Climate change adaptation in the fisheries of Anguilla and Montserrat

Assessment of vulnerability to climate change in the Anguilla and Montserrat fisheries sectors

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Acronyms and Abbreviations

AFMP	Anguilla Fisheries Management Plan
CANARI	Caribbean Natural Resources Institute
CARICOM	Caribbean Community
CC4FISH	Climate Change Adaptation in the Eastern Caribbean Fisheries Sector Project
CCA	Climate Change Adaptation
CCCCC – 5Cs	Caribbean Community Climate Change Centre
CDM	Comprehensive Disaster Management
CDEMA	Caribbean Disaster Emergency Management Agency
CIMH	Caribbean Institute for Meteorology and Hydrology
CLME	The Caribbean Large Marine Ecosystem (GEF project)
CNFO	Caribbean Network of Fisherfolk Organisations
CERMES	Centre for Resource Management and Environmental Studies – University of the West Indies
CRFM	Caribbean Regional Fisheries Mechanism
CSO	Civil Society Organisation
DFMR	Department of Fisheries and Marine Resources (Anguilla)
DOE	Department of the Environment
DMCA	Disaster Management Coordination Agency (Montserrat)
DRM	Disaster Risk Management
EAF	Ecosystem Approach to Fisheries
EBA	Ecosystem-based approaches
FAO	Food and Agricultural Organization of the United Nations
FD	Fisheries Division
FFO	Fisherfolk Organisation
IPCC	Intergovernmental Panel on Climate Change
MATLHE	Ministry of Agriculture, Trade, Lands, Housing and the Environment (Montserrat)
NGO	Non-governmental organization
OECS	Organisation of Eastern Caribbean States
OT's	Overseas Territories
P3DM	Participatory Three-Dimensional Modelling
SIDS	Small Island Developing States
SME	Small and micro-enterprises
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
UWI	University of the West Indies
VCA	Vulnerability and Capacity Assessment
VA	Vulnerability Assessment

Executive Summary

The Caribbean Natural Resources Institute (CANARI), Department of Fisheries and Marine Resources (DFMR) – Anguilla, Fisheries and Ocean Resources Unit - Montserrat and the Centre for Resource Management and Environmental Studies (CERMES) of the University of the West Indies (UWI) are jointly implementing the project ***Climate change adaptation in the fisheries of Anguilla and Montserrat***. The project aims to mainstream climate change adaptation (CCA) into fisheries governance and management in Anguilla and Monserrat, using an ecosystem approach to fisheries (EAF). It is being implemented from April 2017 to March 2020, with total funding of £260,925 from the Darwin Plus: Overseas Territories Environment and Climate Fund.

This report presents the main findings and recommendations from an assessment of the vulnerability of the fisheries sector in Anguilla and Montserrat to climate change and natural disasters. The vulnerability assessment complements the institutional assessment of readiness for CCA in the fisheries sector of Anguilla and Montserrat that identifies priorities for institutional strengthening under the project. These assessments serve as a key first step towards mainstreaming CCA in the fisheries sector to deliver enhanced stewardship of fisheries and coastal and marine resources and livelihood benefits in Anguilla and Montserrat.

The vulnerability assessment was based on a comprehensive desk review and participatory three-dimensional modelling (P3DM). P3DM served as a participatory mapping tool to capture local knowledge and experiences related to climate change impacts and vulnerabilities and identify potential adaptation actions for the fisheries sector. It involved building physical representations of the entire island of Anguilla and the island of Montserrat that were to scale and geo-referenced, focusing on areas critical to the fisheries sector (e.g. fishing communities, landing sites, fishing grounds and supporting ecosystems such as coral reefs and mangroves). Since the 3D models were produced to scale, the local knowledge captured on the models was also digitised and placed within a geographic information system (GIS) for integration with scientific knowledge and improved land use planning and decision-making. A wide range of stakeholders were actively engaged in the P3DM, such as key resources users like fisherfolk, community residents, civil society organisations (CSOs), government agencies and the private sector, to assess key vulnerabilities and priorities for action in the areas where they live and work. P3DM also supported EAF, taking into account biophysical, cultural and socioeconomic dimensions of vulnerability within ecologically meaningful boundaries (e.g. 'ridge to reef' area or entire island and its marine zone).

The P3DM in Anguilla highlighted a range of climate change hazards that have affected the fisheries sector, or will pose a significant risk in the future, including:

- Coastal erosion and flooding due to sea level rise which poses a critical challenge to this low lying island, especially beaches and coastal cliffs, and results in groundwater salinization.
- More extreme weather, including hurricanes, tropical storms and storm surge. Stakeholders noted that the Category 5 Hurricane Irma in 2017 was much stronger than other previous major hurricanes (e.g. Category 4 Hurricane Luis in 1995 and Category 4 Hurricane Donna in 1960), with maximum sustained winds of 180 mph and storm surge reaching 200 feet (61 m) inland.
- Sargassum influx that inundates beaches and coves, affects boat engines and limits access to nesting sites by sea turtles.
- Coral bleaching with warmer sea temperatures that affects reef-based fisheries, marine biodiversity and dive tourism.
- Ocean acidification which will result in reduced health of coral reefs and shellfish and affect reef-based fisheries and dive tourism.

- Erratic rainfall and more dry periods that affects access to rainwater, which is the main source of safe, drinking water on the island.
- Inland flooding that affects agricultural lands, increases sedimentation in the coastal zone and damages infrastructure including in the capital, The Valley.

These climate change hazards have begun to trigger a range of biophysical and socio-economic impacts on fisheries in Anguilla, which are compounded by existing pressures. These pressures include coastal development, sand mining and beach nourishment that alters coastal dynamics, pollution and sedimentation from land based sources, spread of diseases and invasive species such as the lionfish and non-native sea grasses, and overfishing in nearshore reef fisheries leading to declines in species such as parrotfish and surgeonfish. The potential impacts are negative, such as loss of coastal areas, as well as positive, such as opportunities to diversify the economy and fisheries sector.

Priorities for CCA in Anguilla's fisheries included: 1) organisational strengthening of key government agencies, in particular the DFMR; 2) building the adaptive capacity of fisherfolk through enhancing knowledge, skills and resources related to safety at sea, insurance, sustainable fishing practices and technologies and alternative livelihoods like aquaculture and seamoss cultivation; 3) strengthening the system of marine protected areas (MPAs); 4) sustainable financing to encourage entrepreneurship and small business development as well as effective management in the fisheries sector; 5) improving knowledge management and sharing to inform adaptation planning and decision-making; and 6) strengthening legislation, policies and plans to climate proof coastal infrastructure and enable integrated coastal zone management (ICZM) and EAF.

