAICA | | TRINIDAD | |
|---|---|---|---|---|---|---|---|
| | | Capital Cost ($US) | ROI in 5 years | Capital Cost ($US) | ROI 5 years | Capital Cost ($US) | ROI 5 years |
| Residential | Install water efficient faucets and shower head | $90.00 | 9x | $90.00 | 4.8x | $60.00 | 0.7x |
| SME Warehouse | Install water efficient faucets and shower heads | $1,900.00 | 0.8x | $1,900.00 | -0.4x | $1,266.67 | -0.7x |





## RAINWATER HARVESTING

Rainwater collection from a rooftop in Jamaica

This system collects roof runoff in moderate to heavy rain falls events for storage in water tanks for later use. This reduces the surface runoff into drains and water demand.

**HAZARD ADDRESSED: FLOODING, DROUGHT**

**Best Practice/Recommendation:**
- Assessment of Flood Plain
- Useful for water collection
- Can be done during or after construction

**OTHER CONSIDERATIONS:**
- Requires space around the structure.
- Increase in cost for installation and maintenance.
- Limitation on storage capacity
- Helps to reduce consumption costs

| ARCHITYPE | BARBADOS | | JAMAICA | | TRINIDAD | |
|---|---|---|---|---|---|---|
| | Capital Cost ($US) | ROI in 5 years | Capital Cost ($US) | ROI 5 years | Capital Cost ($US) | ROI 5 years |
| Residential | $240.00 | 7.3x | $240.00 | 27.1x | $240.00 | 7.3x |
| SME Warehouse | $8,600.00 | 0.5x | $8,600.00 | 2x | $8,600.0 | 0.5x |

## UTILISING ALTERNATIVE WATER

Collection of water into water storage tanks

Alternative water can include AC condensate, and grey water. These can be captured and used for landscaping.

**HAZARD ADDRESSED: DROUGHT**

**Best Practice/Recommendation:**
- Useful for collection of AC condensate water
- Can also be used to recycle grey water for irrigation

**OTHER CONSIDERATIONS:**
- Increase in cost for installation and maintenance.
- Storage space required

| ARCHITYPE | BARBADOS | | JAMAICA | | TRINIDAD | |
|---|---|---|---|---|---|---|
| | Capital Cost ($US) | ROI in 5 years | Capital Cost ($US) | ROI 5 years | Capital Cost ($US) | ROI 5 years |
| Residential | $240.00 | 70.9x | $240.00 | 0.1x | $160.00 | -0.7x |
| SME Warehouse | $1,600.00 | 7.4x | $1,600.00 | 1.8x | $1,066.67 | 0.4x |





## WATER STORAGE TANKS

Onsite water storage tanks

Rainwater can be captured and stored via tanks and cisterns and then used for flushing of toilets & irrigating the landscape. The quantity of water that can be harvested is based on actual rainfall through the year.

**HAZARD ADDRESSED: DROUGHT**

**Best Practice/Recommendation:**
- Useful for storage of water
- Polyethylene water tanks are a popular option which can be added before or after construction

**OTHER CONSIDERATIONS:**
- Increase in cost for installation and maintenance.
- Storage space required.

| ARCHITYPE | BARBADOS | | JAMAICA | | TRINIDAD | |
|---|---|---|---|---|---|---|
| | Capital Cost ($US) | ROI in 5 years | Capital Cost ($US) | ROI 5 years | Capital Cost ($US) | ROI 5 years |
| Residential | $240.00 | 1.6x | $240.00 | 0.5x | $160.00 | -0.6x |
| SME Warehouse | $8,600.00 | 11x | $8,600.00 | -0.3x | $5,733.33 | -0.3x |

## PUBLIC EDUCATION ON WATER CONSERVATION


Signage of conserving water

**HAZARD ADDRESSED:**
**DROUGHT**

**Best Practice/Recommendation:**

- **Useful for water conservation**

**OTHER CONSIDERATIONS:**

- **Increase in cost of producing and installing signage**



# Return on Investment



### Return on Investment (ROI) Estimates

The Return on Investment (ROI) is used to determine the profitability of an investment by dividing the investment's cost-benefit by its initial cost. The ROI estimates for different resilience measures were determined and used to prioritise opportunities for resilience measures. Architypes (prototypes) were proposed for residential and commercial buildings to enable cost comparison of resilience measures. The architypes used were 70m2 affordable-income residential solutions, with concrete walls and hip or slab roofs (Trinidad and Tobago and Barbados) and concrete walls with concrete slab roof (Jamaica) and 465m2 commercial warehouses with mezzanine floors and steel sheeting cladding, or masonry walls office type buildings.

