Integrating digital technologies and participatory tools to support coastal community resilience in Trinidad & Tobago (Tech4CoastalResilience)

Roxborough Community Resilience Plan

April 30, 2025

Acknowledgements

CANARI would like to thank the Department of Marine Resources and Fisheries, Tobago House of Assembly for their support in conducting action planning in Roxborough, Tobago, as well as the community and other key stakeholders from the public and private sector for generously giving of their time and sharing their knowledge and perspectives, to develop this community resilience plan.

Citation: Granderson, A., Ramkissoon, C., Khan, K., and Thanoo, A. 2025. Roxborough Community Resilience Plan. Prepared under the Tech4CoastalResilience project. CANARI, Port of Spain.

Cover photo: Aerial view of coastline near Roxborough, Tobago, Credit Kerry Walcott 2024

1. Overview

The Roxborough Community Resilience Plan aims to guide coastal planning and resilience actions and identify ways to reduce vulnerability and adapt to climate change and other coastal changes in Roxborough, Tobago. It is based on the key findings from the vulnerability and capacity assessment in Roxborough completed in January to October 2020 and the inputs from community residents and other key stakeholders from an action planning workshop held on July 18, 2024.

The Plan has been developed under the "Integrating digital technologies and participatory tools to support coastal community resilience in Trinidad and Tobago (Tech4CoastalResilience)" project, which is being implemented from 2023-2025 by the Caribbean Natural Resources Institute (CANARI) in partnership with the Fisheries Division, Ministry of Agriculture, Land and Fisheries and the Department of Marine Resources and Fisheries, Tobago House of Assembly (THA). The project aims to improve the resilience of vulnerable coastal communities to climate change impacts in Trinidad and Tobago. It is supported by the "Harnessing Innovative Technologies to Support Resilient Settlements on the Coastal Zones of the Caribbean (HIT RESET Caribbean)" programme. HIT RESET Caribbean is funded by the ACP Innovation Fund implemented by the Organization of African, Caribbean and Pacific States (OACPS) and European Union (EU).

2. Approach and methodology

The process to develop the Plan was facilitated by CANARI and the Department of Marine Resources and Fisheries, THA. It was designed to be interactive and participatory, engaging the community in practical exercises and discussions to support action planning for coastal resilience. See Appendix 1 for the agenda for the Roxborough Community Action Planning workshop.

The process engaged fisherfolk, other coastal resource users and community-based organisations (CBOs), including the Roxborough Fisherfolk Association, Roxborough Village Council, Roxborough Police Youth Club, Tobago Unified Fisherfolk Association (TUFA), Environment Tobago and Tobago Wildlife and Environment Protection Group (TWEP-G), interested private sector entities such as the Tobago Tourism Agency Limited and Tobago Agribusiness Development Company (TADCO), Trinidad and Tobago Red Cross as well as key government agencies including the Tobago Emergency Management Agency (TEMA), Department of Environment and Coastal Zone Management Unit, THA. See Appendix 2 for the list of participants.

The Plan is based on findings from the vulnerability and capacity assessment in Roxborough completed between January to October 2020. The assessment involved desk review and community scoping, participatory mapping and geographic information systems (GIS), household surveys and development of an impact and capacity matrix to collect data and better understand local impacts from climate change and other issues affecting the coast. The findings were reviewed and validated, as well as updated, as part of the action planning workshop in July 2024. See Appendix 3 for the vulnerability and capacity assessment findings and the summary poster here.

3. Priorities for Action

A range of actions to adapt and build coastal resilience have been identified as part of the Plan (see section 5 and Appendix 4 for further details). In particular, key climate-related impacts from coastal erosion, sargassum influxes, extreme weather events (leading to floods, landslides, increased water and heat stress) were highlighted by participants, affecting the fisheries and tourism sectors, health and education services, settlements and key infrastructure in Roxborough. The following priorities for action have therefore been identified in the short to medium term (1-6 years):

- Implementing coastal protection measures, including reinforcement of seawall, construction of breakwater or use of gabion baskets, in high risk areas
- Providing access to safe storage facilities for fisherfolk (e.g., boatyards, equipment for hauling boats) to minimise damage from storms, storm surge and other extreme weather
- Enabling access to insurance for boats, engines, gear, and personal insurance for fisherfolk
- Providing equipment/tools and training on best practices for regular community-led clean-ups, particularly targeting watercourses and sargassum influxes along beaches
- Establishing and implementing air quality monitoring and early warning systems for addressing health and other risks from sargassum influxes
- Improving ventilation systems in schools and other key government buildings along the coast to reduce health impacts from decaying sargassum
- Diversifying and developing alternative livelihoods for fisherfolk, farmers and other underemployed residents (e.g. aquaculture, mariculture, collection and use of sargassum to create value-added/commercial products like liquid fertilizer, biofuels and building materials)
- Increasing use of water storage tanks and rainwater harvesting systems for residential and commercial purposes to improve water access, via training, financing and enabling policies
- Upgrading and maintaining drainage systems to address flash flooding
- Developing home-schooling kits to reduce school disruptions and ensure continuity in education/less missed days during storms, floods and other hazards

Prioritisation was based on the level of impact/risk to the community that the action can address, whether it benefits multiple sectors and community needs, and whether it can be implemented in the short to medium term.

Three priorities for action were highlighted as feasible options for support under Tech4CoastalResilience and other current projects, given the available timeframe and budget: small-scale drainage upgrade and maintenance to mitigate flooding e.g. clearing blocked drains or installing check dams/silt traps; increasing use of water storage tanks and rainwater harvesting, particularly in schools and fish landing site; and providing equipment/tools and training on best practices for community-led environmental clean-ups. CANARI and the Department of Marine Resources and Fisheries will follow up to refine and implement at least one of these options.

4. Use of this Plan

This Plan serves as a guide for coastal planning and resilience actions in Roxborough. It should be used and further operationalised by key government agencies, including the Coastal Zone Management Unit, Department of Marine Resources and Fisheries, and Tobago Emergency Management Agency in THA and Institute of Marine Affairs, CBOs, residents in Roxborough, and relevant civil society organisations and the private sector to inform efforts to address climate change and other coastal changes. It is also aligned with, and contributes to, the National Adaptation Plan and Integrated Coastal Zone Management Policy Framework for Trinidad and Tobago.

Figure 1: Stakeholders from Roxborough engaging in action planning activities *(Source: CANARI 2024)*

5. Summary of Roxborough Community Resilience Plan

Note the table below includes only the key climate-related impacts and priorities for action identified and highlighted by participants. The full list of all the identified impacts and actions is in Appendix 4.

** = top priorities

Community impacts & risks	Actions to adapt/build resilience	Roles and responsibilities (Lead/supporting actors)	Required resources	Time frame	Indicators of Success
Fisheries and Marine Resources					
Extreme weather including heavy rainfall and storms, extreme heat, and drought with related water stress Impacts • Disruption to fishing operations and reduced income due to storms and related rough seas and storm surge • Damage to and loss of fishing boats, gear and fisheries-related infrastructure (e.g. jetty and fishing facility) • Safety at sea risks for fishers, and reduced fishing days, with potential for loss of income • Water stress/shortages impacting fishing operations, particularly vending and processing	• **Construction of breakwater to create a sheltered space for fishing vessels and protect fisheries infrastructure • **Access to safe storage facilities e.g. boatyard and equipment to haul boats, to minimise damage from storms and storm surge • **Access to insurance to address damage to boats, engines and gear, and personal insurance for fisherfolk to enhance financial resilience • Safety at sea training, access to required equipment and improved early warning systems for storms and other extreme weather for fisherfolk • Establishment of rainwater harvesting systems for climate-	• Coastal Zone Management Unit (CZMU), Department of Environment, Climate Change and Energy, Tobago House of Assembly (THA) (co-lead) • Department of Marine Resources and Fisheries (DMRF), THA (co-lead) • Roxborough Fisherfolk Association (co-lead) • Fisherfolk • Division of Infrastructure, Quarries and Urban Development (DIQUD), THA • Division of Finance, Trade and Economy, THA • Tobago Emergency Management Agency (TEMA)	• Expertise (coastal engineering, fisheries management, disaster response) • Financing (significant amount for breakwater) • Equipment (e.g. trailer/tractor/ trolley to pull up vessels) • Materials • Early warning information and technology • Training programmes	Short to medium term (1-6 years)	• Reduced loss and damage of fishing vessels, engines and gear • Reduced number of safety incidents reported by fisherfolk • Increased number of rainwater tanks and improved water access to support fisheries operations

Community impacts & risks	Actions to adapt/build resilience	Roles and responsibilities (Lead/supporting actors)	Required resources	Time frame	Indicators of Success
• Increased discomfort for fishers and vendors due to extreme heat, leading to higher cooling costs, expenses e.g. for ice and greater risk of fish spoilage Vulnerable groups • Fisherfolk (including boat owners) • Households dependent on fishing as a food or income source • Small businesses dependent on local fish supply (e.g. food establishments, hotel/guest accommodations)	smarting fisheries operations, supported by training, policies and financing	• Trinidad and Tobago Meteorological Service (TTMS) • Town and Country Planning Division • All Tobago Fishing Association (ATFA) • Tobago Unified Fisherfolk Association (TUFA) • Finance and insurance providers • Telecommunication service providers • Caribbean Fisheries Training and Development Institute (CFTDI) • University of the West Indies (UWI) • UN Food and Agriculture Organization (FAO)			
<u>Sargassum influxes</u> Impacts • Disruption to operations as blocked access to shoreline and jetty for fishing vessels, resulting in reduced fishing days and income • Damage to engines, nets and other fishing gear, and	• **Identification of storage site and provision of equipment/tools for clean-up of sargassum influxes on a regular basis by local community groups • Awareness raising on sargassum response plan	• Division of Agriculture, Marine Affairs, Marketing and the Environment (DAMME), THA (co-lead) • DMRF (co-lead) • Roxborough Fisherfolk Association (co-lead) • TEMA	• Expertise (marine science, disaster response, business development) • Funding • Equipment/ tools (e.g. protective gear – gloves, light machinery, booms for removal/	Short to medium term (1-6 years)	• Reduced loss and damage to fishing vessels, engines and gear from sargassum influxes • Reduced length of time that sargassum is stranded on beach