The P3DM in Montserrat highlighted the following climate change hazards and impacts on the fisheries sector:

- More extreme weather, including hurricanes, tropical storms and storm surge. Stakeholders noted they also felt the effects of Category 5 Hurricane Maria in September 2017, although not as severe as in other islands, and highlighted the devastation caused by past events such as Hurricane Hugo in 1989 which resulted in erosion of shorelines and damage to corals.
- Flooding and coastal erosion related to extreme weather and to sea level rise, especially in low-lying coastal areas such as the proposed new capital, Little Bay, and the Carr's Bay area (i.e. where the already limited fishing activity on the island is concentrated).
- Intense rainfall events, which have also contributed to secondary hazards such as flash floods – as storm-water rushes down through ghauts (ravines running down hillsides), and mudflows or lahars as volcanic debris is picked up and washed down from slopes (e.g. Belham Valley and Trants/Farms area).
- Coral bleaching is thought to be limited currently, but expected to increase if sea temperatures continue to warm. This is a concern for coral reefs already degraded by other anthropogenic stressors, such as land based sources of pollution, and volcanic activity.
- Influx of sargassum, which was noted to be of concern for all coasts, hindering fishing activity and also impacting turtle nesting sites and recreational beaches (e.g. Carr's Bay beach and Marguerite Bay).

Notably, climate change was treated as secondary to other hazards in Montserrat such as volcanic activity, which was perceived to be the most serious threat by far to the island. Other key hazards include inland flooding, landslides and rockfalls, and existing anthropogenic pressures from coastal development, quarrying/sand mining, environmental degradation related to pollution and sedimentation from land based sources, spread of invasive species such as the lionfish, and intensified fishing practices in nearshore areas.

Priorities for CCA in Montserrat's fisheries focused on a multi-hazard approach that promotes economic diversification and improved coastal and marine resources management. They included: 1) promoting participatory fisheries data collection and monitoring to build the knowledge base for adaptation planning and decision-making; 2) enhancing awareness and capacity among fishers about potential options and strategies for CCA; 3) promoting ICZM and EAF and addressing existing stressors to fisheries and coastal and marine resources, especially land based sources of pollution and alien invasive species; 4) climate proofing coastal infrastructure and fisheries assets; and 5) implementing innovative technologies like artificial reefs and smart fish aggregating devices (FADs) to offset habitat changes and build resilience.

Key recommendations for moving forward under the project and ensuring effective mainstreaming of CCA into fisheries governance and management in Anguilla and Montserrat include:

- Presenting and validating the findings from the P3DM and the priorities for CCA in the fisheries sector through a series of community meetings with fisherfolk and other key community stakeholders in Anguilla and Montserrat in order to gain additional input and finalise action plans for CCA to guide next steps under the project.
- Ensuring that the final action plans for CCA not only reflect stakeholder priorities but make linkages to, and are aligned with, strategic priorities and commitments at the national, regional and international levels related to CCA, DRM and sustainable fisheries management.
- Enabling public access and use of the P3DM outputs, including public display of the 3D models of Anguilla and Montserrat for awareness raising and communication of the impacts of climate change and natural disasters and key vulnerabilities and use of GIS maps and datasets for further spatial planning and analysis in the fisheries sector and other sectors.
- Utilising participatory video[1] and other information and communication technologies (ICTs) to further document and share local and traditional knowledge, best practices and innovations in the fisheries sector that are relevant to CCA. There is particular need for documentation of traditional knowledge of fisherfolk which may be at risk of being lost given the aging fishing population, particularly in Montserrat, and value of traditional knowledge related to fishing practices and navigational skills such as dead reckoning for CCA and other sociocultural aspects.
- Empowering fisherfolk and coastal communities to address identified vulnerabilities to climate change and related hazards from P3DM and promote local stewardship of fisheries and coastal and marine resources through capacity building, including training, mentoring and access to grants to support implementation.
- Engaging and strengthening of national fisherfolk organisations (e.g. fishing associations and co-operatives) to improve dialogue and knowledge exchange between different generations of fishers, amongst fishers' representatives and with other key stakeholders, such as fisheries authorities and other government agencies and national CSOs. This will enable sharing of best practices and innovations (e.g. related to selection of gear and fish species and value added products in the context of changing climate). Active fisherfolk organisations can also improve representation of fisherfolk in sectoral and national decision-making processes and enable collective voice and action on key issues affecting fisherfolk and the fisheries sector.
- Promoting ecosystem based management, including EAF, to enable an integrated, multi-hazard and cross-sectoral approach and build resilience to climate change within the fisheries sector recognising that climate change is one of many challenges affecting the sector. Other key challenges include habitat degradation, pollution, resource overuse, invasive species and impacts from other natural hazards such as volcanic and seismic activity. Adaptation actions that offer co-benefits through addressing climate change and other key non-climatic stresses should be given particular consideration.

[1] For further details, see http://www.canari.org/cm1

- Mainstreaming CCA as well as DRM considerations into fisheries management plans and policies in Anguilla and Montserrat to effectively address extreme climate events and reduce losses from climate-related hazards. This includes taking into account the comprehensive disaster management approach within any sectoral adaptation strategy, investments in early warning systems, safety at sea and insurance, and development of disaster preparedness plans as part of national fisheries management plans.
- Supporting sustainable and resilient livelihoods within fishing and coastal communities in Anguilla and Montserrat through development of value added fish products and SMEs related to aquaculture, aquaponics and seamoss cultivation. This could provide opportunities for increased income generation and livelihood diversification as well as incentives for sustainable utilisation of fisheries and coastal and marine resources.
- Strengthening regional cooperation and partnerships to improve management of shared resources and exchange knowledge and experiences on climate change impacts, vulnerabilities and potential adaptation options for fisheries and coastal and marine resources more broadly. Synergies with other relevant regional projects need to be explored, such as the Climate Change Adaptation in the Fisheries Sector of the Eastern Caribbean project (CC4FISH) that seeks to improve vulnerability assessments in the fisheries sector, build adaptive capacity among fisherfolk and aquaculturists and mainstream CCA into fisheries policies and plans using EAF. The Joint Nature Conservation Committee (JNCC) is also conducting a number of initiatives that support ICZM and marine spatial planning in both OT's.

1. Introduction

The fisheries sector in Anguilla and Montserrat makes significant contributions to livelihoods and food security. In Anguilla, fish production in 2014 was 752 metric tonnes (mt), valued at US$9.4 million, with approximately 130 fishers operating 84 fishing vessels[2]. In Montserrat, fish production in 2015 was approximately 36 mt, valued at US$0.3 million, with 110 fishers operating 27 fishing vessels[3]. The contribution of the fisheries sector to Gross Domestic Product (GDP) for Anguilla in 2014 was 2.26%[4], while it was 0.38%[5] for Montserrat in 2015.

Both Overseas Territories (OTs) are particularly vulnerable to the impacts of climate change and variability. Increased sea surface temperature, intensity of storms and sea level rise are expected to trigger a complex series of biophysical and socio-economic impacts on fisheries. Needs assessments for Anguilla and Montserrat, commissioned by the Department for International Development (DFID) in 2012[6,7], showed that resilience activities are hampered by inadequate planning and adaptive capacity. Mainstreaming climate change adaptation (CCA) in the fisheries sectors is therefore crucial.

