FINAL REPORT

VULNERABILITY AND CAPACITY ASSESSMENT FOR THE TREASURE BEACH COMMUNITY, ST. ELIZABETH

Submitted: September 6, 2018

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ACKNOWLEDGEMENTS

Environmental Solutions Limited (ESL) would like to thank all the government agencies and private organizations who contributed to the preparation of this report. We are grateful for the support of Jason Henzell, Breds, The Treasure Beach Foundation, and members of the community who assisted us throughout the entire project and were willing participants in our stakeholder consultations and group discussions. We would also like to thank the St. Elizabeth Municipal Corporation for providing important context for the project.

We are grateful to the Sandy Bank Primary School for hosting the workshop held on July 12, 2018 and especially grateful to all the stakeholders that took time out of their busy schedules to attend and provide meaningful feedback.

Finally, ESL would like to acknowledge its team for the collaborative approach towards the development of this report; Mrs. Eleanor Jones, Chairman and CEO of Environmental Solutions Limited, Dr. Theresa Rodriguez- Moodie, the team Project Manager and Climate Vulnerability Specialist, Mr. George Campbell, Socio-economist, Ms. Abigail McIntosh, Mrs. Annmarie Goulbourne and Mr. Richard Coutou.

The views expressed herein are those of the authors and do not necessarily reflect the views of Do Good Jamaica, the EFJ or the PPCR.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS

AAR	After Action Report
CDRMG	Community-based Disaster Risk Management Group
CERT	Community Emergency Response Team
CDRT	Community Disaster Reduction Team
DRM	Disaster Risk Management
EOC	Emergency Operations Center
NEOC	National Emergency Operations Center
NGO	Non-Government Organisation
ODPEM	Office of Disaster Preparedness and Emergency Management
PDC	Parish Disaster Coordinator/Committee
PEOC	Parish Emergency Operations Center

GLOSSARY

Adaptation	The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate harm or exploit beneficial opportunities. In natural systems, human intervention may facilitate adjustment to expected climate and its effects.
Adaptive Capacity	The ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences.
All Clear	An All Clear is a statement issued by the pertinent authority when a threat has passed. The All Clear, for a Hurricane – is when the storm has passed and the associated strong impacts from winds and rains will no longer affect the country/community.
Climate	Climate in a narrow sense is usually defined as the average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The classical period for averaging these variables is 30 years, as defined by the World Meteorological Organization. The relevant quantities are most often surface variables such as temperature, precipitation, and wind. Climate in a wider sense is the state, including a statistical description, of the climate system.
Climate Change	Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes in the composition of the atmosphere or in land use. Note that the Framework Convention on Climate Change (UNFCCC), in its Article 1, defines climate change as: 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods'. The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition, and climate variability attributable to natural causes.
Climate Variability	Climate variability refers to variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all spatial and temporal scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forcing (external variability).
Disaster	A serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts.
Disaster Risk Reduction	Disaster risk reduction is aimed at preventing new and reducing existing disaster risk and managing residual risk, all of which contribute to strengthening resilience and therefore to the achievement of sustainable development.

Drought	A drought occurs when there is an extended period of deficiency in precipitation (relative to what is considered normal), which is then insufficient to meet economic, social and environmental demands.
Emergency Operations Center (EOC)	A multi-agency coordination center, that provides support and coordination to the on-scene responders.
Flood	An overflow of water from a river, lake or other body of water due to excessive precipitation or other input of water.
Groundwater	Water beneath the surface of the earth which saturates the pores and fractures of sand, gravel, and rock formations
Hurricane	A hurricane is a large tropical storm with winds of 74 mph or greater, moving counterclockwise. In addition to intense winds, hurricanes are accompanied by heavy rains, flooding along the coast, flooding inland and tornadoes. The Saffir-Simpson Hurricane Scale is a one to five rating based on the hurricane's present intensity. This is used to give an estimate of the potential property damage and flooding expected along the coast from a hurricane landfall. Wind speed is the determining factor of this scale.
Incident	An event that occurs that may lead to an emergency condition.
Natural Hazard	These are naturally occurring physical phenomena caused either by rapid or slow onset events which can be geophysical (earthquakes, landslides, tsunamis and volcanic activity), hydrological (avalanches and floods), climatological (extreme temperatures, drought and wildfires), meteorological (cyclones and storms/wave surges) or biological (disease epidemics and insect/animal plagues).
Rain Water Harvesting	This is the accumulation and deposition of rainwater for reuse on-site, rather than allowing it to run off. Its uses include water for garden, water for livestock, water for irrigation, water for domestic use with proper treatment, and indoor heating for houses etc.
Sensitivity	The degree to which a built, natural or human system is directly or indirectly affected by changes in climate conditions (e.g., temperature and precipitation) or specific climate change impacts (e.g., sea level rise, increased water temperature).
Surface water	Water collecting on the ground, in a stream, river, lake, wetland, or ocean
Tropical Disturbance	A tropical disturbance is a cluster of thunderstorms poorly organized.
Tropical Depression	A tropical depression is a cluster of storms organized around a central circulation with surface wind speeds of 38 mph or less.
Tropical Storm	A tropical storm is a cluster of smaller storms with substantial circular rotation and sustained surface winds of 39-73mph

EXECUTIVE SUMMARY

Treasure Beach, St. Elizabeth, the focus of this study, is located on the south coast of Jamaica and comprises eight smaller districts spanning hilly areas all the way to the coastal plains. It has certain inherent characteristics that exposes the community to climate related hazards. In order to determine the vulnerability of the community to climate change, Do Good Jamaica sought grant funding from the Environmental Foundation of Jamaica to conduct a Vulnerability and Capacity Assessment (VCA) study and to prepare a Disaster Risk Management Plan (DRMP) for the community.

This study has been undertaken using a consultative and participatory approach involving all key stakeholders in combination with scientific analyses. Several stakeholder consultations were held including a Workshop to present the findings and get feedback.

This report presents the findings of the Vulnerability and Capacity Assessment for the community. This project was designed to be undertaken using a consultative and participatory approach involving all key stakeholders in combination with scientific analyses. The three main components of the VCA are aimed at determining where the community is vulnerable and the nature of that vulnerability. The objective of the DRMP is to help the community to increase its resilience by reducing underlying vulnerability and risk factors and is informed by the VCA.

Based on the projections in the State of Jamaica's Climate, 2015, St Elizabeth and therefore Treasure Beach, is likely to be affected by higher temperatures, more variable rainfall with a general decreasing trend over the next century, increased intensity of tropical cyclone activity, rising sea levels and lower average wind speeds, but higher wind speeds in storm events.

The community is considered to be sensitive to climate change and the main climate related hazards that have typically affected the Treasure Beach community include; droughts, floods and tropical storms/ hurricanes (including storm surge and coastal erosion). The community has a moderately low adaptive capacity largely because measures needed to improve their adaptive capacity lie within the remit of local government whose frequent complaint is one of financial resources. The combined findings of the sensitivity and adaptive capacity analysis show that Treasure Beach can be considered to be moderately vulnerable to the impacts of climate change and variability. Action items have been outlined for the Community.

There is a separate report which presents a Draft Community Disaster Risk Management Plan for Treasure Beach, St. Elizabeth, which is a living document, and once adopted by the community, may be subject to continuous updates. The plan focuses on climate related hazards. The overall objective of this plan is to provide a framework for increasing the resilience of the Treasure Beach community to climate related hazards by reducing underlying risk factors. The Disaster Risk Management (DRM) plan framework developed includes strategic actions for prevention, mitigation, preparedness, response and recovery; and are all directly related to the levels of hazard exposure, vulnerability and risk indicators identified in

the VCA. It is a living document and is intended to be developed further once the Treasure Beach Zonal Committee is established.

The DRM Plan follows the principles of the International Strategy for Disaster Reduction (ISDR), which reflects a major shift from the traditional emphasis on disaster response to disaster reduction, and in effect seeks to promote a "culture of prevention". It is also developed with the mission and vision of ODPEM, whose mission statement reads: "*The Office of Disaster Preparedness and Emergency Management is committed to leading the process of reducing the impact of disasters on Jamaica through Comprehensive Disaster Management (CDM). The vision is to be a proactive world-class agency building a disaster resilient nation*".

The plan has three main components which are elaborated on further in the document; prevention and mitigation; preparedness and response; and rehabilitation and recovery. This Section has been concluded with Next Steps for the community to implement.

1 INTRODUCTION

1.1 Purpose and Objectives

Ninety percent (90%) of recorded major disasters caused by natural hazards from 1995 to 2015 were linked to climate and weather, including floods, storms, heatwaves and droughts (UNISDR, 2017). Over 96 percent of Jamaica's GDP and population is considered to be at risk from two or more hazards making Jamaica the third most exposed country in the world to multiple hazards. Its primary risks are linked to hazards including hurricanes, floods, droughts, earthquakes, storm surges, and landslides. The high exposure is due to the country's location in the Atlantic Hurricane Belt, the geophysical orientation of its low-lying coastal zones, and its mountainous topography (GFDRR, 2017). Climate change projections for Jamaica could increase the frequency of catastrophic natural events which would have significant impacts on livelihoods, infrastructure and essential services.

Treasure Beach, the focus of this study, located along the southern coastline of St. Elizabeth has certain inherent characteristics that make it vulnerable to the adverse impacts of climate variability and change. These include a limited reserve capacity to handle the effects of natural hazards such as extreme flooding and droughts. Additionally, much of the community's economy is dependent on the coastal zone, making it particularly vulnerable to the impacts of sea level rise (coastal flooding), storm surge and coastal erosion. The sectors in Treasure Beach that are most susceptible to the impacts of climate change include: water resources, coastal infrastructure, agriculture, tourism and fisheries.

In recognition of Treasure Beach's vulnerability to climate change, Do Good Jamaica sought grant funding from the Environmental Foundation of Jamaica to conduct two main activities in the community:

a. To conduct a Vulnerability and Capacity Assessment (VCA) study
b. To prepare a Disaster Risk Management Plan

The overall objective of the Grant is:

- To build awareness of the climate hazards to which the community is exposed.
- To build the community's capacity to not just respond to climate hazards but to identify the risks and undertake preventative and mitigative actions against potential impacts
- To allow the community to prepare and recover from any climatic event experienced in the shortest time possible.

Environmental Solutions Limited has been contracted by Do Good Jamaica to carry out these services on their behalf while working closely with the community and ensuring that there is knowledge transfer throughout the entire process. This project report comprises the following:

- Introduction and Overview of the Treasure Beach Community including current climate conditions and projected climate changes
- Vulnerability and Capacity Assessment

1.2 Intended Use of the Document

In order for a community to adapt and become more resilient to climate change impacts they need to be aware of their risks and vulnerabilities. This study is considered the first step in bringing awareness to the community. Therefore, this document is intended to be used by members of the Treasure Beach Community, including community-based organizations, the St. Elizabeth Municipal Council and the Office of Disaster Preparedness and Emergency Management. It is intended to identify the most vulnerable sections of the community and suggest possible ways for the community to increase their resilience to natural hazards and climate change impacts. It also intended to guide future development.

1.3 The Scope and Approach

This project was designed to be undertaken using a consultative and participatory approach involving all key stakeholders in combination with scientific analyses. The approach outlined below has been adapted from two methods; the NOAA Community Vulnerability Assessment Tools (CVAT) and the Preparing for Climate Change: A Guidebook for Local, Regional and State Governments (2007).

1.3.1 The Vulnerability and Capacity Assessment (VCA)

The VCA has three main components as illustrated in Figure 1-1 below.

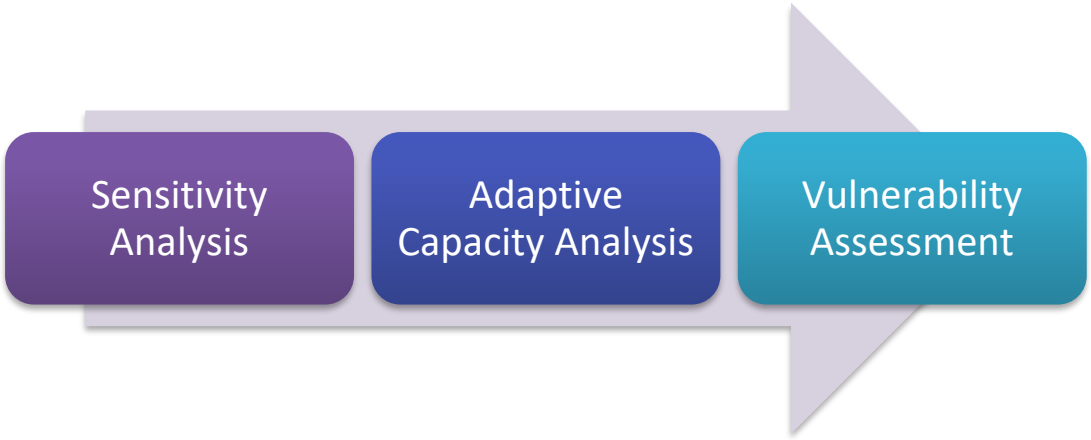

Figure 1-1: Organization of the VCA

In order to ensure that investments in adaptation measures achieve the desired outcomes it is first necessary to determine the degree to which Treasure Beach is vulnerable to climate related events and the extent of its capacity to adapt and/or cope. The sensitivity analysis includes a discussion on the existing Treasure Beach community and the climate related threats that they are faced with.

Assessment of the adaptive capacity of the community is intended to identify its social and economic resilience to climate change. The findings on sensitivity and adaptability are then combined to determine how and where the community is vulnerable to climate change.

The results of the VCA should then be used to guide the decision-making process in prioritizing appropriate steps that ought to be taken to make the community more resilient to the impacts of climate variability and change. If the community is already highly vulnerable and does not have the financial, technical or human resource capacity to implement and sustain adaptation practices it is not possible to adapt to the impacts of climate change.

Step 1- Sensitivity Analysis

This step involved identifying the climate hazards to which Treasure Beach is sensitive. It was determined in consultation with key stakeholders as well as from reviewing historical and existing meteorological and climate data and projections.

The aim of these consultations was to answer the following key questions:

- How exposed is the community to climate related hazards?
- Is the community subject to any existing climate related stress?
- How exposed is the community to the impacts of climate change?

The scale/ scope of this project did not allow for climate profiles of the community to be developed through statistical downscaling. Therefore, a review of authoritative works on climate change was done in order to examine the state of knowledge about climate change for Treasure Beach. These included, but were not limited to, reports from the Intergovernmental Panel on Climate Change (IPCC), Caribbean Community Climate Change Centre (CCCCC) and Climate Studies Group, Mona, UWI (CSGM).

Step 1a- Hazard and Risk Analysis

Following stakeholder consultations and mapping exercises conducted in several communities, high risk locations were identified. These are locations that are most likely to be affected by a given hazard.

Step 1b- Societal Analysis

This step involved examining the vulnerability of people of different ages, income levels, ethnicity, capabilities, and experiences to a hazard or group of hazards. This analysis identified areas for special consideration/ high-need neighbourhoods, that is, areas where personal resources or characteristics are such that their ability to deal with hazards is limited. Once this was done, their locations in relation to the high-risk zones were then identified.

Community members were asked to participate in the mapping exercises.

Step 1c- Critical Infrastructure Analysis

Critical infrastructure within the community was identified, mapped and assessed. Included were physical structures, facilities, networks and other assets which provide services that are essential to the social and economic functioning of the community. The steps included:

i. Preparing a critical infrastructure inventory
ii. Identifying intersections of critical infrastructure with high-risk areas

Critical Facility categories include but are not limited to the following: Fire and Rescue; Police; Communication; Transportation; Utilities; Government; Daycare Facilities; Schools; Hospitals; Health Centres; Nursing Homes; Shelters; Petrol Stations; Evacuation Routes.

Step 2- Adaptive Capacity Analysis

A community that has a high adaptive capacity is better able to deal with the impacts of climate variability and change. The stakeholders/ community members consulted assisted in identifying gaps and needs for the community (institutional framework, physical infrastructure, human and financial resources). This analysis was aimed at answering the main question "To what extent is the community able to accommodate changes in climate at minimum disruption or cost?"

Step 3- Vulnerability Assessment

This combined the findings on sensitivity and adaptability to determine how and where the community was vulnerable to climate related hazards and change.

Following the VCA a Draft Disaster Risk Management Plan (DRMP) was prepared.

1.4 Limitations/ Constraints

The hazard assessment component of the VCA did not include any form of modeling as hazard modeling was not a part of the scope. Previously generated data was the sole source of information.

In the sections offering estimates of income generation for crop production and tourism, RADA data was very helpful and willingly given. However, the Consultants were also required to rely on best available assumptions where critical data was absent. The validity of these assumptions was not able to be tested nor independently verified. Therefore, care has been taken to flag the findings as very indicative.

2 OVERVIEW –TREASURE BEACH

2.1 Physical Characteristics

The community of Treasure Beach is located on the south coast of Jamaica in the Parish of St. Elizabeth. It is made up of eight smaller districts which includes Beacon, Billy's Bay, Blunters, Calabash Bay, Frenchman's Run, Fort Charles, Great Bay and Sandy Bank. The community is bounded by Newcomb Valley and Hopewell to the north, Pedro Plains to the North East and Flagaman to the East. The Caribbean Sea lies to the south, south west and west (Figure 2.1).

The community consists of more than 12km of coastline comprising mainly sandy beaches with a few rocky sections. The inland area, a few hundred meters from the coast, is generally flat with several large ponds (some of which are seasonal) and no natural rivers and streams.

Figure 2.1: Image showing the Treasure Beach Community and surrounding communities (Boundary adopted from Social Development Commission, Base Map from Google Earth)

The area is underlain by limestones which are partly overlain by younger coastal sediments (Figure 2.2). The limestone consists of shallow water carbonates produced from skeletal plants and animals and deep-water carbonates produced by pelagic algae, planktic foraminifers, and detritus from the carbonate platforms (Mitchell, 2016). At depth, these limestones are fractured or sometimes form caverns which can be good aquifers for fresh water. The quaternary coastal sediments consist of a Sandy Bar Member, Eolian (wind derived) Dune Sands, Relic Dunes, New Eolinate and a Raised Reef.