Community impacts & risks	Actions to adapt/build resilience	Roles and responsibilities (Lead/supporting actors)	Required resources	Time frame	Indicators of Success
increased safety at sea risks for fishers • Pungent smell (hydrogen sulphide and ammonia gas) from decaying sargassum causes health issues • Marine ecosystems are impacted by influx of sargassum Vulnerable areas • Fisheries infrastructure - fishing depot, landing site, jetty Vulnerable groups • Fisherfolk, including boat owners • Recreational fishers • Households dependent on fishing as a food or income source • Small businesses dependent on local fish supply (e.g. food establishments, hotel/guest accommodations)	and any best practices for safe collection and use • Access to insurance to address damage to boats, engines and gear, and personal insurance for fisherfolk • Establishment and implementation of regular air quality monitoring and early warning system for sargassum at Roxborough to inform response • **Diversification and development of alternative livelihoods (e.g. aquaculture, mariculture, collection and use of sargassum to create value-added/commercial products like liquid fertilizer, biofuels and building materials)	• CZMU/ Department of Environment, Climate Change and Energy, THA • National Sargassum Task Force • Institute of Marine Affairs (IMA) • Environmental Management Authority (EMA) • ATFA • TUFA • Fisherfolk • Roxborough Police Youth Club and local community groups • Local entrepreneurs • Finance and insurance providers • CFTDI • UWI • FAO • Caribbean Agricultural Research & Development Institute (CARDI), Inter-American Institute for Cooperation on Agriculture (IICA)	harvesting of sargassum) • Materials • Suitable storage areas		• Increased number of fisherfolk engaged in alternative livelihoods
Settlements, Infrastructure & Social Services					
Coastal erosion from rough seas, storms and storm surge and sea level rise	• **Implementation of coastal protection measures - reinforcement	• CZMU/ Department of Environment, Climate	• Expertise (coastal engineering, construction,	Short to medium	• Reduced costs from loss and damage of coastal property and

Community impacts & risks	Actions to adapt/build resilience	Roles and responsibilities (Lead/supporting actors)	Required resources	Time frame	Indicators of Success
Impacts • Damage to homes, other property and key infrastructure along coastline (e.g. roads, schools, businesses, stadium) • Disruption in livelihoods when key infrastructure is damaged • Erosion of beaches and degradation and loss of coastal vegetation and other ecosystems Vulnerable areas • Ten Chain and jetty park area affected by sinkhole • Coastal roads – Windward Road, Main Road, New Street Vulnerable groups • Residents • Business owners • Property owners along coast	of seawall, construction of breakwater or use of gabion baskets - in high risk areas • Replanting of coastal vegetation (e.g. sea-grape, coconut, vetiver etc.) to address erosion and threats to homes, property and livelihoods • Improved monitoring of coastal erosion and other changes to inform response • Improved access to home/property insurance to address risks from coastal erosion • Upgrading and enforcement of building codes taking into account coastal erosion and sea level rise	Change and Energy (co-lead) • DIQUD (co-lead) • Roxborough Village Council (co-lead) • DMRF • IMA • EMA • Town and Country Planning Division • Property owners • Local businesses • Roxborough Police Youth Club and other local community groups • Environmental Research Institute of Charlotteville (ERIC), North East Tobago Climate Change Champions Network supporting replanting efforts, IAMovement and other NGOs • Insurance providers	ecosystem restoration) • Financing • Equipment and materials • Labour • Seedlings for restoration • Planning approvals/ environmental impact assessments	term (1-6 years)	infrastructure (e.g., roads, schools) • Increased extent and health of coastal vegetation (e.g. sea-grape, coconut trees)
Tourism					
<u>Dry spells/drought and related water stress</u> Impacts	• Implementation of public awareness/information drives on climate change, impacts on water quality and access and appropriate solutions,	• WASA (co-lead) • Tourism Division, THA (co-lead) • Local tourism-related businesses (co-lead)	• Expertise (water management, construction, sustainable tourism, law) • Finance	Short to medium term (1-6 years)	• Increased number and use of water storage and rainwater harvesting systems to improve water supply

Community impacts & risks	Actions to adapt/build resilience	Roles and responsibilities (Lead/supporting actors)	Required resources	Time frame	Indicators of Success
• Water scarcity disrupts tourism-related businesses (e.g., food and hospitality) • Limited water availability exacerbates sanitation problems, increasing the risk of waterborne diseases and public health concerns • Agri-tourism and outdoor tourism activities may be restricted due to water stress, reducing visitor experiences and revenue • Increased risk of bush fires and related risks to health, safety and property Vulnerable groups • Tour and hotel/guesthouse operators • Vendors and other tourism-related small businesses, especially those dependent on water for their production/service • Households dependent on tourism as income source • Visitors	targeting tourism-related businesses and visitors • **Increased use of water storage tanks and rainwater harvesting among tourism-related businesses • Legislative change, including tax incentives or subsidies, to allow for expansion of rainwater harvesting and other techniques to improve water security	• Division of Health, Wellness and Social Protection, THA • TEMA • Office of the Chief Secretary, THA • Office of Attorney General/Ministry of Legal Affairs • Chamber of Commerce • Tobago Hotel and Tourism Association • Tobago Tourism Agency Ltd. • Local community groups	• Equipment • Materials • Labour • Planning/ development approvals		for tourism-related businesses

APPENDICES

Appendix 1: Roxborough Community Action Planning Workshop Agenda

Integrating digital technologies and participatory tools to support coastal community resilience in Trinidad & Tobago (Tech4CoastalResilience)

Roxborough Community Action Planning Workshop
July 18, 2024

CONCEPT NOTE & AGENDA

Background
The project, "Integrating digital technologies and participatory tools to support coastal community resilience in Trinidad and Tobago (Tech4CoastalResilience)", is being implemented from 2023-2024 by the Caribbean Natural Resources Institute (CANARI) in partnership with the Fisheries Division, Ministry of Agriculture, Land and Fisheries and the Department of Marine Resources and Fisheries, Tobago House of Assembly. It aims to improve the resilience of vulnerable coastal communities to climate change impacts in Trinidad and Tobago (T&T). It is supported by the "Harnessing Innovative Technologies to Support Resilient Settlements on the Coastal Zones of the Caribbean (HIT RESET Caribbean)" programme. HIT RESET Caribbean is funded by the ACP Innovation Fund implemented by the Organization of African, Caribbean and Pacific States (OACPS) and European Union (EU).

CANARI, the Fisheries Division, Ministry of Agriculture, Land and Fisheries and Department of Marine Resources and Fisheries, Tobago House of Assembly are conducting action planning workshops in ten coastal communities – Blanchisseuse, Carli Bay, Icacos, Mayaro, Matelot and Moruga in Trinidad and Castara, Roxborough, Speyside and Scarborough in Tobago – from June to August 2024 under the project. These workshops will involve validating the findings from the vulnerability and capacity assessments conducted in these communities to better understand local impacts from climate change and other issues affecting the coast, and prioritising actions to build local resilience. This will inform efforts to implement specific coastal resilience actions under the project and in the future.

Workshop goal and objectives
The goal of this workshop is to engage community residents in Roxborough and other key stakeholders to review key climate impacts and vulnerabilities and prioritise adaptation strategies.

The specific objectives of the workshop are to:

- review findings from the vulnerability and capacity assessment completed in 2021 in Roxborough in terms of key impacts and vulnerabilities related to climate change and other changes, including for the fisheries and tourism sectors and related livelihoods;
- conduct participatory action planning to improve understanding of and identify ways to reduce vulnerability and adapt to climate and other changes; and
- prioritise specific strategies to adapt and build coastal resilience in Roxborough.

Workshop venue

The workshop will be held July 18, 2024, from 10am – 3:15pm at Roxborough High School, Tobago.

Target group

The workshop will target 20-30 participants, including fisherfolk, hotel and tour operators, other coastal resource users and community-based organisations in Roxborough. The project partners and government and civil society organisations involved in fisheries, coastal and marine management, climate change and disaster risk management in Roxborough will also be engaged. This includes:

- key government agencies involved in adaptation, disaster risk management and coastal and marine resource management, including Department of Marine Resources and Fisheries, Coastal Zone Management Unit - Division of Infrastructure, Quarries and Urban Development, Institute of Marine Affairs and Tobago Emergency Management Agency;
- civil society organisations, including fisherfolk organisations, environmental non-governmental organisations (NGOs), women's, youth and other community groups; and
- private sector, including fisherfolk and hotel and tour operators.

Approach

The workshop will be facilitated by CANARI in collaboration with the Department of Marine Resources and Fisheries, Tobago House of Assembly. It will be designed to be interactive, engaging the community in practical exercises and discussions to support coastal resilience action planning.

Outputs

A local action plan for building coastal resilience will be developed based on the key findings from the vulnerability and capacity assessment in Roxborough and the inputs from community residents and other key stakeholders. Specific strategies to adapt and build coastal resilience in Roxborough will also be identified to be further implemented under the project.

Travel and meals

CANARI will cover the costs of the venue and meals for all participants. Local travel to Roxborough may also be covered for civil society representatives where needed.

Provisional Agenda

July 3, 2024	
9:30 am	Registration of participants
10:00 am	Opening remarks, welcome and introductions Overview of the project and workshop objectives
10:30am	Presentation and Q&A – VCA findings for Roxborough community Group discussion – Validating the VCA findings
12:00 pm	**Lunch**
12:45 pm	Introduction to participatory scenario planning Interactive exercise – Participatory Scenario Planning for Roxborough
2:35 pm	Group discussion – Prioritising strategies to adapt and build Roxborough's resilience
3:10 pm	Wrap up and next steps for project Closing remarks
3:15 pm	**End of workshop**

For more information, please contact CANARI via Candice Ramkissoon, Senior Technical Officer at candice@canari.org or Aditi Thanoo, Technical Officer at aditi@canari.org or call 638-6062

Appendix 2: Roxborough Community Action Planning Workshop Participant List

July 18, 2024 | Roxborough High School (Library) | 10am-3:15pm

NO.	FULL NAME	ORGANISATION	TITLE	EMAIL
1	Jaime Hamilton	Red Cross	Volunteer	hamiltonajaime@gmail.com
2	Shermain Stephens	Red Cross	Member	Ssstephens90@gmail.com
3	Ashlyn Lemessee	Red Cross	Volunteer	ajlimesse@gmail.com
4	Bertrand Bhikarry	Environment Tobago	Director	bertrand@environmenttobago.net
5	Esther Tobias-Clarke	DMRF	Research Officer	Marinepark08@gmail.com
6	Kerry Walcott	Roxborough Police Youth Club	Volunteer	kerrywalcott@gmail.com
7	Alysa Johnson	Coastal Zone Management Unit	OJT	Alysaj44@gmail.com
8	Ian Daly	Bloody Bay Fisheries Association	Secretary	Iandaly6229@gmail.com
9	Natalie Alleyne	Tobago Agribusiness Development Company (TADCO)	Processing Manager	Natalie.alleyne@tadco.tt
10	Aliyah Brooks	Roxborough Police Youth Club	Project Assistant	Aliyahbrooks66@gmail.com
11	Shirnel Kennedy	Roxborough Fisherfolk Association	Fisherfolk Vice President	shirnelkennedy@gmail.com
12	Eustace Modeste	Argyle Village	Fisherfolk	eustacemodeste@gmail.com
13	Kossmie B Hercule	Roxborough Village Council	Secretary	Kossmieb1970@gmail.com
14	Bobby Arthur	Tobago Wildlife and Environment Protection Group (TWEP-G)	Member	Bso65@live.com
15	Wendell Walker	Tobago Tourism Agency Ltd.	Director Product Development	wwalker@tobagotourism.org
16	Kimmesha Campbell	Argyle Waterfall	Secretary	argylewaterfalls@gmail.com; kimmeshacampbell@yahoo.com
17	Trevor Wright	Betsy Hope	Boat Builder	-
18	Allison Thomas	TUFA	Secretary	tufafisherfolkassociation@gmail.com
19	Dexter Taylor	TUFA	President	tufafisherfolkassociation@gmail.com
20	Darlington Chance	Parlatuvier Fisherfolk/TUFA	President	Chancedarlington021@gmail.com

Appendix 3. Roxborough Vulnerability and Capacity Assessment

Overview of community

An overview of the Roxborough community is provided below, including the geography, demographics and socio-economic activities, and previous assessments in the area of relevance to climate change.