In an effort to mainstream CCA into fisheries governance and management in Anguilla and Monserrat, using an ecosystem approach to fisheries (EAF), the Caribbean Natural Resources Institute (CANARI), Department of Fisheries and Marine Resources (DFMR) – Anguilla, Fisheries and Ocean Resources Unit - Montserrat and the Centre for Resource Management and Environmental Studies (CERMES) of the University of the West Indies (UWI) are jointly implementing the project ***Climate change adaptation in the fisheries of Anguilla and Montserrat***. It is being implemented from April 2017 to March 2020, with total funding of £260,925 from the Darwin Plus: Overseas Territories Environment and Climate Fund.

The project is employing innovative and participatory tools to support stakeholders in the fisheries sector, including fisheries authorities and fisherfolk and their organisations, to achieve the following key outputs:

1. Local and scientific knowledge combined to assess vulnerabilities and potential adaptation actions for the fisheries sector, including priorities for institutional strengthening.
2. Knowledge mobilisation and exchange strengthened among key policy makers, resource managers and resource users to catalyse change in policy and practice for enhanced stewardship.
3. Actions taken to mainstream adaptation to climate change and variability in fisheries-related policies and plans using EAF.
4. Capacity of fisherfolk and their organisations in coastal communities strengthened to undertake practical actions for CCA for improved ecosystem stewardship and livelihoods.

[2] DFMR. 2015. Anguilla Fisheries Development Plan 2015-2025. Government of Anguilla, The Valley, Anguilla.
[3] Ponteen, A. 2016. Presentation - Training workshop on Value Chain Approach in Fisheries, CRFM/UNU-FTP PROJECT, 18 –22 July 2016, Suriname.
[4] DFMR. 2015. Anguilla Fisheries Development Plan 2015-2025. Government of Anguilla, The Valley, Anguilla.
[5] Ponteen, A. 2016. Presentation - Training workshop on Value Chain Approach in Fisheries, CRFM/UNU-FTP PROJECT, 18 –22 July 2016, Suriname.
[6] DFID. 2012a. Addressing Climate Change by Promoting Low Carbon Climate Resilient Development in the UK Overseas Territories. Needs Assessment: Anguilla. DFID, London, UK. July 2012. http://jncc.defra.gov.uk/pdf/2012-07-23%20Anguilla.pdf
[7] DFID. 2012b. Addressing Climate Change by Promoting Low Carbon Climate Resilient Development in the UK Overseas Territories. Needs Assessment: Montserrat. DFID, London, UK. July 2012. http://jncc.defra.gov.uk/pdf/2012-07-23%20Montserrat.pdf

This report presents the main findings and recommendations from an assessment of the vulnerability of the fisheries of Anguilla and Montserrat to climate change and natural disasters using participatory three-dimensional modelling (P3DM). This vulnerability assessment, along with the institutional assessment of readiness for CCA in the fisheries sector, serves as a key step in achieving output 1 of the project and supporting mainstreaming of CCA in the fisheries sector to deliver enhanced stewardship of fisheries and coastal and marine resources and livelihood benefits.

2. Climate Change and Its Impacts on the Caribbean Fisheries Sector

It is becoming increasingly clear that the fisheries sector in the Caribbean, including Anguilla and Montserrat, is highly vulnerable to climate change and variability due to high levels of exposure of local fisheries and coastal and marine resources to climate hazards, economic dependence on the fishing industry, and low adaptive capacity. A recent global vulnerability assessment of the fisheries sector by Monnereau et al. (2015)[8] highlighted Caribbean small island developing states (SIDS) as the most vulnerable country group to the impacts of climate change and variability and its fisheries sector as particularly vulnerable. The sector is highly exposed to a number of climate change hazards such as rising sea levels, rising sea surface temperatures, ocean acidification and extreme weather events.

Current climate change projections for the Caribbean region, which are based on the recent Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report[9] and supported by the Caribbean Community Climate Change Centre (CCCCC), indicate that:

1. Sea levels in the Caribbean Sea are likely to continue to rise on average during the century. However, projections are not precise as there are few long-term sea level records available for the Caribbean small island developing states (SIDS). Also, detecting variability caused by climate change, rather than temporary conditions such as storm waves and surges, deep ocean swells and tidal cycles, is very difficult.
2. Average surface air and sea temperatures in Caribbean SIDS are very likely to increase during this century. This warming is likely to be somewhat smaller than the global annual mean warming in all seasons. Downscaled projections for the Caribbean region indicate an increase in temperature of 1–4 °C up to 2100.[10] Warmer sea temperatures will likely result in more frequent and intense coral bleaching events and more intense hurricanes.
3. Short-term variability in rainfall patterns (e.g. as caused by El Niño Southern Oscillation events) will likely continue with an increase during the latter part of the wet season in the northern Caribbean and drier conditions in the southern Caribbean. The prevailing warmer conditions may make the convection associated with the short-lived rainfall events more intense. In general, climate change will produce a drier (in the mean) region. Lengthening of seasonal dry periods and increasing frequency of drought are expected to increase demand for freshwater across the region.

[8] Monnereau, I., Mahon, R., McConney, P., Nurse, L., Turner, R., and Vallès, H. 2015. Vulnerability of the fisheries sector to climate change impacts in small island developing states and the wider Caribbean. Centre for Resource Management and Environmental Studies (CERMES), Barbados. CERMES Technical Report No 77.

[9] Climate and Development Knowledge Network (CDKN). 2015. The IPCC's Fifth Assessment Report: What is in it for Small Island Developing States? CDKN, London, UK. https://cdkn.org/wp-content/uploads/2014/08/IPCC-AR5-Whats-in-it-for-SIDS_WEB.pdf

[10] These projections are made under the emissions scenarios used in the previous IPCC *Fourth Assessment Report* (SRES A2 and B2, which are respectively relatively high- and low- emissions scenarios)

4. It is likely that tropical cyclone activity will increase in intensity (but tracks and the global distribution are uncertain).
5. Ocean acidification is projected to continue as carbon dioxide emissions are absorbed by the ocean, reducing pH, carbonate ion concentration and the availability of biologically important calcium carbonate minerals.