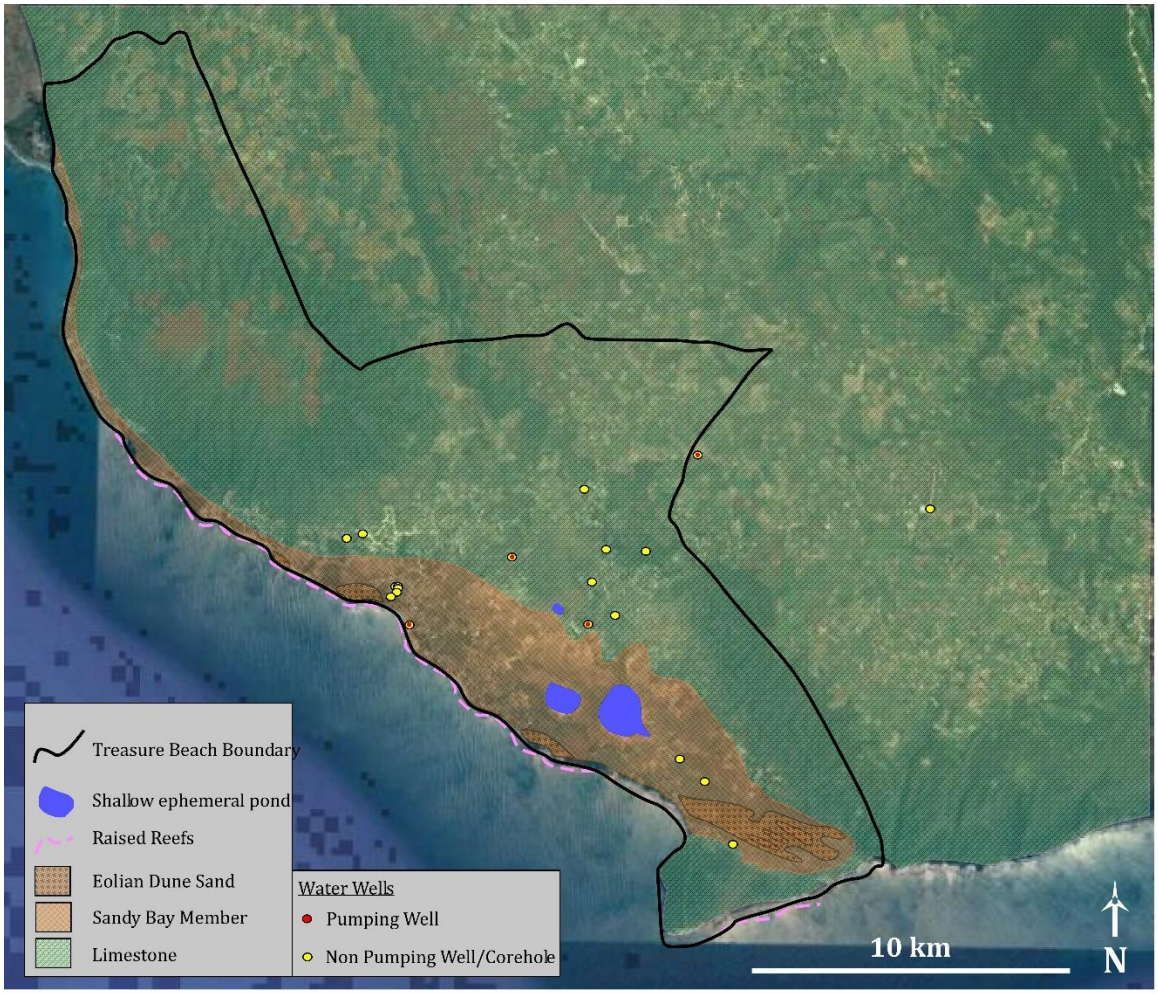

Figure 2.2: Basic geological map of Treasure Beach over Google Earth image (Geology after Maharaj, 1997. Base Image from Google Earth).

The Sandy Bay Member is considered to be originally wind deposited units which have been re-worked by a rising sea-level about 12,000 years ago (Burrows, 1997). Eolian Dune Sands which consist of old dune sands formed at a time when sea-level was about 100m lower than present day (Burrows, 1997). Relict Dunes are generally degraded and usually covered and stabilized by dune grass and New Eolinate dunes are found on top the Relict Dunes.

Figure 2.2 shows that the majority of the town in Treasure Beach sits on top of the re-worked sands and eolian sands. These sands are generally porous and permeable as they are usually not very well cemented. Therefore, they create good aquifers along the coastline where present (Figure 2.3). The poor cementation of these sands also makes it easily susceptible to erosion during storm events. A Raised Reef is also present along the coast which appears as distinct rudstone debris apron (Burrows, 1997).

The area also has a fair amount of groundwater with twenty-one (21) wells drilled in and around the community. The USACE (2001) have stated that the limestones contain large to enormous amounts of ground water and the coastal sands contains very small to very large amounts of brackish water. Eleven

(11) of these wells have been drilled within the limestones and 10 in the coastal sands WRA, pers. comm.). Currently, only one well within the coastal sands, and three wells within the limestones are active.

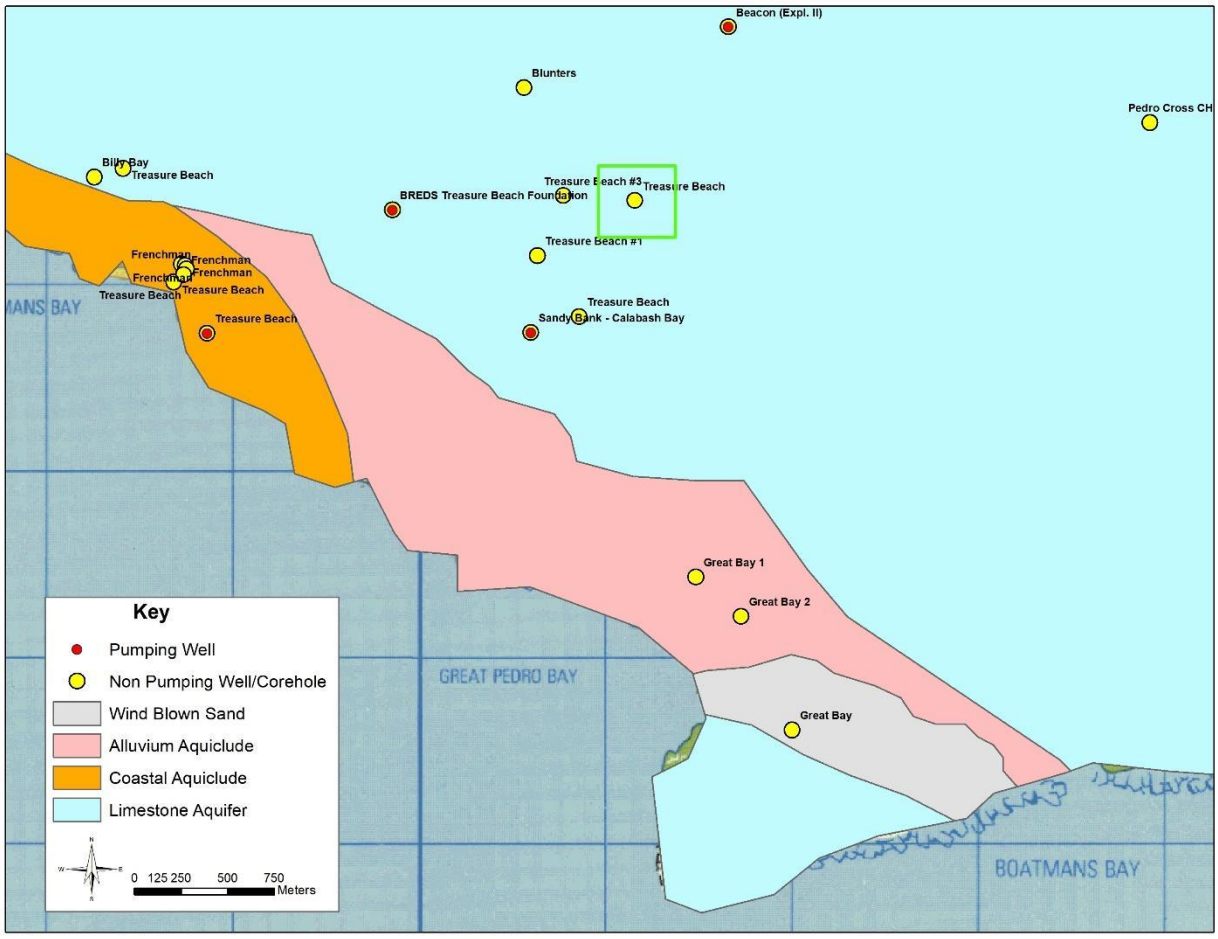

Figure 2.3: Hydrostratigraphic Map of the Treasure Beach area. Most of the coastal section of the community is underlain by an alluvium and coastal aquiclude.

2.2 Socioeconomic Characteristics

In 2011, the estimated total population of Treasure Beach was 3,005 of which 52% were males and 48% were females. The total number of households was 1,086 and the average household size was 2.76 persons (STATIN, 2011). Majority (62.6%) of the population is between 14 and 60 years of age or within the working age group (SDC, 2010). An estimated 67% of household heads are employed, however, the majority of these persons are self-employed- 41.7% are self-employed full-time and 12.5% are part-time (SDC, 2011).

The economy of the community depends largely on fishing, farming and tourism (more details in Section 3.4). Most of the people employed in these industries are self-employed- 40.0% listed their occupations as skilled agricultural and/or fisheries workers. Other household heads who are employed on a full-time, part-time or contractual basis included elementary occupations, professionals, senior officials and technicians (SDC, 2010).

The income distribution within the community has 72.7% of the household heads with an income ranging from JA$20,000 to $80.000 (SDC, 2010). 18.2% of the household heads have a monthly income of less than JA$20,000 and only 9.1% monthly income greater than JA$80,000. Additional income is earned from overseas remittance and assistance from local friends and family members. The majority of households (93.75%) have reported that they own their homes and therefore almost no household income is spent on rent/lease of property/land. Additionally, 87% of all houses are constructed of concrete and block with less than 5% being wooden. In relation to sanitation, 70% of households had inside toilets and 17% used pit latrines (STATIN Census 2011).

These statistics are consistent with the low-density profile of Treasure Beach, and support stakeholder opinion that the community is low on the poverty index, small family based, and with a housing stock considered well-built and resilient to storm winds by comparison with other small communities on the island.

2.3 Climate Variability and Change

The climate in Treasure Beach is similar to that of the other coastal areas around Jamaica. The following subsections describe the existing conditions, and provide some future projections for climate change. The values for temperature and rainfall are given as averages from nearby stations or from general island wide averages.

2.3.1 Temperature

A lack of temperature stations in St. Elizabeth and specifically Treasure Beach makes it difficult to accurately conduct a temperature analysis. However, nearby stations are used along with the national averages. The average monthly surface temperature in Jamaica ranges between 24°C and 27°C with a maximum temperature of 33°C during the warmest months of the year and a minimum of 19°C during the coldest months (CSGM, 2017). Frome, Westmoreland which is the nearest known temperature station to Treasure Beach, has an average monthly surface temperature ranging from 19°C to 28°C.

2.3.1.1 Future Projections

There is a general increasing trend for minimum, maximum and average temperatures for Jamaica from 1950 to present (Figure 2.4). General Climate Models show an increase in mean absolute temperatures for south St. Elizabeth of 1.32°C by 2020 and an increase of 2.09°C degrees by 2030 from the 1986-2005 baseline periods. This general trend of increasing temperature is expected to continue to the end of the century.

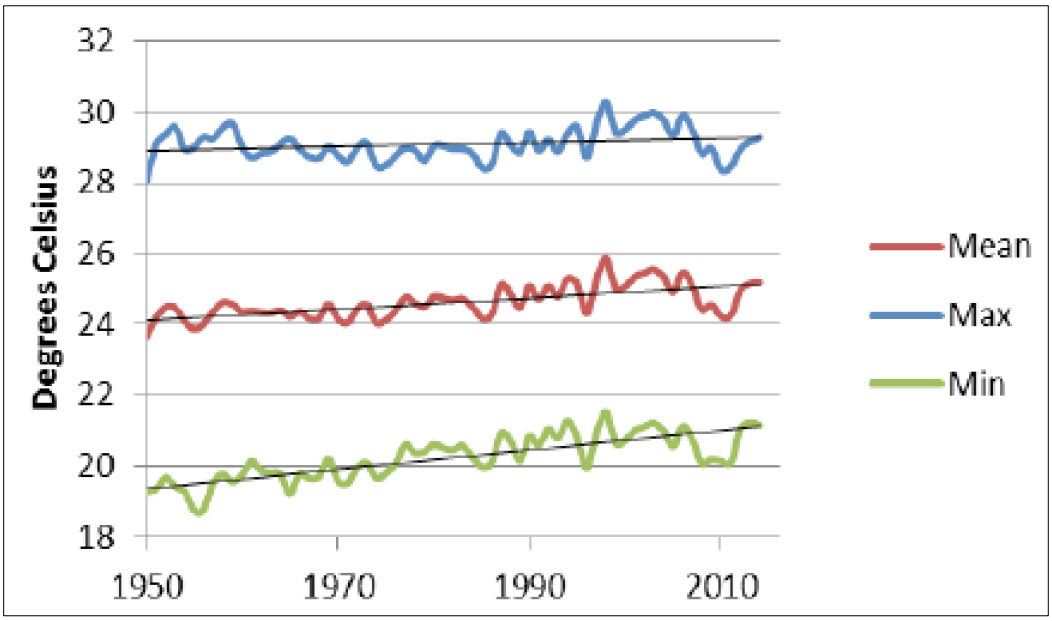

Figure 2.4: Annual maximum, minimum and average temperatures for Jamaica from 1950 to 2010 (CSGM, 2017).

There is also a projection for increased sea surface temperatures which are expected to:

- Affect coral reefs and commercially viable fish stock. Fish may migrate to more temperate seas
- Increase the presence of the Atlantic Sargassum seaweed in the Caribbean region which threatens coastal ecosystems by smothering sea grass beds, coral reefs and mangroves. It also threatens endangered species such as sea turtles by entangling them. Sargassum may wash up on beaches reducing the aesthetics for swimmers.
- Affect reproduction of sea turtles since sex is determined by temperature
- Reduce the ability of corals to withstand impacts of extreme events and also leads to habitat loss for reef fish and their eventual decline. Shore protection will also be reduced where coral reefs are degraded.
- Result in sea grass decline. Sea grasses are sensitive to thermal discharges and can only accept temperatures up to 2–3 degrees Celsius above summer temperatures (CSGM, 2017).

2.3.2 Rainfall

Treasure Beach falls within Zone 4 identified by the Metrological Services of Jamaica. This Zone (Coastal Zone) is characterized as the dry north and south coasts of Jamaica (Figure 2.5). The parish of St. Elizabeth

receives on average between 1500 and 1750mm of rainfall per year (1971-2000) (Figure 2.6) with the months of May and October receiving the highest average rainfall of 262mm and 263mm respectively. During December, the parish receives the lowest average rainfall of 62mm.

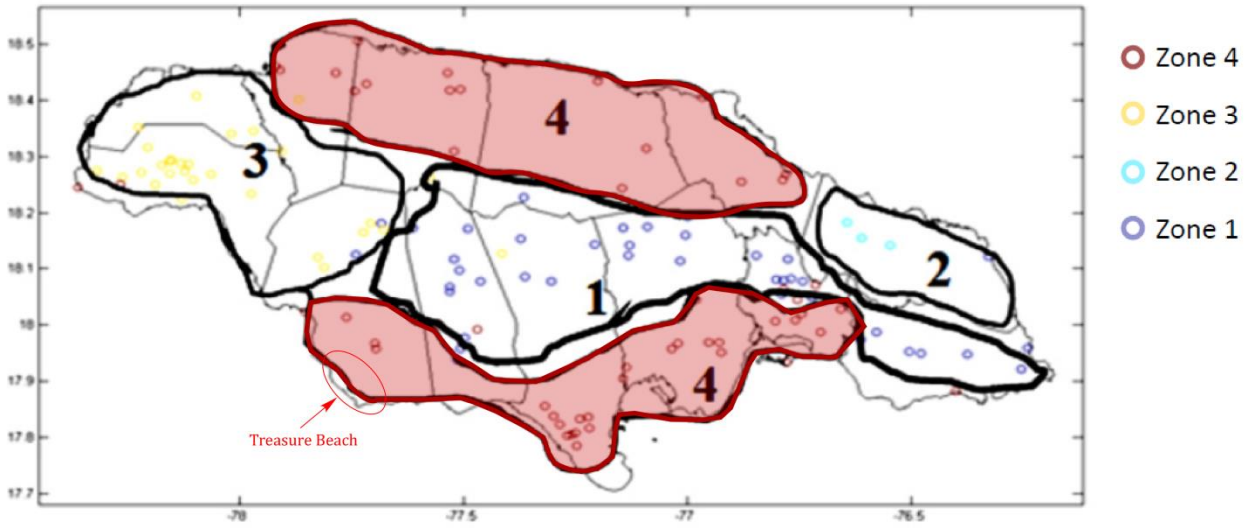

Figure 2.5: Meteorological stations that cluster together with respect to rainfall variability and the four rainfall zones. Zone 1 (The Interior, Zone 2 (The East), Zone 3 (The West) and Zone 4 (The Coastal Zone) (CSGM, 2017).