Roxborough, Tobago
Geography Roxborough is the largest town along the windward coast of Tobago and the second largest town on the island. It lies along Queens Bay on the windward coast. The area boasts a former sugar estate (GoRTT, 2019), which is currently nominated as a heritage site nationally. The Argyle River drains the land surrounding Roxborough and the Argyle Falls, which is a main tourism attraction in Tobago, is an easy walk from the main road and neighbours the community. The Falls receives domestic, stay-over and cruise ship visitors. Tourism here is managed by The Roxborough Estate Visitor Services Cooperative of 16 members, half of whom are female (GoRTT, 2019). One of Tobago's most scenic routes is a new road built from Roxborough over the Main Ridge to the north coast which also serves as a tourist attraction. The Roxborough community also makes use of resources within the Proposed North-East Tobago Marine Protected Area (NETMPA)[1], which includes healthy coral reefs and attracts dive tourism. **Demographics** Based on the last 2011 census, Roxborough has 2,089 residents (1,085 males and 1,004 females) (CSO, 2011). Of these residents, 152 are elderly (65 years and older), 549 are minors (15 years and under) and 1,388 comprise the working population (16-64 years) (CSO, 2011). 65.6% of Roxborough's population is 15 years and older and engaged in work, while 5.13% are under/unemployed (CSO, 2011). **Socio-economic activities** • Key livelihood activities include fishing, diving and tour guiding (FAO, 2014). • Fishing is done on a small-scale as well as on a commercial basis. There is one main fish landing site, with approximately 70 fishers (registered and non-registered) operating from 40 vessels (Ottley, 2019). Types of fishing include palange, fish pot, a la vive, banking, seine and trolling (Ottley, 2019). • The Roxborough Fisherfolk Association represents fisherfolk in the area, and fisherfolk have been identified as key stakeholders for the proposed NETMPA as they have traditional use and access rights to the coastal and marine resources, and they possess an interest in food security, income generation and a sustainable source of fish (FAO, 2014). • Tourism includes the Roxborough Sea Sports and Seafood Festival (THA, 2017), Argyle Waterfall hikes and tours, and diving around offshore islands like Little Tobago and Goat Island. Dive shops offer professional instruction, and a decompression chamber can be found in Roxborough.
Past assessments • In a vulnerability assessment for T&T, Roxborough was identified as an area with specific climate vulnerabilities to flood and storm damage to major roads, transportation links such as marinas, ports, jetties and sea defenses and offshore industrial infrastructure, residential infrastructure, utilities, industrial facilities and plants including sewage (Clarke *et al.,* 2019). • Knowledge, Attitudes and Practices (KAP) Survey conducted on coastal communities of T&T on tsunamis (Kanhai *et al.* 2016). This led to "Dark Wave" tsunami drill conducted by Tobago Emergency Management Authority (TEMA).

[1] Proposed North-East Tobago Marine PA covers an estimated 59,280 ha, extending on Tobago along the entire coastal strip from Roxborough on the north-east coast, north to Parlatuvier on the north-west coast and extending seawards for 11 km.

- Participatory Three-Dimensional Modelling (P3DM) conducted in Tobago in 2012 to enhance the understanding of participants about climate change and its impacts on natural resources and natural resource-based livelihoods (CANARI, 2014).

Methodology

The vulnerability and capacity assessment (VCA) in Roxborough was conducted from 2020-2021 by CANARI and a field team of four persons trained as part of the two-day VCA training workshop held in December 2019 in Trinidad[2].

Participatory geographic information systems (P-GIS) and impact and capacity matrix tools were applied in Roxborough in a half-day workshop on July 29, 2020. Production of maps based on information gathered in the workshops was supported by a GIS expert who digitised and input maps into GIS. The field team then conducted 78 surveys over four weeks. Surveys targeted fisherfolk, including fishers, fish processors and vendors, and selected households and individuals that are representative of various demographics, livelihood activities and sectors and vulnerable groups identified in the P-GIS and impact and capacity matrix exercises.

The field team included fisheries officers/data collectors operating in the community from the Department of Marine Resources and Fisheries, Tobago House of Assembly (THA), the CC4FISH National Project Coordinator for T&T, and community representatives. The field team collectively encompassed a mix of competencies, including in climate change, fisheries and socio-economic/community development, to ensure a holistic approach and effective implementation.

Figure 1. Participatory mapping in Roxborough, Tobago. Photos show participatory mapping process and resulting map highlighting relevant climate and other hazards, as well as areas in Roxborough vulnerable to the impacts of identified hazards.

Source: CANARI (2021)

[2] https://canari.org/wp-content/uploads/2018/02/CC4FISH-TT-VCA-Training-Workshop-Report-Jan2020.pdf

Key climate change impacts and vulnerabilities for Roxborough

The specific findings from the applications of the three VCA tools in Roxborough are detailed below.

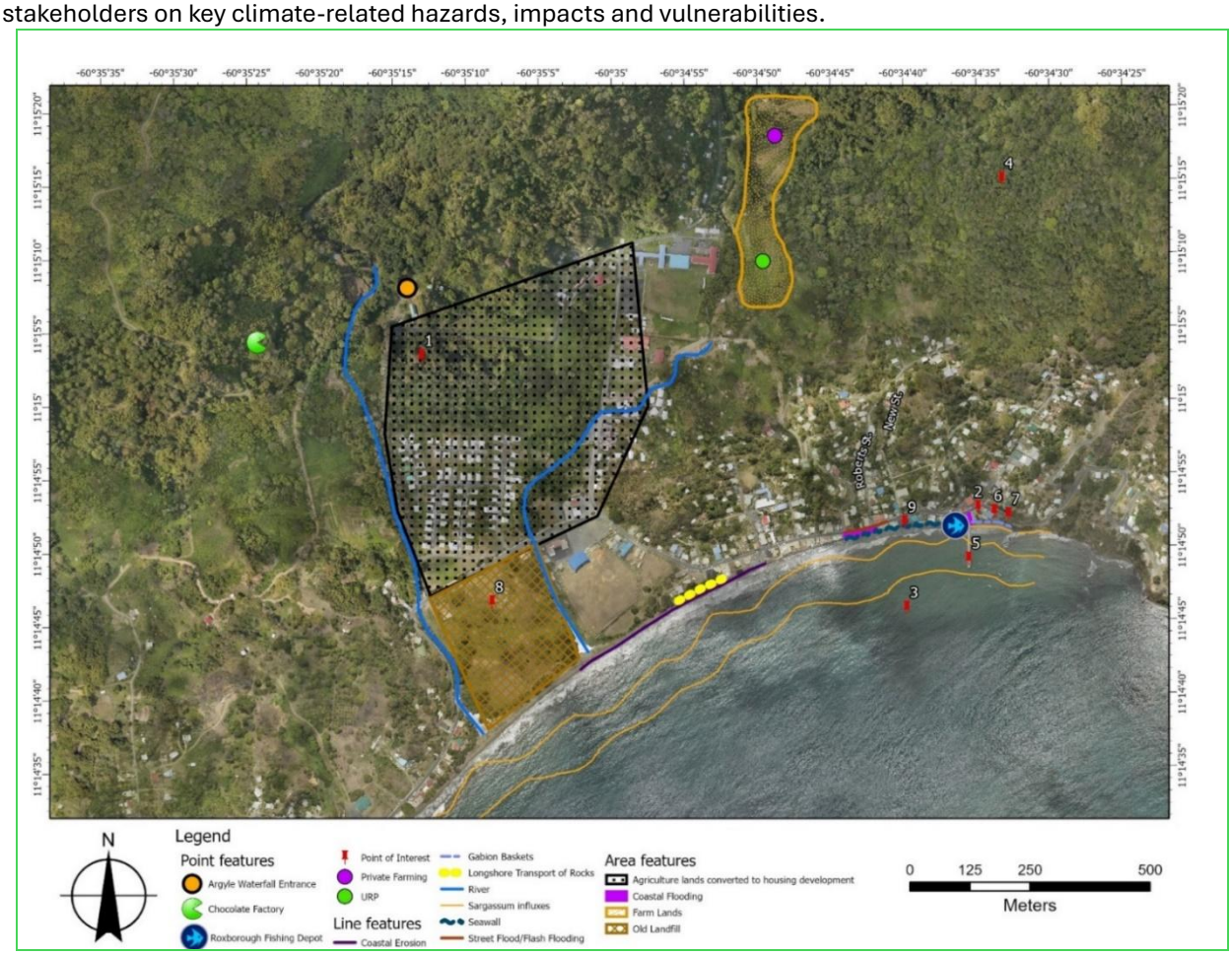
Participatory mapping and GIS findings

Fisherfolk and other community stakeholders identified and mapped a range of climate-related hazards that they had experienced, or which will pose a significant risk to the community of Roxborough, with a focus on fisheries-related assets and vulnerable areas and groups during the P-GIS exercise. The key hazards included:

- Sargassum influxes that impact beaches and affect fisheries sector operations and the wider community of Roxborough.
- Coastal erosion and flooding due to rough seas and seal level rise (SLR), which especially affects beaches and infrastructure such as the sea wall, main access road along the coast and other roads.
- Inland flooding that affects a housing development built on what was previously wetland and agricultural lands.

The local knowledge captured through the mapping exercise was digitised and placed within a GIS for integration with scientific knowledge and other data. Figure 2 below shows the P-GIS map developed through digitisation of the annotated satellite imagery maps created during exercise.

Figure 2. Digitised participatory GIS map of Roxborough developed through discussions with community stakeholders on key climate-related hazards, impacts and vulnerabilities.