Effects from these are compounded by inherent vulnerabilities of SIDS related to factors such as remoteness, small size, limited human resources and high dependency on foreign aid and investment. In addition, the fisheries sector is already prone to various challenges such as overexploitation, pollution, and illegal, unreported and unregulated (IUU) fishing. The link between climate change, disasters and other environmental issues also adds to the complexity of impacts on the fisheries sector. As outlined in the IPCC Special Report on Extreme Events, climate change is already influencing weather-related hazards, leading to more intense extreme events, and will only further exacerbate natural hazards in the coming decades.[11]

The biophysical and socio-economic impacts of climate change on the fisheries sector in the Caribbean are expected to be significant with changes in fish size, fish redistribution, fish production and eroding reef habitats. Negative climate change impacts on the fisheries sector are already obvious across the Caribbean region, including coral bleaching, increasing levels of damage from more intense storms and hurricanes, coastal erosion and flooding with sea level rise and sargassum influxes, disrupting fishing operations and communities, damaging critical fish habitats and impacting the sustainability of the resource[12]. Both OTs, Anguilla and Montserrat, have already begun to experience these impacts and future impacts from climate change are likely to be significant.

Anguilla's draft *National Climate Change Policy (2011)* notes the potential for considerable impacts from climate change on fisheries and coastal and marine resources including:

- destruction of coral reefs as a result of bleaching from higher sea surface temperatures and ocean acidification;
- salinisation of groundwater due to sea level rise;
- loss of mangroves and wetlands, sea grass beds and sand dunes in areas where coastal topography, mangrove systems, and coastal infrastructure do not allow sedimentation to keep pace with rising sea levels;
- increased coastal erosion, including the loss of beaches, due to sea level rise and storm surge and increased costs of sea defence mechanisms;
- increased run off and pollution in coastal and marine areas from land based sources as a result of a changing precipitation patterns;
- increased demand and competition for coastal lands as a result of land lost to sea level rise;
- decrease in nearshore fish stocks, due to loss of important nourishing systems like coral reefs, mangroves and sea grass beds; and
- decrease in deep water fish stocks as a result of changes in sea temperature and currents.

In particular, rising sea surface temperatures and sea levels are a significant cause for concern for Anguilla, which is a low lying island fringed by temperature-sensitive coral reefs upon which its tourism and fisheries sectors depend and future economic growth relies.

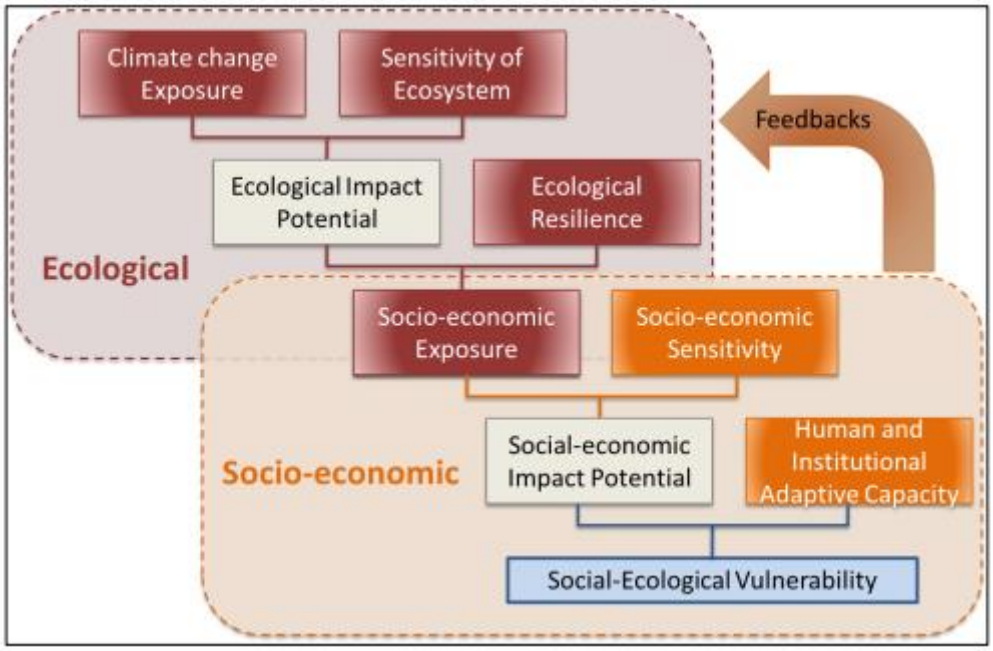
[11] IPCC. 2012. Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation.
[12] Monnereau, I., Oxenford, H.A. 2017. 'Impacts of climate change on fisheries in the coastal and marine environments of Caribbean Small Island Developing States (SIDS)'. Caribbean Marine Climate Change Report Card: Science Review 2017, pp. 124-154.

According to Montserrat's draft *National Climate Change Policy (2015)*, the potential impacts of climate change on the fisheries sector and associated coastal and marine ecosystems are significant given its hazard profile and capacity limitations. The ongoing eruption of the Soufriere Hills Volcano (starting in 1995) has significantly transformed Montserrat's coastal and marine ecosystems, with over 50% of the coast and coral reefs damaged by volcanic flows and ash and adverse impacts on the fisheries sector. The ongoing risk of volcanic and seismic activity raises the likelihood of a multi hazard event and reduces overall resilience to climate change and other natural hazards. Additionally, Montserrat will face increasing risks from annual and increasingly intense tropical storms and hurricanes and storm surge, rainfall extremes and inland flooding, rising air and sea surface temperatures and ocean acidification. These effects are likely to severely impact the fisheries sector by changing the population size and distribution of target species and could potentially lead to decreasing nearshore and deep water fish stocks and diminishing benefits associated with fishing activities.

3. Assessing Vulnerability to Climate Change in the Fisheries of Anguilla and Montserrat

Recognising that fisheries are linked social-ecological systems, it is important to understand both the ecological vulnerability and socio-economic vulnerability of fisheries in relation to climate change and their linkages[13]. Vulnerability to climate change is defined as "the degree to which a system is susceptible to, or unable to cope with, the adverse effects of climate change, including climate variability and extremes"[14]. As shown in Figure 1, it is a function of potential impacts due to exposure to climate hazards and sensitivity of the system to these hazards, and the capacity of the system to adapt and address the potential impacts of climate change. Ecological vulnerability relates to impacts on fish populations and wider coastal and marine ecosystems due to climate change and existing threats related to pollution, overharvesting and coastal development that climate change compounds. Socio-economic vulnerability relates to changes in fish abundance which affect food security and livelihoods dependent on the fisheries and aquaculture sector.

Figure 1: Framework linking ecological and socio-economic vulnerability to climate change



Source: FAO. 2013. Report of the FAO/PaCFA Expert Workshop on Assessing Climate Change Vulnerability in Fisheries and Aquaculture

[13] FAO. 2013. Report of the FAO/PaCFA Expert Workshop on Assessing Climate Change Vulnerability in Fisheries and Aquaculture. Rome: FAO.

[14] IPCC. 2007. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and A. Reisenger (eds.)]. IPCC, Geneva, Switzerland, 104 pp.

