# SOJC Report 2019: Impacts of Climate Change on Tourism Sector in Jamaica

TECHNICAL REPORT

Prepared by:

International Institute of Tourism Studies
THE GEORGE WASHINGTON UNIVERSITY

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| | |
|---|---|
| ASB | Annual Severe Bleaching |
| BAU | Business As Usual |
| CARICOM | Caribbean Community |
| CARPHA | Caribbean Public Health Agency |
| CATS | Caribbean Aqua-Terrestrial Solutions |
| CCCCC | Caribbean Community Climate Change Centre |
| CCRIF | Caribbean Catastrophe Risk Insurance Facility |
| CDEMA | Caribbean Disaster Emergency Management Agency |
| CRAIC | Climate Risk Adaptation and Insurance in the Caribbean |
| CREWS | Coral Reef Early Warning System |
| CSGM | Climate Studies Group Mona |
| EAST | Environmental Audits for Sustainable Tourism |
| ESCI | Emerging and Sustainable Cities Initiative |
| ETIS | European Tourism Indicator System |
| GDP | Gross Domestic Product |
| GHG | Greenhouse Gas |
| GPC | Global Protocol for Community-Scale Greenhouse Gas Emission Inventories |
| GSTC | Global Sustainable Tourism Council |
| HCI | Holiday Climate Index |
| ICLEI | Local Governments for Sustainability |
| IDB | Inter-American Development Bank |
| IPCC | Intergovernmental Panel on Climate Change |
| JTB | Jamaica Tourist Board |
| MEGJC | Ministry of Economic Growth and Job Creation |

| | |
|---|---|
| NDP | National Development Plan |
| NEP | National Energy Policy |
| NEPA | National Environment and Planning Agency |
| NOAA | National Oceanic and Atmospheric Association |
| OECD | Organisation for Economic Co-operation and Development |
| PPCR | Pilot Programme for Climate Resilience |
| SIDS | Small Island Developing States |
| SLR | Sea Level Rise |
| TCI | Tourism Climate Index |
| TEF | Tourism Enhancement Fund |
| TEMC | Tourism Emergency Management Committee |
| TEOC | Tourism Emergency Operations Centre |
| UNCTAD | United Nations Conference on Trade and Development |
| UNEP | United Nations Environment Programme |
| UNFCCC | United Nations Framework Convention on Climate Change |
| UNWTO | United Nations World Tourism Organization |
| USAID | United States Agency for International Development |
| WRI | World Resources Institute |
| WTTC | World Travel and Tourism Council |

# Executive Summary

Tourism plays a critical role in the Jamaican economy. Jamaica is considered primarily a sun, sea, and sand destination. Its natural resources, in particular coralline beaches, represent a primary draw for international visitors. Jamaica is the fourth most visited beach holiday destination in the Caribbean.

Jamaica's tourism is highly concentrated in three tourism enclaves—Montego Bay, Negril, and Ocho Rios—located along the north and northwest coasts. These beach destinations account for more than 90% of the island's total room capacity and attract the vast majority of stopover visitors (more than 75%).

The high density of tourism development and infrastructure in coastal areas and tourism's dependence on climate-sensitive ecosystems such as coral reefs make tourism in Jamaica highly sensitive to the impacts of climate variability and change.

Jamaica is already experiencing some effects of climate variability and change, including severe weather systems and other extreme events as well as more subtle changes in temperatures and rainfall patterns. And climate modelling projections for Jamaica predict additional changes by the end of the century: increasing temperatures, decreasing annual rainfall, the potential for more intense tropical storms, increasing sea surface temperature, and sea level rise in the Caribbean.

The direct impacts of climate change on tourism in Jamaica are affecting both tourism supply (i.e., local destinations and tourism enterprises) and tourism demand (i.e., destination attractiveness to travellers). From a tourism supply standpoint, these are the main impacts:

- More frequent and severe storms are affecting tourism enterprises through increases in operating costs that include additional emergency preparedness and management requirements, increased infrastructure damage, backup power and water systems, evacuations, and business interruptions. These effects of storms on infrastructure are translating into higher insurance costs for tourism businesses.
- As temperatures increase, restaurants, hotels and resorts, and other tourism enterprises will need to increase cooling and incur higher air conditioning costs and also incur additional costs for pest fumigation and other measures to protect visitors from insects that carry vector-borne diseases.
- As sea level rises, tourism enterprises will experience increased costs associated with beach engineering and building additional seawalls and other coastal

defence structures to counter beach erosion. They will also experience business disruptions and increased infrastructure damage which is predicted to increase insurance costs for tourism businesses.

- Projections reflect less rainfall overall which will reduce freshwater resources and could present challenges in meeting water demands for the local population, the tourism sector, and agriculture. Food production and security may also be affected by less rainfall resulting in hotels and restaurants Jamaica incurring higher costs for food supplies.

The direct impacts of climate change on Jamaica's coastal assets such as coral reefs, beaches, and coastal and marine ecosystems affect the **quality of natural resources**. The climatic changes are also affecting operating costs (such as energy and water consumption and insurance premiums) of tourism enterprises, which ultimately impacts the **price of the destination**. Furthermore, travellers respond to these climatic changes by adjusting their **risk perception** of the destination. As frequency or magnitude of certain weather and climate extremes increase—for example, heat waves or hurricanes—travellers may choose not to travel to a destination they consider risky.

A collective of indicators is proposed to track over time how climate change is impacting tourism. The collective of indicators aims to measure:

1. Attractiveness of the destination; and
2. Destination vulnerability

In the monitoring framework proposed, the attractiveness of a destination (A) is reduced as the price of the destination (P) increases, visitors' risk perception (R) increases, and the quality of natural resources (Q) declines:

$$>P + <Q + >R = <A$$

The risk perception of travellers (R) for Jamaica is measured by the Holiday Climate Index: Beach (HCI: Beach). This index rates the climatic suitability of a beach destination based on international tourist climate preferences.

Destination vulnerability (V) is defined as a reduction in the attractiveness of a destination caused by climate change (A) combined with the consequences of adaptation (AS) and mitigation strategies (MS):

$$<A \pm (AS) + (MS) = V$$

The recommended collective of indicators is shown in Table A.

Table A: Recommended Destination Indicators for Jamaica

| | Indicators |
|---|---|
| Price of Destination (P) | 1. Percentage change in share of energy and water consumption as part of overall operating costs of hotels in a beach destination (O) |
| | 2. Percentage change in insurance premiums and number of high risk areas in beach destinations where insurance is no longer available for the accommodation sector (I) |
| | 3. Percentage change in carbon taxes as a component of the average airfare from key source markets, where applicable (T) |
| Quality of Natural Resources (Q) | 4. Change in average percent coral cover in reefs in the beach destination (C) |
| | 5. Percentage change in incidents of coral bleaching that affect the beach destination (B) |
| | 6. Percentage change in annual beach erosion in the beach destinations (E) |
| Visitor Risk Perception | 7. Change in Holiday Climate Index score (HCI: Beach) |
| Adaptation Strategies (AS) & Mitigation Strategies (MS) | 8. Percentage change in number of hotels implementing climate adaptation and mitigation actions, such as carbon dioxide offsets and low energy systems (HA) |
| | 9. Percentage change in energy consumption by hotels in a destination (EC) |
| | 10. Percentage change in water consumption by hotels in a destination (WC) |
| | 11. A destination plan exists, is publicly available, and addresses climate adaptation, mitigation, and disaster risk management, including natural disasters, health, resource depletion, and others appropriate to the location (DP) |
| | 12. Percentage of tourism accommodations, attractions, and transportation support infrastructure located in vulnerable zones (VZ) |

These indicators were applied to Montego Bay, which is the largest tourism enclave in Jamaica. The main findings (Table B) are based on an extensive review of existing literature and calculation of the HCI: Beach based on place-based climatic factors for Montego Bay.

Our historical and future analyses of these indicators for Montego Bay indicate that the price of insurance premiums is increasing and is predicted to continue to do so as a result of climate change impacts. Over time, these increases may impact the cost of hotels in Montego Bay and ultimately the price of the destination.

Table B: Main Findings for Montego Bay Destination Indicators

| | Indicator | Historical Analysis | Future Analysis |
|---|---|---|---|
| Price of Destination (P) | Cost of Accommodations | There are no enterprise-level data available to calculate the percentage change in share of energy and water consumption as part of overall operating costs of hotels in Montego Bay. | There are no enterprise-level predictions available to calculate future percentage change in share of energy and water consumption as part of overall operating costs of hotels in Montego Bay. |
| | Insurance Cost | There is some evidence (but no comprehensive historical data) that insurance premiums for hotels are increasing due to climate change. In early 2020, the Insurance Association of Jamaica announced that it expects that property insurance rates will rise by 10%–15% in 2020 as a result of the increasingly destructive hurricane seasons that the Caribbean has experienced in recent years. | Insurance costs are expected to increase further based on regional data. The Association of British Insurance estimates that insurance premiums in the Caribbean could increase by 20%–80% by 2050. Also, private insurance may no longer be available in high risk areas, forcing governments to provide coverage or decelerate development in these areas. No national level projections are available. |
| | Travel Cost | Not applicable to date. | No predictions are available regarding carbon taxes on airfare from Jamaica's main source markets (the US and Canada). |
| Quality of Natural Resources (Q) | Coral cover | Analysis of the trend data reveals a dramatic decrease in the average percent of coral cover—from 50% in 1970 to about 10% in 1990—in the reefs in Montego Bay. This represented an 80% decrease over two decades.<br><br>In 2000, live coral cover for reefs in Montego Bay remained low at about 11.27%. By 2010, the live coral cover of Montego Bay reefs was up to 15.42%, an increase of 36.82% since 2000. Although improving, the percent live coral cover of reefs in Montego Bay was well below the 20% Caribbean regional average.<br><br>NEPA's Coral Reef Health Index—which measures live coral cover, among other indicators—gave | While there are no predictions for percent change in live coral cover in reefs in Montego Bay, in general reefs in Montego Bay may remain degraded, as many human-induced and natural stresses persist. The projected sea level rise and intensity of hurricanes attributed to climate change is expected to exacerbate the impact of degrading reef structures. |

| | Indicator | Historical Analysis | Future Analysis |
|---|---|---|---|
| | | Montego Bay reefs a "poor" rating of 2.00 out of 5.00 in 2013, and 2.70 out of 5.00 in 2017. | |
| | Coral bleaching | Coral bleaching events have occurred in Jamaica. The specific impacts of these events on coral reefs in Jamaica could only be found at a national level. In 2000, bleaching was noted in 2.3% of all the coral colonies assessed in an islandwide study. The most severe bleaching event occurred in 2015, affecting 45%–75% of coral cover. In 2010, another bleaching event affected 18%–40% of coral cover. Coral colonies are under more stress and subject to mortality because of these incidents. | The onset of annual severe bleaching (ASB) predicted based on Caribbean coral bleaching forecasts indicates that most of the Caribbean, including Jamaica, could experience ASB anywhere between 2035 and 2050. ASB is a point in which coral reefs will change and recovery will be limited. |
| | Beach erosion | No historical data are available, but several studies have calculated base (current) annual beach erosion rate for Montego Bay. The annual beach erosion rates range from 1 m/yr (2007) to 0.23 m/yr (2010) and 0.30 m/yr (2011). | The beach erosion rate for Montego Bay could increase from 0.30 m/yr to 0.48 m/yr over 10 years, representing a 60% increase, due to accelerated degradation of coral reefs. |
| Visitor Risk Perception (R) | HCI: Beach | Weather attractiveness declined between 1980 -2020 but is still in the "Good to very good" rating. | The prognosis indicates a further decline in weather attractiveness with a drop to the lower band of the "Good to very good" bracket. |
| Adaptation Strategies and Mitigation Strategies (AS + MS) | Hotel Actions | No historical data are available, but lists of Jamaican hotels that are Green Globe and EarthCheck certified are available online. The following six Montego Bay hotels are Green Globe certified: Half Moon, Hyatt Ziva and Hyatt Zilara Rose Hall, Royalton Blue Waters – Montego Bay, Royalton White Sands Resort, and The Tryall Club. The only EarthCheck certified hotel in Montego Bay is Sandals Royal Caribbean. | There are no projections on how many hotels will be implementing climate change adaptation and mitigation efforts. Vision 2030 does prioritize the implementation of sustainable practices, mitigation measures, and environmental management systems by tourism entities. |

| | Indicator | Historical Analysis | Future Analysis |
|---|---|---|---|
| | Energy Consumption | While some enterprises may monitor energy consumption there is no clear sector-based repository. National reports that track energy consumption have not traditionally reported on the tourism sector specifically. | It is forecasted that Jamaica may experience a decline in energy consumption from fossil-fuel-based sources and increase in energy from renewable energy technologies. Mitigation scenarios forecast a potential reduction in emissions of 59,561 tonnes CO2e/year provided that the hotel sector adopts energy saving strategies. |
| | Water Consumption | Some hotels track data but there is no large-scale repository or ongoing monitoring. Hotels that participate in voluntary environmental certification schemes are likely to have more data (see "Hotel Actions" in this table for a list of internationally certified hotels in Montego Bay). Water demand of the tourism sector was 10 MCM/yr in 1985, 15 MCM/yr in 2000, and 23 MCM/yr in 2015. This data shows an increasing trend in water consumption in the tourism sector. | There are no predictions for how water consumption by tourism enterprises may change in the future. |
| | Destination Plan | The 2015 "One Bay for All: Sustainable Montego Bay" action plan serves as the destination's plan to enhance its resilience and adapt to the changing climate. There has been no disaster risk management plan at the destination level, although there have been various hazard maps created and risk assessments conducted of the city. | While there is the "One Bay for All: Sustainable Montego Bay" action plan, there is no indication of a future plan or a timeframe for review/revision of the current plan. The current plan stresses the need for the future development of a planning and disaster risk management unit. |
| | Tourism Infrastructure located in Vulnerable Zones | It is estimated that 80%–90% of public critical infrastructure in Montego Bay is vulnerable to natural disasters. | In Montego Bay, 72% of airport land and facilities are projected to be inundated over the 25-year storm surge return period and approximately 92% are projected to be inundated over the 50-year period. |

As a beach destination, Montego Bay is highly reliant on its coralline beaches and coral reefs. The quality of natural resources, in particular coral reefs, remains degraded despite some recent recovery, and coral cover is below the Caribbean average. Coral bleaching

events have stressed coral reefs in Montego Bay and throughout the island, making them subject to increased mortality. Annual severe bleaching may begin between 2035 and 2050, which could be devastating for coral reefs throughout the Caribbean including Jamaica. The beach erosion rate for Montego Bay could increase by 60% due to the accelerated degradation of coral reefs.

The visitors' risk perception of Montego Bay as a beach destination was measured through the HCI: Beach rating for Montego Bay. While the findings indicate a decline in weather attractiveness between 1980 and 2020, the rating is still in the "Good to very good" range. The forecast indicates a further decline in the weather attractiveness of Montego Bay as a beach destination, with ratings dropping to the lower band of the "Good to very good" bracket.

**Overall, these findings indicate a decrease in the overall attractiveness of Montego Bay as a beach destination**. It is therefore critical for Montego Bay to enhance its resilience and adaptive capacity to counter these threats to tourism. This study found that Montego Bay has an action plan for enhancing its resilience. However, it is unclear how much of the plan has been implemented; hence, it is uncertain how much the destination is adapting to the changing climate. It is estimated that 80%–90% of public critical infrastructure in Montego Bay is located in areas vulnerable to natural disasters. This indicates that the destination is highly vulnerable to direct impacts of climate change. There is limited information on actions being taken by the tourism sector to mitigate climate impacts. There is an opportunity to encourage the tourism sector to more proactively adopt actions that are already underway in other commercial, residential and agricultural sectors.

Recommendations for mitigating, minimising, and monitoring impacts on the sector follow.

Recommendations for mitigation include:

- Target the accommodation subsector for adoption of energy-saving schemes (solar hot water, LED and fluorescent lighting, increased co-generation, water-saving devices, and use of solar heating technologies are just a few possible initiatives). Engage other key subsectors in Montego Bay in mitigation schemes in the medium term.
- Incorporate measures to monitor tourism-based GHG emissions within National Reporting frameworks such as Jamaica's National Communication to the UNFCCC, supported by data from enterprises in the seven destination areas.

- Encourage individual responsibility and action through ethical and other approaches; for example, offering carbon offset options to visitors and encouraging longer stays for long-haul travellers.

Recommendations for adaptation include:

- Mainstream climate change adaptation in tourism policy, planning, and practice
- Enhance design, siting standards, and climate resilience planning guidelines for tourism infrastructure.
- Assess risk of all tourism infrastructure development, modification, and maintenance projects in coastal areas and improve insurance cover for critical facilities in hazardous zones. Future tourism development should be redirected away from highly vulnerable areas.
- Use regulation to stimulate changes and adaptation and create incentives for reduced water and energy consumption among tourism enterprises.
- Implementation of wastewater recycling and stormwater drainage strategies by tourism enterprises.
- Reduce pressures on coral reefs and dependency on beach tourism by diversifying the tourism product.
- Develop and expand early warning systems and contingency plans for extreme weather and climatic events such as storm surges and hurricanes.

It is recommended that a Climate and Tourism Monitoring Working Group be established to share management of the proposed monitoring system. The working group should be chaired by the Ministry of Tourism through its Climate Change Focal Point in collaboration with the Tourism Product Development Co. Ltd. The working group would consist of key industry associations and public agencies. The Tourism Enhancement Fund (TEF) may be a potential funding source for monitoring costs such as data collection, analysis and reporting at the local destination and national levels.

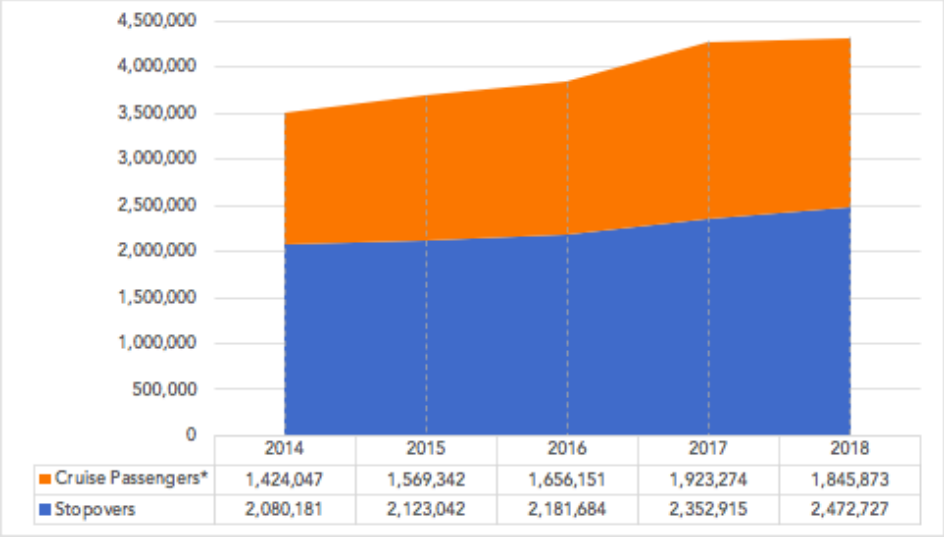
# 1.0 Introduction

## 1.1 Situational Analysis

Tourism is a significant driver of economic growth and prosperity for Jamaica and leads all other sectors in terms of its contribution to GDP, creation of jobs, and production of foreign revenues. In 2019, tourism's total contribution accounted for 31% of Jamaica's GDP, 33% of its employment and almost 57% of total exports (World Travel & Tourism Council [WTTC], 2020). Tourism also has substantial linkages with other sectors such as agriculture, manufacturing, and entertainment. The country ranks 16th globally in terms of economic dependence on the tourism sector (Mooney, 2020).

The sustained global growth trend in tourism over the past decade is evident in Jamaica. Annual visitor arrivals to Jamaica increased by nearly 72% between 2004 and 2018, and by over 23% from 2014 to 2018 (Jamaica Tourist Board [JTB], 2019). Figure 1 shows the growth of stopover and cruise passenger arrivals to Jamaica from 2014 to 2018 based on the available data from JTB.

Figure 1: Growth in Visitor Arrivals to Jamaica 2014–2018




| | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|
| Cruise Passengers* | 1,424,047 | 1,569,342 | 1,656,151 | 1,923,274 | 1,845,873 |
| Stopovers | 2,080,181 | 2,123,042 | 2,181,684 | 2,352,915 | 2,472,727 |

*Source: JTB, 2019.*

**Cruise Passengers includes members of armed forces on naval vessels*

In 2019, Jamaica welcomed 4.3 million visitors, comprising 2.7 million stopover arrivals (an 8.4% increase compared to 2018) and 1.6 million cruise passengers, whose combined spending brought US$3.64 billion into the country (Linton, 2020). Overall foreign

exchange earnings from tourism increased by 10.3% in 2019, up from US$3.3 billion in 2018. By the end of 2019, Jamaica's tourism industry was on target to become the country's fastest growing economic sector, and was recording the fastest growing stopover arrivals and earnings of all Caribbean destinations (Hines, 2019). Growth was projected to continue and exceed 2016's five-year targets of 5 million visitors, US$5 billion in earnings, and 125,000 in total direct employment by 2021 ("Tourism sector on track to exceed growth targets", 2019). The COVID-19 pandemic will greatly impact these growth projections. The International Monetary Fund estimated in May 2020 that Jamaica's economy will retract by 5.3%, and tourist arrivals are expected to recover only gradually over the 2020–2021 fiscal year. Tourism had initially been projected to earn US$4.25 billion for the 2020–2021 fiscal year, which was reduced to US$3.69 billion in early March 2020 (Campbell, 2020). Due to the ongoing effects of the pandemic and the second wave beginning at the time of this report, these impacts have probably been underestimated.

Jamaica is considered primarily a sun, sea, and sand destination, as are most other Caribbean countries (Hyman, 2014). It is the fourth most visited beach holiday destination in the Caribbean, after the Dominican Republic, Cuba, and Puerto Rico (Ratliff, 2019).

Tourism in Jamaica is concentrated in three enclaves—Montego Bay, Negril, and Ocho Rios—that feature all-inclusive mega hotels and facilities located along the north and northwest coasts. As shown in Table 1, these three resort areas accounted for 90% of total room capacity on the island from 2014 to 2018 (JTB, 2019). Furthermore, all-inclusive hotels accounted for 88.8% of all room stays on the island in 2018 (JTB, 2019).

Table 1: Average Room Capacity 2014–2018

| Resort Area | 2014 | 2015 | 2016 | 2017 | 2018 | +/- 2018/17 | % Change 2018/17 | % Share 2018 |
|---|---|---|---|---|---|---|---|---|
| **Montego Bay** | 6,388 | 7,304 | 7,576 | 8,961 | 9,277 | 316 | 3.5 | 39.3 |
| **Ocho Rios** | 5,112 | 4,971 | 5,920 | 6,007 | 6,272 | 265 | 4.4 | 26.6 |
| **Negril** | 5,103 | 4,885 | 5,026 | 5,360 | 5,965 | 605 | 11.3 | 25.3 |
| **Port Antonio** | 84 | 114 | 145 | 184 | 178 | (6) | -3.3 | 0.8 |
| **Kingston & St. Andrew** | 1,176 | 1,139 | 1,261 | 1,337 | 1,240 | (97) | -7.3 | 5.3 |
| **Mandeville & Southcoast** | 545 | 592 | 614 | 704 | 683 | (21) | -3.0 | 2.9 |

| Resort Area | 2014 | 2015 | 2016 | 2017 | 2018 | +/- 2018/17 | % Change 2018/17 | % Share 2018 |
|---|---|---|---|---|---|---|---|---|
| **Jamaica** | **18,409** | **19,005** | **20,542** | **22,553** | **23,615** | **1,062** | **4.7** | **100** |

*Source: Jamaica Tourist Board, 2019.*

In 2018, Montego Bay, Ocho Rios, and Negril accounted for 77% of total stopover visitors (see Table 2). Montego Bay is the largest of the three coastal resort areas, with a 35.3% share of total stopover arrivals.

