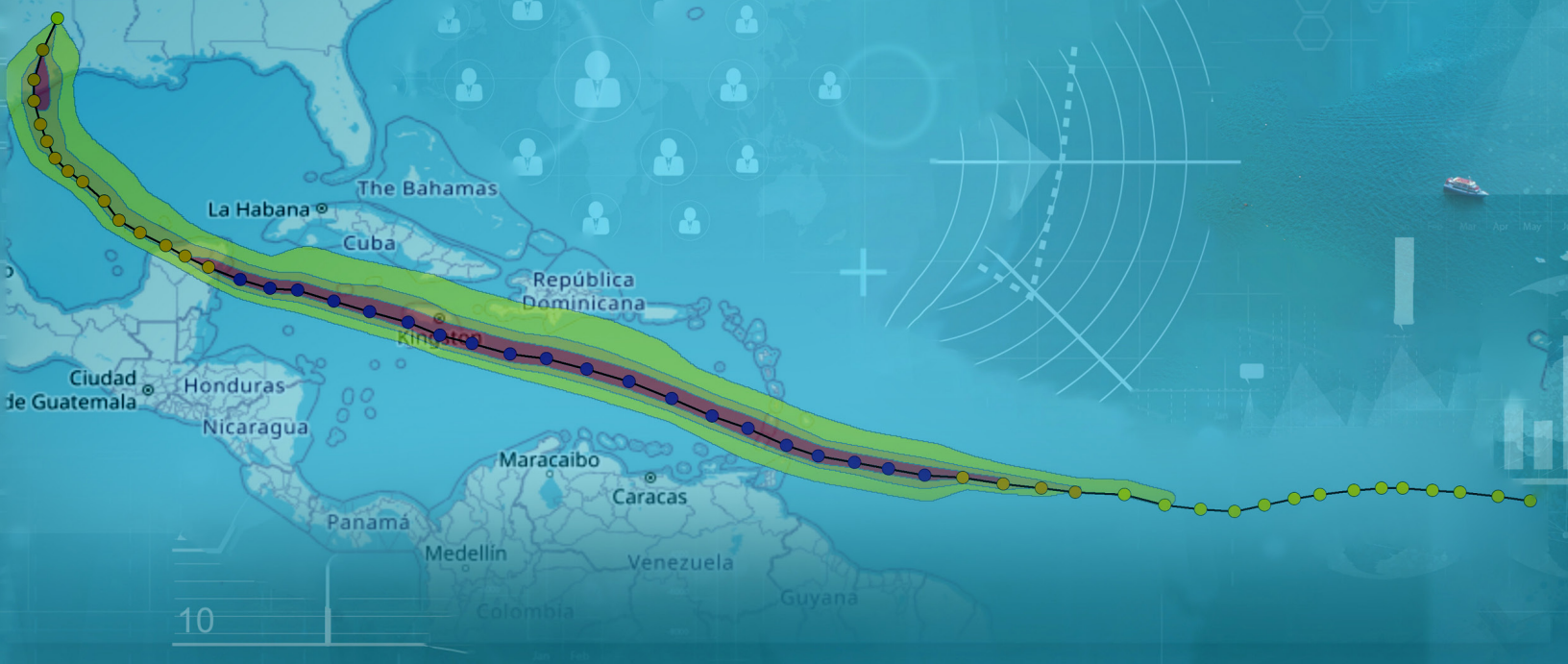
Assessment

of the **effects** and **impacts** of **Hurricane Beryl** on **Barbados**

2024



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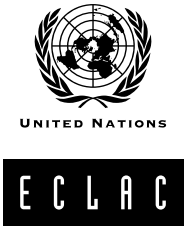
Assessment of the effects and impacts of Hurricane Beryl on Barbados, 2024



The preparation of this document was coordinated by Omar Bello, Economic Affairs Officer of the Office of the Secretary of the Economic Commission for Latin America and the Caribbean (ECLAC), and Jônatas de Paula, Associate Environmental Affairs Officer of the ECLAC subregional headquarters for the Caribbean, in partnership with the Ministry of Finance, Economic Affairs and Investment of Barbados.

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Abbreviations

BBD	Barbadian dollars
BBS	Barbados Statistical Service
BESS	Battery energy storage systems
BFD	Barbados Fisheries Division
BFC	Bridgetown Fisheries Complex
BHTA	Barbados Hotel and Tourism Association
BL&P	Barbados Light & Power Company
BMS	Barbados Meteorological Service
BSA	Building Standards Authority
CCREEE	Caribbean Centre for Renewable Energy and Energy Efficiency
CCRIF SPC	Caribbean Catastrophic Risk Insurance Facility Segregated Portfolio Company
CDEMA	Caribbean Disaster Emergency Management Agency
CDM	Comprehensive Disaster Management
CZMU	Coastal Zone Management Unit
DaLA	Damage and Losses Assessment
DEM	Department of Emergency Management
EMDAT	Emergency Events Database
FAO	Food and Agricultural Organization
FTC	Fair Trading Commission
iGOPP	Index of Governance and Public Policy in Disaster Risk Management
ICZM	Integrated Coastal Zone Management
MENB	Ministry of Environment and National Beautification
METVT	Ministry of Education, Technological and Vocational Training
MHAI	Ministry of Home Affairs and Information
MHLM	Ministry of Housing, Lands and Maintenance
MPEEA	Ministry of People Empowerment and Elder Affairs
MTW	Ministry of Transport and Works
MW	megawatts
NCC	National Conservation Commission
NEOC	National Emergency Operation Centre
NHC	National Housing Corporation
NHC-NOAA	National Hurricane Center- National Oceanic and Atmospheric Administration

OFC	Oistins Fisheries Complex
PDD	Planning and Development Department
PHC	Population and Housing Census
RCC	Roller compacted concrete
SIDS	Small island developing States
SSA	Sanitation Service Authority
SDI	Spatial Data Infrastructure
TBR	Total Beach Revenue

Methodology

The estimation of the effects and impacts of the Hurricane Beryl in Barbados follows the third edition of the Damage and Loss Assessment (DaLA) methodology developed by the Economic Commission for Latin America and the Caribbean.

The methodology allows standardized data collection and analysis on a sectoral basis, applying the same criteria to every sector under study. In this regard, the following concepts are used in the assessment:[1]

(i) Effects: Damage, Losses and Additional costs

- Damage: the effect the disaster has on the assets of each sector, expressed in monetary terms. Assets may include buildings, machinery, equipment, transportation, furnishings, roads, ports, stocks of final and semi-finished goods, among others.
- Losses: goods that go unproduced and services that go unprovided during a period running from the time the disaster occurs until full recovery and reconstruction is achieved.
- Additional costs: outlays required to produce goods and provide services because of the disaster. These represent a response by both the public and the private sectors and may take the form of additional spending or a shift in expenditure.

(ii) Impacts: consequences of the effects on macroeconomic variables, such as Gross Domestic Product (GDP), and public finance.

The assessment includes the following sectors: (i) the social sector analysis focuses on the affected population, housing, and education; (ii) the infrastructure sector comprises transportation, power and telecommunications and (iii) the productive sectors analyzed are tourism, fisheries and agriculture. Additionally, the report includes a cross-cutting assessment of the effects suffered by the environmental sector. All of the effects and impacts are estimated in Barbarian dollars (BBD).

The DaLA team visited Barbados from 21-26 July 2024, to collect data and obtain an overview of the effects of the Hurricane Beryl on the country. In addition, the DaLA team held meetings remotely and interviews with representatives from government agencies responsible for each sector under analysis.

[1] ECLAC (2014). Handbook for disaster assessment. See https://www.cepal.org/sites/default/files/publication/files/36823/S2013817_en.pdf.

The assessment used official data provided by the government, interviews with the private sector, observations from the field visits and, close collaboration with United Nations Development Programme (UNDP) and United Nations Office for Disaster Risk Reduction (UNDRR). In this sense, the team of Ministry of Finance, Economic Affairs and Investment of Barbados played a relevant and active role in the evaluation process by providing contacts, facilitating site visits, and organizing and participating in meetings.

However, as it will be detailed in each pertinent sector, the main limitation of the assessment was access to information, either due to unavailability during the assessment or because it is not yet collected/ produced in the country. This limitation was overcome by creating reasonable assumptions where data was unavailable. Both official information and informed assumptions were used to estimate the effects of the hurricane and are presented in each section.

Executive summary

Hurricane Beryl was a destructive category 5 Atlantic hurricane that impacted parts of the Caribbean, the Yucatán Peninsula and the Gulf Coast of the United States in late June and early July 2024. It is the earliest-forming category 5 hurricane on record and the second such storm to occur in the month of July. It was the second named storm, first hurricane and first major hurricane of the 2024 Atlantic hurricane season.

Barbados was impacted by Hurricane Beryl from 8 p.m. on Sunday, 30 June, until 2 p.m. on Monday, 1 July. The eye of the hurricane passed approximately 150 km south of the island in the early hours of 1 July. At that time, Beryl was classified as a category 3 hurricane with a maximum wind speed of 120 mph (193 km/h). These storm winds provoked large swells, propagating large waves that primarily affected the south and west coasts of Barbados. Maximum gusts of 68.4 mph (110 km/h) were recorded in Charnocks, in the parish of Christ Church. In addition, some locations along the south and west coasts registered increased wave activity. However, at a maximum of 0.5 inches, rainfall was minimal.

Hurricane Beryl's passage caused moderate damage to the island's basic infrastructure without causing a humanitarian crisis. There were no casualties or in-patient cases related to the hurricane, nor were large parts of the population evacuated or living in shelters. The hurricane's most significant physical impacts or damages occurred along the south and west coasts of the island, across multiple sectors and asset categories, including ports and harbours, transport infrastructure, fisheries, tourism and the environment. This outcome is attributable to the nature of the event and the location and nature of the assets. The hurricane passed south-west of the island, and while it did not generate significant rainfall or winds on land, it did generate significant waves, which caused considerable damage to coastal assets, predominantly in the south and west of the country. The specific areas that sustained the greatest damage to property and infrastructure were parts of the capital city, Bridgetown, in the parish of Saint Michael; coastal areas along Highway 7 in the parishes of Saint Michael and Christ Church; and coastal areas in the parishes of Saint James, Saint Peter and Saint Lucy. The impacts of Hurricane Beryl highlight specific risk factors, in particular the situation facing critical assets located very near the shoreline and the lack of safe harbour during extreme events, which is fundamentally the result of the island's physical geography, in addition to ageing infrastructure and housing stock.

The economic impact of Hurricane Beryl was moderate, estimated at approximately 193 million Barbados dollars (BBD) overall. The private sector accounted for 52% of the disaster's total effects, including 56% of the damage, 50% of losses and 29% of additional costs.[2]

Table 1
Total effects of Hurricane Beryl on Barbados
(Thousands of Barbados dollars)

Category of effects	Public sector	Private sector	Total
Damage	49 634	63 099	112 733
Losses	34 960	35 302	70 262
Additional costs	7 172	2 908	10 080
Total	**91 766**	**101 309**	**193 075**

Source: Prepared by the damage and loss assessment team, 2024.

Table 2
Effects of Hurricane Beryl on Barbados, by sector
(Thousands of Barbados dollars)

Sector	Damage	Losses	Additional costs
Social	2 979	2 391	258
Productive	74 783	35 241	6 659
Infrastructure	22 216	33	2 869
Environment	12 755	32 597	294
Total	**112 733**	**70 262**	**10 080**

Source: Prepared by the damage and loss assessment team, 2024.

Three subsectors accounted for 84% of the overall impact: tourism, fisheries and agriculture, and environment. This reflects the major impact sustained by coastal areas, specifically in the south and west. The productive sectors accounted for 66% of total damage, 50% of losses and 66% of additional costs. Of these sectors, fisheries and agriculture accounted for the most damage, at 63%; tourism accounted for 81% of losses; and fisheries and agriculture accounted for 59% of additional costs.

The environment accounted for 11% of total damage, 46% of losses and 3% of the additional costs. Infrastructure sectors accounted for 20% of total damage and 29% of additional costs. Social sectors accounted for 3% of total damage, 3% of losses and 3% of additional costs. Within these sectors, housing accounted for the largest share of damage, and education accounted for most of the losses, while 85% of the additional costs went to education and initial care for the affected population.

The Barbadian economy was projected to grow at 3.90% in 2024. Taking into account Hurricane Beryl's estimated impact of 0.15% of GDP, the economy's post-disaster growth projection has been revised to 3.75%.

[2] The methodology adopted for this damage and loss assessment goes beyond a traditional estimation of the disaster's effects based exclusively on the monetary value attributed to tradeable goods and services. Recognizing the vital contributions of ecosystemic services to individuals, communities and economies, the methodology incorporates the effects of disasters on natural capital, a critical component of a comprehensive disaster assessment. However, if the effects of the disaster on the environment sector were discounted from the overall estimation, the share of the private sector in the total effects would increase from 52% to 69%. The private sector share by category of effects would also rise, to 63% of damage, 94% of losses and 30% of additional costs.

Table 3
Summary of the effects of Hurricane Beryl on Barbados, by sector and subsector
(Thousands of Barbados dollars)

Sector and subsector	Damage	Losses	Additional costs
Social	2 979	2 391	258
Housing	2 960	28	38
Education	19	2 363	127
Affected population	0	0	93
Productive	74 783	35 241	6 659
Fisheries and agriculture	46 991	6 697	3 902
Tourism	27 792	28 544	2 757
Infrastructure	22 216	33	2 869
Transportation	22 198	0	2 846
Power	18	33	23
Environment	12 755	32 597	294
Total	**112 733**	**70 262**	**10 080**

Source: Prepared by the damage and loss assessment team, 2024.

The results and highlights of each sector chapter are presented below.

Affected population

Fortunately, there were no casualties or in-patient cases in Barbados as a consequence of the hurricane. The primary affected population included people living in shelters and people whose homes were damaged or destroyed. The damage and loss assessment team was informed that 33 category 1 emergency shelters had been activated as of Sunday, 30 June, to accommodate people during the hurricane. There were at least 443 people in emergency shelters across the country when the all clear was issued. The highest occupancy was at the Lloyd Erskine Sandiford Centre (87) and Combermere School (43).

The secondary affected population included people who suffered indirect or secondary effects of the disaster, such as deficiencies in the provision of public services, trade, employment and education, as well as isolation. This hurricane significantly affected people working in the fisheries sector (approximately 4,091) and the tourism sector (209). Disruptions to the school system impacted 44,160 students, who lost three days of teaching instruction.

Housing

Residential settlements in the southern half of Barbados were affected to varying degrees, with the most damage occurring in the parishes of Christ Church, Saint Michael and Saint George. Though the number of houses that sustained damage is small, it includes dwellings that were destroyed or rendered uninhabitable by the hurricane's effects. Impacts to homes included wind damage to roofs, water damage due to rain intrusion and damage caused by falling trees and flying debris.

According to information from the Department of Emergency Management and the Ministry of Housing, Lands and Maintenance, in addition to field inspections, a total of 50 homes sustained and presented damage due to the effects of Hurricane Beryl. In the affected districts, about 29 dwellings were affected in some way, and 21 were severely damaged, collapsed or unsafe for use. With respect to public buildings, including government offices, churches and shelters, no measurable damage was observed.

Damage to the housing sector in Barbados was estimated at BBD 3 million. The disaster and loss assessment team calculated losses of BBD 30,000 corresponding to the 21 homes left uninhabitable by the hurricane. Additional costs were estimated at BBD 40,000 and included debris removal, cleaning out destroyed dwellings and some staff expenses.

Education

According to information from the Ministry of Education, Technological and Vocational Training, only three secondary schools sustained damage. There were no reports of damage to primary, special, private or tertiary institutions. One school sustained minor roof damage, while the others presented minor damage to non-structural components, such as fences and bathrooms. No damage to furnishings, equipment or teaching materials was reported. The damage to the education sector was estimated at BBD 19,000.

Losses in the sector are estimated at BBD 2.4 million, primarily reflecting the value of lost instructional time due to the interruption of school for three days (when some facilities were used as emergency shelters). The Ministry incurred additional costs for preparing schools to be used as shelters and for cleaning the facilities after the shelters were deactivated. There were no reports of damage to equipment or furniture sustained while the shelters were in use. Additional costs are estimated at BBD 127,000.

Fisheries and agriculture

The sector was severely impacted by strong swells, winds up to 150 mph, heavy rainfall and flash flooding. The estimated economic impact of this disaster on the fisheries sector was around BBD 47 million in damage to fisheries assets, BBD 5.3 million in losses to fisheries economic flows and approximately BBD 3.9 million in additional costs.

The estimated economic effects on the country's agricultural sector were around BBD 1.4 million in losses to economic flows, with plantain crops accounting for 90% of that figure. The rest of the losses were recorded in crops such as bananas (5%), tomatoes (3%), beans (1%) and pumpkin (less than 0.5%). Damage to agricultural assets was estimated at BBD 34,500, with greenhouses and shade houses accounting for 87% of that figure. The rest of the damage was to agricultural irrigation tanks. There were no additional costs reported in this sector.

Tourism

The tourism sector is the cornerstone of the Barbadian economy, driving key industries such as commerce, restaurants and entertainment. It is also a significant source of employment and government revenue. The severe winds and large waves propagated by Hurricane Beryl inflicted considerable damage on numerous coastal tourism facilities. The total damage is estimated at BBD 27.8 million, with facilities facing challenges due to damage to coastal infrastructure, waterlogging and extensive sand deposits. The sector's losses amounted to BBD 28.5 million, owing to operational closures and cancellations during and after the hurricane. Additional costs totalled BBD 2.8 million, which included storm preparation, post-storm clean-up and increased operational costs.

Power and telecommunications

Hurricane Beryl had a small impact on the power sector, with damage primarily limited to the distribution network. Wind damage to utility poles and pole-top transformers were the main cause of power outages in small communities across the island. Less than one percent of utility poles were affected, resulting in an estimated BBD 17,500 in damage. In response to the disruption, the Barbados Light & Power Company moved to quickly restore power, with 97% of customers regaining electricity within 24 hours of the hurricane's passage. Losses, primarily due to power outages and the corresponding loss of electricity sales, amounted to BBD 33,100. Additional costs, including extraordinary labour expenses, were estimated at BBD 23,000. Overall, the total impact on the power sector, including damage, losses and additional costs, was estimated at BBD 70,000.

In contrast, the telecommunications sector in Barbados experienced no measurable damage or losses from Hurricane Beryl. Major providers, including Digicel and Flow, reported no infrastructure damage, and the assessment team confirmed the robustness of the island's telecommunications network. Any unreported damage is expected to be minimal.

Transportation

Critical facilities, such as the Bridgetown Port and the Bridgetown Fisheries Complex, sustained significant damage, underscoring the severity of the storm. Remarkably, none of the 326 bridges and footbridges under the administration of the Lands and Surveys Department sustained any damage during the hurricane. However, the road network experienced significant disruptions due to debris and structural failures, which led to a considerable increase in operational costs. The country's extensive road network, which comprises approximately 2,300 km^2 of highways, main roads secondary roads and minor roads, was heavily impacted. Key routes like Highway 7, which are essential for maintaining connectivity, were among the most affected.

While certain areas of the road network were affected and the port infrastructure sustained substantial damage, Grantley Adams International Airport was largely unscathed, allowing for continued operations despite the storm's impact. The damage to the port and roads was estimated at BBD 17 million and BBD 5 million, respectively. No losses were reported in the sector. Additional costs were estimated at BBD 3 million for ports and BBD 400,000 for roads. No losses to transportation infrastructure were reported.

Environment

The storm significantly impacted the beaches and coral reefs along the south and west coasts of Barbados, exacerbating existing environmental issues, such as coastal erosion and coral reef degradation. Recovery times may vary widely by site, making it difficult to project an exact timeline for recovery, but the hurricane's effects will undoubtedly have long-term consequences for coastal habitats. Minor facilities damage was reported at beaches, parks and other public recreational infrastructure sites.

The overall environmental impact of Hurricane Beryl was estimated at BBD 45.6 million, including BBD 12.7 million in damage, BBD 32.5 million in losses and BBD 294,000 in additional costs. The most significant contributors to this total were the damage and losses to coral reefs, particularly the loss of goods and services provided by this important ecosystem. It should be noted that these are conservative estimates, as data on the full extent of the damage to the country's coral reefs were limited. Damage and losses to beaches were the second largest contributors to the overall impact. Given the importance of this asset to the country's economy, in particular the tourism sector, the assessment team expects additional indirect and long-term impacts.

I. Description of the event

Introduction

Hurricane Beryl was a destructive Category 5 Atlantic hurricane that impacted parts of the Caribbean, the Yucatán Peninsula, and the Gulf Coast of the United States, in late June and early July 2024. It was the earliest forming Category 5 hurricane on record and the second such storm in the month of July. Hurricane Beryl was the second named storm, first hurricane, and first major hurricane of the 2024 Atlantic hurricane season.

Barbados was impacted by Hurricane Beryl from 8 p.m. on Sunday, 30 June until 2 p.m. on Monday, 1 July. The eye of the hurricane passed approximately 150 kilometres south of the island in the early hours of 1 July. During this period, Beryl was a Category 3 hurricane with maximum wind speed of 120 mph (193 km/h). These storm winds provoked large swells resulting in propagating large waves that primarily affected the southern and western coasts of Barbados. During this time, maximum wind gusts were recorded at Charnocks, Christ Church was 68.4 mph (110 km/h). In addition, different places along the south and western coasts registered increased wave activity. However, rainfall activity was minimal with a maximum of 0.5 inch of rainfall.

The passage of Hurricane Beryl in Barbados caused moderate damage to the island's basic infrastructure. However, there were impacts in specific areas along the southern and western coastal zones of the country. These effects were primarily caused by the force of the storm winds and propagating large waves. The specific areas that suffered the greatest damage to property and infrastructure were sectors of the capital Bridgetown in the Parish of Saint Michael; coastal areas along Highway 7 in the Parishes of Saint Michael and Christ Church; and coastal areas in the Parish of Saint James.

A. Historical events in Barbados

Historically, numerous hurricanes have hit Barbados. According to the Emergency Events Database (EMDAT)[3], since 1955, the country was affected by various hydrometeorological events and at least ten hurricanes (table 4). Note that of the eleven hurricanes in EMDAT, there are only damage figures for four of them.

Table 4
Historical disasters in Barbados: deaths, affected population and damage

Year	Event	Total deaths	Total affected population	Total damage *(Thousands of dollars 2024)*[a]
1955	Hurricane Janet	57	20 000	
1963	Hurricane Edith			
1980	Hurricane Allen		5 007	5 327
1987	Hurricane Emily		230	257 562
1995	Hurricane Marylin			
2002	Hurricane Lili		2 000	325
2004	Hurricane Ivan		880	7 747
2010	Hurricane Tomas		2 500	
2017	Hurricane Irma	1		
2021	Hurricane Elsa		3 300	
2023	Tropical Storm Bret		179	

Source: DaLA team with information from EMDAT, 2024.
[a] Damage estimates are in 2024 USD. This currency has been referenced because historical databases from EMDAT are generated in this currency.

During the twentieth century, there were five Hurricanes that caused disaster. Hurricane Janet, a small but powerful system, the centre of which passed not far off the South Coast in 1955. It mainly impacted the southern part of Barbados. In its wake, 57 persons were killed, 8,100 homes destroyed, and 20,000 persons left homeless. Hurricane Allen in 1980 was a relatively large hurricane which passed north of Barbados, destroying 35 homes and damaging over 200, especially in the northeastern parish of Saint Andrew. Hurricane Edith, in 1963, also passed 50 miles north of Barbados, dumping seven to nine inches of rain on the island.

In 2010, Tropical Storm Tomas became a Category 1 Hurricane just after the centre passed Barbados, with maximum sustained winds at Charnocks, Christ Church below hurricane strength, causing significant damage. The storm brought strong winds, heavy rainfall, and flooding, leading to power outages, roof damage, and blocked roads. The agriculture sector, particularly the banana crop, was heavily affected. It is estimated that 25 thousand persons were affected. Due to Hurricane Thomas, Barbados received a payout of USD 8.6 million from the Caribbean Catastrophic Risk Insurance Facility Segregated Portfolio Company (CCRIF SPC). However, EMDAT does not report any specific damage figures for this hurricane.

Hurricane Irma (2017) was one of the most powerful and destructive hurricanes ever recorded in the Atlantic. Although it did not directly hit Barbados, the island experienced indirect effects such as increased surf, heavy rainfall, and gusty winds. The proximity of such a powerful hurricane brought heightened vigilance and preparedness across the island.

[3] It is a global database maintained by the Centre for Research on the Epidemiology of Disasters (CRED) that compiles data on natural and technological disasters worldwide. The database includes information on disaster occurrences, impacts, and human and economic losses. It is commonly used by researchers, policymakers, and humanitarian organizations to analyze trends and inform disaster risk reduction and management strategies.

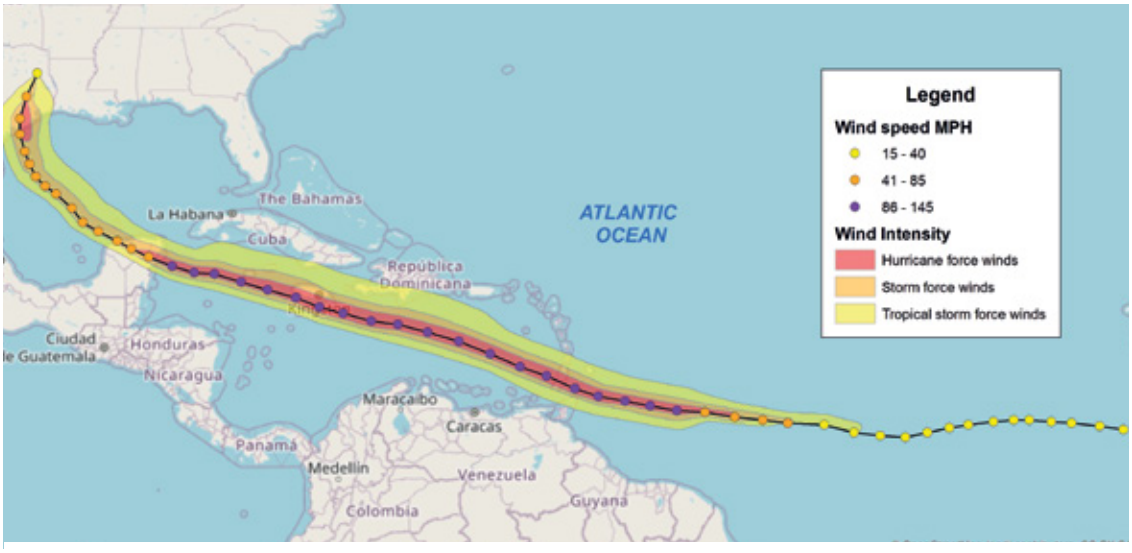
Hurricane Elsa made landfall in Barbados in 2021 as Category 1, causing widespread damage to buildings, uprooting trees, and disrupting power and water services. The storm's heavy rainfall caused flooding in low – lying areas. It affected at least 3,300 persons (186 were left homeless). Similarly, following Hurricane Elsa, Barbados received two payouts from CCCRIF SPC under the country's parametric insurance policies for tropical cyclones and excess rainfall, amounting to a total of USD 2.5 million. As with Hurricane Thomas, EMDAT does not provide damage figures for Hurricane Elsa.

Based on the above description, hurricane-induced disasters have been the most frequent in Barbados. However, the island has also experienced floods, earthquakes, and droughts. In 1970, floods affected the entire country, resulting in three deaths, 210 affected people, and estimated damages of around USD 3.8 million. In 2007, a magnitude 7.4 earthquake on the Richter scale occurred, with its epicentre recorded 168 miles from Barbados. The country also experienced earthquakes of magnitude 4.2 and 5.7 on 28 September 2018, during the passage of Tropical Storm Kirk. Additionally, in 2010, a prolonged drought event affected the Eastern Caribbean, including Barbados, primarily impacting agricultural production.

B. Hurricane Beryl in the Caribbean

Based on reports and advisories of the National Hurricane Center-National Oceanic and Atmospheric Administration (NHC-NOAA), Hurricane Beryl was the earliest Category 5 hurricane and the strongest pre – July hurricane in the Atlantic's Main Development Region (see map 1).

Map 1
Path of Hurricane Beryl across the Atlantic



Source: DaLA team with data from the NHC-NOAA, 2024.

Beryl originated from a tropical wave off the African coast on 25 June. It rapidly intensified in unusually conductive conditions, including record – warm sea surface temperatures, light wind shear, and high atmospheric moisture. The system became a tropical depression on 28 June, quickly strengthening to a tropical storm and then a hurricane by 29 June Beryl reached major hurricane status on 30 June.

On 1 July, Beryl made its first landfall on Carriacou, Grenada, as a high – end Category 4 hurricane with 150 mph (241 km/h) winds. It further intensified in the Caribbean Sea, peaking as a Category 5 hurricane on 2 July with maximum sustained winds of 165 mph (266 km/h) and a minimum central pressure of 934 millibars (mb). The storm then weakened due to wind shear as it passed south of Jamaica and the Cayman Islands.

Beryl made its second landfall near Tulum, Quintana Roo, on 5 July, as a Category 2 hurricane. After weakening to a tropical storm over the Yucatán Peninsula, it entered the Gulf of Mexico, where it reorganized into a Category 1 hurricane. On 8 July, Beryl made its final landfall near Matagorda, Texas, with 80 mph (129 km/h) winds. The storm then moved northeast, becoming post-tropical over Arkansas on 9 July and dissipating over Ontario the following day.

Throughout its duration, Beryl underwent several intensity fluctuations due to eyewall replacement cycles, wind shear, and dry air intrusions. The hurricane's unusual strength for the early season was attributed to exceptionally favourable environmental conditions.

C. Hurricane Beryl in Barbados

Before Hurricane Beryl approached the vicinity of Barbados, models from the NHC-NOAA predicted that the hurricane's trajectory would almost directly impact the country's territory. However, three days before passing Barbados, the hurricane's path shifted towards the south, moving away from the island and heading towards Grenada, Carriacou, Petite Martinique, and Saint Vincent and the Grenadines.