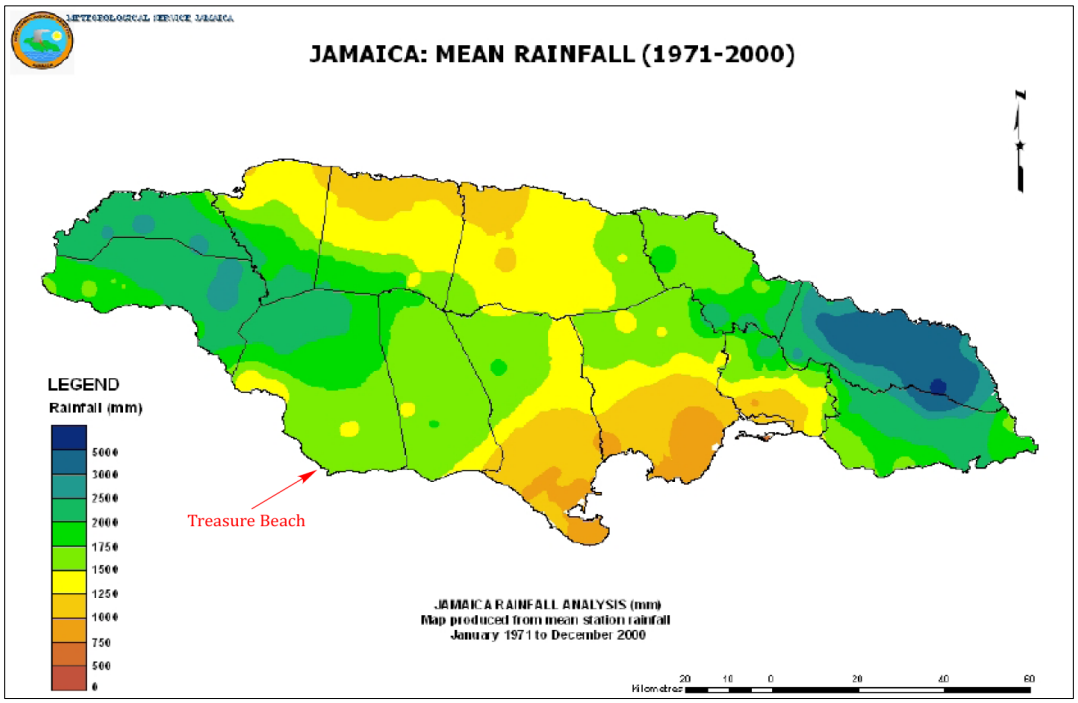

Figure 2.6: Distribution of mean rainfall for Jamaica (in millimeters) for the period of 1971-2000. The location of Treasure Beach is shown which receives an average rainfall of 1500 – 1750 mm per year.

2.3.2.1 Future Projections

Annual average overall rainfall is expected to decrease in Zone 4 over the next century. St. Elizabeth is expected to have an increase in rainfall (from 1971-2000 averages) between 3.04% and 5.43% by the year 2020; however, it is expected to decrease between 10.11% - 15.64% by end of the 2030's.

2.3.3 Tropical Cyclone Activity

The Hurricane season for Jamaica runs from June 1 to November 30 with peak activity in mid-August to late –October (Figure 2.7). Seventy-two (72) tropical storms/hurricanes have passed within 200 km of Jamaica between 1845 and 2015. Between 1950 and 2015, 14 of these storms have passed within 200 km of St. Elizabeth (Figure 2.8). Treasure Beach has been directly impacted by at least 5 of these tropical storms/hurricanes (CSGM, 2017).

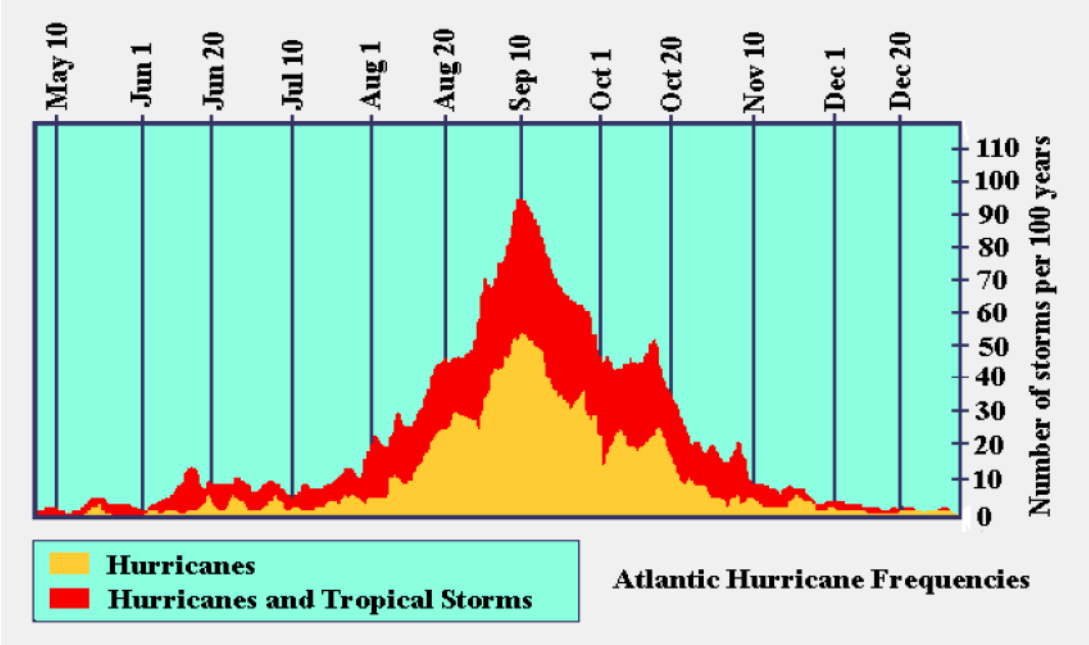

Figure 2.7: Hurricane frequency for the Atlantic hurricane season (CSGM, 2017)

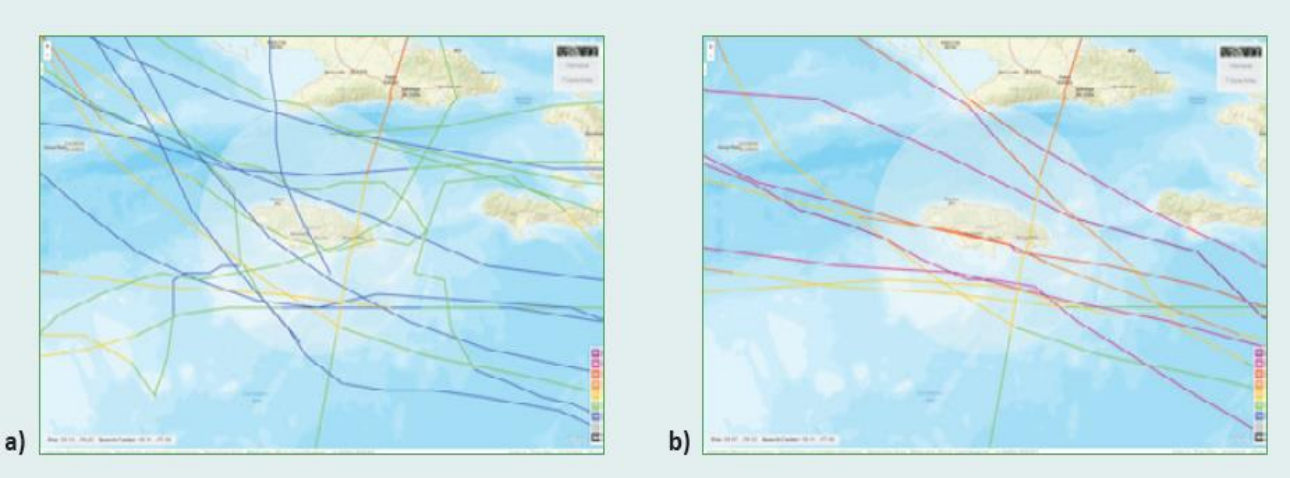

Figure 2.8: (a) All hurricanes impacting the Caribbean basin between 1950 and 2015. (b). Tropical Depressions and Tropical Storms. Source: http/coast.noaa.gov/hurricanes taken from CSGM, 2017

2.3.3.1 Future Projections

It is expected that tropical storms and hurricanes will impact Jamaica with the same frequency of the last two decades, however, the intensity of the storms is expected to increase (CARIBSAVE, 2012). Based on 1950-2015 historical data, there is a 29% chance that a tropical storm will pass within 50km of Treasure Beach (Figure 2.9) (CSGM, 2017).

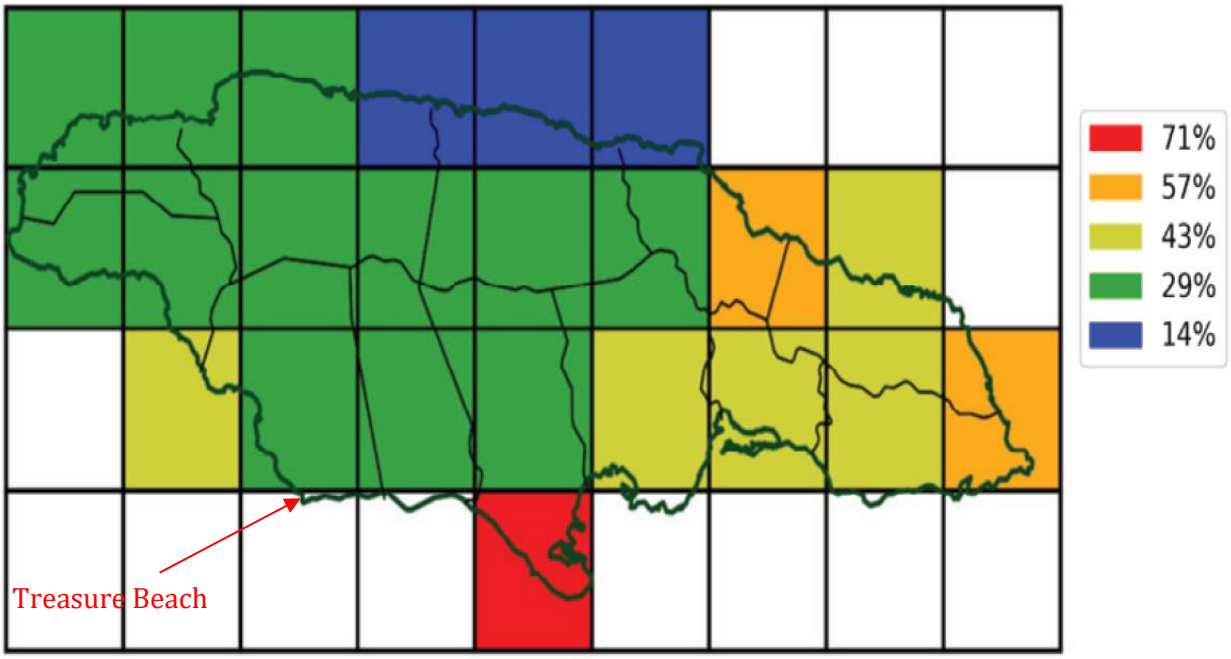

Figure 2.9: Map of Jamaica showing the probability of a hurricane passing within 50km of a grid box based on 66 years (1950- 2015) of historical data (CSGM, 2017).

2.3.4 Sea Level Rise

There is no tide gauge situated in Treasure Beach to directly measure sea level changes. However, it is noted that sea level rise in the Caribbean has followed the Global trend (CSGM, 2017). Measured data shows that sea level is rising at 2.4 ± 0.4 mm/year in the Caribbean Basin with a large increase in more recent years due to El Niño (CSGM, 2017). Measurements at Port Royal, Jamaica shows an average sea-level rise of 1.66 ± 1.6mm per year over the last 18 years.

2.3.4.1 Future Projections

Sea-level is expected to continue its rising trend into the future at an accelerated pace due to higher sustained global and regional temperatures (CSGM, 2017). There are few reports and research done on projections for sea-level rise around Jamaica, and Treasure Beach in particular. However, studies done have attributed present day and future expected coastal erosion to sea-level rise in Jamaica (CSGM, 2017).

2.3.5 Wind

St. Elizabeth is known to have some of the highest wind speeds across the island. There are several windfarms in the parish for that reason. Data has shown a general increase in wind speeds across the parish since 1960 (CSGM, 2017). There is no specific data for Treasure Beach.

2.3.5.1 Future Projections

There are no site-specific future wind projections for Treasure Beach. However, average wind speed across the island is expected to decrease (CSGM, 2017). It is also worth noting that wind speed during storm events are expected to increase due to an expected increase in the general intensity of tropical cyclones.

VULNERABILITY AND CAPACITY ASSESSMENT

3 SENSITIVITY ANALYSIS

The sensitivity analysis is the first step in the vulnerability and capacity assessment. Examining the sensitivity of Treasure Beach will determine the degree to which the community is directly or indirectly affected by changes in climate conditions, e.g. temperature and precipitation, or specific climate change impacts e.g. sea level rise, increased water temperature (Centre for Scient in the Earth System (The Climate Impacts Group Joint Institute for the Study of the Atmosphere and Ocean University of Washington and King County, Washington in association with ICLEI- Local Governments for Sustainability, 2007). If the community is likely to be affected as a result of climate change projections, the community will be considered *sensitive* to climate change.

The analysis will among other things discuss:

- Known climate conditions resulting in stresses on the community;
- How these climate conditions affect the community presently;
- How the impact of climate change will in turn affect the community's main economic livelihoods.

3.1 Existing Climate Related Hazards affecting the Community

A historical review of the events that have impacted Treasure Beach indicate that the main climate related hazards include drought, flooding during heavy rainfall events, and storm surge from passing tropical cyclones or storms. Coastal erosion occurring over a long period of time has been exacerbated by storm surge and high waves during storm events.

The impacts from these different events have at various times resulted in economic and social dislocation to various sections of the community. However, the community has demonstrated its resilience and ability to cope with these events. Despite the seeming resilience or coping strategies, risk to the Treasure Beach community is expected to increase as climate change is expected to exacerbate these hazards.

This section of the report focuses on the main climate related hazards that have affected and are likely to affect the community. It is important to note that as indicated above no hazard modeling was done for this project. The maps presented were based on previously generated data and information gathered during stakeholder consultations with the community and other key stakeholders. This sensitivity analysis attempts to highlight the locations within the community that are most at risk. Proper identification of the extent of these hazards is important to develop adaptation strategies within the Community.

3.1.1 Drought

The coastal areas as shown in zone 4 of Figure 2.5, have been far more prone to year-long drought occurrence than the rest of the island. St. Elizabeth is generally regarded as the driest parish in Jamaica as it receives the lowest total rainfall. (Table 3-1). This lack of precipitation is due to the natural barrier provided by the Santa Cruz Mountains to the east. This is evident in the vegetation of the area which is largely scrubland with a variety of cacti, acacia and lignum vitae trees. These vegetation types are well adapted to low rainfall.

Table 3-1: The number of dry periods as determined by SPI3 and SPI12 in each rainfall zone over the period 1970- 2012 (Zone 4 includes Treasure Beach)

	Number of Dry Periods			
SPI	Interior (zone 1)	East (zone 2)	West (zone 3)	Coasts (zone 4)
3	34	23	25	36
12	6	6	5	11

**The Standardized Precipitation Index (SPI) allows for the determination of the rarity of drought events (or anomalously wet events) on a variety of time scales. Source: State of Jamaica's Climate (CSGM, 2017)*

Records show that the community has been more recently affected by drought in 2009/2010, 2012/2013 and 2015- 2017. The drought in 2012 was considered the worst in decades. During these extended dry periods the entire community is impacted, but the agriculture and tourism sector tend to be the hardest hit.

Very few households and businesses in Treasure Beach rely on rainwater harvesting and storage. In recent years, more residents have purchased water tanks for storage of piped water from NWC. Only 13% of households also depend on private wells or catchments for their water supply (SDC, 2010). Those that receive water from NWC have recently complained of poor water quality as a result of old pipes. The pipes frequently burst because of water pressure and so added to periods of drought, the poor water supply has meant needing to buy water from trucks at $4,000 per load. This is particularly difficult for those involved in tourism.

The St. Elizabeth Municipal Corporation (SEMC) purchases water and supplies to the community. However, this is expensive and, in the past, has put considerable pressure on the SEMC. Over 135 water tanks were made available to farmers in St. Elizabeth by the end of the 2016/17 financial year through the Rural Agricultural Development Agency (RADA) as farmers are forced to purchase water during the dry periods.

The SEMC has indicated that their permit requirements for new developments now make it mandatory for rainwater harvesting.

3.1.2 Flooding

Jamaica has traditionally had a bimodal pattern to flooding occurrences which mirrors the rainfall climatology of the island. There is a minor peak in April-May-June (27% of occurrences) and a maximum in September-October-November (39%) (Figure 3.1). Since there is a statistical correlation with the mean monthly distribution of floods and the mean rainfall climatology this suggests that any changes in the mean rainfall regime will likely be accompanied by changes in the frequency of severe floods. There has been an increasing trend in flood occurrences over the last century as seen in Figure 3-1. The period between 2000 and 2010 was the most intense decade on record with 35 flood events (CSGM, 2017) with Treasure Beach being most seriously affected in 2005.

Hurricanes, depressions and waves account for 46% of all the devastating flood events in Jamaica while storms and troughs account for 21%. Rainfall events of one and two days duration dominate (67%) the occurrence of severe events (CSGM, 2017).

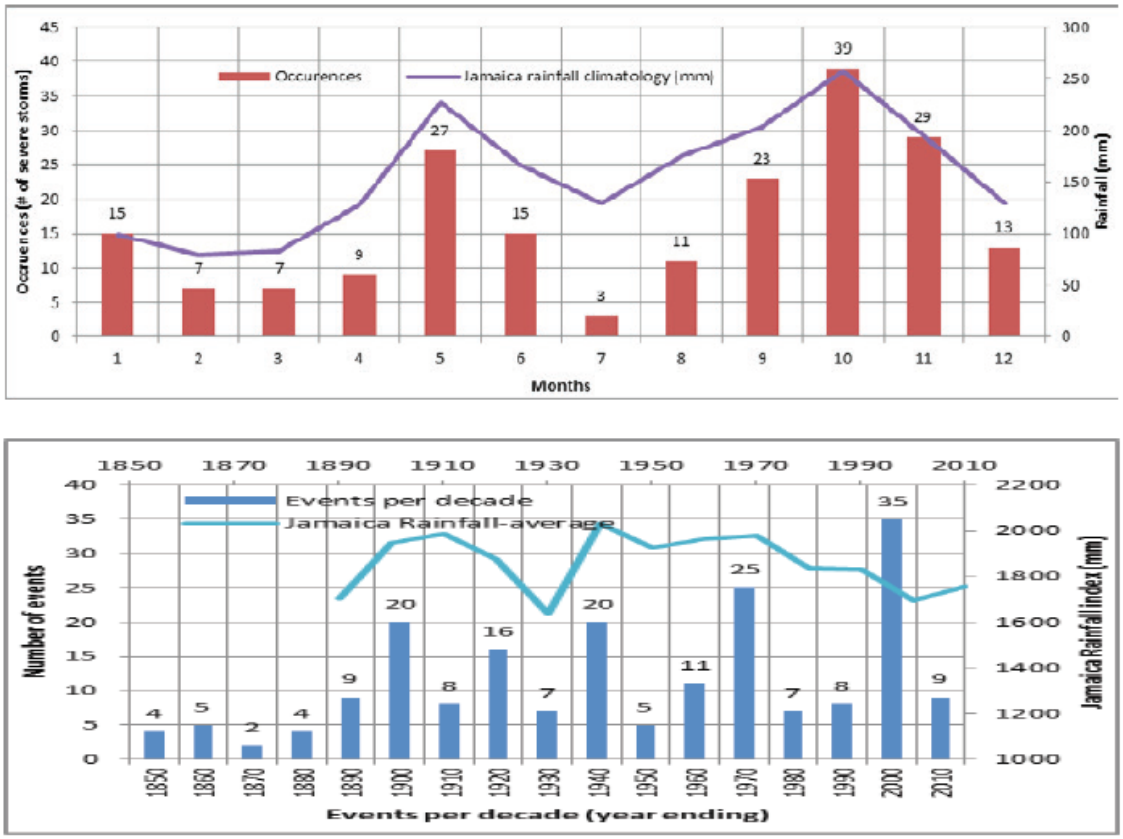

Figure 3.1: Severe flooding climatology for Jamaica for the period 1850 to 2010 for 198 events (top). Occurrences of severe flood events per decade for the period 1850 to 2010 with decadal mean Jamaica Rainfall index (mm). Source: Burgess et al. (2015) from CSGM, 2017.