The prevailing market costs were used as an initial basis, and a climate change factor was applied to determine the incremental climate change cost of the resilience measure. Benefits throughout the measures' economic life were identified year-by-year, and present values were determined using discounted cash flow techniques. The ROI was then computed from the aggregated current value of the benefits and the cost of the resiliency measure. The prioritised list of measures was reduced to the most pragmatic for each prioritised hazard for each country and options that developers rather than owners would most likely implement.

This method is consistent with Green Climate Fund policy and avoids double counting measures that should already be included to comply with building codes and respond to natural hazards.

## Barbados ROI estimates of proposed resilience measures for floods, hurricane winds, drought and heat.

| HAZARDS | ARCHITYPE | MITIGATION MEASURE | COST OF EACH RESILIENCE MEASURE WITH RESPECT TO CLIMATE CHANGE | DERIVED BENEFITS OVER 5 YEARS | ROI IN 5 YEARS |
|---|---|---|---|---|---|
| **Flood** | Residential - Affordable income | Using fill to make up levels contained with block base walls | $640 | $2,000 | 2.1x |
| | | Installation of flood doors | $1,800 | $2,000 | 0.1x |
| | SME - Warehouse | Water retention and infiltration | $104 | $2,000 | 18.2x |
| | | Elevation of structures | $368 | $12,875 | 34.0x |
| | | Elevation of equipment | $1,824 | $12,875 | 6.1x |
| **Hurricane Winds** | Residential - Affordable income | Installation of hurricane /wind roof clips and ties | $9 | $1,103 | 121.6x |
| | | Installation of hurricane shutters | $1,900 | $1,424 | -0.3x |
| | SME - Warehouse | Installation of hurricane/ wind roof clips and ties | $60 | $1,060 | 16.7x |
| | | Installation of impact resistant windows and doors | $90 | $2,120 | 22.6x |
| **Drought** | Residential - Affordable income | Install high efficiency toilets | $800 | $600 | -0.3x |
| | | Install water efficient faucets and shower heads | $60 | $600 | 9.0x |
| | | Install tanks for rainwater collection | $160 | $420 | 1.6x |
| | SME - Warehouse | Install high efficiency toilets | $800 | $5,400 | 5.8x |
| | | Install water efficient faucets and shower heads | $1,267 | $2,250 | 0.8x |
| | | Install tanks for rainwater collection | $5,733 | $12,000 | 1.1x |
| **Heat** | Residential - Affordable income | Prodex 10mm insulation and radiant barrier | $450 | $3,650 | 7.1x |
| | | Use concrete filling to block walls | $30 | $1,245 | 40.5x |
| | | Install double glazed windows | $104 | $2,875 | 26.7x |
| | SME - Warehouse | Prodex 10mm insulation and radiant barrier | $123 | $48,390 | 393.3x |
| | | 3/4" gypsum board lining | $17,700 | $13,900 | -0.2x |
| | | Install double glazed windows | $104 | $2,875 | 26.7x |





## Jamaica ROI estimates of proposed resilience measures for floods, hurricane winds, drought and heat.

| HAZARDS | ARCHITYPE | MITIGATION MEASURE | COST OF EACH RESILIENCE MEASURE WITH RESPECT TO CLIMATE CHANGE | DERIVED BENEFITS OVER 5 YEARS | ROI IN 5 YEARS |
|---|---|---|---|---|---|
| **Flood** | Residential - Affordable income | Using fill to make up levels contained with block base walls | $320 | $3,375 | 9.6x |
| | | Installation of flood doors | $1,800 | $2,000 | 0.1x |
| | SME - Warehouse | Water retention and infiltration | $104 | $3,375 | 31.5x |
| | | Elevation of structures | $368 | $12,875 | 34.0x |
| | | Elevation of equipment | $1,824 | $12,875 | 6.1x |
| **Hurricane Winds** | Residential - Affordable income | Installation of hurricane /wind roof clips and ties | $9 | $1,103 | 121.6x |
| | | Installation of hurricane shutters | $1,900 | $1,424 | -0.3x |
| | SME - Warehouse | Installation of hurricane/ wind roof clips and ties | $60 | $1,060 | 16.7x |
| | | Installation of impact resistant windows and doors | $90 | $2,120 | 22.6x |
| **Drought** | Residential - Affordable income | Install high efficiency toilets | $800 | $350 | -0.6x |
| | | Install water efficient faucets and shower heads | $60 | $350 | 4.8x |
| | | Install tanks for rainwater collection | $160 | $563 | 2.5x |
| | SME - Warehouse | Install high efficiency toilets | $800 | $900 | 0.1x |
| | | Install water efficient faucets and shower heads | $1,267 | $375 | -0.7x |
| | | Install tanks for rainwater collection | $5,733 | $2,000 | -0.7x |
| **Heat** | Residential - Affordable income | Prodex 10mm insulation and radiant barrier | $450 | $2,180 | 3.7x |
| | | Use concrete filling to block walls | $30 | $445 | 13.8x |
| | | Install double glazed windows | $104 | $1,710 | 15.5x |
| | SME - Warehouse | Prodex 10mm insulation and radiant barrier | $123 | $28,785 | 233.5x |
| | | 3/4" gypsum board lining | $194 | $488 | 1.5x |
| | | Install double glazed windows | $194 | $1,723 | 7.9x |