Source: CANARI (2021)

Local knowledge data for map provided by stakeholders in Roxborough, Tobago during the 'Workshop for the Vulnerability and Capacity Assessment of Roxborough' (July 29, 2020). Map developed by CANARI (2021) using EPSG:32620; Google Earth (13/03/2015), Trinidad and Tobago. 11°17'45.59"N, 60°31'53.88"W, Eye alt 1.44km. CNES 2021, Airbus 2021. https://earth.google.com [01/10/2020].

Points of interest

#	Description
1	Area of inland flooding, where agricultural land was converted to housing developments
2	Coastal flooding reached the road
3	Fishing patterns have changed - Queen Island (~8-10 km off of coastline)
4	Forest Park Estate
5	Needs a floating jetty – sea level too high in low tide to dock and unload boats
6	No coconut trees anymore
7	Previous erosion area - fixed with gabion baskets
8	Previous landfill area
9	Seawall undermined by ocean

Impact and capacity matrix findings

Fisherfolk and other community stakeholders ranked the climate and other related hazards that they had identified and their impacts, including on the fisheries sector and vulnerable areas and groups, during the impact and capacity matrix exercise. Additionally, current or potential coping and adaptation strategies were identified for these impacts.

In Roxborough, stakeholders highlighted storms and storm surge, coastal erosion and sargassum influx as the hazards of most significance in terms of impacts and as priorities to address. These hazards impact key fisheries and tourism sector assets (e.g. boats and fishing gear in the fisheries sector or hotels and restaurants in the tourism sector), local livelihoods and income generation opportunities that are dependent on these sectors.

The impacts of the current COVID-19 pandemic were also assessed along with other non-climate hazards, including loss of livelihoods and income due to business closures or reduced opening hours and restrictions related to public gathering, mobility and access to beaches, rivers and other recreational areas.

Coping and adaptation strategies were discussed for the priority hazards identified. Strategies included improving safety at sea via further training and early warning systems, consideration of a floating jetty that will allow access fishers and other boat users access despite erosion/changing depth of water, development of a community action plan with the Tobago Sargassum Response Committee to address sargassum influx and identifying best practises to safely collect and use sargassum, and improved access to third party insurance for fisherfolk.

Table 1 shows detailed matrix including other notable hazards impacting the community such as pollution and the current COVID-19 pandemic.

Table 1. Impact and capacity matrix for Roxborough, Tobago

Key:	3 – High Impact	2 – Medium Impact	1 – Low impact	0 – No impact

Key Fisheries & Tourism Assets	**Hazard Ranking**							
	Storms and storm surge*	Sargassum*	Coastal erosion*	Heavy rainfall events (flooding)	Pollution (marine and other litter)	COVID-19	Sahara Dust	Crime (theft and piracy)
Fishing gear	3	3	2	1	1	1	1	1
Boats	3	3	3	2	1	1	1	1
Jetty	2	1	2	1	1	1	1	1
Slipway	2	2	3	1	1	1	1	1
Fish market facility	2	1	1	1	1	3	1	2
Fishers	3	2 (pros & cons)	3	2	1	2	2	1
Fishing grounds	2	2 (pros & cons)	1	3 (sedimentation from run off)	2	1	2	1
Natural ecosystems (mangrove, reefs, seagrass)	3	2	3	3 (sedimentation from runoff)	3	1	2	1
Boat repair	1	1	1	1	1	1	1	1
Tackle shop/ suppliers	1	1	1	1	1	1	1	1
Hotels & restaurants	3	3	3	3	2	3	1	2
Total	**25**	**21**	**23**	**19**	**15**	**16**	**14**	**13**
Potential coping/adaptation strategies?	Improve safety at sea (e.g. via training); Improve communication and early warning system;	Identify and implement best practices to safely collect and use sargassum; Work with Tobago Sargassum	Jetty (e.g. floating jetty) that will allow access despite erosion/changing depth of water					

	Improve access to third party insurance; Access to trolley to haul boats and safe storage; Develop adaption/disaster preparedness plan and mobilise investments and resources to implement plan	Response Committee to develop community action plan						

* hazards identified as most significant and priorities to address

Source: CANARI (2021).

Survey findings

A total of 78 surveys were administered in Roxborough, with 30% of respondents being female and 69% male. 40% of survey respondents did not indicate their age. Of those who indicated their age, 22% were 20-39 years and 27% were 40-59 years. Responses disaggregated by age/gender showed no significant difference in responses between groups.

The majority of survey respondents in Roxborough noted 'other' as their main source of income (45% of respondents), followed by the public sector (35% of respondents), the fisheries sector (13% of respondents) and agriculture sector (6% of respondents). In terms of secondary sources of income, 60% of respondents noted 'other' as their secondary source of income, while 19%indicated the fisheries sector, 9% agriculture, 7% public sector and 6% tourism. These other sources of income included self-employment, pension and the private sector.

Table 2. Sources of Income for Roxborough survey respondents

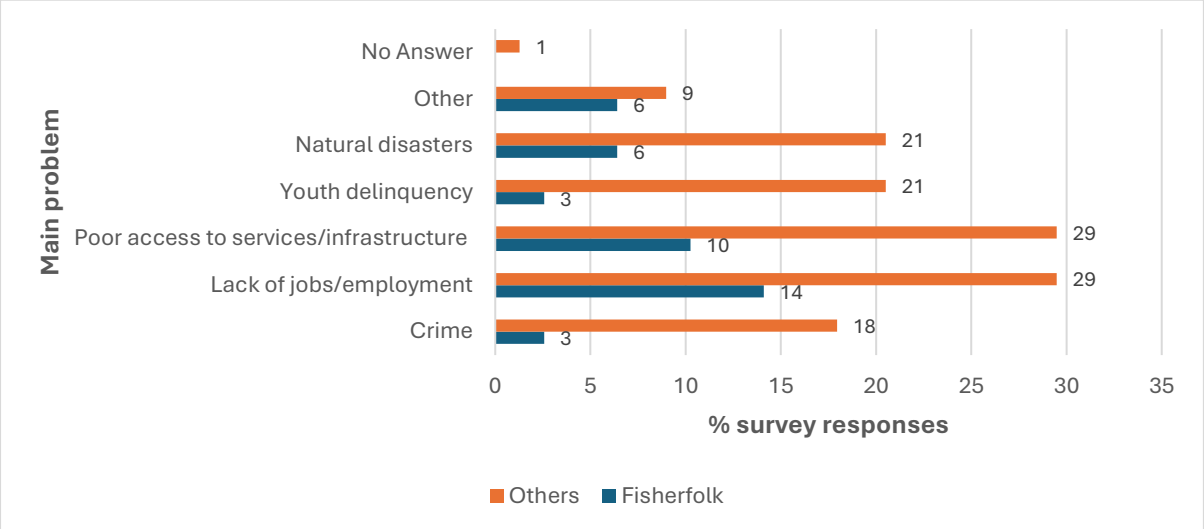
Source of Income	Agriculture	Fisheries	Public Sector	Tourism	Other	No answer
Main source	**6%**	**13%**	**35%**	**0%**	**45%**	**1%**
Secondary source	**9%**	**19%**	**7%**	**6%**	**60%**	**21%**

Source: CANARI (2021)

All survey respondents working within the fisheries sector were male and mainly aged 20-39 in Roxborough. Survey respondents, who were female, largely indicated income sources from employment in the private sector, self-employment and pensions. Notably, the 'Other' category included 53% unspecified sources of income from respondents across primary and secondary income sources and for both genders.

Lack of jobs/employment was the main problem identified by Roxborough respondents (44%), followed closely by poor access to services and infrastructure (40%). Natural disasters (27%), youth delinquency (23%) and crime (21%) were also highlighted by survey respondents as issues affecting Roxborough households and livelihoods. See Figure 3.

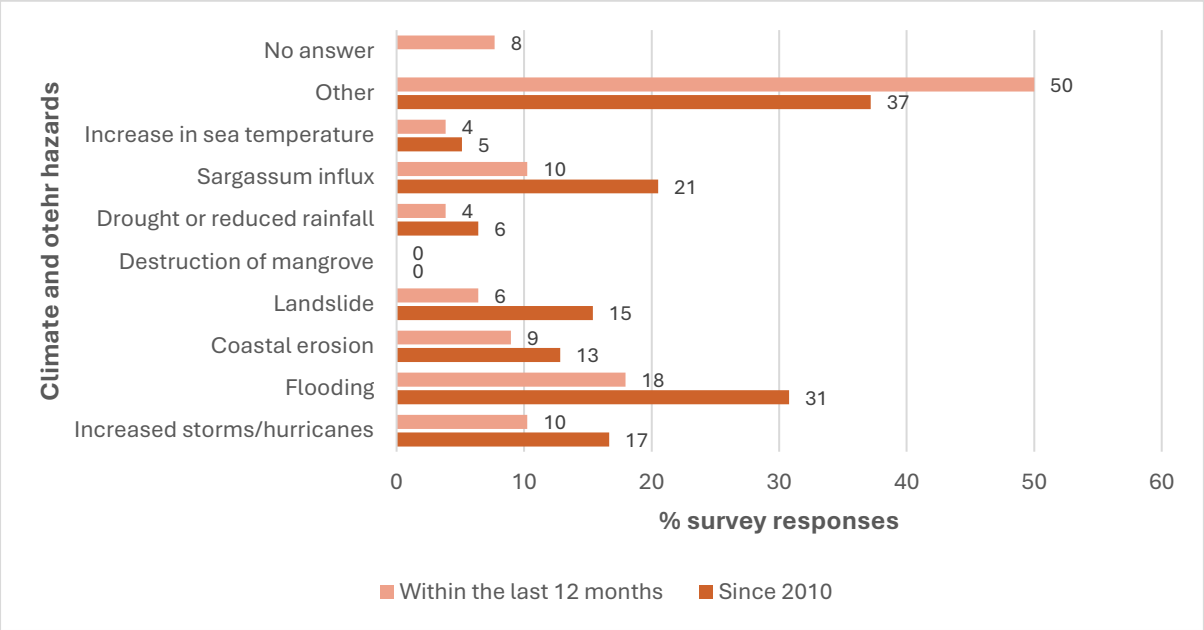
Figure 3. Main problems impacting fisherfolk vs. others' households and livelihoods in Roxborough, Tobago