Despite the area being typically dry, Treasure Beach has been affected periodically by flooding due to heavy rainfall events. Flooding tends to be worst in the coastal sections of Treasure Beach, affecting not only houses but also sections of roadway in Great Bay, Calabash Bay, Billy's Bay and Pedro Plains. When flooding does occur along these roadways it has made it impassable for cars and/or pedestrians, forcing residents to move around using small canoes.

Due to the community's location towards the base of the Santa Cruz Mountains, heavy rainfall within the mountain range flows down the slopes over the farmlands and down the main roads into the coastal section of the community. The area has several ponds, including the Great Pond, some of which are intermittent and act as temporary storage or slows the flow of water until it reaches the sea.

Flooding has impacted negatively on farm lands causing farmers to divert the water which now impacts the main road. Since there are limited drains, the main roads act as large waterways during heavy rainfall.

Increased development in sections of the community, particularly along the coastline, has also resulted in changes in the amount and concentration (ponding) of run-off. In some instances, it causes run-off to back-up and form large ponds in areas that would not typically pond. Increased development along the coastline further restricts flow out to sea.

After the floods in 2005, which most consider the worst to have ever affected the community in recent times, there were calls for a comprehensive drainage plan for the area. Thereafter, in 2016 a 1,000 metre drainage canal from Great Bay to the sea at Old Wharf Bay was constructed by the NWA. It was intended to drain the ponds so as to reduce the flooding that was typically caused by heavy rainfall in sections of the community. However, only about 15% of the drain was paved (Jamaica Observer, 2017).

This drain has made a significant improvement for only some areas closest to the Great Bay Pond. Several of the communities still experience flooding during heavy rainfall. Heavy rains in June 2017 resulted in extensive flooding of sections of main roads and resulted in renewed calls for a comprehensive drainage plan for the community (Jamaica Observer, 2017).

The other drains that do exist along sections of Calabash Bay main road and in Great Bay are not adequate for the volume of water that is generated during heavy rainfall.

Additionally, due to the several ponds in the area, mosquitoes are a pervasive issue after 5pm. However, whenever there is heavy rainfall resulting in more ponding it becomes an even greater issue, particularly for visitors. This is a major cause for concern with respect to vector borne diseases such as dengue and malaria.

3.1.3 Tropical Cyclones/ Hurricanes

The location of Treasure Beach along the South Coast of Jamaica makes it susceptible to Tropical Cyclones/Hurricanes which travel south of the island. Records of the National Library of Jamaica (NLJ) going as far back as 1722 indicate that forty-three hurricanes or tropical storms are recorded as impacting Jamaica. From the descriptions, given their paths or impacts, nineteen or approximately one in every 2.3 events, impacted or were likely to have impacted Treasure Beach. Additionally, in the past 70 years, more than 14 tropical cyclones/hurricanes have passed within 200km of St. Elizabeth. The impacts experienced from these passing storms includes storm surges, coastal flooding, wind damage and coastal erosion.

In 2004 Hurricane Ivan passed just 30km south of Jamaica causing significant damage across the island. In Treasure Beach there was significant damage to property along the coastline. Roads, hotels, and houses all experienced severe damage and beach loss was significant. In 2007, Hurricane Dean passed 40 km south of St. Elizabeth (Edwards, 2007). Despite not making landfall the hurricane caused significant beach loss and property damage in the community (PIOJ, 2007). Table 3.2 below highlights some of the most notable events occurring in the last 3 decades which have had a significant impact on Treasure Beach.

Table 3-2: Recent significant storm events experienced by the Treasure Beach Community

Event and Date	Damage
Hurricane Gilbert, 1988	● Severe damage, to housing, property, tourism, agriculture and fishing livelihoods ● Damage to road network, other public infrastructure and beaches
Hurricane Ivan, 2004	● Erosion on the recreational beaches in Treasure Beach ● Damage to housing along the coast ● Damage to road network along the coast ● The winds of the hurricane and the associated storm surge caused severe damage to hotel and restaurant infrastructure in Treasure Beach
Hurricane Emily, 2005	● Flooding in the Treasure Beach community made it inaccessible. The road in the vicinity of the Police Station had split in two.
Hurricane Dean, 2007	● Loss of property from the ocean side of Treasure Beach Hotel
Tropical Storm Sandy, 2012	● Storm surges impacted coastal properties

3.1.3.1 Storm Surge and Waves

The south coast of Jamaica only has patchy fringing reefs which leaves the Treasure Beach coastline at great risk from storm surge and strong/high waves. It has been estimated that storm surge during Hurricane Ivan and Hurricane Dean reached heights above 1.5 m and inundation was up to 30m inland in sections causing significant beach erosion (Figure 3.2) (Robinson & Khan, 2008). Tropical Storm Sandy also caused high surges which severely impacted Treasure Beach. Other south coast communities and beaches have experienced and recorded similar and significant impacts from tropical cyclones passing more than 200km from Jamaica. Hurricane Felix in 2007 passed some 790 km south of Jamaica (NOAA, 2007) causing significant damage to south coast beaches including the Palisadoes (Robinson et al., 2011).

Figure 3.2: View looking south from Siwind towards Treasure Beach Hotel. Older dunes are partly exposed at the base of the cliff. This area had a sandy beach before hurricane Ivan (Source: Marine Geology Unit, UWI, 2008)

It has been estimated that Hurricanes Ivan and Dean caused the beach in Calabash Bay to erode some 25m inland (Figure 3.3) due to significant wave action and storm surge (Robinson & Khan, 2008). Other areas of the coastline in the community also experienced significant beach loss particularly sections of Billy's Bay to Frenchman's Bay and sections of Starve Gut Bay. A fisherman in Frenchman's Bay indicated that storm surge has reached up to 16.5 meters inland (Figure 3.4).

Figure 3.3: Calabash Bay, Treasure Beach showing limited beach sand after the passage of Hurricane Ivan (Source: Robinson & Khan, 2007).

With expected increased intensity of tropical cyclones and hurricanes in the Atlantic Basin along with increasing rates of sea level rise, impacts of storm surge and strong/high waves will be far reaching with greater intensity. This will exacerbate the impacts experienced on coastal communities around Jamaica such as Treasure Beach.

Figure 3.4: Fort Charles Bay: A fisherman stands where the storm surge reached during Hurricane Dean (2007) 16.5 meters from the water's edge.

3.1.3.2 Coastal Erosion

Reports of battering waves coupled with rising sea levels have caused significant beach erosion along Treasure Beach within the last five years (Jamaica Observer, 2016). While the majority of the beach was eroded by hurricanes, locals have indicated that in 2016 almost 10m of beach had eroded due to strong waves within the past year (Jamaica Observer, 2016).

Consultations with key stakeholders in the community have indicated that sections of the coastline have been undergoing erosion, specifically Great Bay fishing beach, Calabash Bay, Billy's Bay, and Fort Charles. Up to 100 feet of beach has reportedly been eroded over the last 50 years (community stakeholder consultation). However, Hurricane Ivan has been credited with causing the most significant coastal erosion and much of the coastline has been either recovering very slowly or continuing to erode since. The famous turtling beach between Billy's Bay and Fort Charles has also reportedly eroded over 50 ft due to Hurricane Ivan and has not recovered since. The coastline between Frenchmen's Bay and Fort Charles shows evidence of coastal erosion (Figure 3.5 and Figure 3.6).

Figure 3.5: The remnants of an eroded well shaft located along the coastline in Billy's Bay

Figure 3.6: Evidence of coastal erosion along Billy's Bay (top image) and Fort Charles (lower image)

3.2 Critical Infrastructure

The UNISDR (2017) defines critical infrastructure as the physical structures, facilities, networks and other assets which provide services that are essential to the social and economic functioning of a community or society. Critical infrastructure are especially important right before an event and in the immediate aftermath of a disaster. The table below describes the critical infrastructure within the Treasure Beach Community and Figure 3-7 shows their location.

Table 3-3: Description of Critical Infrastructure in the Treasure Beach Community

TYPE OF CRITICAL INFRASTRUCTURE	DESCRIPTION
Health Centres	There are no health centres within the Treasure Beach community. The closest health centre is the Newell Maternity Centre (Type II) but it does not have a curative session with a visiting doctor. The nearest health centre where patients can visit with a doctor for certain issues is in Southfield (Type III). The closest hospital is located in Black River (upgraded Type C).
Police Stations	The Pedro Plains Police Station is within the Treasure Beach community and is considered an outstation to the Black River Police Station.
Fire Stations	There are no fire stations in the Treasure Beach community. The nearest station is in Black River. However, if the truck is not at base the next closest station to respond is the Junction Fire Station followed by Santa Cruz Fire Station.
Main Routes- Evacuation Routes	Great Bay Road- the main exit/ entrance road for the Great Bay Community Beacon Road- the main exit/ entrance road Pedro Plains Road- the main exit/ entrance back to Junction Calabash Bay Main Road-the main road between Billy's Bay and Calabash Bay *The coastal road from Billy's Bay to Parottee/ Black River- this is not considered a main route but could be used as an alternative in the event that other major routes are impassable.*
Gas Stations	The nearest gas station is Pedro Cross which is not within the study area and is also not expected to be affected by storm surge or flooding.
Main Economic Centres	Agriculture- Beacon, Blunters and Pedro Plains Tourism , Retail, Commerce - Calabash Bay Area Fishing- Great Bay, Calabash Bay, Frenchman's Bay, Fort Charles
Shelters	Parotee Primary, Sandy Bank Primary, Hopewell Primary, Geneva Primary and Newcombe Valley Primary School (Priority shelter).

As outlined in the table above, there are no health centres, or fire stations within the Treasure Beach community, however there is one police station. This police station is not within the zone of influence for storm surge or flooding. Figure 3-8 shows their location in relation to the impact zones of climate related events.

Several of the main roads which would act as evacuation routes in the event of an emergency are coastal and sections are located near to ponds which typically flood in extended periods of heavy rainfall. Several sections of these routes have been affected in the past by flooding namely sections along Great Bay Road and Calabash Main Road (See Section 3.1.2). JPS infrastructure located along the main roads is also likely to be affected particularly in heavy wind events.

There are four available vehicular roads out of Treasure Beach:

1. A coastal route via Fort Charles Bay to Black River. This would be the most hazardous and least recommended, because of potential landslides, flooding across parts of the alignment, and the existing narrow and poor road surface conditions.
2. An inland route through Newell and Williamsfield is the quickest to Black River but assumes that the Crane Road leading into Black River is not inundated which is reported to be a very infrequent event.
3. A third route through Mountainside and to Lacovia Holland and then Black River is available. Although this route joins the main A1 road connecting south coast parishes, flooding along the Lacovia /Middle Quarters segment happens frequently in heavy rainfall.
4. The fourth route, across the Pedro Plains and then ascending though Southfield to descend to Gutters, although being a very popular route to Mandeville and Kingston, would be impractical and long if Black River was the emergency destination to be reached.

The conclusion in relation to evacuation planning, is that choices among routes are poor and underscores the need for early evacuations to be ordered, to allow timely use of the routes available.

The main economic centres are likely to be affected by any of the climate related events. Drought affects the agricultural communities greatest and flooding and storm surge and wave activities affect the tourism and fishing communities greatest. In the event of poor weather conditions, fishers are unlikely to go to sea which would affect their earning potential for that time period.

Five shelters serve the Treasure Beach Community, however only one is actually in the Treasure Beach community. According to Figure 3.8 only one of these shelters is at risk of being affected by storm surge/ coastal inundation. Although it is at the base of slight elevation, the school has not been affected by flooding in the past. The section of the school that is designated to be used as a shelter has some roof issues resulting in leakage in sections. However, the school has reportedly never been used by community members. Consultations with the community revealed that there is a general preference by persons to stay in their own homes in the event of a storm despite the risks.

As illustrated above there is little critical infrastructure except for lifelines (roads) within the community itself that is likely to be affected. However, in case of the emergencies, the distance and access to health centres/ hospitals, fire and police stations from the community may be problematic, especially given the potential issues with the main evacuation routes as discussed above.

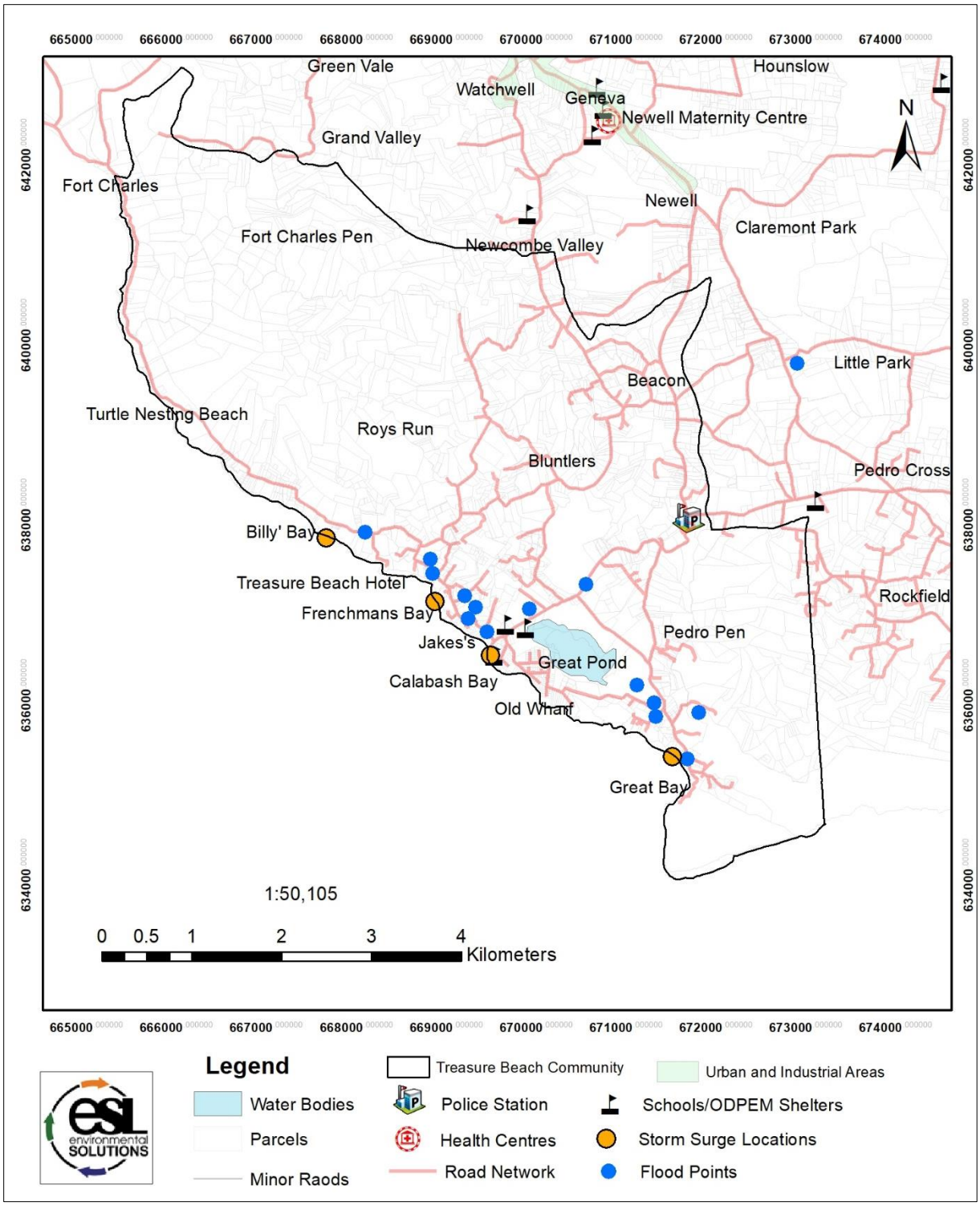

Figure 3.7: Critical Infrastructure in Treasure Beach

3.3 Summary of Climate Sensitive Locations

The previous sections highlight that the Treasure Beach community is most often affected by extended dry periods, flooding and storm surge and coastal erosion. Figure 3.8 shows that the areas most often affected, and therefore most at risk include:

- Drought- The entire area
- Flooding- Areas closest to seasonal ponds-
- Coastal Inundation and Storm Surge- The entire coastline is at risk, particularly sections of Great Bay, Calabash, Frenchman's Bay and Billy's Bay
- Wind- The entire community is exposed, however properties nearest to the coastal zone are at greatest risk.

As indicated above, the map was generated based on historical events and not on current modelling.