Consequently, the Barbados Meteorological Service (BMS) issued the initial statements on the morning of 26 June, 2024, and published Weather Information Statement #1 stating:

> "The Barbados Meteorological Service is closely monitoring the progress of a Tropical Wave located in the eastern Atlantic along 29/30W, about 3200 km or 2000 miles of the east of Barbados.
>
> Current Situation: The tropical wave is currently disorganized and is moving westward at around 17 mph or 28 km/h. [THERE] ARE CURRENTLY NO WATCHES OR WARNING IN EFFECT for Barbados.
>
> Intensity Forecast: Some slow development is possible over the next few days as the wave tracks westwards across the Atlantic.
>
> Track Forecast: The wave is expected to track generally westward at 15 to 20 mph over the next few days. On the current forecast track, the wave is expected to affect the island Sunday night into early Monday morning next week…"

In the following days, the system continued to develop, increasing the probabilities of hazardous sea conditions, strong winds, and increased precipitation. Therefore, on 28 June, a warning was issued for high waves, particularly for small vessels, with wave heights forecasted to reach up to four meters in open waters around the marine area of Barbados. That same day, the system was forecasted to develop into a Category 1 hurricane. Thus, the BMS issued a Hurricane Watch for the entire country in the early hours of 29 June. Additionally, the NHC-NOAA forecasted that Beryl would strengthen to Category 3. Therefore, at 5 p.m. a hurricane warning was issued (Statement #11, on Tropical Storm Beryl – A Hurricane Warning is in Effect for Barbados), standing:

> "**TROPICAL STORM BERYL STRENGTHEN[S] INTO A HURRICANE**
>
> The Government of Barbados has upgraded the Hurricane Watch to Hurricane Warning. Hurricane Beryl continues to intensify as it is expected to become a major hurricane before reaching Barbados late Sunday night.
>
> On the current projected track, the center of Beryl is expected to pass 40 miles (74 km) south of Barbados. The island is expected to feel the impact associated with this system as early as Monday morning 1st July, 2024…"

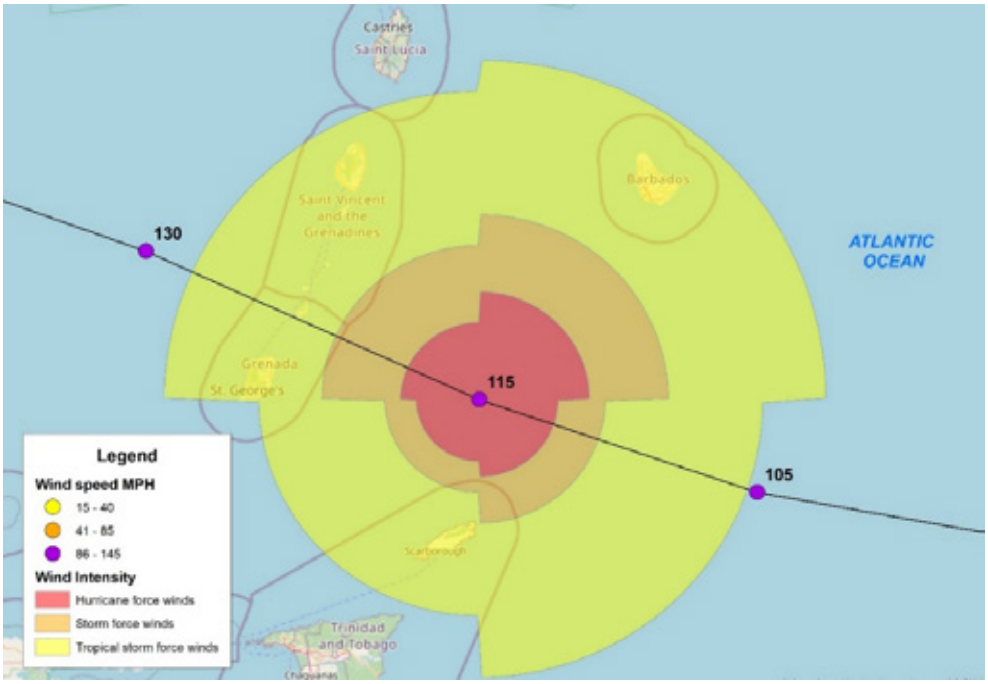
> The BMS continued monitoring the development and trajectory of Hurricane Beryl on 30 June, 2024. In the early hours of the evening, Advisor #15 "On Major Hurricane Beryl – A Hurricane Warning Remains in Effect for Barbados" was issued, stating:
>
> "Hurricane Beryl is a category 4 hurricane. A hurricane warning remains in effect for Barbados.
>
> Higher gusts have already been reported across the island during the afternoon. The center of Beryl is expected to pass about 80 miles (130 km) south of Barbados sometime early Monday morning 1st July 2024. However, from early tonight, feeder bands associated with Beryl will begin occasional showers and gusty winds up to storm force.
>
> **** Hazard Info ****
>
> During the passage of Beryl storm-force winds are extremely likely and heavy rainfall with accumulations of 1 to 3 inches which could cause flash flooding. Additionally, marine conditions are expected to significantly deteriorate tonight.
>
> ...At 5 pm today Sunday 30th June, 2024 the eye was located near 11.1 N 56.5 W on about 400 km (250 miles) east-southeast of Barbados. Maximum sustained winds are 130 MPH (215 km/h). The system has slightly changed direction and slowed down to west-northwestward at 18 MPH (30 km/h). The minimum central pressure remains at 960 mb. Hurricane – force winds extended outward up to 45 km (30 miles) from the center and tropical storm – force winds extend outward up to 185 km (115 miles) ..."

Based on the advisories and the imminent impact stemming from Hurricane Beryl's passage near the island, the Government of Barbados activated The National Emergency Operation Centre (NEOC)[4] on the night of 30 June, with the objective of acting on the emergency and coordinating the national response.

According to the BMS, the country was impacted by Hurricane Beryl from 8 p.m. on Sunday, 30 June until 2 p.m. on Monday, 1 July. The centre of the hurricane passed approximately 150 kilometres south of Barbados between 4 am and 5 am on 1 July (map 2). During this period, Beryl was a Category 3 hurricane with maximum wind speed of 120 mph (193 km/h). These storm winds provoked large swells resulting in propagating large waves that primarily affected the southern and western coasts of Barbados. Storm winds were recorded from 12:30 a.m. to 1 p.m., with their peak occurring from 2 a.m. to 9:30 am. During this time, maximum wind gusts of 68 mph (110 km/h) were recorded at Charnocks and Christ Church. Moreover, increased wave activity was registered in different places along the south and western coasts. However, rainfall activity was minimal with a maximum of 0.5 inch of rainfall.

[4] The NEOC comprises representatives from key organizations in Barbados, both Government and Private Sector. The organization that were represented in the NEOC during the passage of Beryl were: 1) Ministry of Home Affairs and Information ; 2) Ministry of Education, Technological and Vocational Training; 3) Caribbean Disaster Emergency Management Agency ; 4) The Barbados Police Service; 5) Department of Emergency Management ; 6) Barbados Fire Service; 7) Barbados Statistical Service; 8) National Housing Corporation; 9) Barbados Defense Force; 10) Ministry of People Empowerment and Elder Affairs – Welfare Department; 11) Barbados Light and Power; 12) Barbados National Oil Company Limited; 13) National Petroleum Corporation; 14) Ministry of Transport and Works; 15) Barbados Meteorological Services; 16) Barbados Government Information Service; 17) Ministry of Industry, Innovation, Science and Technology; 18) Ministry of Housing and Lands; 19) Barbados Red Cross; 20) Ministry of Health and Wellness; 21) Barbados Water Authority; 22) District Emergency Organizations; 23) Ministry of Tourism and International Transport; 24) Barbados Hotel and Tourism Association; 25) Barbados Citizen´s Band Radio Association.

Map 2
Path of Hurricane Beryl across Barbados



Source: DaLA team with data of the NHC-NOAA, 2024.

Finally, at 2 p.m. on 1 July, the Hurricane Warning was discontinued following the passage of Beryl, and the ALL-CLEAR was declared. The NEOC was deactivated later that same evening.

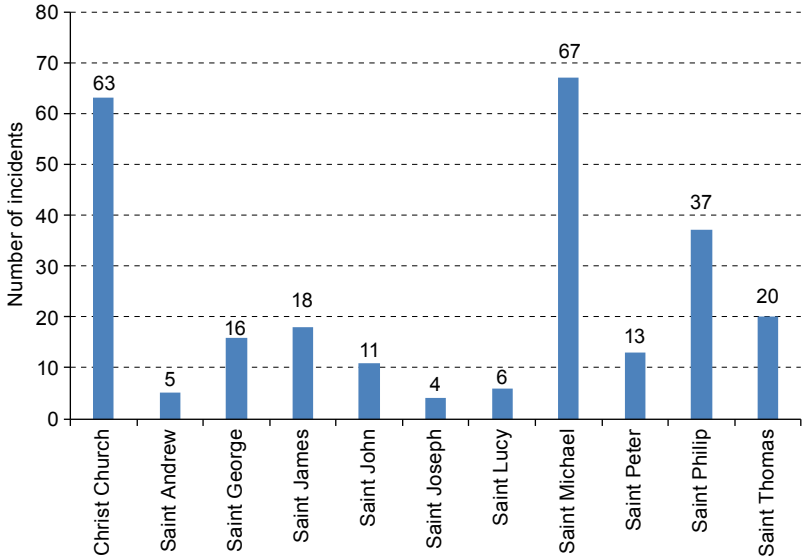
D. Affected areas

The passage of Hurricane Beryl in Barbados did not cause significant damage to the island's basic infrastructure. However, there were localized impacts in specific areas along the southern and western coastal zones of the country. These effects were primarily caused by storm force winds and propagating large waves.

Based on information collected by the DEM, around 260 incidents were reported in various localities of the island on 1 July. These incidents specifically included damage to the roofs of houses, fallen trees, and damage to certain service infrastructure, among others. Figure 1 shows the distribution of incidents which occurred on 1 July, broken down by parish. As clearly observed, the parishes of Saint Michael (67 incidents), Christ Church (63 incidents), and Saint Philip (37 incidents) account for 64% of the incidents reported on 1 July, when the most significant events occurred due to the passage of Hurricane Beryl.

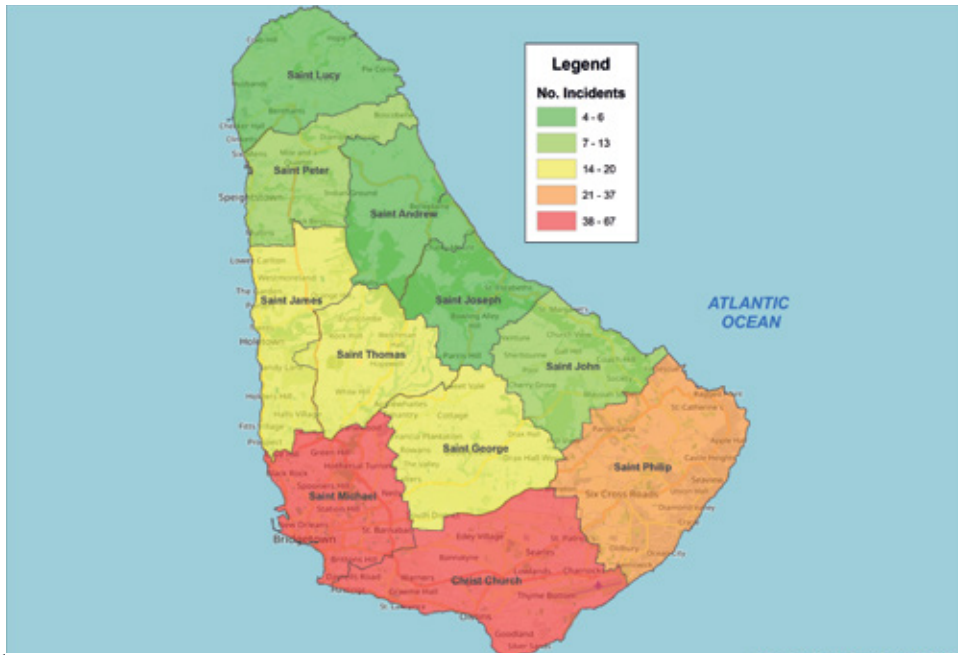
Additionally, map 3 shows the geographic distribution of the number of incidents that occurred, confirming that the parishes with coastal lines along the southern and western side of the island were the most affected by the hurricane.

Figure 1
Number of incidents, by parish, 1 July 2024



Source: DaLA team with data from the DEM, 2024.

Map 3
Geographic distribution of incidents in Barbados



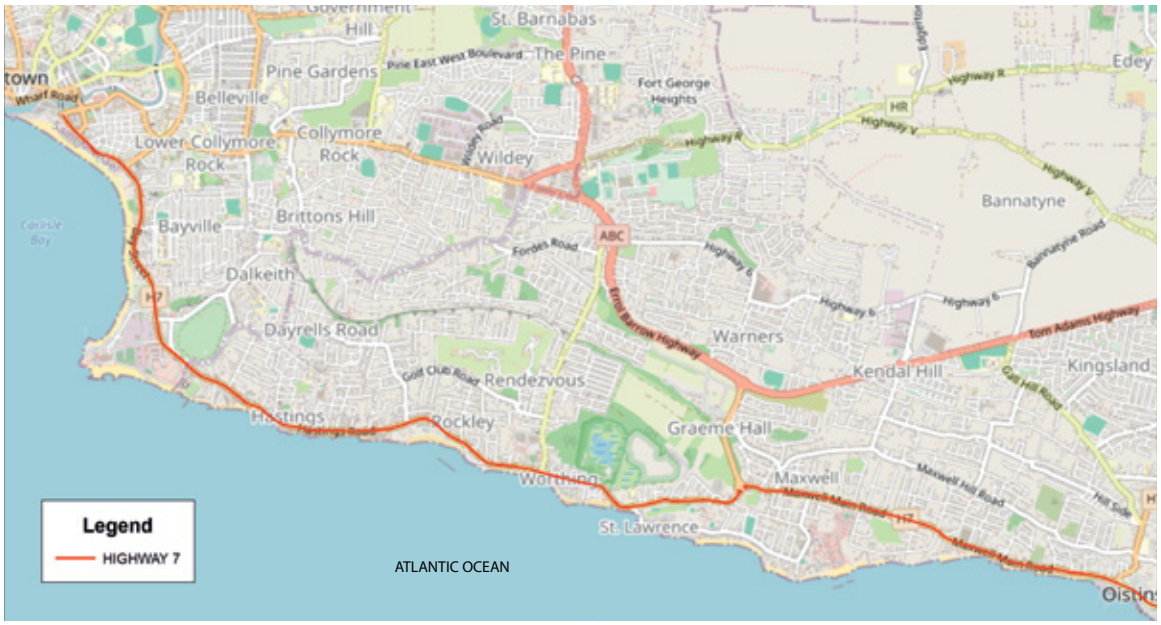
Source: DaLA team with data from the DEM, 2024.

According to the information reported by the Government of Barbados, the specific areas that suffered the greatest damages to property and infrastructure because of Hurricane Beryl were sectors of the capital Bridgetown in Saint Michael Parish. The Bridgetown Fisheries Complex (BFC), located in Carlisle Bay, was heavily affected by propagating large waves, destroying boats and infrastructure in this important fisheries sector asset (image 1).

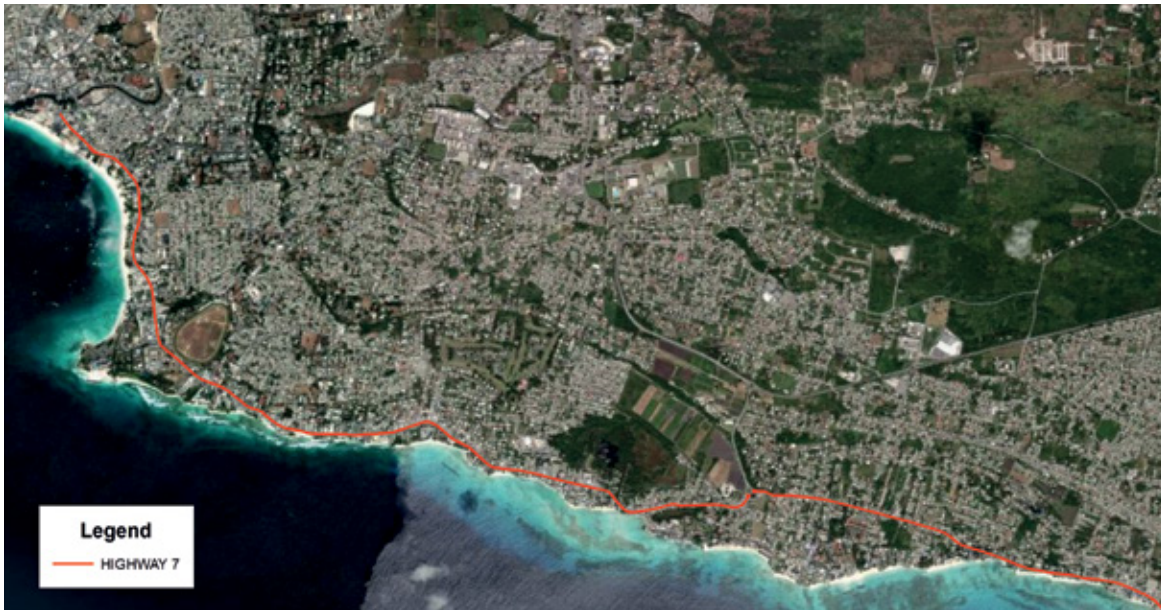
Another area where considerable damage occurred, especially to the road infrastructure, was the south-western coastal areas along the Highway 7 between the Parishes of Saint Michael and Christ Church (map 4). These areas were affected by road blockages due to propagating large waves and debris deposits. In addition to the damage to the roads in Christ Church, there were fallen trees, damage to the power infrastructure, and the roofs of houses.

Map 4
Coastal areas along Highway 7

A. Base map



B. Satellite image



Source: DaLA team with data from OpenStreetMap, 2024, and Maxar Technologies, 2023.

Propagating large waves damage was also reported on the northwest coast of the island, in the parish of Saint Peter, specifically on the beaches of Speightstown (map 5). Among the most reported incidents in this parish were power outrages due to damage to infrastructure, as well as road blockages along the coast.

Map 5
Coastal areas Speightstown

Source: DaLA team with data from OpenStreetMap, 2024, and Maxar Technologies, 2023.

II. Affected population

Introduction

This section presents an overview of the effects of Hurricane Beryl on the population of Barbados with an emphasis on the description and quantification of the affected population. Based on the Handbook for Disaster Assessment (ECLAC, 2014), the affected population consists of:

- Primary affected population: People affected directly by the disaster, that is, those who died, were injured or became ill, were disabled (primary trauma victims), were displaced and living in shelters, or suffered material losses as a direct and immediate consequence of the disaster.
- Secondary affected population: People who suffered indirect or secondary effects of the disaster, including deficiencies in the provision of public services, trade, employment, or education, as well as isolation.

Overall, the effects of Hurricane Beryl on the population of Barbados were moderate, largely due to the timely warnings and advisories issued by the relevant authorities. These efforts encouraged people to take necessary precautions, which, combined with the government's preparedness measures, likely minimized the hurricane's impact. The population's response to these warnings played a significant role in reducing the overall impact on the country.

Based on official reports from government entities responsible for emergency coordination and management, there were no reports of casualties or injuries related to the hurricane. However, the housing sector did sustain some damage due to destructive winds and heavy rains, particularly in the south-western and central parishes of Christ Church, Saint George, and Saint Michael. The DaLA Team estimates that around 180 persons experienced damage to their homes, while 443 individuals sought refuge in shelters. Additionally, the population's quality of life temporarily declined due to disruptions in telecommunications, electricity, and water services. As with most Caribbean small island developing States (SIDS), Barbados's small size means that a hurricane can have widespread national impacts. The hurricane significantly affected those working in the fisheries sector (approximately 4,091 persons) and the tourism sector (209 persons). Disruptions in the school system also impacted students who would have lost three days of teaching instruction (see table 5). These factors are analysed in greater detail in the following sections.

Table 5
Summary of the affected population

Affected population	Estimated number of persons
Primary affected population	
Persons in shelters	443
Persons who suffered damaged or destructions to their homes	180
Secondary affected population	
Fisherfolk	4 091
Tourism sector employees	209
Students	44 160

Source: DaLA team, 2024.

The baseline information in this section was obtained from the 2021 Population and Housing Census of Barbados and the Digest of Statistics 2019-2021, as well as information collected through interviews by the DaLA Team. Supplemental information was also provided by the DEM, the METVT, the Barbados Fisheries Division (BFD) and the Barbados Statistical Service (BSS). Various sector assessments were provided by the Ministry of People Empowerment and Elder Affairs (MPEEA), Ministry of Housing, Lands and Maintenance (MHLM), the Ministry of Health and Wellness (MHW) and CDEMA.

Affected parishes

The effects of Hurricane Beryl were primarily felt on the West and South Coasts of the country, specifically in the parishes of Christ Church, Saint James, and Saint Michael, on the eastern in the parishes of Saint Philip, Saint John and Saint Joseph and on the central in the parishes of Saint Thomas and Saint George. Based on the PHC 2021 by the BSS, these areas comprise about 238,710 inhabitants, with Saint Michael and Christ Church being the most populated parishes in Barbados. Not all the population of these parishes was directly affected by the hurricane, as its intensity varied among settlements. Based on the verified Incident Report from the Ministry of Housing, Lands and Maintenance (MHLM), and the National Housing Corporation (NHC), the mainly affected settlements due to some damage to houses are:

- Christ Church: Bartletts Tenantry Road, Charnocks, Enterprise, Inch Marlowe, Silver Sands, Saint Matthias Road, Thyme Bottom.
- Saint George: Ashbury, Carmichael, Constant, Good Intent, Jericho, Lower Estate Road, Superlative.
- Saint James: Welches Grove.
- Saint John: Massiah Street.
- Saint Joseph: Bathsheba, Orange Grove.
- Saint Michael: Bibby's Lane, Black Rock, Brittons Hill, Carington Village, Dunlow Lane, Ellis Village, Goodland, Laynes Road, Station Hill, Saint Stephens Hill, Mahagony Lane, Mapp Hill, Pinelands, Queens Street, White Hall.
- Saint Philip: Marley Vale, Merricks, Rock Hall, Woodbourne.
- Saint Thomas: Bagatelle, Forty Acres, Frout Hill, Bridge Road, Hopewell, Spring farm.

Demographics

The demographic profile of the eight parishes under analysis helps estimate the impact and the population potentially affected by Hurricane Beryl. According to the 2021 PHC, Barbados has a total estimated resident population[5] of 269,090, with the affected parishes accounting for approximately 238,710 inhabitants.

[5] Includes the institutional population and undercount.

Between 2021 and 2022, the average population growth rate was 0.15%. As of 2024, Barbados has an overall population density of 656.53 persons per square mile, with Saint Michael having the highest population density with 1,146 persons per square mile followed by Christ Church with 470 persons per square mile.

Barbados has a fairly balanced population of females and males, but there is a slight predominance of females in all the parishes under review, except for Saint John and Saint Joesph. The proportion of females ranges from 48.4% to 52.7%, while males range from 47.3% to 51.6%. As highlighted in the 2021 PHC, the age structure of Barbados reveals an ageing population that is not replenishing quickly enough. In 2021, persons over 65 years of age accounted for 18.6% of the total estimated population, an increase of 6.5 percentage points compared to the year 2000. Women accounted for 51.7% of people over 65 years. Table 6 below provides a snapshot of the baseline demographics for the affected parishes.

The 2021 census data indicated that approximately 4,602 persons, constituting 3.4% of the population, reported having some form of disability. Women make up 59% of the total population with disabilities. The most common disabilities are related to vision and mobility challenges, followed by mental disorders and hearing difficulties.

Table 6
Demographics of the affected parishes

Demographic	Christ Church	Saint George	Saint James	Saint John	Saint Joseph	Saint Michael	Saint Philip	Saint Thomas
Total population	51 184	21 939	24 819	10 417	6 697	77 394	32 130	14 130
Female *(Percentages)*	52.7	51.6	52.0	49.5	48.4	51.9	52.3	52.4
Male *(Percentages)*	47.3	48.4	48.0	50.5	51.6	48.1	47.7	47.6
Density *(In persons per square mile)*	470	251	267	159	86	1146	307	148
Distribution by age *(Percentages)*								
Under 15 years	14.6	15.8	14.3	17.0	15.7	17.1	15.3	17.1
15–64 years	64.8	66.6	62.9	65.3	65.7	65.3	66.9	68.2
+65 years	20.6	17.6	22.8	17.7	18.6	17.6	17.8	14.7

Source: BSS, Population and Housing Census 2021.

A. Primary affected population

Displaced persons during the Hurricane

Fortunately, Barbados did not have any casualties or any in-patient cases as a consequence of the hurricane. The DaLA Team was informed that 33 Category 1 emergency shelters[6] were activated from Sunday, 30 June to accommodate persons during the hurricane. There were 443 persons in emergency shelters across the country until the "all clear" was issued. The highest occupancies were at the Lloyd Erskine Sandiford Centre with 87 persons and Combermere School with 43 persons (see table 7). All shelters were deactivated on Monday, 1 July. Additionally, the MPEEA informed the DaLA team that pre-hurricane outreach was conducted by phone or home visits to vulnerable persons from their database. This resulted in 10 vulnerable persons (mainly elderly persons between the ages of 59 to 98 who were either living alone and/or wheelchair users) being transported to shelters. This meant that the Ministry absorbed at least BBD 3,000 in transportation costs for the vulnerable persons, and BBD 207 for two caregivers to accompany older persons in an emergency shelter.

[6] Emergency shelters are listed in two categories. Category 1 shelters are those that may be used during a hurricane or other hazard event and Category 2 shelters are those which may be used if they are still in a reasonable condition after a hazard event or disaster.

Table 7
Population in shelters

Parish	Shelter	Estimated number of persons
Christ Church	Blackman and Gollop Primary School	22
	Christ Church Foundation School	39
	Dunamis Outreach Ministries	0
	Gordon Walters Primary School	13
	St Christopher Primary School	5
Saint Andrew	Hillaby Seventh Day Adventist Church	12
Saint George	Cuthbert Moore Primary School	6
	Ellerton Wesleyan Holiness	5
Saint James	Church of God Orange Hill	4
	Gordon Greenidge Primary School	8
	Queen's College	5
	Saint Silas Primary School	6
Saint John	Mount Tabor Primary School	0
	The Lodge School	11
Saint Joseph	Tamarind Hall Branch Library	2
Saint Lucy	Connell Town Pentecostal House of Prayer	12
	Ignatius Byer Primary School	5
	The William Donald George Parish Centre	17
Saint Michael	Black Rock Seventh Day Adventist Church	18
	Combermere School	43
	Faith Wesleyan Holiness	2
	George Lamming Primary School	5
	Harrison College	11
	Lloyd Erskine Sandiford Centre (LESC)	87
	Saint Barnabas Senior Citizens Centre	2
	University of the West Indies	12
	Westbury Primary School	4
Saint Peter	Roland Edwards Primary School	6
Saint Philip	Hilda Skeene Primary School	39
	Ruby Church of the Nazarene	6
	Six Roads Church of Christ	18
Saint Thomas	Hillaby Turners Hall Primary School	0
	The Lester Vaughan School	18
Total		**443**

Source: Shelter Management Committee Report after the Passage of Hurricane Beryl from The Ministry of Education, Technological and Vocational Training.
Note: Information was not disaggregated by sex or age to reflect the differential effects of the hurricane on each segment of the population.

The DaLA team was informed that a few shelters experienced some challenges with the use of generators during the passage of the hurricane due to power outages. While ten shelters utilised generators, reports were received that two malfunctioned and one was without fuel. Maintaining generators is crucial to ensuring their reliable operation during emergencies like hurricanes. It is recommended to periodically run the generators to ensure that they start and run smoothly, especially in the lead up to the hurricane season. Additionally, storing an adequate supply of fuel would optimize preparedness for a disaster event.

The DEM and the METVT, responsible for emergency shelter management, should be commended for their ongoing assessment and maintenance of shelters nationwide. Notably, all Category 1 public shelters and 7 of the 11 privately owned Category 1 shelters are wheelchair accessible (DEM, 2024). A Shelter Assessment Committee conducts annual evaluations to ensure the structural integrity of these buildings, though most are only designed to withstand up to a Category 3 storm.

Information provided to the DaLA Team from the Ministry of Health and Wellness indicated that there were no related injuries during and after the passage of the hurricane. Additionally, access to health services and medical care was unaffected by the hurricane, which could have been different in the event of a more severe impact. The only issues reported were a minor roof leak at the psychiatric hospital and the need to refuel the generator at the geriatric hospital. In addition to having a representative placed in the National Emergency Operations Centre, the Ministry of Health and Wellness also activated its Health Emergency Operations Centre to coordinate the Health Sector response to the hurricane and activated its disaster management plans. During the hurricane, all residential health facilities remained open, except for polyclinics. That Ministry also provided first aid supplies to hurricane shelters at a total cost of BBD 19,338.

Population who suffered damage or destruction to their homes

The primary affected population also includes individuals or families who suffered damage or destruction of their homes. After all the clear was given, the BSS undertook an initial damage assessment in the affected parishes, based on incident reports received by the DEM. The DaLA Team confirmed that in the affected parishes, especially Christ Church, Saint Micheal and Saint George, most of the damages sustained to households were to roofs and walls, due to strong winds and the subsequent water damage to interiors including furnishings, appliances, and other equipment and property. An estimated 50 houses throughout the country suffered some type of effects, of which 52% had Level 2 and 3 damage (minor damage and significant structural damage respectively). An additional 18% of the affected houses were considered destroyed due to structural instabilities that cannot be repaired. Given that the average household size in Barbados is estimated at 3.6 persons per household, an estimated 180 persons suffered some type of damage or destruction to their homes and assets (table 8).

Table 8
Affected population with damage to homes
(Number of persons)

Parish	Damaged houses	Affected population[a]
Christ Church	10	36
Saint George	8	29
Saint James	1	4
Saint John	1	4
Saint Joseph	3	11
Saint Michael	7	61
Saint Philip	4	14
Saint Thomas	6	21
Total	**50**	**180**

Source: DaLA Team, 2024.
Note: Information was not disaggregated by sex or age to reflect the differential effects of the hurricane on each segment of the population.
[a] Numbers have been rounded for simplicity and easier estimation.

Relief efforts and emergency costs

The DEM activated NEOC on the night of Sunday, 30 June, to manage the national response to the passage of Hurricane Beryl before the effective national shutdown and remained fully operational until the post event situation was stabilized and under control. The NEOC was deactivated on the night of Monday, 1 July. The NEOC comprises representatives from key organizations in Barbados, both Governmental and private sector, and is tasked to receive all information and reports, collate the information and then make the decisions that keep the country safe. The expenditure for the activation of the NEOC was estimated at BBD 92,870 (see table 9).

Table 9
Costs associated with the activation of the NEOC
(Barbadian dollars)

Activity	Cost
Incidental travelling (estimated inland travel costs of EOC personnel)	6 400
Overtime (scale Z38-17) DEM staff	5 277
Allowance projected for shift 1 (50 persons x $60.00 per hour) from 6 p.m. Sunday to 3 p.m. Monday	63 000
Allowance projected for shift 2 (19 persons x $60.00) from 3 p.m. – 9 p.m. Monday	6 840
Catering	6 100
Allowance projected for shift 1 and shift 2 (DEM staff above Z17)	5 940
Allowance projected for shift 1 (15 volunteers x $30.00 per hour) from 6 p.m. Sunday to 3 p.m. Monday for 21 hours	9 450
Allowance projected for shift 2 (3 volunteers x $30.00 per hour) 3 p.m. to 9 p.m. 6 hours	540
Utility	1 000
Total projected expenditure	**92 870**

Source: Department of Emergency Management, 30 July 2024.

With regards to welfare and relief efforts, the DaLA team was informed that the MPEEA was in the process of conducting needs assessments for four families to determine appropriate medium- and long-term housing solutions following the hurricane. One woman was already in temporary housing at a cost of BBD 900 per month, with the expectation that the Ministry would cover this expense for at least three months, possibly up to a year, while her home is being repaired. The estimated transportation cost for her move to temporary accommodation was around BBD 475, which is expected to be the average cost for other families requiring temporary housing once their assessments are completed. The DaLA team also learnt that DEM donated supplies to persons affected by the hurricane at a total cost of BBD 61,037.75.

B. Secondary affected population

The secondary affected population comprises those persons who suffer indirect or secondary effects of the disaster, such as interruptions in public services, trade, employment, and from isolation. This hurricane significantly affected those working in the fisheries sector (approximately 4,091 persons) and the tourism sector (209 persons). Disruptions in the school system also impacted 44,160 students who would have lost three days of teaching instruction.

The fisheries sector was the most severely impacted by Hurricane Beryl, with much of its infrastructure and assets either damaged or completely destroyed. The BFD records indicate that 6,218 persons are registered in various roles within the fishing industry, including boat owners, agents, fisherfolk, fish sellers, and processors. The fish value chain employs about six percent of the island's workforce, totalling more than 8,800 persons.

According to the BFD's damage assessment database, the propagating large waves caused by the hurricane severely compromised the infrastructure at the Bridgetown Fisheries Complex (BFC). This resulted in damage or destruction to approximately 234 boats, affecting around 796 persons[7] connected to these vessels, including boat owners, agents, and crew members. It is important to note that 75% of the affected vessel owners reported that their boats were not insured.

Furthermore, it should be recognized that while those directly associated with the affected vessels will experience significant impacts, others in the industry such as fishers, fish sellers, processors, and vendors will also be affected due to a disruption in catchment and sales. Two of the island's most significant fisheries infrastructure elements, the BFC and the Oistins Fisheries Complex (OFC) were extensively damaged, along with considerable damage reported at the Six Men's Bay landing site. The DaLA team estimates that a further 3,295 persons[8] associated with the fishing industry were impacted. The parishes of Christ Church and Saint Michael, which have a high concentration of fishing and vessel-related activities, are the most affected parishes.

Fishing capacity, including landing infrastructure and vessels, is expected to recover gradually over the next five to six months. The fisheries sector is vital for Caribbean SIDS like Barbados, providing a key source of income and employment, while also significantly contributing to food security, cultural heritage, tourism, and climate resilience. Proper management and development of this sector are therefore essential for the island's overall well-being.

In response to the losses experienced by the fishing industry, the Government of Barbados has developed a comprehensive rescue plan.[9] As part of this effort, a new benevolent fund, supported by a BBD 500,000 humanitarian donation from the Latin American Development Bank (CAF), has been established to assist affected fisherfolk. Additionally, the Business Interruption Benefit, which was initially introduced during the COVID-19 pandemic, will be extended to all eligible individuals. A 30-year revolving fund has also been announced, with support from financial institutions to raise the necessary funds. This fund aims to assist with financing for boat repairs and the purchase of new vessels, with the government offering separate grants covering up to 25% of the costs. The goal is to ensure that access to financing is not a barrier for the fishing community.