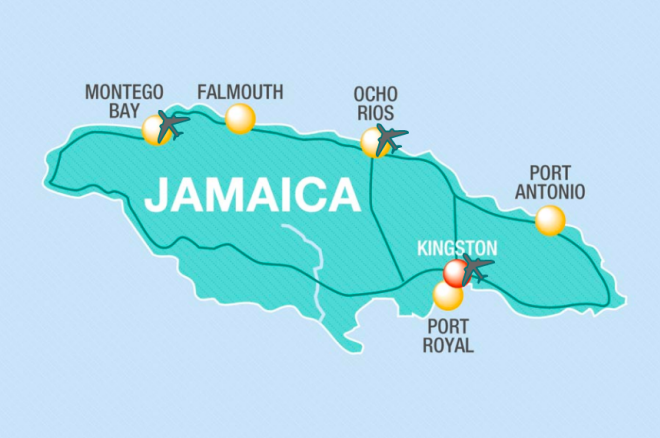
Table 2: Visitors to Jamaica by Type of Accommodation, 2018

| Accommodation | Kingston | Mande-ville | Montego Bay | Ocho Rios | Port Antonio | Negril | Other Areas | Total | % Share | Average Length of Stay in Days |
|---|---|---|---|---|---|---|---|---|---|---|
| Hotels | 63,638 | 36,700 | 748,671 | 460,470 | 958 | 410,665 | 580 | 1,721,682 | 69.6 | 6.2 |
| Resort Villas | 10 | 3,727 | 31,403 | 14,847 | 3,598 | 9,606 | 31 | 63,222 | 2.6 | 8.1 |
| Guesthouses | 8,295 | 3,770 | 10,999 | 4,486 | 2,869 | 12,533 | 1,191 | 44,143 | 1.8 | 9.7 |
| Apartments | 894 | 16 | 5,039 | 5,471 | - | 558 | 1 | 11,979 | 0.5 | 9.4 |
| Private Homes | 160,177 | 87,227 | 69,304 | 72,141 | 17,299 | 31,992 | 164,087 | 602,227 | 24.4 | 15.8 |
| Other/Not Stated | 8,399 | 3,367 | 8,157 | 5,306 | 957 | 2,317 | 971 | 29,474 | 1.2 | 16.2 |
| **Total** | **241,413** | **134,807** | **873,573** | **562,721** | **25,681** | **467,671** | **166,861** | **2,472,727** | **100** | **8.8** |
| % Share | 9.8 | 5.5 | 35.3 | 22.8 | 1.0 | 18.9 | 6.7 | 100 | | |
| Average Length of Stay in Days | 12.0 | 13.5 | 6.8 | 8.0 | 14.3 | 7.8 | 15.6 | 8.8 | | |

*Source: JTB, 2019.*

Another key component of Jamaica's tourism product is cruise tourism. Jamaica's main cruise ports in Montego Bay, Ocho Rios, and Falmouth are equipped to receive the largest cruise ships and offer a full range of facilities and services. Port Antonio, known for its idyllic bays and low-key resorts, caters to boutique cruise ships and mega yachts. The Port Royal Cruise Port which opened in January 2020 is bringing cruise ships back to the cultural capital of Kingston for the first time in more than four decades. All the infrastructure for cruise tourism is located in the north coast of the island and hence highly vulnerable to impacts from climate change.

Figure 2: Cruise Ports and Airports in Jamaica




*Adapted from "Location…Jamaica," by the Port Authority of Jamaica, 2018,* Cruise Jamaica *(https://cruisejamaica.com/location).*

Tourism in Jamaica is predominantly coastal, and hence the sector is inextricably linked to coastal areas. Jamaica's tourism brand promise is therefore highly dependent on weather, beaches, and sea. The effects of a changing climate pose a wide range of short- to long-term risks to the beaches and the high concentration of hotels, facilities, and infrastructure—including three airports and five cruise ports—located along the coast.

## 1.2 Impacts of Climate Change on the Sector

One of the primary reasons tourists choose Jamaica and other Caribbean nations for their holidays is the tropical climate—particularly during the winter in North America and Europe (Mendoza-González et al., 2018; Rutty & Scott, 2014). However, the regional climate is projected to change, and the Caribbean is forecasted to be among the first and worst to be affected by climate change (Nurse et al., 2009; Taylor et al., 2018).

Jamaica is already experiencing some effects of climate variability and change, including severe weather systems and other extreme events, as well as more subtle changes in temperatures and rainfall patterns (Caribsave, 2012; Climate Studies Group, Mona [CSGM], 2017). And climate modelling projections for Jamaica predict additional changes by the end of the century (Hyman, 2014; Caribsave, 2012):

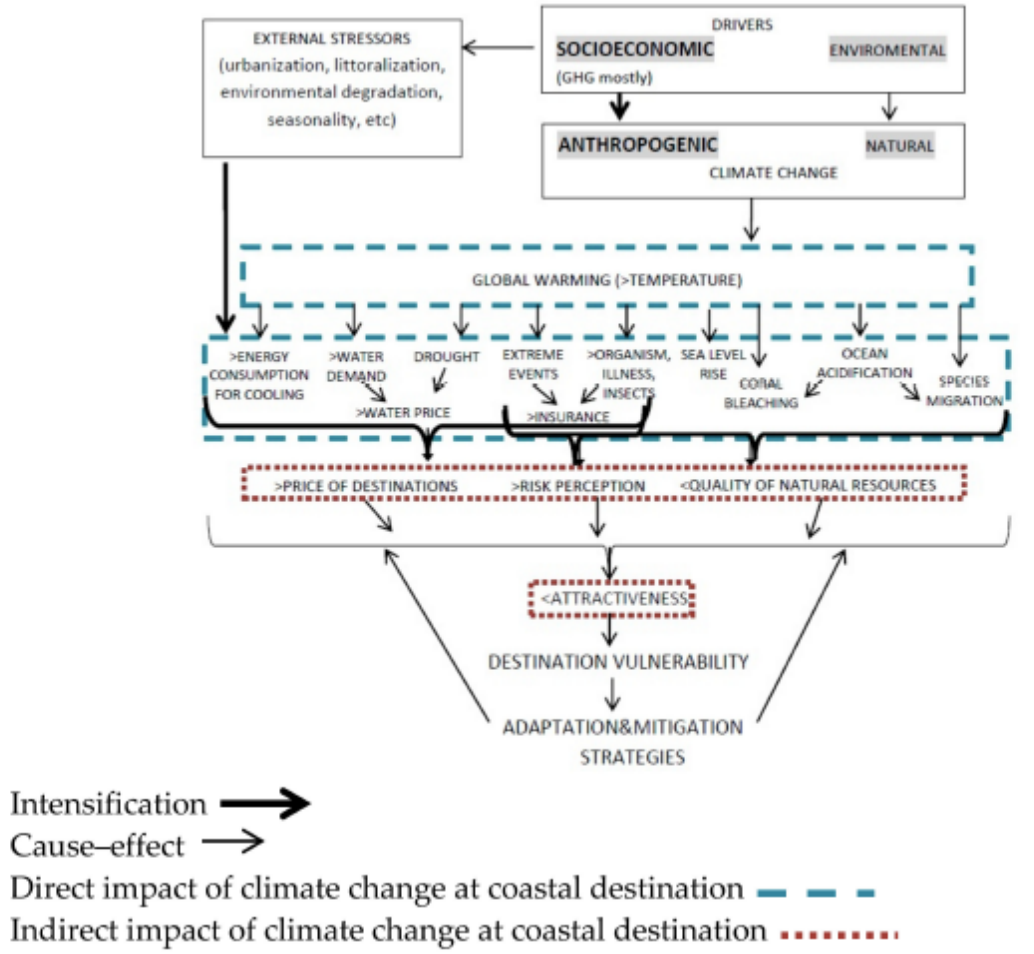
- An increase in atmospheric temperature of 1.1–3.5 °C resulting in warmer days and nights;
- Decrease in annual rainfall, with a possibility of droughts;
- Potential for more intense tropical storms and hurricanes;
- Increases in sea surface temperature; and

- Increases in sea level rise in the Caribbean, including Jamaica's coastline, ranging from 0.17 to 0.24 metres by 2050.

Jamaica's Third National Communication, a report on the country's response to climate change required by the United Nations Framework Convention on Climate Change (UNFCCC), recognises the tourism sector's importance to the nation's development and its vulnerability to the effects of climate change, especially in context of its linkages with other sectors such as agricultural production, water, coastal and marine resources, and fisheries. The Intergovernmental Panel on Climate Change (IPCC) defines vulnerability as "the propensity or predisposition to be adversely affected" which is determined by the "sensitivity or susceptibility to harm and lack of capacity to cope and adapt" (Mach et al., 2014, p. 128). Jamaica's national communication report concludes that the effects of climate change on tourism—in particular sea level rise, storm surges, and droughts—are complex and interconnected, and will have a definite negative effect on GDP (Ministry of Economic Growth and Job Creation [MEGJC], 2018).

The IPCC fourth assessment synthesis report (2007) indicates that "warming of the climate system is unequivocal" mainly due to increases in air and ocean temperatures, extensive melting of snow and ice, and global rise in sea level (p. 2). As shown in Figure 3, climate variability and change, seasonality, and extreme weather events can affect tourism supply (local destinations and tourism operators) and demand (visitor arrivals, source markets, and travel patterns) in many direct and indirect ways.

Figure 3: Climate Influences on the Tourism Sector




*Source: Scott & Lemieux, 2010.*

## A. Impacts on Tourism Supply (Destinations and Tourism Operators)

This section takes a closer look at how climate variability and change is affecting and forecasted to continue impacting tourism supply (destinations and tour operators) and tourism demand (visitor arrivals, source markets, and travel patterns).

### 1. Increasing Storm Frequency and Intensity

The State of the Jamaican Climate 2015 report notes that there has been a "dramatic increase in the frequency and duration of Atlantic hurricanes since 1995" and an "increase in category 4 and 5 hurricanes, rainfall intensity, associated peak wind intensities, [and] mean rainfall for same period" (CSGM, 2017, p. xvi). The increased frequency and intensity of hurricanes are posing considerable risks to infrastructure and

coastal settlements in Jamaica. The estimated current cumulative cost of damage associated with natural disasters in Jamaica is about 7% of GDP (or US$120 billion) (United Nations Conference on Trade and Development [UNCTAD], 2017). This significant figure is expected to increase as hurricanes are predicted to become more frequent and intense.

While hurricanes have not severely impacted the tourism sector, the sector's risk is increasing in conjunction with rising sea levels that create greater storm surge heights (Caribsave, 2012). Tropical storms and hurricanes are also damaging important tourism attractions such as beaches—altering their shape and area, and causing storm surge damage to coral reefs. Tropical storms and hurricanes appear to be the dominant factor influencing beach erosion (CSGM, 2017). Caribsave estimates that 50% of beaches in Jamaica experienced erosion during Hurricane Gilbert in 1988 (2012).

With the predicted increase in the intensity of tropical storms striking Jamaica, more damage to infrastructure and coastal communities from wind, rain, and storm surges may occur (Caribsave, 2012). Over time, these impacts can result in coastal erosion and inundations. These risks will put tourism infrastructure such as hotels, airports, and cruise ports at great risk from inundation, flooding, and physical damage associated with coastal land loss. More severe storms will also translate into more severe damage to beaches and longer recovery periods.

Estimates indicate that the costs from hurricane damage, loss of tourism revenue, and infrastructure damage may together account for 27.9% of Jamaica's GDP by 2050, and could reach as high 56.9% of GDP by 2100, based on 2004 GDP (Bueno et al., 2008). These estimates translate into a total annual loss of about US$4.9 billion (US$292 million in damages from storms, US$593 million in loss of tourism revenue and US$4.1 billion in infrastructure damage) by 2100 (Bueno et al., 2008). These amounts are in 2007 dollars.

More frequent and severe storms affect tourism enterprises through operating costs that include additional emergency preparedness and management requirements, increased infrastructure damage, higher insurance premiums, backup power and water systems, evacuations, and business interruptions (World Tourism Organization [UNWTO] & United Nations Environment Programme [UNEP], 2008; Government of Jamaica, 2015). The effects of storms on infrastructure are translating into higher insurance costs for tourism businesses. The Association of British Insurance estimates that insurance premiums in the Caribbean could increase by 20%–80% by 2050 (Dlugolecki, 2004). Private insurance may no longer be available in high risk areas, forcing governments to provide coverage or decelerating development in these areas (Caribsave, 2012).

### 2. Warmer Sea Temperatures

Jamaica has been experiencing increases in temperature consistent with global trends (CSGM, 2017). Warmer sea temperatures and acidification of the seas are affecting one of Jamaica's prime tourism assets, its coral reefs. In addition to being an important tourist attraction, coral reefs also play a critical role as a physical barrier to ocean waves and serve as habitat for fisheries.

The warming trend is causing significant coral bleaching and mortality. Coral bleaching events occurred in Jamaica in 1988 and 1990 (Anderson, 2000). Furthermore, a regional bleaching event that occurred in 2005 affected a significant percentage of Jamaica's reefs and considerably reduced hard coral cover (Kane, 2005). Coral bleaching is predicted to increase in intensity and frequency, possibly becoming an annual event in the Caribbean by 2020 (UNWTO and UNEP, 2008). Increased coral bleaching leads to a breakdown in reef protection and leaves the coastline and beaches more vulnerable. It also degrades the aesthetics at dive and snorkel sites.

Beach erosion due to reef degradation is predicted to reduce visitor demand and present additional costs to the tourism sector associated with beach engineering (e.g., sand replenishment). Jamaica's coralline beaches remain a top attraction for international visitors. In 2018, 77% of all visitors stayed at one of Jamaica's three main beach destinations—Negril, Montego Bay, or Ocho Rios. A 2011 study by Kushner et al. for the World Resources Institute (WRI) found that beach erosion rates in Jamaica could increase significantly above the base (current) erosion rate of 0.3 metres per year with further reef degradation. This study estimates that beach erosion rates could increase by more than 50% in Montego Bay, 70% in Ocho Rios, and more than 100% in Negril above the 2011 rate over a 10-year period, and estimated the significant economic impact that may accrue from decreased visitor satisfaction and visitor arrivals caused by degraded beaches. The details are outlined in Section B.2.

Jamaica's tourism relies heavily on its coralline beaches and crystalline blue waters. The warmer sea surface temperatures are triggering sargassum blooms in the Caribbean, including Jamaica. Since 2011, unprecedented levels of sargassum seaweed have been washing up on shorelines throughout the Caribbean. In Jamaica, sargassum blooms on the north coast of the island in 2014 and 2015 negatively impacted Jamaica's main beach destinations. These blooms covered the ocean 300 times more than was normal before the first sargassum event in 2011 (Brown, 2020). The effects on the visitor experience are considerable: sargassum blooms limit access to the sea directly from the beach, and diminish the aesthetics of the shoreline, turning the water brown and creating a foul smell. Blooms also affect sea bathing and water sports, and reduce visibility for

snorkelling and diving. From an environmental standpoint, sargassum seaweed accelerates beach erosion, degrades water quality, damages critical habitats such as seagrass beds and coral reefs, and affects endangered species such as turtles and marine mammals (Oxenford & McConney, 2019). The economic impacts to tourism from sargassum blooms are tremendous. In 2018, estimated cleanup costs totalled US$120 million in the Caribbean (Ministry of Tourism, 2019). From 2015 to 2019, Mexico spent US$17 million in cleanup costs in the Mexican Caribbean (Casas-Beltrán et al., 2020). Furthermore, the visitor's beach experience—and ultimately overall satisfaction with the destination—is negatively impacted, putting tourism revenue at risk. Casas-Beltrán et al. found that 47% of visitors spent less time at the beach in the Mexican Caribbean due to the seaweed problem. Over time, the destination's brand and reputation can be negatively affected.

Warmer temperatures, precipitation, and humidity also have a strong influence on the reproduction, development, behaviour, and population dynamics of insects and pathogens, ultimately increasing the incidence of infectious and vector-borne diseases such as dengue, malaria, and cholera in small island developing states (SIDS), including Jamaica (Caribsave, 2009). The mean relative vectorial capacity for dengue fever transmission in Jamaica is projected to increase through 2070 (World Health Organization, 2017).

As temperatures increase, restaurants, hotels and resorts, and other tourism enterprises will need to increase cooling and incur higher cooling costs. Like most of the Caribbean, Jamaica is plagued by high electricity costs. As of 2020, the price of electricity for Jamaican businesses is US$0.19 per kWh (which includes the cost of power, distribution, and taxes) compared to the global benchmark of US$0.12 per kWh (GlobalPetrolPrices.com, 2020). Tourism enterprises will also incur additional costs for pest fumigation and other measures to protect visitors from insects.

### 3. Sea Level Rise

The Caribbean sea level rose 0.18 ±0.01 mm/year between 1950 and 2010, and about 3.2 mm/year between 1993 and 2010, indicating increased rates of sea level rise (SLR) (CSGM, 2017). The forecasted SLR for the north coast of Jamaica is 0.43–0.67 metres by the end of the century with a maximum rise of 1.05 metres (UNCTAD, 2017). Projections are similar for the south coast of the island.

Jamaica's tourism assets are concentrated in coastal areas and hence very vulnerable to SLR, particularly inundations from SLR and SLR induced beach erosion which will impact

- tourism infrastructure (e.g., hotels and resorts),

- tourism attractions (e.g., beaches, sea turtle nesting sites), and
- supporting transportation infrastructure (e.g., roads, cruise ports, airports).

Beaches retreat inland at about 100 times the rate of SLR (CSGM, 2017). Caribsave (2012) found that a 1-metre sea level rise could negatively affect 8% of the major tourism properties in Jamaica, with this figure increasing to 18% at a 2-metre sea level rise. Thirty-two percent of coastal hotels and resorts are forecasted to be at risk of inundation with beach erosion of 50 metres. This figure increases to 50% with 100 metres of beach erosion. Caribsave (2012) predicts that transportation infrastructure will be the most heavily impacted. All seaports are at risk under 1 and 2-metre sea level rise scenarios. Twenty percent of airports are predicted to be at risk at 1 metre of sea level rise, with this figure increasing to 60% at 2 metres of sea level rise. Caribsave (2012) also estimates that Jamaica's tourism sector could incur annual losses of US$1 billion in 2050 and more than US$8.7 billion in 2080. Additionally, the costs of rebuilding hotels and resorts are estimated at US$500 million in 2050 and possibly up to US$6 billion in 2080.

At the operational level, tourism enterprises will experience increased costs associated with beach engineering and building additional seawalls and other coastal defence structures, increased infrastructure damage, higher insurance premiums, increased costs associated with additional emergency preparedness and management requirements, and business interruptions (UNWTO & UNEP, 2008; Government of Jamaica, 2015).

### 4. Droughts and Flooding

Tourism activities are heavily weather dependent. Adverse weather conditions such as more intense rainfall can affect the visitor experience and ultimately visitor satisfaction. Observed climate trends for Jamaica indicate increases in the intensity and frequency of extreme rainfall events between 1940 and 2010 (CSGM, 2017).

At the same time, projections reflect less rainfall overall, which will reduce freshwater resources and could present challenges in meeting water demands for the local population, the tourism sector, and agriculture. Several studies demonstrate that tourists use considerably more water on average compared to the domestic population (Emmanuel & Spencer, 2009; Essex et al., 2004; Gössling, 2005). Total tourism water consumption includes direct water use by visitors as well as use in tourism facilities such as hotels, swimming pools and golf courses. Tortella and Tirado (2011) found that small hotel chains had 18% lower water consumption levels than independent hotels, whereas larger hotels that belong to international chains had 34% higher levels of water consumption compared to independent hotels.

Ekwue (2010) found that in 2003, 74% of water use in Jamaica was for irrigation, 18% was for domestic consumption, and 8% was for industry which may have included tourism (there was no discrete category for accommodations). While the same study projected no water scarcity in the near future, it classified Jamaica's water stress level which refers to the proportion of available water that is in use as "medium" (22.4%).

Food production and security are forecasted to be affected by droughts and other climatic factors. Tourism operators may have to incur higher costs for food supplies (UNWTO & UNEP, 2008). Hotels and restaurants in Jamaica consume an "estimated 8.8% and 11.9% of the total output from Primary Agriculture and the Processed Food sector, respectively. At the same time, for every one dollar of Primary Agriculture production, 16 cents is sold to the Processed Food sector, which, in turn, supplies 12 cents of its total output to hotels and restaurants." (Segura, 2010, p. 6).

## B. Impacts on Demand and Destination Choice

Tourism demand for a destination is affected by many different factors, including the motivation for the trip, the economic climate, and destination attributes, making destination choice a complex process. Tourism demand studies use a variety of methods and variables to forecast arrivals. Many demand studies differentiate between "push" and "pull" factors. Push factors are origin-related and refer to factors such as travellers' motivations, including the undesirable aspects of the climate in their home region. Pull factors are attributes that determine a destination's attractiveness, such as natural resources and climate (Amelung et al., 2007). Weather and climate can be both a pull and a push factor. While seasonality has always been of interest, as it directly impacts demand, very few demand studies have used climate factors. Weather and climate were seen as static variables with little structural change from year to year; the long-term effects of climate change have now changed that notion (Amelung et al.).

Another distinction common in tourism studies is climate-dependent versus weather-sensitive tourism (Smith, 1993). In the case of climate-dependent tourism, the climate itself is the pull factor. For example, a sunny and dry location is attractive for people who live in colder regions. In the case of weather-sensitive tourism, the climate is not a tourist attraction in its own right, but weather conditions play an important role for enabling specific activities. People prefer a destination with a climate that suits their holiday plans. For example, hikers usually prefer locations and times with little chance of rain. A gradual warming and changing weather patterns could then influence tourists to seek different

holiday destinations or travel at different times during the year. Climate change is therefore likely to lead to changes in tourist behaviour and thus demand.

Mather et al. (2005) established that the Caribbean is less likely to be attractive to travellers from North America due to factors such as increased temperatures, beach erosion, degradation of reef quality, and greater health risks.

Some destinations will be more impacted by climate change than others, and research has shown that Caribbean destinations are more affected by climate change than average. There are several different ways climate change can impact tourism demand in the Caribbean, including Jamaica (Gössling et al., 2012):

### 1. Direct Impact of Changed Climate

The weather and climate play an important role in the tourist decision-making process, influencing motivation, destination choice, and timing of travel. Changes in weather conditions and climate will then also directly affect tourism demand in a destination. Much of the Caribbean depends on the "sun, sea and sand" product, making the Caribbean's tourism offering reliant on its climate. Change in climate can disrupt demand in two ways:

a. **Rising temperatures in the main source markets and in other destinations can shift demand.** The demand for winter getaway holidays is anticipated by researchers to decline if temperatures in home countries rise, and other destinations may become more attractive if their temperatures rise and become more like the Caribbean. A longer and more intense hurricane season could also make the Caribbean region less attractive. Tourists from its main market, North America, like to escape from the cold winter climate to enjoy warmth, sunshine, and beaches. Parts of North America may become warmer, making people feel less need to escape. Scott et al. (2007) found that, in the Caribbean, "climate distance" plays an important role in demand for tourism—the greater the difference in climate between home and destination countries, the higher the demand will be. An adverse change in climatic features relative to competitors could then also lead to substitution away from the region (Lorde et al., 2016). If climatic conditions in other destinations improve sufficiently, they may become more competitive with the Caribbean.

b. **Increases in the frequency or magnitude of certain weather and climate extremes (e.g., heat waves, hurricanes) can make the destination less attractive**. Caribbean destinations can become too hot for tourists during some parts of the year. A

survey of European tourists showed that the optimal temperatures for beach tourism are between 27° C–32° C (Rutty & Scott, 2010). Rising temperatures and increased humidity can make the climate less pleasant. Academic studies project that rising temperatures may make the Caribbean unbearable for visitors, making the region less attractive. (Attz, 2009; Richardson, 2007). There are also hazards such as more frequent high-intensity hurricanes and flooding, which will be more of a deterrent than changes in temperature (Richardson, 2007).