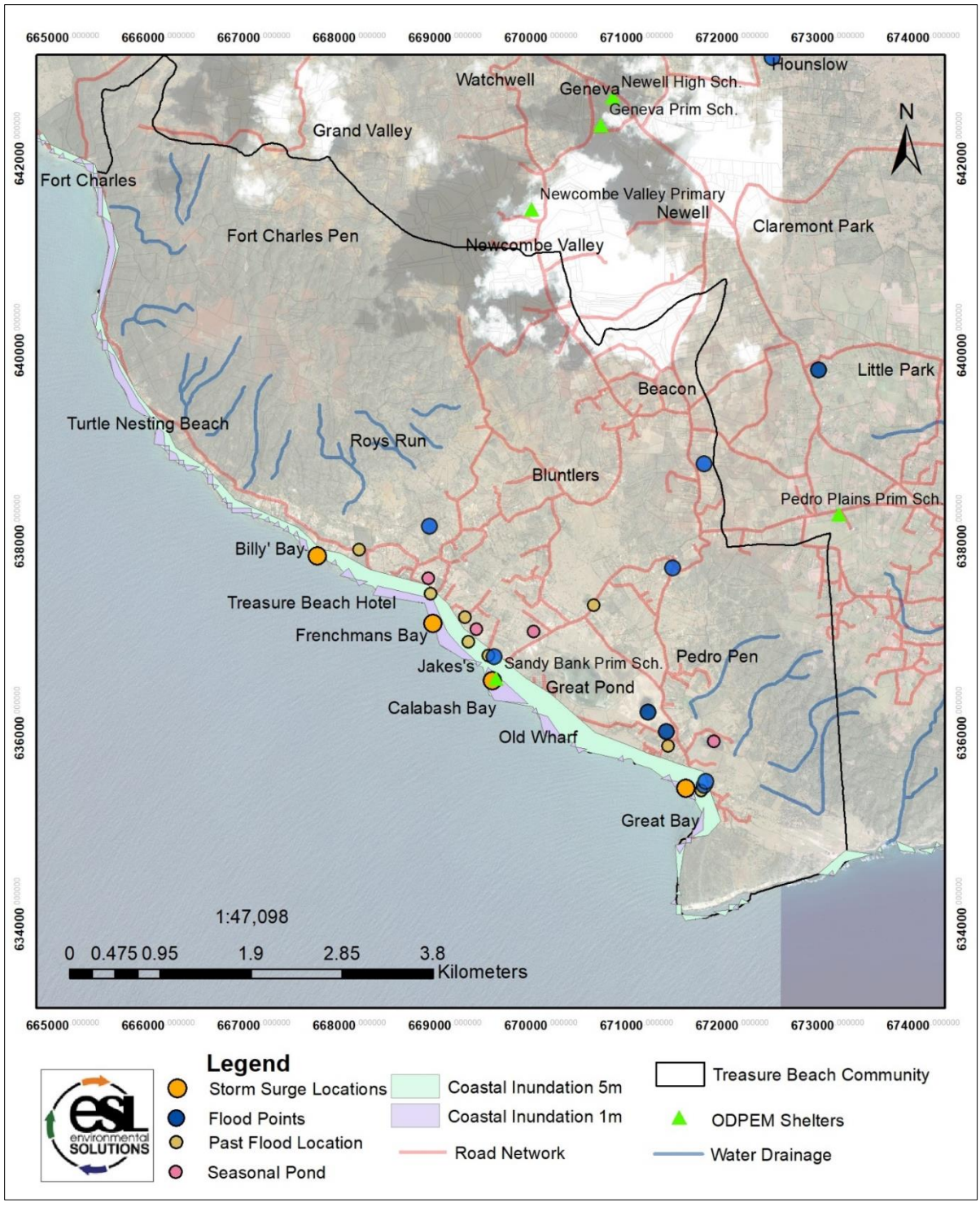

Figure 3.8: Locations sensitive to flooding, storm surge and coastal inundation based on previous events

3.4 Societal Analysis

Since most of the community is involved either directly or indirectly in the three main economic activities (agriculture, fishing and tourism), the sensitivity of the community is discussed under these three headings.

The other characteristics of the community that potentially increase their vulnerability to climate related events include the number of persons with disabilities, age of the population and gender. These are further discussed in section 3.3.4 .

The following subsections describe each of these activities in greater detail and explain how exposed they are to the impacts of climate variability and change.

3.4.1 Agriculture

The Treasure Beach Community is administratively within the Pedro Plains Enterprise Area managed by Rural Agriculture Development Authority (RADA) on behalf of the Ministry of Industry, Commerce, Agriculture and Fisheries (MICAF). Although the main areas of crop production in Treasure Beach (Figure 3.9) are centered in Beacon, Blunters and Pedro Plain (Figure 3.10), the Enterprise Area comprises several other producing communities to the North (Farenough, Watchwell, and to the South East (Claremont Park and Hounslow).

Figure 3.9: Farming in Blunters and Pedro Plains in Treasure Beach

Figure 3.10: The Main Treasure Beach Agricultural Communities highlighted in Green (based on the STATIN ED 65, ED 67 & SW 75).

3.4.1.1 Crops

Consultations with both Government Agencies and local farmers put Treasure Beach's contribution to production within the Pedro Plains Enterprise Area at about 55%. Crop production data provided by the MICAF for the Pedro Plains Enterprise Area was adjusted by the Consultants, using this percentage to arrive at an indicative value of production for select crops.

Table 3-4: Estimated Main Crop Cultivation in Treasure Beach Community Volume and Value

	Crops	Production in lbs. 2017	Average Farm Gate Price (JA$)	Production Value 2017 (JA$)
High Importance	Melon	7,320,500	47.50	347,723,750
	Cantaloupe	2,265,120	81.00	183,474,720
	Tomatoes	1,617,660	70.40	113,883,264
	Beet Root	1,151,040	50.00	77,352,000

	Crops	Production in lbs. 2017	Average Farm Gate Price (JA$)	Production Value 2017 (JA$)
	Cucumber	1,335,180	36.42	48,627,255
Lower Importance	Peanuts	62,920	2,500/bushel	7,865,000
	Green Pepper	263,340	128.70	33,891,858
	Scallion	184,140	124.00	22,833,60
Total		**14,199,900**		**812,817,847**

Inspection of the tables shows that the production value of the main crops planted at farm gate prices in the Treasure Beach Community was in the order of JA$813m in 2017.

Existing Climate Stresses

Farmers are becoming more informed as to what climate variability means. They readily identify the changing local weather patterns. They identify climate change and variability with the observed changing patterns of both rainfall and drought and consider them the leading contributors to the challenges faced by the farming community in Treasure Beach.

Opinions vary among farmers spoken to as whether they are more vulnerable to drought or to flooding. The farmers in communities that have access to irrigation water are more concerned about flooding. Those mainly closer to the coast, see flooding as the more important hazard.

The climate challenges experienced are described further in the table below.

Table 3-5: *Existing climate challenges faced the agricultural sector in Treasure Beach*

Existing Climate Related Stresses	Description
Water Supply/ Variability of rainfall	Lack of a regular and steady supply of water and the absence of surface water, large catchment areas and having only a limited number of wells, is an important challenge for farmers. Water supply affects some Treasure Beach Communities more so than others. Pedro Plains is a production growth area that is heavily affected. Blunters and Beacon both receive irrigation water from NIC but it is not consistently reliable and the cost increases the cost of production. As such there is heavy reliance on rainfall. The conventional rule of thumb "One month of rain followed by 2 to 3 months of drought" is no longer considered valid. Farmers lack predictability in their planting and reaping

Existing Climate Related Stresses	Description
	schedules. This has been particularly evident over the 2016-2017 calendar year which saw prolonged periods of rainfall.
Temperature increase	Farmers have observed increasing temperatures. In overly hot conditions the high evaporation rate limits water reaching the roots of crops. This in turn stunts growth. By contrast the normally windy conditions act to mitigate the full effect of temperature rise. The timing and duration of both rain and heat can therefore determine the percentage of any crop that farmers can expect to lose during the growing period.
Increase in plant diseases	Farmers associate climatic variability with the incidence of plant disease. Heavy rainfall brings with it the challenge of fungal and bacterial infection in crops. The main infections of concern is downy mildew (Pseudoperonospora a fungus that affects plants like melons, tomatoes, cucumber and generally the *Cucurbitaceae* family of crops. This disease results in the withering of leaves, the stunted growth of the plants and poorly flavored fruit. Periods of excessive heat farmers associate with insect borne diseases. The Broad-Mite (*Polyphagotarsonemus Latus*) propagates rapidly and has a very large host range which includes over 60 families of plants. Many of these plants are the staple fruit and legume crops in the Treasure Beach Community. The Root Knot Nematode (Meloidogyne SP) is particularly damaging to new plantings.
Flooding	Flood events, when they do occur, contribute significantly to loss of production. The unusually prolonged rainy season in 2017, though not generating consistent flood conditions, caused significant crop loss in the farming communities. In addition to physically damaging or destroying crops, flooding removes top soil, which can easily find its way into drainage systems that in turn, because of blockage, create inundation or major ponding issues for other farms and residential areas closer to the coast.

Several farmers see recent years as periods of much uncertainty in planting decisions, both in terms of crop selection and sowing times. This in turn adds to their risk during the growing periods and can cumulatively bring about market disequilibrium which may affect supply and demand. The consequences of this chain of market uncertainties can be poor prices during gluts and lack of production during scarcities.

Another cultivation practice that increases flood risk is the reported cutting of guinea grass from the hillsides by farmers to use for mulching. This however increases surface run-off which in turn leads to flooding of the farm lands.

3.4.1.2 Livestock

Livestock farming in Treasure Beach comprises mainly goat and sheep. Some features include:

- Typical farm lots are between 1 and 2 acres but farmers often have multiple lots.
- Goat and sheep are foraging animals and tend to require less husbandry effort than crop cultivation does.
- Herd sizes are small comprising typically about a dozen on the hoof.
- Animals are usually penned at night to prevent straying and praedial larceny.
- Farmers often employ part time assistance or use family labour.

Livestock farming in the community is an income supplementing activity rather than a main income generator for most farmers engaged. Cattle are not a popular farm animal, mainly because of its greater food and water requirements. Production systems therefore are much smaller than crops and are reported to contribute much less to farm income and employment within Treasure Beach. The production value for livestock in 2017 was JA$36,114,000 (Table 3-6).

Table 3-6: Estimated Main Livestock Production in Treasure Beach Area Volume & Value

	Livestock	Production lbs. 2017	Average Farm Gate Price (JA$)	Production Value (JA$)
High Importance	Goat	52,000	300	15,600,000
	Sheep	780	300	234,000
Lower Importance	Chickens	6,500	180	4,680,000
	Cattle	130,000	120	15,600,000
Total				**36,114,000**

Existing Climate Stresses

The primary stress faced by livestock farmers relate to drought. For those in communities not supplied by the NIC (See subsection above), water is derived from sources of domestic supply in periods of low rainfall. This is very costly. It was reported that in 2015 during the very bad drought period, one farmer lost over 50 cows.

3.4.2 Fishing

Fishing in the community is centered mainly along the Great Bay and Frenchman's Bay Area as well as in select beach areas along the coastline of Fort Charles. Data requested from the Fisheries Division is presented in Table 3-7 below.

Table 3-7: *Main Fish Production in the Pedro Plains Enterprise Area*

	Production in lbs. 2017	Average Farm Gate Price	Production Value
All Fish Products	2,584,197	350	J$904,468,999

The Great Bay fishing beach is the main berthing point in Treasure Beach, although other beaches provide berthing. In all, there are 5 locations where boats (in varying numbers) berth:

- Great Bay
- Calabash Bay
- Frenchman's Bay
- Billy's Bay
- Fort Charles Bay

The number of sea worthy vessels at Great Bay is about 15 and there are about 45 regular fishers. Fort Charles Bay has a very small fishing beach near 'Gut Bay on Mays' comprising 5 boats and 13 regular fishers. In all it is estimated that one in every 3 community members is involved directly in, or by close proxy, to fishing.

Fishing, like farming, is a traditional economic activity in Treasure Beach. It provides alternate and often seasonal rotational employment exchanges between fishers and farmers. This exchange of occupations is determined as market, economic or even climatic conditions dictate.

Figure 3.11: The Great Bay Fishing Beach

Existing Climate Stresses

The following table describes the issues considered by fishers to be leading contributors to the climatic challenges faced by the fishing community in Treasure Beach.

Table 3-8: Existing climate challenges faced the fishing communities in Treasure Beach

Existing Climate Stresses	Description
Increasing storm conditions- High waves	The main natural hazards that fishers contend with are winds in the form of cold fronts which are accompanied by high waves. Fishers have reported that winds are increasingly arriving from different directions. This has increased the risk of losing fishing pots and gear. Storm conditions usually require beaching vessels well away from the beach, or finding marshy inlets for shelter.
Species loss	Fishers report that some species are leaving the area, namely Jack and Fry Bait. The latter is very seldom seen, though up to 30 years ago it was an abundant staple. The Lionfish was once a very present predator, more recently it is seen in diminishing quantities. Fishers have blamed increase in sea surface temperatures. Although, they do acknowledge some species may have been affected by overfishing.
Loss of beach area/ berthing area	This is claimed or contradicted depending where along the coastline fishers are asked. In Great Bay some older residents speak of a time when the beach extended almost to the Pedro Bluff headland and interpret this as evidence of loss of beach because of climate change. A younger generation of fishers has seen the beach 'reclaiming the sea' and expanding seawards (Figure 3-11). They too interpret this as due to climate change. Fort Charles Bay also has reported significant beach loss over time. A likelihood supported by the coastal erosion which is taking place along this coastline (also see discussion in section 3.4.2).
Inland Flooding	The impact of flooding on fishing activities is an important concern for fishers from Great Bay and Fort Charles Bay. Flood events end up depositing large volumes of debris and soil in both bays. In Great Bay fishers estimate that turbidity is experienced for almost a three quarters of a mile offshore.

Figure 3.12: Great Bay fishers remember jumping into the water from these piles

3.4.3 Tourism

Treasure Beach while still categorized as a small tourist resort area has been developing rapidly into an internationally branded cultural tourism destination. A strategic development model has marketed it as laid-back and informal with an accent on rustic-rural, which offers friendliness, very good cuisine and adventure tours to the more mainstream beauty spots. The accommodation sector comprises 4 main hotels and about 230 properties engaged in Air B&B (also known as home stay) accommodation (Figure 3-12). Data on this latter sector is not readily available. However, based on data from the Ministry of Tourism in relation to national averages, a working assumption about the importance of the accommodation sector in Treasure Beach has been attempted.

Figure 3.13: *Two Hotels: South View Hotel and Jakes*

The tourism accommodation market in Treasure Beach offers an estimated total of 324 rooms. This is made up of 93 hotel rooms and an estimated 231 Home Stay rooms. Based on national average indicators for both hotels and home stays provided by TPDCO and estimates of the number of available Home Stay person nights, the Consultants estimated that Treasure Beach visitor accommodation generated a very approximate value spend of JA$303.5M in 2017 (Table 3-9).

The average length of stay in Treasure Beach is likely to be around 15 nights based on a similar official figure for the Island's private accommodation sector in 2017.

Table 3-9: Indicative Features of the Tourism Sector in Treasure Beach

Type of Accommodation	Available Rooms Nights	Occupancy Ratios 29%	No of Occupants (1.5per room)	Estimated Per Person Night Expenditure (US$1 =JA$125	Value of Tourism Spend
Hotels	33,945	9,844	14,766	Ja$ 5,900	87,119,400
Air BnB	84,315	24,451	36,677	Ja $5,900	216,394,300
Totals	**118,260**	**34,295**	**51,443**	**Ja$5,900**	**303,513,700**

Notes: 1) Occupancy Ratio is industry average for Hotels 50 rooms and under. 2) Per person night Expenditure is all Island average for House Stays, Tourism Product Development Co.

Existing Climate Stresses

The industry's greatest existing climate challenges relate to inland flooding, drought resulting in issues with the availability or adequacy of drinking water and to a lesser extent wind events and storm surge.

Table 3-10: Existing climate challenges faced the tourism sector in Treasure Beach

Existing Climate Related Stresses	Description
Inland flooding	Flooding is a major concern in the community generally. The main locations that support local tourism activities lie in flood prone locations. Calabash Bay, Frenchman's Bay and to a lesser extent Billy's Bay are severely impacted during heavy flooding events. The relative linearity of these locations along the major coastal main road means that visitors can easily be marooned or even flooded out of accommodation. The project area has shown repeated effects of flooding from short duration, high intensity rainfall events mainly from the passage of tropical storms and hurricanes (see section 3.3 for further details). Flooding has been responsible for significant social and economic losses including recorded loss of human lives in some events.

Existing Climate Related Stresses	Description
	Stakeholder interviews and observation by the Consultants also point to some anthropogenic factors: ● Poor drainage and low-lying topography in coastal sections ● Construction of structures within natural drainage paths impeding the flow of run-off ● Lack of infrastructure to trap silt and to remove it when it floods ● Clearance of large tracts of land for agriculture upland areas which when it rains, erodes water courses and flooding occurs. The potential of vector borne diseases, in both an intense wet season or drought, is increased by the low lying nature of the community and the presence of wet lands and ponding or air borne pathogens in the community's semi- arid and windy environment.
Inadequate Water Supply	Due to the dry nature of the area, Tourism accommodation are often challenged to provide acceptable water supply for both direct and indirect visitor needs including cooking, washing and cleaning (important in the hotel, villa and Air B&B trade). It is worse in drought years. Persons often have to buy water from trucks which is expensive and eats into their profit margin.
Tropical Storms/ Hurricanes- wind and storm surge	Many of the coastal properties are located within the setback zone- several properties have been observed to be built on dunes. As such during major hurricanes such as Ivan in 2004, many of these properties experienced major beach loss and damage to their property. Properties not located immediately along the coastline also experienced roof damage.

Where tourism-related fresh water demand is significant, tourism can add considerable pressure on available fresh water resources, particularly when these are concentrated in regions with few or no water resources, low aquifer renewal rates, and few or no surface water sources, such as typifies the Treasure Beach area (Ref Gössling, 2002b; Rodriguez Diaz et al., 2007).

The tourism demand on water resources can be expected to increase with:

- tourist numbers
- more rigid accommodation standards
- increasing demand of other sectoral water requirements as tourism grows.

These themes have been explored in the context of climate change in studies such as those done by Gossling, Peter, Hall, et al (2011). The paper drew attention to the fact that in the context of climate change some observable features are: *"Water consumption by hotels is far higher than household consumption, due largely to … watering of gardens that must be kept attractive, daily cleaning of rooms, filling of swimming pools, kitchen and above all, laundry. Furthermore, holidaymakers have a 'pleasure'*

approach to the shower or bath and generally use more water than they would normally" (Gossling, Peter, and Hall. Et al 2011).