## Trinidad and Tobago ROI estimates of proposed resilience measures for floods, hurricane winds, drought and heat.

| HAZARDS | ARCHITYPE | MITIGATION MEASURE | COST OF EACH RESILIENCE MEASURE WITH RESPECT TO CLIMATE CHANGE | DERIVED BENEFITS OVER 5 YEARS | ROI IN 5 YEARS |
|---|---|---|---|---|---|
| **Flood** | Residential - Affordable income | Using fill to make up levels contained with block base walls | $640 | $2,000 | 2.1x |
| | | Installation of flood doors | $1,800 | $2,000 | 0.1x |
| | SME - Warehouse | Water retention and infiltration | $104 | $2,000 | 18.2x |
| | | Elevation of structures | $368 | $12,875 | 34.0x |
| | | Elevation of equipment | $1,824 | $12,875 | 6.1x |
| **Hurricane Winds** | Residential - Affordable income | Installation of hurricane /wind roof clips and ties | $9 | $1,103 | 121.6x |
| | | Installation of hurricane shutters | $1,900 | $1,424 | -0.3x |
| | SME - Warehouse | Installation of hurricane wind roof clips and ties | $60 | $1,060 | 16.7x |
| | | Installation of impact resistant windows and doors | $90 | $2,120 | 22.6x |
| **Drought** | Residential - Affordable income | Install high efficiency toilets | $800 | $100 | -0.9x |
| | | Install water efficient faucets and shower heads | $60 | $100 | 0.7x |
| | | Install tanks for rainwater collection | $160 | $705 | 3.4x |
| | SME - Warehouse | Install high efficiency toilets | $800 | $900 | 0.1x |
| | | Install water efficient faucets and shower heads | $1,267 | $375 | -0.7x |
| | | Install tanks for rainwater collection | $5,733 | $2,000 | -0.7x |
| **Heat** | Residential - Affordable income | Prodex 10mm insulation and radiant barrier | $450 | $565 | 0.3x |
| | | Use concrete filling to block walls | $30 | $190 | 5.3x |
| | | Install double glazed windows | $104 | $545 | 4.3x |
| | SME - Warehouse | Prodex 10mm insulation and radiant barrier | $123 | $9,180 | 73.8x |
| | | 3/4" gypsum board lining | $17,700 | $3,475 | -0.8x |
| | | Install double glazed windows | $194 | $545 | 1.8x |

## Average ROI estimates on Resilience Measures for the residential and commercial sectors for Barbados, Jamaica and Trinidad and Tobago.

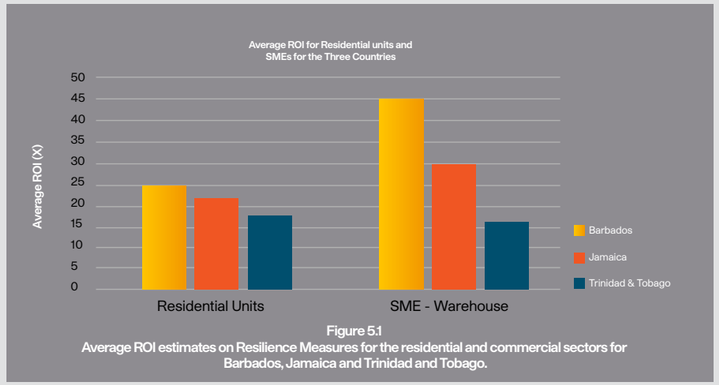



Figure 5.1
Average ROI estimates on Resilience Measures for the residential and commercial sectors for Barbados, Jamaica and Trinidad and Tobago.