A study that assessed the impacts of hurricanes on tourist arrivals in the Caribbean, using data for the period 2003–2008 from 26 countries including Jamaica, found that arrivals may decrease from 2% to 20% during the actual month of the strike. Hurricane Ivan, which struck Jamaica in 2004, had the largest negative impact, reducing tourist arrivals by 20% (Granvorka and Strobl, 2013).

This combined effect of change in the main source countries and in the destination can affect demand. How much demand in a Caribbean destination changes also depends on its largest source markets. Barbados would be impacted more by a change in preference by European tourists while Jamaica would be more at a disadvantage from a change in the US market. Impacts within the Caribbean region are also expected to be heterogeneous. Countries such as Dominica, the Dominican Republic, Haiti, St Kitts and Nevis, and Suriname are projected to experience some increase in tourism demand under different climate change scenarios, while arrivals to St Lucia are likely to decline marginally under all scenarios (Moore, 2010). Moore estimated that under worst-case scenarios arrivals to Bermuda, Jamaica, and Trinidad and Tobago could fall by about 5% per year due to the effects of climate change between 2071 and 2100. Richardson (2007) argues that North American demand for the Caribbean will reduce as the region becomes less appealing due to global warming, translating into a loss of tourist expenditures of between $8 billion and $13 billion in US dollars by 2050.

### 2. Indirect Impact of Changed Environment

Climate change can affect the natural resources that are essential for tourist activities, making the destination less attractive. These effects include reef degradation, beach erosion, and seawater pollution, which can impact tourists' experiences and satisfaction. Affected natural resources may take some time to recover or be permanently altered. There is currently a "lack of longitudinal research in assessing long-term environmental changes on tourist awareness, activities, satisfaction and destination choice." (Gössling et al., 2012, p. 39). A study in Mauritius suggested that experiences of scuba divers and

snorkelers are less affected by reef degradation unless a certain threshold was exceeded (Gössling et al., 2007).

Beach erosion seemed to have a larger impact on tourism demand; in a study in Bonaire and Barbados proposing a scenario where ''beaches largely disappeared'', 77% of respondents would be unwilling to return (Uyarra et al., 2005). Research in Hawaii and the Gulf of Mexico showed that pollution of water bodies and growth of invasive species have a negative effect on tourism demand (Purcell, 2012). The perception of environmental impacts varies depending on a number of factors, of which the following are most relevant to Jamaica:

- **Type of trip.** Long-haul travellers are less likely to accept environmental degradation caused by climate change than short-haul travellers (Scott et al., 2007).
- **Demographics.** For example, there are differences in preferred beach temperature among age groups and nationalities (Rutty & Scott, 2010).
- **Travel career.** For example, novice divers are more likely to accept reef degradation than more experienced divers (Dearden & Manopawitr, 2010).

The Kushner et al. (2011) predicts that visitor satisfaction will be negatively impacted by degraded beaches, which will result in significant annual losses for Jamaica's main tourism enclaves (see Table 3).

Table 3: Annual Loss in Visitor Satisfaction (US$) at Beaches Due to Coral Reef Degradation (*after 10 years of erosion*)

| Location | Loss in value due to current rates of beach erosion | Loss per tourist | Loss in value if the beach erodes faster due to reef degradation | Loss per tourist | Difference due to further reef degradation |
|---|---|---|---|---|---|
| Negril | $5.5 million | $15 | $10.9 million | $30 | $5.3 million |
| Montego Bay | $7.1 million | $15 | $10.7 million | $23 | $3.6 million |
| Ocho Rios | $6.5 million | $15 | $11.1 million | $26 | $4.6 million |
| **Total:** | **$19.2 million** | | **$32.7 million** | | **$13.5 million** |

Note: The loss in consumer satisfaction was calculated using a per meter value of $5.11 per visitor (based on Edwards 2009), coupled with the average number of overnight visitors a year for each site: Negril (360,927), Montego Bay (466,075), and Ocho Rios (425,026) (Jamaica Tourist Board 2009).

*Source: Kushner et al., 2011.*

Over time, the decrease in visitor satisfaction is expected to indirectly impact visitor demand. Arrivals to Jamaica could decrease by 9,000–18,000 annually, at a cost of US$9 million to US$19 million a year to the tourism sector, and US$11 million to US$23 million to the entire Jamaican economy (Kushner et al., 2011).

## C. Adaptation and Mitigation Strategies

In light of the importance of tourism to Jamaica's economy and its vulnerability to climate change, it is critical that the Government of Jamaica respond with policies and programmes that provide a governance framework to support Jamaica's management of climate change impacts on the sector by reducing its carbon footprint and adapting to the changing climate.

The United Nations defines adaptation as "an adjustment, in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (UNWTO & UNEP, 2008, p. 81). Adaptive capacity is therefore "the ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences" (Mach et al., 2014, p. 118).

While the tourism industry generally displays a higher level adaptive capacity than other industries because of its ability to bounce back from a variety of major shocks such as natural disasters and terrorism attacks, adaptive capacity greatly varies within the industry across destinations, subsectors, tourism businesses, and tourists (UNWTO et al., 2008). The adaptive capacity of a destination greatly influences its ability to reduce its overall vulnerability to climate change impacts. Destinations like those in the Caribbean that are highly exposed to climate change, sensitive to its impacts, and less able to adapt are the most vulnerable (Jopp et al., 2010).

Small island destinations tend to have low adaptive capacity, and adaptation costs are high compared to GDP (Mimura et al., 2007). But high adaptive capacity does not guarantee efficient or effective adaptation; there must be a high level of awareness of potential impacts and risks, capacity to analyse the potential impacts and risks, and commitment to sustained action (Moser & Luers, 2008). Research shows that developing countries, particularly SIDS do recognise these challenges and their high vulnerability to climate change. SIDS like Jamaica have shown a consistent dedication to the work required "to collect data on the effects and implications of climate change and sea level rise, to improve public understanding of climate change issues, to promote more efficient energy use and to formulate their own comprehensive adjustment and mitigation policies to be able to cope with and respond to climate change" (Nurse et al., 2009, p. 6). These efforts are detailed in the following sections.

Like other sectors, tourism has a reciprocal relationship with climate change. Research has provided evidence of the impacts of climate change on tourism in particular, and

direct impacts from tourism that contribute to worsening climatic conditions. It is estimated that tourism-generated greenhouse gas (GHG) emissions make up approximately 5% of the global anthropogenic GHG emissions (Vourdoubas, 2019). There are varying methodologies used to measure tourism's contribution to GHG emissions, which differs by tourism subsector and by the origin of tourists in each destination. On average, air travel to Jamaica generates 635 kg of carbon dioxide per tourist. Air travel from the US, which is Jamaica's most important source market, is not considered long-haul travel and hence has a lower carbon footprint (Caribsave, 2012).

Policies to mitigate climate change, such as tax- and market-based instruments, may increase the costs of travel to the Caribbean as well as awareness of climate change and travel emissions (Emmanuel, 2014). However, studies have shown that mitigation policies have had little effect on overall demand for travel for now (Gillen et al., 2003). Growing awareness of the environmental impact of flying has also not significantly affected the global demand for travel (Cohen & Higham, 2011). The overall increase in global demand for travel is most likely outpacing the decline due to environmental awareness and so-called "flight shaming". There are no studies available on the effect of the growing awareness of environmental impacts of travel for the Caribbean.

The following sections take a closer look at the policies, plans, programmes, and initiatives that are helping to enhance climate resilience in Jamaica.

### 1. National Policies and Initiatives

The Tourism Sector Plan of the Vision 2030 – National Development Plan (NDP) explicitly recognises the need for adaptation planning at the sector and enterprise levels, and for a mechanism to govern sector emissions. The Climate Change Policy Framework and Action Plan 2015 includes both mitigation and adaptation as national goals, and provides an overarching framework for mainstreaming climate change considerations. The goal of the Policy Framework is to create a sustainable institutional mechanism to facilitate the development, coordination, and implementation of policies, sectoral plans, programmes, strategies, and legislation to address the impacts of climate change. It includes a list of climate change impacts on tourism and sectoral plans and initiatives to address these impacts. It also establishes the country's Climate Change Focal Point Network, with representation from all priority sectors (including tourism) to be actively involved in integrating and mainstreaming climate change considerations into the development policies, plans, and programmes.

Jamaica's Third National Communication on Climate Change 2018 extensively recognises tourism impacts and suggests potential projects to include mitigation of GHG

emissions in the tourism sector. The National Community Tourism Policy and Strategy 2015 includes strategies to facilitate the integration of climate change adaptation and mitigation measures and other hazard management in community tourism product development.

The Ministry of Tourism manages a Climate Change and Multi-Hazard Contingency Programme which aims to mainstream disaster risk management into tourism planning and development. The Tourism Emergency Management Committee (TEMC) was formed to build a resilient tourism industry with the ability to bounce back quickly and coordinate effectively in the event of an emergency so as to substantially reduce loss of life and damage to economic, social, physical, and environmental assets caused by natural and human-induced hazards and disasters. The Tourism Emergency Operations Centre (TEOC) is the primary emergency organisation responsible for coordinating emergency response in the tourism sector. A number of capacity-building activities have taken place within the sector under this programme. These mentioned policies and programmes are not exhaustive.

Jamaica's National Energy Policy (NEP) 2009 outlines energy-efficient standards for incorporation in national building codes, incentivising construction of carbon-neutral buildings and promotion of energy conservation and efficiency among hoteliers and others. The National Renewable Energy Policy focuses on the deployment of wind, the emerging potential and deployment of biomass and biofuels, exploratory work on ocean energy, and the deployment of other technologies such as solar and hydro technologies. This policy calls out the tourism sector as an important opportunity for increased renewable energy. The Updated National Determined Contributions 2020 takes steps to move Jamaica towards an economy wide target for emission reductions—mitigate the equivalent of 1.1 million metric tonnes of carbon dioxide per year by 2030 versus the business-as-usual scenario (Chambers, 2018). It commits the country as a whole to levels of national reduction of GHGs through decarbonising energy generation and preservation of forestry. As tourism is energy intensive, it has a de facto commitment for decarbonising the sector.

Caribsave (2012) posits that it is difficult to identify the share of tourism in national energy use, as it is unknown which share of electricity is used by accommodation establishments and other parts of the tourism-related service sector. Knowing which share of energy is used in tourism-related car travel or by cruise ships (bunker fuels) is also difficult. The Third National Communication of Jamaica to the United Nations Framework Convention on Climate Change (2018) does not indicate energy consumption data specific to tourism. The inconsistencies associated with measuring the impact of tourism directly

may present a difficulty in determining how much mitigation effort is actually required from the sector.

## 2. Regional Policies and Initiatives

Jamaica has implemented a number of climate adaptation strategies, programmes, and initiatives that include adaptation and mitigation measures for the tourism sector. But there are also global and regional strategies, programmes, and initiatives that Jamaica participates in to further enhance its climate resilience. These are briefly summarised below. This list is not exhaustive but rather focuses on strategies, programmes, and initiatives that either directly or indirectly support Jamaica's destinations and tourism sector.

Opened in 2005, the Caribbean Community Climate Change Centre (CCCCC) coordinates the Caribbean's response to climate change. It is recognised by the UNFCCC, UNEP and other prominent international agencies as the leading centre for climate change issue outreach, education, and projects in the region. It houses key documentation and data on regional climate change information and issues and provides policy advice and guidelines to Caribbean Community (CARICOM) Member States, including Jamaica (CCCCC, 2020). It has also developed a number of tools to support programming across the region, including a clearinghouse for access to regional data and documentation, a Caribbean Climate Online Risk and Adaptation Tool to support climate resilient decision-making, and a Tourism Sector Emission Calculator (Global Programme on Risk Assessment and Management for Adaptation to Climate Change [GIZ], 2017). In collaboration with the US National Oceanic and Atmospheric Association (NOAA), CCCCC developed an integrated regional Coral Reef Early Warning System (CREWS) network that includes installations in Jamaica. These monitoring stations collect data on climate, marine, and biological parameters of the health of the coral reefs over time to track changes due to climate.

The CCCCC is implementing a regional Coastal Protection for Climate Change Adaptation in four Caribbean States including Jamaica. Four Local Adaptation Measures projects in Jamaica will receive funding to improve the ability of vulnerable communities to withstand the impacts of climate change (CCCCC, 2017). The projects are Portland Bight and Negril Environmental Protected Areas, East Portland Fish Sanctuary, and the Closed Harbour (also known as 'Dump-up' Beach) in Montego Bay.

The Regional Disaster Risk Management for Sustainable Tourism in the Caribbean Project was implemented over three years from 2007 to 2010 by the Caribbean Disaster Emergency Management Agency (CDEMA), with support from the Inter-American

Development Bank (IDB) and in collaboration with the Caribbean Tourism Organization (CTO), CARICOM Regional Organization for Standards and Quality, and the University of the West Indies. Jamaica was one of the five beneficiary countries of this project. A key output of this project was the Regional Disaster Risk Management Strategy and Plan for Action for the Tourism Sector which includes strategies for mitigation, preparedness, response, and recovery for the tourism sector throughout the region. The strategy also provides guidance for the national adaptation of these strategies, standards for conducting hazard mapping, vulnerability assessments and economic valuation for risk assessment, and a manual for baseline data collection (CTO, n.d.).

The Caribbean Catastrophe Risk Insurance Facility (CCRIF) is a multicountry catastrophe fund that seeks to limit the financial impacts of catastrophes such as hurricanes, earthquakes, and excess rainfall by quickly providing short-term liquidity when these types of events occur and trigger insurance policies (CCRIF, 2020). CCRIF offers earthquake, tropical cyclone, and excess rainfall policies to Caribbean and Central American governments. Jamaica is one of its insured member countries, and must pay an annual premium to be eligible to receive CCRIF coverage and compensation. CCRIF also collects and disseminates detailed information though hazard event and economic impact reports, country risk profiles, and other technical materials to the Caribbean (GIZ, 2017).

The Climate Risk Adaptation and Insurance in the Caribbean (CRAIC) project promotes weather-index-based insurance to address climate change, adaptation, and vulnerability throughout the Caribbean. Funded by Germany's Ministry for the Environment, Nature Conservation, Building and Nuclear Safety and implemented by the CCRIF and Munich Re, the first phase of the project was launched in 2011 and currently operates in Jamaica, Saint Lucia, and Grenada (GIZ, 2017). The two parametric weather-index-based risk insurance products that have been developed through this project—the Livelihood Protection Policy and Loan Portfolio Cover—financially assist local communities and institutions exposed to natural disaster risk or extreme weather events (Munich Climate Insurance Initiative, n.d.).

Caribbean Aqua-Terrestrial Solutions (CATS) is an umbrella programme implemented by GIZ and the Caribbean Public Health Agency (CARPHA) that applies a ridge-to-reef approach across eight CARICOM member states, including Jamaica. The goal of the programme is to improve the adaptation of rural economies and natural resources (primarily agriculture and forestry) to the impacts of climate change (GIZ, 2017). It also includes a water component focused on reducing water loss, enhancing the resilience of coastal resources, and conserving marine biodiversity. Current CATS' activities in

Jamaica include operational support to four marine managed areas and the "Dollar-a-Day" sustainable financing mechanism as well as the management of the Blue and John Crow Mountains National Park (CATS, n.d.).

The Pilot Programme for Climate Resilience (PPCR) is a global funding mechanism from the Climate Investment Funds that is being used in 17 countries, including Jamaica. The PPCR helps national governments of developing countries integrate climate resilience into development planning, long-term strategic investments, and activities across sectors, and provides funding to implement these plans and launch solutions aimed at climate-related risks (MEGJC, 2020). In collaboration with the IDB and the World Bank, the government of Jamaica developed Jamaica's Strategic Programme for Climate Resilience, which focuses on strengthening the island's resilience to climate change by improving adaptive capacity across priority sectors—which specifically includes tourism (MEGJC, 2020).

The PPCR Adaptation Programme and Financing Mechanism project in particular supports the mainstreaming of climate change across Jamaica's priority sectors through funding of vulnerability assessments, climate change adaptation and disaster risk reduction plans; training and coordination of the Climate Change Focal Point Network; development of climate change awareness programmes for national- and local-level governments; creation of financial mechanisms such as the Special Climate Change Adaptation Fund and Climate Change Adaptation Line of Credit for small businesses; and management and sharing of knowledge, lessons learned, and communications strategies across programme initiatives (MEGJC, 2020).

The Caribbean Climate-Smart Accelerator Programme, a coalition of 26 countries including Jamaica and more than 40 private- and public-sector partners, launched in Kingston in 2018 to "implement transformative climate action" and support the Caribbean's efforts to become the first "climate-smart zone" in the world (International Institute for Sustainable Development, 2018). The Accelerator focuses on implementing climate solutions for physical and economic resilience, renewable energy, sustainable urban development, oceans, and transportation.

# 2.0 Approach and Methodology

## 2.1 Methodology

The aim of this research is to assess how the direct impacts of climate change are impacting, and will continue to impact, Jamaica's tourism sector. A comprehensive literature review was used to identify key frameworks and indicators that can be used to measure changes in

- **tourism demand,** based on visitors' climatic preferences;
- destination attractiveness, based on changes in price of destination, risk perception, and quality of natural resources; and
- destination vulnerability, based on destination attractiveness and adaptation and mitigation strategies.

The literature review revealed that there are very few frameworks that provide a holistic overview of the complex dimensions of the relationship between tourism and climate change. This study aims to provide Jamaica with such a holistic framework.

The indicators outlined in this section of the report measure direct impacts of climate change on tourism demand and supply and the destination's adaptive capacity. The indicators were drawn from the literature review, including international best practices and case studies. The proposed indicators are interconnected and form part of an integrated system that measures a tourism destination's attractiveness and vulnerability, where:

>Price of a Destination (P) + >Visitors' Risk Perception (R) + <Quality of Natural Resources (Q) = <Attractiveness of a destination (A)

and

<A ± [Adaptation Strategies (AS) + Mitigation Strategies (MS)] = Vulnerability of a Destination (V)

The following criteria were used to select the collective of indicators:

- Data availability
- Measurability (how realistic and practical they are to measure)
- Alignment to national climate change policies, plans, and programmes

## 2.2 Selection of Key Indicators

This section of the report describes the recommended key frameworks and indicators that can be used by Jamaica to assess climate change impacts on coastal tourism.

### A. Tourism Demand

This section contains two core and two supplemental indicators that can be used to measure the impact of climate change on tourism demand. There are two core indicators.

- Holiday Climate Index: Beach evaluates the relationship between destination climate and visitors' climatic preferences.
- The Tourism Seasonality Index evaluates the effect of climate changes on the distribution of arrivals during the year.

The supplemental indicators involve coordination with the JTB to expand its existing visitor exit survey to track satisfaction with the weather and quality of natural resources.

#### 1. Holiday Climate Index: Beach

Studies have shown that the use of average temperature alone as a proxy for climate dismisses the complex decision-making process of tourists. Tourism climate indices have been developed that "aim to reflect the influence of annual climate distributions at a given location, showing periods of peak climatic conditions as desired by tourists" (Rutty et al., 2020, p. 413). The equation for the Tourism Climate Index (TCI), which was developed in 1985, includes thermal comfort (TC), which is a combination of daily maximum temperature (C) and mean relative humidity as a percentage; aesthetic (A) (cloud cover percentage); and physical (P), which is a combination of precipitation (mm) and wind speed (km/h). Although widely used, recent studies show that the weighting scales in the TCI do not adequately reflect tourists' preference for the climate of beach destinations.

Based on the TCI, Scott et al. (2016) developed the Holiday Climate Index: Beach, or HCI: Beach, especially for "sun, sea, and sand" holidays (see Table 4). When the HCI: Beach was compared to the TCI for three Caribbean destinations—St Lucia, Antigua and Barbuda, and Barbados (for the Canadian market)—the HCI: Beach showed a much closer relationship to arrivals than the TCI did (Rutty et al., 2020). The HCI: Beach uses the following weighting formula: 2(TC) + 4(A) + [(3(P) + W)]. The data for each factor in the equation (e.g., wind speed) is rated based on surveys of tourist preferences. See Table 5 for the rating scheme.

Table 4: Holiday Climate Index: Beach

| **Holiday Climate Index: Beach** | |
|---|---|
| Reason for Measuring | Evaluates climate informed by tourists' stated climatic preferences for coastal-beach tourism |
| Data Requirements | Weather reports |
| Unit of Measurement | Index |
| Data Method | TC= Thermal Comfort: Humidex formula using daily maximum temperature (C) and mean relative daily humidity (%)<br>A= Aesthetic: Percentage daily cloud cover<br>P= Physical: includes daily precipitation (mm) and wind speed (km/h). |
| Frequency of Data Collection | Daily |
| Reporting Format | Index |
| Analysing Results | Score ranges between 0 (potentially dangerous for tourists, e.g., extreme heat/cold stress, very high winds or precipitation) to 100 (ideal for tourism) |
| International Benchmarks | N/A |
| Key Stakeholders/Users | Destination managers, tourism associations, tourism enterprises |
| Suggested Actions | If the HCI: Beach score falls below "good to very good" for the main source markets, alternative markets need to be identified and targeted. |
| References | https://www.mdpi.com/2073-4433/11/4/412/htm |

Table 5: Holiday Climate Index: Beach Rating Scheme

**TC** — Thermal comfort rating scheme

| HCI:Beach | |
|---|---|
| THumidex (°C) | Rating |
| ≥39.0 | 0 |
| 38.0–38.9 | 2 |
| 37.0–37.9 | 4 |
| 36.0–36.9 | 5 |
| 35.0–35.9 | 6 |
| 34.0–34.9 | 7 |
| 33.0–33.9 | 8 |
| 31.0–32.9 | 9 |
| 28.0–30.9 | 10 |
| 26.0–27.9 | 9 |
| 23.0–25.9 | 7 |
| 22.0–22.9 | 6 |
| 21.0–21.9 | 5 |
| 20.0–20.9 | 4 |
| 19.0–19.9 | 3 |
| | |
| 18.0–18.9 | 2 |
| 17.0–17.9 | 1 |
| 15.0–16.9 | 0 |
| 10.0–14.9 | -5 |
| ≤9.9 | -10 |

**A** — Aesthetic rating scheme (cloud cover)

| HCI:Beach | |
|---|---|
| CC (%) | Rating |
| 0–0.9 | 8 |
| 1.0–14.9 | 9 |
| 15.0–25.9 | 10 |
| 26.0–35.9 | 9 |
| 36.0–45.9 | 8 |
| 46.0–55.9 | 7 |
| 56.0–65.9 | 6 |
| 66.0–75.9 | 5 |
| 76.0–85.9 | 4 |
| 86.0–95.9 | 3 |
| ≥96.0 | 2 |

**P** — Precipitation rating scheme

| HCI:Beach | |
|---|---|
| Precipitation (mm) | Rating |
| 0 | 10 |
| 0.01–2.99 | 9 |
| 3.00–5.99 | 8 |
| 6.00–8.99 | 6 |
| 9.00–11.99 | 4 |
| 12.00–24.99 | 0 |
| ≥25.00 | −1 |

**W** — Wind rating scheme

| HCI:Beach | |
|---|---|
| Wind (km/hr) | Rating |
| 0–0.5 | 8 |
| 0.6–9.9 | 10 |
| 10.0–19.9 | 9 |
| 20.0–29.9 | 8 |
| 30.0–39.9 | 6 |
| 40.0–49.9 | 3 |
| 50.0–69.9 | 0 |
| ≥70.0 | −10 |

*Source: Scott, D.; Rutty, M.; Amelung, B.; Tang, M. (2016)*

## 2. Tourism Seasonality Index

Changing climate in the destination and the main source markets can influence the distribution of arrivals during the year. Destinations generally strive to reduce seasonality as this negatively impacts efficient use of resources, returns on capital, and the ability of the sector to generate year-round jobs.