Although a number of vulnerability assessments have been carried out across Caribbean SIDS[15,16,17], including Anguilla and Montserrat, these often do not specifically cover climate change or the fisheries sector. Vulnerability assessments need to be adapted to meet the specific needs of the fisheries sector and enhance understanding of local level situations to enable the design of appropriate, location-specific CCA strategies. This includes modifying assessments to integrate both ecological and socio-economic dimensions, including national and regional fisheries policies, plans and priorities and consideration of fisheries-based livelihoods in a more comprehensive manner.

Given limited data on socio-economic aspects of fisheries, the use of participatory approaches and incorporation of local knowledge of fisherfolk and other community stakeholders is also key. Such participatory approaches and tools need to be designed recognising the unique characteristics and capacities of fisherfolk and their organisations (e.g. fisherfolk may have varying levels of literacy and are engaged in a wide variety of activities within geographical sites ranging from the deep sea to fish markets and processing plants on land). Stakeholder buy-in and engagement also promotes uptake of the vulnerability assessment findings and catalyse partnerships that bring benefits beyond completion of the assessment (e.g. opportunities for promoting co-management and community stewardship of fisheries).

Under the project, participatory three-dimensional modelling (P3DM) was used as a tool to assess the vulnerability of Montserrat and Anguilla to climate change and natural hazards, focusing on impacts on areas critical to the fisheries sector (e.g. fishing communities, landing sites, fishing grounds, supporting ecosystems such as coral reefs and mangroves), and identify potential adaptation actions. The vulnerability assessment complements the institutional assessment of readiness for CCA in Montserrat and Anguilla that has been undertaken to identify priorities for institutional strengthening to inform mainstreaming of CCA into fisheries governance and management[18].

3.1 Assessing the vulnerability of fisheries to climate change using P3DM

P3DM is a participatory mapping tool which seeks to capture and share local knowledge and experiences around an identified issue of interest, such as vulnerability to climate change, via building a physical representation of an area that is to scale and geo-referenced. Based on recollections from memory, key landmarks, land and resource use and other features of importance can be depicted by informants on the 3D model. Both quantitative information (e.g. length of beaches or size of fishing grounds) and qualitative information (e.g. areas prone to erosion or perceptions of risk) can be captured on the 3D model. The 3D model can be further used to depict the past, present and future conditions and is therefore a valuable tool to show the potential impacts of climate change and plan for adaptation and resilience building. Since the model is produced to scale, the local knowledge collected can be digitised and placed within a geographic information system (GIS) for integration with scientific knowledge for land use planning and decision-making.

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[15] The Nature Conservancy (TNC). 2016. At the Water's Edge Project: https://www.conservationgateway.org/ConservationByGeography/NorthAmerica/Caribbean/science/adaptation/Pages/awe.aspx

[16] IFRC. 2010. Regional Evaluation. Review of the implementation of the vulnerability and capacity assessment (VCA) methodology in the Caribbean region. Geneva, Switzerland: IFRC.

[17] CARIBSAVE. 2014. Vulnerability impact and adaptation analysis in the Caribbean (VIAAC). Prepared by the CARIBSAVE Partnership with funding from the United Nations Environment Programme: Regional Office for Latin America and the Caribbean (UNEP-ROLAC).

[18] CANARI. 2018. Summary report of the assessment to determine institutional readiness for climate change adaptation in the fisheries sector of Anguilla and Montserrat. Prepared for the Darwin+ project, Climate change adaptation in the fisheries of Anguilla and Montserrat. Laventille: CANARI.

The key steps in the process of implementing P3DM are outlined in Table 1.

Table 1: Key steps in P3DM process

P3DM PROCESS	
PRE-P3DM (Preparatory work) ▶ Define purpose and objectives ▶ Conduct stakeholder analysis ▶ Acquire resources and mobilise stakeholders	• Think about what is the problem you are trying to solve and what you are trying to achieve – Will P3DM help? • Identify who should be involved e.g. for logistics, mobilising participants, building model, inputting information on model, etc. • Identify materials, equipment and supplies and human resources needed to build the model and facilitate the process • Mobilise - Get stakeholders aware and ready to engage in the process e.g. via community meetings, invitations, TV or radio interviews and announcements, press releases, etc.
DURING (P3DM implementation) ▶ Construct blank model & develop legend ▶ Model population ▶ Analysis of model results ▶ Evaluations ▶ Handover to the local community/ government	• Construct the blank model with layers of cardboard representing various elevations of the land. • Develop a legend to guide what information should be put on the model and to help persons interpret it correctly • Work with stakeholders to input information on the model; ask probing questions to help them focus and think about what is relevant to include • Analyse the final model results with key stakeholders e.g. discuss the full picture of what was shared and use the information to think about future scenarios and solutions needed or decisions to be made • Evaluate the process – e.g. can be qualitative assessment of how people felt, what they learnt, noticed, or would like to suggest • Have a ceremony to officially hand over model to the community or other relevant key stakeholder/s, showcase the final model results and share recommendations
POST ▶ Digitising the model to create GIS outputs- data and maps ▶ Storage of the model ▶ Identifying & planning for further use	• Take photographs of the model and use these to digitise the model in a GIS; create GIS datasets of the various features that were placed on the model and a map representing all the features • Identify a suitable space where the model will be stored • Think about what else the model can be used for

P3DM enables local knowledge to be incorporated into the decision-making process to identify key vulnerabilities and priorities for CCA[19]. It facilitates the engagement of a wide range of stakeholders, such as community residents, resource users, government staff, civil society organisations (CSOs) and academia, in the process of assessing vulnerabilities in the areas where they live and work. Its ability to engage youth, elderly, low literacy and other marginalised groups, who are not often targeted in planning and decision-making processes is notable. Use of simple means of communication like colours, shapes and dimensions makes for ease of communication and does not require participants to be highly educated or literate to participate. The P3DM process and 3D models developed can be further used to support multi-stakeholder communication for awareness raising and advocacy at the community and national levels.

P3DM is particularly useful in examining geographical or spatial relationships (e.g. between an area's resources and its inhabitants, users and/or customary custodians) and enabling EAF, as it takes into account and allows for examination of biophysical, cultural and socioeconomic factors within ecologically meaningful boundaries (e.g. a watershed, 'ridge to reef' area or entire island and its marine zone). The process not only allows spatial features to be depicted but intangible features like values, tenure, local names and resource uses sacred areas and culturally significant boundaries, which are not on typical maps.

However, there are limitations to the application of P3DM. P3DM is time and labour intensive. Typically, it takes between four to twelve weeks to complete the entire process, and requires skilled facilitation and GIS expertise. It therefore can be very expensive. Also, there is a need to identify a place to house the final 3D model for public display and GIS outputs, such as a GIS map and datasets.

[19] CANARI. 2017. Implementing climate change action: A toolkit for Caribbean civil society organisations. Laventille: CANARI.