The hurricane also affected several hotels and restaurants that are key components of the tourism sector. Tourism plays a major role in the economy, driving related industries such as commerce, food services, and transportation. This sector employs approximately 16,000 people, with a higher proportion of women in these roles (BSS, 2024). According to the Barbados Hotel and Tourism Association (BHTA), the hurricane forced partial or complete closures lasting between one and six weeks; however, the DaLA team was informed that this time can extend to one to three months. This disruption can impact the jobs of many persons employed in this sector, leading to loss or reduction of income. At the time of this DaLA, reports indicate that an estimated 209 employees across the industry were affected. Consequently, more women were likely to experience income loss and financial insecurity. This situation underscores the need for considering the implementation or expansion of temporary unemployment benefits, specifically aimed at supporting women who have lost their jobs in the tourism sector.

Approximately 44,160 students were affected when primary and secondary school classes were suspended for three days due to the hurricane. Although the damage to school facilities was minimal, many schools were used as emergency shelters. If the hurricane had caused more widespread damage

7 Based on DaLA Team estimations from the BFD damage assessment database.

8 Based on DaLA team estimation for the BFD Fisher Registry.

9 See: Article "Financing Announced for Barbados Fishing Industry Recovery and Coastal Protection" https://www.businessbarbados.com/post/financing-announced-for-barbados-fishing-industry.

or displacement of persons, the schools would have remained occupied as shelters for a longer period, leading to extended suspensions of classes. This would have had significant repercussions on the students' education, by further delaying the continuation of lessons. The situation highlights the delicate balance between using school facilities as emergency shelters and ensuring minimal disruption to education during natural disasters.

Regarding access to services, segments of the population experienced a disruption in electricity, water and telecommunications in some areas for a period during and immediately after the hurricane, although all crucial services had been restored by the next day.

III. Housing

Introduction

Residential settlements in the south-western and central portion of Barbados were affected to varying degrees, with the most damage occurring in the parishes of Christ Church, Saint Michael, Saint George. Though a small number of houses sustained damages, among this small number there were dwellings that were destroyed or rendered uninhabitable by the hurricane's effect. Impacts to homes included wind damage to roofs, water damage as a result of rain intrusion, or damage caused by falling trees and flying debris.

The materials and building practices used for constructing low-income houses in Barbados create a vulnerability to the country's population due to the low resistance of such structures to the strong forces created by hurricanes. Authorities at the Ministry of Housing, Lands and Maintenance, and the National Housing Corporation have paid special attention to the need for a comprehensive, understandable, and enforceable Building Code for Barbados and are working toward a suitable solution. It is worthy to mention that the Cabinet has endorsed the CARICOM Regional Organization for Standards and Quality (CROSQ) Code of Practice for the Construction of Climate Resilient Homes in Barbados. It should furthermore be noted that the Policy and Gender Sensitive Protocols for the Retrofitting of Low- and Middle-Income Homes, prepared on behalf of the Ministry, was approved by the Cabinet. An enforced building code can provide the construction sector with detailed guidance for new design, construction and the reconstruction of existing damaged structures. Also, legislation and financial support for government departments involved in the housing sector, can boost nationwide implementation and enforcement of building standards. With time, consistent building practices and legislative support can have a direct impact on the quality of the housing stock of Barbados, reducing the vulnerability of structures to major weather events such as Category 5 hurricanes.

According to information from the DEM and the Ministry of Housing, Lands and Maintenance, and based on field inspections, a total of 50 homes sustained and presented damage because of Hurricane Beryl. In the affected districts, about 29 dwellings were affected in some way, and 21 were severely damaged, collapsed or unsafe for use. With respect to public buildings, including government offices, churches and shelters, among others, there were no measurable impacts in terms of damages.

The DaLA team estimated damage to the housing sector in Barbados at BBD 2.96 million, losses of BBD 0.03 million resulting from the 21 homes left uninhabitable after the hurricane. Additional costs are estimated at BBD 0.04 million, reflecting activities such as removing debris, cleaning out destroyed dwellings, and some staff expenses.

To assess the damage in the housing sector, the DaLA team conducted interviews and meetings with authorities and personnel from different ministries of the Government of Barbados, as well as, visited some of the affected sites. The evaluation process also included a review of design and construction standards and codes, and the evaluation and analysis of the data received. The estimation of cost of damages considers only dwellings assessed by the responsible ministries and DaLA team. It does not consider unreported homes that sustained minor damage.

Table 10
Summary of the impacts in the housing sector, in of BBD
(Thousands of Barbadian dollars)

Impact	Public	Private	Total
Damages	-	2 960	2 960
Losses	-	28	28
Additional costs	38	-	38
Total	**38**	**2 988**	**3 026**

Source: DaLA team, 2024.

A. Damages

According to the 2021 Census, Barbados has 73,571 households and a population of approximately 269,090, with an average rate of about four persons per household (see table 11).

Table 11
Dwellings and persons by district, including percentages of the entire population

Parish	Households	Percentages	Persons	Percentages
Saint Michael	21 327	29	77 394	32
Christ Church	17 097	23	51 184	21
Saint George	5 332	7	21 939	8
Saint Philip	10 797	15	32 130	14
Saint John	2 673	4	10 417	4
Saint James	6 088	8	24 819	7
Saint Thomas	2 406	3	14 130	4
Saint Joseph	1 144	2	6 697	2
Saint Andrew	918	1	5 677	1
Saint Peter	3 315	5	13 565	4
Saint Lucy	2 474	3	11 136	4
Barbados	**73 571**	**100**	**269 090**	**100**

Source: Population and Housing Census, 2021.

Based on the same source, about 63% of those households have outer walls constructed from concrete, blocks, or stone, and as many as 31% of them have outer walls that are made of wood or wood and concrete (see table 12).

Table 12
Main materials of outer walls of dwellings in Barbados

Materials	Dwellings	Percentages
Stone	273	0
Concrete	46 508	63
Wood + Concrete	12 113	16
Wood	10 951	15
Makeshift	243	0
Other	334	0
Unknown	3 149	4
Total	**73 571**	**100**

Source: Population and Housing Census, 2021.

Structure aging is an important factor in hurricane resistance. In Barbados, about 20% of the housing stock was reported to be constructed in the year 1980 or before and is thus over 40 years old. This proportion of older houses may be underestimated, considering there is a large proportion (55%) dwellings are either of unknown or unreported age (see table 13).

Table 13
Year of completion of dwellings

Year	Dwellings	Percentages
2018–2021	1 048	1
2014–2017	1 513	2
2010–2013	2 159	3
2001–2009	4 850	7
1991–2000	5 162	7
1981–1990	5 521	8
1980 or before	12 252	17
Unknown	28 255	38
Unreported	12 811	17
Total	**73 571**	**100**

Source: Population and Housing Census, 2021.

Damage estimates are based on official reports provided by the Ministry of Housing, Lands and Maintenance, and the National Housing Corporation based on their internal assessments. Initial damage assessments were undertaken for determining the provision of government assistance to affected persons. The DaLA team used these initial estimates as a reference and expanded the number of dwellings to include all those reported as being affected by Hurricane Beryl. Further, field inspections were made directly by the assessment team to independently verify various findings.

Though the most damage occurred in the communities to the southwestern end of Barbados, more severe impacts were correlated with physical vulnerabilities in the housing structure. Most of the damages sustained by the structures were to roofs and walls, due to strong winds and the subsequent water damage to interiors including furnishings, appliances, and other equipment and property. According to official data and field inspections, 50 homes in Barbados sustained damage totalling an estimated BBD 2.96 million (see table 14).

Table 14
Summary of damages in the housing sector by parish
(Thousands of Barbadian dollars)

Parish	Dwellings	Estimated cost
Christ Church	10	666.0
Saint George	8	525.0
Saint James	1	55.0
Saint John	1	54.1
Saint Joseph	3	317.8
Saint Michael	17	732.0
Saint Philip	4	245.0
Saint Thomas	6	365.3
Total	**50**	**2 960.1**

Source: DaLA team, 2024.

Estimated damage to dwellings was calculated considering the level of damage assigned to each house as follows:

- Level 1: No significant damage: Structure is usable and can be occupied. Repairs required are minimal. Examples: some metal sheets are shifted or loosened allowing for leaks.
- Level 2: Minor damage: Structure is usable and can be occupied after urgent temporary measures are taken. Occupiers will need assistance with repairs. Examples: portions of roof covering are missing or damage from fallen trees.
- Level 3: Major damage: Structure is not usable and cannot be occupied until repairs are made. Example: roof covering is blown off exposing interior of structure, windows and doors are missing, and walls are damaged.
- Level 4: Destroyed: Structure is not usable and cannot be repaired. Must be rebuilt. Example: walls are blown down and structural instability.

Table 15
Summary of levels of damage to dwellings by parish
(Thousands of Barbadian dollars)

PARISH	Damage Level 1	Damage Level 2	Damage Level 3	Damage Level 4	Estimated replacement
Christ Church	26	100	145	395	666.0
Saint George	-	245	150	130	525.0
Saint James	-	55	-	-	55.0
Saint John	-	54.1	-	-	54.1
Saint Joseph	-	-	166.4	151.3	317.8
Saint Michael	82	155	225	270	732.0
Saint Philip	-	100	145	-	245.0
Saint Thomas	26.2	-	80	259.1	365.3
Total	**134.2**	**709.1**	**911.4**	**1205.4**	**2 960.1**

Source: DaLA team, 2024.

There seems to be a pattern of damage among older houses and poorly maintained properties (see image 1). Several of the most severely damaged dwellings were quite old, poorly maintained, and already susceptible to weather damage. Many dwellings in Barbados are over 40 years old (at least 20%), and as such, can suffer from low levels of preventive maintenance due to deterioration with age. Risk of damage is therefore relatively high among this section of the housing sector and is reflected in the destruction of such dwellings during the event.

Image 1
Damaged houses with roofs blown off

Source: DaLA team, 2024.

B. Losses

Losses in the housing sector relate to the interruption of accommodation services to the occupants, due to severe damage or destruction of the housing stock, thus making it temporarily or permanently uninhabitable. According to census data, a total of 11% of the Barbados housing stock is used for rental properties, as such, the estimate for the interruption of services is based on 11% of dwellings for homes deemed uninhabitable (damage levels 3 and 4). The average rental rate was estimated to be BBD 977 per month. Losses were, therefore, estimated for six months in the case of level 3 damage and for one year in the case of complete destruction of the dwelling. Table 16 shows estimate of losses for homes deemed uninhabitable after Hurricane Beryl.

Table 16
Losses due to uninhabitable dwellings in the housing sector
(Thousands of Barbadian dollars)

Condition	Number of Dwellings	Time *(Months)*	Estimated value *(Per month)*	Losses
Level 3 Damage - Uninhabitable	12	6	0.98	8.1
Level 4 Damage - Destroyed	9	12	0.98	19.8
Total				**27.9**

Source: DaLA team, 2024.

C. Additional costs

Additional costs comprise costs incurred as a result of several activities, namely demolition of the most affected dwellings (level 4), debris cleaning and handling (levels 3 and 4), and extra staff costs associated with transportation and extra work related to the assessments done by the government in response to Hurricane Beryl. The estimated additional cost of debris removal from demolition and organic debris from affected dwellings is BBD 10,500, according to estimates provided by the Government of Barbados. The additional cost is approximately BBD 38,000 (see table 17).

Table 17
Summary of additional costs to the housing sector
(Thousands of Barbadian dollars)

Description	Cost per unit	Number of units	Estimated cost
Demolition	2.5	9	22.5
Debris removal	0.5	21	10.5
Staff and services	5	1	5.0
Total			**38.0**

Source: DaLA team, 2024.

IV. Education

Introduction

According to information from the METVT, only three secondary schools experienced damage. There were no reports of damage to primary, special, private, or tertiary institutions. One school sustained minor roof damage, while the others had minor damage to non-structural components such as fences and bathrooms. No damage was reported to furnishings, equipment, or teaching materials. The estimated damage to the education sector amounts to BBD 19 thousand.

Losses in the sector, primarily reflecting the value of lost instructional time due to the interruption of school for three days (when some facilities were used as emergency shelters), are estimated at BBD 2.4 million. The METVT incurred additional costs for preparing schools to be used as shelters and for cleaning the facilities after the shelters were deactivated. There were no reports of damage to equipment or furniture while the shelters were in use. Additional costs are estimated at BBD 127 thousand (see table 18).

The estimates provided in this report are based on information from the METVT and focus on public education facilities in the parishes of Saint Andrew, Saint Joseph, and Saint Michael.

Table 18
Summary of the impacts in the Education sector
(Thousands of Barbadian dollars)

Impact	Total
Damages	19
Losses	2 363
Additional costs	127
Total	**2 509**

Source: DaLA team, 2024.

A. Damages

Barbados has achieved universal education and has seen a significant increase in pre-primary enrolment, growing from 57% in 2000 to 94% in 2020. Secondary enrolment has remained steady at 98 percent, while tertiary enrolment reached 40% in 2020. The ongoing education reform agenda aims to equip more youth and adults with the skills needed for decent jobs, entrepreneurship, and national development, while also enhancing learning opportunities for persons with disabilities (Government of Barbados, 2023).

The country boasts of a well-developed education system, which emphasizes lifelong learning, critical thinking, and problem-solving skills. The government's current educational priorities include improving the quality of education, expanding access to tertiary education, and promoting Science, Technology, Engineering, Arts, and Mathematics (STEAM) education to support their long-term vision of developing a Blue Green Economy.

According to data from the METVT, a total of 44,160 students were enrolled in public and private schools across Barbados during the 2018-2019 school year. Additionally, 3,142 students were enrolled in post-secondary non-tertiary education facilities across the country. The gender distribution among these students was fairly balanced, with 51.3% male and 48.7% female. Approximately 9,286 students attended the three tertiary education institutions. However, for the purposes of this DaLA, tertiary education students were not included in the analysis, as their school term had ended before the hurricane's passage (see table 19). The data also shows that there are 3,288 teachers in public and private primary and secondary schools, with women comprising about 72% of this workforce (Statistics in Education in Barbados, 2018-2019).

Table 19
Distribution of pre-primary, primary and secondary education students, 2018–2019
(Number of students)

	Male	Female	Total
Pre-primary education	2 638	2 506	5 144
Primary education[a]	10 307	9 588	19 895
Secondary education[b]	9 600	9 521	19 121
Post-Secondary non-tertiary education[c]	1 701	1 441	3 142
Total	**24 246**	**23 056**	**47 302**

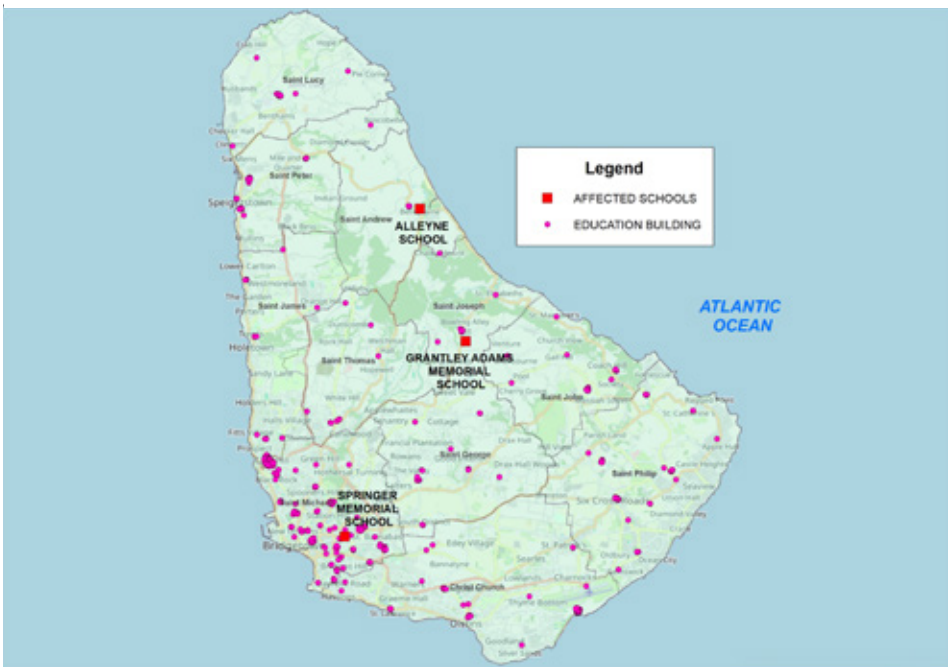
Source: Ministry of Education, Technological and Vocational Training, Statistics on Education in Barbados at a Glance; 2018–2019.
[a] Primary Education includes both public and private entities, as well as special needs facilities.
[b] Secondary Education includes both public and private entities, as well as long-term alternatives.
[c] Post-Secondary Non-Tertiary Education includes 10 secondary schools that offer two years of 6th Form and the Samuel Jackman Prescod Institute of Technology.

The pre-primary, primary, special needs, and secondary education levels in Barbados serve children aged 3 to 16 years. Compulsory education begins at age 5 and continues until age 16, making pre-primary education optional. However, recent policies have promoted the expansion of pre-primary education. Regarding the distribution of educational facilities, Barbados has 68 public primary schools and 25 private primary schools. Over 40% of these are located in the parish of Saint Michael, followed by Christ Church. The country also has 33 secondary schools, 22 of which are public, while 11 are private institutions. Additionally, ten public secondary schools offer two years of post-secondary non-tertiary education, commonly known as 6th Form. The Samuel Jackman Prescod Institute of Technology is the only institution in Barbados dedicated solely to post-secondary non-tertiary education. For tertiary education, there are three public institutions: the Erdiston Teachers' Training College (ETTC), the

Barbados Community College (BCC), and the University of the West Indies, Cave Hill Campus (UWI). Saint Michael has the highest concentration of educational facilities, followed by Christ Church.

Damage estimates are based on the sector assessment report from the METVT. The education sector sustained minimal damage to three secondary schools, Alleyne School, Grantley Adams School and Springer Memorial School located respectively in the parishes of Saint Andrew, Saint Joseph and Saint Michael, requiring minimal repairs (see map 6).

Map 6
Distribution of primary and secondary schools



Source: Land and Survey Department, Layer with Buildings of Barbados – 2023.

The estimated cost of damage to education facilities is approximately BBD 18.7 thousand (see table 20). The Alleyne School in Saint Andrew suffered the most damage, particularly to four prefabricated buildings, including the roofs and windows of the Staff Room and Business Block. One building had a split beam, and the Industrial Arts and Human Ecology Buildings experienced water damage to its roof. A carpenter had already been contracted and was in the process of making repairs at the time of the DaLA. At Grantley Adams Memorial School, a fallen tree damaged the perimeter fence, and there were leaks in the main building block. The Springer Memorial School experienced water damage to a bathroom door, detached guttering, and a waterlogged ceiling. Despite these issues, no damage was reported to educational materials, equipment, or furniture, and all schools resumed normal operations three days after the hurricane passed. The DaLA team was informed that there was no damage to primary and tertiary educational facilities, and the METVT did not receive any reports from private institutions at the time of the assessment.

Table 20
Summary of damages in the education sector by parish
(Barbadian dollars)

Parish	Facility	Description of damage	Estimated cost
Saint Andrew	Alleyne School	Minor damage	6 389[a]
		Four (4) prefab buildings damaged (galvanize on one roof to be replaced, window frames to be replaced).	
		Beams attached to building were split.	
		Galvanize sheets to be reinforced on the southern part of staff room and business block.	
		Roofs of Industrial Arts and Human Ecology Blocks have water damage.	
Saint Joseph	Grantley Adams School	Minor damage	4 952
		Perimeter fence damaged due to fallen tree.	
		Switch IT compromised.	
		Water leaks in main building.	
		Blocked drain from broken branches and fallen leaves.	
Saint Michael	Springer Memorial School	Minor damage	7 381
		Swollen bathroom door.	
		Detached guttering and waterlogged ceiling on landing between new block & needlework room.	
Total			**18 722**

Source: DaLA team, 2024.
Note: DaLA estimations based on the details provided from the damage assessment report on secondary schools.
[a] This cost was already provided by the Ministry of Education, Technological and Vocational Training.

B. Losses

Losses in the education sector refer to affected flows like the reduction in hours or days of classes taught. Hurricane Beryl interrupted the normal operation of all public and private educational facilities in Barbados, from pre-primary to secondary schools. Tertiary institutions, including the Samuel Jackman School (post-secondary non-tertiary), were already on semester break at the time. Schools were closed from Monday, 1 July and reopened three days later, on Thursday, 4 July. For this analysis, losses were estimated for public pre-primary, primary, and secondary education where data was available. Although the "all clear" was given on the night of 1 July, schools were used as emergency shelters and needed to be cleaned before classes could resume. Losses are estimated based on the principle that when a service, such as teaching, is paid for but cannot be provided for three days due to a disaster, it constitutes a financial loss. The interruption of educational services, even temporarily, translates into lost instructional time, which has financial implications, especially when salaries are being paid despite the lack of service delivery.

Estimations were based on the duration of school closure, using the average monthly salaries of teachers for the 2023-2024 academic year as a proxy. The total estimated personal emoluments for staff at each school in the pre-primary, primary, and secondary sectors were considered, and the number of hours lost was calculated based on a school schedule of 8:00 a.m. to 3:00 p.m. Salary scales included principals, deputy principals, graduate teachers, qualified and special education teachers, guidance counsellors, and IT coordinators, where available. The estimated losses incurred were approximately BBD 2.4 million (see table 21).

Table 21
Losses in the public education sector
(Thousands of Barbadian dollars)

Education Sector	Losses
Pre-primary & primary	1 288
Secondary	1 075
Total	**2 363**

Source: DaLA team, 2024.
Note: Estimated losses are based on 3 days disruption in school. Monthly salary estimates are based on the number of teaching staff and their salary scales. Teaching Staff Includes Principals, Deputy Principals, Teachers, Guidance Counsellors, IT Coordinators.

C. Additional costs

The METVT incurred additional costs related to preparation of the schools that were converted to temporary shelters. This included cleaning, sanitizing and upgrade of potable water tanks, refuelling diesel generators and installing temporary hurricane shutters. There were also costs associated with cleaning the shelters after the passage of the hurricane, in preparation for the resumption of schools. Additional costs are estimated to be BBD 127,089 (see table 22).

Table 22
Additional costs in the education sector
(Barbadian dollars)

Additional costs	Total
Upgrade of potable water tanks in shelters	32 323
Refuelling of diesel generators	31 281
Temporary hurricane shutters in shelters	60 105
Cleaning of shelters	3 380
Total	**127 089**

Source: DaLA team, 2024.

V. Fisheries and agriculture

Introduction

The fishing sector in Barbados accounts for around 4% of the agricultural gross domestic product of the island. Based on data from the BSS, the fisheries sub-sector registered BBD 9.9 million value-added in 2023. The fisheries sector has an important role from the social, economic, cultural and tourism point of view. The sector has been developed under the areas of marine commercial, recreational fishing, aquaculture and post-harvest activities. Also, the local fisheries contribute significantly to food and nutrition security and the development of small family businesses.

The fisheries and agricultural sectors' economic activity and productive assets suffered impacts from Hurricane Beryl. The total economic impact was significant in the fishing sector (BBD 56 million) and slight in the agricultural sector (BBD 1.5 million). The physical assets and operations of the fisheries sector, which is important for its social relevance, cultural heritage and food security in Barbados, were severely impacted by a strong swell, winds up to 150 mph (241 km/h), heavy rainfall and flash flooding. The estimated economic impact of this disaster in the Barbados' fisheries sector was around BBD 47 million in damages to fisheries assets; BBD 5.3 million in losses to fisheries' economic flows and approximately BBD 3.9 million in additional costs.

Table 23
Summary of the impacts in the fisheries sector
(Thousands of Barbadian dollars)

Effect	Public	Private	Total
Damages	14 627	32 329	46 956
Losses	-	5 258	5 258
Additional costs	3 630	128	3 902
Total	**18 401**	**37 714**	**56 115**

Source: DaLA team, 2024.

The total estimated damage in the fishing sector was BBD 47 million, 69% of which was fishing vessel damage, 30% was fishing landing site damage, and 1% was other fisheries assets damage. The BFD determined that 240 vessels were totally or partially damaged from 312 active vessels prior to this disaster. Two of the largest landing and vending fisheries infrastructure assets on the island were extensively damaged: Bridgetown Fisheries Complex (BFC), 82.5%, and Oistins Fisheries Complex (OFC), 9.2%. This infrastructure lands around 92% of the total fisheries captured in the island.

The total fisheries losses estimated were BBD 5.3 million in 23 fishing group species, 83%were in three main species groups: flying fish (35.4%), dolphinfish (23.1%) and tuna (24.3%). Other losses' of about 14% were distributed in the group species jacks (3.3%), barracuda (3.1%), marlin (white/blue) (1.7%), bill fish - Atlantic sailfish (1.6%), kingfish - mackerel (1.5%), pot fish (1.4%), and swordfish (1.3%). These estimated fisheries losses refer to a 95% decrease in post-event fishing capacity due to a reduction in the fishing fleet, fishing landing capacity and supply of inputs for the vessels.

The estimated additional costs for the recovery of fishing capacity in Barbados were BBD 3.9 million. 90% of the estimated additional costs are related to governmental support to the fishing community directly affected by this event. This benefit is related to the people employed by the 240 affected vessels. The remaining 10% of the additional costs are related to the movement of vessels from the port (5%), cleaning of debris (2%) and temporary storage of affected vessels (3%).

Additionally, the estimated economic effect in the Barbados' agricultural sector was around BBD 1.4 million in losses at the agriculture's economic flows, 91% of the losses were in plantain crops. The rest was observed in banana (5%), tomato (3%), beans (1%) and pumpkin (less than 0.5%) crops. Damage to agricultural assets was estimated at BBD 34.5 thousand; 87% of the damage was in greenhouses and shade houses. The rest was in tanks of agricultural irrigation systems. There were no additional costs reported in this sector.

Table 24
Summary of the impacts in the agricultural sector
(Thousands of Barbadian dollars)

Effect	Public	Private	Total
Damages	35	-	35
Losses	-	1 440	1 440
Additional costs	-	-	-
Total	**35**	**1 440**	**1 475**

Source: DaLA team, 2024.

A. Damages

Fisheries sector

The BFD has on file over 6,218 persons registered in different activities in the fishing industry. Some of these registered persons are boat owners, boat agents, fishermen, fish seller, fish processors and aqua culturists. Six percent of the island's workforce is employed by the fish value chain. The total number of persons employed in this value chain exceede.d 8,800 persons[10].

The Government of Barbados (2017) has estimated that there the local fishing fleet was at that time 1,163 fishing vessels[11] targeting the various types of species caught by the island's fishermen. This number of vessels involves small open boats (3-6 m LOA[12]) and large, long liners

[10] Barbados Fisheries Division, 2024.
[11] Local Fishing Fleet – Government of Barbados, 2017 / Barbados Fisheries Division declared 312 vessels active, 2024.
[12] LOA means Length Overall.

propelled (12-24 m LOA) with inboard engines between 135 – 600 horsepower (hp). Regarding the fishing fleet, 57% are moses, 22% are day boats, 17% are ice boats and 4% are long liners.

The smallest vessels in the fishing fleet are the moses, which are 3-6 metres long and have the general characteristics of an open boat. They are commonly constructed with wood or glass reinforced plastic and propelled by oars or motor (10 – 40 hp). The day boats or launches are decked wooden boats with a length of 6 – 12 meters and powered by a diesel engine (10 – 180 hp). Iceboats are decked wooden boats with a length greater than 12 meters, equipped with navigation, communication, GPS equipment, with insulated ice cellars and propelled by a diesel engine (180 – 200 hp). The long liners are boats like iceboats; but they are greater than 12 meters length (12 – 24 meters). These boats usually designed to have a crew of 4 or 5 persons and are equipped with navigation systems, communication and safety equipment.

All these types of vessels have specific landing sites around the coastal perimeter of the island. Barbados has around 31 fish landing and vending sites. Most of these fish landing and vending sites are in the western part of the island. These sites have been classified by the BFD into primary sites, secondary sites and tertiary sites. Most sites are monitored by government regulatory institutions. Primary sites provide infrastructure for the post-harvest fishing process with access to water, ice production, processing capacity and internal sales. Secondary sites are simple buildings with access to running water and fish-cutting infrastructure, but no ice-making capacity and no windows or doors. Tertiary sites are places with minimal or almost no permanent infrastructure for fish processing.

There are six primary sites spread across the western part of the country: Speightsown, Weston - Read's Bay, BFC, OFC, Consett Bay and Paynes Bay. Additionally, the island has five secondary sites distributed around its eastern and western perimeter: Half Moon Fort, Fitts Village, Pile Bay, Martins Bay and Tent Bay.

There are 19 tertiary sites which are distributed around the coastal perimeter of the island: Stroud Bay, Six Men's Bay, Road View Beach, Lower Carlton, Mount Standfast, Holetown, Brooklyn Beach, Prospect, Shallow Draught, Bay Street Esplanade, Burkes Beach, Worthing, Saint Lawrence, Dover Beach, Silver Sands, Foul Bay, Crane Beach, Long Bay and Bath Beach. BFD also monitors Shallow Draught, Foul Bay and Bath Beach from these tertiary sites.

Map 7
Fish landing sites and fishing vessels mooring sites in Barbados

Source: DaLA team, 2024 with data from the Barbados Fisheries Division.

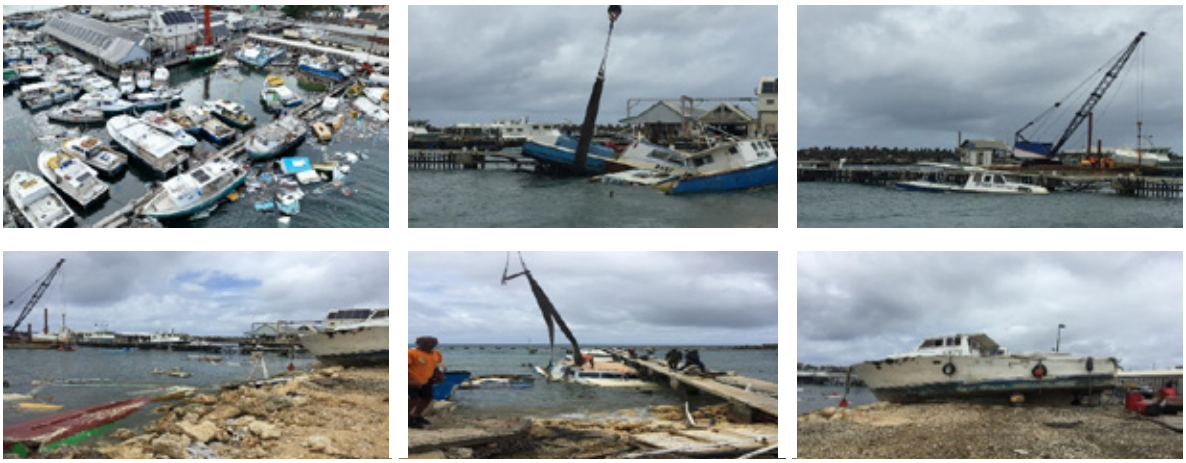
The government authorities monitor 74% of landing and vending sites. Only the sites at Road View Beach, Lower Carlton, Prospect, Shallow Draw, Worthing, Dover Beach, Foul Bay and Bath Beach are not monitored.

The largest sites on the island are the Bridgetown Public Market and Oistins - Berinda Cox Fish Market. These two primary sites have additional infrastructure that other primary sites do not have. Bridgetown Public Market has processing rooms, ice production facilities and a fishing harbour. Oistins – Berinda Cox Fish Market has a jetty, ice production facilities, fish processing rooms and market stalls.

Barbados' fisheries assets and infrastructure were at high risk from extreme weather conditions on 1 July 2024. Large propagating waves were the weather effects in southern Barbados. The BFD has reported significant damage to the island's fishing fleet, partial damage to some of the main fishing landing facilities, to fish aggregating devices, to fish pots and some ecosystem damage due to fuel pollution (gas, diesel and oil).

Prior to the event, the BFD had around 312 vessels registered and active for the different types of fishing activities carried out on the island (2024)[13]. Fisheries authorities determined or estimated that around 240 vessels were totally or partially damaged by the passage of Hurricane Beryl, 50% of the affected vessels were ice boats (121); they were the most affected of all the types of fishing boats. The second most affected type of vessel by number was moses (42); representing 18% of the total vessels affected. Longliners were the third most affected vessel type by number (37), representing 15% of the total vessels affected. The types of vessels least affected by number were launches (19 units or 8% of total affected vessels), day boats (17 units or 7%) and sport fishing vessels (4 units or 2%).

Image 2
Photographs of private damage to assets/vessels in the fishing sector



Source: DaLA Team and Barbados Fisheries Division, 2024.