There are several methodologies to measure the seasonality of tourism demand, of which the Gini coefficient method is considered the most reliable (see Table 6). The Gini coefficient
measures inequalities—the deviation from a uniform distribution of demand. The coefficient can range between zero and one. The higher the coefficient, the more unequal the distribution and the higher the seasonality.

This index measures the distribution of international stopover tourists throughout the year.

Table 6: Tourism Seasonality Index

| **Tourism Seasonality Index** | |
|---|---|
| Reason for Measuring | Evaluates the effect of climate changes on the distribution of arrivals during the year |
| Data Requirements | Stopover arrivals by month |
| Unit of Measurement | Index |
| Data Method | The Gini coefficient reveals to what extent the destination is affected by seasonality (the amplitude of seasonality). |
| Frequency of Data Collection | Annual |
| Reporting Format | Coefficient |
| Analysing Results | Score ranges between 0 and 1. A value approaching 0 corresponds to limited seasonality and a value approaching 1 relates to a highly concentrated distribution of arrivals (high seasonality). |
| International Benchmarks | Limited availability |

| Tourism Seasonality Index | |
|---|---|
| Key Stakeholders/Users | Destination managers, tourism associations, tourism enterprises |
| Suggested Actions | If the index trend indicates increasing seasonality, efforts should be taken to mitigate this |
| References | http://www.tourmis.info/index_e.html |

Following are two additional indicators that could provide valuable insights on the impact of climate change on demand but for which currently the data is not available.

#### 3. Tourist Satisfaction With Weather

The JTB annual visitor satisfaction survey measures different elements of tourist satisfaction during different points in the year. It includes a general section on the environment where respondents can leave specific comments, which mostly indicate disappointment over rain and overcast weather. In the future, the survey could include a specific question on weather and climate.

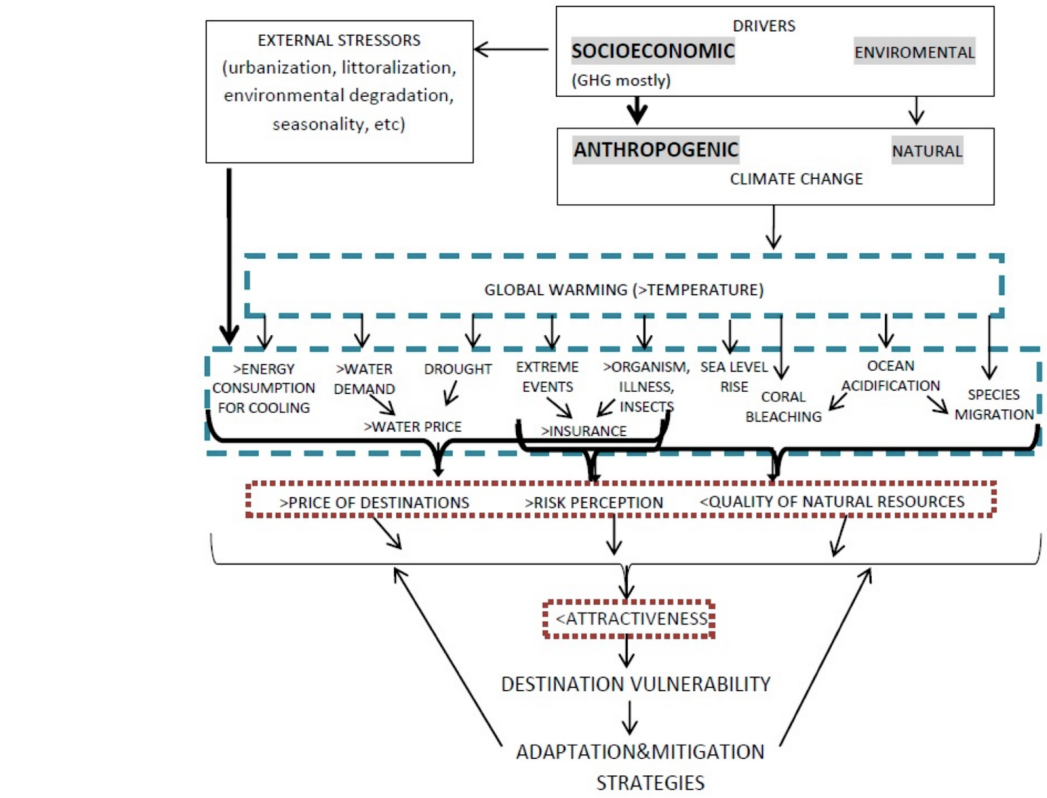
#### 4. Tourist Satisfaction With the Natural Environment

To measure the indirect impact of climate change on tourist satisfaction with the destination, future JTB surveys could assess visitor satisfaction with the quality of natural resources in particular beaches (asking about beach erosion, sargassum seaweed), marine activities such as diving, and other visible impacts of climate change on the environment.

## B. Measuring Tourism Supply: Destination Attractiveness

The direct impacts of climate change are already affecting tourism destinations and operators in Jamaica in a myriad of ways as outlined in Section 1.2 of this report. Figure 4 illustrates the recommended framework that Jamaica can use to better understand how climate change impacts on tourism are interconnected and affect the attractiveness and vulnerability of local coastal destinations.

Figure 4: Framework of Vulnerability of Coastal Destinations to Climate Change




*Source: Santos-Lacueva et al., 2017.*

Based on this framework, it is recommended that Jamaica assess destination attractiveness periodically.

Santos-Lacueva et al. (2017) posit that destination appeal is influenced by three main factors: price of destination, visitor risk perception, and quality of natural resources. This study concludes that the attractiveness of a destination (A) is reduced as the price of the destination (P) increases, visitors' risk perception (R) increases, and the quality of natural resources (Q) declines:

$$>P + >R + <Q = <A$$

A set of recommended indicators for evaluating price of the destination, visitor risk perception, and quality of natural resources is outlined in Table 7 and further detailed in

Table 8. These indicators are drawn from Santos-Lacueva et al. (2017) as well as findings from the broader literature review.

Table 7: Indicators That Measure Direct Impacts on Destination Attractiveness

| Climatic Drivers | Direct Impacts | Indicators to Measure Direct Impacts | Indirect Impacts |
|---|---|---|---|
| Increased temperatures, decreased precipitation, more insects | Increased energy consumption for cooling | 1. Percentage change in share of energy and water consumption as part of overall operating costs of hotels in a beach destination | **Price of Destination (P)** |
| | Higher water price resulting from scarcity | | |
| | Increased water consumption for recreation or visitor comfort | | |
| Sea level rise, more extreme weather events | Increased beach engineering (e.g., sand replenishment, costs) | 2. Percentage change in insurance premiums as a result of climate change for the accommodation sector | |
| | Higher rebuilding costs associated with damaged facilities and infrastructure | | |
| Increased temperatures | Higher taxes to reduce GHG emissions | 3. Percentage change in carbon taxes as a component of the average airfare from key source markets, where applicable | |
| Sea level rise, more extreme weather events, ocean acidification, species migration, decreased precipitation | Decreased reef health | 4. Percentage change in incidents of coral bleaching that affect destination<br>5. Change in average percent coral cover in reefs in beach destination | **Quality of Natural Resources (Q)** |
| | Increased beach loss | 6. Percentage change in annual beach erosion in beach destination | |
| Increased | Decreased climate-related | 7. Change in score for | **Visitor Risk** |

| Climatic Drivers | Direct Impacts | Indicators to Measure Direct Impacts | Indirect Impacts |
|---|---|---|---|
| temperatures | attractiveness of destination based on visitor preferences | HCI: Beach | **Perception (R)** |

There are seven proposed core indicators:

1. Percentage change in share of energy and water consumption as part of overall operating costs of hotels in a beach destination
2. Percentage change in insurance premiums resulting from climate change
3. Percentage change in carbon taxes as a component of the average airfare from key source markets, where applicable
4. Percentage change in annual beach erosion in beach destination
5. Percentage change in incidents of coral bleaching that affect beach destination
6. Change in average percent coral cover in reefs in beach destination
7. Change in score for HCI: Beach

A full description of the Holiday Climate Index: Beach is provided in Section 2.2 A of this report.

Table 8: Indicators That Measure Indirect Impacts on Destination Attractiveness

| Price of Destination | |
|---|---|
| Reason for Measuring | Evaluates the effect of climate change on travel costs that influence the overall price of vacationing in Jamaica. |
| Data Requirements | 1. Percentage change in share of energy and water consumption as part of overall operating costs of hotels in a beach destination (A)<br>2. Percentage change in insurance premiums and number of high risk areas in beach destinations where insurance is no longer available for the accommodation sector (I)<br>3. Percentage change in carbon taxes as a component of the average airfare from key source markets, where applicable (T) |
| Unit of Measurement | Percentage |
| Data Collection Method | 1. Enterprise surveys of hotels located in beach destinations<br>2. Trend analysis of insurance premiums for the accommodation sector and availability of insurance in high risk areas.<br>3. Trend analysis of carbon taxes as part of the airfare from the top two key source markets. |

| Price of Destination | |
|---|---|
| Frequency of Data Collection | Periodic—every three to five years |
| Reporting Format | Graphs |
| Analysing Results | Trend analysis.<br><br>>cost of hotel operating cost (A) + >cost of insurance (I) + >cost of air travel (T) = >price of destination (D) |
| International Benchmarks | Limited availability |
| Key Stakeholders/Users | Destination managers, tourism associations, tourism enterprises |
| Suggested Actions | Efforts should be taken to ensure that the Destination Price Index does not increase by ensuring that affordable insurance products are available to coastal hotels, and by helping hotels monitor and reduce energy and water consumption through environmental best practices. |
| References | https://www.ccrif.org/<br>http://www.caribbeanhotelandtourism.com/downloads/CHTAEF_WaterConservation.pdf<br>http://www.caribbeanhotelandtourism.com/downloads/CHTAEF_Energy.pdf |
| **Quality of Nature Resources** | |
| Reason for Measuring | Evaluates the effects of climate change on the quality of natural resources that are critical for coastal tourism in Jamaica. |
| Data Requirements | 1. Change in average coral cover in reefs adjacent to destination(C)<br>2. Percentage change in incidents of coral bleaching (B)<br>3. Percentage change in beach erosion in beach destination (E) |
| Unit of Measurement | Percentage |
| Data Collection Method | 1. Live coral coverage data<br>2. Coral bleaching data<br>3. Beach erosion monitoring data |

| Price of Destination | |
|---|---|
| Frequency of Data Collection | Annual |
| Reporting Format | Graphs |
| Analysing Results | Trend analysis<br><br>>Beach Erosion (E) + >Coral Bleaching (B) + <Living Coral Cover (C) = <Quality of Natural Resources (Q) |
| International Benchmarks | N/A |
| Key Stakeholders/Users | Destination managers, tourism associations, tourism enterprises |
| Suggested Actions | To proactively avoid decreases in Quality of Natural Resources, consider new hotel siting, design, and construction guidelines that include setback requirements, and encourage coral restoration projects supported by the tourism sector. |
| References | https://www.crc.uri.edu/download/CoastalAdaptationGuide.pdf<br>https://coralive.org/coral-restoration-jamaica/ |

## C. Assessing Adaptation and Mitigation: Destination Vulnerability

There are two major strategies that the tourism sector can use to reduce the negative effects of climate change—adaptation and mitigation. The OECD describes adaptation as "accepting the inevitability of climate change and the identification of steps to restrict its negative effects)" and mitigation as "measures to curtail the production of greenhouse gases to reduce the speed of climate change" (2010, p. 69). Because SIDS like Jamaica are disproportionately affected by climate change impacts, the tourism sector must have a vested interest in adapting to changes to mitigate adverse effects.

This section includes one core indicator for measuring overall destination vulnerability and supplemental indicators for measuring adaptation and mitigation strategies at both the tourism enterprise and destination levels.

Santos-Lacueva et al. (2017) posit that destination vulnerability is influenced by three main factors: destination attractiveness, adaptation strategies, and mitigation strategies. In that study, destination vulnerability was defined as "the result of the reduction in the destination's attractiveness caused by climate change, combined with the consequences [both positive and negative] of adaptation and mitigation strategies" (p. 6). This is shown in the following equation:

<A ± [Adaptation Strategies (AS) + Mitigation Strategies (MS)] = Vulnerability of a Destination (V)

Destination Attractiveness is discussed in Section 2.2 B. A set of recommended indicators for evaluating adaptation and mitigation strategies is outlined in Table 9, drawn from Santos-Lacueva et al. (2017), the European Tourism Indicator System (ETIS) (European Commission, 2016), and the Global Sustainable Tourism Council (GSTC) Destination Criteria (2019), as well as findings from the broader literature review.

Table 9: Indicators That Measure Destination Vulnerability

| Enterprise-level Initiatives | |
|---|---|
| Reason for Measuring | Tracking tourism enterprise engagement in adaptation and mitigation activities and reduction of energy and water consumption helps gauge the success of adaptation and mitigation programmes and initiatives in the destination. |
| Data Requirements | 1. Percentage change in number of hotels implementing climate adaptation and mitigation actions, such as carbon dioxide offsets and low energy systems (HA)<br>2. Percentage change in energy consumption by hotels in a destination (EC)<br>3. Percentage change in water consumption by hotels in a destination (WC) |
| Units of Measurement | Percentage |
| Data Collection Method | 1. Inventory of destination-level adaptation and mitigation initiatives and programmes to collect list of participating hotels<br>1. Enterprise survey to collect information on enterprise-level adaptation and mitigation activities in hotels |

| | |
|---|---|
| | 2. Usage data and reports for trend analysis of energy consumption levels<br>3. Usage data and reports for trend analysis of water consumption levels |
| Method of Calculation | 1. (number of hotels that participate in adaptation and mitigation initiatives ÷ total number of hotels) * 100 = % of hotels that participate in adaptation and mitigation initiatives<br>1. (number of hotels that have taken adaptation and mitigation actions ÷ total number of hotels) * 100 = % of tourism enterprises that have taken adaptation and mitigation actions<br>2. [(Energy consumption of current year after implementation of energy-saving actions – Energy consumption of previous year) ÷ Energy consumption of previous year] * 100 = % change in energy saved after actions to reduce energy consumption<br>3. [(Water consumption of current year after implementation of water conserving actions – Water consumption of previous year) ÷ Water consumption of previous year] * 100 = % change in water conserved after actions to reduce water consumption |
| Frequency of Data Collection | Annually |
| Reporting Format | Graphs: Pie Charts, Clustered Bar Graphs, Line Graphs |
| Analysing Results | Trend analysis<br><br>>hotel adaptation and mitigation actions (HA) + <hotel energy consumption (EC) + <in hotel water consumption (WC) = >Adaptation Strategies (AS) and >Mitigation Strategies (MS) = <Destination Vulnerability (V) |
| Key Stakeholders/Users | Water, Energy, Environmental and Tourism authorities, hotel/tourism associations, individual tourism enterprises |
| Suggested Actions | Increased investment in energy-saving and water conservation programmes for the tourism sector |
| References | https://ec.europa.eu/growth/sectors/tourism/offer/sustainable/indicators_en |
| Destination-level Policies, Plans and Initiatives | |

| | |
|---|---|
| **Reason for Measuring** | Determines if the destination is aware of climate-related vulnerability. Determines if the destination has appropriate adaptation, mitigation, and risk management policies, plans, and/or initiatives and evaluates their effectiveness. |
| **Data Requirements** | 1. A destination plan exists, is publicly available, and addresses climate adaptation, mitigation, and disaster risk management, including natural disasters, health, resource depletion, and others appropriate to the location (DP)<br>2. Percentage of tourism accommodations, attractions, and transportation support infrastructure located in vulnerable zones (VZ) |
| **Units of Measurement** | 1. Scale:<br>0 – "no plan/policy/initiative"<br>1 – "evidence of implementation of adaptation/mitigation activities but no documented plan/policy" or "evidence of documented plan/policy but no implementation"<br>2 – "implementation and public awareness of policy/plan/initiative"<br>3 – "full implementation and public awareness of policy/plan/initiative by other destinations"<br>2. Percentage |
| **Data Collection Method** | 1. Destination Management Survey—collection and review of destination plans and policies, land use and zoning reports and other relevant documentation<br>2. Enterprise Survey / Physical Verifications |
| **Method of Calculation** | 1. Collect and review destination plans and policies, land use and zoning reports and other relevant documentation, then rank using the scale above.<br>2. (number of tourism accommodations, attractions, and transportation supports located in vulnerable zones ÷ total number of accommodations, attractions, and transportation supports) * 100 = % of tourism accommodations, attractions and transportation supports located in vulnerable zones |
| **Frequency of Data Collection** | Annually |

| | |
|---|---|
| **Reporting Format** | Pie Charts, Bar Graphs |
| **Analysing Results** | Trend analysis<br><br>If DP<1, then <AS and <MS and >V<br>If DP≥1, then >AS and >MS and <V<br><br>>Destination Plan score (DP) + <Infrastructure in Vulnerable Zones (VZ) = >AS and >MS = <V<br><Destination Plan score (DP) + >Infrastructure in Vulnerable Zones (VZ) = <AS and <MS = >V |
| **Key Stakeholders/Users** | Emergency, Environmental and Tourism authorities; hotel/tourism associations; individual tourism businesses |
| **Suggested Actions** | Increase efforts (investment, local awareness, training, etc.) to engage the tourism sector in mitigation and adaptation and to increase adaptive capacity (or decrease vulnerability) of the destination |
| **References** | https://ec.europa.eu/growth/sectors/tourism/offer/sustainable/indicators_en<br>https://www.gstcouncil.org/gstc-criteria/gstc-destination-criteria/ |

## 2.3 Selection of Geographic Location & Site Description

The main criteria used to select a destination to pilot test the proposed set of indicators are:

- Beach destination: a frequently visited coastal tourism destination
- Full range of assets: a destination that has a high concentration of tourism businesses and is located near major tourism transportation infrastructure
- Data availability: a destination that has some data available

The destination identified to pilot test the proposed set of indicators is Montego Bay, whose boundaries are shown in Figure 5. Montego Bay is a city located on a coastal plain in northwest Jamaica and bordered inland by steep hills. It is world-renowned for its white sand beaches and lagoons surrounded by mangroves and coral reefs, and has been unofficially labelled the tourism capital of Jamaica. Montego Bay is one of the most visited coastal tourism destinations on the island due to its abundant natural attractions, high concentration of tourism businesses, and close proximity to both a cruise port and

an airport. In 2018, this coastal resort area accounted for 35.3% of total stopover arrivals, and 39.3% of total room capacity on the island (JTB, 2019). As Jamaica's largest destination, Montego Bay is a specialised area of interest for the tourism sector and can be used as a localised focal point for current and future climate information.

There is a full range of tourism transportation infrastructure nearby Montego Bay. The Sangster International Airport is 3 miles east of Montego Bay and receives about 72% of all international arrivals (JTB, 2019; UNCTAD, 2017). Montego Bay received more than 2.1 million stopover arrivals in 2019 (JTB, 2020). Furthermore, there are two important cruise ports in Montego Bay. The port of Falmouth, located about 18 miles west of Montego Bay, accounted for 40.3% of total cruise passenger arrivals in 2018, and the port of Montego Bay accounted for 27.8% (JTB, 2019).

The high concentration of tourism enterprises and the success of the tourism sector have led to recent improvements in Montego Bay's infrastructure. Under the North Coast Improvement Project, upgrades have been made to roads, waste management systems, and water treatment plants, but at the expense of forested and agricultural lands (CSGM, 2017). While the strong influence of the tourism and hospitality sector has brought economic benefits and development to the area, it has also created issues due to rapid and unmanaged urban growth. These include increases in water demand and waste production, an inadequate public service system, and unequal distribution of resources, all of which will be exacerbated by the impacts of climate change if left unaddressed (CSGM, 2017).

Figure 5: Urban Boundaries of Montego Bay


*Source: IDB, 2015*

Montego Bay is highly vulnerable to climate hazards due to its geographical location as a coastal city. Much of its major tourist infrastructure, including the airport, resorts, and markets, is located along the coast which makes it particularly vulnerable to storm activity and coastal erosion. Resort development along the coastline has also contributed to coastal erosion, beach and mangrove depletion, and reduction of water quality, which in turn has reduced the city's natural forms of protection against storms and natural disasters. The city also does not have any early warning systems or preparedness plans in place for managing climate hazards such as erosion, storm surges, and hurricanes. Flooding by low pressure systems, tropical cyclones, and blockage on major roads has been a notable ongoing issue in the city, and the Montego River in particular has experienced substantial flooding. Storm surge flooding is a particular threat to Catherine Hall, around the airport, and at Flankers (CSGM, 2017). Strong winds and landslides are other notable climate risks impacting critical infrastructure in Montego Bay.

The Meteorological Service's weather station at Sangster International Airport provides Montego Bay with ample historical and projected climate data. Key historical and projected climate observations for Montego Bay that impact tourism enterprises and activities are provided below (CSGM, 2017).

- Mean **annual temperature** is 27.5 °C. This has increased by 0.41 °C per decade between 1973 and 2008. Temperatures are highest in July and August, and lowest in January and February. The annual temperature is expected to increase by 2.5–3.2 °C in Montego Bay through the end of the century. Increases in the number of hot days/nights and decreases in cool days/nights are also anticipated.

- **Rainfall** decreased approximately 18% over the period of 1973–2008. Peak rainfall occurs in May and October. While the dry season officially begins in December, July is also a typically dry month. Mean annual rainfall is projected to decrease anywhere from 25% to 52% through the end of the century. This decrease is expected to be most notable in the late wet season and the dry season. While projections indicate a decrease in wet days, they also indicate an increase in intense rainfall events.

- **Wind speed** is generally relatively high in Montego Bay, a trend that has been increasing over the last 50+ years. However, wind speed is projected to decrease across the island.

- Mean daily **relative humidity** is currently around 70%, and is typically higher in the morning than in the afternoon. Relative humidity is projected to decrease by up to 4% annually. This decrease is anticipated to be most noticeable in the summer.

- Mean daily **sunshine hours** are 8.06, highest in April and lowest in September. A statistically significant increase in sunshine hours has been noted for the area and is expected to continue in the future.

# 3.0 Climate Change Impacts on the Sector: *Historical and Future Analysis of Indicators*

## 3.1 Outcomes of Analysis on Selected Sector Indicators

This section of the report presents the results of applying the proposed set of indicators to measure the destination attractiveness and vulnerability of Montego Bay. We present the historical and future analyses of some of the indicators for which there is data.

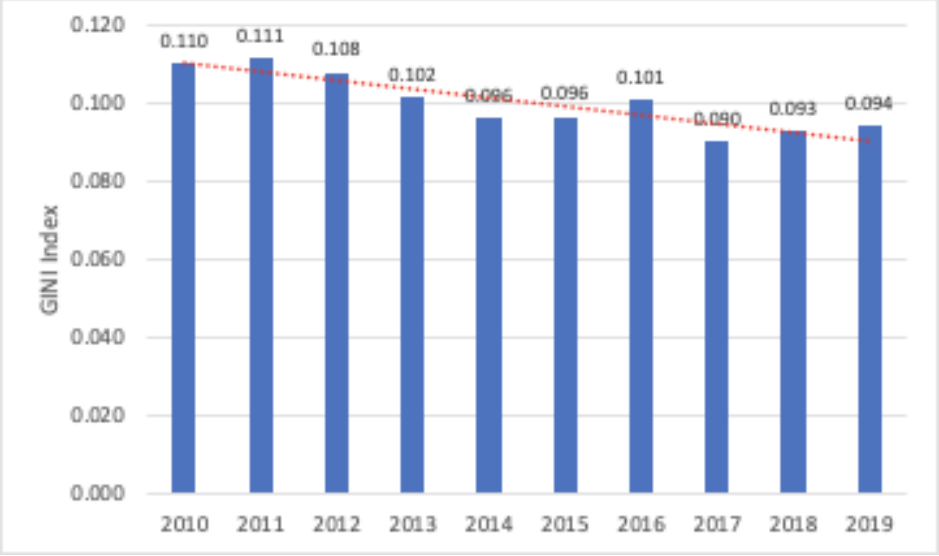
### 3.1.1 Historical Analysis of Climate Impacts on Tourism

### A. Tourism Demand

#### 1. Tourism Seasonality Index

To understand the recent seasonality of the tourism sector in Jamaica, JTB data on the number of international arrivals by month was used to calculate annual variance from 2010 to 2019 (Figure 6). Detailed data are not publicly available for specific destinations like Montego Bay.