## Financial Opportunities

Currently, there are various financing mechanisms available to support climate-resilient solutions for heat, drought, flood, and hurricane-resistant measures including:

- International Climate Funds such as the Green Climate Fund (GCF) and the Adaptation Fund provide financial resources to developing countries for climate change adaptation and resilience projects.
- Multilateral Development Banks (MDBs) such as the Inter-American Development Bank Group (IDBG) offer financing and technical assistance for climate resilience projects.
- National Climate Funds that finance climate resilience initiatives.
- Public-Private Partnerships (PPPs) bring together public and private sector entities to jointly finance and implement climate resilience projects.
- Insurance and Risk Transfer Mechanisms such as catastrophe bonds, can provide financial protection against climate-related risks.
- Climate finance innovation mechanisms attract capital from investors interested in supporting sustainable and resilient projects.
- Increasingly, banks and other financial institutions are seeking green investments including climate-resilient investments.

The availability and accessibility of these financing mechanisms may vary between countries.

From consultations with national and regional agencies of the three target countries, current opportunities for the introduction of financial products targeting climate-resilient infrastructure are more likely to be in the areas of Agricultural warehousing, Distribution goods warehousing and Provision of low-income and affordable housing.

### Opportunities in SME Sector

Several opportunities exist based on the gap between possible resilience solutions and those currently employed. Opportunities exist for:

1. Retailing certain materials such as hurricane shutters, radiant barriers and low-flow water fixtures.
2. Provide design and installation services for less popular resilience measures such as rainwater harvesting systems, flood barriers and photovoltaic systems.

# Market Demand



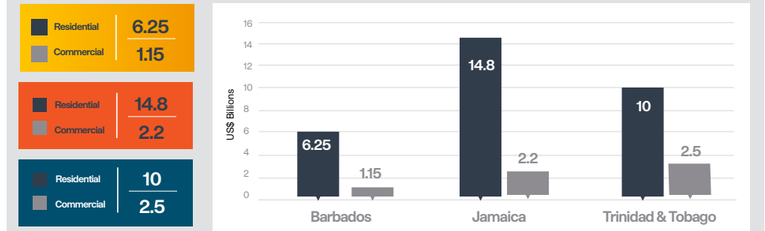
## Methodology

The study assessed the demand for climate-resilient infrastructure in the three island territories using a combination of secondary and primary data sources, qualitative and quantitative approaches, and two surveys. The study looked at people's willingness to pay for climate-resilient infrastructure, the use of insurance as a resiliency measure, and the cost and affordability of various options. Each of the three countries' market sizes was estimated using the data.

## Market Size Estimate (MSE)

The market demand was calculated using a formula considering an individual's ability and willingness to pay. As a result, the study estimated the 5-year potential market size for residential and commercial properties in the three countries to be US$6.25 billion, US$14.8 billion, and US$10 billion for residential and US$1.15 billion, US$2.2 billion, and US$2.5 billion for commercial, respectively.

## Market size estimate for Barbados, Jamaica and Trinidad and Tobago



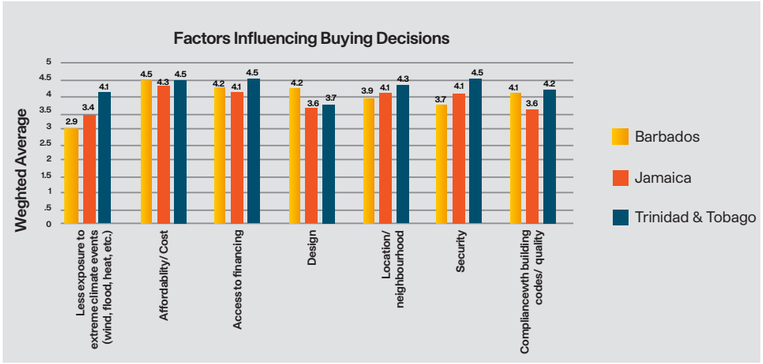

The study also discovered that the highest annual demand for residential units was for three bedrooms in Barbados and Trinidad and Tobago and two bedrooms in Jamaica. In all three countries, most commercial unit demand was for units priced between $100,000 and US$250,000. The study estimated market size using mathematical and economic calculations based on current market conditions such as income, affordability, cost, interest, and inflation rates.

## Willingness To Pay (WTP)

The Willingness to Pay (WTP) survey was conducted in Barbados, Jamaica and Trinidad and Tobago to measure and quantify factors influencing the purchase of climate-resilient infrastructure. According to the survey, access to financing, affordability and cost were the most important motivators in decision-making, while exposure to extreme weather events was among the least important. The most significant challenge was heat. People were more willing to pay for heat mitigation measures due to their cost-effectiveness and frequency of occurrence. Timber and composite were preferred in Barbados, Hempcrete and composite cement in

Jamaica and Timbercrete and composite cement in Trinidad for constructing outer walls.