Based on damage statements reported by boat owners[14], 27% of the vessels have total or non-repairable damage (64 boats). The remaining 73% of the vessels have partial or repairable damage (176 boats). Some of the vessels declared totally damaged were confirmed and identified through aerial surveys using drone technology and remotely operated vehicles in the BFC's Harbour. The aerial survey determined that 28 vessels were sunken at the bottom of the Harbour.

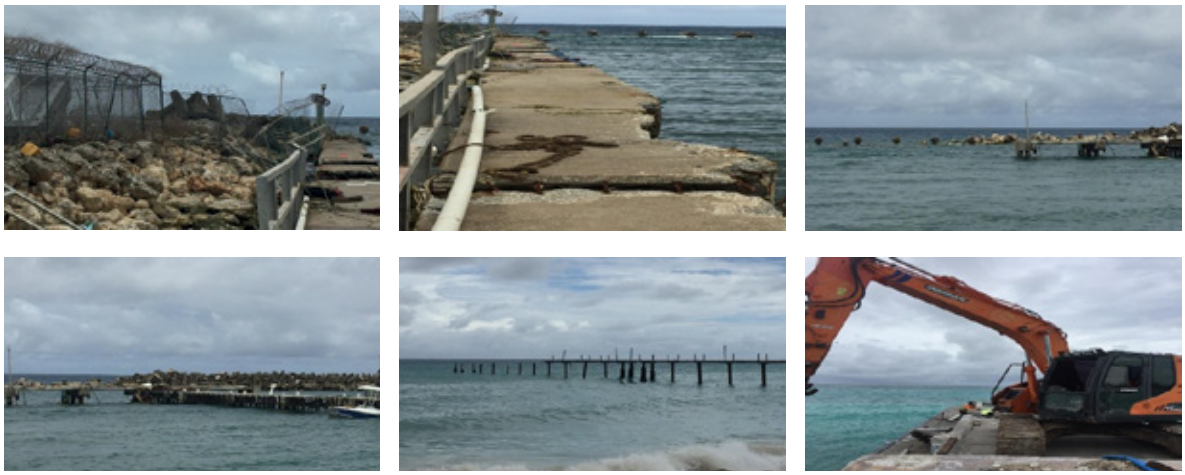
[13] Government of Barbados - Data collection, 2024.
[14] Barbados Fisheries Division had received 166 damage declaration forms until July 16, 2024 / 64 boats are confirmed with total losses.

It is important to highlight that 75% of the owners of the total affected vessels declared that they do not have their vessels insured. Only 8% declared that they have their vessels insured, 17% preferred to not answer the question. All vessels with reported damage were privately owned; this reflects the impact of Hurricane Beryl on the assets of the fishing economic sector.

Most of the fisheries infrastructure damaged by this disaster are publicly owned. Two of the largest landing and vending fisheries infrastructure assets on the island were extensively damaged: BFC and OFC. Also, extensive damage has even been reported at the Six Men's Bay landing site.

Major damage was observed and identified in the infrastructure of the BFC. The concrete infrastructure of the jetties was damaged, the port fence was destroyed in areas close to the sea, fuel dispensers at the end of pier were dislodged, fuel transmission lines were severely affected (bent 130 degrees), electrical installations in the jetties suffered damage and the wave-breaking infrastructure was altered to a significant extent. The infrastructure at OFC suffered significant damage but to a lesser extent than the infrastructure at BFC. The force of the waves from Hurricane Beryl ripped out the pumping station and caused significant damage to the fuel transmission lines.

Image 3
Photographs of public damage to infrastructure in the fishing sector



Source: DaLA Team, 2024.

Other fisheries assets damaged by Hurricane Beryl include fish aggregating devices (FADs) and fish pots. The swells generated by Hurricane Beryl caused movement and damage to FADs; the BFD reported that two FADs were forcibly moved form their original locations and another two were completely lost. The increase in wave energy also caused destruction and significant damage to the fish pots, several of which needed to be repaired. The BFD has estimated 118 fish pots damaged in different landing sites. The landing sites that reported damaged fish pots were: Pile Bay (56 pots), Bay Street (28 pots), Half-Moon (18 pots), Saint Lawrence (12 pots) and Holetown (four pots).

The total estimated damages in the fishing sector were BBD 47 million, 77% of these total estimated damages are related to fishing vessels used in the different fishing modalities. The other 22% of the total damage is related to the infrastructure of the fishing landing sites. The other 1% of the recorded damage is related to fishing aggregating devices and fish pots affected by the climatic event.

Table 25
Damages in the fisheries sector
(Thousands of Barbadian dollars)

Vessel damage			
Types of vessels	**Public**	**Private**	**Total**
Long liners	-	11 295	11 295
Ice Boats	-	17 610	17 610
Fishing Sport Vessels	-	1 980	1 980
Moses	-	558	558
Launches	-	486	486
Day Boats	-	400	400
Sub total	**-**	**32 329**	**32 329**
Infrastructural damage			
Type of infrastructure	**Public**	**Private**	**Total**
Break Waters	13 064	-	13 064
Jetties	921	-	921
Fuel Dispenser Houses	115	-	115
Fence	16	-	16
Sub total	**14 116**	**-**	**14 116**
Other infrastructure			
Type of infrastructure	**Public**	**Private**	**Total**
Fishing Aggregating Devices	400	-	400
Fish Pots	111	-	111
Sub total	511	-	511
Total	**14 627**	**32 329**	**46 956**

Source: DaLA team, 2024.

In terms of damage to fishing vessels, ice boats were the most affected type of vessel. The total estimated cost of replacement and repair for this type of vessel amounts to BBD 18 million; representing a little more than half (55%) of the total damage estimated in this fishery assets category. The second most affected type of vessel was Longliners with an estimated replacement or repair value of BBD 11 million, representing nearly 35% of the total estimated damage to fishing vessels. Ten percent of boat damages were recorded in fishing Sport vessels (6%), moses (2%), launches (1%) and day boats (1%).

Regarding the infrastructural damage at the main landing sites, the greatest damage observed was in the wave-breaking infrastructure. The assessment team has estimated the cost of replacing or repairing the infrastructure to be approximately BBD 13 million, representing 93% of the total damage registered in the infrastructure at the fishing landing sites. The remaining 8% of the total infrastructure damage at fishing landing sites is related to repair and replacement of parts of the jetties. Other minor damages identified are related to fuel dispenser houses (BBD 0.1 million), fencing (BBD 16 thousand), fishing aggregating devices (BBD 0.4 million) and fish pots (BBD 56 thousand). The replacement or repair of these minor assets is essential to re-establish the fishing operations of the island.

Agriculture sector

The Agricultural Sector had minimal damage to its assets compared to the fishing sector. The Food and Agricultural Organization (FAO) estimates that Barbados has around 10,000 hectares of agricultural land and approximately 6,300 hectares of forest land. FAO in its statistical portal (FAOstat) records around 5,601 agricultural hectares cultivated and harvested in 2022.

Table 26
Structure of agricultural land by crop in Barbados

Crop	Acres	Hectares	Percentages
Sugar	6 304	2 551	72.0
Potato (sweet)	400	162	4.6
Watermelon	214	86.5	2.4
Yam	181	73.4	2.1
Okra	148	60.0	1.7
Squash	142	57.6	1.6
Cucumber	137	55.4	1.6
Lettuce	135	54.5	1.5
Tomato	133	53.8	1.5
Pumpkin	124	50.0	1.4
Cassava	82.2	33.3	0.9
Onion	81.8	33.1	0.9
Cotton	81.0	32.8	0.9
Pepper (sweet)	80.3	32.5	0.9
Bean	74.0	29.9	0.8
Cantaloupe	51.4	20.8	0.6
Carrot	49.9	20.2	0.6
Peas	43.0	17.4	0.5
Cabbage	34.3	13.9	0.4
Chinese cabbage	32.9	13.3	0.4
Beet	27.0	10.9	0.3
Eddoe	25.3	10.2	0.3
Pepper (hot)	24.9	10.1	0.3
Chive	24.6	10.0	0.3
Plantain	19.5	7.9	0.2
Bananas	19.0	7.7	0.2
Egg Plant	18.4	7.4	0.2
Corn	14.1	5.7	0.2
Zucchini	9.8	4.0	0.1
Runcifers	9.3	3.8	0.1
Spinach	6.1	2.5	0.1
Thyme	5.9	2.4	0.1
Muskmelon	4.2	1.7	0.05
Peanut	3.6	1.5	0.04
Christophene	3.3	1.3	0.04
Paw paw	3.2	1.3	0.04
Squash (finger)	2.4	1.0	0.03
Parsley	2.1	0.9	0.02
Bonavise	0.9	0.4	0.01
Seasoning	0.9	0.4	0.01
Marjoram	0.7	0.3	0.01
Celery	0.1	0.03	≤ 0.01
Basil	0.1	0.03	≤ 0.01
Cauliflower	0.1	0.03	≤ 0.01
Figs	0.01	≤ 0.01	≤ 0.01
Broccoli	0.01	≤ 0.01	≤ 0.01
Dill	≤ 0.01	≤ 0.01	≤ 0.01
Total	**8 754**	**3 542**	**100**

Source: FAO, 2022, adjusted with data from Ministry of Agriculture, Food and Nutritional Security.

The assessment of agricultural damage begins with understanding the decomposition of land use in its different economic activities to estimate damage on assets linked to the land: agricultural soil, greenhouses, tractors, seeders, harvesters, agricultural equipment, agricultural warehouses, among others. Land is the main asset for agricultural production. The total damage to this productive asset can completely limit agricultural production in the Island.

The main asset of livestock production is the stock of animals of each species, with other assets including the infrastructure to support housing, breeding, and production.

Table 27
Livestock stocks in Barbados
(Number of animals)

Type of livestock	Animals
Chickens	4 655 000
Laying Hens	1 009 000
Turkeys	84 000
Swine / pigs	24 000
Sheep	13 320
Cattle	12 239
Goats	5 599
Dairy Cows	3 196
Asses	2 181
Mules and hinnies	2 000
Horses	1 236

Source: FAO, 2022.

Based on the number of animals, the assets or livestock infrastructure necessary for their breeding and production of livestock products are estimated. Livestock installations depend on the number of animals existing on each property and the technological level used in its production. The type of technology used depends on the size of the initial investment made and the two economic flows for its maintenance and replacement.

Based on the number of animals, the most common livestock species on the island are poultry: chickens, hens and turkeys. More than 9.9 million chickens are slaughtered every year in Barbados based on their stock and slaughter reports. Other species with a significant number of stocks are pigs and sheep. More than 32 thousand pigs are slaughtered each year.

Even though expectations of damage to Barbados' agricultural sector were minimal, the Ministry of Agriculture, Food and Nutritional Security conducted a damage assessment around the island. The assessment was carried out one day after Hurricane Beryl by Extension Officers (BADMC) in twenty-seven agricultural districts in the following parishes: a) Parish Saint Lucy: Spring Hall and Mount Poyer; b) Parish Saint John: Wakefield and Bath; c) Parish Saint Philip: River Plantation, Moncrieffe, Rices, Ruby, Heddings and Marchfield; d) Parish Saint Michael: Pine Basin, Haggatt Hall and Lears Urban; e) Parish Saint George: Salters and Redland; f) Parish Christ Church: Silver Hill, Fairy Valley, Spencer's, Graeme Hall, Saint Patrick's – Fairview, Gibbons Boggs, Pegwell Boggs, Wilcox and Silver Hill; g) Parish Saint Andrew: Greenland; h) Parish Saint Joseph: Frizers Plantation; and i) Parish Saint John: New Castle.

Damages were mostly concentrated in the south, south-eastern and eastern areas of the island. Some protected agricultural structures such as shade houses and greenhouses were damaged by the forced of the wind. Some cover and structural materials need to be replaced to establish operativity of these shade houses and greenhouses. Additionally, irrigation equipment as tanks has been reported with damages in the agricultural activity. The total damage estimated in the sector of agriculture was around BBD 34.5 thousand.

Image 4
Photographs of damages to public infrastructure in the agricultural sector

Source: Ministry of Agriculture, Food and Nutritional Security, 2024.

Table 28
Damages in the agricultural sector
(Thousands of Barbadian dollars)

Structure			
Location	**Public**	**Private**	**Total**
BADMC Greenhouse (Lears)	12	-	12
Chinese Greenhouse (Fairy Valley)	2	-	2
Redland Plantation (Redland)	16	-	16
Sub total	**30**	**-**	**30**
Tanks			
Location	**Public**	**Private**	**Total**
Ramases Squires (Mount Poyer)	1.5	-	1.5
Ron Camille (Mount Poyer)	1.5	-	1.5
BADMC Vacant Lot (Plot 18 / Mount Poyer)	1.5	-	1.5
Sub total	**4.5**	**-**	**4.5**
Total	**34.5**	**-**	**34.5**

Source: Ministry of Agriculture, Food and Nutritional Security, 2024.

B. Losses

Fisheries sector

The fisheries sector structures its activity into multi-gear fishing, multi-species fishing and seasonal fishing. The diversity of fisheries on the island varies from near-shore or reef species to deep-sea (pelagic) species with migratory capacity. The species most commonly and traditionally fished are flying fish, dolphinfish, wahoo, tuna, billfish, sailfish and swordfish. The most common reef species caught near shore are snappers, parrotfish, squirrelfish and surgeonfish. Other species are also fished, such as coastal pelagics (jacks, herrings and barracudas), sharks, rays, sea urchins (sea eggs) and shellfish (conchs and lobsters).

The historical annual fishing catch has ranged from 1,300 to 3,500[15] metric tons (MT) over the past 20 years. An average annual catch of approximately 2,300 MT can represent an important source of revenue for Barbados. Figures from the BSS show a downward trend in GDP figures for the fishing sector in Barbados. The GDP of the fishing sector has decreased by 58% in the last decade.

The fisheries sector has contributed between 2.9 to 10.9% of agricultural GDP over the past fourteen years. Over the past five years, this contribution has reached its lowest levels and fluctuated between 2.9 to 4.5% of agricultural GDP. The fishing industry is also characterized by the export of a part of its annual catch and the import of a significant quantity of fresh, semi-processed and processed fish. Barbados exports around 2% of its local landings. Its main export destination is the United States with the yellowfin tuna species. However, it imports a significant amount of fresh, semi-processed and processed fish. Its imports exceeded the volume of 6,234 MT per year with a commercial value of around USD 23.3 million[16]. Barbados' fish imports are structured as follows: chilled, fresh or frozen fish (49%); canned fish (40%) and processed fish (11%). A large amount of fish imports is distributed through the local channel and the tourism chain. Additionally, fish imports in different stages are an important component of the island's food security.

Over the years, most of the total marine capture in Barbados were pelagic fishes (81%) and tunas, bonitos and billfishes (11%). Historically, 66% of the total annual catch is related to flying fish fishery, although this percentage has fluctuated drastically over the past few years[17]. The most caught species is *Hirundichthys affinis* (Four-Winged flying fish) and represents about 90% of the total catch in flying fish fishery. The second most important species are dolphinfish (*Coryphaena hippurus*) commonly compromising around 13 - 17% of the total annual landings.

The main fisheries in Barbados can be defined as follows: shallow-shelf reef; bank-reef and deep slope; coastal pelagics, flying fish; large pelagics, sea eggs; lobsters; conch and sea turtles. Below are the different species captured during the fishing processes on the Island:

Table 29
Main fisheries and species captured in Barbados

Fishery	Species
Shallow - shelf reef	Hinds (Serranidae), Parrotfishes (Scaridae), Grunts (Haemulidae), Surgeonfishes (Acanthuridae) and Triggerfishes (Balistidae)
Deep - slope and bank Reef	Snappers (Lutjanidae), Queen Snapper (Etelis Oculatus), Silk Snapper (Lutjanus vivanus) and Vermillion Snapper (Rhomboplites aurorubens)
Coastal pelagic	Jacks (Carangidae), Herrings (Clupeidae), Silversides (Atherinidae), Anchovies (Engraulidae), Ballyhoo (Hemiramphus), Robins (Decapterus), Barracuda (Sphynaena), Garfish and small tunas
Large pelagic	Tunas (Scombroidei), Wahoo (Acanthocybium solandri), Billfishes (Istiophoridae), Dolphinfish (Coryphaena hippurus), Swordfish (Xiphias gladius) and Mackerels (Scombermorous)
Flying fish	Hirundichthys affinis
Sea urchin (sea egg)	White Sea Urchin (Tripneustes ventricosus)
Conchs	Queen Conch (Strombus gigas)
Lobsters	Minor catch
Sharks and rays	Incidental catch
Sea turtles	Prohibited and Illegal

Source: FAO (2016)..

[15] FAO records a catch of up to 5,000 tons.
[16] CRFM, 2018.
[17] Barbados Fisheries Division reported 37.8% (Flyingifish) at June, 2024.

The distribution of catches of the species has varied drastically in recent years due to different environmental conditions that limit the development of certain species. Based on communication with authorities on the island, a significant and drastic decrease in the flying fish fisheries has been perceived within the last decade.

Barbados has minimal fish production in aquaculture and mariculture systems. The BFD reports only one commercial aquaculture farm dedicated to produce red tilapia and crayfish. Lately, small scale tilapia operations are initiated activities for producing and selling in pounds. Recently, the fisheries authority has reported pilot initiatives in aquaponics fish farming with demonstration purposes.

The BFD (2024) has collected information on fourteen main landing sites around the Island: Bridgetown Complex, Oistins, Consett Bay, Pile Bay, Holetown, Half Moon Fort, Six Men's, Payne's Bay, Browne's Beach – Bay Street, Fitts Village, Saint Lawrence, Shallow Draught – Sand Pitt, Bath Beach and Brooklyn. The latest report[18] registered that 99.4% of the total annual catch[19] was landed at 6 landing sites: Bridgetown Fisheries Complex (82.5%), Oistins (9.2%), Consett Bay (3.1%), Pile Bay (2.7%), Half Moon Fort (0.9%) and Holetown (0.9%). The remaining 0.6% of the total annual catch was landed at: Payne's Bay (0.23%), Six Men's (0.15%), Saint Lawrence (0.08%), Browne's Beach - Bay Street (0.07%), Fitts Village (0.05%), Shallow Draught - Sand Pitt (0.02%), Bath Beach (0.01%) and Brooklyn (0.01%).

So far this year, the BFD has recorded a total annual catch of around 527 MT from these fourteen landing sites. The months with the highest fishing records are February (95.4 MT), March (114.3 MT) and May (109.5 MT). The other months recorded lower fishing levels in tonnage: January (54.4 MT), April (79.3 MT) and June (74.1 MT). Government records show capture of more than 23 species groups during this year. Around 84% of this year's fishing tonnage was recorded within the four species groups: flying fish (37.8%), tuna (23.4%), dolphinfish (17.1%) and amberfish (5.3%). The remaining 16% was recorded in the following species groups: barracuda (2.8%), turpit (2%), kingfish - mackerel (1.7%), A.OV. (1.6%), marlin - white - blue (1.4%), potfish (1.4%),shark (1.2%), jacks (1%), swordfish (0.9%), snapper (0.7%), billfish- Atlantic sailfish (0.7%), brim - queen snapper (0.3%), bonito (0.2%), cavally (0.2%), lionfish (0.1%), lobster - Carib - Spiny (0.1%), triggerfish - ocean - old man (0.1%), octopus - sea cat (0.05%) and queen conch (0.02%).

Prices[20] for the main species groups fluctuate between 6.2–31.4 BBD per kilogram (BBD/kg). The species that register the highest prices per kilo are the following: lobster (31.4 BBD/kg), octopus (26.4BBD/kg), brim (24.2 BBD/kg), barracuda (22 BBD/kg) and dolphinfish (22 BBD/kg). Species groups with prices in an average range are as follows: kingfish (BBD/kg 19.8), snapper (19.8 BBD/kg), swordfish (18.8 BBD/kg), Marlin (18.8 BBD/kg), Lionfish (17.6 BBD/kg), pot fish (17.6 BBD/kg) and tuna (17.6 BBD/kg). Species groups with prices below the species average are: A.O.V (12.2 BBD/kg), amberfish (12.2 BBD /kg), bonito (12.2 BBD/kg), cavally (12.6 BBD/kg), flying fish (12 BBD/kg), jacks (11.4 BBD/kg), shark (10.4 BBD/kg) and turpit (6.2 BBD/kg). The prices mentioned are average prices for the month of June just before this disaster.

Fishing capacity in Barbados and its related economic fishing flows are being affected and will be affected by this disaster during the following months. Some factors will influence the behaviour of the economic fishing flows for the rest of year and some months in 2025. Some of these factors are: restoration time of the fishing capacity for the fleet of vessels, the landing capacity restoration in the fishing landing sites, the supply capacity restoration to the vessels at the fishing docks and the fishing seasonality during the year.

The BFD stated in its latest assessment report[21] that landings can be expected to be down by around 91%, since BFC (82.3%) and Oistins Landing Site (9.3%) contributed substantially to the total

[18] Barbados Fisheries Division – Data Collection Report – June, 2024.
[19] Fishing between January and June, 2024.
[20] Wholesales prices, June 2024 (BFD).
[21] BFD, July 16 of 2024.

landings this year[22], and these facilities have major damage to their infrastructure. This condition reduces substantially the landing capacity of the island and the input supply capacity to the vessels related to these landing sites. Due to the importance of these fishing infrastructures in the fish landing, it is estimated that the facilities should be fully operational again for the start of the new fishing season[23]. Also, it is important to consider that Barbados was at the end of the fishing season at the time of this disaster and fish landing should be decreasing considerably in the following months, especially for the pelagic species.

Table 30
Losses in the fisheries sector
(Thousands of Barbadian dollars)

Species	Public	Private	Total
Flying fish	-	1 862	1 862
Tuna	-	1 278	1 278
Dolphinfish	-	1 212	1 212
Jacks	-	172	172
Barracuda	-	166	166
Marlin - White / Blue	-	92	92
Billfish - Atlantic Sailfish	-	82	82
Kingfish/Mackerel	-	78	78
Potfish	-	76	76
Swordfish	-	70	70
Amberfish	-	34	34
Snapper	-	32	32
Shark	-	30	30
A.O.V.	-	18	18
Turpit	-	18	18
Other species	-	36	36
Total	**-**	**5 258**	**5 258**

Source: DaLA team, 2024.

Additionally, BFD informed the DaLA team that 312 registered boats were active across the island prior to the passing of Hurricane Beryl for fishing purposes. This information was collected by investigators from this governmental agency. Around 56% of these active vessels were related to the BFC and 7% were accountable to Oistins landing facility. At the time of the disaster, 15 boats from Oistins, Weston and other landing sites sheltered in the BFC, since this facility had better structural conditions for securing fisheries assets. The BFD has completed a preliminary assessment of the fishing fleet situation and estimated that it will take around 3 months to get half of the fleet back in operation. The remaining half of the fishing fleet is expected to gradually return to operations in the next six months[24].

Under these assumptions and combining these affected fisheries infrastructural capacities, general fishing capacity in Barbados will be drastically reduced in the next three months and by November 2024 is expected to gradually increase for the following six months. Fishing losses were calculated and estimated for the period from July 2024 to April 2025, which is the estimated period for restoring fishing capacity across all fisheries assets.

[22] Total landings: January to May, 2024.
[23] November, 2024.
[24] DaLA team's estimation, 2014.

The total fisheries losses estimated are around BBD 5.3 million due to the passing of Hurricane Beryl, 83%of the total fishery losses were estimated in three species groups: flying fish (35.4%), dolphinfish (23.1%) and tuna (24.3%). Another 14% of the estimated fishery losses are distributed in the following species groups: jacks (3.3%), barracuda (3.1%), marlin - white – blue (1.7%), billfish - Atlantic sailfish (1.6%), kingfish - mackerel (1.5%), pot fish (1.4%), swordfish (1.3%). The remaining 3% of total fishery losses were estimated in thirteen species groups: snapper, shark, amberfish, A.O.V, turpit, brim, queen snapper, lionfish, cavally, lobster, carib, spiny, bonito, octopus, sea cat, queen conch and triggerfish.

Agriculture sector

Agricultural production accounts for over BBD 249 million of Barbados' GDP[25]. Food crop production (54%) contributes the largest share to agricultural GDP with a value of BBD 134.5 million in constant values. Livestock production (36%) contributes around BBD 89.3 million to the agricultural gross domestic product. Food crop production and livestock production contribute 90% of the total gross domestic product of the agricultural sector. The other 10% of agricultural GDP is contributed by the production of sugar cane (5%), fishing (4%) and the production of other crops (1%).

The losses in the Barbados' agricultural sector exceeded the estimated damages. The damage assessment conducted around the island also estimated losses related to the food production. Based on the assessment done the Ministry of Agriculture, Food and Nutritional, losses were estimated at BBD 1.4 million, 91% plantain crops, 5% in banana, 3% in tomato, and 1% in beans. Plantain crop losses were concentrated in the Spring Hall, River Plantation, Bath Plantation, Kirtons, New Castle, and Fairy Valley farming districts. Banana production losses were observed in the Frizers and Bath Plantation districts. Tomato crops were affected only in Haggatt Hall.

Table 31
Losses in the agricultural sector
(Thousands of Barbadian dollars)

	Crops		
Crop	**Public**	**Private**	**Total**
Plantains	-	1 306	1 306
Bananas	-	76.5	76.5
Tomatoes	-	45	45
Beans	-	7.5	7.5
Pumpkin	-	5	5
Total	**-**	**1 440**	**1 440**

Source: Ministry of Agriculture, Food and Nutritional Security, 2024.

C. Additional costs

The process of restoring or recovering fishing capacity began with efforts related to the cleaning up and repair of fishing landing facilities at the BFC and OFC. Most of the vessels were removed from the BFC's harbour by specific companies that provide this type of service: Hinds Transport Services Ltd, Marenco Marine Ltd and Crane & Equipment Ltd. Vessel removal services were accounted for and estimated within the additional costs in the damage and loss assessment process. Damaged vessel storage costs were also considered as additional costs until the vessels are repaired, refurbished or replaced in the case of total losses. Several sites within the island were designated for temporary storage of vessels.

[25] Barbados Statistical Service, 2023.

These temporary storage sites are located close to BICO Ltd., Barbados Coast Guard, Kensington Mall, Pelican Annex, A&T Marine, Helipad car park, Careenage, Flour Mill Complex and other private sites. The largest vessels, measuring over 45 feet in length, were removed at the end of the harbour clean-up process from the BFC.

The debris removal process has been led by the Coast Guard in coordination with companies and institutions related to this process: Marenco Marine Ltd, BARNUFO, the Clean-up Barbados organization and the island's fishing community. The BFD is considering the possibility of issuing a benefit to the island's fishermen for the interruption of their main economic activity for a period.

Table 32
Additional costs in the fisheries sector
(Thousands of Barbadian dollars)

Additional costs	Public	Private	Total
Grain - Hauled out	180	-	180
Six Men's - cleaning	90	-	90
Vessel Housing	-	128	128
Business Interruption Benefit	3 504	-	3 504
Total	**3 774**	**128**	**3 902**

Source: DaLA team, 2024.

The estimated additional costs for the recovery of fishing capacity were BBD 3.8 million. Approximately, 90% of the estimated additional costs are related to governmental support to the fishing community directly affected by the climatic event. This benefit is related to the persons employed by the 230 affected vessels. The remaining 10% of the additional costs are related to the movement of vessels from the port (5%), cleaning of debris (2%) and temporary storage of affected vessels (3%).

VI. Tourism

Introduction

The tourism sector is the cornerstone of the Barbadian economy, driving key industries such as commerce, restaurants, and entertainment. It is also a significant source of employment and government revenue. Barbados' tourism sector directly contributes approximately 16% to the country's GDP as of 2023, with significant spillover effects on other sectors. The sector is a major employer, with the accommodation and food service industry accounting for 16.2% of total employment in the first quarter of 2024. This employment is predominantly female, with women comprising 10.1% and men 6.1%, highlighting the sector's important role in job creation and economic stability.

The severe winds and propagating large waves generated by Hurricane Beryl inflicted considerable damage on numerous coastal tourism facilities. The total damage is estimated at BBD 27.8 million, with facilities facing challenges from damage to coastal infrastructure, waterlogging, and extensive sand deposits. Additionally, the sector incurred losses amounting to BBD 28.5 million due to operational closures and cancellations during and after the hurricane. Furthermore, the sector faced additional costs totalling BBD 2.8 million, which included expenses related to storm preparation, post-storm cleanup, and increased operational costs.

Table 33
Summary of the impacts in the tourism sector
(Thousands of Barbadian dollars)

Impact	Public	Private	Total
Damages	-	27 792	27 792
Losses	-	28 544	28 544
Additional costs	-	2 757	2 757
Total	**-**		**59 093**

Source: DaLA team, 2024.

This assessment was informed by historical data, survey results, and reports from the BSS, the Caribbean Tourism Organization, the BHTA, and the Barbados Tourism Product Authority. Additionally, interviews with key tourism stakeholders were conducted, and field visits to various tourist properties provided valuable insights from hotel managers and other relevant parties.

Damages and losses associated with other infrastructural elements that play a key role in the tourism industry (elements of the Bridgetown Port Complex) are addressed in Section VIII (transportation). Damages and losses associated with beaches (erosion) and other waterfront assets that represent critical elements of the resource/asset base underpinning the tourism industry are addressed in Chapter IX *(*environment).

A. Damages

Most of Barbados' tourism accommodation and other physical assets are located close to the shoreline, making them more exposed to propagating large waves and other coastal damage. This geographic proximity significantly increased the impact of Hurricane Beryl on the sector. To assess the extent of the damage, a comprehensive listing of accommodations was compiled. As of January 2023, the Barbados Tourism Product Authority has 154 registered accommodations, including hotels, apartments, villas, and guesthouses. Additionally, 30 unregistered accommodations, which are members of the BHTA, were included in the assessment due to reported damages. In total, 184 different accommodations were assessed, of which 68 have reported some level of damage after the hurricane, which represents approximately 37% of the total number of accommodations. Furthermore, seven restaurants and 38 tourism-related shops throughout the island also reported some level of damage. Particularly, the Bridgetown passenger cruise terminal at the Bridgetown Port was significantly affected by the event, resulting in damage to 33 shops. The information presented in this section and the further damage estimations are obtained from the Barbados Tourism Product Authority, the BHTA, and a field visits to tourism facilities.

The total estimated damage for the tourism sector is approximately BBD 27.8 million, which has been divided into hotels, apartments/villas, restaurants, and tourism shops (e.g., souvenir stores or yacht rentals), as shown in table 34. Hotels experienced the most significant damage, accounting for approximately 76% of the total damage, while restaurants represented less than 2% of the overall damage. This difference is primarily explained by two factors: (i) restaurants are considered standalone facilities without associated accommodations (if a restaurant was part of a hotel, its damage is included in the hotel category), and (ii) restaurants generally have lower replacement costs than hotels. This approach was adopted given the granularity of the available information.

Table 34
Damage in the tourism sector
(Thousands of Barbadian dollars)

Categories	Public	Private	Total
Hotels	-	21 217	21 217
Apartment/Villas	-	2 435	2 435
Restaurants	-	500	500
Tourism Businesses	-	3 640	3 640
Total	**-**	**27 792**	**27 792**

Source: DaLA team, 2024.

The damages are estimated considering the assets' value before the event, and their condition, construction materials, and level of damage after the event. Consequently, estimating the damage to tourism facilities involves a detailed description of each facility's footage, construction material, pre-event condition (structural and non-structural deterioration), average construction costs on the

island, and post-event damage reports. The methodology considers an average construction cost (which is then divided by structural and non-structural elements) and equipment per square meter, which are then devalued. It is important to note that structural, non-structural, and equipment elements are devalued at different rates, reflecting the varying life cycles of each element. Finally, each facility is analyzed independently to include the level of damage in the final estimations.

This assessment considers six different levels of damage for the tourism facilities: (i) no damage implies that the facility did not have any consequences to their facilities, but their coastal structure could have been affected; (ii) minimum damage corresponds to facilities that did not have structural nor non-structural damage, but there is a cleaning cost involved, and few equipment losses; (iii) slight damage includes some non-structural and equipment compromised, but structural elements remained unaffected; (iv) medium damage implies few structural elements compromised during the event, while non-structural elements and equipment were considerably affected; (v) severe damage considers few structural elements affected by the event and most non-structural and equipment with significant damage; and (vi) total damage implies that most structural elements are compromised and all non-structural and equipment elements are destroyed.

The damage description for each facility is obtained from the field visit and complemented with self-reported state of damages from each different accommodation. In the cases where no information was provided about the state of damage, but the facility was included in the affected facility list, that facility adopts the state of damage of the closest facility with data. Most tourism-related affected facilities had minimum or slight damage (76.4%), and consequently, the facilities with no data mostly adopted that state of damage.