Figure 6: Gini Coefficient for Seasonality of International Tourist Arrivals in Jamaica, 2010–2019



The trendline data shows an overall decline of the Gini coefficient between 2010 and 2019. This means that the seasonality of international stopover tourists during those years decreased and arrivals were more evenly distributed throughout the year. However, the Gini coefficient has increased since 2017, indicating an increase in seasonality. Destinations generally strive for less seasonality in arrivals in order to reduce the negative impacts (see Section 2.2, Subsection A.2 for a full discussion).

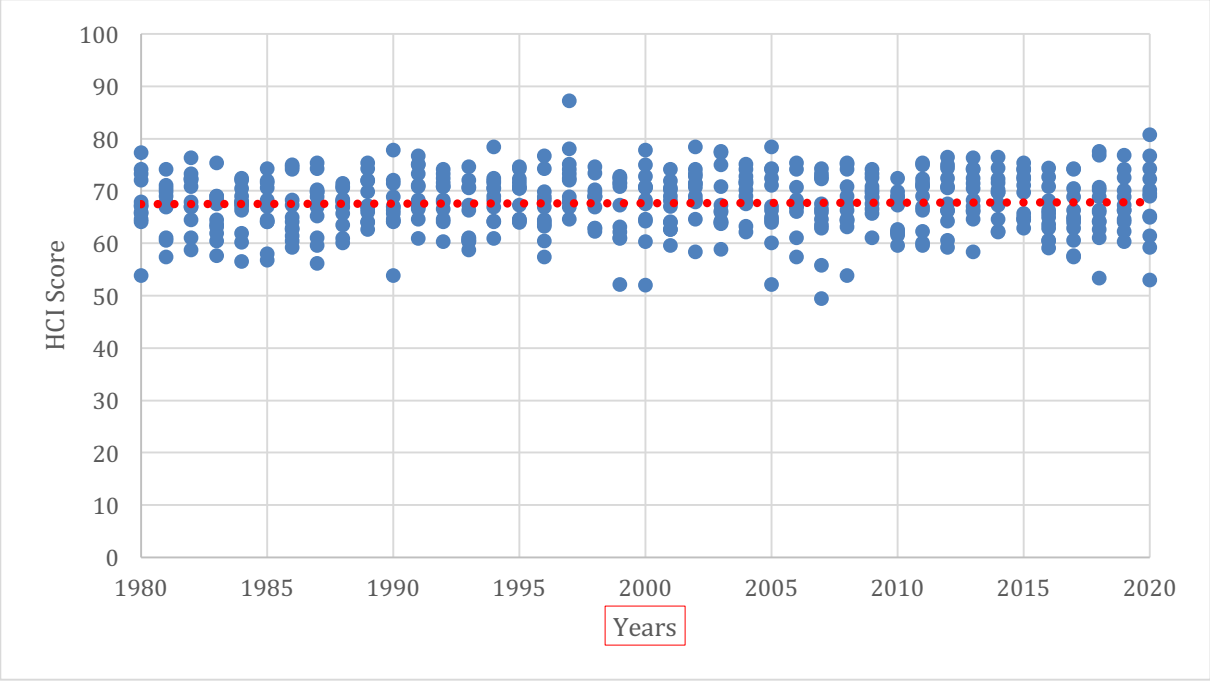
### 2. Holiday Climate Index: Beach

Historical data from 1980 to 2020 was used to calculate the HCI: Beach for Montego Bay. Given the geographical characteristics of Jamaica, the indicators used to calculate this index will vary by location. For example, mountainous destinations tend to have lower maximum temperatures and a higher percentage of daily cloud cover, which will affect the index score.

Figure 7 shows the HCI: Beach scores from1980 to 2020. The rating scale is:

- Impossible or dangerous: 0–19
- Unfavourable or unacceptable: 20–39
- Marginal to acceptable: 40–59
- Good to very good: 60–79
- Excellent to ideal: 80–100

Figure 7: Montego Bay HCI: Beach, 1980–2020



The trend line shows an increase of the HCI: Beach score from 1980 until 2009 and a slight decline thereafter. Table 10 shows the average score by decade.

Table 10: Montego Bay Average HCI: Beach Score, by Decade, 1980–2020

| Year Range | Average Score | HCI Rating |
|---|---|---|
| 1980 - 1989 | 67.02 | Good to very good |
| 1990 - 1999 | 68.21 | Good to very good |
| 2000 - 2009 | 67.93 | Good to very good |
| 2010 - 2019 | 67.56 | Good to very good |

Montego Bay remained in the "Good to very good" bracket from 1980-2020. However, while the HCI score went up from 1990-1999, it has been declining since then. This means that, based on the results of the Index, Montego Bay has become a slightly less attractive destination due to changes in the climate.

Figure 8 shows the fluctuation of the score by month. The lower scores in June, September and October coincide with the rainy seasons in Jamaica.

Figure 8: Montego Bay Average HCI: Beach, by Month, 1980–2020

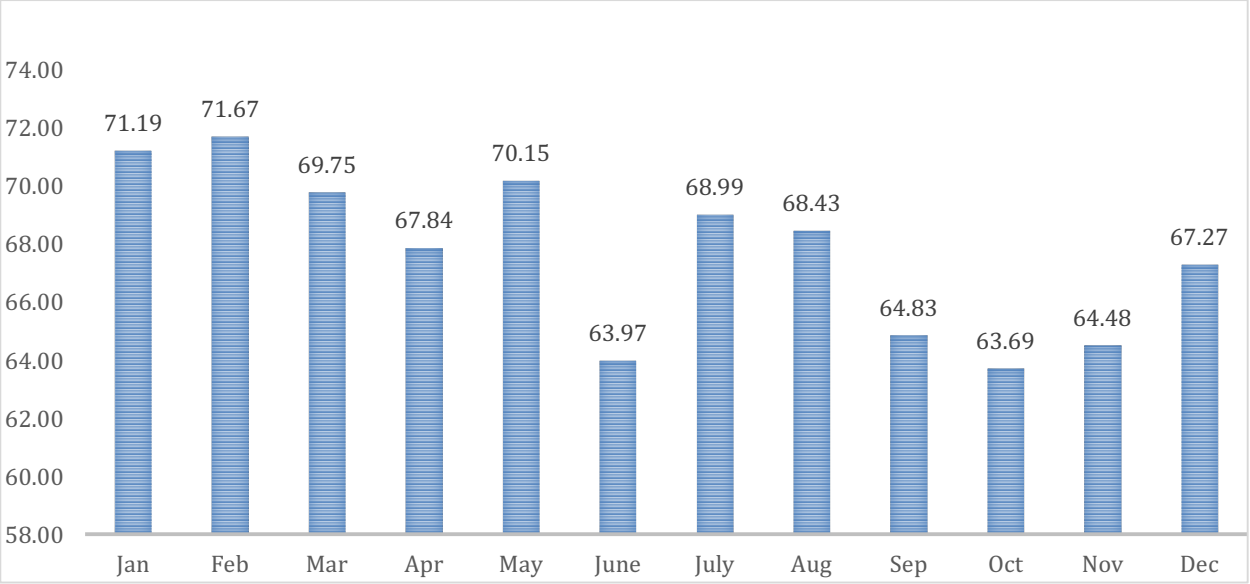
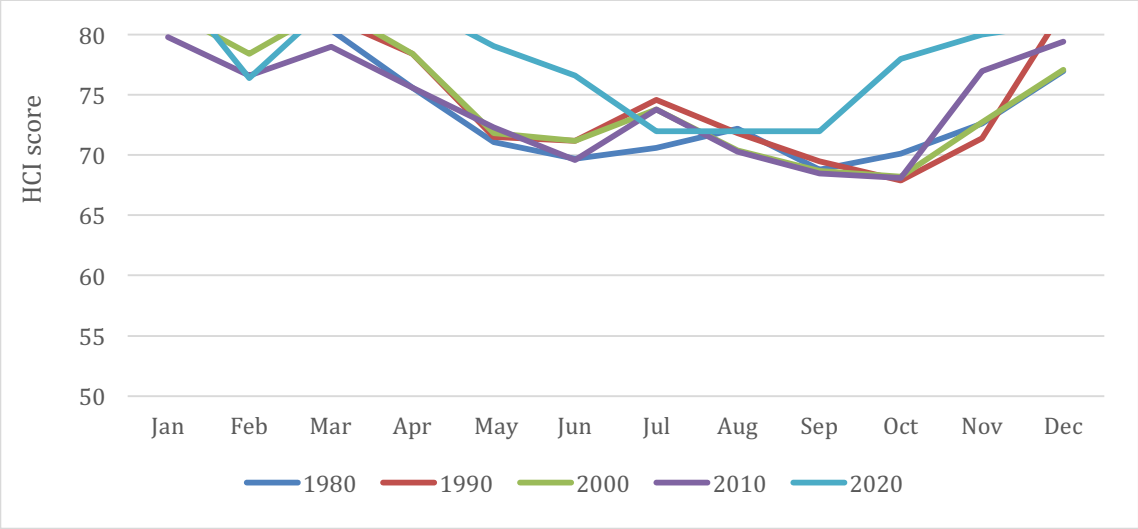


Figure 9 illustrates the HCI: Beach by month for 10-year intervals from 1980 to 2020. The index score is around 70 points—in the mid-range of the "Good to very good" bracket—during the winter months. However, during May and June, as well as October and November, the score drops into lower band of the "Good to very good" bracket.

Figure 9: HCI: Beach by 10-Year Intervals, by Month, 1980-2020




## B. Tourism Supply

For the six proposed indicators to measure destination attractiveness, the availability of historical data was variable (see Table 11).

Table 11: Availability of Historical Data for Destination Attractiveness Indicators for Montego Bay

| | Indicator | Availability of Data |
|---|---|---|
| Price of Destination | 1. Percentage change in share of energy and water consumption as part of overall operating costs of hotels in a beach destination | No historical data are readily available. Data would need to be collected from a representative sample of hotels in Montego Bay to establish a baseline, and changes tracked through periodic enterprise surveys. |
| | 2. Percentage change in insurance premiums and number of high risk areas in beach destinations where insurance is no longer available for the accommodation sector | Historical data could not be found from secondary sources such as the Insurance Association of Jamaica. |
| | 3. Percentage change in carbon taxes as a component of the average airfare from key source markets, where applicable | No historical data are available since there is no carbon tax on air travel from Jamaica's main source markets. |

| | Indicator | Availability of Data |
|---|---|---|
| Quality of Natural Resources | 4. Change in average percent coral cover in reefs in beach destination | Data are available. |
| | 5. Percentage change in incidents of coral bleaching that affect destination | Data are available. |
| | 6. Percentage change in annual beach erosion in beach destination | Data are available. |
| Visitor Risk Perception | 7. Change in score for Holiday Climate Index score (HCI: Beach) | Results presented in Section 3.1.1, Subsection A.2 of this report. |

### 1. Price of Destination

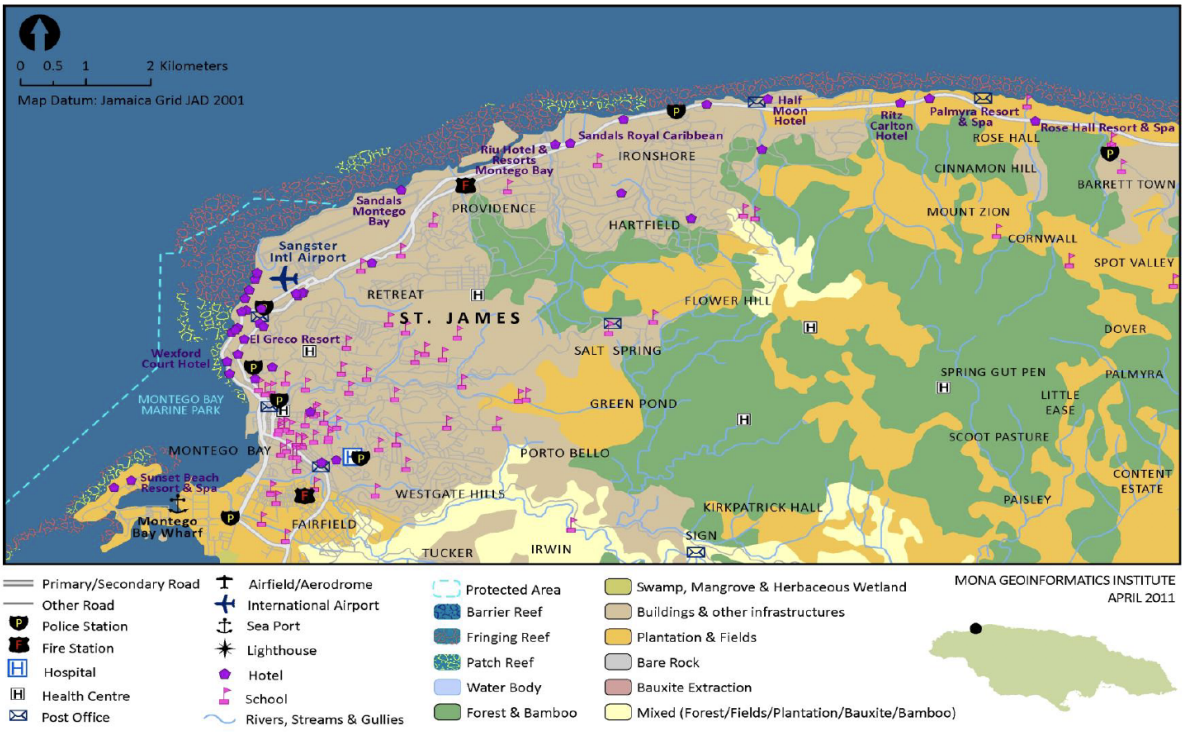
Currently, there is no historical information available to assess the change in energy and water consumption costs or in insurance premiums incurred by coastal hotels in Montego Bay as a result of changing climate. The Insurance Association of Jamaica may be the ideal partner to help establish baseline information.

There is some evidence (without historical data) that insurance premiums are increasing as a result of the increasingly destructive hurricane seasons that the Caribbean has experienced in recent years. In early 2020, the Insurance Association of Jamaica announced that it expects that property insurance rates will rise by 10%–15% in 2020 even though Jamaica has not been affected by any intense storms over the past few years (Murphy, 2020). This is because Caribbean insurers subscribe to a common reinsurance pool and international reinsurers are increasing their cost of coverage to the region to recover Caribbean losses incurred in prior years, such as the US$8 billion loss from Hurricane Dorian in 2019 and the US$90 billion in losses caused by Hurricanes Harvey, Irma, and Maria in 2017. Increases in regional reinsurance rates force local insurers to raise their rates in turn. The Insurance Association of Jamaica estimates that just over half of insurance premiums are used to buy reinsurance coverage for major catastrophes (Murphy, 2020).

### 2. Quality of Natural Resources

The Quality of Natural Resources is measured by the change in percentage change in incidents of coral bleaching, change in average percent of coral cover in reefs adjacent to Montego Bay, and percentage change in annual beach erosion in Montego Bay. Figure 10 shows the reefs and infrastructure in Montego Bay.

Figure 10: Montego Bay Reef and Infrastructure




*Source: Kushner et al., 2011.*

### a) Change in Average Percent Coral Cover

Aiken et al. (2014) drew from a wide range of previous past studies to calculate the average percent coral cover for the period from 1970 to 2010. Table 12 lists the studies used, and Figure 11 shows the data collection sites reported on in the studies as well as the results of these studies.

Table 12: Data Sources With Map Code Representing Individual Studies

| Map Code | Contributor | Location | Time Period | Year Count | Coral | *Diadema antillarum* | Macroalgae | Fishes |
|---|---|---|---|---|---|---|---|---|
| 3 | Cho & Woodley 2000 | Montego Bay, North Central Jamaica | 1994, 1997 | 2 | X | | X | |
| 5 | Dustan, Phil | Montego Bay, North Central Jamaica | 1972-1973 | 2 | X | | | |
| 9 | Hardt, Marah, Paredes, Gustavo | Montego Bay, North Central Jamaica | 2006 | 1 | X | | X | X |
| a | Hughes, Terry | 9 sites | 1977-1990, | 15 | X | X | X | |

| Map Code | Contributor | Location | Time Period | Year Count | Coral | *Diadema antillarum* | Macroalgae | Fishes |
|---|---|---|---|---|---|---|---|---|
| | | islandwide | 1993 | | | | | |
| c | AGRRA | 66 sites islandwide | 2000, 2005 | 2 | X | X | | X |
| d | Knowlton et al. 1990 | Montego Bay, North Central Jamaica | 1982, 1984-1987 | 6 | X | X | X | |
| h | Williams, Ivor; Polunin, Nicholas | Montego Bay, North Central Jamaica | 1997 | 1 | X | | X | X |

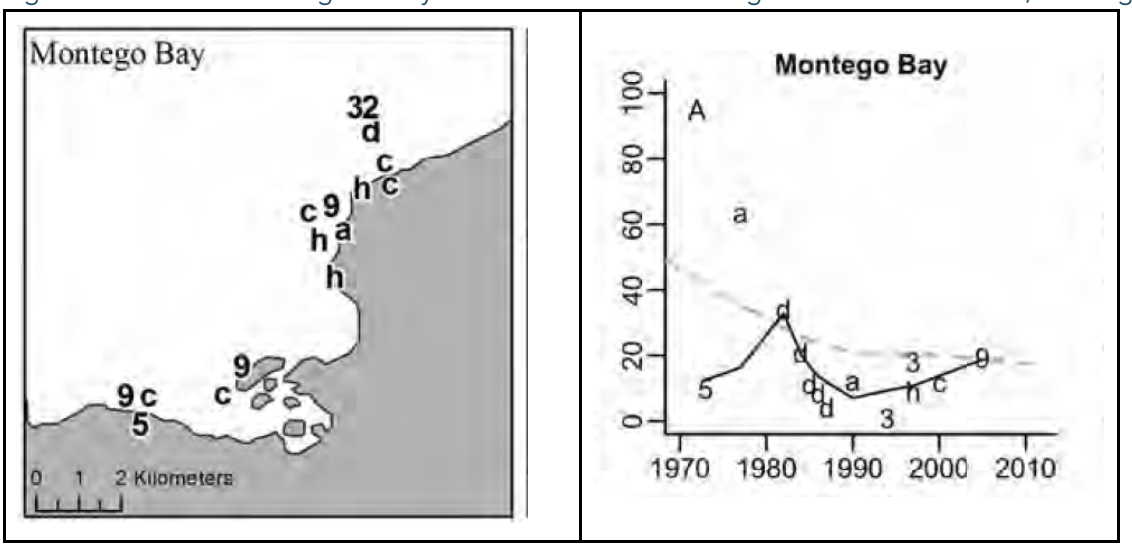
*Source: Aiken et al. (2014).*

Analysis of the trend data reveals a dramatic decrease in the average percent of coral cover—from 50% in 1970 to about 10% in 1990—in the reefs located in Montego Bay. This represented an 80% decrease over two decades.

Since 1990, the reefs have recovered slowly and the average percent change of coral cover continued to increase gradually—to about 11.27% in 2000 (Klomp, 2000). By 2010, the live coral cover of Montego Bay reefs was up to 15.42% (NEPA, 2011), an increase of 36.82% since 2000. Although improving, the percent live coral cover of reefs in Montego Bay was well below the 20% Caribbean regional average (NEPA, 2008).

NEPA's Coral Reef Health Index—which measures live coral cover, among other indicators—gave Montego Bay reefs a "poor" rating of 2.00 out of 5.00 in 2013, and a "fair" rating of 2.70 out of 5.00 in 2017 (NEPA, 2014; NEPA 2017). Ongoing threats to the reefs in Montego Bay include poor waste disposal, heritage clearance for hotel development, overfishing, hurricanes, and bleaching events.

Figure 11: Coral Monitoring Sites by Coded Studies and Average Percent Coral Cover, Montego Bay




*Source: Jackson, J. et al. (Eds), 2014.*

b) Percentage Change in Incidents of Coral Bleaching

Following is a timeline of coral bleaching events in Jamaica that were attributed to increased sea surface temperatures (Aiken et al., 2014):

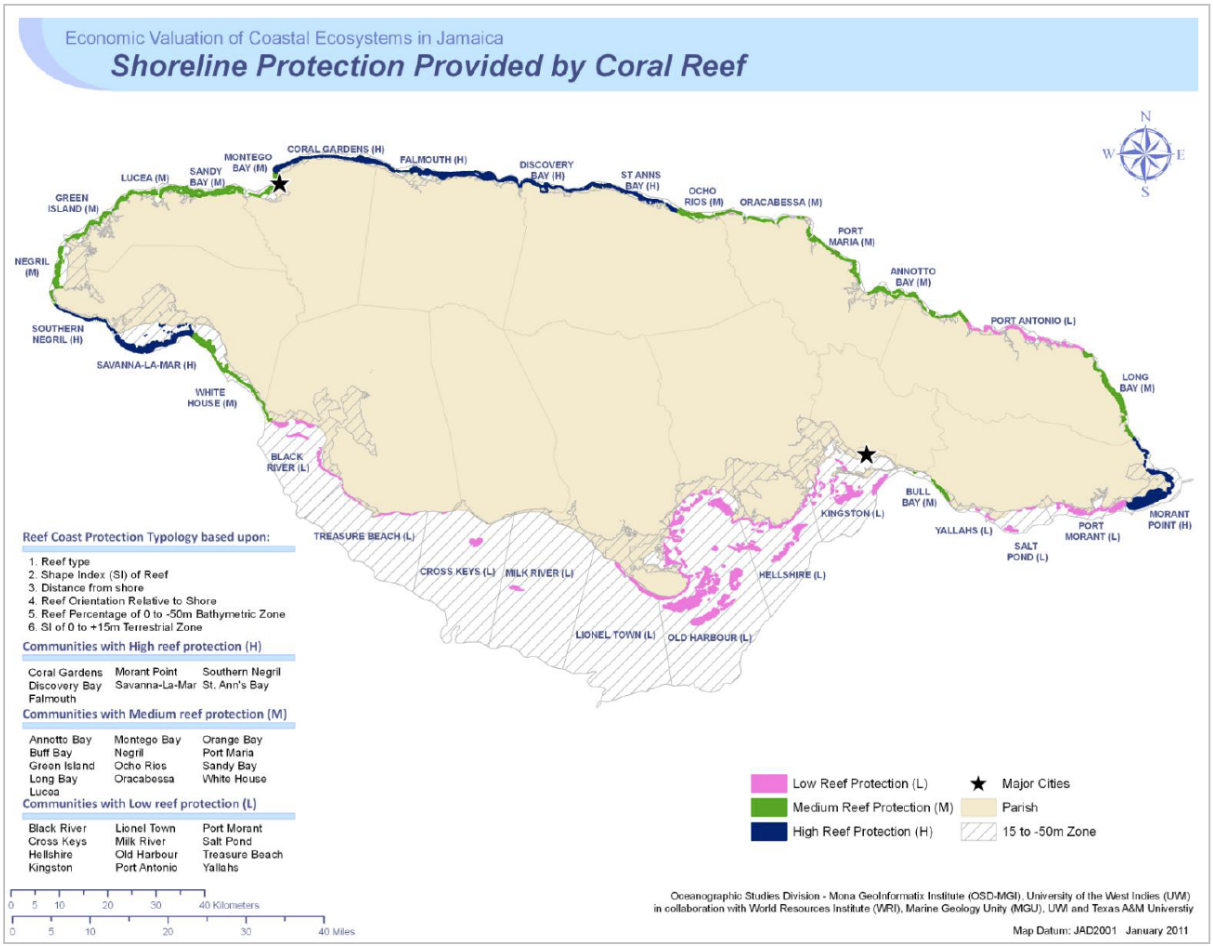
- 1963: Massive bleaching event along the south coast of the island
- 1987: Minor bleaching event
- 1995: Minor bleaching event
- 2000: Klomp (2002) found that bleaching was noted in 2.3% of all the coral colonies assessed in an island-wide study.
- 2005: Bleaching event affecting 45%–75% of coral cover
- 2010: Bleaching event affecting 18%–40% of coral cover

Coral colonies are under more stress and subject to mortality as a result of these incidents.

c) Percentage Change in Annual Beach Erosion

Reefs provide an important source of the white sand for beaches in Montego Bay. They also reduce erosion by dissipating wave energy, and decreasing flooding and wave damage during storms. Declines in reef health accelerate beach erosion. While historical data on beach erosion are not readily available for Montego Bay, Kushner et al. (2011) estimated a base (current) beach erosion rate of 0.3 m/yr (based on a similar estimate for Negril), Khan et al. (2010) estimated erosion at 0.23 m/yr and Smith Warner International Limited (2007) estimated 1 m/yr. Coral reefs in Montego Bay provide medium protection to this community (see Figure 12). Further reef degradation will accelerate rates of erosion.