3.4.4 Other Societal Sensitivities

Outside of the economic sphere, individuals at a household level in communities, particularly due to gender, age restrictions, illness or disabilities, are also challenged by climatic events.

3.4.4.1 Gender and age

Climate variability also creates some stressors because of demographic characteristics. Females traditionally tend to be at higher risk from several physiological and cultural angles. Where single parenting occurs, females are usually the only parent, therefore carrying the financial and emotional cost of caregiving in both the pre- and post-disaster periods. Accessing finance for prevention or recovery is challenging. Females are at a distinct disadvantage in finding employment in the post event period as their skills seldom align with the construction rebuilding skills that males can offer.

Gender roles have also burdened females with having primary responsibility for caring for the aged or disabled. These culturally imposed norms must be assumed to increase the degree of disadvantage imposed by climatic events to the 48% of the population who are females and the 37% percent of the population who are considered too young to work or too old.

3.4.4.2 Disabilities

The number of disabled person found during the STATIN 2011 Census for St Elizabeth was used to extrapolate the likely incidence of disabled persons among the population of Treasure Beach. The severity of the disability is at the level of 'Cannot do at all' which is STATIN's most severe criteria. The number of persons derived include: Sight 9; Hearing 6; Walking 12; Communicating 6; and lifting 6. By similar extrapolation, the number of persons with varying degrees of disability who are required to look after themselves (self care) is 13. It must be emphasized that these figures are indicative of the number of severely disabled persons who would require special care and protection during even the less severe, climatic events.

3.5 Summary Sensitivity Analysis

Treasure Beach is already impacted by climate related events, it is also highly likely to be affected by the projections made for the area for climate change. As such the community is considered ***sensitive*** to climate change.

Table 3-11 presents a summary of the sensitivity of the community, highlighting the current stresses, the projected stresses and its likely impacts on the community and the projected change in stresses without any action.

Table 3-11: Summary of Sensitivity Analysis

Current Stresses	Projected Stresses from Climate Change	Likely Impacts	Projected change in stresses to systems *(without preparedness action)*	Degree of sensitivity
Reduced annual rainfall	Increasingly drier conditions.	Less supply in the watershed. Reduction in available groundwater supply. Less acquifer recharge. Less environmental water. Stress to economic system particularly agriculture. Increased demand management requirements for other sectors including domestic consumption. Increase in pests (plant diseases)	Likely to get worse	High
Temperature Increase	Increase in annual temperatures	Increase in trans-evaporation. Increased irrigation demand. Likely sea level rise and coastal erosion. Increased sea surface temperatures likely to cause further migration of commercial fish stock. Increase in pests (plant diseases).	Likely to get worse	High
Flooding due to high intensity rainfall events	Increased intensity of events	Denuding of watershed soils. Transportation of sediments to coast. Turbidity. Overtopping of shallow surface ponds. Flooding of properties, blocking access to main evacuation routes. Possible increase in pathogens and Vectors.	Likely to get worse	High
Exposure to hurricanes and tropical storms	Hurricane intensity expected to increase (not necessarily frequency)	Damage to coastal properties and sections of roadways (closer to Fort Charles), loss of beach. Major loss of crops, reduction in crop yield. Damage to fish pots, boats. Loss of livestock. Loss of marine resources.	Could get worse but uncertainties in frequency of high intensity storms	Moderate
Meeting increased demand from population growth and economic activities	Reduction in annual average rainfall- more droughts	Climate change impacts on water supply likely to be compounded by increasing demand due to population growth and increasing economic activities.	Likely to get worse	High

4 ADAPTIVE CAPACITY ANALYSIS

The adaptive capacity analysis is the second step in conducting the vulnerability assessment. This analysis describes the ability of the Treasure Beach community to accommodate changes in climate with minimum disruption or minimum additional cost (Climate Impacts Group, King County, Washington, and ICLEI-Local Governments for Sustainability, 2007).

The analysis among other things discusses:

- If the community is already able to accommodate changes in climate
- If there are any barriers to the community to accommodate changes in climate
- If the community is already stressed in ways that will limit its ability to accommodate changes in climate
- If the rate of the projected climate change is likely to be faster than the adaptability of the community
- If there are efforts already underway to address impacts of climate change in the community

4.1 Policy, Legislation and Institutional Review

This section outlines the policy, legislation and institutions relevant to/involved in the management of climate-related hazards. It also discusses the existing coping and adaptation strategies for the local community and economic sector to deal with projected impacts of climate change.

4.1.1 Policies and Plans

Within Jamaica there exist a number of policy frameworks which support the objectives of hazard-risk reduction and by extension, mitigation. Some of these are summarized below:

National Hazard Mitigation Policy, 2005

The National Hazard Mitigation Policy was adapted from a Model National Hazard Mitigation Policy developed by the Caribbean Disaster Emergency Response Agency (CDERA) through its Caribbean Hazard Mitigation Capacity-building Programme (CHAMP) and the Caribbean Development Bank (CDB) through its Disaster Mitigation Facility for the Caribbean (DMFC).

This policy provides a framework for integrating hazard mitigation into all policies, programmes and plans at national and community levels. It sets out the broad goals and guiding principles for hazard risk reduction and informs the development of national hazard mitigation plans.

The main goals of the policy are:

- The acceleration of the attainment of sustainable development objectives through hazard mitigation.
- The minimization of physical, economic and social dislocations through hazard-mitigation strategies.

The five major policy objectives are:

- To provide an integrated legislative, regulatory and institutional framework in support of hazard mitigation at all levels of society;
- To reduce environmental, social and economic dislocations, with emphasis on infrastructure, land-use practices and rehabilitation of degraded areas;
- To promote collaboration and coordination among national, regional and international agencies in order to harmonize activities towards achieving common hazard mitigation objectives;
- To empower communities to manage hazard risk; and
- To protect and rehabilitate the natural, social and economic environments through hazard mitigation.

National Disaster Action Plan, Revised 1997 (Also referred to as the National Disaster Plan)

Jamaica has a National Disaster Plan (NDP) which details the mechanisms in place to cope with the effects of natural and/or man-made disasters occurring in Jamaica. It seeks to assign responsibilities and to provide coordination of emergency activities connected with major disasters, in general and specific ways. The NDP was produced under the provisions of the Disaster Preparedness and Emergency Management Act, 1993.

The NDP outlines the structure of the National Emergency Organization (NEO) which refers to all participants in national disaster management efforts, whether Government, Non-Government Organizations (NGO's), Private Voluntary Organizations (PVO's) or Volunteers. The NEO structure is outlined below:

i. The National Disaster Committee (NDC)
ii. The National Disaster Executive (NDE) and its committees
    a. Health
    b. Emergency Operations, Transport and Communications
    c. Public Information and Education
    d. Administration and Finance
    e. Welfare and Shelter/Relief Clearance
    f. Damage Assessment, Recovery and Rehabilitation
iii. The Office of Disaster Preparedness and Emergency Management (ODPEM)
iv. National Emergency Operations Centre (NEOC)
v. Regional Disaster Coordinators
vi. Regional Emergency Operations Centres (REOC's)
vii. Parish Disaster Committees (PDC's)
viii. Parish Disaster Executives (PDE's)
ix. Parish Emergency Operations Centres (PEOC's)
x. Zonal Committees
xi. Government Organizations, Agencies and Individuals (GO's)

xii. Non-Governmental Organizations and Agencies (NGO's)
xiii. Private Voluntary Organizations (PVO's)
xiv. Volunteers
xv. Regional and International Agencies

There are also several hazard-specific sub-plans which are intended to provide the legal framework upon which disaster preparedness, operations and training are predicated, and under which government officers can be held accountable for disaster responsibilities. These include, but are not limited to:

- National Oil Spill Response Plan
- National Fire Management Plan
- National Earthquake Response Plan
- Hurricane Plan
- National Damage Assessment Plan

It was reported that there is a basic Disaster Plan prepared for St. Elizabeth in 2014. This plan however is scheduled to be revised. A sub-committee of the Parish Disaster Committee has been tasked with meeting to go through the revisions. No specific timeline has been set for its completion. There is no Community Disaster Plan in place for Treasure Beach hence why it is an objective of this project. A separate report will present this.

4.1.2 Legislation

Disaster Risk Management Act, 2015

The Disaster Risk Management Act was enacted to repeal the Disaster Preparedness and Emergency Act of 1993, and to make new provisions for the management and mitigation of disaster and the reduction of risks associated with disaster. The Disaster Preparedness and Emergency Act established the Office of Disaster Preparedness and Emergency Management (ODPEM) which is responsible for carrying out the provisions of the Act.

The 2015 Act outlines that one of the functions of the ODPEM is to “initiate, coordinate, inspect, evaluate and support the development of a National Disaster Risk Management Plan as the document that articulates the overall framework for disaster risk management in Jamaica, and details the processes and actions critical for effective identification, assessment, transfer, reduction, prevention and mitigation of risk”. The ODPEM is also supposed to “ensure that the agencies and organizations with functions under the National Disaster Risk Management Plan are made aware of those functions and are provided with adequate information for the purpose of understanding and carrying out those functions”.

At present the 1997 NDP (referenced above) is the most recent DRM action/management plan. DRM in Jamaica is also influenced by other instruments, some of which are mentioned here as they are of particular relevance to the DRM planning agenda:

- Building Act;
- Defence Act 1962;
- Draft National Building Codes
- Emergency Powers Act (1938)

- Fire Brigade Act 1988;
- Housing Act;
- Kingston and St. Andrew Corporation Act 1931;
- Local Government Act;
- Meteorological Act;
- National Solid Waste Management Act 2002;
- Natural Resources Conservation Authority Act (1991);
- Beach Control Act (1956)
- Parish Council Act (1972)
- Parish Development Orders;
- Public Health Act 1985;
- Severe Weather Orders (1990);
- Town & Country Planning Act (1957);
- Urban Development Corporation (UDC) Act;
- Water Resources Authority Act 1996;
- Road Maintenance Act

Some of this legislation contains deficiencies and areas of overlap in relation to responsibilities and require updating of relevant sections. There is also oftentimes observable lack of effective monitoring and enforcement, for example observance of building codes and set-backs. This is partly a cultural problem and also a financial resource problem. Several of these plans, policies, guidelines, legislation and regulations will need to be amended/updated to incorporate climate change considerations, e.g. the Beach Control Act, the NRCA Act, The Town and Country Planning Act and the Parish Development Orders.

It should be noted that the St. Elizabeth Provisional Development Order (2018) is in the process of being updated. It has been circulated to the public for inspection and comments. This document replaces the 1976 Development Order.

4.1.3 Institutions

4.1.3.1 ODPEM

The ODPEM is the National Disaster Organization responsible for disaster management in Jamaica and has been charged with the responsibility for taking action to reduce the impact of disasters and emergencies on the Jamaican population and its economy. It plays a coordinating role in the execution of emergency response and relief operations in major disaster events.

According to Section 4 of the ODPEM Act, the Organization is mandated:

… to advance disaster preparedness and emergency management measures in Jamaica by facilitating and coordinating the development and implementation of integrated management systems.

As a statutory body the ODPEM operates out of the Office of the Prime Minister with a Board of Management overseeing its activities. The ODPEM has the unique role of being the only government agency to provide disaster management functions in Jamaica. Its operations are designed towards:

- Developing and implementing policies and programmes for the purpose of achieving and maintaining an appropriate state of national preparedness for natural disasters and other emergency events
- To encourage and support disaster preparedness and mitigation measures in all parishes in association with Local Government authorities, community-based organizations and private and voluntary agencies
- Providing early warning, emergency response, relief and recovery operations in emergency situations
- Advocating and supporting risk reduction measures
- Providing training in all areas of disaster management
- Promoting a greater national awareness for disaster management issues through public education and awareness
- Conducting hazard identification and risk assessments
- Conducting research in social behaviour in relation to disaster mitigation and response
- Establishing and maintaining mutual assistance and co-operation agreements among partner agencies, private sector and international donor organizations.

Other functions of the ODPEM include:

- Being the executing arm of the National Disaster Committee (NDC), with responsibility for maintaining links with other agencies
- Providing training to schools, businesses, community groups and other organizations
- Conducting site visits and the inspection of areas to assess risk.

ODPEM oversees all the disaster coordination efforts at the parish scale and their mandate is carried out by some of the groups described below. One of the main players in carrying out ODPEM's mandate is the Parish Disaster Coordinator, who effectively reports to the Municipal Corporation but also to ODPEM.

Consultations held to date suggest that the mandate of ODPEM is being met, particularly at the parish level. Community stakeholder in Treasure Beach however, point to a lack of outreach programmes, such as training, public education campaigns, community specific initiatives, etc. in climate change and disaster risk reduction. This is discussed further in Section 4.1.3.3 below.

4.1.3.2 National Disaster Committee (NDC)

The NDC is the overarching disaster planning body. The ODPEM is the main body within the NDC responsible for coordinating management of the various types of disasters that affect the nation.

Several agencies that are also members of the NDC work alongside the ODPEM to fulfill its mandate. These include:

- All government ministries
- All utility companies

- International donor agencies such as the Salvation Army and the Red Cross
- Search and rescue organizations such as the Jamaica Defense Force (JDF), the Jamaica Constabulary Force (JCF) and the Jamaica Fire Brigade (JFB).

4.1.3.3 Parish Disaster Committees

At the Parish level, the ODPEM works through Parish Disaster Committees (PDCs) that operate out of the Municipal Corporation Offices. These committees respond at the parish level whenever there is a disaster. They also forge linkages with the response agencies, community groups and community-based organizations.

The Custos and Mayor of the parish, with the Mayor being the working member of the committee, chair the PDC jointly. Other sitting members of the committee include all Parish Councilors and local representatives of the various agencies and interested groups. Some of the organizations represented on the St. Elizabeth PDC include:

- National Works Agency
- Public Health Inspector (Min of Health)
- Accompong Maroons
- RADA
- Food for the Poor
- Black River Hospital
- Parish Development Committee
- Ministers Fraternal
- Chamber of Commerce
- Police
- Ministry of Labour
- ODPEM
- The Adventist Development and Relief Agency (ADRA)
- Salvation Army
- NEPA
- SDC
- NWC
- NIC

The St. Elizabeth PDC meets monthly on the 3rd Tuesday. It is reported that attendance at the PDC meetings is very good. For St. Elizabeth, the Black River Fire Brigade Station is the Parish's Emergency Operations Centre. The center manager is the Mayor or the Custos, and - in the event that neither of them is available - the Parish Disaster Coordinator.

Each Parish Disaster Coordinator is also responsible for coordinating all activities geared towards awareness, prevention and response. The Parish Disaster Coordinator has the responsibility of formulating the parish's own plan to meet with local emergencies in keeping with the guidelines set out

by the ODPEM. The Disaster Coordinator also submits monthly reports to the Municipal Corporation which are to be copied to the ODPEM.

Some of the work reportedly being undertaken includes training, capacity building, sensitization sessions, and drills/simulation exercises. For example, a community-based training session in basic DRM was conducted in 2014. This was held at the Pedro Plains Church. Participants were trained in administering CPR, search and rescue, and first aid. The Disaster Coordinator reports that there are now trained persons in the community who can respond in the event of a disaster. Shelter managers received training last year (2017), and in April of this year (2018), Emergency Operations Centre workers (this includes representatives from all agencies and administrative persons) received training.

In 2015, an earthquake drill/simulation exercise was carried out at the St. Elizabeth Infirmary in Santa Cruz. Also, an earthquake drill was reportedly carried out at the Pedro Plains Primary School. It is reported that training includes testing knowledge of persons trained.

As previously mentioned, community stakeholders consulted had indicated that there was a need for more outreach programmes, as many of them had never attended any training sessions where climate change and DRM was discussed.

4.1.3.4 St. Elizabeth Municipal Corporation

The Municipal Corporation (MC) is responsible for monitoring disasters within the parish, preparing a Parish Disaster Plan, educating the public on precautionary measures for disasters, conducting simulation exercises and establishing emergency shelters for mass care relief. The Municipal Corporation is also responsible for the equitable distribution of critical food and relief items.

There are 5 shelters which serve the Treasure Beach Community (Table 3-3). Consultations with community members as well as with shelter managers confirm that during disasters the shelters in the Treasure Beach area have been rarely utilized. Persons opt to stay in their homes instead.

The MC reports that it has sufficient relief supplies in place such as raincoats, flashlights, water boots, bedding, 3-day supply of clothing, etc. However, more emergency equipment is needed – e.g. Power packs, power saws, and generator units. There is a plan to put in place a system which allows the MC to create an MOU with supermarkets and other entities such as hardware stores, to purchase food directly as required.

The Ministry of Labour and Social Security, the Jamaica Red Cross Society, and ODPEM also contribute to providing relief supplies. Anecdotal information from speaking to persons involved in welfare management suggest the system functions, but with constraints. Some of which are cultural (dishonest claims) most of which are financial and the challenges inherent in depending on voluntary assistance in times of disasters.

The Social Development Commission (SDC) is also another group that provides assistance particularly as it relates to conducting damage assessments. The SDC, through their network of community-based organizations (CBOs) helps the MC to organize groups whenever they want to have meetings, etc.

4.1.3.5 Other Agencies

Disaster coordination efforts are carried out by multiple agencies, each of which has specific roles before, during, and after an event. The three main agencies are the National Works Agency, The Jamaica Fire Brigade, and the Jamaica Constabulary Force.

National Works Agency (NWA)

The NWA has a pool of contractors that they are able to mobilize in the event of a disaster to primarily clear blocked roads and drains. Information coming out of the Emergency Operations Center is usually shared by the NWA Parish Manager or the Assistant Parish Manager to the Regional Manager. The Regional Manager then issues instructions for deploying contractors. There is a designated emergency pool of funds that can support emergency works. However, any work conducted 24 hours after an event must be tendered. Such requests have to be passed to the NWA head office in Kingston and approval given.

Some works undertaken prior to an event include drain cleaning. There are 9 identified disaster areas in St. Elizabeth, of which Treasure Beach is one. These areas are closely monitored during an event due to their known potential for either flooding, land slippage etc.