The affected facilities are located mostly in the coastal zone, primarily in the west and south parts of the country, as shown in map 8, with more than 90% of the affected facilities located within 1 km of the coastline. This is because most tourism assets are located near the coastline, and in the instance of Hurricane Beryl, the most significant impacts related to large waves, and therefore occurred at the coastline.

Map 8
Affected tourism facilities

Source: DaLA team, 2024.

Based on the description of the impact on facilities provided by the Barbados Hotel and Tourism Association survey and observations from the field visit, two main types of phenomena were primarily observed: (i) coastal erosion and damage to assets close to the shore, and (ii) waterlogging and sand deposit throughout the facilities. The first type of damage, the ones to coastal assets, was observed in most facilities that had access to the beach or had any type of coastal protection structure. For example, several facilities had significant damage to their access to the beach stairs (as shown in image 6) or to sea walls. Although these assets are not usually part of the main accommodation building, their deterioration or potential loss directly affects the use of the premises of the hotel and directly affects the service quality.

Image 5
Coastal assets damage: New Mansion Accommodation

Source: Barbados Hotel and Tourism Association, 2024.

Image 6
Waterlogging damage: Coral Reef Club

Source: Barbados Hotel and Tourism Association, 2024.

The second consequence that was observed was waterlogging and sand deposits in some facilities, as shown in images 7 and 8. In this scenario, the main consequence is direct damage to equipment and some non-structural elements, but not structural elements, which were significantly compromised. In these cases, the main damage considered is related to equipment.

Image 7
Sand deposits: Sugar Bay Barbados

Source: Barbados Hotel and Tourism Association, 2024.

B. Losses

Baseline

In 2023, Barbados welcomed 636,540 stay-over arrivals, an 18% increase from 2022 CTO, (2024). This upward trend continued into 2024 before the passage of Hurricane Beryl, reflecting a strong recovery from the COVID-19 pandemic and other climatic challenges. Despite recent challenges, including the impact of Hurricane Elsa in 2021 and volcanic ash events, the tourism sector has demonstrated remarkable resilience. The industry has steadily rebounded, with the first half of 2024 marking an 18% increase in stay-over arrivals compared to the same period in 2023. The island's tourism offerings are diverse, including luxury resorts, boutique hotels, guesthouses, and vacation rentals, catering to a wide array of visitor preferences.

The cruise sector is also a vital component of Barbados' tourism industry, with thousands of passengers arriving each year to explore the island's attractions. In 2023, Barbados hosted 376 cruise ship arrivals, bringing a total of 527,169 passengers — a 76.2% increase from 2022.

Tourism expenditure is a key indicator of the sector's economic impact. Between August and December 2023, stay-over visitors spent an estimated BBD 2,506 per trip, highlighting the sector's importance in generating foreign exchange and supporting local businesses, CTO (2024).

Barbados' tourism infrastructure continues to evolve, supported by investments in new properties and upgrades to existing facilities. The island's diverse attractions, rich cultural heritage, and strategic marketing efforts position Barbados as a premier destination in the Caribbean, appealing to a broad spectrum of international visitors. However, natural disasters such as hurricanes pose a significant threat to the sector's resilience and stability. These events can disrupt tourism activities, cause extensive damage to infrastructure, and lead to substantial economic losses, making disaster preparedness and mitigation strategies essential for sustaining the sector's long-term growth.

The significant damage inflicted by the passage of Hurricane Beryl on key tourism infrastructure in Barbados led to operational changes across several tourism facilities. Most businesses had to close temporarily or operate on a limited basis during the hurricane (95%) while others required partial (3%)

or full closures (2%) for extended periods due to various degrees of damage. According to the results of the Barbados Hotel and Tourism Association survey, approximately 215 hotel staff were reported to be affected. Additionally, operations were disrupted by the temporary closure of major ports of entry. Collectively, these factors contributed to total losses in the tourism sector amounting to BBD 28.5 million. This value represents the decline in tourism spending expected until the sector fully restores its room capacity by October 2024.

Table 35
Summary of Losses in the Tourism sector
(Thousands of Barbadian dollars)

Year	Losses
July 2024	19 319
August 2024	6 275
September 2024	2 950
Total	**28 544**

Source: DaLA team, 2024.

Barbados' air and seaports were able to reopen relatively quickly after the climatic event. The Grantley Adams International Airport, which experienced minimal impact, closed briefly from 7 p.m. on Sunday, 30 June, and reopened on 2 July, 2024, thus minimizing disruptions by swiftly resuming operations post-hurricane. The Bridgetown Port Inc., however, sustained considerable damage across various areas, including the passenger cruise terminal. This damage impacted 33 tourism businesses —comprising 16 duty-free shops, 16 courtyard shops, and one kiosk— necessitating temporary closures. Despite these challenges, the port managed cleanup efforts efficiently and reopened by 5 July, in time to welcome the next scheduled cruise ship, ensuring no interruptions to cruise ship schedules and maintaining a steady flow of tourist arrivals.

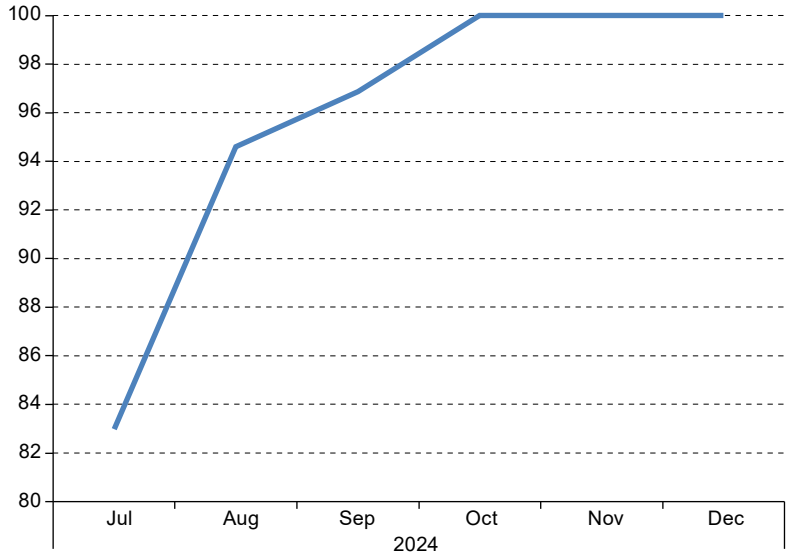
Figure 2 depicts the estimated timeline for the full recovery of room capacity, based on reported or estimated closure periods from all accommodations. The expected recovery rates were determined based on actual reports of closure periods from tourism facilities, as well as estimated recovery times for those with limited to no damages. The assumptions for these estimates include:

- Operations of all accommodations were minimally for approximately three days —immediately before, during, and after the passage of the hurricane.
- For facilities reporting partial closures without specific dates, the closure period was assumed to be about one week.
- Accommodations with scheduled closures post-hurricane were excluded from the assessment.

Room capacity experienced an estimated decline of 16.7% in July 2024 following the hurricane but is expected to fully recover by October 2024. This prolonged impact is largely due to significant damage at a few key properties; for instance, Sugar Bay Barbados reported a closure period of up to 12 weeks due to the hurricane's impact.

To estimate tourism-sector losses, a monthly baseline of total stay-over expenditures prior to 1 July, 2024, was used to simulate how the sector would have operated without the disaster. A monthly forecast was then developed based on expected recovery rates, considering the impact of the event. For this forecast, it was assumed that there would be some cancellations due to the disaster, but overall demand would remain relatively stable, with full recovery anticipated by October 2024, provided no additional climatic events occur. The difference in expenditure forecasts with and without the hurricane's impact represents the loss to the sector.

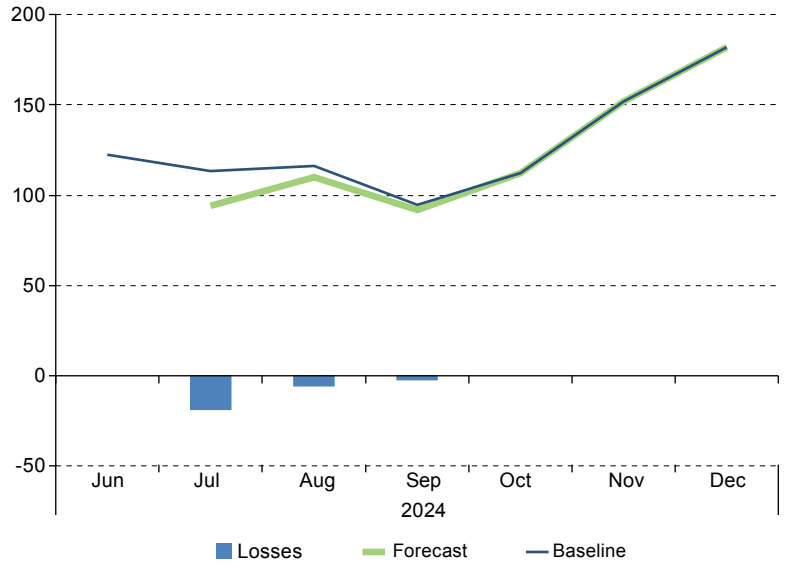
Figure 2
Room capacity recovery following Hurricane Beryl
(Percentages)



Source: DaLA team, 2024.

For the visitor forecast, it was assumed that the primary factor dominating the recovery in the tourism sector is room capacity and that there was no impact on cruise arrivals given the quick re-opening of the Barbados Port and no reported changes to cruise ship arrivals due to the hurricane's passage. Figure 3 depicts the monthly baseline scenario, the forecasted monthly expenditure of stay-over visitors and the monthly loss in expenditure.

Figure 3
Baseline expenditure, forecasts, and estimated losses in the tourism sector
(Millions of Barbadian dollars)



Source: DaLA team, 2024.

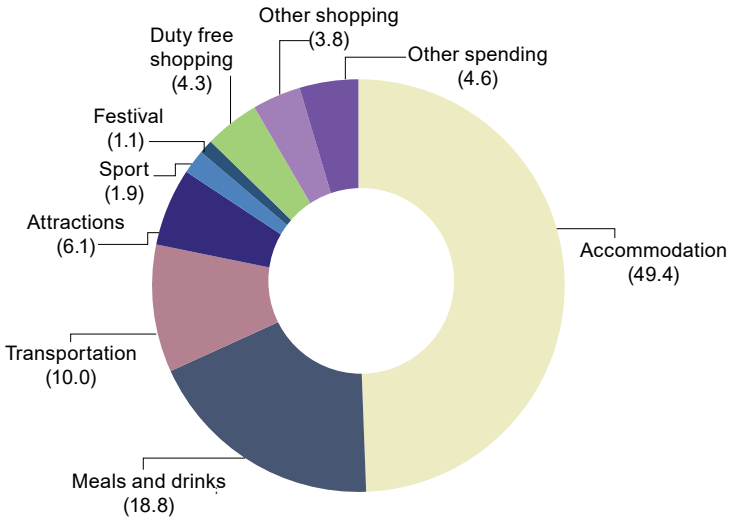
Based on estimations of expenditure disaggregated by item, the majority of losses are projected to occur in accommodations, meals and drinks, and transportation. Accommodations are expected to suffer the most significant financial impact, with losses amounting to BBD 13.5 million, which represents approximately 49% of the total tourism loss of BBD 28.5 million. Meals and drinks, encompassing restaurants and other food establishments, are projected to incur losses of about 18.8%, amounting to BBD 5.4 million. Transportation expenditure is expected to see a 10% loss, totalling BBD 2.9 million. Table 36 details the disaggregated losses across expenditure items while Figure 4 illustrates the percentage losses for each category.

Table 36
Disaggregated losses in the tourism sector
(Thousands of Barbadian dollars)

Expenditure item	Total
Accommodation	14 101
Meals and drinks	5 366
Transportation	2 854
Attractions	1 741
Sport	542
Festival	314
Duty-free shopping	1 227
Other shopping	1 085
Other spending	1 313
Total	**28 544**

Source: DaLA team, 2024.

Figure 4
Tourism sector losses by type of expenditure
(Percentages)



Source: DaLA team, 2024.

C. Additional costs

The passage of Hurricane Beryl resulted in additional costs for the tourism sector, estimated at approximately BBD 2.8 million as shown in table 37. These costs were determined based on field visit information, reported damages, and the size of the facilities. It was assumed that properties reporting no damages had minimal additional costs. The largest portion of the additional costs, totaling approximately BBD 1.2 million, was related to operational disruptions. These included emergency staffing, overtime for maintenance crews, and the procurement of temporary power solutions for facilities that experienced outages. Clean-up costs followed closely at BBD 1.1 million, driven primarily by the need to remove large deposits of sand, debris, and even boulders from coastal properties, which were deposited by the severe propagating waves. While the National Conservation Commission, Ministry of Transport and the Defence Force were responsible for the clean-up along the beaches and coastline, the clean-up directly impacting coastline properties was primarily the responsibility of the property owners and management. Large tourism businesses managed to access the necessary equipment quickly, but smaller facilities, faced delays in the clean-up process, further compounding their operational challenges.

Preparation costs amounted to approximately BBD 0.5 million and included pre-emptive measures taken to minimize damage. These activities included securing outdoor furniture and equipment, installing temporary barriers or sandbags to prevent flooding, and relocating valuable assets to safer locations. While costly, these proactive measures were essential in reducing the overall impact of the hurricane on tourism facilities.

Table 37
Additional costs in the tourism sector
(Thousands of Barbadian dollars)

Additional costs	Total
Preparation	461
Cleaning up and rubble removal	1 119
Operations	1 177
Total	**2 757**

Source: DaLA team, 2024.

VII. Power and telecommunications

Introduction

Power

Hurricane Beryl caused minor damage to Barbados' power distribution network, with less than one percent of the country's utility poles sustaining significant damage. Power generation facilities located across Barbados sustained no measurable damage and were able to maintain power generation throughout the event. Total damage in the power sector was estimated at BBD 17.5 thousand, of which the two main line items were BBD 7 thousand in damage to utility poles and BBD 7.5 thousand in damage to pole-top transformers. Losses were estimated at BBD 33.1 thousand, reflecting the value of power that was not sold because of power outages during the event. Additional costs were estimated at BBD 23 thousand, which mainly reflects extraordinary labour, and labour support costs. The total value of damage, losses, and additional costs in the power sector is estimated at BBD 0.07 million.

Wind damage to utility poles and damage to pole-top transformers were the main effects which lead to power outages for small sections of the island. Information for estimates was collected through interviews with representatives of the Barbados Light and Power Company Limited (BL&P), and documents from the Ministry of Energy, Small Business and Entrepreneurship, and the Caribbean Centre for Renewable Energy and Energy Efficiency (CCREEE).

Telecommunications

Barbados is currently served by two primary telecommunications providers, Digicel and Flow (formerly known as Cable & Wireless), and recently licensed KW Telecommunications Limited. Flow is currently the leading provider of fixed telephone and broadband services, offering high-speed internet and cable television services. Both Digicel and Flow compete in the mobile communications market, providing various prepaid and postpaid plans with extensive LTE (Long Term Evolution) coverage. Digicel also offers fibre connections for businesses and home internet services. KW Telecommunications is expected to further enhance competition in the mobile sector within the near future.

The telecommunications sector did not seem to suffer any measurable asset damage or losses due to the passing of hurricane Beryl. The DaLA team did not note any telecommunications infrastructure damage during its field visits and up until the writing of this report, neither damages nor other effects were reported by any of the telecommunications service providers, or by the Government of Barbados. Possible unreported damage or losses are likely to be minimal considering the intensity of the hurricane's effects compared with the robustness of the telecommunications infrastructure on the island.

Table 38
Summary of the impacts in the power sector
(Thousands of Barbadian dollars)

Impact	Public	Private	Total
Damages	-	17.5	17.5
Losses	-	33.1	33.1
Additional costs	-	23.0	23.0
Total	**-**	**73.6**	**73.6**

Source: DaLA team, 2024.

A. Damages

The Barbados Light & Power Company Limited (BL&P), established in 1899, is one of the oldest electric utilities in the Caribbean. It operates as a vertically integrated monopoly, regulated by the Fair Trading Commission (FTC). Since 1986, BL&P has held an exclusive license to sell electricity in Barbados, a franchise that extends until 2028. The company is fully owned by Emera Inc., a Canadian-based corporation. BL&P is responsible for electricity generation, transmission, and distribution across Barbados and has been transitioning towards cleaner energy, aiming for 100% renewable energy by 2030.

While specific financial figures are not readily available, BL&P has been involved in significant investments in renewable energy infrastructure. In terms of power generation BL&P operates several power plants, including diesel and gas turbine units at West Spring Garden and Seawell; a temporary plant at the Saint Ann's Garrison; and a 10 megawatts (MW) solar farm at Trents, Saint Lucy. BL&P's conventional generation portfolio includes about 226 MW of conventional power generation and 10 MW of Renewable Energy, with about 21 MWh of battery energy storage systems (BESS). The company's distribution infrastructure includes both above ground and underground transmission lines, with about 60% of the transmission lines buried underground. The above-ground sections of the BL&P's transmission network are supported by class-two utility poles, while the distribution network uses class-three utility poles. All buildings housing power generation facilities are built to resist Category 3 hurricanes, while their solar farm is built to resist a Category 4 hurricane. In terms of disaster preparation activities, the company reports having yearly disaster drills for staff readiness and stockpiling essential hardware materials yearly for quick access after a disaster.

Table 39
Cost of damaged assets
(Thousands of Barbadian dollars)

Asset	Unitary cost	Quantity	Total
Poles	0.7	10	7
Wire	1.5	2	3
Transformers	1.5	5	7.5

Source: DaLA team, 2024

A few areas of Barbados were impacted by fallen utility poles or damaged pole-top transformers. There were approximately 10 fallen poles, including poles that were broken, cracked, or leaning. Observation of the downed utility poles indicated that the primary reason for failure was damage caused by debris —mostly trees— or previously compromised poles. In a few scenarios, the effect of wind caused enough rocking to loosen the base of the utility pole, causing it to lean to the extent that it needed to be replanted or replaced. Less than five pole-top transformers were blown, most likely due to intrusion of water into the transformer housing or damage from debris. Damaged utility poles usually imply downed distribution cables, which in many cases can be restrung but may need replacing if severely damaged. Table 40 summarizes the damaged assets from the power sector. The damage caused to distribution circuits caused power loss to some areas, however, most areas were otherwise unaffected by power loss.

Table 40
Damages in the power sector
(Thousands of Barbadian dollars)

Description	Private	Public	Total
Generation	-	-	-
Transmission and distribution	17.5	-	17.5
Buildings and equipment	-	-	-
Total	**17.5**	**-**	**17.5**

Source: DaLA team, 2024.

B. Losses

Losses in the power sector are estimated at BBD 33.1 thousand (see table 41). The figure reflects a loss of revenue to the power company because of electricity not sold due to hurricane Beryl. The BL&P's team reported that all systems functioned as expected, maintaining a normal power supply across the country until disruptions began at 5 a.m. on 1 July. During the passage of the hurricane, 13 of the company's 61 feeder lines were negatively affected by adverse weather conditions, causing their respective circuits to either trip or be manually taken out of service. Such disruptions continued until the weather system had passed. However, no repair efforts were initiated until the government issued an all-clear for technical work at 11:00 AM.

Table 41
Losses in the power sector
(Thousands of Barbadian dollars)

Description	Private	Public	Total
Value of lost electricity sales	33.1	-	33.1
Total losses	**33.1**	**-**	**33.1**

Source: DaLA team, 2024.

After inspection, it was noted that hurricane Beryl's effects were minimal and immediate actions were taken to restore power to all customers. Power was successfully restored to 97% of customers by 24 hours after the all-clear. The remaining areas, which required more work, were reconnected over the following 48 hours. Using the rates provided by the BL&P, and an average residential electricity consumption rate of about 323 kWh per month, an estimate for loss was calculated. Table 42 shows the loss of supply for customers over time. Loss figures were estimated using power consumption figures from previous years, along with interim rates provided by the BL&P.

Table 42
Time without power supply

Customers without supply	Hours	Total hours
30 300	9	272 700
4 357	20	87 140
278	44	12 232
33	68	2 244
32	76	2 432
Total		**376 748**

Source: BL&P and DaLA Team, 2024.

C. Additional costs

Additional costs include the extra labour deployed to perform restoration work in Barbados on the distribution network. The additional human resource costs associated with supporting this labour are also included. Not included in additional costs are those associated with power generation by private generators in the absence of commercial power because these values are included as part of the additional costs in other sectors. Total additional costs are estimated at BBD 23 thousand, as listed in table 43.

Table 43
Additional costs in the power sector
(Thousands of Barbadian dollars)

Description	Private	Public	Total
Labor costs	15	-	15
Human resource support	8	-	8
Total	**23**	**-**	**23**

Source: DaLA team, *2024*.

VIII. Transportation

Introduction

Hurricane Beryl had a moderate impact on Barbados, with strong winds, torrential rains, and subsequent floods causing widespread destruction, particularly along the island's vulnerable western and southern coasts. Critical coastal facilities such as the Bridgetown Port and the Bridgetown Fisheries Complex sustained significant damage, underscoring the severity of the storm. The predominant physical impacts on transportation assets related to the Bridgetown Port and sections of the road network. The impact on fisheries infrastructure and assets is addressed in Chapter V.

The waterfront of the capital Bridgetown is dominated by interconnected ports and harbour assets and infrastructure, including Carlisle Bay, the Careenage, the Fisheries Complex, the Barbados Port, containing the deepwater harbour, the Shallow Draught harbour, and Flour Mill, and the Coast Guard Base. The Barbados Port is critical to the country's basic functioning and its economy. It is the country's single major seaport, serving both cargo delivery and cruise berthing. Barbados, like many SIDS, is significantly dependent on imports for basic provisions including food, so that the cargo port is essential to the countries' basic functioning. With the cruise terminal also located within the same Port complex, the Port forms a critical component of the countries' tourism infrastructure - a major contributor of the local economy. While damages to the Port incurred during this event did not result in major disruptions, it does highlight the vulnerabilities of this critical infrastructure element, to these types of events.

Barbados' has a high road density, and extensive road network, which comprises approximately 2,300 square kilometres of highways, main roads, secondary roads, and minor roads. The road network experienced significant disruptions due to debris and structural failures, which led to a considerable increase in operational costs. Key routes, like Highway 7 along the south-west coast, essential for maintaining connectivity, were among the most affected. Remarkably, none of the 326 bridges and footbridges under the administration of the Ministry of Transport and Works (MTW) sustained any damage during the hurricane.

While certain areas of the road network were affected and the port infrastructure sustained substantial damage, Grantley Adams International Airport remained largely unscathed, allowing for continued operations despite the storm's impact. This spared the island from even greater logistical challenges. A comprehensive assessment of the damages, losses, and additional costs in the transportation sector revealed an impact of approximately BBD 25 million, primarily due to propagating large waves and floods. These estimates, though based on limited data sources, reflect assessed damages and the relative scale of the affected services.

Table 44
Summary of the impacts in the transportation sector
(Thousands of Barbadian dollars)

Type of infrastructure	Damage	Losses	Additional Costs	Total	Private	Public
Roads	5 144	-	356	5 500	-	5 500
Ports	17 054	-	2 443	19 497	-	19 497
Airports	-	-	46	46	-	46
Total	**22 198**	**-**	**2 845**	**25 043**	**-**	**25 043**

Source: DaLA team, 2024.

The listed infrastructure- roads, the port, and airport are all publicly owned. There are no costs associated with private ownership, and as such, all costs are linked to public infrastructure. Information presented in this assessment was provided by the MTW, CDEMA, and the Ministry of Finance, Economic Affairs and Investment. Data was further corroborated through interviews and field visits to the most affected areas.

A. Damages

Barbados Port Inc.

Hurricane Beryl inflicted substantial damage on Barbados's port infrastructure, particularly at the Port of Bridgetown, a vital hub for commercial and passenger activities. This is the country's sole major seaport. According to a detailed report by Barbados Port Inc., critical infrastructure, including the breakwaters and revetments creating the harbour, water supply main, electrical systems, and fibre optic cables, were severely affected, leading to significant disruptions in port operations. Additionally, the storm's impact was felt across commercial spaces, with several duty-free and courtyard shops experiencing water ingress, roof damage, and in some cases, complete destruction of equipment and fixtures.

The Deepwater Harbour within the Port of Bridgetown is not a natural harbour. The Port Facility is built at least partially on reclaimed land, and the harbour created by an artificial breakwater installation, originally built in the 1960s. The existence of the country's seaport in this location is dependent on the structures that create the deepwater harbour. The protective coastal structures, revetments and breakwaters, were significantly impacted by Hurricane Beryl, which caused extensive damage to both the infrastructure and the protective structures along the port's southern boundary. The revetment, composed of limestone boulders, serves as the first line of defence against waves generated by storms. During the hurricane, the revetment was heavily battered, which caused several boulders to slide further down the slope into deeper water. Despite the improvements made to the revetment after Hurricane Ivan in 2004, including raising its crest elevation, it was unable to fully withstand the force of the Category 4 hurricane, leading to overtopping and significant damage to the port's landward infrastructure.

The Taxi Dispatch Centre at the terminal suffered extensive damage. During the site visit by the DaLA team, reconstruction efforts were underway using cinder blocks and reinforced concrete. Given the exposure to salt air and the increased likelihood of corrosion, timber elements were incorporated into the roof design. It is further recommended that the roof structure be strengthened using hurricane tie braces (brackets) along the timber joints to offer greater durability and resistance in this harsh environment.

Image 8
Photographs of the Taxi Dispatch Centre and internal street shoulder

Source: DaLA team, 2024.

The Signal Station at the Port of Bridgetown sustained considerable damage during Hurricane Beryl, primarily due to the overtopping of the breakwater, which led to seawater flooding through three damaged windows. This resulted in significant water damage to essential equipment, including a UPS on the ground floor, a PC, monitors, and a TV used for AIS on the top floor, as well as a fibre switch, network switch, and access control equipment on various floors. Although the building itself did not suffer major structural damage, the compromised windows allowed seawater to enter, highlighting the need for improved protective measures.

The terrain within the southern section of the port was inundated with seawater, mud, stones, and debris, reaching depths of up to 18 inches. This flooding was made worse by the fact that the port's drains were clogged with debris, preventing the proper drainage of seawater. While the revetment's integrity was not completely compromised, immediate action is required to replenish the lost boulders and restore the revetment's profile to ensure it can continue to protect the port from future storms. These measures are deemed necessary to prevent similar devastation in the future, particularly considering the increased frequency and intensity of storms.

In response to the significant damage caused by Hurricane Beryl, particularly to the southern end of the Port of Bridgetown, several measures were discussed to enhance the resilience of the port's infrastructure. Immediate actions include the conduct of an underwater survey along the toe and sloping face of the revetment, estimated to cost BBD 1.9 million, to assess its condition and address any weaknesses. This is inclusive of hydrographic, LIDAR drone and wave modeling surveys to guide the coastal engineering and reconstruction.

The DaLA team was informed that Canada-based private coastal engineering consulting firm, Baird & Associates, was engaged to conduct a cursory review of potential designs to upgrade the main breakwater of the Port of Barbados. Although it was acknowledged that some aspects of the engineering process were incomplete due to time constraints and limited field information, they provided a preliminary range of costs for proposed upgrades. These estimates take into account factors such as materials, delivery and placement, mobilization and demobilization, insurance and bonding, environmental considerations, engineering requirements, and a contingency range of 20 to 40 percent. These upgrades are crucial for enhancing the port's wave protection capabilities and ensuring its long-term resilience against future extreme weather events.

Additionally, replacing asphalt with concrete for roads near the revetments, at an estimated cost of BBD 5 million, is proposed to improve durability and reduce potential damage from future storms.

The Port's resilience was severely tested, exposing the inadequacy of the existing revetment and drainage systems to withstand such extreme weather conditions. This highlighted the urgent need for immediate repairs, with the estimated damages and repair costs totalling approximately BBD 17 million. While normal operations were significantly disrupted, rapid post-event solutions and restoration efforts minimized the duration of the impact.

Table 45
Estimated cost of repairs
(Thousands of Barbadian dollars)

Item description	Cost
Repacking of boulders from the south revetment and installation of concrete seawall behind revetment	5 000
Roadway repairs	910
Repairs to cruise terminal & taxi dispatch	5 507
Repairs to Signal Station Mooring Facility & Breakwater	524
Repairs to water main	895
Replacement of manhole covers on the breakwater and repair of damaged slabs	180
Drainage replacement around gym/fire station	125
Replacement of three (3) treadmills at the Gym	48
Reinstallation of lamp posts and cabling on the breakwater	450
Repairs to asphalt working areas on berths 2 & 3	712
Repairs to door at shed #3	6
Replacement of water storage systems at various locations	90
Jetty repairs (Speightstown)	25
Repairs fence and revetment located Bridgetown helipad	32
Repairs to Bulk Facility Revetment at Mighty Grynner Highway	750
Weston revetment encompassing the Millie Ifill Market and the fire station	1 800
Total	**17 054**

Source: Barbados Port Inc (2024).

Grantley Adams International Airport

Grantley Adams International Airport is a public airport owned by the Government of Barbados (GOB) and managed by the Grantley Adams International Airport Inc. with the overarching responsibility for its operation, maintenance, and development. Unlike the extensive damage sustained by the ports, the airport's infrastructure including runways, terminals, and ancillary facilities remained largely intact due to robust construction standards and pre-emptive measures. Interviews and field visits confirmed

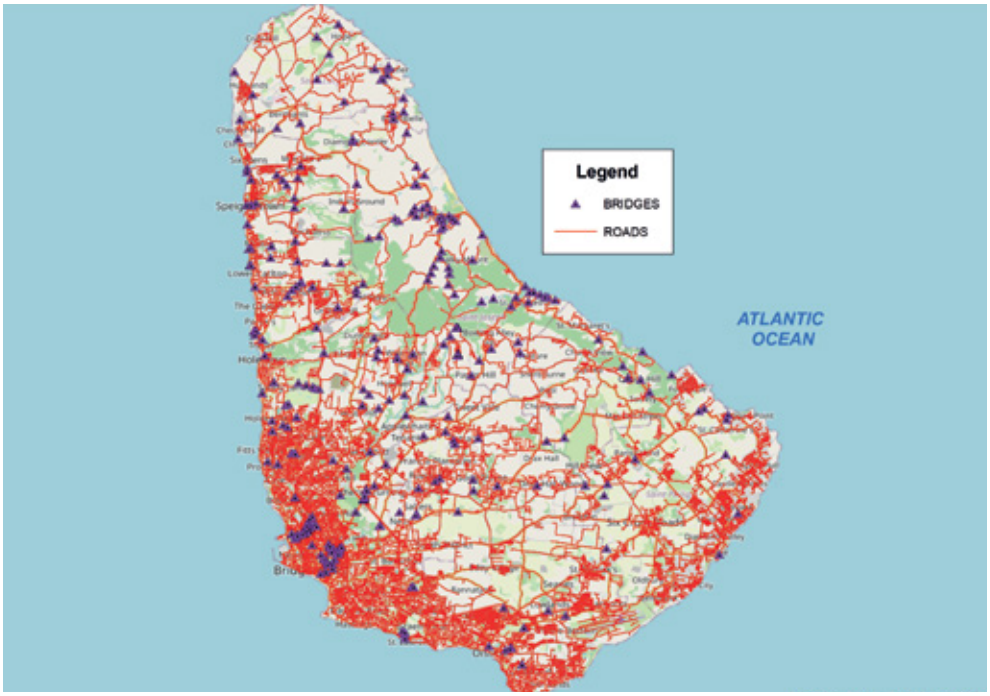
minimal damage, allowing the airport to quickly resume operations, maintaining critical connectivity for both passengers and cargo, and facilitating the delivery of emergency supplies and relief efforts, to the neighbouring islands of Carriacou and Petit Martinique as well as Saint Vincent and the Grenadines.

Road network

The road network comprises a range of road sizes and types from major highways to smaller, rural roads, with a four-tier classification system as per the Physical Development Plan (PDP). There is a high density of both roads and motor vehicles, and therefore ongoing maintenance and development efforts to accommodate increasing traffic and tourism demands. Coastal highways along the west and south coasts (Class 1 roads; Highways 1 and 7 respectively) are critical routes for overall connectivity on the island.

The floods caused extensive wear and erosion of road surfaces, creating potholes and weakening the structural integrity of many roads. These issues posed significant challenges for motorists and necessitated immediate repair and maintenance efforts. The most affected regions include Bridgetown, Speightstown, and several western and southern parts of the island. The damages in these areas were particularly severe due to their proximity to the coast and lower-lying topography, which were subject to both inland and coastal flooding from propagating large waves.