Figure 12: Protection Provided by Coral Reefs and Their Associated Bathymetric Segments




*Source: Maxam et al., 2011.*

## C. Adaptation and Mitigation Strategies

The availability of historical data was variable for the proposed indicators application to Montego Bay (see Table 13). This section discusses adaptation and mitigation strategies existing for Montego Bay. This inventory of tourism-based GHG emissions and adaptation strategies being undertaken will provide baseline information to guide future actions.

There have been few studies that have developed a GHG inventory or undertaken significant mitigation analysis for the tourism sector specifically. Currently, there is no ongoing tracking mechanism nor any clear, consistent methodologies for calculation of tourism's impact. The IDB (2015) "One Bay for All" report, however, sought to prepare

an inventory of GHG emissions with projections based on current trends, and an alternative scenario in which mitigation measures are implemented. It used the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC), developed by the Local Governments for Sustainability (ICLEI), which allows the standard calcu-lation and reporting of GHG emissions. The study found that total (direct and indirect) per capita GHG emissions in Montego Bay in 2010 were 7.88 tonnes carbon dioxide equivalent (CO2e)/person, a level considered "yellow," or unsustainable but not critical, by the Emerging and Sustainable Cities Initiative (ESCI) indicator stoplight classification system. For the 2015 study, climate change mitigation as a whole was classified as "red" because of the lack of mitigation plans and the lack of emissions data prior to the ESCI study.

The study identified stationary units such as commercial buildings, mainly those associated with the tourism sector, as producing the greatest percentage of total emissions (26.86%). Contributions from aviation (11.66%) were also measured. Jointly, these two measures mark a significant contribution from tourism. According to the mitigation scenario projected for 2030, if the hotel sector applied various energy-saving strategies emissions would be reduced by 59,561 tonnes CO2e/year.

Mitigation measures proposed in the IDB (2015) study included recovery and destruction of meth-ane generated in the retirement landfill, generation of compost from organic waste, replacement of household appli-ances with energy-saving units, energy savings in the hotel sector, and conversion of taxis, cars, and vehicles under three tonnes from gasoline to natural gas.

This baseline study for Montego Bay can be used as a starting point for monitoring emissions in the tourism sector.

Table 13: Availability of Historical Data for Destination Vulnerability Indicators for Montego Bay

| | Indicator | Availability of Data |
|---|---|---|
| Tourism Enterprise-Level Action | 1. Percentage change in number of hotels implementing climate adaptation and mitigation actions, such as carbon dioxide offsets and low-energy systems | No historical data are available, but lists of Jamaican hotels that are Green Globe and EarthCheck are available online. The following six Montego Bay hotels are Green Globe certified: Half Moon, Hyatt Ziva and Hyatt Zilara Rose Hall, Royalton Blue Waters – Montego Bay, Royalton White Sands Resort, and The Tryall Club. The only EarthCheck-certified hotel in Montego Bay is Sandals Royal Caribbean. |
| | 2. Percentage change in energy consumption by hotels in a destination | Data are tracked by some hotels but there is no national repository or ongoing monitoring. |

| | Indicator | Availability of Data |
|---|---|---|
| | | Hotels that participate in voluntary environmental certification schemes are likely to have more data (see Indicator 1 in this table for a list of internationally certified hotels in Montego Bay). Baseline data from the IDB (2015) study for emissions from the Montego Bay tourism sector are available. |
| | 3. Percentage change in water consumption by hotels in a destination | Data are tracked by some hotels but there is no national repository or ongoing monitoring. Hotels that participate in voluntary environmental certification schemes are likely to have more data (see Indicator 1 in this table for a list of internationally certified hotels in Montego Bay). There are national reports that contain historical water demand data for the tourism sector, such as the Water Resources Master Plan 1990 and Water Resources Assessment 2001. Water demand of the tourism sector was 10 MCM/yr in 1985, 15 MCM/yr in 2000, and 23 MCM/yr in 2015. These data show an increasing trend in water consumption in the tourism sector. |
| Destination-Level Policies, Plans and Initiatives | 4. A destination plan exists, is publicly available, and addresses climate adaptation, mitigation, and disaster risk management, including natural disasters, health, resource depletion, and others appropriate to the location | Yes, there is a plan. The 2015 "One Bay for All: Sustainable Montego Bay" action plan fits this criteria. Historically there was no disaster risk management plan at the destination level, though there have been various hazard maps created and risk assessments conducted of the city. |
| | 5. Percentage of tourism accommodations, attractions, and transportation support infrastructure located in vulnerable zones | Historical data are available in Caribsave 2009 Montego Bay Report and the 2015 "One Bay for All: Sustainable Montego Bay" action plan, but do not specifically list the percentage of tourism infrastructure that is located in vulnerable zones. The plan notes that 80%–90% of public critical infrastructure is vulnerable to natural disasters. |
| Destination Attractiveness | Seven indicators presented in Section 3.1.1, Subsection B6. | Results presented in Section 3.1.1, Subsection B. |

### 3.1.2 Analysis of Future Climate Impacts on Tourism

## A. Tourism Demand

#### 1. Holiday Climate Index: Beach

When using the forecasting data for the RCP 8.5 scenario[1], we see that the HCI: Beach score continues to decline between 2019 and 2096. The HCI: Beach score is forecasted to drop from an average of 80 in 2020 to 72 by 2095 (Figure 13). The lower score is still in the "Good to very good" bracket, but the trend is worrisome. Closer examination of the score shows that the change in thermal comfort (TC), which is a combination of the maximum daily temperature and humidity, has the strongest effect on the predicted score.

Figure 13: HCI: Beach Estimates, 2019–2096

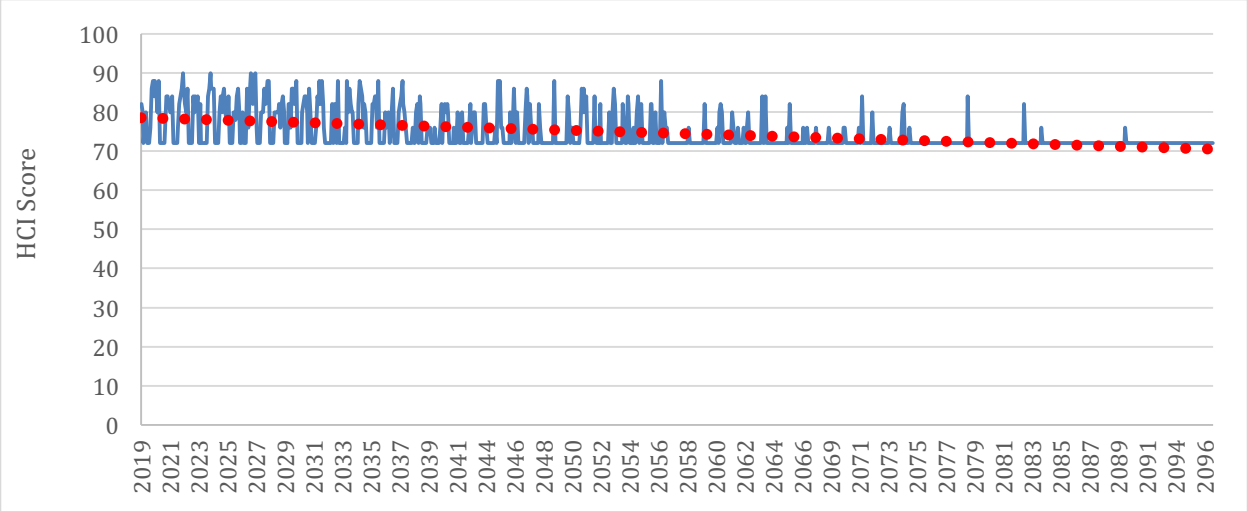



Table 14 shows the average HCI score per decade declining from 2030-2096.

[1] The RCP8.5 combines assumptions about high population and relatively slow income growth with modest rates of technological change and energy intensity improvements, leading in the long term to high energy demand and GHG emissions in absence of climate change policies.

Table14 Montego Bay Average HCI: Beach Score, by 10-Year Intervals, 2020- 2096

| Year Range | Average Score | HCI Rating |
|---|---|---|
| 2020 - 2029 | 79.03 | Good to very good |
| 2030 - 2039 | 77.38 | Good to very good |
| 2040 - 2049 | 74.68 | Good to very good |
| 2050-2059 | 74.58 | Good to very good |
| 2060-2069 | 72.96 | Good to very good |
| 2070-2079 | 72.58 | Good to very good |
| 2080 -2089 | 72.11 | Good to very good |
| 2090-2096 | 72.05 | Good to very good |

When reviewing scores by month for the decades 2020, 2030, 2040, 2050, 2060, 2080, and 2090 (Figures 14a and 14b), we see that seasonality becomes less pronounced and that June, July, August and September show a much less desirable climate for tourists than the rest of the year.

Figure 14a: Montego Bay Average HCI: Beach, by Month, 2020-2090

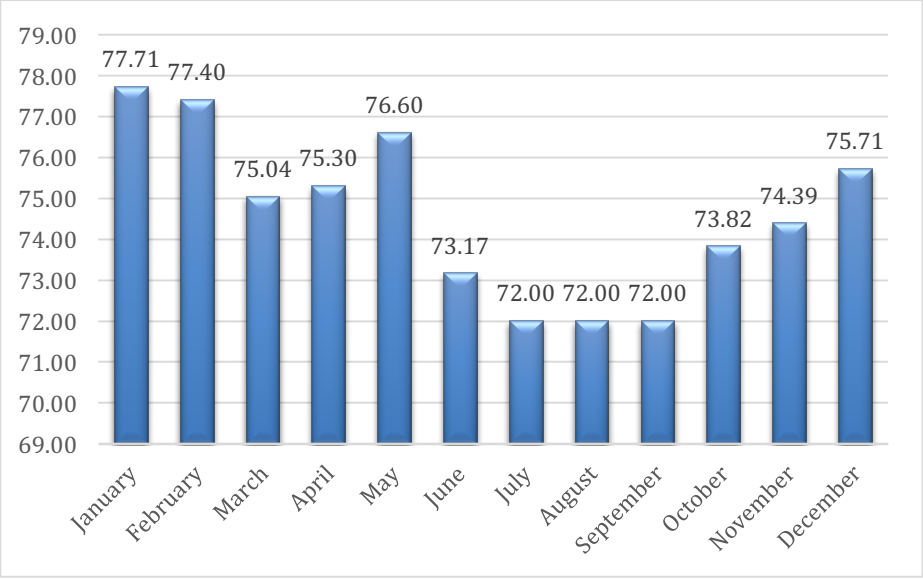
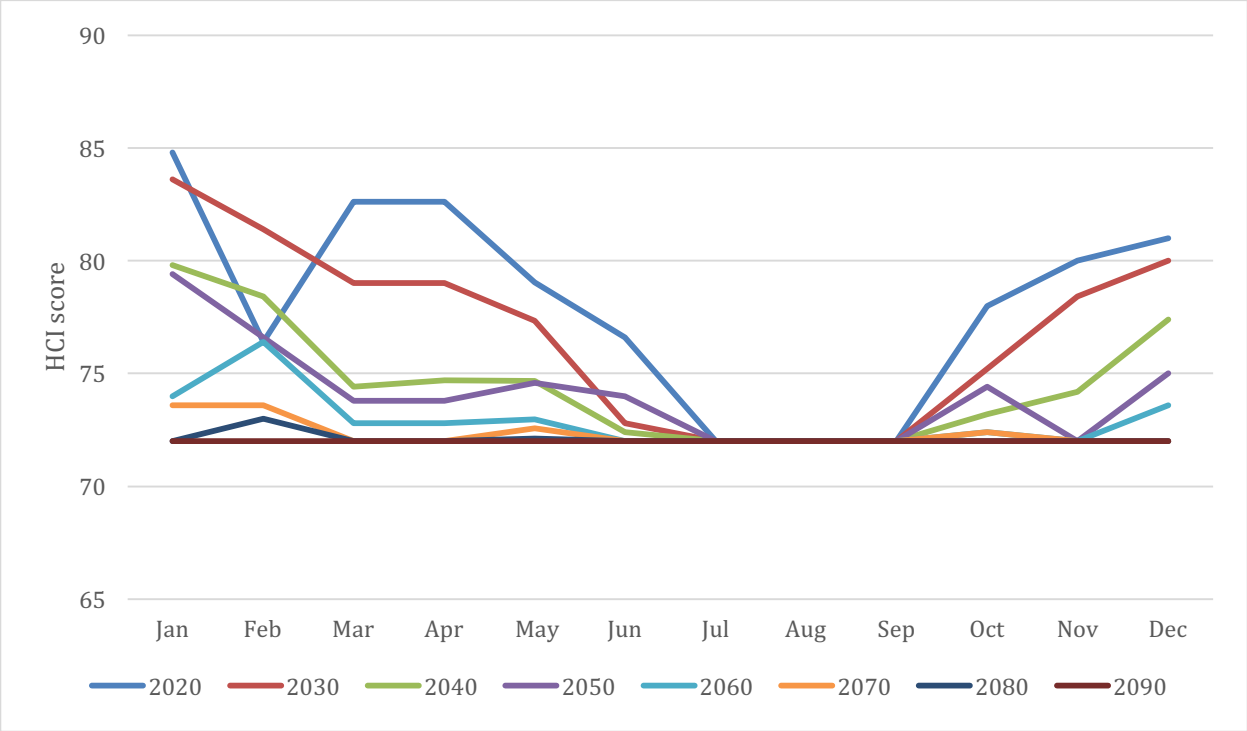


Figure 14b: HCI: Beach Estimates by Month, 10-Year Intervals, 2020–2090




### 2. Tourism Seasonality Index

The results of the monthly HCI: Beach show that there will be less difference in the weather during the year but that conditions during the summer months become very unattractive for beach tourism, with temperatures in the upper 40s Celsius. While only July and August are currently affected by increased TC, towards the end of this century this period will extend from June to October. Under these conditions, the summer months will likely become unattractive for visitors from current source markets such as North America and Europe.

## B. Tourism Supply

The availability of data to help predict changes to Destination Attractiveness is quite limited (see Table 15).

Table 15: Availability of Future Data for Destination Attractiveness Indicators for Montego Bay

| | Indicator | Availability of Data |
|---|---|---|
| Price of Destination | 1. Percentage change in share of energy and water consumption as part of overall operating costs of hotels in a beach destination | No data are readily available for projections. Data will need to be collected from a representative sample of hotels in Montego Bay to establish a baseline, and |

| | Indicator | Availability of Data |
|---|---|---|
| | | changes tracked through periodic enterprise surveys. |
| | 2. Percentage change in insurance premiums and number of high risk areas in beach destinations where insurance is no longer available for the accommodation sector | Limited regional projections available. |
| | 3. Percentage change in carbon taxes as a component of the average airfare from key source markets, where applicable | No data are available, since there is no timeline for carbon taxes on air travel from Jamaica's main source markets. |
| Quality of Natural Resources | 4. Change in average percent coral cover in reefs adjacent to the destination | No projections of coral cover in reefs adjacent to Montego Bay were found. |
| | 5. Percentage change in incidents of coral bleaching | Limited regional projections are available for coral bleaching. |
| | 6. Percentage change in annual beach erosion in the beach destination | Limited data are available. |
| Visitor Risk Perception | 7. Change in HCI: Beach score | Results presented in Section 3.1.2, Subsection A.1 of this report. |

### 1. Price of Destination

Of the three proposed indicators identified to measure change in the price of vacationing in Montego Bay based on destination-level climate change forecasts, only regional projections regarding increases in insurance premiums are available. The Association of British Insurance estimates that insurance premiums in the Caribbean could increase by 20%–80% by 2050 (Dlugolecki, 2004). Private insurance may no longer be available in high risk areas, forcing governments to provide coverage or decelerate development in these areas (Caribsave, 2012).

Efforts should be made to partner with the Insurance Association of Jamaica to develop historical and projected estimates of percentage change in insurance costs for coastal hotels and resorts to more effectively track changes in this operating expense that will influence the price of accommodation in the destination—and ultimately the price of the destination and its competitiveness.

### 2. Quality of Natural Resources

There are some data available to predict percentage change in annual beach erosion in Montego Bay as well as change in average coral cover in reefs adjacent to this destination.

#### a) Change in Average Percent Coral Cover

While there are no predictions for percent change in live coral cover in reefs in Montego Bay, in general reefs in Montego Bay may remain degraded, as many human-induced and natural stresses persist. The projected sea level rise and intensity of hurricanes attributed to climate change are expected to exacerbate the impact of degrading reef structures.

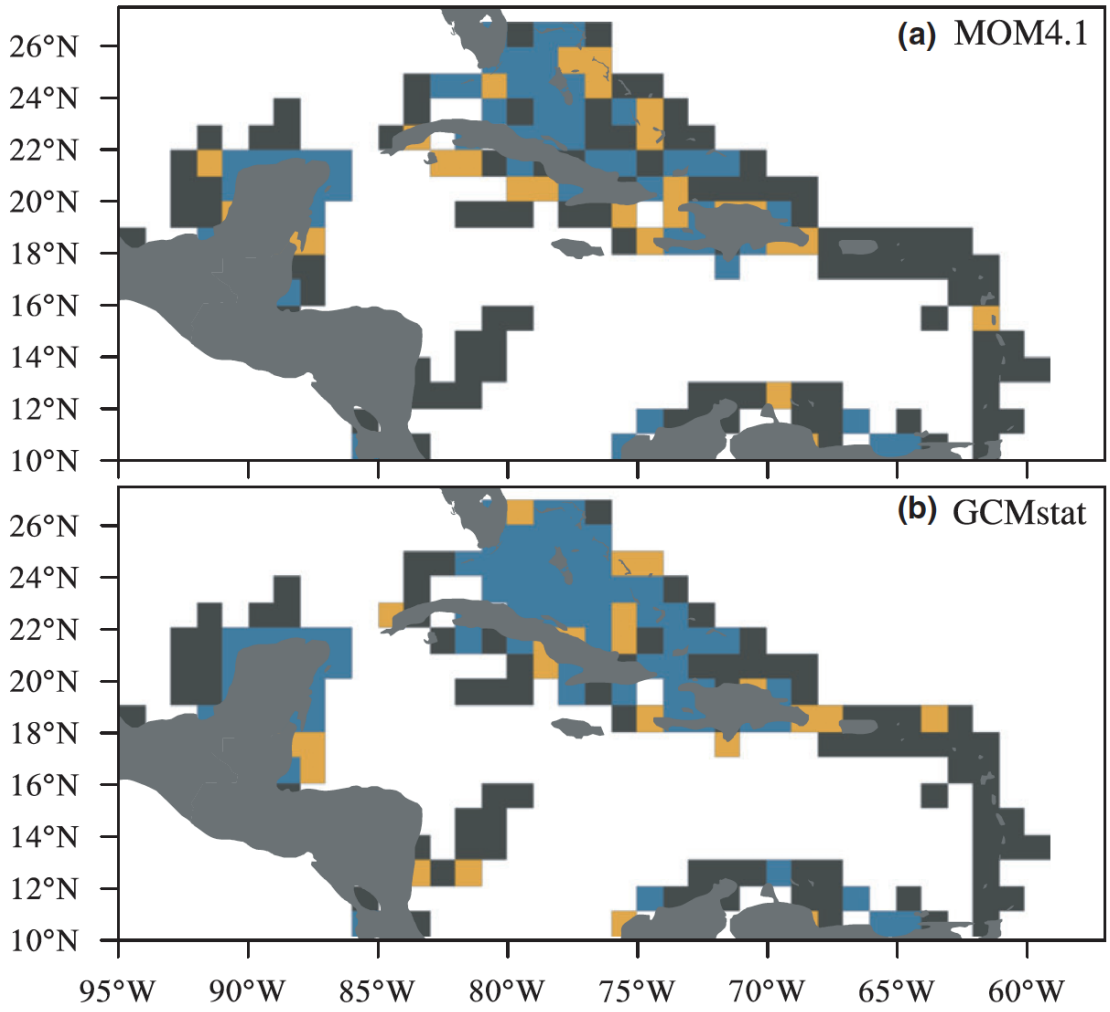
#### b) Percentage Change in Incidents of Coral Bleaching

Global and regional studies do provide predictions for the onset of annual severe bleaching (ASB) which is "a point in which reefs are certain to change and recovery will be limited" (UNEP, 2017, p. 5). The extent to which the ASB predictions will affect reefs in Montego Bay is much less clear.

Van Hooidonk et al. (2015) produced downscaled projections of Caribbean coral bleaching which predict the onset of ASB using two downscaling approaches. The results of their analysis follow:

- Dynamical downscaling (Figure 15a): 0–10 years, 56% of sites in the region; 10–15 years, 15%; >15 years, 29%.
- Statistical downscaling (Figure 15b): 0–10 years, 49% of sites in the region; 10–15, 13%; >15 years, 38%.