Jamaica Fire Brigade

The Fire Brigade is primarily responsible for search and rescue efforts during and after an event. They are deployed based on information received from the Emergency Centre.

Jamaica Constabulary Force

The police force is responsible for maintaining law and order during and after an event particularly as it relates to looting, and other forms of unrest.

4.2 Socio-economic Analysis

As indicated in Section 3.1.3, The Treasure Beach community regularly experiences drought, flooding and tropical cyclones and storms. As such the community has evolved some cultural resilience and adaptive capacity to cope with these events. The absence of accurate, damage assessment time series, makes analyzing this resilience qualitative rather than quantitative.

4.2.1 The Community's ability to accommodate changes in climate

4.2.1.1 Agriculture

Farmers have evolved a number of cultivation and husbandry practices that over time they regard as adaptation to climatic variability. In relation to crops, farmers spoken to, indicated a general willingness to adopt advice on improvements in seed stock to increase yield and resilience to environmental issues such as heat and crop diseases. Slash and burn practices are being rejected by the serious farmers. Wetting down crops, and also using shading to protect crops from severe sunlight are methods farmers say they resort to. In times of extreme climatic events, farmers try and enclose their small livestock animals. However, RADA claims that they often leave larger animals to fend for themselves. Farmers also imply

that they have generally improved the balance struck between market opportunities and risk. They are predisposed to keeping reaping times shorter by determining the crops they plant. In this respect the market acknowledgment of St Elizabeth as the best producer of many staple crops, suggests that product demand is not the only focus of the farmers. Potential economic loss from climate variability is also factored by them.

On the other hand, RADA officials have tried, with somewhat discouraging results, to bring farmers into an appreciation of several available best practices in both the pre and post harvesting phases. However, some traditional ways of farming persist, probably because market produce acceptability has been slow to change.

Logan (2018) has identified the nationally recurring themes that beset the goal of sustainable cultivation. These are fertilizer use, shading, intercropping, pest and disease management, water conservation cultivation, rain water harvesting. Supporting his view point, informed opinions both within RADA and among Treasure Beach farmers themselves, confirm that most of these challenges for improved agricultural practices exist in the project area.

For example, the consultants have observed the deep cultural attachment that farmers have to Guinea Grass as a solution for several cultivation challenges. However, Guinea Grass is an invasive species which very quickly inhabits any open land, whether cleared for replanting or more problematic, afforestation. The economic cost of eliminating it or controlling it whether for cultivation purposes, landscaping, or other land use purposes can be high. Its potential role in range fires, is debated, as it is profiled as containing live fuel moisture. The dry limestone scrublands of Treasure Beach flags this as an issue for further monitoring.

Much of the farmers' efforts to control plant diseases is as a result of RADA's research and guidance. Fungal bacterial and pest control are expensive, and farmers cannot always finance the levels of protection required. Nevertheless, RADA is looked to by farmers for technical guidance in plant disease management.

The resilience of farmers has in recent years been augmented by GOJ's policy emphasis of reducing post-harvest loss (estimated about 20%-30%). This, by the introduction of a food processing facility in the Parish. Also, by the re-establishment and *on lining* of the Jamaica Agriculture Market Information System, JAMIS, to increase farmers protection against market swings caused by insufficient market information.

The table below discusses the responses by the agriculture sector to the observed climate impacts affecting the community.

Table 4-1: Observations and responses to climate change by the farmers

Observations	Response to Climate Change
Water Supply/ Variability of rainfall	Farmers have adapted to low rainfall and high temperatures with mulching with Guinea grass and drip irrigation. Several have bought water tanks and fill as necessary. Very few farmers rely on rain water harvesting (Figure 4.1), claiming it is expensive and not cost effective, preferring to purchase water and store in tanks. Green house farming is rarely done in the community (Figure 4.2).
Temperature increase	In addition to mulching referred to above, in very hot periods farmers will resort to 'wetting down' crops. They also practice covering crops with shading material to deflect full exposure to sunlight. Farmers are also moving away from slash and burn practices. This past practice, coupled with low rainfall, has left the farming landscape still very sparsely shaded. Choice of crop such as the Cucurbit group also enable resistance to hot temperatures as bright sunlight is their preferred environment.
Increase in plant diseases	Farmers are concerned about plant and animal diseases and are guided by RADA in treating fungal, bacterial or pest control issues. Their limitation is oftentimes financial as proper prevention regimes can be expensive.
Flooding	Limited to no response to flooding. Acceptance of risk - they deal with it as it comes

Nearly all farmers spoken to, report that they have three main problems adapting to climate change.

1. They have a need to better understand exactly what climate change is going to mean for them
2. How do they go about protecting themselves from its confusing effects (variability)
3. Where will the financing come from that will support the desirable mitigation measures

Figure 4.1: A rare sight in Treasure Beach- Rain Harvesting for domestic use and agriculture in Blunters community.

Figure 4.2: A rare sight in Treasure Beach- Greenhouse farming in Blunters Community. An FAO in the EU assisted project

4.2.1.2 Fishing

Fishing is still considered profitable although there is the consensus within the fishing communities visited that there has been a reduction in fish stock over the years. Despite this general decline there are some intervening periods where catch levels appear to improve. The cause for this decline has been attributed

both to the impacts of climate change and poor fishing practices. While not being able to decide the issue empirically, several observations were made by the Consultant which highlight how the fishing community has been responding to climate changes (Table 4-2).

Table 4-2: Observations and responses to climate change by the fishers

Observations	Response to Climate Change
Change in Fishing Grounds- fishers have reported changing their fishing grounds in response to their need to 'follow the fish'.	● They now go further along the coastline and at times further out to sea. ● Recently, fishers from Treasure Beach have started to relocate their operations to Black River in order to accommodate their shift to offshore fishing on the Pedro Banks, and in so doing taking a more direct role in Jamaica's offshore fisheries. One informed opinion put the percentage of fishers, resident in Treasure Beach who have relocated their fishing operations to Black River at about 30%. The existence of docking facilities and the deep-water trade in Black River is the main reason for using that port.
Decline in Fish Catch/ Species Loss	● It has traditionally been the case that fishers and farmers will step into and out of each other's occupational roles. Anecdotal information suggests that recently more people are moving away from fishing and towards farming. Perhaps a hold-over from the inclement fishing weather during long stretches in 2017.
Increasing storm conditions- High waves	● When fishers have sufficient warning of storm events they retrieve their fish pots to prevent loss. This is sometimes a collaborative undertaking. Nevertheless, pots have been lost at considerable expense to replace.

With the 2018-2019 Hurricane Season about to start, both farmers and fishers are apprehensive about the uncertainty they face with respect to climatic variability. By their own admission they are receptive to guidance and support. It is therefore an appropriate time to again deliver the messages and seek *buy-in* for implementation of mitigation and adaptation strategies.

4.2.1.3 Tourism

The tourism sector has two main advantages over agriculture and fishing as it relates to adaptability to climatic variability:

For the most, the main owners and operators in the sector can command the financial resources to manage their risks. The most obvious areas of targeted interventions have been; disaster insurance; better construction practices; energy; water security systems and food security arrangements in the event

of disasters. However, the consultants were not able to arrive at an informed opinion on the degree to which all of these adaptive practices were being followed in the hotels or the significant Air B&B accommodation sector.

However, cost containment is a major focus of hospitality enterprises, and high cost centers are associated with energy, water, and beach protection. Property owner's investments in securing savings or minimizing risks in these areas is a reasonable conclusion. In so doing they are in fact pursuing adaptive responses to climate change even if not necessarily optimally. These are adaptative supporting capacities not available to the typical farmer or fisher because of costs.

A further advantage, supportive of minimizing their exposure, is that their main source of income, tourists, are so risk-averse that they will quickly relocate themselves away from high risk climatic events.

The table below discusses the responses by the tourism sector to the observed climate impacts affecting the community.

Table 4-3: Observations and responses to climate change by the tourism sector

Observations	Response to Climate Change
Fluctuations in Water supply	Many operators have opted to purchase large tanks to store water in times of drought or inadequate supply. Very limited facilities have rainwater harvesting. Those that depend on wells do not appear to have adapted their usage or planned for any future changes in their supply. The St. Elizabeth Municipal Corporation has indicated that new developments that need a permit are required (as a Condition) to include rainwater harvesting.
Flooding Impacts	There have been no improvements to drainage beyond a new culvert built by the NWA on behalf of the St. Elizabeth Municipal Corporation. Development has continued as normal. There have been calls for a Drainage Plan for the community.
Impacts of Wind	Newer structures are now being built with slab roofs, especially since Hurricane Ivan. Hurricane straps are used more frequently on hip roofs. However, there were still many structures which did not have these.
Storm Surge	There does not appear to be a change in how construction along the coast has taken place since events such as Hurricane Ivan which caused major damage to many coastal properties. Development continues to take place along the coastline despite the setback regulation by NEPA and the St. Elizabeth Municipal Corporation.

4.2.2 Barriers to the community to accommodate changes in climate

4.2.2.1 Agriculture

Opinions in agriculture have pointed to the need to move the sector to a more sustainable level of practice on five fronts; safe food, productivity, risk reduction, environmental preservation, financial viability and the social (Logan, 2018). Climate change has a direct and long- term influence on each of these fronts.

There are very few substantial initiatives currently in place that adequately support the Treasure Beach agricultural community on any of these fronts. At the most parochial level, there are no technological or educational initiatives in rainwater harvesting that can claim any success. There are neither drainage plans nor works, that seek to address increasingly intense rainfall and flooding events as predicted. In effect there are no long-term solutions either in implementation, or available in the public domain, to the issues of flooding and water. This is an issue of lack of forward planning that is probably a consequence of inadequate funding.

Also important is an investment in education which helps farmers and workers in the industry better understand the future of agriculture under climate change and offer mitigation and coping strategies that will help offset their risks. The barrier here appears to be the allocation of resources within RADA to increase its institutional capacity to meet training needs. Additionally, DRM training through the Municipal Corporation is needed.

4.2.2.2 Fishing

Lee (2017) explains that Jamaica's catch composition has already shifted to being mostly of low value, "trash" fish, and particularly parrotfish – a species that has been shown to play an important role in coral reef health. The Low-value catches (in quantity and quality) tend to force fishers to spend longer time at sea and catch more fish (leading to over-exploitation) to make their income. Additionally, since Jamaica's fishery is primarily reef fishery, if there is migration of fish species to cooler waters, the majority of Jamaica's fishermen are not equipped (with the gear or the skills) to fish in the deeper, cooler waters.

As described in section 3.3.2,the fishing community has already responded to the changes in climate that have impacted their traditional fishing methods. However, climate change is expected to exacerbate existing conditions, and fishers on their own are unlikely to be able to further accommodate any changes.

The Government of Jamaica has recognized these impacts on the fisheries sector, and the broader coastal zone, and as such a number of climate change adaptation efforts have taken place over the past few years from a variety of different organizations.

These climate change adaptations relate mainly to small pilot projects that have sought to:

- Restore reefs
- Protect against beach erosion
- Provide guidance for supplementary income earning to fishing.

Treasure Beach's fishing community will likely only increase its resilience of climate change by being the beneficiary of a specific project for their area.

In 2009, the coastal area between Crawford, Galleon Beach, Malcolm Bay, and Hodges Bay, was declared a Fish Sanctuary by the Jamaica Ministry of Agriculture and Fisheries. It is a zone in which no fishing is permitted. Its objective was to provide a coastal zone in which the fish stock could be replenished and protected. Its location extends from Black River southeast to the Galleon Beach area to the West in the direction of Bluefields. It is managed by Breds, an NGO located in Treasure Beach. A marine scientist who was familiar with the sanctuary offered the opinion that it was likely succeeding as a conservation area but the level of monitoring needed for verification has not yet been achieved. The consultants were unable to confirm either anecdotally or by reference to data seen, that the fish sanctuary has impacted the fisheries resources of Treasure Beach. However, it can be reasonably inferred that the conservation message has been noted by those fishers familiar with the project.

4.2.2.3 Tourism

The sector's ability to accommodate further changes in climate, beyond what has already occurred lies within the local government responsibilities particularly as it relates to drainage maintenance and improvement and vector management. However, the government, through the St. Elizabeth Municipal Corporation also has the responsibility to ensure that coastal setback is observed and new developments utilize hurricane mitigation mechanisms such as having slab roofs or using hurricane straps on roofs.

The use of rain water harvesting needs to be an important consideration. The sector cannot continue to simply rely on purchasing water from trucks in drought periods. Developments should be retrofitted and storage tanks built to accommodate this. The Municipal Corporation has a responsibility to ensure that this is being done, particularly by new developments. As communities continue to expand there will be added pressure on the Corporation for providing these services.

However, the impression is given that the Municipal Corporation does not have the resources required to service the expanding needs of the community. Road infrastructure, and as importantly, linkages to airports and attractions, street lighting and health facilities reflect a level of planning, inconsistent with the importance of Treasure Beach to the Parish and increasingly to the national economy and national psyche.

4.3 Summary Adaptability of the Treasure Beach Community

As described in the previous sections, the community is already stressed in ways that will limit its ability to accommodate further changes in climate. Several of the measures needed to be taken to improve the adaptive capacity of the community lie with local government who have indicated their stressed resources. Though, Treasure Beach has been recognized as an increasingly important community in relation to economic and cultural development, some stakeholders point to other communities as requiring priority focus for disaster risk management planning. In these opinions, population centers such as Santa Cruz (flooding) New Market (Flooding) and Malvern (flooding) are potential disaster areas that have been accorded priority.

As a result, if financial resources continue to be the reason why the Treasure Beach community and its economic activities are unable to improve their adaptability to climate change, this will act as a limitation

resulting in the continued decline of agriculture and fishing. The tourism sector has a greater ability to accommodate further changes, on an individual level, despite inadequate commitment of financial resources by local government.

Several studies have been conducted of Treasure Beach and its tourism sector, namely:

- The Greater Treasure Beach Sustainable Development Plan (2013)
- Consultancy To Prepare a Tourism Destination Marketing Plan Baseline Assessment Report and the Treasure Beach Marketing Report **,** Treasure Beach DMO" 2016. (IDB et al)

Once these plans are implemented, they are also likely to improve the resilience of the economic sectors to climate change.

The general trends and future projections for climate (as described in section 2.3) show that Treasure Beach's exposure and sensitivity will only continue to increase over time. This is something that cannot be changed by the community. However, if the community's adaptive capacity, its ability to cope with these changes, improve, then its vulnerability will decrease.

Gaps/Limitations

Treasure Beach does not have a formal community-level disaster committee. There exist a few organized groups which include (but are not limited to):

1. The Calabash Bay Fisherman's Cooperative
2. Greater Treasure Beach Citizens Alert Benevolent Society
3. Great Bay Development Committee

In the event of a disaster, however, there is no singular coordinated effort that seeks to ensure that all the communities within Treasure Beach and the various stakeholder groupings (tourism, agriculture, and fishing, women's groups, persons with disabilities, etc.) are catered for. In the past, a few citizens have come together and used their combined resources to assist in recovery efforts. The effects of this, however, were not very far-reaching and some stakeholders within the Treasure Beach area believe that post-disaster it is "every man for himself".

The Consultants also found that the lack of clear roles and responsibilities for important activities such as drain cleaning and road repair may further reduce the community's ability to cope. For example, when asked who is responsible for maintaining road and drain networks, the Municipal Corporation (MC) indicated that the NWA was responsible. When the NWA was consulted they indicated that the MC owns the roads, and what typically happens is that the MC allocates funds and utilizes the NWA as the implementing agency of the works.

It was also reported that drain cleaning remains the highest priority, and the evacuation routes are in need of repairs.

There remains no drainage plan for Treasure Beach nor are there any immediate plans for infrastructure improvement in the community, particularly as the recently constructed canal remains incomplete. Improvements have been made, however, on the Montego Bay to New Market, St. Elizabeth main road which commenced in 2018 and is currently 70% paved. This improvement is expected to lessen the journey to only 45 minutes and will also open up linkages bringing more persons to Treasure Beach.

Table 4-4 presents the Consultants qualitative assessment of the adaptive capacity of the Treasure Beach community. The table illustrates that the community has a ***moderately low*** adaptive capacity. The main constraint to adaptation is due to financial resources and lack of understanding of the impacts of climate change.

In Section 5, the Consultants examine the issue of vulnerability, and derive a working position on the vulnerability of the community to climate change.

Table 4-4: Summary of Adaptive Capacity

Current Stresses	Projected Stresses from Climate Change	Projected Impact of Changes to the Systems *(without preparedness action)*	ADAPTIVE CAPACITY ANALYSIS	
			Ability of the Systems to Accommodate Projected Impacts with Minimum Disruption or Costs	**Adaptive Capacity**
Reduced annual rainfall	Increasingly drier conditions.	Increased evaporation combined with drier conditions and poor farming practices will result in reduced yield. Reduction in rainfall and inadequate supply to tourism sector may result in a decline in visitor stay	Farming techniques can be improved. Rainwater harvesting methods can be employed. Use water from existing surface water (ponds)	Moderate
Temperature Increase	Increase in annual temperatures	Reduction in crop yield to temperature sensitive species. Increased irrigation demand may increase cost of goods at market. Could lead to reduction in the industry. Migration of fish species	Farming techniques can be improved. Fishing has to migrate further offshore- but fishers would need to be adequately equipped	Low- Moderate
Flooding due to high intensity rainfall events	Increased intensity of events	Loss of crops, reduction in crop yield Increase in flooding, particularly affecting the coastal section of the community	Deepen surface ponds, particularly those closest sections of the community that flood. Conduct regular maintenance of the drains along the roadways. Building new drains are needed but this is expensive and relies on local government.	Low

Exposure to hurricanes and tropical storms	Hurricane intensity expected to increase (not necessarily frequency)	Damage to coastal structures and those exposed to wind.	Housing and developments can improve how they are constructed. Retrofitting existing structures Existing structures cannot be removed.	Low- Moderate
Meeting increased demand of water from population growth and economic activities	Reduction in annual average rainfall- more droughts	Reduction of water supply	There needs to be an increased use of RWH	Moderate

5 VULNERABILITY ASSESSMENT

The final step in the vulnerability assessment process is to combine the findings about sensitivity and adaptability to determine how and where the community is vulnerable to climate change. Once the community/ sections of the community and have limited ability to adapt/ cope with the changes it is considered vulnerable to the impacts of climate change. It is important to note that the vulnerability assessment does not remain static, it can improve or worsen with time. Changes can occur within the community, implementation of preparedness activities, new threats may emerge, for example, invasive species. These can all influence a community's vulnerability. Therefore, each time the DRM plan for the community is revised, the vulnerability assessment of the community should also be reviewed.