Map 9
Road network

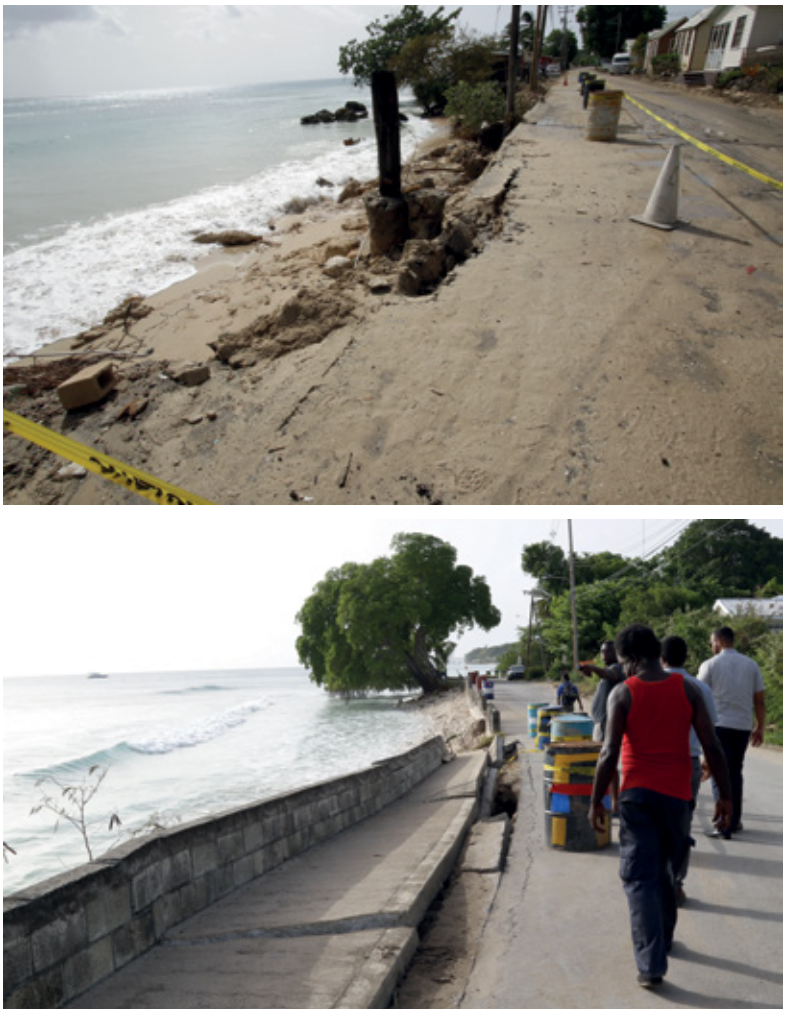


Source: DaLA team and Land Survey Department, 2024.

While the GOB has made significant investment in coastal protection infrastructure in the densely developed urban corridor along the west and south coasts, there remain sections of coastal road that are very near to the waterfront and/or without adequate coastal protection. As noted during the site visits by the DaLA Team, the vulnerability of coastal roads in Barbados, especially in sections without proper revetments or coastal protection, is significantly heightened. The lack of adequate protective structures leaves these roads exposed to erosion, propagating large waves, and other environmental hazards, making them susceptible to damage and potentially compromising the safety and accessibility of coastal areas. This exposure not only leads to immediate surface damage but also renders the roads impassable during severe weather, disrupting transportation and access to vital areas.

Coastal roads in Barbados are not only exposed and vulnerable but also face increased maintenance demands due to the relentless forces of waves and tides. The absence of protective revetments can result in frequent damage, including potholes and cracks, which necessitate regular and costly repairs. This continuous need for maintenance strains local government budgets and diverts resources from other essential infrastructure projects. To ensure the safety, functionality, and long-term sustainability of these critical transportation routes, it is crucial to address these vulnerabilities by implementing proper coastal defences.

Image 9
Photographs of Six Men's and Shermans damages on coastal roads



Source: DaLA team, 2024.

Highly exposed sections of road along the waterfront on the west coast were significantly damaged. Six Men's Road was severely impacted by propagating large waves, leading to significant flooding and the deposition of coral rubble on both the beach and the coastal road. The waves reached properties on the landward side, highlighting the extent of the damage sustained by the transport infrastructure in that area. Clinketts Road, Shermans, and Sand Street also experienced considerable erosion, which resulted in the collapse of the protective seawalls.

The pavement behind these walls also gave way, and even under normal wave conditions, the seawalls continued to be undermined, indicating ongoing vulnerability and the urgent need for repairs. These examples underscore the extensive impact on transport infrastructure along Barbados' coastal areas, especially where roads are situated close to the shoreline.

Image 10
Street Road inundated by storm waves

Source: DaLA team, 2024.

Table 46
Summary of damages on the road network
(Thousands of Barbadian dollars)

Type of damage	Public	Private	Total
Road surface	1 075	-	1 075
Revetments or retaining walls	1 739	-	1 739
Road structure	2 329	-	2 329
Total	**5 143**	**-**	**5 143**

Source: DaLA team, 2024.

Restoration and repair to the transportation infrastructure would require significant efforts. Immediate actions include clearing debris, implementing temporary road closures, and conducting emergency repairs to ensure the safety and accessibility of essential routes.

B. Losses

Despite Hurricane Beryl's severe impact, the transportation sector managed to avoid significant economic losses thanks to a combination of preparedness, resilience, and swift recovery efforts. Key transportation routes remained operational, preventing major economic disruptions. The rapid response from both government agencies and private sector partners was critical in minimizing potential losses, clearing debris, making emergency repairs, and restoring port operations swiftly.

C. Additional costs

The MTW faced substantial costs as part of their preparation and response to Hurricane Beryl, focusing on both infrastructure repairs and emergency operations. The Operations Division was heavily involved across various locations, tackling debris clearing and other support tasks. The Bath Depot Team, for instance, spent BBD 2.3 thousand on labour during day and night shifts, with additional expenses for callouts and equipment rentals. Similarly, the Golden Ridge Depot Team incurred BBD 3.7 thousand for their operations, which included both labour and material costs for debris removal and supporting boat removal efforts.

In Bridgetown, significant resources were allocated to clearing debris along the Princess Alice Highway and the Port, along with providing support to the Coast Guard and Barbados Defence Force (BDF) for boat removal. These efforts resulted in a total expenditure of BBD 31.5 thousand. The work along Highway 7, stretching from Oistins to Hastings, involved heavy machinery and labour, adding another BBD 8.2 thousand to the expenses. Meanwhile, the Northern Division carried out debris cleaning across locations such as Bathsheba, Paynes Bay, and Six Men's, with total costs amounting to BBD 3.6 thousand. Altogether, the Operation Division's efforts in preparing for Hurricane Beryl resulted in a total spend of BBD 49.5 thousand.

The Drainage Division incurred substantial expenses, particularly in paying BBD 8.7 thousand in overtime to staff for clearing flood-prone areas and making specific preparations in Saint Lawrence and Dover. Additionally, the Division allocated BBD 200 thousand for repairing six damaged outfall drains, contributing to a total expenditure of BBD 306.5 thousand. A significant portion of this budget, categorized as "Expenditure to Civil Contractors," was allocated for contracting private companies or individuals to perform specialized tasks related to drainage and flood management. These contractors were engaged to clear watercourses, maintain or repair drainage infrastructure, and undertake projects that required expertise or resources beyond the government's capacity. This careful allocation of funds reflects a balance between addressing immediate needs and making strategic investments to maintain and enhance critical infrastructure.

At the airport, the continuous operation during the hurricane led to significant costs. Overtime pay amounted to BBD 26 thousand reflecting the need to extend staffing to ensure safety and functionality. Additionally, the use of 6,000 litres of diesel to power generators added BBD 20.5 thousand to the total costs, emphasizing the critical role of energy resources during such emergencies. In total, the airport's expenditure during Hurricane Beryl was BBD 46.5 thousand.

In summary, the MTW's preparation and response to Hurricane Beryl involved extensive and coordinated efforts across various divisions, with significant financial implications. These efforts underscore the importance of proper planning, resource allocation, and collaboration between different entities to effectively manage the impact of disasters.

Bridgetown Port Inc. has incurred various additional costs, totalling BBD 3 million. These costs include the removal of debris (such as soil, grass, sand, and stone) an expense of BBD 257 thousand, and the removal of the damaged asphalt wearing course from the internal roadways, which costs BBD 176 thousand. Additionally, the replacement of three treadmills at the gym amounts to BBD 48 thousand. Finally, hydrographic, LIDAR, and wave modelling surveys are listed at the cost of BBD 2 million. These activities collectively represent the additional expenses beyond the basic damage repair costs.

Table 47
Additional costs in the transportation sector
(Thousands of Barbadian dollars)

Additional costs	Public	Private	Total
Roads	356	-	356
Ports	2 443	-	2 443
Airport	46	-	46
Total	**2 845**	**-**	**2 845**

Source: DaLA team, 2024.

IX. Environment

Introduction

Barbados' natural coastal ecosystems are integral to the nation's identity and economy, supporting tourism, fisheries, and the country's cultural heritage and lifestyle. The island's 97 kilometres of coastline, featuring diverse and beautiful landscapes —cliffs, beaches, and coral rock platforms— are invaluable assets that attract visitors worldwide.

These coastal resources face significant threats from both climate change and human activity. Rising sea levels, more frequent and intense tropical storms, and the expansion of the built environment have accelerated coastal erosion, an issue that has become the focus of several policy strategies and projects by the Government of Barbados and international partners.[26] Over the past decade, coral cover has declined from 37% to 23%, and 80% of Barbados' fringing reefs have been reported to be seriously degraded. Considering that coral reefs naturally absorb and dissipate wave energy, this situation further increases the vulnerability of the country's coast, which has had an average loss of 15 meters of shoreline over the past century (CZMU, 2020a). This ongoing degradation threatens the island's natural beauty, the livelihoods dependent on these vital coastal resources, and the critical coastal infrastructure upon which the Barbadian economy heavily relies.

Hurricane Beryl has exacerbated several of these existing problems. The storm significantly impacted natural assets such as coral reefs, beaches, and infrastructure in recreational areas, including parks and public facilities, particularly in the west and south of the country. These affected assets are the primary focus of this report. Table 48 summarises the estimated damages, losses, and additional costs incurred by the country in the environmental sector, totalling BBD 45.6 million. Damages account for BBD 12.7 million, losses contribute the most significant share at BBD 32.5 million, and additional costs amounted to the smallest portion, BBD 294 thousand. All these impacts are categorised under public sector expenditures, with no costs allocated to the private sector in this assessment.

The Coastal Zone Management Unit (CZMU), the National Conservation Commission (NCC), and the Sanitation Service Authority (SSA) generously provided the DaLA Team with data to calculate damages, losses, and additional costs for the environmental sector. To support these estimations, the DaLA team conducted geospatial analyses using databases hosted by the Lands and Surveys Department on the Barbados geoportal.

[26] More information on various projects and programmes aimed at increasing Barbados' coastal resilience is available at the CZMU's website: https://coastal.gov.bb/.

Table 48
Summary of the impacts in the environmental sector
(Thousands of Barbadian dollars)

Impact	Public	Private	Total
Damages	12 755	-	12 755
Losses	32 597	-	32 597
Additional costs	294	-	294
Total	**45 647**	**-**	**45 647**

Source: DaLA team, 2024.

A. Damages

The Government of Barbados reported coral reefs and beaches as the two main natural environmental assets that suffered from Hurricane Beryl's impacts. Therefore, the calculation of the baseline for the environmental sector focused primarily on these two main elements, as explored in the sections below. The status of coastal areas is briefly discussed below as additional contextualisation for this sector.

As highlighted earlier, coastal erosion is a significant challenge for the country and in this context, Barbados has become a Caribbean leader in integrated coastal zone management —a practice that involves bringing together various sectors, disciplines, and levels of government to address the complex issues affecting both marine and terrestrial habitats, as well as the built environment along coastal zones (Scruggs and Bassett, 2013). The prominent role of integrated coastal zone management in policy planning has facilitated the development of several information databases, studies, assessments, and other knowledge projects on the condition of Barbados' coastal areas. Map 10 below presents an island wide shoreline classification coastline type, and for beaches according to long-term historic trends in beach dynamics.

Map 10
Coastal classification

Source: DaLA team, 2024, based on data provided by the Lands and Surveys Department.

Table 49 shows the distribution in length of each of the different classification categories of the coastal areas of Barbados. A total of 31 kilometres of coast are classified as stable and dynamically stable, 8 kilometres are classified as eroding, and 2.6 kilometres are classified as accreting.

Table 49
Coastal areas, by classification

Coastal classification	Length (kilometres)
Accreting coast (engineered)	0.73
Accreting coast (natural)	1.85
Artificial coast	7.32
Coastal cliff	46.21
Dynamically stable coast (natural)	8.57
Eroding coast (engineered)	0.81
Eroding coast (natural)	7.21
Stable coast (engineered)	8.91
Stable coast (natural)	13.64

Source: Lands and Surveys Department.

The data in table 50 provides a detailed breakdown of the damages incurred across various categories due to Hurricane Beryl. Beach restoration represents the largest share of damages, with an estimated cost of BBD 9.4 million. Further considerations of the adequate policy measures to address the impacts of the hurricane on the beaches of Barbados are explored below. Coral reef restoration is estimated to cost BBD 2.9 million. Combined, the restoration costs for beaches and coral reefs total BBD 12.3 million, constituting most of the total damages listed. Additionally, the NCC reported infrastructure and facility damages amounting to BBD 40 thousand.

Table 50
Damages in the environmental sector
(Thousands of Barbadian dollars)

Natural capital	
Categories	**Amount**
Beach restoration estimates	9 416
Coral reef restoration estimates	2 919
Total	**12 336**
NCC managed facilities and infrastructure	
Categories	**Total**
Damaged equipment	25
Lifeguard stations	41
Infrastructure in public parks and beaches	317
NCC facilities	36
Total	**419**

Source: DaLA team, 2024.

The subsequent section will provide further information on the methodologies used to calculate damages to the categories pertaining to natural capital.

Coral reefs

Assessing coral reef damage after a hurricane presents significant challenges, including difficult accessibility, technological limitations, and significant required resources (Chegoonian et al., 2017). Data is typically collected from specific sites, and comprehensive assessments of tropical storm impacts on Caribbean coral reefs are relatively scarce. A meta-analysis by Gardner et al. (2005) found that, on average, coral cover across the region decreased by 17% in the year following a hurricane. In another study, Edmund (2019) observed a reduction in coral cover of up to 4% in specific sites in the British Virgin Islands after Category 5 hurricanes Irma and Maria struck the archipelago in 2017. These studies demonstrate that hurricane damage to coral reefs can vary significantly; this can be attributed to a range of factors, including the storm's strength and path, the specific composition of the coral, its depth, and other environmental conditions.

At the time of this report, detailed assessments of the damage to Barbados' coral reefs were unavailable. Anecdotal evidence reported to the DaLA team indicated that Hurricane Beryl caused significant reef damage, with several areas of natural reef experiencing flattened corals as well as destruction of artificial nurseries established for restoration. Additionally, a post-storm assessment by the CZMU revealed the presence of coral rubble on beaches and roads in numerous locations. Although the hurricane did not make landfall in Barbados, its Category 4 strength generated immense wave energy that propagated along the coast, particularly affecting marine environments in the west and southwest parts of the country.

The critical services that coral reefs provide to Barbados underscore the importance of not neglecting this biome in this damages and losses assessment. The topic of ecosystemic services will be further explored in the section below; just to illustrate, de Groot et al. (2012) estimated that nearly 45% of the monetary value of coral reef ecosystem services comes from their role in erosion prevention, which is especially vital for Barbados.

This study adopted a conservative estimate of 0.5% loss[27] in coral cover along the west and southwest coasts, the areas most affected by the storm (see map 11), totalling 47.6 hectares of area of coral reef estimated to be damaged. In the absence of local prices for coral restoration per area, the estimated amount of BBD 2.9 million in damages was calculated based on the median total restoration cost of coral reefs in developing countries per unit area calculated by Bayraktarov et al. (2016). It is worth noting that this estimate may be conservatively low for two reasons. Firstly, the cost regime in Barbados is higher than average. Secondly, the referenced study bases its estimated costs primarily on methods that rely on in situ nurseries, whereas feasibility studies for coral reef restoration in Barbados (Degia 2020, Baird 2017) found that several factors of the country's geography point towards the need for a land-based coral culture facility (larger upfront capital investment) to enable large scale restoration in Barbados. An improved estimation could be conducted following a more comprehensive assessment of the severity of Beryl's effects on this critical biome.

[27] This estimate took into consideration the pre-existing degradation of the coral biome before the hurricane. The 2020 Status of Coral Reefs report (CZMU, 2020b) lists various factors as key stressors of this ecosystem, including declining water quality, harvesting, climate change, physical damage, and invasive species. The overall health of Barbados' coral reefs is concerning, with many reefs showing clear deterioration. In 2017, the Reef Health Index for Barbados rated the overall condition of the reefs as fair. However, this average score masked considerable variation among different reef types; the west coast fringing reefs had the lowest health scores, while the south coast patch reefs were in the best condition (ibid). This degradation is critical to note, as the health of an ecosystem directly influences the quality and extent of the services it can provide.

Map 11
Coral reef cover in the most affected area by the storm

Source: DaLA team, 2024, based on data provided by the Lands and Surveys Department.

Beaches

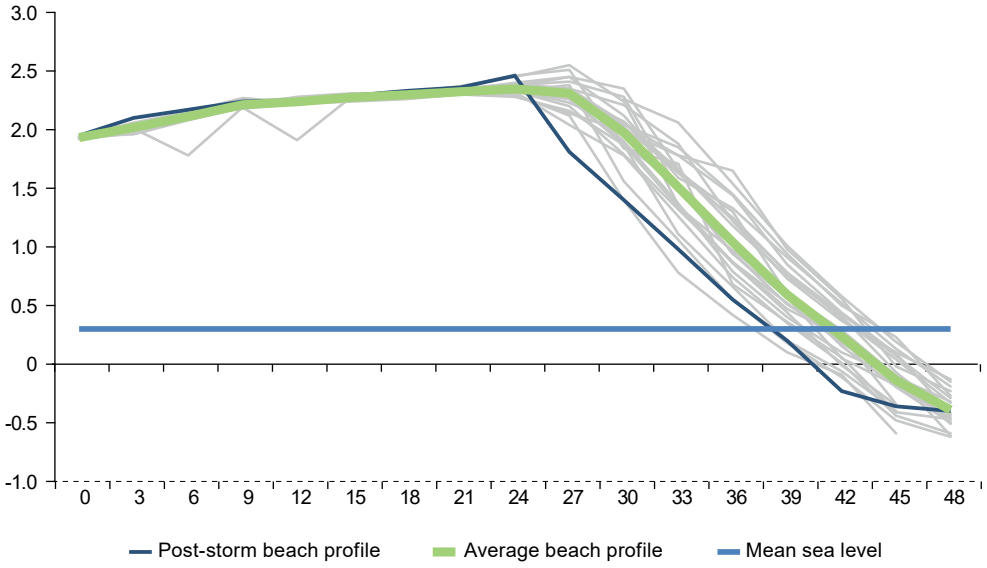
The estimation of the damages conducted by this study was circumscribed to beaches located on the west and southwest coasts, which were more heavily affected by the storm. During interviews with the CZMU and site visits carried out in coastal areas during the mission, it was reported that hurricane Beryl decimated nesting turtle sites, and significant coastal erosion and propagating large waves were recorded on the south coast. The CZMU team prepared qualitative post-storm rapid assessments that recorded the erosion suffered by beach areas in detail. The Unit also provided post-storm beach profiles for nine out of approximately 60 monitoring sites (see map 12) that are part of their permanent beach profiling programme. A time series for these nine sites was also shared with the DaLA team.

To illustrate the methodology of calculation of damages and losses incurred by beaches, Figure 5 presents a time series of beach profiles for Brandon's monitoring site. The grey lines represent past beach profiles since March 2019, highlighting the significant variation in sand levels at this location. The green line shows the average profile, calculated from all readings taken along the same reference points. The red line shows the beach's condition following the hurricane, revealing severe erosion and significant sand loss. The beach width loss was a key factor in determining the extent of losses, as will be discussed in the next section. It was estimated by determining the horizontal distance between the post-storm profile and the average profile at the water line - the blue line shown at an elevation of 0.3 m, this being equivalent to the mean sea level in the national Lamont Datum (Miller et al 2010).

Map 12
Beach profile monitoring sites

Source: DaLA team, 2024, based on data provided by the Lands and Surveys Department.

Figure 5
Beach profiles at Brandon's beach, time series from March 2019 until July 2024



Source: DaLA team, 2024, based on data from CZMU.

The estimation of loss of beach sand was used as a proxy to estimate the damage to Barbados's beaches. The first step involved calculating the sand loss at nine monitoring sites for which data was produced by CZMU in a post-storm beach profile assessment. An average sand loss per linear meter of beach was determined for each site, and these averages were applied to the other beaches on the south and southwest coasts based on their proximity to these monitoring sites. It was estimated that a total of 141,566 cubic meters of sand was removed from the beaches by the force of large propagating waves

after Hurricane Beryl. The study used the cost of one cubic meter of compacted sand, as estimated by the IDB (2022), to calculate the total damages to the beaches, resulting in an estimated BBD 9.4 million in damages caused by this hurricane.

It should be noted that using the cost of sand as a proxy in the above valuation for the abovementioned exercise should not be construed as a recommendation that the Government of Barbados undertake extensive country-wide coastal rehabilitation following the passage of Beryl, a recommendation that sand replacement is the appropriate method for rehabilitation, or justification that such undertaking is done by the private sector. Decisions regarding coastal rehabilitation should be based on a thorough multi-criteria analysis and prioritization. As part of the DaLA methodology, assigning a monetary value to damaged natural capital is crucial to ensure that environmental damages are fully accounted for in the overall assessment. Therefore, the use of the cost of sand is justified in the scope of this assessment only.

B. Losses

Table 51 summarises losses stemming from the loss of total beach revenue for four months[28], amounting to BBD 1.5 million, and the loss in ecosystem services provided by coral reefs until the end of 2024, which is significantly higher at BBD 31 million. The combined total loss from these two categories is BBD 32, million. The remaining of the section will further explore the methodology utilised for these calculations.

Table 51
Losses in the environmental sector
(Thousands of Barbadian dollars)

Losses	Total
Loss of total beach revenue	1 579
Loss in ecosystemic services provided by coral reef	31 017
Total	**32 597**

Source: DaLA team, 2024.

The estimation of beach losses was based on the concept of Total Beach Revenue (TBR), defined as the yearly revenue derived from tourism, calculated as a percentage of GDP, and allocated across the country's beach areas according to the significance of each segment. This value is expressed in US dollars per square meter per year (US$/m²/year) (IDB, 2022). To avoid double counting the contributions of beaches to the sun-and-bath tourism sector —already covered in the tourism chapter— the environmental sector's assessment classified all beach areas in Barbados as Category 1[29], with a TBR of USD 32 m²/year. This category represents beaches with the least direct contribution to tourism. The goal was to isolate the economic value of beaches as areas for recreation and leisure, without overemphasizing their tourism-related economic contributions.

The methodology for estimating the loss in TBR involved calculating the area of beach lost due to the storm. The beach profile recession at each of the nine monitoring sites, where data was available, was determined using the receding profile at the waterline, as previously described. After estimating the beach profile recession for each site, the averages of beach width loss were applied to all beaches in the south and southwest coasts, based on their proximity to each of the nine monitoring sites. This approach led to an estimated loss of 66,775 square meters of beach across the entire country.

[28] The recuperation of a beach following an acute episode of erosion, such as that caused by the passage of a hurricane, depends on various factors, including the coastal conditions (see map x for the coastal classification of Barbados). It can take from several weeks to several months, depending on these environmental conditions. CZMU staff informed the DaLA team that most of the beaches could have a relative recovery within four months of the storm; hence, this timeframe was adopted for calculating losses.

[29] The IDB's technical note "Public Investment Programme for Disaster Risk Reduction—Beach Erosion and Risk Mitigation Model for Barbados" (IDB, 2022) provides more information on the beach area classification.

It's important to recognize that ecosystems provide not only tradeable goods and services with market value, such as a beach's contribution to tourism but also other essential functions. These include regulating processes, providing habitats for various species, and offering non-material benefits, such as aesthetic, spiritual, and psychological inspiration, recreation and leisure, ecotourism, and scientific and cultural knowledge (ECLAC, 2014). The use of TBR as a proxy for losses related to beaches stems from the absence of other established estimates for other ecosystemic services provided by beaches that could be adopted by this study.

To estimate the losses from the damaged coral areas, the already calculated area of 47.6 hectares of damaged coral was multiplied by an international natural capital monetary valuation benchmark developed by de Groot et al. (2012). Their analysis identified coral reefs as the biome with the highest monetary value for the goods and services they provide, estimated at BBD 651,562 per hectare per year. Notably, the loss of coral reefs constitutes the most significant component of the damage and loss assessment for the environmental sector. While the development of local natural capital valuation methodologies and studies is recommended to allow for further accuracy of this assessment, this benchmark underscores the substantial benefits of preserving coral reefs, especially when the services provided by a hectare of coral are compared with the average cost of restoration per hectare - BBD 19,510 (Bayraktarov et al.,2016).

C. Additional costs

A significant portion of the additional costs in the environmental sector resulted from post-hurricane cleanup operations conducted by the NCC on beaches and other public spaces, in coordination with the MTW and the Barbados Defence Force. The NCC's broad mandate includes maintaining and upholding sanitary conditions in public parks, gardens, and beaches, as well as providing landscape services to various sites and properties. Additionally, the NCC operates a plant nursery and provides ranger and lifeguard services across the island. Following Hurricane Beryl, the NCC focused on clearing and repairing areas impacted by flooding and debris, particularly along the South Coast in locations such as Enterprise, Oistins, Welches, Dover, Rockley, and Hastings Rocks. The additional costs included in this chapter primarily involved fuel for vehicles and machinery, as well as regular and additional labour expenses.

The SSA also incurred additional costs within the environmental sector. The SSA, responsible for waste management and sanitation across Barbados, reported increased labour costs due to the heightened demand for cleaning services after the hurricane.

Table 52
Additional costs in the environmental sector
(Thousands of dollars)

Additional costs	Public	Private	Total
Preparatory activities	14.66	0	14.66
Fuel used by vehicles during clean-up operations	132	0	132
Labour costs	147	0	147
Total	**295**	**0**	**295**

Source: DaLA team, 2024.

Costs associated with debris removal from sunken vessels in coastal areas were detailed in the chapter on fisheries and agriculture. Costs resulting from decontamination requirements, particularly due to diesel spills at sites where significant damage to fishing vessels occurred, and the collection and disposal of contaminated materials in those places, were not reported to the DaLA team and not included in this report.

X. Macroeconomic impacts

Introduction

Barbados is relatively highly developed Caribbean country. It was ranked 62 in the Human Development Index in UNDP's 2023-24 Human Development report and categorized as a country with "very high human development". With a GDP per capita of USD 22,672 in 2023, it is classified at a high-income country by the World Bank. Because of this classification, however, Barbados has limited access to affordable concessional financing. Despite the high income, Barbados remains a small open economy will all the vulnerabilities of Small Island Developing States. Barbados is currently recovering from an economic crisis that predates the COVID-19 pandemic and is in the midst of an IMF programme; while it has been meeting its targets under the programme, it has limited fiscal space. As such, the costs associated with a disaster could significantly impact its fiscal performance.

Prior to the event, the Barbadian economy was projected to grow at 3.90% in 2024. The estimated impact of Hurricane Beryl is 0.15 percentage points of GDP, which implies that post-disaster, the economy of Barbados is expected to grow by 3.75%. The estimates in this section are based on data from the BSS and the Central Bank of Barbados.

A. Evolution of the economy before Hurricane Beryl

Real sector

The Barbados economy is heavily service based. According to the Barbados Statistical Service's latest GDP estimates, the largest industry in 2023 was the accommodation and food services at 11.6% of all GDP. The size of the accommodation and food services industry, which is a proxy for tourism activity, highlights the importance of tourism to the Barbadian economy. While no official tourism satellite account exists for the economy, the Central Bank of Barbados estimates tourism activity at 6.4% of total GDP in 2023 (CBB 2024a). Following accommodation and food services, the next largest industries are wholesale and retail trade (11.6%), real estate (11.0%), business services (7.5%) and education services (6.9%). The

primary sectors are of relatively little importance to Barbados. Mining and quarrying contribute 0.9% to GDP while agriculture and fishing accounted for just 1.9% of GDP in 2023; fisheries accounted for 4.0% of agriculture and fishing, or just 0.07% of total GDP.

Table 53
Barbados GDP by industry 2023, in current prices

Industry	Millions of Barbadian dollars	Percentages of GDP
Accommodation and Food Services	1 556.39	11.6
Wholesale & Retail Trade	1 554.22	11.6
Real Estate	1 477.45	11.0
Business Services	1 007.43	7.5
Education Services	928.41	6.9
Transportation and Storage	848.48	6.3
Finance & Insurance	842.64	6.3
Manufacturing	752.15	5.6
Construction	628.11	4.7
Public Administration, Defence & Social Security	574.52	4.3
Information & Communications	548.36	4.1
Health Services	499.35	3.7
Electricity, Gas & Water Supply	281.42	2.1
Agriculture and Fishing	249.21	1.9
Other Personal services	161.32	1.2
Arts, Entertainment and Recreation services	142.22	1.1
Mining and Quarrying	118.88	0.9
Less FISIM Adjustment	351.86	2.6
Total Value Added at Basic Prices	**11 818.71**	**87.9**
Taxes less Subsidies on Products	**1 622.76**	**12.1**
Gross Domestic Product at Market Prices	**13 441.47**	**100.0**

Source: DaLA team based on data from the Barbados Statistical Service, 2024.

The Barbados economy has been performing well since the shock of the COVID-19 pandemic in 2020. Following a major contraction in 2020 of 15.1% and a smaller one of 0.3% in 2021, the economy expanded by 17.8% in 2022 and an estimated 4.1% in 2023. The performance in 2023 was driven largely by strong tourist arrivals, which grew by 18% relative to the previous year. Cruise passenger arrivals increased by 76.3% on account of increased visits and new homeporting arrangements. This increase in visitors led to a 10.7% increase in accommodation and food services, which contributed one percentage point to overall growth. Education services expanded by 17.9% and made the largest contribution to growth at 1.2 percentage points. The third largest contribution to growth came from finance and insurance industry with 0.6 percentage points. Conversely, construction and health services had the largest negative contributions to growth, at -0.3 and -0.1 percentage points respectively.

The economic expansion continued in the first half of 2024 (CBB 2024a). The recovery from the pandemic shutdown could be considered complete in this half as Barbados received a record number of long-stay tourist arrivals (17.9% higher than in 2023). Part of the increase was due to the fact that Barbados cohosted the ICC Men's T20 Cricket World Cup. With respect to the tourist markets, most of the increase was due to increased visitors from the United States and Canada, but it is expected that

arrivals from all markets will exceed pre-pandemic averages by the end of the year. Cruise visitors in the first six months of 2024 increased by 17.9% and were almost at pre-pandemic levels. Unfavourable weather conditions impacted production of certain crops, but agricultural production increased by 5.4%. There were expansions in manufacturing (1.1%), wholesale and retail trade (3.6%), electricity, gas and water (3.9%), production and construction (7.1%). In their first half economic review, the Central Bank of Barbados estimated full year growth of 3.9% for 2024.

Fiscal

Barbados has long suffered from chronic fiscal deficits and high public debt. The government ran overall fiscal deficits of over 4.5% of GDP from 2009 to 2017, with average overall and primary deficits of 7% and 0.7% respectively over the period (ECLAC 2024). These deficits resulted in total public debt rising steeply and reaching as high as 179% of GDP in 2018. To deal with this economic crisis in 2018 Barbados launched its Barbados Economic Recovery and Transformation (BERT) plan and sought assistance from the IMF. In October 2018 the government entered into an Extended Fund Facility (EFF) arrangement with the IMF in the amount of USD 290 million. The government also began a restructuring of public debt. Following the expiration of the EFF in June 2022 the Barbados government launched an updated reform programme, BERT 2022, and entered into another 36-month EFF with the IMF, in the amount of USD 113 million, as well as a Resilient and Sustainability Fund (RSF) in the amount of USD 189 million. The new BERT programme aims to implement some initiatives from the previous iteration that it could not be because of the pandemic, including reforming the pension system. Since launching the original BERT programme, the government has been on a programme of fiscal consolidation and has managed to contain its fiscal deficits and lower its public debt ratio. They were able to hit their quantitative targets under the programme over the last two years (IMF 2024).