Figure 15: Projected Ranges in the Onset of Annual Severe Bleaching Conditions

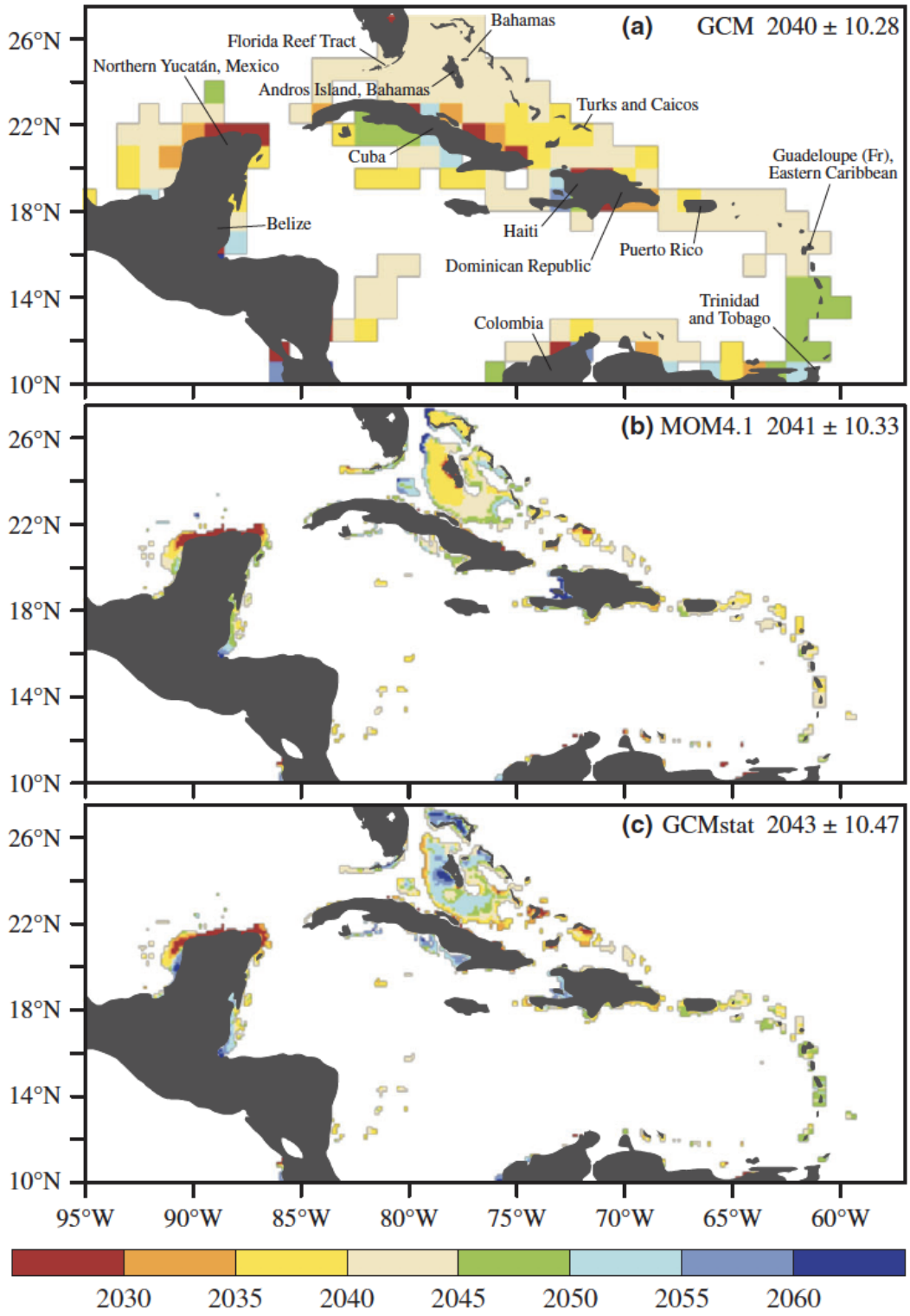



Dark grey, orange, and blue correspond to a range <10, 10–15, >15 years, respectively.
*Source: Van Hooidonk et al., 2015*

The average year for the onset of annual severe bleaching (ASB) projected using the Global Climate Model (GCM) ensemble is 2040 ±10.28 (see Figure 16a), and 2041 ±10.33 (see Figure 16b) using the dynamic downscaling approach. These are very similar results.

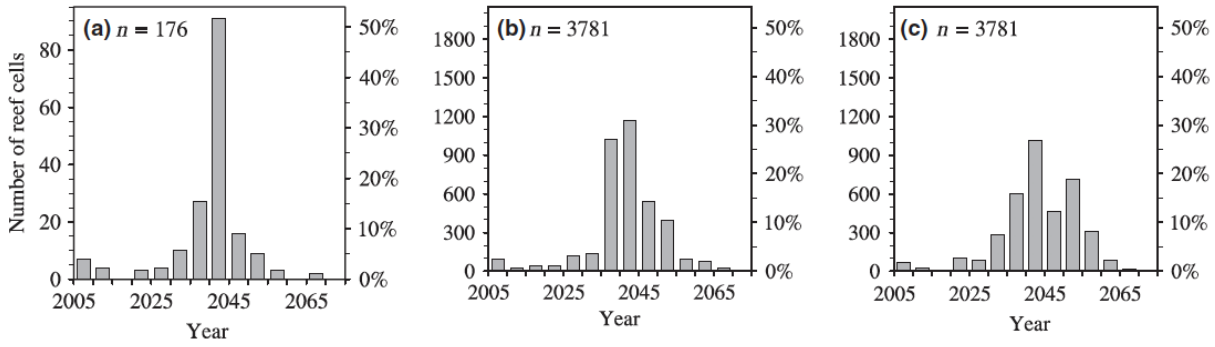
The GCM model estimates that 76.14% of reef locations will begin experiencing ASB between 2035 and 2050 (see Figure 17a), while the dynamic downscaling model indicates that 72.41% of reef locations have a projected timing for the onset of ASB between 2035 and 2050 (Figure 17b). Furthermore, the dynamical downscaling model estimates that more than 15% of reef locations are projected to experience ASB after 2050, representing twice that seen in the GCM projections (7.95%; see Figure 17a).

Figure 16: Projected Timing for the Onset of Annual Severe Bleaching for Various Models




*Source: Van Hooidonk et al., 2015*

Figure 17: Histograms Showing the Distribution of the Data Presented in Figure 16*




*Labels here and in Figure 16 match, (a) GCM, (b) MOM4.1, (c) GCMstat.
*Source: Van Hooidonk et al., 2015*

These findings indicate that most of the Caribbean, including Jamaica, could experience the onset of ASB between 2035 and 2050.

### c) Percentage Change in Annual Beach Erosion

A study that assessed predicted beach loss in Montego Bay over a 10-year period confirmed significant increases in erosion due to further degradation of coral reefs (Kushner et al., 2011). They estimated that beach loss over 10 years could increase more than 50%, or 4.6 metres, compared to a 3-metre loss of beach if the reef remains in its current condition. The beach erosion rate could increase from 0.3 m/yr to 0.48 m/yr over 10 years, representing a 60% increase. The study concluded that beach erosion due to reef degradation will reduce visitor demand, and increase the costs from beach engineering solutions, such as beach replenishment.

Table 16: Model Results Predicting the Impact of Reef Degradation on Beach Loss

| Montego Bay | Wave height (m)<br>$H_o$ is the initial wave height with the reef intact, and H is the wave height for each period after all corals die | % increase in wave height | % increase in erosion relative to current<br>$\left[\left(\frac{H}{H_o}\right)^{2.5} - 1\right] * 100$ | Beach loss (in meters)<br>(This erosion rate includes the current (base) erosion rate of 0.3 m/yr) |
|---|---|---|---|---|
| Current (live coral cover = 15%) | $H_o$ =.344 | - | - | - |
| No live coral (bottom friction is reduced) | H=.398 | 15.7 | 44.0 | - |
| Year 1 (erosion of the reef substrate begins) | H=.400 | 16.3 | 45.8 | .44 |
| Year 2 | H=.401 | 16.6 | 46.7 | .44 |
| Year 3 | H=.403 | 17.1 | 48.5 | .45 |
| Year 4 | H=.405 | 17.7 | 50.4 | .45 |
| Year 5 | H=.406 | 18.0 | 51.3 | .45 |
| Year 6 | H=.408 | 18.6 | 53.2 | .46 |
| Year 7 | H=.410 | 19.2 | 55.1 | .47 |
| Year 8 | H=.411 | 19.5 | 56.0 | .47 |
| Year 9 | H=.413 | 20.1 | 57.9 | .47 |
| Year 10 | H=.415 | 20.6 | 59.8 | .48 |
| **Sum** | | | | **4.6** |

*Source: Kushner et al., 2011.*

## C. Adaptation and Mitigation

The availability of data to help predict changes to Destination Vulnerability, including tracking changes in emissions, is more limited (see Table 17). However, previous baseline studies for tourism-based emissions in Montego Bay can be utilised to inform methodology for future calculations. The National Framework currently measures GHG contributions for some sectors and should seek to include measurements for the tourism sector directly. This will be supplemented and validated by mitigation actions and data collection by enterprises that monitor and measure energy use and water consumption.

Table 17: Availability of Future Data for Destination Vulnerability Indicators for Montego Bay

| | Indicator | Availability of Data |
|---|---|---|
| Tourism Enterprise-Level Action | 1. Percentage change in number of hotels implementing climate adaptation and mitigation actions, such as carbon dioxide offsets and low energy systems | No projections on how many hotels will be implementing climate change adaptation and mitigation efforts. Vision 2030 does prioritize the implementation of sustainable practices, mitigation measures, and environmental management systems by tourism entities. |
| | 2. Percentage change in energy consumption by hotels in a destination | Data are tracked by some hotels but there is no national repository or ongoing monitoring. Hotels that participate in voluntary environmental certification schemes are likely to have more data. See "Hotel Actions" in Table B for a list of internationally certified hotels in Montego Bay. Future work can build on the baseline data in the IDB (2015) study that sought to measure GHG emissions from tourism in Montego Bay. |
| | 3. Percentage change in water consumption by hotels in a destination | Data are tracked by some hotels but there is no national repository or ongoing monitoring. Hotels that participate in voluntary environmental certification schemes are likely to have more data. There are national reports that contain projections for water demand for the tourism sector, such as the Water Resources Master Plan 1990 and Water Resources Assessment 2001; however, these projections are now outdated. It is unclear whether new or more updated projections for the tourism sector have been made publicly available. |
| Destination-Level Policies, Plans, and Initiatives | 4. A destination plan exists, is publicly available, and addresses climate adaptation, mitigation, and disaster risk management, including natural disasters, health, resource depletion, and others appropriate to the location | There is the current "One Bay for All: Sustainable Montego Bay" plan, but no indication of a future plan. The current plan stresses the need for the future development of a planning and disaster risk management unit. |
| | 5. Percentage of tourism accommodations, attractions, and transportation support infrastructure located in vulnerable zones | Projections are available in Caribsave 2009 Montego Bay Report and the 2015 "One Bay for All: Sustainable Montego Bay" action plan for total infrastructure located in vulnerable zones and likely inundation. In Montego Bay, 72% of airport land and facilities are projected to be inundated over the 25 year storm surge return period and approximately 92% are projected to be inundated over the 50 year period. |
| Destination Attractiveness | Seven indicators presented in Section 3.1.2, Subsection B6. | Results presented in Section 3.1.2, Subsection B |

## 3.2 Recommendations for a Tourism & Climate Change Monitoring Framework

The monitoring framework proposed for tracking climate change impacts on tourism destinations in Jamaica will require public-private partnerships. Following are the core partners.

**Ministry of Tourism (MOT).** MOT will oversee the monitoring system through its climate change focal point in collaboration with the Tourism Product Development Co. Ltd. (TPDCo).

**University of the West Indies Climate Science Group, Mona (CSGM).** CSGM will prepare destination-specific climate modelling profiles for all major tourism destinations in Jamaica based on the collective of indicators proposed in this report.

**Jamaica Hotel and Tourism Association (JHTA).** JHTA is a key partner in the surveying of tourism enterprises in local destinations throughout the island. They can facilitate access to member enterprises for surveys focused on energy and water consumption, for instance.

**Insurance Association of Jamaica (IAJ).** IAJ can provide data on insurance costs for hotels in Jamaica.

**Jamaica Vacations Ltd (JamVac).** JamVac can provide airfare costs monitoring data related to potential future carbon taxes charged on airfare to Jamaica from key source markets.

**The Energy Division of the Ministry of Science, Energy and Technology.** The Energy Division of the Ministry can support the process of assessing energy consumption trends of hotels in tourism destinations in Jamaica.

**Water Resources Authority (WRA) and National Water Commission (NWC).** The WRA and NWC can support the process of assessing water consumption trends of hotels in tourism destinations in Jamaica. They can also help monitor water costs for the tourism sector over time.

**National Environment and Planning Agency (NEPA).** NEPA can provide important data on the quality of natural resources in coastal tourism destinations, which can inform indicators such as coral cover, bleaching events, and beach erosion.

**Jamaica Tourism Board.** Changes in the natural environment, including weather, can directly impact tourism satisfaction and thereby demand. It is recommended that the JTB annual visitor satisfaction survey be expanded to include questions that directly relate to elements that are impacted by climate change. These questions should be measured during different times of the year. Survey questions could include:

1) How would you rate the temperature during your stay? (5-point scale ranging from too cold to too hot).
2) How would you rate the quality of the coral reef? (rating from 1 to 10)
3) How would you rate the quality of the beach? (rating from 1 to 10)

To measure the indirect impact of climate change on tourist satisfaction with the destination, future JTB surveys could assess visitor satisfaction with the quality of natural resources, particularly beaches (asking about beach erosion and sargassum seaweed), marine activities such as diving, and other visible impacts of climate change on the environment.

A Climate and Tourism Monitoring Working Group could be established to share management of the proposed monitoring system. This working group should meet at least twice a year. The Tourism Enhancement Fund (TEF) could be a potential source of funding to cover monitoring costs such as data collection, analysis, and reporting at the local destination and national levels.

## 3.3 Mitigating Climate Change Impacts on Tourism in Jamaica

Jamaica is a small island with mountainous inland areas and narrow coastal plains, which contain the highest concentration of locals, tourists, and tourism infrastructure. With this in mind, the Jamaican government must prioritise mitigating, minimising, and monitoring the impacts of climate change on its tourism sector.

### 3.3.1 Recommendations for Climate Change Adaptation

How can destinations like Jamaica adapt to a changing climate and increase their adaptive capacity? Burki et al. (2003) suggest four adaptation options for coastal and mountain destinations that can be adjusted and applied to Jamaica:

1. maintain existing coastal infrastructure with adjustments (building codes, set back limits, increasing insurances, etc.);
2. find alternatives to beach tourism (inland, cultural heritage, and community-based tourism);

3. close down the industry completely or operate "business as usual"; and/or
4. subsidise at-risk tourism enterprises.

Options 3 and 4 are not feasible in the near term given limited resources, the importance of the tourism sector, and the significant physical and economic impacts that climate events have already had on Jamaica. Options 1 and 2 are therefore the recommended courses in the short and medium-term. Possible adaptation measures that align with these two options follow.

Table 18 addresses possible adaptation measures and barriers to implementation for coastal and small island tourism sectors based on international best practices in climate change adaptation. In addition to these measures, an integrated policy framework is essential for the effective implementation of climate change adaptation across a destination. There must be coordinated and ongoing effort among ministries, departments and agencies for the mainstreaming of climate change adaptation and sustainable development (UNWTO & UNEP, 2008).

Table 18: Possible Adaptation Measures for Tourism in Small Island Countries

| Adaptation Measures | Relevance to Tourism | Barriers to Implementation | Measures to Remove Barriers |
|---|---|---|---|
| **"Soft" coastal protection to prevent erosion** | Many valuable tourism assets at growing risk from coastal erosion | Lack of credible options that have been demonstrated and accepted | Demonstration of protection for tourism assets and communities |
| **Enhanced design, siting standards and planning guidelines for tourism establishments** | Many valuable tourism assets at growing risk from climate extremes | Lack of information needed to strengthen design and siting standards | Provide and ensure utilisation of targeted information |
| **Improved insurance cover** | Growing likelihood that tourists and operators will make insurance claims | Lack of access to affordable insurance and lack of finance | Ensure insurance sector is aware of actual risk levels and adjusts premiums |
| **Shade provision and crop diversification** | Additional shade increases tourist comfort | Lack of awareness of growing heat stress for people and crops | Identify, evaluate, and implement measures to reduce heat stress |
| **Reduce tourism pressures on coral** | Reefs are a major tourist attraction | Reducing pressures without degrading | Improve off-island tourism waste |

| Adaptation Measures | Relevance to Tourism | Barriers to Implementation | Measures to Remove Barriers |
|---|---|---|---|
| | | tourist experience | management |
| **Water conservation: desalination, rainwater storage, wastewater recycling, etc.** | Tourist resorts are major consumers of freshwater | Lack of information on future security of freshwater supplies | Provide and ensure utilization of targeted information |
| **Tourism activity/product diversification** | Need to reduce dependency of tourism on "sun, sea, and sand" | Lack of credible alternatives that have been demonstrated and accepted | Identify and evaluate alternative activities and demonstrate their feasibility |
| **Education/awareness raising** | Need to motivate tourism staff and tourists | Lack of education and resources that support behavioural change | Undertake education/ awareness programmes |

*Source: Becken & Hay (2007); UNWTO et al. (2008)*

Caribsave (2012) developed a Climate Change Risk Profile for Jamaica that recommends the following adaptation measures for Jamaica's tourism sector:

1. **Mainstream climate change adaptation in policy, planning, and practice** through awareness campaigns, information sharing, planning and design, implementation and evaluation.

2. **Integrate SLR considerations in local land use and development planning, with special consideration for vulnerable coastal areas and tourism hot spots to reduce or avoid impacts.** Key activities include but are not limited to:
    a. Storm surge mapping
    b. Developing local coastal protection systems
    c. Assessing risk of all infrastructure development, modification, and maintenance projects in coastal areas
    d. Analysing vulnerability of secondary and tertiary economic impacts of damages to tourism sector due to SLR
    e. Conducting further analysis of the impacts of SLR for tourism infrastructure and identifying where development can retreat to in response to SLR
    f. Working with insurance companies to develop policies that consider unique coastal risks

g. Providing subsidies for the implementation of adaptation measures that will result in long-term benefits for the sector and the local community

3. **Use regulation to stimulate changes and adaptation and create incentives for low-carbon technology use**. Possible measures include carbon pricing, building codes, and other minimum standards for emission reduction, ecological tax reform, bonus-malus systems, and other financial support and rewards mechanisms.

4. **Assess the possibility of broad-scale implementation of wastewater recycling schemes and legislation**. Collaboration between the National Water Commission, National Irrigation Commission, and private tourism sector is essential to ensure that the water supply system is effectively monitored and adaptation measures are enforced.

5. **Generate a more sustainable (organic and local) food supply that can be used for tourism while providing sustainable livelihoods that can adapt to changing agricultural conditions.** Facilitate and strengthen the linkages between the agriculture and tourism sectors to advance sustainable food production and national food security adaptation. This can be achieved through an integrated production and protection management protocol for cultivation of high-yielding varieties of fruits and vegetables for supply to the local hotel and restaurant sector.

6. **Expand early warning systems to incorporate more technologies (cell phones, media tools, etc.) so that information is widely and equally dispersed.**

7. **Build a "culture of resilience" into the tourism industry that also integrates the tourists.** Operational and infrastructural changes for resilience include but are not limited to: reducing the use of electricity and water, better managing solid waste disposal, installing water catchment tanks, reducing or eliminating cutting down of trees, cleaning drains on a regular basis, and incorporating infrastructural improvements to prevent or minimise impacts and damage due to extreme climate-related events.

### 3.3.2 Recommendations for Climate Change Mitigation

There is a need to target mitigation strategies at key subsectors of tourism such as air travel, car transport, and accommodation (UNWTO & UNEP, 2008). International and domestic flights, cooling in the accommodation sector, cruise ships, and other tourist activities have been singled out as significant contributors.

Mitigation efforts within the tourism sector must therefore address mechanisms to reduce and ultimately eliminate fossil-fuel-based energy consumption and GHG emissions from the activities within the tourism value chain at the destination and tourism enterprise levels. UNWTO (2008) suggests four major mitigation strategies for addressing GHG emissions from tourism: 1) reducing energy use, 2) improving energy efficiency through new technologies, etc., 3) increasing the use of renewable energy, and 4) sequestering carbon through sinks.

The Third National Communication of Jamaica to the United Nations Framework Convention on Climate Change (2018) summarises mitigation actions for Jamaica. While not singling out the tourism sector, it itemises actions at the level of residential (relevant for community tourism) and commercial buildings, industry, transport, electricity production, agriculture, waste, and wastewater for which various mitigation actions have been planned or have the potential for inclusion in future plans. Use of solar hot water, LED and fluorescent lighting, increased co-generation, natural gas buses, SMART LED lighting, blending, reduced water and electricity distribution loss, and utility-scale wind and solar power are among some of the mitigation actions planned and proposed that can be appropriated, and have been in many instances, by Jamaica's tourism sector. Installation of LED and fluorescent lighting, installation of water-saving devices, and use of solar heating technologies are just a few initiatives that have been applied in some of Jamaica's tourism enterprises.

There have also been numerous recommendations regarding engaging visitors in reforestation projects with associated geo-referencing of trees planted to support sequestering through carbon sinks. Some properties have sought to implement some of these initiatives through adopting voluntary standards such as Green Globe certification. Environmentally certified tourism enterprises now consider emissions reduction measures an integral part of sustainable tourism development (Zeppel & Beaumont, 2014). Destination managers and planners, tourists, and tour operators all have a role to play in mitigation action. Tour operators may try to influence behaviour of tourists by encouraging travel on environmentally friendly airlines and offering carbon offset options and carbon-smart tourism products (UNEP, 2008).

Various funding mechanisms have been instituted to support adoption of renewable technologies in the sector. The United States Agency for International Development (USAID), through the Environmental Audits for Sustainable Tourism (EAST) Project in 2012, supported energy audits in the hotel sector. The TEF has provided loan facilities

to support retrofitting of tourism enterprises, with little uptake. Efforts should be made to encourage tourism enterprises to take advantage of this programme.

Tax-based instruments may impact traveller destination choice. Taxation on long-haul travel has been proposed as a mitigation measure. Small tourism-based economies who may rely on long-haul travellers can implement strategies to encourage longer stays. Carbon tax regimes that do not seem to support long-haul travel could prove challenging for small Caribbean states that rely on tourists from both near and distant markets. Encouraging longer stays, visits to more destinations in the region, and engagement in carbon offset schemes are mechanisms that can still attract the "green traveller".

Caribsave (2009) suggests adoption of a mitigation spiral approach towards carbon neutrality that should have cost savings for businesses. It argues that savings to businesses, along with a sustained approach towards carbon neutrality and "greening" the destination, will encourage commitment by the individual business owners. Zeppel and Beaumont (2014) posit that the key motives for tourism operators implementing carbon actions are related to ecological responsibility and business competitiveness via cost savings and differentiating their business as "climate friendly". Carbon reduction actions are therefore largely driven by environmental ethics and business goals for tourism operators.

Technological and financial needs are required to support mitigation at the destination and enterprise level. A future of increasing temperatures will necessitate increased adoption of mitigation strategies across the board. Leveraging climate change resources internationally, regionally, and locally, and introducing or expanding use of technologies nascent to Jamaica will be critical for mitigation in the tourism sector.

The Third National Communication of Jamaica to the United Nations Framework Convention on Climate Change (2018) explores various mitigation pathways and their abatement potential. From 2017 to 2055, the three pathway scenarios lower emissions by between 56 and 70 million tonnes of carbon dioxide equivalent, at a direct cost savings exceeding US$40 per tonne.

Where tourism enterprises apply some of the above-mentioned mitigation actions, they can lower emissions and generate cost savings. Resetting national emissions targets is dependent on the implementation and success of mitigation actions, including actions taken by the tourism sector.

## 3.4 Mitigating Climate Change Impacts on Tourism in Montego Bay

In 2011, the IDB created the Emerging and Sustainable Cities Initiative to help Latin American and Caribbean cities improve their sustainability, residents' quality of life, and resiliency (IDB, 2015). From 2012 to 2015, the IDB collaborated with the St. James Parish Council and other local and national agencies in Jamaica to develop the "One Bay for All: Sustainable Montego Bay" action plan. The development of the plan was a multiyear process that considered the city's local challenges as well as Caribbean regional challenges, including the impacts of natural disasters and climate change. The plan was made publicly available in 2015.

The action plan notes the critical need for a comprehensive programme of action to reduce the city's vulnerability. The plan specifically calls for Montego Bay to "strengthen capacity of the city government for disaster risk management and the impact of climate change, including disaster preparedness and response and risk-sensitive land use planning; and build resilience to coastal hazards in order to protect and conserve existing and proposed physical and natural assets in the coastal zone and safeguard the tourism industry" (2015, p. 167). Components of the recommended programme of action for Montego Bay that directly or indirectly impact the tourism sector include:

- Conducting vulnerability audits of critical facilities in both natural and man-made hazardous zones
- Developing a hazard risk reduction strategy to include climate change considerations
- Developing a contingency plan for severe weather systems, focusing on storm surge and coastal flooding and including a plan for airport responses to climate change
- Building capacity of a planning and disaster risk management unit through training and implementation of a GIS-based disaster risk management information system
- Implementing a coastal zone management programme
- Implementing a stormwater drainage plan
- Conducting a private waste collection study
- Deploying additional waste collection vehicles and creating a modern service garage for these vehicles
- Establishing a composting programme and facility
- Updating and implementing the sustainable urban development plan and a mobility master plan

- Rehabilitating historic landmarks

Montego Bay has the largest room stock compared to other key tourism destination areas in Jamaica, boasting 7,720 licenced rooms of a total licenced room stock in the island of 20,401 (Tourism Product Development Company, 2020). The accommodation subsector in Montego Bay is therefore best placed to support mitigation efforts that will yield reductions in GHG emissions by reducing energy consumption. Demands on cooling, heating of water, and general lighting requirements place a heavy burden on fossil-fuel energy sources. The proposed indicators could therefore be applied to these properties and measured and monitored where energy reduction initiatives are adopted.