5. Findings of the P3DM Vulnerability Assessment

5.1 Anguilla

5.1.1 Overview

Anguilla is a British Overseas Territory in the Eastern Caribbean comprised of a small island and several offshore cays and islets. The island is about 26 km long and 5.5 km at its widest, with an area of about 91 km^2 (see the map in Figure 2). It is relatively flat and undulating with its highest point at Crocus Hill recorded at about 65 m above sea level. Coastal cliffs are common on the northern side of the island, and flatter areas are found towards the south and southeast. There are several uninhabited offshore cays and islets, the largest of which are Anguillita, Dog Island, Prickly Pear East, Prickly Pear West, Scrub Island and Sombrero Island. Most of the island and offshore cays are composed of hard crystalline limestone, non-crystalline limestone and clay marls[20].

Anguilla has an exclusive economic zone (EEZ) of over 92,000 km^2, which includes a common submarine shelf with St. Martin to the south. There are extensive reefs off the north coast and fringing reefs along most of the south coast. The 17 km long reef along the north east coast is considered to be one of the most important largely unbroken reefs in the Eastern Caribbean[20]. There are over 40 white sandy beaches around the island, which are comprised mainly of calcareous algal sands, coral and shell fragments, and small areas of mangroves.

Anguilla has an estimated population of 13,534 (est. December 2011). It is a middle income island with a gross domestic product (GDP) of about US$ 319.75 million in 2015[21]. The economy depends heavily on tourism, offshore banking, construction, fishing and remittances from emigrants. Tourism, which has spurred the growth of the construction sector, is the main contributor to economic growth and is also the main source of employment. The fisheries sector is also an important contributor to livelihoods and the economy. It is valued at US$ 9.4 million, contributing about 2.26% to Anguilla's GDP in 2014[22].

5.1.2 Anguilla Fisheries Profile

A fisheries sector profile for Anguilla is provided below, including a brief overview of the fisheries sector, governance arrangements, key stakeholders, and opportunities and challenges for the sector of relevance to climate change.

[20] DFMR. 2017. Management Plan for Anguilla's Marine Park System and Associated Shallow Water Habitats and Fisheries (2015-2025). The Valley: DFMR, Government of Anguilla.
[21] Government of Anguilla. 2016. 2017 Budget Address. Anguilla at 50: "Celebration and Realignment". December 5, 2016. http://www.gov.ai/documents/finance/2017%20Budget%20Address.pdf
[22] DFMR. 2015. Anguilla Fisheries Development Plan 2015- 2025. Government of Anguilla, The Valley, Anguilla. http://www.gov.ai/documents/fisheries/2015%20fisheries%20development%20plan.pdf

Sector overview:

The fisheries sector contributes significantly to food security and local livelihoods in Anguilla. It includes coastal and offshore pelagic, demersal and deep slope and reef-based fisheries. It is comprised of largely artisanal small-scale fisheries. There is no large-scale industrial fishing and aquaculture is very limited. For the 2016 licensing period, there were 141 licensed seasonal fishers and 96 licensed vessels. While there has not been a significant growth in the number of fishers entering the industry, Anguilla is unique in that its fisheries sector is dominated by many young fishers under 30 years.

The most economically valuable species are conch, lobster such as Caribbean spiny lobster and spotted spiny lobster, reef fish such as hinds, grunts, parrotfish and surgeonfish, demersals such as snappers and pelagics such as sharks, tunas, wahoo and mahi mahi. Of these, the Caribbean spiny lobster is the most valuable species financially. The queen conch is also an important commercial species. Some fisheries with potential commercial value include: the invasive lionfish, sea cucumber, sea urchins, flyingfish and eels. Fish production in 2014 was 752 metric tonnes, valued at US$ 9.4 million. It contributed about 2.26% to Anguilla's gross domestic product in 2015.

There are eight main fishing villages and landing sites, including Crocus Bay, Cove Bay, Forest Bay, Island Harbour, Sandy Ground/Road Bay, Sand Hill Bay, Shoal Bay and Sile Bay. The largest proportion of the catch is landed at Island Harbour, Cove Bay and Sandy Ground/Road Bay. The fishing methods employed includes: purse seines, handline fishing, Antillean or Z designed fish and lobster traps, spear guns, vertical longlines and fish aggregating devices (FADs). SCUBA and skin diving is employed for fishing conch and cray fish respectively. There are currently three, ~14m operational trawlers on the island which are powered by inboard diesel engines. Besides those, the majority of the boats are primarily wood and fiberglass, open hull vessels which are constructed locally, powered by outboard engines and ranging in size from 5m – 15m. Less than an estimated 30% of fishers utilise GPS and electronic safety devices such as E-pubs/SPOT. There is one small-scale fish market on the island that engages only in scaling and gutting of fish.

While a number of fishery resources are underutilised and boast no processing plants or value added products, the rising demand for fish products within Anguilla's tourism sector is placing pressure on the nearshore coral reef fishery. The nearshore fishery is heavily fished and currently diminishing and in poor health. It is hoped that by providing training in new fishing techniques, fishers will increasingly shift from the coral reef fisheries and into the underutilised offshore pelagic and deep slope fisheries. The sector faces further governance challenges due to antiquated legislation and the inability of fishers to mobilise and enable collective voice and action through the Anguilla Fishing Association and Anguilla Fishing Co-operative.

Relevant governance/institutional arrangements:

- The national fisheries authority is the Department of Fisheries and Marine Resources (DFMR). The DFMR currently, falls under the Ministry of Infrastructure, Communications, Utilities, Housing, Agriculture, and Fisheries. DFMR is mandated to manage Anguilla's fisheries resources and to safeguard the functional integrity of the critical marine habitats upon which fish species depend. It currently operates within the legislative boundaries of the revised Fisheries Protection Act of 2000 and Regulations of 2010 and a revised Marine Parks Act of 2000 and Regulations of 2010. The core functions of the DFMR include fisheries management, coastal and marine resources management and conservation through marine protected areas (MPAs).
- A number of other government agencies, such as the Department of Environment, Physical Planning Department, Department of Disaster Management, and CSOs, such as the Anguilla

Fishing Association and Anguilla National Trust, play an important role in managing the impacts of climate change on Anguilla's fisheries and coastal and marine resources.

- Anguilla has a Fisheries Development Plan (2015-2025)[23] developed by the DFMR. The main objective of the plan is to diversify Anguilla's economy through the optimal and sustainable utilization of the fisheries resources in Anguilla's EEZ and the creation of specific management plans for existing and potential fisheries. The development plan lays out the steps for developing the fisheries sector; aid in influencing Government decisions; and serve as a guide for fishers wanting to enter the industry or develop their trade. However, CCA considerations need to be mainstreamed into the plan, and the plan should be formalised.
- Anguilla has a draft Climate Change Policy 2011 - Transforming to a Climate-Resilient, Energy Efficient and Low Carbon Economy[24,25]. The draft policy was a key outcome for Anguilla from the ECACC[26] project and is informed by the technical and scientific analysis afforded by a vulnerability and capacity assessment (VCA) conducted under this project. Relevant policy goals and objectives for the fisheries sector include education of key stakeholders on climate change impacts on coastal and marine resources and need to protect and enhance the resilience of these resources, conservation of biodiversity and addressing climate change impacts on community livelihoods, health and wellbeing.
- Several other pieces of legislation and policies have been adopted within the past few years that provide a broad institutional framework for addressing climate change in Anguilla. These include the Disaster Management Act of 2007 and a Comprehensive Disaster Management Strategy, Land Development Control Act of 2000, Anguilla Environment Charter and National Environmental Management Strategy and Action Plan (2005-2009)[27].