In fiscal year[30] 2023/2024 the Government of Barbados posted a fiscal deficit of 1.7% of GDP (CBB 2024a), which is narrowed from 2.0% in the prior fiscal year. The government also achieved a primary surplus of 3.7% of GDP, up from 2.4% in year before. The improved result was due to a 1.9% increase in total revenue, which outweighed a 1.2% increase in total expenditure. The increase in revenue was driven by increased indirect taxes; VAT income rose with increased economic activity and increased imports. Direct taxes fell by 0.1%, as the pandemic levy, which was introduced in 2022 to support Barbados' response to COVID-19, was discontinued. Personal and corporate taxes did increase, and the latter benefited from tax reforms which advanced payments which would have been due in fiscal 2024/2025. The increase in total expenditure resulted from a 4.9% increase in current expenditure offsetting a 22.4% decline in capital expenditure. The current expenditure outlay was largely due to increased interest payments; particularly external interest payments, which were affected by rising international interest rates. Capital expenditure and net lending fell despite continued spending on major infrastructural projects. The public debt to GDP ratio declined to 114.3% by the end of the fiscal year.

In the first quarter of fiscal year 2024/2025 the Barbados government posted a fiscal surplus of 2.3% and a primary surplus of 3.5%. Prior to the passage of the hurricane the government was expected to post a surplus for the current fiscal year and targeted a primary surplus of 4% of GDP. Revenue in the first quarter of the fiscal year increased as both direct and indirect taxes grew. Direct taxes benefited from the aforementioned tax reforms which resulted in earlier than previous collection of corporation taxes and land taxes. Indirect taxes grew as a result of increased VAT collection stemming from increased tourism and construction activity. Expenditure increased in the first quarter, as increases in interest payments and transfers and subsidies offset a decline in expenditure on goods and services. Part of the increase in interest payments was due to step-up rates on restructured domestic debt. Capital expenditure and net lending increased 46% on account of road infrastructural projects and the purchase of land. The debt ratio fell to 105.3% of GDP, continuing its downward trend. A fall in the debt stock as well as an increase in GDP contributed to the decline.

[30] The fiscal year runs from April to March.

B. Impact on the macroeconomy

Real sector

The overall impact of the passage of Hurricane Beryl on the Barbadian economy is expected to be limited. GDP growth of 3.75% is expected, instead of the 3.90% projected before the event. This estimate was made using just the sectors assessed for this report, as well as data from the BSS on GDP in current and constant prices from 2010 to 2023 and estimates of intermediate consumption and gross value added from their Supply and Use Table (SUT). The GDP deflators were calculated using the GDP in constant and current prices.

In order to estimate the impact on GDP, first a baseline level for 2024 GDP was estimated in current and constant prices. GDP by industry in constant prices was estimated using the Central Bank's 3.9% estimate for 2024. The growth rate of 3.9% was distributed among the industries using the industry contributions to growth in 2023. This was then used to calculate the industry growth rates and gross output for 2024. The GDP deflator for 2024 was estimated using the Central Bank's estimate for end of 2024 inflation of 3.5%. The nominal GDP for 2024 was then estimated using the estimated 2024 real GDP and GDP deflators.

The next stage of the estimation involved calculating the technical coefficients of SUT from the estimates of intermediate consumption and gross value added for each industry. With these coefficients the losses in each sector were converted to gross value added and the additional costs were converted to intermediate consumption. The additional value added from increased construction activity were also estimated based on the additional costs in each sector[31].

Finally, these estimates were then subtracted from the baseline 2024 gross production values in the corresponding industries. The new values were summed to calculate the post-disaster nominal GDP estimate. This was converted to real GDP using the deflator estimates. Post-disaster annual growth was calculated at 3.75%. Therefore, the impact of Hurricane Beryl was -0.15 percentage points of GDP growth. The sector that was most affected, with the highest proportion of damaged assets was the fisheries sector, but given its small size in the wider economy, its impact will be minimal.

The impact on labour is expected to be minor. Most business in the tourism sector ceased operations for just a few days. While the fisheries sector was significantly impacted, the event occurred toward the end of the fishing season, thus limiting the impact on employment.

Fiscal

The fiscal policy implemented after the passage of the hurricane included the extension of the Business Interruption Benefit to all affected fisherfolk. In the aftermath of the hurricane the government received a grant from the Latin American Development Bank (CAF) of USD 250,000. This donation will be used to capitalize the Fisheries Benevolent Fund to assist fisherfolk in financing new equipment and addressing existing debt. The government also announced a plan to establish a 30-year revolving fund that will offer grant financing for fisherfolk to purchase or repair boats. The full impact on the central governments operations was not known at the time of writing.

The government will face some costs related to housing assistance. According to data from the BSS, 42 households are being assisted by the government with repairs. The amount of assistance required is compounded by a lack of insurance coverage. Home insurance coverage in the Caribbean is often below international benchmarks. While in the United States over 85% of homeowners are insured (Croll 2022), the number in Barbados will be much smaller. Of the 65 households that reported damage from the storm, only 4 of them were insured.

[31] The additional costs are assumed to be intermediate consumption required to generate production in each industry. All additional costs were then assumed to be construction activity and converted to additional value added in the construction industry.

To increase its resilience to natural disasters, Barbados has parametric insurance with the Caribbean Catastrophe Risk Insurance Facility (CCRIF), which it has been a member of since its inception in 2007. CCRIF is an ex-ante financing instrument that provides liquidity injections within two weeks of a disaster to assist in restoring critical infrastructure and continuity of government operations. Barbados also has a disaster contingent credit line with the Inter-American Development Bank (IDB). Both parametric insurance and this credit line represent significant steps toward establishing a comprehensive disaster financial policy, which should be grounded in a thorough understanding of disaster risk. Ideally, such a policy would include budget forecasting to cover catastrophic events and the efficient, transparent management of resources for disaster risk reduction. The ultimate goal is to enhance the country's fiscal resilience and its ability to respond effectively to disasters. Similar strategies were developed in recent years across Latin America and the Caribbean, with support from the World Bank and the IDB, in countries like Guatemala (2018), Jamaica (2019), Panama (2020), and Honduras (2022).

As part of the response to their recent economic crisis, Barbados made efforts to make their debt stock more climate resilient. Taking inspiration from Grenada's recent experience with implementing Hurricane Clauses, as well as from the damage wrought by Hurricane Irma in 2017, Barbados implemented natural disaster clauses in the majority of their debt agreements in their debt restructuring exercises from 2018 to 2020 (Ho and Fontana 2021). The clauses are linked to their policy with CCRIF: if CCRIF makes a policy payout as a result of a qualifying natural disaster, the clause allows Barbados to defer principal and interest payments for two years. However, since the parameters of the policy were not met by Hurricane Beryl, the CCRIF did not make a payout, and the government will not be able to defer debt service payments.

XI. Recommendations for a resilient reconstruction

This section of the document presents the key recommendations for resilient reconstruction in Barbados. These recommendations were developed with reference to the four priorities of action outlined in the Sendai Framework for Disaster Risk Reduction 2015–2030. The disaster caused by Hurricane Beryl should bring disaster risk management (DRM) to the forefront of the public policy agenda, prompting the adoption of measures across all sectors and levels of government to ensure effective DRM.

Table 54
Sendai Framework for Disaster Risk Reduction 2015-2030

Goal	Prevent the emergence of new disaster risks and reduce existing ones by implementing integrated and inclusive measures across various domains—economic, structural, legal, social, health, cultural, educational, environmental, technological, political, and institutional. These measures should aim to reduce exposure to hazards and vulnerability to disasters, increase preparedness for response and recovery, and ultimately strengthen resilience.
Expected results in 2030	The significant reduction of disaster risk and disaster losses—including lives, livelihoods, health, and the economic, physical, social, cultural, and environmental assets of individuals, businesses, communities, and countries.
Priorities for action	A. Understanding disaster risk B. Strengthening disaster risk governance to manage disaster risk C. Investing in disaster risk reduction for resilience D. Enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation and reconstruction.

Source: UNDRR (2015).

The recommendations are based on the main conclusions drawn from information gathered during field visits and data collected from official sources. For each of the priorities for action, the measures suggested by sector specialists will be detailed. Additionally, the results of the Index of Governance and Public Policy for Disaster Risk Management (iGOPP) in Barbados, including its overall index, subindices, and indicators, will be discussed. Developed by the IDB in 2012, the iGOPP evaluates the existence of regulatory, institutional, and budgetary conditions necessary for effective disaster risk management, using 245 binary indicators of good practices.[32] In the case of Barbados, the index was published in 2020, but the data used was up to 2018 (Lacambra et al., 2020).

[32] The iGOPP is composed of six components: General Governance Framework for Disaster Risk Management (MG), Risk Identification and Awareness (IR), Risk Reduction (RR), Response Preparations (RP), Post-Disaster Recovery Planning (CR), and Financial Protection (PF). The index and its subindices for each component range from 0 (most unfavorable) to 100 (optimal). These values are also interpreted on a qualitative scale: low (0-20%), incipient (21-40%), appreciable (41-70%), notable (71-90%), and outstanding (91-100%).

These recommendations provide a framework for a resilient reconstruction process, considering the most relevant findings from each sector. The prioritization of actions, allocation of resources, and timing of implementation will ultimately depend on the Government of Barbados, based on its internal human and financial resources, ongoing initiatives, anticipated developments, and overarching priorities.

Risk Factors Highlighted by Beryl and National Context for Recovery

The most significant physical impacts/damages from Hurricane Beryl occurred along the south and west coasts of the island, across multiple sectors or asset categories, including ports and harbours, transport infrastructure, fisheries, tourism, and environment. This is a result of the nature of the event combined with the location and nature of the assets. The hurricane passed south-west of the island, and while it did not generate significant rainfall or winds on land, it did generate significant waves that battered the shoreline predominantly along the south and west coasts. Barbados is densely developed overall, with a concentration of dense mixed-use development in the urban corridor along the south and west coasts. Having undergone significant physical development earlier than many other Caribbean SIDS, including prior to Independence in 1966, the country faces a legacy of unsustainable physical development practices that include physical development and placement of critical infrastructure unsuitably close to the shoreline or along waterways, as well as aging, and in some cases, poorly maintained infrastructure and housing stock.

Significant damage was incurred at ports and harbour facilities and fish landing sites highlighting the challenges the country faces with providing safe harbour during extreme events. Barbados is highly exposed to high wave energies - the island itself lies at the edge of the Atlantic with no windward landmasses to provide sheltering, and there are little to no sheltered areas along the coastline, including no significant indentations that would profile natural safe harbour. There is an inherent lack of 'safe asset protection sites' and 'low risk areas' as it relates to safe harbour. This is an underlying issue that affects all ports and harbour facilities and therefore has implications across sectors. The cargo port is critical for food security and general provisioning in a country that is heavily dependent on imports. It also plays an important role in several sectors of the economy that rely on exports, an area the country is working to develop and expand. Harbour facilities are also critical for the fisheries and tourism sectors.

Notwithstanding a complex suite of challenges in which typical SIDS challenges combine with its own particularities of geography and history, Barbados has made significant progress with sustainable development, including climate change response and disaster risk reduction. The country has a robust and well-developed policy and legal framework, including key instruments, legislation and policy related to physical development, coastal zone management, water resources protection and pollution control, as well as energy transition, among other areas. The national Roofs to Reefs Programme (R2RP), positioned within the Prime Minister's Office, is the overarching flagship programme for sustainable and resilient physical development, intended to operationalise key policies such as the physical development plan.

In an effort to produce this DaLA report in a timely fashion following the event so that its results may be incorporated into recovery planning and budgetary processes as required, the report does not include an exhaustive inventory or assessment of current or ongoing policies, plans and interventions. As such, it is recognised that some of the general recommendations included in this chapter may already be under consideration or in progress in some form. It is recommended that the recovery planning process combine these recommendations with a more extensive assessment of ongoing efforts to produce more specific actions.

A. Recommendations - Understanding disaster risk

The disaster risk management process, encompassing all its components —risk assessment, prevention, mitigation, preparedness, and response— must be grounded in a comprehensive understanding of disaster risk. This understanding should consider all dimensions, including vulnerability, capacity, the exposure of people and assets, hazard characteristics, and the environment. Recognizing these dimensions requires

acknowledging a wide range of issues and demands a coordinated effort, which is the responsibility of national and local authorities across all socioeconomic sectors.

In the 2018 application of the iGOPP, the component of that index most aligned with this priority is Risk Identification, which scored 15%, corresponding to a "low" rank. At that time in Barbados, there were no regulations designating a responsible national entity to provide technical assistance and guidelines at territorial and sectoral levels for disaster risk analysis, nor was there a mandate for the creation and maintenance of a database on the impacts of disasters.

Since the 2018 application of the iGOPP, Barbados has advanced considerably in identifying and understanding disaster risk. Key information resources and initiatives include: the hazard mapping incorporated into the National maps of the Physical Development Plan[33], a comprehensive multi-hazard coastal risk assessment and associated National Coastal Risk Information Planning Platform (NCRIPP)[34] commissioned by the Coastal Zone Management Unit (CZMU) and intended to support development planning, the National Disaster Preparedness Baseline Assessment (NDPBA)[35] commissioned by DEM, and a geospatial map developed by the MPEEA[36] that will help determine the location of people across the island, identify vulnerable persons and respond to their needs before and after a disaster, among other things. Furthermore, the Roofs to Reefs Programme (R2RP), which is the countries flagship sustainable and resilient physical development programme, is grounded in a risk-informed development approach.

1. Generate new application of the iGOPP and CDEMA CDM Audit Tool

Given the advancements made since the 2018 application of the iGOPP, it is recommended that the country ask the IDB for a new application to have a quantitative measure of both advancement and areas in which progress must be made.

Moreover, the Application of the Comprehensive Disaster Management (CDM) Audit Tool would be recommendable. The CDM Audit Tool is an instrument used by the Caribbean Disaster Emergency Management Agency (CDEMA) to investigate the needs of its Participating States (PS) in terms of capacity development and institutional strengthening to pursue CDM integration in all aspects of the planning process at the national level.

The CDM Audit Tool now includes an updated Sectoral Recovery Capacity Assessment (SRCA), that provides a deep analytical dive into the recovery capacity of a given sector. The SRCA spans three areas: governance, competencies, and resources and tools. This tool has been tested in several countries through the EnGender Project.

2. Use geospatial information to support disaster risk management

One of the key components of risk assessment is data and information management related to potential hazards, as well as data concerning exposure and vulnerability to have an estimate for affected population and assets. According to the 2018 CDM Audit, some critical strengths exist within Barbados' National Disaster Management Framework. These stem from the alignment of its Mitigation Phase of reporting with regional and international standards. For Sendai Priority 1: Understanding Disaster Risk, strengths were noted within risk identification. For instance, Risk assessments are a common feature within the national landscape; however, hazard analyses are performing at an unsatisfactory level. The sub-elements of hazard analyses include: (i) hazard knowledge, (ii) hazard mapping, (iii) hazard modelling and (iv) the availability of useful resources. In terms of the Sendai Monitor indicators, there is a paucity of information on the various subsidiary standards under the hazard assessment sub-elements.

[33] http://townplanning.gov.bb/physical-development-plan/pdp-resources/.

[34] https://coastal.gov.bb/czmu-coastal-conservation-programmes-timeline/coastal-risk-assessment-and-management-programme/#1680286601624-97dd85bb-5c81.

[35] https://reliefweb.int/report/barbados/barbados-national-disaster-preparedness-baseline-assessment-data-driven-tool-assessing-risk-and-building-lasting-resilience.

[36] https://barbados.loopnews.com/content/geospatial-map-launched-help-vulnerable-persons-barbados.

In this context, geo-information and spatial databases are fundamental for a country's planning processes and for informed decision-making during disaster scenarios such as the one in Barbados. Geo-information is also valuable in rehabilitation and reconstruction efforts, aiding in planning, execution and monitoring. For instance, the Lands and Surveys Department oversees the Barbados Geoportal, where they upload layers from different thematises that are produced by government institutions such as Environment, Power, Education and Housing, among others. Geo-information has also been extensively compiled and/or is held by other agencies, including the Planning and Development Department (as it relates to the Physical Development Plan and associated National Maps[37]), the Coastal Zone Management Unit (as it pertains to the previously referenced multi-hazard risk assessment and NCRIPP, which is intended to support development planning), and the DEM as it relates to the previously referenced NDPBA. However, during consultations meetings, it was revealed that although data was made available and shared with entities responsible for emergency and response coordination and management before and after Hurricane Beryl, geo-spatial data in Barbados remains fragmented across multiple agencies and platforms, and there are no specific protocols in place for producing, collecting, and sharing geo-information.

Therefore, it is strongly recommended that the Government of Barbados initiate a process to establish legislation regarding geo-information management. Such legal frameworks would define responsibilities and competences for the production, management, and dissemination of geo-information at various territorial levels.

In parallel with this process, it is recommended to establish multi-sectoral baseline assessments for disaster evaluation in the short term. These baselines could be developed following the DaLA methodology like in Chile, Guatemala and Honduras, see Allen et al. (2023), and Bello and Bonnafé (2023, 2024), aiming to estimate the replacement costs of assets in priority sectors and variables for assessing economic flows. Developing these baselines and establishing multi-hazard early warning protocols for their regular updates will provide essential tools for maintaining an up-to-date and accurate risk profile of the country. This, in turn, will help identify and correct vulnerabilities, contributing to disaster risk reduction strategies. For example, this type of information can complement studies such as the study on "Public Investment Profile for Disaster Risk Reduction: Beach Erosion and Risk Mitigation Model for Barbados" that was done by the Inter-American Development Bank (IDB, 2022).

3. Strengthen local oceanographic, climatological, geospatial, and statistical information system for a myriad of hazards

The Caribbean region regularly faces a myriad of hazards in particular the impact of tropical cyclones each year, influenced by climatic and oceanographic factors that affect their frequency and intensity. Early identification of these weather events with the potential to affect one or more countries is crucial to minimizing their impact. Strengthening local oceanographic, climatological, geospatial, and statistical information systems is therefore essential for achieving this objective.

Timely access to information is recommended for effectively managing and mitigating the risks associated with these weather events. Real-time data on oceanographic and climatic variables during such events can significantly reduce damage to fishing assets and economic flows in the sector. Establishing a network of monitoring stations at strategic fishing sites for oceanographic and climatic information is vital for tracking and forecasting key variables with the aim of minimizing losses.

Furthermore, regular training and enhanced local capacities in risk management and administration within the fishing sector are essential for a region prone to tropical cyclones. Climate change and the heightened intensity and frequency of weather events necessitate continuous protocol updates to address the increased risk of potential damage and impacts to fishing assets and economic flows in Barbados.

[37] http://townplanning.gov.bb/physical-development-plan/pdp-resources/.

4. Enhance Information Systems for Risk Management within the tourism sector

Integrating real-time weather monitoring data with tourist accommodation booking systems is proposed to pre-emptively manage cancellations and relocations during severe weather events. Establishing a centralized database would consolidate specific data on threats, exposure, vulnerability, and risk from various institutions. This would significantly improve the sector's ability to assess risks and respond accordingly.

Enhancing the availability of training and education on disaster risk reduction for government officials, civil society, and the private sector within the tourism industry is also recommended. This will ensure that all stakeholders are well-informed and prepared to handle disaster risks effectively.

5. Conduct natural capital assessment for Barbados

It is recommended that Barbados build on existing efforts and continuously invest in credible marine natural capital appraisements and ecosystem services accounting by conducting locally tailored studies with appropriate methodologies that consider the unique characteristics of local natural habitats. These studies would establish a solid baseline for assessing the comprehensive contributions of the country's natural capital to society and the Barbadian economy, allowing also a better understanding of the scale of risks to the country's natural capital. This approach would better inform policies aimed at protecting natural habitats and enable the assessment of related damages and losses following disasters. Additionally, it would provide valuable information for decision-makers during economic policy planning, cost-benefit analyses of key infrastructure projects, and the planning of conservation efforts. It would also help raise awareness of nature's importance to society. By integrating this data into central accounting processes, Barbados can make informed decisions to enhance hurricane resilience and ensure the sustainable management of its natural resources. The Government of Barbados, through the Ministry of Environment, Natural Heritage Department, the CZMU and/or other relevant agencies, can spearhead these efforts with the support of local universities, research institutions and relevant local and international partners.

B. Recommendations - Strengthening disaster risk governance to manage disaster risk

Disaster risk governance involves mainstreaming disaster risk reduction within and across all sectors; implementing disaster risk reduction strategies; providing incentives for disaster risk reduction activities (such as compliance with building codes requirements); establishing and strengthening coordination mechanisms; and instituting legislation and policies in support of disaster risk management.

Risk governance emphasizes the importance of establishing clear objectives, plans, competencies, guidelines, and coordination within and across sectors to foster collaboration and partnerships in prevention, mitigation, preparedness, response, recovery, and rehabilitation.

The iGOPP component most closely related to this priority for action is the DRM General Framework, which scored 27%, placing it in the "Incipient" category according to iGOPP classifications. The analysis at that time indicated that while Barbados' Emergency Management Act was fairly comprehensive, covering aspects related to risk reduction, response, and recovery, it did not establish a clear framework of responsibilities across all levels of government (central, decentralized, and local). As a result, the key indicators for regulatory conditions necessary for effective disaster risk management at central, sectoral, and territorial levels were not met.

According to the 2018 CDM Audit, some critical strengths exist within Barbados' National Disaster Management Framework. These stem from the alignment of its Mitigation Phase of reporting with regional and international standards. For Sendai Priority 2: Strengthening Disaster Risk Governance to Manage Disaster Risk, strengths were noted within structural mitigation. It can be further disaggregated into (i) new facilities and (ii) existing facilities. Under new facilities, sub-elements such as the planning

process and maintenance aspects were deemed as satisfactory. This suggested that there is an effective planning process regarding protocols like building permits that were established for critical infrastructure[38] and land use planning policies.

Similarly, the existence of a dedicated maintenance budget for critical infrastructure facilitates a maintenance schedule for educational facilities – institutions which primarily act as emergency shelters during inclement weather events. Under existing facilities, the two sub-elements of retrofitting and maintenance were deemed as satisfactory. The former seeks to improve the resilience of old critical infrastructure and may require external financing to improve the structural and non-structural vulnerability of physical assets. Maintenance under this component generally relates to educational facilities as religious buildings —for instance, churches are maintained via their respective budgets. In terms of the Sendai Monitor indicators, there is no information regarding new and or old facilities.

However, the country's performance on the non-structural mitigation component was deemed as unsatisfactory. This component consists of four elements: (i) Land Use Planning, (ii) Safety Standards, (iii) Building Codes, and (iv) Incentives – the latter two of which represent major areas of special attention as the level of performance of these measures was deemed as unsatisfactory. For instance, in terms of the Sendai Monitor indicators, there is no information regarding National Building Codes.

Under the stewardship of Barbados, the DEM commenced the CDM Audit process 11 June 2024. The information from this ongoing process should inform disaster management policy and strategies going forward. All stakeholders should therefore participate actively in the process as benefits can be derived especially after the recent impacts of Hurricane Beryl.

1. Improve inter-disciplinary, cross-sectoral, and multi-stakeholder involvement in disaster risk reduction

Beyond the need for multi-stakeholder involvement in risk data compilation, is the need for strengthened institutional mechanisms. Such mechanisms seek to create a platform for enhanced cooperation across stakeholders for actions geared towards addressing the underlying risk drivers. Institutional mechanisms must therefore support collaboration across state (interministerial and sectoral collaboration at national and subnational levels) and non-state actors, including civil society, private sector, academia, and the media. Systemic risk planning calls for a paradigm shift from assigning national disaster offices, in this case the DEM, as the main entity for risk reduction towards mainstreaming risk reduction and management across a wide spectrum of stakeholders.

It is also important to foster stronger collaboration between tourism businesses and local disaster management agencies, ports, and maritime authorities. This coordination can ensure a unified response during hurricanes, including the effective use of resources and safe evacuation of guests, and the safeguarding of critical fisheries infrastructure, if necessary.

2. Understanding existing capacities and gaps, and strengthening arrangements

Adopting and promoting systemic risk assessments for planning must first commence with an in-depth assessment of national capacities, policies and frameworks, and understanding where there may be shortfalls. In recovering from the fallout of the COVID-19 pandemic and in strengthening resilience for future risks, countries must commence with a review of existing institutional and governance mechanisms to understand the barriers to effective systemic risk planning. The 2023 UNDRR Situational Analysis for Barbados39 provides useful information that can support Barbados in understanding some of its existing capacities and necessary areas for intervention to advance systemic risk assessment and planning efforts.

[38] This is related to educational facilities on the island.

[39] UNDRR, 2022. Disaster Risk Reduction in Barbados, Situational Analysis 2022, United Nations Office for Disaster Risk Reduction (UNDRR). https://www.undrr.org/publication/disaster-risk-reduction-caribbean-situational-analysis-2022.

3. Strengthen efforts to mainstream disaster risk reduction into development planning

Mainstreaming disaster risk reduction into development planning supports risk-informed policies and actions across sectors for systemic risk planning. Development pillars and sectors must integrate risk planning into activities in support of resilience. Key sectors such as health, tourism, transportation, housing, urban development, agriculture, water, etc. must be equipped with the necessary capacities to promote this mainstreaming. Achieving this will address the underlying drivers of disaster risk that contribute to system failure when an event occurs.

Barbados has made significant progress and is well placed to advance further in mainstreaming DRR into development planning. Barbados has had a national Physical Development Plan as a central element of its policy landscape since the 1970s and recently approved an update (August 2023). The most recent version of the PDP explicitly incorporates current issues such as climate change adaptation (CCA) and disaster risk reduction (DRR). Furthermore, a cross-cutting policy/plan– the integrated coastal zone management policy/plan – has also been updated to explicitly mainstream CCA and DRR. Treating these key issues can be strengthened through further mainstreaming of a risk-informed approach in decision making and expansion and wider uptake of existing tools such as the NCRIPP.

4. Curb overdevelopment of the built environment in coastal areas

Ensuring the sustainable development of Barbados' coastline is essential for mitigating coastal erosion. The country possesses a robust legal framework to address this issue, as outlined in the Planning and Development Act of 2019, the amended Physical Development Plan of 2017,[40] the Coastal Zone Management Act (Cap. 394), and the Integrated Coastal Zone Management Plan of 2020, among other policy and legislative instruments. These mechanisms have provisions that can be employed to restrict inappropriate coastal development, which can exacerbate erosion by disrupting the natural flow of sediments and altering wave patterns when buildings, roads, and other infrastructure are constructed too close to the shoreline. While acknowledging the rising demand from the real estate market and the potential for economic growth and job creation, particularly within the tourism sector (Barbados Today, 2024), it is crucial that coastal development be rigorously assessed in accordance with legal provisions and curbed when possible. Additionally, spatial considerations should be prioritised to prevent large-scale developments, such as large resorts and hotels, from heavily impacting coastal ecosystems. It is recommended that the Planning and Development Department (PDD), in collaboration with the CZMU, continue to work closely to promote sustainable spatial development in Barbados. This approach should focus on optimising the use of already developed areas while preserving, where possible, undeveloped coastal regions.

5. Formalise building standards and develop the necessary architecture to implement and enforce

The implementation of a National Building Code or set of building standards is essential and an irreplaceable tool on the road to disaster risk reduction in the long term. Building codes/ standards would allow for the formalization of legally binding minimum standards for new construction and for the regular assessment of structures during their useful life. While Barbados has a draft building code, it faces several challenges and barriers to formalization, implementation and enforcement to achieve the desired outcomes in more resilient buildings. Beyond a legally binding document, an entire architecture for implementation and enforcement is needed, to establish processes, institutional arrangements and responsibilities, and deploy

[40] The Physical Development Plan 2023 (Amended) is now in the final stages of adoption. The Plan sets out the government's vision for developing Barbados and provides a spatial framework to help deliver the government's mandate. A review of the Physical Development Plan Amended 2003 was completed in 2017 and produced a Draft Physical Development Plan Amended 2017 (Draft PDP Amended 2017). In the intervening period, several circumstances and events occurred that necessitate the review and targeted update of the Draft PDP Amended 2017 to ensure its currency and applicability to changed circumstances in Barbados. The Physical Development Plan 2023 (Amended) embodies further changes to the draft document that was made available to the public as a 2017 amendment. Available at: http://townplanning.gov.bb/draft-physical-development-plan-2023/.

resources. This architecture must be customized for the existing context, factoring in existing regulatory frameworks and mandates (such as physical development and building permissions for environmental health and fire safety). It must identify where and how in the process of designing and building a structure is the building code applied and enforced. It must clearly and appropriately define roles and responsibilities for the various actors in designing structures (design professionals like architects and engineers, building contractors, and developers/owners), while providing for a range of types of structures and capacities. The development of such an architecture, although already underway, as well as the provisioning of resources (responsible agencies, staff such as building inspectors) represents a significant effort and investment. Such a process must be implemented with an aim to reduce vulnerability while being accessible and equitable, and not unfairly or disproportionately targeting those with less means.

A key obstacle is the absence of a formal legislative authority for the department responsible for developing and enforcing building codes - the Building Standards Authority (BSA). While the BSA codes outline clear roles and responsibilities for monitoring and enforcing building codes, the BSA itself cannot monitor, inspect, or enforce any unlegislated standards. However, other institutions can and do monitor and enforce aspects of the building code that align with their mandates. These entities include the Planning and Development Department (PDD), which inspects buildings for compliance with fire safety codes.

Once the process is advanced to the point of enforcement processes and resources in place, educating and preparing building inspectors is crucial to ensure that they are capable of enforcing building codes effectively, especially for countries like Barbados that is situated in a climate prone region. Implementing comprehensive training programmes that cover all aspects of building codes, construction standards, and inspection procedures is important and should include classroom based and on-site practical experience. Incorporating on-site training as a core component of the education process, where new inspectors work alongside experienced mentors, is essential for developing practical skills. Utilizing scenario-based learning and simulations can further prepare inspectors for the various challenges they may encounter in the fields. Additionally, equipping inspectors with the ability to analyze data gathered during inspections and generated detailed, actionable reports enhances their effectiveness. Training inspectors in communication skills is also crucial to ensure they can effectively engage with builders, contractors, and property owners, fostering positive relationships while enforcing regulations.

It is also recommended that the development of the building code anticipate the potential impact of stronger hurricanes, which are likely to increase in frequency, intensity, and change of seasonality because of the effects climate change. A useful resource recommended by CDEMA and CROSQ is the adoption and implementation of the CARICOM Regional Standard CRS 10: 2023, Construction of Houses – Code of Practice by national governments. This technical document outlines recommendations for building codes with appropriate building practices, design and materials to increase capacity to withstand disasters.

6. Develop complementary policies to improve building structure maintenance

Building standards are also necessary to reduce the vulnerability of older and undermaintained structures, including public and commercial buildings as well as residential structures. Older structures can work perfectly under normal conditions yet fail during a tropical cyclone due to the presence of strong winds and high precipitation. Minor details such as roof support and attachment and quality of the openings (e.g. windows, doors, and frames) can make a major difference in the degree of internal damage sustained. With a relatively large portion of the national housing stock over 40 years of age, preventative maintenance and retrofitting becomes an important factor for disaster preparedness and readiness. Currently, the responsibility rests with private owners to manage their disaster preparedness and by extension their level and frequency of maintenance. This approach can prove costly in the event of a disaster, as many individuals may choose to delay or deprioritize essential repairs and maintenance. To alleviate this challenge the Government of Barbados can develop its legislation around building maintenance and retrofitting, by for instance implementing mandatory policies to encourage citizens to participate in timely upkeep and maintenance.

However, in the absence of an enforceable building code, tax legislation may be expanded to incentivize owners and occupiers to ensure property maintenance is undertaken. The opportunity to reclaim income spent on maintenance, specifically designated as related to disaster risk reduction, can bring citizens to participate more actively. Similarly, the implementation of penalties for under-maintained, abandoned, or potentially hazardous properties can help reduce vulnerabilities within the housing stock.

Policy can take the form of the National Housing Corporation (NHC) carrying out yearly inspections in homes that fall under its purview, to ensure proper maintenance. Though properties under the remit of the NHC are likely to be of a high standard, the practice of periodic inspections help to create a discourse of preparedness and awareness among the home owning population. After all, "If the government consistently inspects its houses to ensure they are disaster ready, shouldn't I do the same?" It should furthermore be noted that the Policy and Gender Sensitive Protocols for The Retrofitting of Low- and Middle-Income Homes, was approved by the Cabinet.

Implementation of such measures as tax incentives, penalties, and disaster related policy help to create a sense of importance around the topic of disaster preparedness. Taken along with the diligent enforcement of already established disaster risk reduction activities, legislation and policy implementation can slowly and certainly increase the resilience of the Barbados housing sector.