Climate and other hazards affecting the Roxborough community

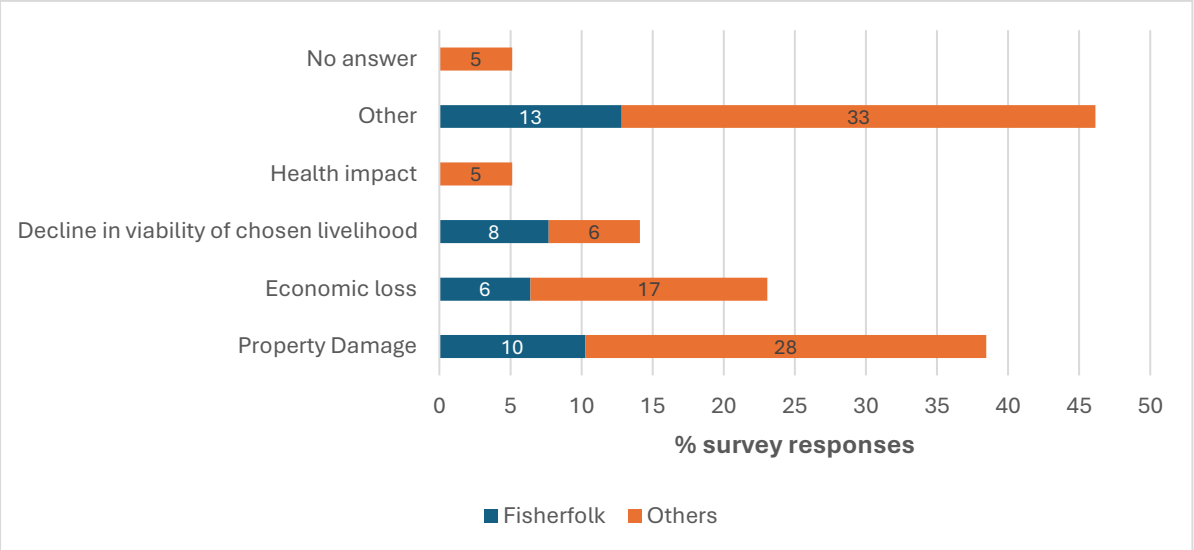
Generally, flooding, sargassum influxes and increased storms and hurricanes were identified most frequently by respondents (Figure 4). Analysis of the 'Other' category revealed the majority of responses here did not provide a response to detail their selection of 'Other'. Of those who did indicate details, the majority stated they were not affected (Figure 5).

Figure 4. Climate and other hazards identified by Roxborough survey respondents



Property damage was the main impact resulting from the climate-related hazards indentified (38% of respondents), followed by economic loss (23% of respondents) and decline in viability of livelihood (14% of respondents). In terms of other impacts indicated by 46% of respondents, half of these were unspecified and half indicated no impact incurred. See Figure 5.

Figure 5. Impact as a result of climate and other hazards in Roxborough, Tobago

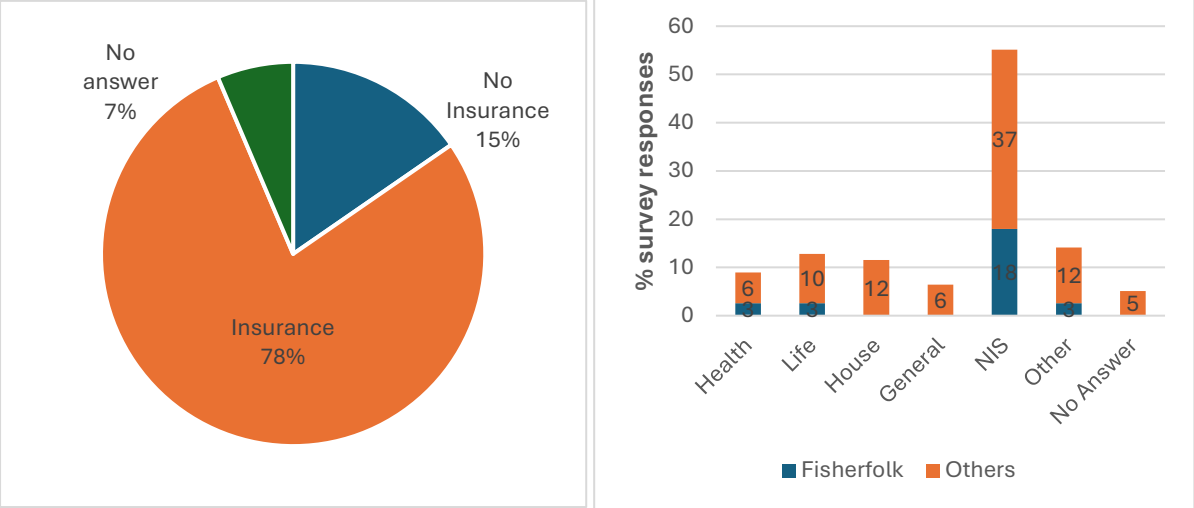


Recovery methods and coping and adaptation strategies

Of those surveyed, 33% indicated self-initiated recovery methods including responses such as 'paying to fix it' or through the help of family and friends. 36% of respondents had taken less than 6 months to recover from impacts from identified hazards. However, 48% of survey respondents did not indicate either recovery methods from identified hazards or length of recovery time.

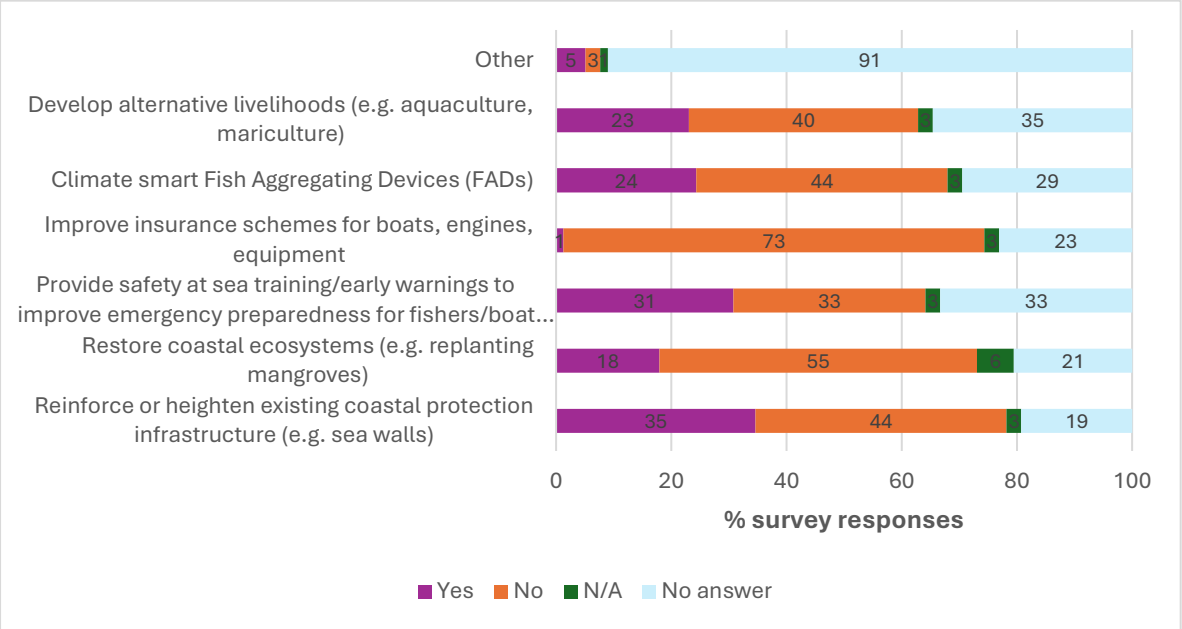
78% of survey respondents had insurance, while 15% did not. Of the 78% that indicated insurance, 56% had NIS, 13% had life insurance and 9% had health insurance. The majority of respondents indicating insurance were not fisherfolk. The most frequent response for fisherfolk regarding insurance was NIS (18%) (Figure 6).

Figure 6. Insurance status and type of insurance for survey respondents in Roxborough, Tobago



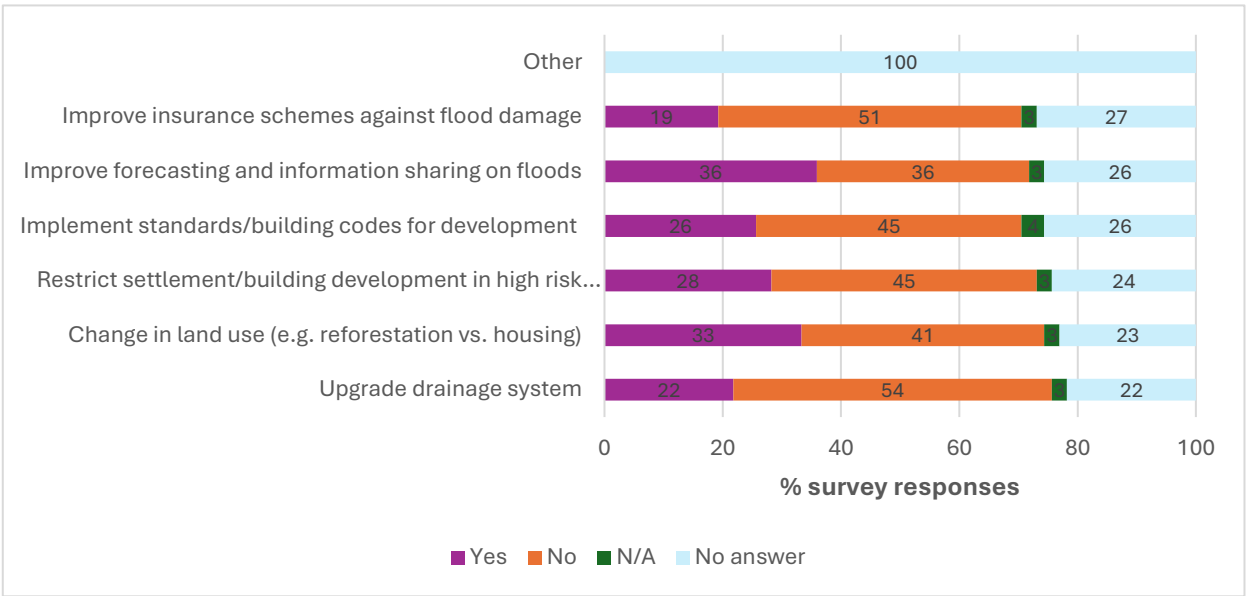
While some respondents noted adaptation measures that have been implemented, generally respondents indicated that no measures had been implemented. In terms of the coastal and marine zone, adaptation measures identified included reinforcement of coastal protection infrastructure (e.g. sea defences) (35% of respondents), safety at sea measures (31% of respondents), FADs (24% of respondents) and development of alternative livelihoods (23% of responses). See Figure 7.

Figure 7. Coastal and marine zone adaptation measures implemented in Roxborough, Tobago



In terms of flood protection, identified adaptation measures included improving forecasting and information on floods (36% of respondents), change in land use such as reforestation (33% of respondents), restriction of development (28% of respondents) and implementing building codes (26% of respondents). See Figure 8.

Figure 8. Flood protection adaptation measures, Roxborough, Tobago



For drought/low flow protection, there were generally more responses indicating adaptation measures were implemented than those for the coastal and flood protection. Respondents indicated implementation of measures such as increased water supply (38%), water restrictions (38%), upgrades to irrigation systems and efficiency (37%) and improved forecasting and information sharing on droughts (28%). See Figure 9.