**Factors such as geographical location, vulnerability to different climate change hazards, economic conditions as well as awareness, play significant roles in shaping the demand for these measures**




## Finance and Insurance

According to the market consultations, there is a market for integrating climate resilience into new and existing infrastructure. There is however, a reluctance from developers to take any action that would reduce profit margins and raise consumer prices.

To address this, capacity building is required to allow the construction industry to experiment with prototypes that meet purchasers' security and social needs as well as encourage developers to incorporate these measures in construction.

There is also a clear need to educate consumers on the importance of climate resilient infrastructure to reduce risks and potential losses as well as inform them on available mortgage financing options. Mortgage insurance is generally acquired as a mandatory requirement to obtain a mortgage, however, up to 15% of respondents found it unaffordable. This has been exacerbated by a decrease in reinsurance capacity regionally resulting in price increases for catastrophe insurance ranged from 5% to 25% in 2021/2022.

Although financial institutions do not specifically offer products incorporating climate resilience measures, there is a willingness to include resilience addons/ products in mortgage financing for new buildings or retrofitting existing infrastructure.





As such, it would be helpful to create a resilient construction certification that outlines the required resiliency measures for the country in order for the property to be considered resilient in the face of local climate change threats. Such a certification would allow for certain real estate assets to be labeled green. Investors and financial institutions seeking to channel green funding would be incentivized to create specialized financial products and offerings for such projects.

IDB Invest, that has a mandate to advance private sector preparedness for climate change events, could also explore options to create schemes with financial institutions, to offer loans to certified resilient properties that are insured, where IDB Invest absorbs the upfront premium associated with resilient construction, with the assumption that there would be cost savings for the insurance company in the case of climate change trigger event (e.g. hurricane, heat wave, flooding).

# Conclusions and Recommendations



## Conclusions

1. The 5-year potential for residential property development market in Barbados, Jamaica, and Trinidad and Tobago is estimated at US$6.25B, US$14.8B, and US$10B, respectively.
2. The 5-year potential for commercial property in the Barbados, Jamaica and Trinidad and Tobago is estimated at US$1.15B, US$2.2B, and US$2.5B, respectively.
3. There are 121,429 formally registered SMEs across the three countries, contributing 60%-70% to GDP in the Caribbean, bringing the estimated contribution for all three countries to 25.9 billion US$.
4. Climate trends and projections suggest decreasing rainfall, increased rainfall intensities, worsening drought conditions, increased intense hurricanes, hotter temperatures, and higher sea levels in the future.
5. Hurricane winds and floods are the most expensive hazards, followed by drought and heat waves. Prioritisation based on the number of people affected and AAL generally resulted in hurricane winds and floods being ranked 1st and either extreme heat or flooding ranking 2nd.
6. Of the four hazards, heat was highlighted as posing the most significant challenge, as the phenomenon was experienced daily by a larger number of respondents.
7. Insurance agents, risk assessors, and sellers noted that climatic events' impact is not solely factored in assessing risks for coverage. Insurance is mostly sought on a compulsory basis, and coverage lags property values. Hurricanes have resulted in reinsurance cost increases of up to 25%.
8. Access to financing, affordability and cost were among the top motivating factors when purchasing residential and commercial property in all three countries.
9. Climate change resilience measures are generally economically viable for all four prioritised hazards in residential and SME developments, with an average ROI of 21x for residential units and 31x for SMEs across Barbados, Jamaica, and Trinidad and Tobago.
10. There is a market for incorporating climate resilience into new or pre-existing commercial and residential infrastructure, with the greatest willingness to pay for heat resilience measures.





11. Financial institutions do not offer products incorporating climate resilience measures into developing new infrastructure. However, mortgage financiers are willing to include resilience add-ons/products in mortgage financing to deal with drought and heat/cooling to new buildings or retrofit existing infrastructure.
12. Building capacity among developers, contractors, and planners is necessary, and capacity building should focus on allowing the construction industry to test various prototypes that will satisfy customers' social and security needs.

## Recommendations

i. It's recommended that property owners consider resilience investments, as the average returns exceed 100%.

ii. Capacity building is necessary to create financial prototypes that meet purchasers' social and security needs, and innovative lending arrangements should be designed to increase uptake.

iii. Initial lending products can target heat resilience measures, and there is potential for retrofitting existing infrastructure.

iv. Awareness building is necessary for consumers and the general public on climate resilience infrastructure and mortgage financing options.

v. Building codes in the three target countries need to be reviewed and updated for climate resilience.

vi. Engage registered architecture, engineering, project managment and construction companies for building design and construction as this will increase the likelihood that building codes and international best practices are followed.

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