7. Develop and implement construction standards of the implementation of photovoltaic units

Barbados is moving gradually toward a decentralized power system where a major portion of power supplied to households will be generated by rooftop solar panels. In keeping with these efforts, the Barbados Light and Power Company (BL&P) has also expressed plans to gradually transition its power generation capacity from non-renewable sources to only renewable energy sources. Such an initiative is encouraged as it will have a positive impact on the environment, enhance sustainability efforts, and citizen self-sufficiency. No damages to Roof top mounted photovoltaic (PV) units were reported because of Hurricane Beryl. However, evidence from past ECLAC disaster assessments suggests these units are highly vulnerable to climate related weather events. Strong winds and flying debris are major threats to such installations, which can sustain significant damage and be rendered inoperable. This may represent a notable vulnerability with respect to energy security, given the deliberate move towards decentralised power, and already high dependent on roof top solar panels among both commercial operations and residential households, Furthermore, there are currently no enforced standards for construction of PV units on private rooftops. There is increasing research and evidence on how to protect and build resilient PV units. However, it is multi-stakeholder collaboration - industry players, utilities, and national and regional educational institutions – the key to creating the necessary standards, codes, and regulations or to refining existing ones that are suitable for the national circumstances (Burgess, Locke and Stone, 2020).

Two major recommendations arise from this vulnerability, first: each PV unit installation, though private should be up to such a standard that can resist the effects of at least a category 3 hurricane. As individuals become more invested in their own power needs, PV units should gain the importance of critical household infrastructure. This will require that some construction standards be put in place to ensure that rooftop installations are made resilient. This recommendation can be taken hand in hand with the recommendation of the housing sector to establish an enforceable building code; with such a code having a section dedicated to standards required for the installation of PV units. Note that as power becomes a more decentralized utility, the Government of Barbados will need to play a larger role in monitoring its resilience.

To protect these investments, early warnings may activate prompt actions related to conduct regular inspections, reinforce structures, clear surrounding potential hazards, and temporary panel removal.

8. Develop fishing protocols and policies to protect assets and economic flows

Recognising inherent challenges and constraints with the provision of safe harbour in Barbados, fishing planning and temporality policies should be updated to reduce risks to fishing assets and economic flows to the greatest extent possible, especially given recent negative trends in meteorological and oceanographic conditions. It is crucial to redefine policies regarding resilient fishing infrastructure and safe zones, particularly due to more frequent, unpredictable, and severe climatic events.

Local research on the evolution of tropical storms passing through Barbados over time is also essential. It is necessary re-evaluating the protection levels of physical infrastructures at fishing landing sites and ensuring that logistical supplies adapt to evolving risks in the fishing sector are also critical. Protocols for accommodating, distributing, and organizing fishing vessels in safe asset protection sites should be strengthened, especially taking into consideration increased vessel movement and adjusting distribution strategies based on storm severity.

For the fishing sector, early warning protocols and policies to protect assets and economic flows, integrated with real-time oceanographic and meteorological data must be enhanced. Establishing a reliable information platform will generate real-time insights to inform adaptive fishing protocols at each landing site, that would evolve according to the real-time feed of risk indicators. Such action seeks to promote the use of risk-informed policies and initiatives to ensure the efficiency and effectiveness of hazard responses.

Strengthening fishing protocols and policies for the protection of their assets and economic flows articulated with a real-time information system on oceanographic, meteorological variables and risk evolution indicators linked to the landing sites network and critical fisheries infrastructure is important. Strengthening a timely, accurate and reliable information platform (network) will allow the generation of real-time information linked to strengthened fishing protocols and policies in each landing site. Such action seeks to improve fisherfolks' adaptive capacity to ever-changing climatic conditions.

9. Formal registration of all tourism accommodation providers

Additionally, there is a recommendation to implement a requirement for vacation rental and Airbnb properties to formally register with an agency such as the Barbados Tourism Product Authority. This ensures that the size and impact of the informal sector are properly captured and included in disaster risk reduction planning. This can assist to in the development of formal arrangement between accommodations to relocate guests in potentially impacted zones beforehand the occurrence of the event.

C. Recommendations - Investing in disaster risk reduction for resilience

This priority for action emphasizes public and private investments in disaster risk prevention and reduction through both structural and non-structural measures. The goal is to enhance the economic, social, health, and cultural resilience of people, communities, countries, their assets, and the environment.

The iGOPP component most closely related to this priority for action is Risk Reduction, which scored 21% in 2018. At that time in Barbados, there were no regulations in place for integrating or coordinating disaster risk reduction with climate change initiatives at territorial and sectoral levels. Additionally, acceptable risk criteria for at least two hazards had not been established in national regulations. There was also no evidence of regulations mandating the adoption of disaster risk reduction measures in the construction of public and private infrastructure projects.

According to the 2018 CDM Audit, some critical strengths exist within Barbados' National Disaster Management Framework. These stem from the alignment of its Mitigation Phase of reporting with regional and international standards. For Sendai Priority 3, strengths were noted within risk financing (e.g., financial measures). This mitigation phase is solely comprised of the element financial measures

and its sub-element – the private sector. Even though there is comprehensive insurance coverage for residential and commercial properties that factors in a wide array of hazards, the acquisition of insurance for residential policies is not compulsory by law. There is also a paucity of information regarding the enforcement of insurance and renewal scheduled for business licenses – all of which should be linked to national polices such as building codes. There is a paucity of information on crop insurance available to farmers which makes effective planning for inclement/extreme weather conditions very difficult. Risk financing in Barbados can be disaggregated into domestic and external sources of financing.

There needs to be a "holistic deeper dive" into incentivising resilience if Barbados is to achieve their resilience goals. The Ministry of Finance and Economic Affairs should lead on this with active participation by all stakeholders of the emergency management/ disaster risk management system.

1. Reinforce and expand coastal protection infrastructure along vulnerable coastal areas

The GOB has made significant investment in public coastal protection infrastructure through a series of programmes executed by the Coastal Zone Management Unit, outputs of which include successful interventions like the Richard Haynes Boardwalk on the South Coast of Barbados to mitigate coastal erosion, storm surge, and propagating large waves' impacts. Some private waterfront property owners, including both commercial and residential properties, also invested in coastal protection infrastructure, often aimed at reducing beach erosion and/or widening or stabilising the beach as well as protection. Such installations, whether public or private, require significant front-end preparation (technical studies, designs, and permissions) and capital investment, as well as maintenance once installed.

It is recommended that the GOB continue to invest in coastal protection, including through new installations where needed, as well as the maintenance, upgrade and/or replacement of existing structures as needed. Public investment should continue to be carefully planned to focus on priority locations (protection of critical/public infrastructure, high risk areas), and substantiated by cost-benefit analysis. Government should also continue to consider cost-recovery options. Private property owners should be held accountable for maintenance, upgrade, and/or replacement of existing structures for which they are responsible.

It is recommended that planning and design of coastal protection interventions consider both grey and green infrastructure (otherwise stated conventional engineering along with nature-based solutions) as well as hybrid solutions to develop a robust and strategic coastal protection system that combines of engineered and nature-based solutions, appropriately designed and implemented to take into account national context and site-specific factors.

Engaging local stakeholders, private sector interests, and communities in stewardship and protection of the coastline is strongly recommended. Planning instruments could be utilised to incentivise developers to protect or create vegetated areas along the coast of private properties, thereby contributing to the broader effort of coastal preservation.

2. Assessment of risks, costs, and benefits to inform investment in increased resilience in ports and harbours, serving imports/exports, tourism, and fisheries

Port and harbour facilities serve import and export functions along with tourism, and fisheries interests in Barbados, and therefore the interlinked issues of maintaining resilient port and harbour infrastructure and providing safe harbour during extreme events are critical to Barbados' functioning. However, given the exposure to coastal hazards including high wave energies and lack of natural sheltering along the coastline, providing these critical infrastructural elements represents both a major investment and a major challenge for the country. It is recommended that a holistic and rigorous assessment of disaster risk along with relative cost-benefit analysis focused on ports and harbours facilities be undertaken. Such an assessment should identify baseline risks, including the cost of inaction, options for increasing

the resilience of port and harbour facilities, costs and benefits, including risk-reduction potential. This would allow for informed, strategic decision making on the path forward for resilient ports and harbours with a reasoned balance of benefit and risk reduction to cost. Reinforce road network and associated transport infrastructure

The damages sustained by Barbados's road network and associated transport infrastructure due to Hurricane Beryl have highlighted the vulnerabilities and the need for enhanced resilience measures. The extensive erosion and structural failures in several areas necessitated more comprehensive design and reconstruction efforts, including the installation of improved drainage systems and reinforced road structures.

Long term costs involve comprehensive road resurfacing, bridge reinforcement, and the implementation of improved drainage systems to mitigate future flood risks. To mitigate the impact of future hurricanes and enhance the resilience of Barbados's transportation infrastructure, the following prevention strategies are recommended:

(a) Improve Drainage Systems

It is strongly recommended to implement measures to enhance the water volume capacity of existing drainage systems. The stormwater management plan developed in the scope of the Adaptation Measures to Counter the Effects of Climate Change (AMCECC) Project provides important recommendations to address this issue. The implementation of the plan and expansion of the solutions proposed, where possible and following site-specific assessments, are an important step to mitigate flooding resulting from extreme rainfall. Implementing routine inspection and maintenance schedules ensures that drainage systems remain clear of debris and function efficiently.

(b) Strengthen Road Infrastructure

Barbados has an extensive road network and high road density that represents a significant public investment as well as a significant maintenance challenge. Based on the 2019 Global Economy's Road Quality Index[41], Barbados is classified as having some of the worst roads in the world with approximately 70% of the roads in a state of disrepair[42]. In terms of the road network, the geology of the island is quite limiting owing to its coral limestone origins (UNDRR, 2022). Strengthening Barbados's road infrastructure involves employing construction materials and techniques resilient against strong winds and flooding, as well as landslides and earthquakes. This includes retrofitting bridges, and road surfaces to enhance durability and safety in areas most vulnerable to disasters. Significant work is already underway through the Accelerated Mill and Pave Programme, which addressed road maintenance issues prior to Hurricane Beryl.

The road network in Barbados is predominantly surfaced with asphalt. Recently, there has been a shift towards incorporating more durable and maintenance-efficient materials such as roller compacted concrete (RCC) for new road constructions. Site-specific assessments should be carried out to assess the cost benefit of implementing such technologies where most needed. By implementing these strategies, Barbados can significantly enhance the resilience of its transportation sector, minimizing the impact of future hurricanes and ensuring the continued safety and functionality of its critical infrastructure.

Advanced concrete technologies can be utilized to upgrade the road adjacent or associated infrastructure such as curbs, sidewalks, guard walls, and culverts, in areas identified as strategic or most vulnerable. Using high-quality materials such as performance-based mix designs, waterproofed concrete, and fibre-reinforced concrete is integral to building robust concrete structures where suitable throughout the island. These advancements aim to ensure the roads are durable and require minimal maintenance, significantly improving Barbados' overall transportation infrastructure.

[41] Barbados was ranked 108th attaining a score of 3.2 over the period 2006-2019. https://www.theglobaleconomy.com/rankings/roads_quality/.

[42] Barbados Today. 2019. "Bad roads across Barbados". https://barbadostoday.bb/2019/02/20/bad-roads-across-barbados/.

3. Reinforce Telecommunications Infrastructure

Another good safety measure is the hardening of a few highly essential towers with their communications masts being built to meet an extremely high standard for disaster resistance. This requirement will have to be enforced by the government's regulators by possibly making it a requirement for allocating bandwidth to operators from the electromagnetic spectrum.

4. Facilitate greater access to risk transfer instruments to protect fishing assets

Access to risk transfer instruments to protect fishing assets and ensure the sustainability of the fishing industry and the livelihoods of fishermen in during an extreme event is crucial for resilient recovery and reconstruction efforts. These instruments will help maintain a minimum capacity for fishing operations, particularly for essential food security products, and ensure that fishermen in Barbados can secure a baseline income. According to Barbados' policy on sovereignty, food security, and cultural heritage, the government should strongly consider creating financial instruments specifically designed to protect the fisheries sector against recurring catastrophic events, thus ensuring its long-term sustainability.

Moderate or high access to fisheries risk transfer, as for instance in the form of parametric insurance, is recommended in fisheries zones and fishing landing areas with recurrent risk of catastrophic impact by natural phenomena. The fishing policy of Barbados should assess the minimum level of access for fishing insurance that allows the periodic cyclical continuity of such financial instruments. The value and coverage of the policy should be carefully studied at the government level to ensure that most fishermen can afford it, with the private sector's complementary participation in helping to sustain the instrument over time. Fisheries insurance should be a topic of discussion among government policymakers. The cost and coverage of the policy must be analysed to strike a balance between affordability for fishermen and the instrument's long-term sustainability. If the implementation of such insurance scheme is deemed feasible, the government could support the initiative by establishing a fund managed privately. This fund could redirect the money typically spent on reactivating fisheries and providing subsidies, offering a more sustainable solution to fishermen's financial challenges and ensuring the continuity of fishing activities.

It is worthwhile to mention that since 2019, the CCRIF SPC issued the Caribbean Oceans and Aquaculture Sustainability Facility (COAST) fisheries parametric insurance policy to two of its member governments – Grenada and Saint Lucia. The COAST insurance policies provide coverage for fisherfolk and other players in the fisheries industry to enable them to recover quickly after weather-related events. Initial funding for COAST has been provided by the U.S. State Department.

D. Recommendations - Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation and reconstruction

There is a critical need for disaster preparedness mechanisms that take proactive measures before events occur, integrate disaster risk reduction into preparedness strategies, and ensure sufficient capacity for effective response and recovery at all levels. Empowering vulnerable population groups, such as women and people with disabilities, is essential. They should be enabled to lead and publicly advocate for approaches based on gender equality and universal access in response, recovery, rehabilitation, and reconstruction.

For Barbados, some exceptional strengths existed within the Preparedness phase of the Barbados' National Disaster Management Framework during the 2018 CDM Audit. Such strengths stemmed from the alignment of various themes[43] within the island's Preparedness Phase of reporting with regional and international standards. For Sendai Priority 4, strengths were noted within (i) Warning and Alerts, (ii) Training and Exercises; as well as (iii) Community Resilience.

[43] Preparedness phases of reporting encompassed six (6) themes: (i) Governance, (ii) Education and Information, (iii) Training and Exercises, (iv) Warning and Alerts, (v) Finance and Administration, and (vi) Community Resilience.

Disasters have demonstrated that the recovery, rehabilitation, and reconstruction phases must be well informed, planned and viewed as an opportunity to "build back better", meaning that vulnerability is not reconstructed. Emergency care often overlaps with the Early Recovery process, making it crucial to distinguish between actions needed to address the basic and immediate needs of the population—which are part of emergency preparedness—, those aimed to provide temporary solutions and prompt reactivation of the social and economic conditions, and those oriented to invest in mid to long term resilient and sustainable recovery. It is important to make linkages from emergency response to reconstruction and resilience for development, a process defined as recovery planning.

Good recovery practices include having action plans that guide and organize recovery efforts and resources, avoiding the reconstruction of pre-existing vulnerabilities, and recognizing the specific needs of the population, their means of production, and the changes necessary to prevent future disasters.

1. Institutional strengthening and capacity building for data collection and disaster assessment

One of the recommendations of the Sendai Framework for Disaster Risk Reduction 2015 - 2030 is to estimate damage and losses related to disasters. Post-disaster assessments expose both the strengths and weaknesses in disaster risk management processes, offering opportunities to address deficiencies and promote resilient reconstruction. However, one of the major challenges in conducting these assessments is the lack of comprehensive data. Common issues include inconsistent data collection, methodological discrepancies, outdated information, lack of data disaggregation (by sex, age, sector, etc.), and insufficient public dissemination. Additionally, there is a tendency to assume that disaster risk management is the sole responsibility of institutions tasked with disaster response, leading to a fragmented approach. These conditions, among others, have hindered the adoption of a more proactive stance and limited the depth and integration of DRM strategies.

Beyond merely quantifying post-disaster effects, the institutionalization of systematic disaster assessment practices offers significant benefits for future risk reduction. The ongoing collection of multi-sector baseline data enables the anticipation of risks and guides public policy interventions to address underlying issues that exacerbate disaster risks. These data, by highlighting vulnerabilities, make it possible to prioritize interventions, relocate at-risk communities, develop maintenance plans, and design targeted support measures for vulnerable and marginalized populations.

The process of collecting data to quantify disaster effects is often fragmented and inconsistent across sectors. There is a need to train public organizations in best practices for data collection and to involve all sectors in this process. Establishing links and alliances with the private sector and providing training can significantly enhance data collection during disaster evaluations and improve the monitoring of recovery processes

Effectively identifying opportunities for synergy, understanding the comprehensive nature of true disaster risk management, and addressing these issues in a multisectoral manner require a deep understanding of disasters, their causes, and their effects. Therefore, capacity building is essential. Institutions and officials with expertise in these areas, capable of identifying collaboration opportunities, leveraging existing data, and designing comprehensive public policies, form a crucial pillar of disaster risk management. This approach also helps demonstrate the impact of disasters on achieving the Sustainable Development Goals and enables the estimation of disaster-related indicators.

Training must be as crosscutting as the effects of disasters. This includes sectors such as finance, MSMEs (Micro, Small, and Medium Enterprises), education, health, culture and heritage, housing, transportation, energy, water, telecommunications, the environment, and productive sectors like tourism and agriculture. By highlighting the impact of disasters on diverse sectors like education, energy, or transportation, it becomes possible to develop targeted public policies that contribute to truly comprehensive risk management.

Data collection during a disaster should not be limited to sectoral impacts; it is equally important to gather information on populations displaced to shelters. It is recommended to establish a protocol for collecting statistical data to both quantify and characterize the sheltered population and their needs. This population will, in part, be the beneficiaries of resilient reconstruction processes. In this case, disaggregation by age, sex, and other characteristics is crucial, as is the collection of information on occupation, education, employment, and other factors that reflect what people have lost when their living environment is disrupted

Another critical area for data collection during disasters is the tracking of expenditures related to emergency response. Disasters often necessitate the redirection of public resources, which incurs costs that must be identified. Similarly, the monitoring of non-governmental contributions, such as donations, requires strict oversight for transparency and subsequent information systematization. Strengthening registration systems for supplies and costs allocated to emergency care, with detailed breakdowns by item and estimated amounts for donations, is advisable. This also involves coordinating with the various governmental and non-governmental actors involved in the emergency response phase.

2. Strengthen the CZMU's capacity for immediate post-disaster assessments

The CZMU within the Ministry of Environment and National Beautification, Blue and Green Economy (MENB) is responsible for developing and implementing a national risk-resilient Integrated Coastal Zone Management (ICZM) policy and planning framework. As key government advisors, the CZMU supports providing and coordinating high-quality, timely, and relevant information (CZMU, 2024). Over the years, the CZMU has established a robust database on coastal risks and vulnerabilities, including internal data platforms, various risk knowledge products, policies, project documents, and other outputs. The CZMU conducts field-based resource/asset monitoring programs such as beach profiling, metocean monitoring, inventories of coastal structures, and coral reef monitoring to equip the country with tools to understand, measure, and assess coastal risks. Therefore, the CZMU's institutional capacities to understand and address coastal risks and vulnerabilities should be acknowledged and commended. In accordance with its mandate, before and immediately after the DaLA mission, the CZMU produced rapid assessments of damages to coastal infrastructure and properties, a quantitative beach profile from nine out of 62 monitoring sites, and a comprehensive qualitative report on coastal erosion across all beaches in Barbados. However, while the long-term monitoring programme provides baseline data, due to limited resources, the CZMU was unable not assess damages to coral reef ecosystems, which are resource-intensive to evaluate. Given the catastrophic impacts of Hurricane Beryl early in the hurricane season, which left the coast vulnerable to further damage resulting from subsequent storms, it is recommended that the CZMU's field programmes be strengthened and adequately resourced to enable more extensive post-storm assessments of coastal erosion and coral reef damage. Climate change is expected to increase the frequency and severity of such events, making its compounding effects a threat to Barbados' coast. Therefore, it is critical that CZMU is equipped with the necessary resources to quickly generate qualitative and preferably quantitative data on the impacts of hydrometeorological disasters on its coastal and marine resources. This will facilitate the timely implementation of emergency measures to prevent further damage.

3. "Building back better" and integrating risk into recovery plans

Post-disaster, recovery, reconstruction and rehabilitation provide a unique opportunity for "building back better" so as to minimize the vulnerabilities that existed pre-disaster impact. Enhancing preparedness for effective response to "build back better" involves disaster preparedness plans, business continuity planning, strengthening early warning systems, critical infrastructure resilience, training and exercising, community planning, recovery and reconstruction policies as well as relief and donations policies.

In its path to recovery from COVID-19, Barbados has prepared a suite of recovery tools that aim to regenerate growth and sustainable development. The Barbados Disaster Social Relief Plan is set to steer the nation towards a path of resilience by targeting critical development components including

health, economic growth, social protection, disaster risk reduction and climate change. Interventions must recognize that risk encompasses all sectors and systems. Recovery tools must therefore ensure that there is an explicit appreciation for systemic risk planning, propelling the paradigm shift from response to risk management, integrating mitigation, preparedness and monitoring into disaster risk management processes.

4. Retrofitting of shelters

Most emergency shelters in Barbados are multi-purpose facilities owned either by government (such as schools and community centres) or private owners (such as churches and guest houses) that were not originally designed as shelters. While most are built to withstand Category 3 hurricanes, the increasing frequency and intensity of hurricanes, often reaching Category 4 and 5, necessitate upgrading the infrastructure of these shelters. Enhancing the shelters' resilience will improve Barbados' preparedness and response capabilities, ensuring the safety and well-being of its population.

It is therefore recommended that the Government of Barbados consider retrofitting the existing Category 1 Shelters to withstand Category 3 hurricanes by upgrading the structural integrity of buildings according to mandatory national building codes that should be proposed in the short term along with the CARICOM Regional Standard CRS 10: 2023, Construction of Houses - Code of Practice. While not using schools as shelters can benefit the continuity of education in the aftermath of a hurricane, the cost of constructing new shelters that would be used infrequently may not be feasible. Instead, community centres designed to function as shelters for severe natural hazards should be built. These multi-purpose centres should also include protected facilities to store essential supplies needed during and after an emergency.

The DaLA team also recommends implementing the Model Emergency Collective Shelter Management Policy developed by CDEMA. This policy should be adapted to establish, maintain, and provide emergency shelters within the national emergency management system and available resources. It should also include the provision of necessary psychosocial and supportive services for vulnerable groups such as the elderly, persons with disabilities, women and girls during emergencies.

5. Restore normalcy after a disaster in the education sector

Overall, the 2018 CDM Audit revealed that Recovery was the weakest phase for Barbados - particularly within the Revitalization for Affected Sectors. This therefore emphasizes the need to prioritize business and government continuity to create an enabling environment to restore economic activity. Decision-makers should therefore prioritize restoring normalcy as soon as possible after a disaster. Similarly, the Sendai Framework for Disaster Risk Reduction (2015-2030) advocates for shared ownership and partnerships to better address the socio-economic impacts of disasters.

The education sector is crucial in this effort, as it supports children - a large and vulnerable segment of the population. Timely reopening of schools is vital for enhancing well-being and restoring structure to the daily lives of students and teachers. Schools typically close a day or two before a hurricane and may remain closed afterward, even if they suffer minimal or no damage. It is therefore recommended to revise the academic year to include "recovery days" to account for potential time lost due to hurricane-related closures, should there be an event of greater magnitude in the foreseeable future.

Another option to minimize lost school days is to create a temporary online learning environment, like the approach undertaken during the COVID-19 pandemic. Virtual classes would allow continuity of education and reduce the need for makeup days. To avoid connectivity issues, these classes could be pre-recorded, following the normal curricular guidelines.

Additionally, staggered school openings could be considered to minimize lost school days. Schools with minor damage could reopen first to accommodate students. While this approach could significantly reduce lost school days, it requires careful planning and preparation to ensure adequate conditions.

6. Increase disaster preparedness in housing and private property

Enhancing disaster resilience is often misinterpreted as an expensive process that is undertaken by the government to upgrade infrastructure; however, this need not always be the case. Government-led resilience building can focus on thorough preparedness activities that are decentralized, attainable and affordable.

One of the recurring incidence reports during Hurricane Beryl was of damage from trees, branches or other materials crashing into households. This vulnerability can be remedied through routine inspection, tree cutting and coordinated cleaning at the community level. Note that community involvement is a necessary element for implementing this preventative measure. Often a hazardous tree on a person's property is considered that person's responsibility, however, this hazard can cause damage to neighbouring properties and is therefore a community concern. Bricks on rooftops, loose hanging signs, and fences made with loosely secured sheet metal all provide fodder for creating projectiles during a hurricane. Such hazards require simple coordinated efforts and can greatly reduce the risk of damage.

Another element in the disaster readiness strategy involves financial protection, such as insurance coverage. Home insurance should be promoted as much as possible among those owners that can afford it. For a further guarantee of coverage within the housing sector, mandatory budgeting for insurance may be enforced as a required component for approval of mortgages or loans for building new homes. For this, it also must be sought that the insurance premiums reflect the actual risk of the insured properties.

The responsibility for disaster preparedness falls to everyone in a society, and there are several opportunities for the Barbadian Government to harness the public's support in building the resilience of the housing sector.

7. Provide financial support for the fishing sector

The recovery of the fishing sector must guarantee its sustainability and continuity of fishing capacity to support the country's food security. Accessibility to credit lines in accordance with the financial needs of fishermen after a disaster is recommended for a resilient recovery. Flexible terms and favourable interest rates are some components of these credit lines for a resilient recovery. These will help fishermen restart their operations without straining their finances. Also, the use of forecast-based financing instruments (e.g., parametric insurance) can be explored to guarantee that sufficient liquidity is provided to fishermen and compensate the potential losses they can have days in advance of the occurrence of the event.

It is also crucial to restore landing sites, supply chains, and the distribution and sale of fish promptly to allow normal operations as the fishing fleet's capacity is restored. The largest fishing landing and vending complexes should resume activities as soon as possible to prevent further losses due to disrupted distribution channels. Allocation and construction of dedicated docking sites around the island to house vessels when not in the water. These spaces can be utilised when vessels need to be repaired as well. There is also need for adequate heavy duty haul out equipment.

Resilient reconstruction of protective infrastructure at key fishing embarkation and disembarkation centres is essential. The new wave-breaking infrastructure must be designed to withstand the increased frequency and severity of hurricanes in the Caribbean, explicitly considering the effects of changing climate.

8. Support the development of regional plan for climate resilience and financing to protect the tourism sector

Improving coordination at regional and national levels is crucial. Establishing a regional plan for climate resilience and financing would involve coordinated efforts with various partners to protect the tourism sector within a broader framework of climate resilience. This plan would address the interconnected nature of productive sectors and ensure comprehensive disaster preparedness and response strategies.

Developing a comprehensive Tourism Management Plan that includes a shelter system for visitors during weather events is vital. Currently, hotels are responsible for their guests, but a coordinated approach would provide better protection and management.

Identifying and developing secure storage facilities for tour boats, particularly larger crafts vulnerable during storms, is also necessary. Best practices such as roping together boats of similar sizes to minimize damage during extreme weather events, attaching rubber fenders, and storing away from docks should be recommended.

Improving communication with airlines and visitors is essential to manage visitor expectations during weather events and airline cancellations and ensure visitors are aware of accommodation policies during disasters. Establishing reliable communication methods, such as walkie-talkies and satellite phones, to relay emergency alerts during events is critical. During the storm, a WhatsApp group was used to relay emergency alerts. However, while WhatsApp can be powered by batteries, it relies on a functioning cell network or data services, which can be disrupted during disasters. In contrast, VHF radios and satellite phones operate independently of these networks, providing more reliable communication options in such situations. This highlights the importance of diversifying communication systems to ensure continuous connectivity during emergencies.

Providing financial solutions to help tourism entities invest in resilience measures, such as purchasing generators and reinforcing structures, is also recommended. Considerations should also be made to extend customs/duties concessions to essential disaster preparedness equipment to support these investments.

9. Increase access and availability to emergency supplies in the tourism sector

Emergency preparedness measures are also highlighted, emphasizing the mainstreaming of emergency supplies across the hotel sector. This includes power generators, water tanks, and communication systems (e.g. satellite phones, and walkie-talkies) to ensure continuity of operations during disasters. Financial solutions are recommended to assist tourism entities in investing in resilience measures, such as the introduction or expansion of duty-free concessions for essential disaster preparedness equipment.

10. Improve and streamline plans and protocols for post-disaster clean up and debris/waste management

During the DaLA mission, a potential gap was identified in identifying, collecting, treating, and disposing of contaminated materials resulting from a disaster. Specifically, within the Bridgetown Harbour Area near the BFD, where numerous boats sank and diesel spills were evident, there was ambiguity in the logistical chain about how to manage and dispose contaminated debris and sand from that site. The need to identify specific sites to dispose of contaminated refuse was a key issue highlighted during the interview with representatives from the SSA. There is benefit in the development and articulation of a comprehensive post hurricane debris management plan.

It is recommended that assessments be conducted to determine Barbados' current landfill capacity and that potential sites for emergency expansion are identified in the event of a disaster. This concern was also raised during interviews with the Sanitation Services Authority. The absence of an appropriate waste and refuse management strategy following a disaster can lead to significant public health crises. In addition to identifying additional disposal sites and developing contingency plans for waste collection and disposal during disasters, it is prudent to explore alternative technologies for waste management, including the reuse and recycling of materials after a disaster. This approach is particularly important in a country like Barbados, where land availability is limited.

In the case of Hurricane Beryl, while institutions indicated that the clean-up process went smoothly following the agreed upon procedures and protocols, they acknowledged that additional capacity would be needed to cope with a Category 4 Hurricane. They recommended that the government purchase of

additional equipment for debris removal, more training for specialised equipment, additional sites for disposal of debris and additional generators. To plan for this, risk assessments that allow for scenario modelling are encouraged to be developed.

11. Ensure business continuity through back up power and emergency telecommunications

One of the recommendations sought to facilitate the wider availability and distribution of radio devices (such as walk-talkies) and/or satellite phones to maintain contact with key stakeholders during disasters at a wider level. This would ensure that telecommunication channels are not compromised by the lack of electricity.

For the telecommunications sector, a general recommendation is to ensure the availability of securely stored mobile cellular units on the island. The availability of such units will allow for quick deployment to cellular dead-zones after a disaster.

Loss of commercial power remains the greatest threat to the continuance of operational telecommunications services, particularly mobile services, during and after a disaster. Thus, backup systems should be coordinated with the BL&P to ensure that either back-up generators or battery systems are available for continued power supply after a disaster.

A decentralized power grid, that relies heavily upon renewable sources, stands the risk of becoming overwhelmed in a situation where many of the photovoltaic (PV) units controlled by private individuals are rendered inoperable because of the lack of adequate redundancy level. This could be since many citizens suffer a loss of PV supplied power and with a reduced capacity for production, become overly reliant on a connection to the Barbados Light and Power Company (BL&P) grid. As such, it is important to ensure that there are sufficient back-up power supply units to ensure that a post-disaster power supply can meet demand in the event that the BL&P has to supply power to the entire island. Such backup power supply units may take the form of on hand battery capacity, or perhaps, in the form of non-renewable power generation sources that are kept on standby for interim use.

A practice that is typical of traditional power companies is the stockpiling of essential materials. This can include transformers, utility poles and other assets that are at risks of being lost during a hurricane. As many private citizens of Barbados make a shift towards solar energy, a good practice would be to ensure that a supply of PV units and batteries are kept safely on island for ready access after a disaster.

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Hurricane Beryl was the first major hurricane of the 2024 Atlantic season and the earliest-forming category 5 hurricane on record. It impacted Barbados as a category 3 storm while passing approximately 150 km south of the island, generating large swells and waves that affected the island's south and west coasts. While the storm caused only moderate damage to basic infrastructure and did not trigger a humanitarian crisis, it caused substantial damage to coastal assets. The storm's overall effects were estimated at 193 million Barbados dollars, equivalent to 0.15% of the country's GDP. Damage accounted for 58% of the total effects, followed by losses (36%) and additional costs (5%). Tourism, fisheries and agriculture, and the environment accounted for 84% of total effects. Beryl's early formation and its impact on Barbados serve as a reminder of the increasing unpredictability of climate patterns, which exacerbates the vulnerability of Caribbean small island developing States to extreme weather events. In this regard, it is paramount to continually strengthen all phases of disaster risk management, including risk assessment, prevention, mitigation, preparedness and response, to best equip countries and communities to navigate the impacts of extreme weather and climate change.

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