Figure 9. Drought/Low flow protection adaptation measures, Roxborough, Tobago

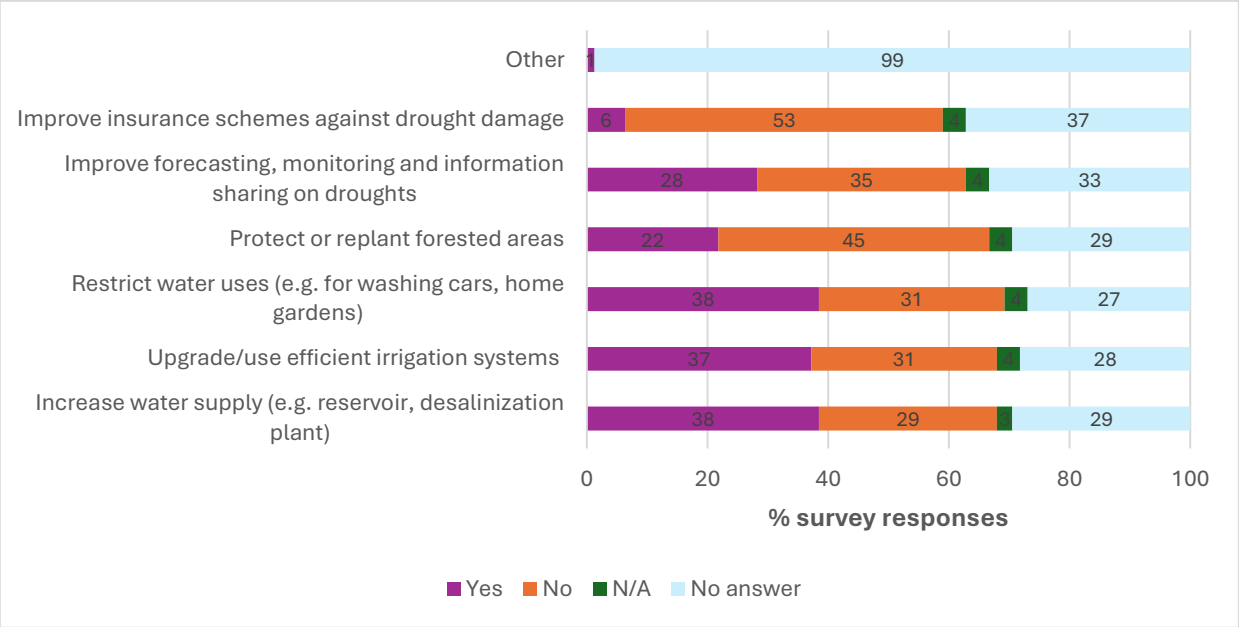
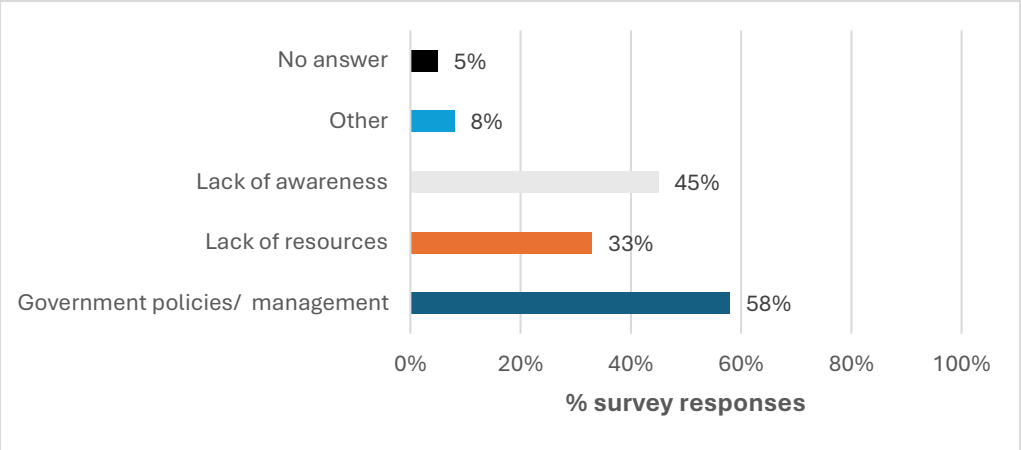


Figure 10. Main barriers to addressing the impacts of identified climate and related hazards in Roxborough, Tobago



In terms of barriers to implementation of climate adaptation and resilience building measures in Roxborough, 58% of respondents indicated weak government policies/management, 45% indicated lack of awareness and 33% indicated lack of resources. See Figure 10.

Summary of findings

A summary of the key climate change impacts, vulnerabilities and adaptation priorities is outlined in Table 3.

Table 3. Key climate change impacts, vulnerabilities and adaptation priorities identified by Roxborough stakeholders

Climate-related hazards	Key impacts	Vulnerable groups and areas	Priorities for adaptation
Coastal and marine biodiversity and ecosystems			
• Storms and storm surge • Rough seas • Sargassum influx • Coastal erosion and flooding • Inland flooding along river	• Coastal erosion impacting beaches and coastal vegetation and leading to degradation and loss of coastal ecosystems and biodiversity. • Marine ecosystems are impacted by influx of sargassum.	• The coastline of Roxborough, including beaches and coastal vegetation and related biodiversity.	• Improved conservation and sustainable management of coastal and marine ecosystems. • Development of a community action plan with the Tobago Sargassum Response Committee to address sargassum influx and identify best practices to safely collect and use sargassum.
Livelihoods and socio-economic practices			
• Storms and storm surge • Rough seas • Sargassum influx • Coastal and inland flooding along river	• Damage and loss of fishing boats, gear and fisheries infrastructure (e.g. jetty) due to rough seas, storms and storm surge and sargassum influx. • Decline in viability fishing operations and income due to sargassum influx. • Damage to community infrastructure, including businesses and residential homes as a result of flash flooding along roads parallel to the coastline.	• Fisherfolk in Roxborough and those dependent on the fisheries sector for their livelihoods (boat owners, fishers, vendors), including their family members dependent on their income. • Business owners and employees working near coast and in low-lying areas prone to flash flooding. • Property owners and households living near coast and in low-lying areas prone to flash flooding.	• Development of an adaptation/disaster preparedness plan and mobilization of investments and resources to implement the plan. • Improved safety at sea via training and better communication and early warning systems for storms. • Consideration of a floating jetty that would allow fishers access despite erosion/changing depth of water for boat users. • Access to trolley to haul boats and safe storage facilities in order to reduce potential for damage from storms and storm surge. • Access to third party insurance for boats, engines and equipment for fisherfolk.
Settlements and infrastructure			

• Storms and storm surge • Rough seas • Coastal and inland flooding along river	• Property damage and loss of coastal infrastructure (e.g. fishing depot, jetty, main access road) from coastal erosion due to rough seas and increased storms and storm surge. • Property damage and loss of community infrastructure (e.g. residential homes, main access road and other roads) as a result of increased flash flooding due to storms and heavy rainfall.	• Fishing depot, landing site and the main access road along coast. • Property and business owners and residents living near to coast and in low-lying areas prone to flash flooding.	• Development of an adaptation/disaster preparedness plan and mobilization of investments and resources to implement the plan. • Consideration of a floating jetty that would allow access despite erosion/changing depth of water.

Source: CANARI (2021).

Stakeholder Validation

A validation exercise was conducted in Roxborough as part of the action planning workshop on July 18, 2024, to determine if there were any significant changes to the key climate change impacts and vulnerabilities identified in the VCA in 2020-2021.

Overall many of the same issues persist but have worsened, particularly impacts from coastal erosion, storm surges, and extreme weather events leading to floods and landslides. Sargassum influxes remain a major issue, though there are mixed perspectives on its impacts. Positive impacts include sargassum mats attracting more of certain fish species, and whether it could be collected to help stabilise beaches affected by erosion. Negative impacts include blocking access for fisherfolk, damaging boat engines and gear, and the pungent smell from rotting sargassum that has health impacts and reduces the attractiveness of the beach for tourism.

New threats have emerged, with heat related issues now a significant concern due to rising air temperatures, and potential long-term impacts on agriculture, tourism and water availability. There are also fresh concerns related to development of infrastructure and settlements in the area – specifically increased flooding risks from development projects altering waterways and increased pollution from land-based runoff – as well as worsening storm impacts. Hurricane Beryl in early July 2024 highlighted the increasing severity of storms, with concerning impacts on homes, roads, and public utilities due to high winds and rough seas although there was no direct impact on Tobago.

Below is a summary of updates shared by community residents, including fisherfolk and tour operators:

Worsening environmental and coastal issues

- Participants noted that those key issues captured in the 2021 VCA - coastal erosion, sargassum influxes and storm surges - are still pertinent and continue to worsen. Examples highlighted include:
    - Ten Chain area and jetty park area, which are particularly affected by coastal erosion, with new concerns of a sinkhole forming due to storm surges.
    - Homes and businesses along the sea wall, as well as the sea wall itself are experiencing increased structural damage (e.g. cracks). Notably, in the past the Windward Road was jeopardised when a seawall failed, severely challenging the connectivity of Roxborough and surrounding villages.
- Additional concerns were noted around increased SLR further exacerbating erosion and storm surge impacts, and pollution from land-based runoff e.g. along Main Road and New Street, leading to degradation of coastal areas.
- Sargassum influxes near the jetty were noted to have worsened, particularly in July and August 2024. Equipment and storage are however required for sargassum removal and clean-up efforts. Some participants questioned whether sargassum could help reduce coastal erosion by acting as a natural barrier. It was also noted that sargassum mats may attract more fish.
- Oil deposits were spotted on the Roxborough coast, related to an oil spill in February 2024 from an overturned vessel off the coast of Cove Eco Industrial and Business Park, Tobago.
- Illegal sand mining is a concern that needs further attention.

Climate and weather impacts

- Rising temperatures and heat related issues were noted as a new concern; 2024 was perceived as the hottest year so far, with impacts on agriculture, tourism and access to potable water.
- There was also increased concern over storms and hurricane activity. Recently, Hurricane Beryl caused heavy winds, fallen trees, landslides (e.g., at Station Hill), and roof damage. Fisherfolk had to secure boats to prevent losses.

Livelihoods and socio-economic practices

- Increased weather extremes, including heatwaves, flooding and storms/hurricanes, are worsening livelihood impacts. These could negatively impact nature-based tourist activities and related income streams e.g. visits to beaches, waterfalls, birdwatching etc.
- Changing and unpredictable conditions are noted as having a potential impact on key economic sectors such as agriculture and tourism. Key tourism sites such as the Argyle Waterfall may be impacted by changing rainfall patterns, affecting visitor numbers. Tour guides have also observed changes in bird migration patterns, which could affect tourism activities.
- With run-off impacting coastal habitats, sargassum influxes and changing ocean conditions, fisherfolk now need to go further out to fish, increasing safety risks during bad weather. As traps are also set farther out, if lost in rough conditions, they may carry fish away with them.
- Participants highlighted the need for more awareness and advocacy on the importance of Northeast Tobago's natural resources, with more community consultation and efforts to quantify the area's economic value and how it benefits local livelihoods.