Table 5-1 below presents a summary of the main findings. It illustrates that Treasure Beach, because of its location along the south coast of Jamaica has inherent characteristic making it sensitive to changes in climate. However, it has a moderately low adaptive capacity. This is because several of the measures to improve the community's adaptive capacity require input/assistance of the local government who have indicated major financial constraints. There are measures that the community can undertake at a smaller scale to improve their adaptive capacity, but this requires an understanding and appreciation for the potential impacts of climate change in the community. As such, Treasure Beach can be considered to be ***moderately vulnerable*** to the impacts of climate change and variability.

Section 6 presents a few recommendations of measures that can be implemented to improve the adaptive capacity of the community which would reduce the vulnerability of the community over time.

Table 5-1: Vulnerability Assessment- Summary

Current Stresses	Projected Stresses from Climate Change	Projected Impact of Changes to the Systems *(without preparedness action)*	VULNERABILITY ASSESSMENT		
			Degree of Sensitivity	Adaptive Capacity	Vulnerability
Reduced annual rainfall	Increasingly drier conditions.	Increased evaporation combined with drier conditions and poor farming practices will result in reduced yield. Reduction in rainfall and inadequate supply to tourism sector may result in a decline in visitor stay	High	Moderate	High
Temperature Increase	Increase in annual temperatures	Reduction in crop yield to temperature sensitive species. Increased irrigation demand may increase cost of goods at market. Could lead to reduction in the industry. Migration of fish species	High	Low- Moderate	Moderate
Flooding due to high intensity rainfall events	Increased intensity of events	Loss of crops, reduction in crop yield Increase in flooding, particularly affecting the coastal section of the community	High	Low	Moderate
Exposure to hurricanes and tropical storms	Hurricane intensity expected to increase (not necessarily frequency)	Damage to coastal structures and those exposed to wind.	High	Low- Moderate	Moderate
Meeting increased demand of water from population growth and economic activities	Reduction in annual average rainfall- more droughts	Reduction of water supply	High	Moderate	Moderate

6 CONCLUSIONS AND RECOMMENDATIONS

Treasure Beach, St. Elizabeth located on the south coast of Jamaica comprises eight smaller districts spanning hilly areas all the way to the coastal plains. The community's main economic activities include, agriculture, fishing and tourism. The settlement pattern is low density and small family based, with well built housing stock. It ranks low on the poverty index.

No specific climate modelling was done for the community. Instead the *State of Jamaica's Climate* (CSGM, 2017) was used to describe the current climate and future projections for the area. This report divided Jamaica into 4 zones based on their climatic characteristics, and the projections indicate the following:

- **Temperature**- The general trend of increasing temperature is expected to continue to the end of the century for St. Elizabeth- 1.32°C by 2020 and an increase of 2.09°C degrees by 2030 from the 1986-2005 baseline periods.
- **Rainfall**- Rainfall is expected to become more variable with a general decreasing trend over the next century for St. Elizabeth- an increase in rainfall (from 1971-2000 averages) between 3.04% and 5.43% by the year 2020; however, decrease between 10.11% - 15.64% by end of the 2030's.
- **Tropical Cyclone Activity-** Frequency is not expected to increase but their intensity is expected to increase.
- **Sea Level Rise**- Sea-level is expected to continue its rising trend into the future at an accelerated pace due to higher sustained global and regional temperatures thus increasing coastal erosion and saline intrusion of coastal wells.
- **Wind**- The average wind speed across the island is expected to decrease. Wind speed during storm events are expected to increase due to an expected increase in the general intensity of tropical cyclones.

The main climate related hazards that have typically affected the Treasure Beach community include: droughts, floods and tropical storms/ hurricanes (including storm surge and coastal erosion). Each of these when they occur have had significant impacts on the community. However, floods and tropical storms tend to have the greatest impact. Additionally, the main economic activities depend largely on the natural environment and as such are significantly impacted whenever there is an event.

Therefore, since the community is already impacted by climate related events and it is also highly likely to be affected by the projections made for the area, it has been designated **sensitive to climate change**.

Analysis of the adaptive capacity of the Treasure Beach community indicates that it has a moderately low adaptive capacity. The reasons for this categorization are that several of the measures needed to improve their adaptive capacity lie within the remit of local government whose frequent complaint is lack of financial resources. The community has already in some instances adapted as much as they can without additional resources/ intervention. Resistance to change can also be considered a barrier to adaptation. There are measures, such as RWH, that can be implemented on an individual scale without intervention by the government but a few persons spoken to expressed a nonchalance or an unwillingness to do so.

The combined findings of the sensitivity and adaptive capacity analysis show that Treasure Beach can be considered to be moderately vulnerable to the impacts of climate change and variability. The table below

presents a few recommendations of measures that can be implemented in the community at different levels to improve the adaptive capacity which would reduce overall vulnerability over time.

Table 6-1: Suggested recommendations and their associated timelines

Sector	Recommendations	Recommended Timeline
Agriculture	● RWH infrastructure needed for sections in the community. Feasibility for individual or group scale will need to be assessed. ● Shade farming should be utilized more widely. ● Invest in water catchment – micro dams (see Israeli and Jordanian models) These could be linked to RWH infrastructure ● Increase sensitivity and acceptance of shade house agriculture. ● Expand drip irrigation	Short- term Short- term Medium term Medium term Short-term
Fishing	● Training programs may be needed for fishers who want to remain in fishing but who have to change their typical fishing ground and type of fish or marine life. ● Training programs may be needed for fishers who want to leave fishing.	Short to medium term
Tourism	● All facilities should have their own RWH infrastructure. ● Facilities should observe NEPA setback for the area. Stop orders should be used for those that violate. Those already within the setback should not introduce new structures in the area. ● Sand dunes are important natural coastal protection mechanisms. Tourism infrastructure should not be built on top of them or impact them negatively in anyway. More enforcement needed. ● Hard engineering structures should not be used on sandy beaches. Structures close to beach should be properly modelled and assessed for potential impact before construction.	Short term- Medium term
General Community	● Conduct Hydrological assessment of the community so as to inform a drainage plan. ● Infrastructure to improve flood control must be put in place once the hydrological assessment has been conducted and the drainage plan drafted. Coastal settlements in particular need. ● Education/ sensitization programs on climate change and the impacts are needed throughout the Treasure Beach community. The big question to be answered /demonstrated during these sessions is "What does/ should it mean to me?"	Short term Medium term Short term Medium term

Sector	Recommendations	Recommended Timeline
	● RWH for individual homes needs to be implemented , to supplement on the NWC source to fill tanks. There is currently a policy enforced by the Municipal Corporations for new developments. ● Active community focus directed at lobbying for the mainstreaming of gender issues into the planning processes, both Municipal and community based is recommended. ● Efforts at improving female opportunities to reduce their special vulnerabilities, e.g. employment, improved social amenities of special interest to women, post event special employment schemes. ● Invitation be extended to government social welfare agencies to structure educational and participatory activities that heighten awareness of gender challenges and disadvantages under climate change. ● The community should organize a registry of disabled community persons, so that there is awareness of numbers, locations and challenges.	Medium term Medium term Medium term Medium term
Legislation and Institution	● The existing community disaster committee needs to be expanded to be inclusive with representatives from each community and stakeholder group (See Section 2). This is essential for building climate resilience in the Treasure Beach area.	Short term

Note: The following actions should commence in the following time periods: Short term= 1-3 yrs; Medium term= 3-5 yrs; Long term= > 5 yrs

6.1 Stakeholder Consultations

A Stakeholder consultation workshop was held on July 12, 2018 (Appendix I) to present the findings of the VCA and to obtain feedback particularly on the recommendations. The feedback received has been used to revise the VCA, however the main points have been summarized below:

- There was general agreement with all the recommendations and timelines. Changes have been made where necessary to accommodate feedback from the stakeholders.
- Most stakeholders were in agreement with RWH however noted that due to its expense financial support may be required, particularly for small farmers.
- An alternative suggestion to RWH was transfer of water from the North to the South. This was considered to possibly be a better long term solution.
- There was definite agreement with training fishers in alternative livelihoods, particularly farming.
- Sensitization and education were considered urgent needs for the community.

- Environmental policies need to be more enforced, particularly in the coastal area.
- Care should be given to approval of developments, especially where they may impede natural drainage. It was suggested that the Municipal Corporation needs to be more involved and should visit the area/site for which application has been made, before approvals/ permits are granted.

6.2 Next Steps for the Community

Based on the findings of the VCA and the feedback from the stakeholders the following have been considered and are submitted as priority actions for the Community:

1. Hydrological Assessment of Treasure Beach Community to inform a Comprehensive Drainage Plan.
2. Sensitization and Awareness Sessions on Climate Change and the potential impacts. The ultimate goal of this would be to arm the community with information so that they are better able to plan for building climate resilience.
3. RWH has been considered important however, due to projected changes in the variability of rainfall it may be necessary to do a feasibility assessment to examine the possibilities of this as opposed to basin transfer. Several agencies are currently undertaking similar type assessments in and around the area so it may be useful to see how the community could benefit.
4. Design a training programme for fishers in alternative livelihoods. However, this programme should not be developed in isolation of the fishers. They should be heavily involved in conceptualization and design.

7 REFERENCES

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APPENDIX I: STAKEHOLDER WORKSHOP

A stakeholder workshop was held on July 12, 2018 at the Sandy Bank Primary School, Treasure Beach. Forty-five people received direct invitations from ESL and others were invited by word of mouth. The Invitation card, letter and agenda are presented below. Thirty-one stakeholders were present at the workshop. The feedback from the stakeholders have been incorporated into the report and have been used in guiding the next steps.

To facilitate discussions each activity was done in groups. There were 6 groups with between 4 and 5 persons. Photos of these sessions are included below.

Invitation Card

DO GOOD JAMAICA

esl environmental SOLUTIONS

Vulnerability and Capacity Assessment and Community Disaster Risk Management Plan for Treasure Beach, St. Elizabeth

A workshop will held on July 12, 2018 to:

1. Present the findings and recommendations of the Vulnerability and Capacity Assessment
2. Introduce and get feedback on the Disaster Risk Management Planning process

DO GOOD JAMAICA

Cordially invites you or a representative from your organization to

the Workshop on July 12, 2018, 8.30 am to 12.30pm

At the Sandy Bank Primary School, Treasure Beach, St. Elizabeth

Please confirm your attendance with: trodriguez@eslcaribbean.com and (876) 978-9519

Invitation Letter

The Guango Tree House
29 Munroe Road, Kingston 6
Jamaica, West Indies
Website: www.dogoodjamaica.org
Email: info@dogoodjamaica.org

June 27, 2018

Name
Title
Address

Dear.....,

Re: Workshop on the Vulnerability and Capacity Assessment and Community Disaster Risk Management Plan for Treasure Beach, St. Elizabeth

Do Good Jamaica has contracted Environmental Solutions Limited to conduct a Vulnerability and Capacity Assessment (VCA) and to develop a Community Disaster Risk Management Plan (DRMP) for the community of Treasure Beach.

As a part of the DRMP, ESL will be conducting a workshop which will be held to present the findings of the VCA (to climate-related risks) and to get stakeholder involvement in the Disaster Risk Management Planning process. You have been identified as a key stakeholder and we warmly invite you to participate and provide your feedback. This workshop will take place on July 12, 2018 from 8.30 to 12.30pm at The Sandy Bank Primary School in Treasure Beach, St. Elizabeth.

We have also attached a document presenting background information on the project and the indicative agenda for the workshop.

For confirmation of your attendance or if you have any queries, please feel free to contact ESL at (876) 978-9519/ 978-6297 or via email at trodriguez@eslcaribbean.com.

Yours truly,
DO GOOD JAMAICA

_____
Kassim Morrison
Director

Directors: Deika Morrison ▪ Kassim Morrison ▪ Terri-Karelle Reid ▪ N. Patrick McDonald

Agenda

Stakeholder Workshop on July 12, 2018 - Preparation of a Community Disaster Risk Management Plan for Treasure Beach, St. Elizabeth

Background and Introduction

Do Good Jamaica, through grant funding from the Environmental Foundation of Jamaica, has contracted Environmental Solutions Limited to conduct two main activities in the community of Treasure Beach in St. Elizabeth:

- To conduct a Vulnerability and Capacity Assessment (VCA) study
- To prepare a Disaster Risk Management Plan

The overall objectives of the project are:

- To build awareness of the climate hazards to which the community is exposed.
- To build the community's capacity to not just respond to climate hazards but to identify the risks and undertake preventative and mitigative actions against potential impacts
- To prepare and recover from any climatic event experienced in the shortest time possible.

Aims of the workshop

1. To introduce the project and present findings and recommendations of the Vulnerability and Capacity Assessment
2. To introduce and get feedback on the Disaster Risk Management Planning process

The indicative workshop agenda is presented below.

Indicative workshop agenda

Timing	Session
8:30-9:00am	**Registration**
9:00-9:15	**Welcome and introductory remarks and objectives of the workshop**
9:15 – 9:45	**Overview of the project and approach and Presentation of VCA findings**
9:45 – 10:00	**Discussion/Feedback Session**
10:00-10:15	**SESSION BREAK**
10:15-10:45	**Introduction to Disaster Risk Management Planning**
10:45- 11:10	**Discuss the establishment of Treasure Beach Zonal Committee**
11:10-11:30	**Discussion on Prevention and Mitigation Measures**
11:30-11:50	**Discussion on Preparedness and Response Measures**
11:50-12:10	**Discussion on Recovery Activities**
12:10-12:30pm	**Final reflections and next steps**

Workshop Sign-in Sheet

Stakeholder Workshop on July 12, 2018

Preparation of a Community Disaster Risk Management Plan for Treasure Beach, St. Elizabeth

	Name	Organization/Community	Phone	Email
1	Beverly Ritchie	Out Of The Blue Villa, Great Bay	876 796 7864 or 876 965 3444	
2	Nickesha Strachan	Jamaica Red Cross	876-806-8726/444-5720	nikkiedestiny5@yahoo.com
3	Randy Deleon	out of the Blue villa		
4	Jermaine Jackson	NWC	990-0071	jermaine.jackson@nwc.com.jm
5	Lester Morgan	NWC	323-7449	lester.morgan@nwc.com.jm
6	Rebecca Wiersma	TBDMO / Treasure Tours	789-1239	rebecca@treasuretours.info
7	Lisett Lynch	TBWG	572-8835	lisettlynch57@gmail.com
8	DAVID MORRIS	ST ELIZABETH CHAMBER OF COMMERCE BLACK RIVER CHAPTER	999-6438	darokmorris@hotmail.com
9	Desmond Williams	Jamaica Constabulary	524-9971	desmond.williams@jcf.gov.jm
10	Andrew Parker	ST ELIZABETH CHAMBER OF COMMERCE BLACK RIVER CHAPTER	377-8068	parkerandrew69@gmail.com
11	Sharon Gordon	Pedro Plains/CDAM	876 406-1844	
12	Julian Russell Francis	Pedro Plains CDAM	876-443-0924	jcrussell73@gmail.com

Stakeholder Workshop on July 12, 2018

Preparation of a Community Disaster Risk Management Plan for Treasure Beach, St. Elizabeth

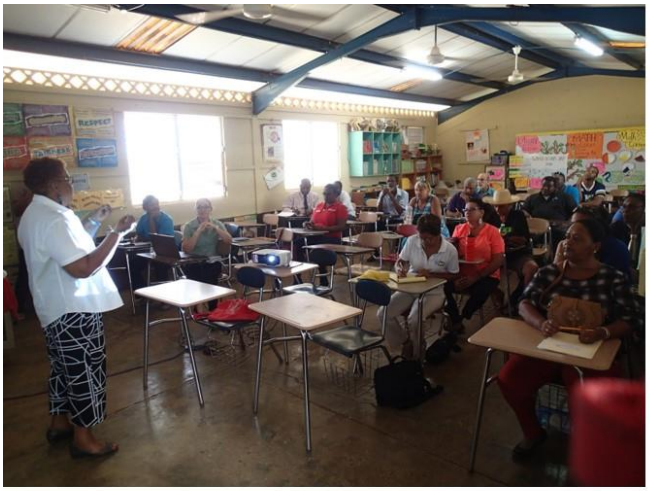
	Name	Organization/Community	Phone	Email
13	Heen Logan	Pedro Plains CDRM	876-445-8874	
14	Elistun A. DeLeon	[illegible]	871-864-9030	
15	Sanique Josephs	RADA	816-7925	
16	Jermaine Wilson	RADA	997-3877	wilsonj@rada.gov.jm
17	NORMA THOMAS	BREDS	876-404-4952	
18	Traysann Malcolm	Happy House	876-422-8007	
19	Quijana Grant	St. Eliz. M.C.	436-3197	
20	Camay Clarke	Treasure Beach Turtle Group	304-7778	Camaygueen@yahoo.com
21	Carvel Ebanks		352-4392	
22	Opal Smith-Alexander	Sandy Bank Primary	323 7688	osmithalexander77@yahoo
23	Gloria Reynolds	Happy House	316-8555/412-9926	bentreny78@gmail.com
24	Angelina Powell-Foster	Sandy Bank Primary	319-7948	angelolene@yahoo.com

Stakeholder Workshop on July 12, 2018

Preparation of a Community Disaster Risk Management Plan for Treasure Beach, St. Elizabeth

	Name	Organization/Community	Phone	Email
25	[illegible]	Jamaica Defence Force Coast Guard	876-967-8193	jdfcgapso@gmail.com
26	Adina Parchment	Jakes Hotel / Breds	876-844-9803	adina@jakeshotel.com
27	Danielle Mullings	Do Good Jamaica	876-379-5984	daniellemullings17@gmail.com
28.	Theresa Rodrigues-Moodie	ESL	876-978-9519	trodrigues@eslcaribbean.com
29	Richard Courtou	"	"	rcourtou@eslcaribbean.com
30	Eleanor Jones	"	"	beleanor@gmail.com
31	Abgail McIntosh	"	"	amcintosh@eslcaribbean.com

Photos from the Workshop



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