Opportunities:

- The draft Climate Change Policy 2011 includes guiding principles, goals and objectives and directives relevant to coastal and marine resources and identifies a number of adaptation actions.
- The Government of Anguilla is supportive of multi-sectoral approaches, including the establishment of a Fisheries Advisory Committee to implement multi-sectoral measures for risk assessment and mainstreaming CCA planning and implementation.
- The fisheries sector is noted as having potential to contribute more to the economy through supplying the growing tourism sector. This may provide incentives for improvements and investments in the sector and motivation for building resilience to climate change impacts.

[23] DFMR. 2015. Anguilla Fisheries Development Plan 2015- 2025. Government of Anguilla, The Valley, Anguilla. http://www.gov.ai/documents/fisheries/2015%20fisheries%20development%20plan.pdf

[24] Government of Anguilla. 2011a: Green paper: a working document to assist with the formulation of a Climate Change Strategy for Anguilla. Caribbean Community Climate Change Centre, Belmopan, Belize.

[25] Government of Anguilla. 2011b: Transforming to a climate-resilient, energy, efficient and low carbon Economy: Anguilla`s Climate Change Policy (draft). Caribbean Community Climate Change Centre, Belmopan, Belize.

[26] For details on the ECCAC project, see http://www.caribbeanclimate.bz/closed-projects/2007-2011-enhancing-capacity-for-adaptation-to-climate-change-ecacc-in-uk-caribbean.html

[27] Government of Anguilla. 2005. Anguilla National Environmental Management Strategy and Action Plan 2005-2009 http://www.gov.ai/documents/Final%20NEMS%20January%2028th%202005.pdf

Challenges:

- Limited research, data collection and monitoring concerning the island's coastal and marine biodiversity, including specific fish species, invertebrates and marine plants.
- Vulnerability assessment work in Anguilla is not fisheries specific or relevant to climate change[28]. In addition, there needs to be a better understanding of the interactive effects between climate and non-climate effects, such as changes in land use, on fish abundance and availability.
- Poor planning and response systems for climate change and disasters, compounded by inadequate skilled human resources and funding, that do not incorporate best practices related to ecosystem-based and multi-hazard approaches to build resilience[29].
- Lack of key legislation in Anguilla, including comprehensive environmental legislation, and a national development plan to inform planning and development of the fisheries sector[30].
- Limited political will and stakeholder buy in to ensure adequate investment in fisheries sector, including capacity building and funding for DFMR and fishers, and effective management and sustainable utilisation of fisheries and coastal and marine resources.
- Limited effective communication and knowledge sharing between government and fishers, and no legal basis for co-management of fisheries and MPAs.
- Low levels of trust and co-operation among fishers.

Key stakeholders:

Public sector

- Key administrative offices - Premier's Office/Ministry of Finance, Attorney General's Chambers, Governor's Office
- Key climate and environment-related ministries – Ministry of Information, Communication, Utilities and Housing, Agriculture and Fisheries, including the DFMR and Department of Environment, Ministry of Social Development and Ministry of Finance
- Other relevant government agencies - Physical Planning Department, Maritime Affairs Department, Port Authority Department, Land and Surveys Department, Department of Agriculture – Policy and Planning, Financial Services Agency, Department of Disaster Management

Civil society and private sector

- Civil society - Anguilla Fishing Association, Anguilla Fishing Co-operative, Anguilla National Trust, Anguilla Red Cross, Anguilla Hotel & Tourism Association, fisherfolk, farmers and coastal communities

[28] Under the ECCAC project, a vulnerability assessment was undertaken for the tourism sector in 2009. Two studies, the Anguilla Drainage Study and the Anguilla Slope Study, had vulnerability assessment components but are not relevant to climate change or the fisheries sector. Hazard maps have been produced for Anguilla, including a national disaster preparedness map identifying flood-prone areas and a hazard vulnerability map of Sandy Ground identifying areas prone to flooding, coastal erosion and landslides from 1992.

[29] DFID. 2012a. Addressing Climate Change by Promoting Low Carbon Climate Resilient Development in the UK Overseas Territories. Needs Assessment: Anguilla. DFID, London, UK. July 2012. http://jncc.defra.gov.uk/pdf/2012-07-23%20Anguilla.pdf

[30] Newcastle University. 2013. Future of reefs for: Anguilla. Anguilla National Consultation Meeting, 27 February 2013. Prepared for the Future of Reefs in a Changing Environment (FORCE) project. http://jncc.defra.gov.uk/pdf/ot_FutureforAnguillareefs.pdf

- Private sector - Dive operators, gear supply stores, small boat operators/water taxis, cruise ship operators and agents, hoteliers, supermarkets (fish importers) and insurance companies
- Academic institutions - Primary level (Omololu International School and seven government schools); Secondary level (Albena Lake Hodge Comprehensive school); Tertiary level (Anguilla Community College, St. James Medical School and UWI Open Campus)
- Media - The Anguilla Newspaper, Anguilla News (online news), ATV and Kool FM Radio

5.1.3 P3DM process

P3DM was used to conduct a vulnerability assessment of Anguilla to climate change and natural hazards, focusing on collection of knowledge on areas critical to the fisheries sector (e.g. fishing communities, landing sites, fishing grounds, supporting ecosystems such as coral reefs and mangroves, and to identify potential adaptation actions. The goal was to develop a scaled, geo-referenced 3D model of the island of Anguilla with spatial information and local knowledge from key stakeholders, including fisheries authorities and fisherfolk and their organisations.

An eight-day P3DM workshop was facilitated by CANARI and the DFMR at the Anguilla Community College from March 1-7, 2018 (see Appendix 1 for the workshop agenda). The target participants for the P3DM workshop included key government, civil society and private sector organisations involved in CCA, disaster risk management and fisheries and natural resource management in Anguilla (see Appendix 2 for the full list of participants). A local mobiliser/administrative assistant was also engaged to support logistics and stakeholder mobilisation for the workshop.

The specific objectives of the P3DM workshop were to work with stakeholders to:

- capture and incorporate their local and scientific knowledge to assess the vulnerability of Anguilla, especially the fisheries sector, to climate change and natural disasters through engagement in building the model;
- analyse the potential impacts of various climate change scenarios for Anguilla's fisheries and coastal communities and their livelihoods;
- identify priorities for action for CCA in the fisheries sector in Anguilla, including priority policy interventions as well as specific actions needed on-the-ground to address the impacts of climate change;
- improve their understanding of and appreciation for the value of local knowledge in decision-making about climate change; and
- enhance their capacity to use P3DM as a tool for vulnerability assessment, spatial planning and resource management to adapt and build resilience to climate change and natural disasters.