Settlements and infrastructure issues

- Roxborough Hospital has improved healthcare services, which is a positive change.
- It was felt that infrastructure damage is worsening including:
    - Seawall deterioration, with increasing cracks and structural weakening.
    - New concerns about sinkhole forming near the jetty park area due to storm surges and erosion
    - Impacts to other key coastal infrastructure from erosion and flooding, such as a local supermarket where flooring damage (e.g. raised tiles) has been observed.

    - Hurricane Beryl highlighted the severity of recent storms with impacts to roads via flood and landslides, homes via high winds causing roof damage and utilities via downed power lines due to high winds and fallen trees.
- New risks are also emerging from development projects and inadequate waste management, including:
    - Renaissance Housing Scheme in Argyle where townhouse development has altered waterways, raising concerns about increased flooding and its impact on lower-income residents especially. Notably, Renaissance Park has experienced flooding over time.
    - Wetlands in Argyle were backfilled to construct a community centre, potentially affecting local ecosystems and typical water flow.
    - Waste management is a growing concern. Participants stressed the need for better waste collection and disposal in the community, including garbage bins and improved waste management practices.

Based on the above, community residents re-emphasised the need for adaptation priorities previously identified, while refining specific interventions and recommending additional adaptation and resilience-building measures to better address emerging concerns as noted below:

- **Landing site improvements**
    - Notably, **floating jetties** were identified as a potential adaptation option earlier on, but concerns were raised about their suitability in rough seas. A **sheltered area (e.g., with a breakwater)** was now considered more critical for fishers, and discussions are needed to explore this further, including a possible location.
    - There is also interest in establishing a **boat yard** in Roxborough which could be used to undertake repairs and safely store and protect vessels from climate-related hazards.
- **Insurance** – participants noted that insurance options should extend beyond third-party coverage for boats, engines and equipment (as identified in the VCA) to include personal insurance for fisherfolk.
- **Water harvesting and storage** – enhancing community water access and resilience to heat stress by expanding water tank capacity and promoting rainwater harvesting, especially for residential use, and at critical facilities supporting key livelihoods (e.g. fishing facilities and schools)
- **Strengthening/reinforcing of the existing sea wall,** which is deteriorating, for more secure coastal protection
- **Improvement of drainage networks,** factoring changing/compromised drainage conditions from built development
- **Awareness raising and education initiatives**, focused on topics such as public health issues related to climate change, the sargassum response plan
- **Community clean-ups**, particularly targeting cleaning of watercourses
- **Sargassum clean-up and harvesting** via procurement of equipment for sargassum removal, as well as identification of a suitable storage area
- **Changes in fishing techniques and diversification (e.g. fish farming)** to help with fisherfolk safety and factor in changing conditions
- **Improvements in education/learning environments in response to extreme weather**, including delivery of home-schooling packages to reduce missed days during storms/floods and improved ventilation and air conditioning systems in schools to combat extreme heat.

Notably, of all the proposed actions, there was particularly strong interest in rainwater harvesting and seawall reinforcement.

Appendix 4. Roxborough Community Resilience Plan

Bold = priority impacts and actions; ** = top priorities

Community impacts & risks	Actions to adapt/build resilience	Roles and responsibilities (Lead/supporting actors)	Required resources	Time frame	Indicators of Success
Fisheries and Marine Resources					
<u>Extreme weather</u> including heavy rainfall and storms, extreme heat, and drought with related water stress **Impacts** • **Disruption to fishing operations and reduced income due to storms and related rough seas and storm surge** • **Damage to and loss of fishing boats, gear and fisheries-related infrastructure (e.g. jetty and fishing facility)** • **Safety at sea risks for fishers, and reduced fishing days, with potential for loss of income** • **Water stress/shortages impacting fishing operations, particularly vending and processing**	• ****Construction of breakwater to create a sheltered space for fishing vessels and protect fisheries infrastructure** • ****Access to safe storage facilities e.g. boatyard and equipment to haul boats, to minimise damage from storms and storm surge** • ****Access to insurance to address damage to boats, engines and gear, and personal insurance for fisherfolk to enhance financial resilience** • **Safety at sea training, access to required equipment and improved early warning systems for storms and other extreme weather for fisherfolk**	• **Coastal Zone Management Unit (CZMU), Department of Environment, Climate Change and Energy, Tobago House of Assembly (THA) (co-lead)** • **Department of Marine Resources and Fisheries (DMRF), THA (co-lead)** • **Roxborough Fisherfolk Association (co-lead)** • **Fisherfolk** • **Division of Infrastructure, Quarries and Urban Development (DIQUD), THA** • **Division of Finance, Trade and Economy, THA** • **Tobago Emergency Management Agency (TEMA)**	• **Expertise (coastal engineering, fisheries management, disaster response)** • **Financing (significant amount for breakwater)** • **Equipment (e.g. trailer/tractor/ trolley to pull up vessels)** • **Materials** • **Early warning information and technology** • **Training programmes**	**Short to medium term (1-6 years)**	• **Reduced loss and damage of fishing vessels, engines and gear** • **Reduced number of safety incidents reported by fisherfolk** • **Increased number of rainwater tanks and improved water access to support fisheries operations**

Community impacts & risks	Actions to adapt/build resilience	Roles and responsibilities (Lead/supporting actors)	Required resources	Time frame	Indicators of Success
• Increased discomfort for fishers and vendors due to extreme heat, leading to higher cooling costs, expenses e.g. for ice and greater risk of fish spoilage Vulnerable groups • Fisherfolk (including boat owners) • Households dependent on fishing as a food or income source • Small businesses dependent on local fish supply (e.g. food establishments, hotel/guest accommodations)	• Establishment of rainwater harvesting systems for climate-smarting fisheries operations, supported by training, policies and financing	• Trinidad and Tobago Meteorological Service (TTMS) • Town and Country Planning Division • All Tobago Fishing Association (ATFA) • Tobago Unified Fisherfolk Association (TUFA) • Finance and insurance providers • Telecommunication service providers • Caribbean Fisheries Training and Development Institute (CFTDI) • University of the West Indies (UWI) • UN Food and Agriculture Organization (FAO)			
<u>Sargassum influxes</u> Impacts • Disruption to operations as blocked access to shoreline and jetty for fishing vessels, resulting in reduced fishing days and income	• **Identification of storage site and provision of equipment/tools for clean-up of sargassum influxes on a regular basis by local community groups • Awareness raising on sargassum response plan	• Division of Agriculture, Marine Affairs, Marketing and the Environment (DAMME), THA (co-lead) • DMRF (co-lead) • Roxborough Fisherfolk Association (co-lead) • TEMA	• Expertise (marine science, disaster response, business development) • Funding • Equipment/ tools (e.g. protective gear – gloves, light machinery, booms	Short to medium term (1-6 years)	• Reduced loss and damage to fishing vessels, engines and gear from sargassum influxes • Reduced length of time that sargassum is stranded on beach

Community impacts & risks	Actions to adapt/build resilience	Roles and responsibilities (Lead/supporting actors)	Required resources	Time frame	Indicators of Success
• Damage to engines, nets and other fishing gear, and increased safety at sea risks for fishers • Pungent smell (hydrogen sulphide and ammonia gas) from decaying sargassum causes health issues • Marine ecosystems are impacted by influx of sargassum Vulnerable areas • Fisheries infrastructure - fishing depot, landing site, jetty Vulnerable groups • Fisherfolk, including boat owners • Recreational fishers • Households dependent on fishing as a food or income source • Small businesses dependent on local fish supply (e.g. food establishments, hotel/guest accommodations)	and any best practices for safe collection and use • Access to insurance to address damage to boats, engines and gear, and personal insurance for fisherfolk • Establishment and implementation of regular air quality monitoring and early warning system for sargassum at Roxborough to inform response • **Diversification and development of alternative livelihoods (e.g. aquaculture, mariculture, collection and use of sargassum to create value-added/commercial products like liquid fertilizer, biofuels and building materials)	• CZMU/ Department of Environment, Climate Change and Energy, THA • National Sargassum Task Force • Institute of Marine Affairs (IMA) • Environmental Management Authority (EMA) • ATFA • TUFA • Fisherfolk • Roxborough Police Youth Club and local community groups • Local entrepreneurs • Finance and insurance providers • CFTDI • UWI • FAO • Caribbean Agricultural Research & Development Institute (CARDI), Inter-American Institute for Cooperation on Agriculture (IICA)	for removal/ harvesting of sargassum) • Materials • Suitable storage areas		• Increased number of fisherfolk engaged in alternative livelihoods

Community impacts & risks	Actions to adapt/build resilience	Roles and responsibilities (Lead/supporting actors)	Required resources	Time frame	Indicators of Success
Coastal erosion from rough seas, storms and storm surge and sea level rise **Impacts** • Deterioration of the jetty • Degradation or loss of coastal vegetation and other key ecosystems and related biodiversity • Increased sedimentation and damage to nearshore marine ecosystems which act as fish nurseries/habitat **Vulnerable areas** • Fisheries infrastructure - fishing depot, landing site, jetty **Vulnerable groups** • Fisherfolk • Households dependent on fishing as income source	• Reinforcement of existing seawall** • Construction of breakwater to mitigate coastal erosion impacts near fisheries and other key coastal infrastructure • Upgrade to a floating jetty to allow fishers access despite erosion/changing depth of water for boat users • Replanting of coastal vegetation (e.g. sea-grape, coconut trees, use of vetiver grass etc.) to address erosion and biodiversity loss	• CZMU/ Department of Environment, Climate Change and Energy (co-lead) • DMRF (co-lead) • Roxborough Fisherfolk Association (co-lead) • DIQUD • EMA • IMA • Town and Country Planning Division • Fisherfolk and local community groups • ATFA • TUFA	• Expertise (coastal engineering, construction, ecosystem restoration) • Financing (significant amount for seawall/ breakwater and upgrading jetty) • Equipment • Materials • Labour • Seedlings for replanting • Planning approvals/ environmental impact assessments	Medium term (4-6 years)	• Reduced maintenance and repair costs for fisheries infrastructure (e.g. landing site/jetty) • Reduced shoreline erosion in high-risk areas (e.g. comparing shoreline stability and infrastructure damage pre- and post-construction measures)
Settlements, Infrastructure & Social Services					
Coastal erosion from rough seas, storms and storm surge and sea level rise **Impacts** • **Damage to homes, other property and key**	• ****Implementation of coastal protection measures - reinforcement of seawall, construction of breakwater or use of gabion baskets - in high risk areas**	• **CZMU/ Department of Environment, Climate Change and Energy (co-lead)** • **DIQUD (co-lead)** • **Roxborough Village Council (co-lead)**	• **Expertise (coastal engineering, construction, ecosystem restoration)** • **Financing**	**Short to medium term (1-6 years)**	• **Reduced costs from loss and damage of coastal property and infrastructure (e.g., roads, schools)** • **Increased extent and health of coastal**