If it is assumed that the associated subsectors in Montego Bay also have a larger share of their respective markets than the rest of the island, this destination provides a significant set of stakeholders for further engagement in GHG emission reduction strategies.

Following are recommendations and key considerations for monitoring and mitigation of climate change impacts for Montego Bay:

- Target the accommodation subsector for adoption of energy-saving schemes (solar hot water, LED and fluorescent lighting, increased co-generation, water-saving devices, and use of solar heating technologies are just a few possible initiatives).
- Use Montego Bay as a pilot for other destinations.
- Measure annual percentage changes in GHG emissions from tourism enterprises at the destination and national levels.
- After demonstrated success with accommodations, engage other key subsectors in Montego Bay in mitigation schemes.
- Expand the range of enterprise-level mitigation approaches to include carbon offset programmes that engage guests and leverage nearby protected areas such as the Montego Bay Marine Park and Cockpit Country.
- Encourage individual responsibility and action through ethical and other approaches; for example, offering carbon offset options to visitors and encouraging longer stays for long-haul travellers.
- Source and leverage funding facilities to support adaptation and mitigation efforts for various subsectors.

- Strengthen current governance frameworks (in both public and private sectors) to support ongoing monitoring, measurement, and alignment with national emission reduction targets.

The climatic changes outlined in this report will demand that these indicators and strategies be measured, monitored, and vigorously matched by educational and communication strategies aimed at encouraging adoption of mitigation programmes. Increased awareness of potential impacts and risks, capacity to analyse the potential impacts and risks, and commitment to sustained action are all critical components to mitigating and minimising climate change impacts across Jamaica.

# 4.0 References


Aiken, K., Carpenter, R., Charpentier, B., Creary, M., D'Silva, R., Dustan, P., Edmunds, P., Gayle, P., Hado, N., Hardt, M., Hughes, T., Idjadi, J., Jackson, J., Jameson, S., Knowlton, N., Lang, J., Loya, Y., Paredes, G., Polunin, … Reef Check. (2014). Jamaica. In J. Jackson, M. Donovan, K. Cramer & V. Lam (Eds.), *Status and trends of Caribbean coral reefs: 1970–2012* (pp. 248–253). Global Coral Reef Monitoring Network, IUCN. https://portals.iucn.org/library/efiles/documents/2014-019.pdf

Amelung, B., Nicholls, S., & Viner, D. (2007). Implications of global climate change for tourism flows and seasonality. *Journal of Travel Research*, *45*(3), 285–296. http://doi.org/10.1177/0047287506295937

Anderson, W. (2000). *Multilateral Environmental Agreements (MEA) implementation in the Caribbean: Report and guidelines*. United Nations Environment Programme (UNEP) Regional Office for Latin America and the Caribbean.

Attz, M. (2009). Natural disasters and remittances: Poverty, gender and disaster vulnerability in Caribbean SIDS. In W. Naudé, A. U. Santos-Paulino & M. McGillivray (Eds.), *Vulnerability in developing countries* (pp. 249–261). United Nations University Press. https://collections.unu.edu/eserv/UNU:2548/ebrary9789280811711.pdf

Becken, S., & Hay, J. (2007). *Tourism and climate change: Risks and opportunities*. Channel View Publications.

Brown, P. (2020, March 16). *Rethinking Sargassum seaweed: Could it be the new normal in Jamaica?* NACLA. https://nacla.org/news/2020/03/12/rethinking-sargassum-seaweed-jamaica

Bueno, R., Herzfeld, C., Stanton, E., & Ackerman, F. (2008, January). *The Caribbean and climate change: The costs of inaction* [Presentation slides]. SEI-U.S.

Burki, R., Elsasser, H., & Abegg, B. (2003, April). *Climate change – impacts on the tourism industry in mountain areas*. Paper presented at the 1st International Conference on Climate Change and Tourism, Djerba, Tunisia.

Campbell, E. (2020, March 4). *Tourism fallout: Sector forecast to shed J$76 billion as coronavirus causes plunge in revenue projections*. The Gleaner. http://jamaica-gleaner.com/article/lead-stories/20200304/tourism-fallout-sector-forecast-shed-j76-billion-coronavirus-causes

Caribbean Aqua-Terrestrial Solutions. (n.d.). *Jamaica*. https://cats.carpha.org/Members/Jamaica

Caribbean Catastrophe Risk Insurance Facility. (2020). *Company overview*. CCRIF SPC. https://www.ccrif.org/about-us

Caribbean Community Climate Change Centre. (2017, May). *Tag: Coastal Protection for Climate Change Adaptation (CPCCA)* [Press release]. https://www.caribbeanclimate.bz/blog/tag/coastal-protection-for-climate-change-adaptation-cpcca/

Caribbean Community Climate Change Centre. (2020). *About us*. https://www.caribbeanclimate.bz/about-us/.

Caribbean Tourism Organization. (n.d.). *Disaster management resources*. https://www.onecaribbean.org/resources/disaster-management/.

Caribsave. (2009, November). *Caribsave final report: Montego Bay – Jamaica*. https://research.fit.edu/media/site-specific/researchfitedu/coast-climate-adaptation-library/latin-america-and-caribbean/cuba-hispanola-jamaica/Caribsave--CCCCC.--2009.--Montego-Bay-CC-Vulnerability--Adaptive-Capacity..pdf

Caribsave. (2012, March). *The Caribsave climate change risk atlas: Climate change risk profile for Jamaica*. https://www.mona.uwi.edu/physics/sites/default/files/physics/uploads/FINAL%20Full%20Risk%20Profile%20CCCRA%20-%20Jamaica.pdf

Casas-Beltrán, D., Gallaher, C., Hernandez Yac, E., Febles Moreno, K., Voglesonger, K., Leal-Bautista, R., & Lenczewski, M. (2020, March 21). Seaweed invasion! Temporal changes in beach conditions lead to increasing cenote usage and contamination in the Riviera Maya. *Sustainability*, *12*(6), 2474. https://doi.org/10.3390/su12062474

Cohen, S., & Higham, J. (2011, May). Eyes wide shut? UK consumer perceptions on aviation climate impacts and travel decisions to New Zealand. *Current Issues in Tourism*, *14*(4), 323–335. http://doi.org/10.1080/13683501003653387

Chambers, S. (2018, October 19). *Harmonising gender and climate change within the NDC process: Jamaica's experience* [Presentation slides]. NDC Support Programme. https://www.ndcs.undp.org/content/dam/LECB/events/2018/20191008-caribbean-ndc-dialogue/undp-ndcsp-caribbean-dialogue-presentations/undp-ndcsp-caribbean-dialogue-26-Panel%2520Discussion-Jamaica.pdf

Climate Studies Group, Mona. (2017, October). *State of the Jamaican climate 2015: Information for resilience building*. Planning Institute of Jamaica.

Dearden, P., & Manopawitr, P. (2010). Climate change—coral reefs and dive tourism in South-east Asia. In A. Jones & M. Phillips (Eds.), *Disappearing Destinations* (pp. 144–160). CABI Publishing.

Dlugolecki, A. (2004). *A changing climate for insurance: A summary report for chief executives and policymakers*. Association of British Insurers. https://engweb.swan.ac.uk/~hewstonr/A%20Changing%20Climate%20for%20Insurance%20-%20ABI.pdf

Ekwue, E. (2010, January). Management of water demand in the Caribbean region: Current practices and future needs. *The West Indian Journal of Engineering*, *32*(1&2). 28–35.

Emmanuel, K., & Spencer, B. (2009). Climate change implications for water resource management in Caribbean tourism. *Worldwide Hospitality and Tourism Themes*, *1*(3), 252–268. http://doi.org/10.1108/17554210910980594

Emmanuel, K. (2014). Shifting tourism flows in a changing climate: policy implications for the Caribbean. *Worldwide Hospitality and Tourism Themes*, *6*(2), 118–126. https://doi.org/10.1108/WHATT-12-2013-0054.

Essex, S., Kent, M., & Newnham, R. (2004). Tourism development in Mallorca: Is water supply a constraint? *Journal of Sustainable Tourism*, *12*(1), 4–28. https://doi.org/10.1080/09669580408667222

European Commission. (2016, March). *The European Tourism Indicator System ETIS toolkit for sustainable destination management.* https://ec.europa.eu/growth/sectors/tourism/offer/sustainable/indicators/

Gillen, D., Morrison, W., & Stewart, C. (2003). *Air travel demand elasticities: Concepts, issues and measurement*. Government of Canada.

GlobalPetrolPrices.com. (2020, March). *Jamaica electricity prices.* https://www.globalpetrolprices.com/Jamaica/electricity_prices/

Global Programme on Risk Assessment and Management for Adaptation to Climate Change. (2017, May). *Climate change realities in Small Island Developing States in the Caribbean*. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.

Global Sustainable Tourism Council. (2019, December 6). *GSTC Destination Criteria with Performance Indicators and SDGs* (Version 2.0). https://www.gstcouncil.org/gstc-criteria/gstc-destination-criteria/

Government of Jamaica. (2015, September). *Climate change policy framework for Jamaica.* https://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2016/05/Jamaica-Climate-Change-Policy-fwL-2015.pdf

Gössling, S. (2005). Tourism's contribution to global environmental change: Space, energy, disease and water. In C. M. Hall & J. Higham (Eds.), *Tourism recreation and climate change: International perspectives* (pp. 286–300). Channel View Publications.

Gössling, S., Lindén, O., Helmersson, J., Liljenberg, J., & Quarm, S. (2007). Diving and global environmental change: A Mauritius case study. In B. Garrod & S. Gössling (Eds.), *New frontiers in marine tourism*. Routledge.

Gössling, S., Scott, D., Hall, C. M., Ceron, J. P., & Dubois, G. (2012). Consumer behaviour and demand response of tourists to climate change. *Annals of Tourism Research*, *39*(1), 36–58.

Granvorka, C., & Strobl, E. (2013). The impact of hurricane strikes on tourist arrivals in the Caribbean. *Tourism Economics*, *19*(6), 1401–1409.

Hines, H. (2019, December 30). *Jamaica records best tourism numbers – Bartlett*. Jamaica Observer. http://www.jamaicaobserver.com/news/jamaica-records-best-tourism-numbers-bartlett_183331

Hyman, T. (2014). Assessing the vulnerability of beach tourism and non-beach tourism to climate change: A case study from Jamaica. *Journal of Sustainable Tourism*, *22*(8): 1197–1215.

Inter-American Development Bank (IDB). (2015). One Bay for All Sustainable Montego Bay Action Plan. https://webimages.iadb.org/PDF/Montego+Bay+Action+Plan.pdf

International Monetary Fund. (2020, May 10). *Jamaica: Request for purchase under the rapid financing instrument* (IMF country report no. 20/167). https://www.imf.org/~/media/Files/Publications/CR/2020/English/1JAMEA2020001.ashx

International Institute for Sustainable Development. (2018, August 16). *New coalition supports Caribbean efforts to become first climate-smart zone* [Press release]. https://sdg.iisd.org/news/new-coalition-supports-caribbean-efforts-to-become-first-climate-smart-zone/

Jackson, J., Donovan, M., Cramer, K., Lam, V. (editors). (2014). *Status and Trends of Caribbean Coral Reefs: 1970-2012*. Global Coral Reef Monitoring Network, IUCN, Gland, Switzerland. https://portals.iucn.org/library/efiles/documents/2014-019.pdf

Jamaica Tourist Board. (2019, December 3). *Annual Travel Statistics 2018*. https://www.jtbonline.org/report-and-statistics/annual-travel/

Jamaica Tourist Board. (2020, September 17). *Annual Travel Statistics 2019*. https://www.jtbonline.org/report-and-statistics/annual-travel/

Jopp, R., DeLacy, T., & Mair, J. (2010). Developing a framework for regional destination adaptation to climate change. *Current Issues in Tourism*, *13*(6), 591–605. https://doi.org/10.1080/13683501003653379

Kane, C. (2005). *Coral reef impacts of the 2005 Caribbean bleaching event*. The Reef Check Foundation. http://www.reefcheck.org/PDFs/Caribbean_Bleaching_Report.pdf

Khan, S. et al. (2010). *Shoreline changes and sea-level rise at Long Bay, Negril, western Jamaica*. University of the West Indies, Marine Geology Unit, Dept. of Geography & Geology.

Klomp, K. (2000). *Coral reefs of Jamaica's northern coast: Assessment of Conditions and Key Threats*. Coral Gables, FLA: Ocean Research and Education Foundation.

Kushner, B., Edwards, P., Burke, L., & Cooper, E. (2011). *Coastal capital: Jamaica; Coral reefs, beach erosion and impacts to tourism in Jamaica* [Working paper]. World Resources Institute. Accessed at http://www.biofund.org.mz/en/biblioteca_virtual/

Linton, L. (2020, June 25). *Jamaica earned US$3.64 billion from tourism in 2019, welcomed 4.3 million visitors*. Jamaica Information Service. https://jis.gov.jm/jamaica-earned-us3-64-billion-from-tourism-in-2019-welcomed-4-3-million-visitors/

Lorde, T., Li, G., & Airey, D. (2016). Modeling Caribbean tourism demand: An augmented gravity approach. *Journal of Travel Research*, *55*(7), 946–956.

Mach, K.J., Planton, S., & von Stechow, C. (Eds.). (2014). Annex II: Glossary. In R. K. Pachauri and L. A. Meyer (Eds.), *Climate Change 2014: Synthesis Report*; *Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 117–130). https://www.ipcc.ch/site/assets/uploads/2018/02/AR5_SYR_FINAL_Annexes.pdf

Mather, S., Viner, D., & Todd, G. (2005). *Climate and policy changes: Their implications for international tourism flows*. Channel View Publications. https://www.cabdirect.org/cabdirect/abstract/20053052066

Maxam, A., Lyew-Ayee, P., & McIntyre, K. (2011). *A Classification of the Protection given by Reef Systems in Jamaica - Utilizing GIS and Oceanographic Methods of Analysis*. Working Paper. Kingston, Jamaica: Mona Geoinformatics Institute (MGI). http://pdf.wri.org/working_papers/coastal_capital_jamaica_shoreline_protection_MGI.pdf

Mendoza-González, G., Martínez, M. L., Guevara, R., Pérez-Maqueo, O., Garza-Lagler, M. & Howard, A. (2018). Towards a sustainable sun, sea, and sand tourism: The value of ocean view and proximity to the coast. *Sustainability*, *10*(4), 1012. http://doi.org/10.3390/su10041012

Mimura, N., Nurse, L., McLean, R. F., Agard, J., Briguglio, L., Lefale, P., Payet, R., & Sem, G. (2007). Small islands. In M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. van der Linden, & C. E. Hanson, (Eds.), *Climate change 2007: Impacts, adaptation and vulnerability*; *Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 687–716). Cambridge University Press. https://www.ipcc.ch/site/assets/uploads/2018/02/ar4-wg2-chapter16-2.pdf

Ministry of Economic Growth and Job Creation. (2020). *Pilot programme for climate resilience Jamaica*. https://ppcrja.org.jm/

Ministry of Economic Growth and Job Creation. (2018, December). *Third national communication of Jamaica to the United Nations Framework Convention on Climate Change*. https://www4.unfccc.int/sites/SubmissionsStaging/NationalReports/Documents/578491_Jamaica-NC3-1-TNC_Final_December132018.pdf

Ministry of Tourism. (2019, August 8). *Sargassum clean-up costs Caribbean US$120 million – Bartlett* [Press release]. https://www.mot.gov.jm/news-releases/sargassum-clean-costs-caribbean-us120-million-%E2%80%93-bartlett

Mooney, H. (2020, Quarter 1). *Jamaica: Caribbean economies in the time of coronavirus*. Inter-American Development Bank. https://flagships.iadb.org/en/caribbean-region-quarterly-bulletin-2020-q1/jamaica

Moore, W. R. (2010). The impact of climate change on Caribbean tourism demand. *Current Issues in Tourism*, *13*(5), 495–505.

Moser, S. C., & Luers, A. L. (2008, January 26). Managing climate risks in California: the need to engage resource managers for successful adaptation to change. *Climatic Change*, *87*, 309–322. https://doi.org/10.1007/s10584-007-9384-7

Munich Climate Insurance Initiative. (n.d.). *Climate Risk Adaptation and Insurance in the Caribbean (CRAIC)*. https://climate-insurance.org/projects/climate-risk-adaptation-and-insurance-in-the-caribbean/

Murphy, J. (2020, February 24). *Insurance fees to jump: Hurricanes blowing property rates through the roof*. The Gleaner. http://jamaica-gleaner.com/article/lead-stories/20200204/insurance-fees-jump-hurricanes-blowing-property-rates-through-roof

National Environment and Planning Agency (2008). *Coral reefs in Jamaica: Status and trends 2007*. Government of Jamaica.

National Environment and Planning Agency (2011). *State of the environment report 2010*. Government of Jamaica.

National Environment and Planning Agency (2014). *Coral reefs of Jamaica: An evaluation of ecosystem health 2013*. Government of Jamaica.

National Environment and Planning Agency (2017). *Jamaica coral reef health index map – 2017*. Government of Jamaica. Retrieved November 23, 2020. https://www.nepa.gov.jm/new/services_products/maps/coral_reef.php

Nurse, K., Niles, K. & Dookie, D. (2009, January 21–23). *Climate change policies and tourism competitiveness in small island developing states* [Paper presentation]. National Centres of Competence in Research, Conference on the International Dimensions of Climate Policies, University of Bern, Switzerland.

OECD. (2010). Tourism 2020: Policies to promote competitive and sustainable tourism. In *OECD Tourism Trends and Policies 2010* (pp. 51–81). https://doi.org/10.1787/tour-2010-en

Oxenford, H., & McConney, P. (2019, October 9–11). *Sargassum: threat or opportunity for a blue economy?* [Conference presentation]. UNCW Global Marine Science Summit, Wilmington, NC, United States. https://www.cavehill.uwi.edu/cermes/projects/sargassum/docs/presentations/presentation_oxenford_2019_sargassum_threat_or_opp.aspx

Purcell, J. E. (2012). Jellyfish and ctenophore blooms coincide with human proliferations and environmental perturbations. *Annual Review of Marine Science*, *4*(1), 209–235. http://doi.org/10.1146/annurev-marine-120709-142751

Ratliff, L. (2019, January 17). *The most and least visited Caribbean destinations*. Oyster. https://www.oyster.com/articles/least-and-most-visited-caribbean-destinations/.

Richardson, L. F. (2007). *Weather prediction by numerical process*. Cambridge University Press.

Rutty, M., & Scott, D. (2010). Will the Mediterranean become "too hot" for tourism? A reassessment. *Journal of Tourism Hospitality and Planning Development*, *7*(3): 267–81.

Rutty, M., & Scott, D. (2014). Thermal range of coastal tourism resort microclimates. *Tourism Geographies*, *16*(3), 346–363.

Rutty, M., Scott, D., Matthews, L., Burrowes, R., Trotman, A., Mahon, R., & Charles, A. (2020). An inter-comparison of the Holiday Climate Index (HCI: Beach) and the Tourism Climate Index (TCI) to explain Canadian tourism arrivals to the Caribbean. *Atmosphere*, *11*(4), 412.

Santos-Lacueva, R., Clavé, S. A., & Saladié, O. (2017, November 9). The vulnerability of coastal tourism destinations to climate change: The usefulness of policy analysis. *Sustainability*, *9*(11), 2062. https://doi.org/10.3390/su9112062

Scott, D., Jones, B., & Konopek, J. (2007, April). Implications of climate and environmental change for nature-based tourism in the Canadian Rocky Mountains: A case study of Waterton Lakes National Park. *Tourism Management*, *28*(2), 570–579.

Scott, D., & Lemieux, C. (2010, December). Weather and climate information for tourism. *Procedia Environmental Sciences*, *1*(1):146–183. https://doi.org/10.1016/j.proenv.2010.09.011

Scott, D., Rutty, M., Amelung, B., & Tang, M. (2016, June 7). An inter-comparison of the Holiday Climate Index (HCI) and the Tourism Climate Index (TCI) in Europe. *Atmosphere*, *7*(6), 80.

Segura, J. A. (2010). *The contribution of agriculture to sustainable development in Jamaica*. Inter-American Institute for Cooperation on Agriculture. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.1006.6901&rep=rep1&type=pdf

Simpson, M., Scott, D., & Trotz, U. (2011, March). *Climate change's impact on the Caribbean's ability to sustain tourism, natural assets, and livelihoods* [Technical Note No. IDB-TN-238]. Inter-American Development Bank.

Smith, K. (1993). The influence of weather and climate on recreation and tourism. *Weather*, *48*(12), 398–403.

Smith Warner International Limited. (2007). *Preliminary engineering report for beach restoration works at Negril*.

Taylor, M. A., Clarke, L. A., Centella, A., Bezanilla, A., Stephenson, T. S., Jones, J. J., Campbell, J. D., Vichot, A., & Charlery, J. (2018). Future Caribbean climates in a world of rising temperatures: The 1.5 vs. 2.0 dilemma. *Journal of Climate*, *31*(7), 2907–2926. https://doi.org/10.1175/JCLI-D-17-0074.1

Tortella, B., & Tirado, D. (2011, October). Hotel water consumption at a seasonal mass tourist destination: The case of the island of Mallorca. *Journal of Environmental Management*, *92*(10). 2568–79. http://doi.org/10.1016/j.jenvman.2011.05.024

Tourism Product Development Company. (2020). *Licensed accommodations database*.

Tourism sector on track to exceed growth targets. (2019, November 7). *Jamaica Observer*. http://www.jamaicaobserver.com/news/tourism-sector-on-track-to-exceed-growth-targets_179048

United Nations Conference on Trade and Development (UNCTAD). (2017, December). *Climate Change Impacts on Coastal Transport Infrastructure in the Caribbean: Enhancing the Adaptive Capacity of Small*

*Island Developing States (SIDS) Jamaica: A case study*. (UNDA 1415O). https://sidsport-climateadapt.unctad.org/wp-content/uploads/2018/07/Jamaica-Case-Study.pdf

United Nations Environment Programme. (2017). *Coral bleaching futures: Downscaled projections of bleaching conditions for the world's coral reefs, implications of climate policy and management responses*. https://wedocs.unep.org/bitstream/handle/20.500.11822/22048/Coral_Bleaching_Futures.pdf

Uyarra, M. C., Côté, I. M., Gill, J. A., Tinch, R. R. T., Viner, D., & Watkinson, A. R. (2005). Island-specific preferences of tourists for environmental features: Implications of climate change for tourism-dependent states. *Environmental Conservation*, *32*, 11–19.

Van Hooidonk, R., Maynard, J. A., Liu, Y., & Lee, S. (2015, April). Downscaled projections of Caribbean coral bleaching that can inform conservation planning. *Global Change Biology, 21*(9), 3389–3401. https://doi.org/10.1111/gcb.12901

Vourdoubas, J. (2019, December). Estimation of carbon emissions due to tourism in the island of Crete, Greece. *Journal of Tourism and Hospitality Management*, *7*(2), 24–32.

World Health Organization. (2017). *Climate and health country profile: 2017 Jamaica*. https://apps.who.int/iris/bitstream/handle/10665/260410/WHO-FWC-PHE-EPE-15.57-eng.pdf

World Tourism Organization & United Nations Environment Programme. (2008). *Climate change and tourism: Responding to global challenges*. https://www.e-unwto.org/doi/pdf/10.18111/9789284412341

World Travel and Tourism Council. (2020, March). *Jamaica 2020 annual research: Key highlights*. https://wttc.org/Research/Economic-Impact

Zeppel, H., & Beaumont, N. (2014). Climate change and sustainable tourism: Carbon mitigation by environmentally certified tourism enterprises. *Tourism Review International*, *17*, 161–177.