Community impacts & risks	Actions to adapt/build resilience	Roles and responsibilities (Lead/supporting actors)	Required resources	Time frame	Indicators of Success
infrastructure along coastline (e.g. roads, schools, businesses, stadium) **• Disruption in livelihoods when key infrastructure is damaged** **• Erosion of beaches and degradation and loss of coastal vegetation and other ecosystems** **Vulnerable areas** **• Ten Chain and jetty park area affected by sinkhole** **• Coastal roads – Windward Road, Main Road, New Street** **Vulnerable groups** **• Residents** **• Business owners** **• Property owners along coast**	**• Replanting of coastal vegetation (e.g. sea-grape, coconut, vetiver etc.) to address erosion and threats to homes, property and livelihoods** **• Improved monitoring of coastal erosion and other changes to inform response** **• Improved access to home/property insurance to address risks from coastal erosion** **• Upgrading and enforcement of building codes taking into account coastal erosion and sea level rise**	**• DMRF** **• IMA** **• EMA** **• Town and Country Planning Division** **• Property owners** **• Local businesses** **• Roxborough Police Youth Club and other local community groups** **• Environmental Research Institute of Charlotteville (ERIC), North East Tobago Climate Change Champions Network supporting replanting efforts, IAMovement and other NGOs** **• Insurance providers**	**• Equipment and materials** **• Labour** **• Seedlings for restoration** **• Planning approvals/ environmental impact assessments**		**vegetation (e.g. sea-grape, coconut trees)**
<u>Extreme weather</u> including heavy rainfall, winds, extreme heat, and drought with related water stress Impacts • Damage of residential homes, property and key infrastructure (e.g. main access road and other roads) as a result of flash	• Development of community disaster preparedness plan and early warning system for extreme weather, including training, financing and other resources to implement • **Upgrade and maintenance of drainage	• DIQUD (co-lead) • Water and Sewerage Authority (WASA) (co-lead) • Roxborough Village Council (co-lead) • TEMA • Division of Education, Research and Technology, THA	• Expertise (engineering, construction, water management, disaster management, public health) • Financing (significant amount to upgrade drainage and WASA's	Short to medium term (1-6 years)	• Reduced costs from loss and damage of property and infrastructure from floods and landslides • Reduced incidence of disruptions to schooling and other key social services due to floods,

Community impacts & risks	Actions to adapt/build resilience	Roles and responsibilities (Lead/supporting actors)	Required resources	Time frame	Indicators of Success
flooding and increased costs for repairs • Landslides and fallen trees due to heavy rainfall and winds, leading to property damage, disruptions in electricity, telecommunications and other utilities, and road blockages restricting access and mobility • Disruptions to schools, government buildings and businesses during extreme weather • Water shortages during dry spells/droughts, leading to increased time and costs securing alternative water sources for households, businesses and essential services (e.g. hospitals) • Heat stress and increase in risk of vector borne diseases (e.g. dengue) with rising temperatures • Increase in risk of forest fires with hotter, drier conditions • Potential for community conflicts over water scarcity	systems to address flash flooding • **Regular community clean ups, particularly targeting cleaning of watercourses, and tree trimming • **Increased use of water storage and rainwater harvesting systems, including renewable energy-powered water pumps, for residential and commercial purposes • Increased use of air conditioning and other cooling systems, including energy efficient and renewable-powered systems, for residential and commercial purposes • **Development of home-schooling kits to reduce the impact of school disruptions and ensure continuity in education/less missed days during extreme weather	• Division of Health, Wellness and Social Protection, THA • Ministry of Public Utilities • Ministry of Energy and Energy Industries • Emergency responders - Fire Services, Community Emergency Response Team (CERT) • TTMS • Local residents and property owners • Local business owners • Schools • Roxborough Police Youth Club and other local community groups • T&T Red Cross • Habitat for Humanity T&T • ERIC and other environmental NGOs • Telecommunication service providers	distribution networks) • Equipment/ tools (e.g. for tree trimming) • Materials • Digital resources/access, instructional guides/ curriculum • Labour		landslides and other extreme weather • Reduced incidence of water stress/ shortages reported by local residents and businesses

Community impacts & risks	Actions to adapt/build resilience	Roles and responsibilities (Lead/supporting actors)	Required resources	Time frame	Indicators of Success
and disruptions in access to food/essential goods Vulnerable areas • Renaissance Housing Scheme, Renaissance Park and Argyle wetland area prone to flooding • Streets near Roxborough Hospital impacted by flooding • Bad Rock, Bloody Bay to Roxborough Link Road, impacted by landslides Vulnerable groups • Residents • Elderly, persons with disabilities and children, who are sensitive to heat and water stress and not very mobile • Households that are not well ventilated and lack access to pipe-borne water • Property and business owners in areas prone to flooding and landslides					
<u>Sargassum influxes</u> Impacts	• **Establishment and implementation of air quality monitoring and early warning system for	• Department of Environment, Climate Change and Energy (co-lead)	• Expertise (marine science, disaster response, business development)	Short to medium term (1-6 years)	• Reduced length of time sargassum stranded on beach

Community impacts & risks	Actions to adapt/build resilience	Roles and responsibilities (Lead/supporting actors)	Required resources	Time frame	Indicators of Success
• Rotting sargassum, which releases hydrogen sulphide and ammonia gas, can affect health of residents and staff/customers at local businesses • Potential closure of schools and businesses in the area due to pungent scent from sargassum, affecting various livelihoods • Damage to paint on buildings, appliances etc. from hydrogen sulphide gas Vulnerable groups • Households/ property owners near coast • Elderly, infants and others who suffer from respiratory diseases • Vendors and tourism-related small businesses	addressing health and other risks from sargassum • **Identification of storage site and provision of equipment/tools and training on best practices for regular clean up of sargassum by local community groups • **Improvement of ventilation systems in schools and other key government buildings located near coast • Use of sargassum to create value-added/commercial products (e.g. for liquid fertilizer, biogas, building materials) and diversify local livelihoods	• Roxborough Village Council (co-lead) • Tobago Regional Health Authority/ Division of Health, Wellness and Social Protection, THA • Occupational Safety and Health Agency (OSHA) • DMRF • TEMA • EMA • IMA • National Sargassum Taskforce • Roxborough Police Youth Club and local community groups • Local residents • Schools • UWI • FAO • CARDI • IICA	• Financing • Equipment (booms, harvesters, light machinery) • Materials • Labour • Planning/ development approvals		• Reduced health impacts reported by residents due to decomposing sargassum
Tourism					
<u>Dry spells/drought and related water stress</u> **Impacts** • **Water scarcity disrupts tourism-related businesses (e.g., food and hospitality)**	• **Implementation of public awareness/information drives on climate change, impacts on water quality and access and appropriate solutions, targeting tourism-related businesses and visitors**	• **WASA (co-lead)** • **Tourism Division, THA (co-lead)** • **Local tourism-related businesses (co-lead)** • **Division of Health, Wellness and Social Protection, THA**	• **Expertise (water management, construction, sustainable tourism, law)** • **Finance** • **Equipment** • **Materials**	**Short to medium term (1-6 years)**	• **Increased number and use of water storage and rainwater harvesting systems to improve water supply for tourism-related businesses**

Community impacts & risks	Actions to adapt/build resilience	Roles and responsibilities (Lead/supporting actors)	Required resources	Time frame	Indicators of Success
• Limited water availability exacerbates sanitation problems, increasing the risk of waterborne diseases and public health concerns • Outdoor tourism activities, such as eco-tourism and water-based recreation, may be restricted due to water stress, reducing visitor experiences and revenue • Agri-tourism and other related businesses relying on water for irrigation and livestock management may be affected • Increased risk of bush fires and related risks to health, safety and property Vulnerable groups • Tour and hotel/guesthouse operators • Vendors and other tourism-related small businesses, especially those dependent on water for their production/service • Households dependent on tourism as income source • Visitors	• **Increased use of water storage tanks and rainwater harvesting among tourism-related businesses • Legislative change, including tax incentives or subsidies, to allow for expansion of rainwater harvesting and other techniques to improve water security	• TEMA • Office of the Chief Secretary, THA • Office of Attorney General/Ministry of Legal Affairs • Chamber of Commerce • Tobago Hotel and Tourism Association • Tobago Tourism Agency Ltd. • Local community groups	• Labour • Planning/ development approvals		

Community impacts & risks	Actions to adapt/build resilience	Roles and responsibilities (Lead/supporting actors)	Required resources	Time frame	Indicators of Success
Extreme weather including storms, high winds and heavy rainfall leading to floods and landslides Impacts • Disruptions to operation of tourism-related businesses (e.g., food and hospitality, tours and recreation) and key events like Carnival, other festivals and regattas • Damage and loss of tourism-related property and key infrastructure, leading to costly repairs and decline in profits • Damage to tourist attractions (e.g., beaches, coral reefs and other dive sites, birdwatching areas), which negatively impacts tourism-related businesses • Increase in unemployment due to disruptions to tourism and other key economic sectors, contributing to crime, poverty, inequality and other issues Vulnerable groups	• Improved early warning systems (e.g. SMS and radio alerts) on extreme weather for tourism-related businesses and visitors • Improved access to insurance for tourism-related businesses and property • Development of alternative tourism products/opportunities that are not dependent on climate-vulnerable sites (e.g. beaches, waterfalls etc), including training and affordable financing	• Tourism Division, THA/ Tobago Tourism Agency Ltd. (co-lead) • Rural Development Unit, Division of Settlements, Public Utilities and Rural Development, THA (co-lead) • Local tourism-related businesses (co-lead) • TEMA • TTMS • Division of Finance and Economy, THA • Chamber of Commerce • Tobago Hotel and Tourism Association • Roxborough Village Council • Local community groups • ERIC, Environment Tobago, CANARI and other NGOs • Finance and insurance providers • Telecommunication service providers	• Expertise (climate adaptation, disaster response, tourism and business development) • Finance • Equipment and tools, including digital infrastructure • Materials • Labour	Short to medium term (1-6 years)	• Reduced costs from loss and damage to tourism-related businesses and property • Increased number of persons engaged in alternative tourism activities

Community impacts & risks	Actions to adapt/build resilience	Roles and responsibilities (Lead/supporting actors)	Required resources	Time frame	Indicators of Success
• Tour and hotel/guesthouse operators • Vendors and other tourism-related small businesses • Households dependent on tourism as income source • Visitors					