The P3DM workshop was conducted in a highly participatory and interactive manner, using a combination of facilitation techniques including plenary presentations and discussions, informal interviews with specific target audiences (e.g. fisherfolk, aquaculture farmers and dive operators) and small group work (see Appendix 5 for slide presentations). The entire exercise was conducted over eight days from start to completion, including approximately three days to build the blank model, one day for drying, two days to input information unto the model and a half day for participatory analysis of key vulnerability and priorities for CCA in the fisheries sector using the completed model (see Figures 3-13 depicting the different steps of the P3DM process). A handover ceremony was also held on completion of the workshop to showcase the final model results and present key recommendations and lessons identified during the process.

Figures 3 and 4: Participants setting out the base map and tracing contours unto cardboard sheets

Figures 5-7: Participants gluing the contour layers out of cardboard sheets to develop the blank 3D model

Figures 8-11: Inputting information on the blank model and finalisation of the 3D model

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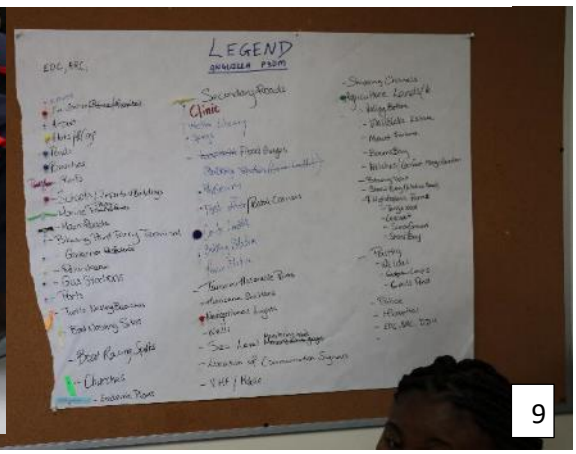

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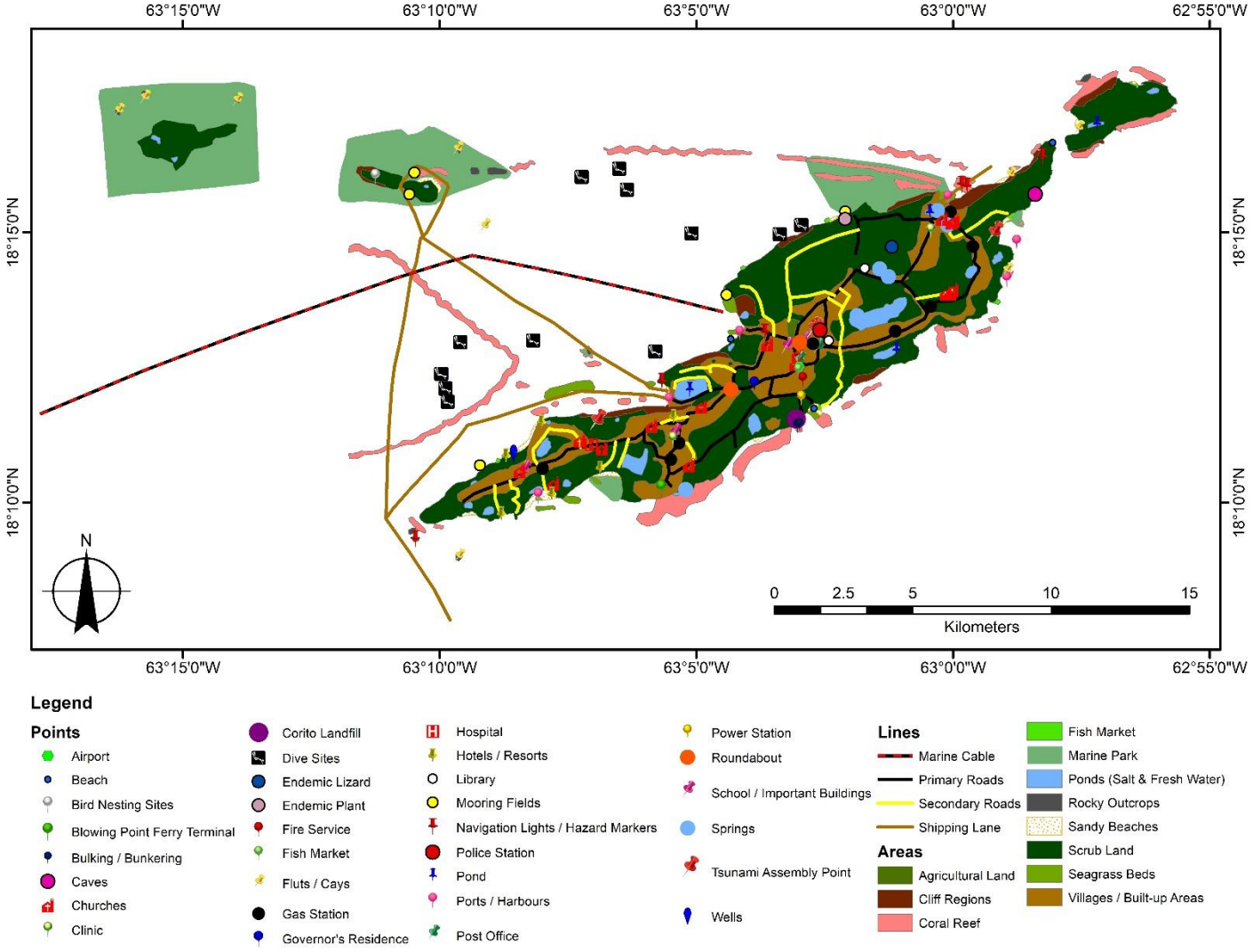
While the workshop successfully engaged a wide range of stakeholders, including six individual fishers, there were limitations to the process due to lack of active participation from leaders of the two key national fisherfolk organisations, Anguilla Fishing Association and Anguilla Fishing Co-operative. The Anguilla National Trust, Anguilla Tourist Board, the Anguilla Hotel and Tourism Association and the Governor's Office were also not able to participate in the process. The Anguilla National Trust plays a key role in conservation, education and research and monitoring of coastal and marine resources and have a vested interest in CCA and building ecological resilience. Given that tourism is a central focus for future economic growth, the participation of stakeholders from this sector is also important to identify features potentially vulnerable to climate change, especially those which may affect or be affected by the fisheries sector, such as beaches and other scenic coastal and marine landscapes.

The local knowledge captured through the P3DM exercise was further digitised and placed within a GIS for integration with scientific knowledge and other data. The GIS datasets and a map were provided to the Government of Anguilla to facilitate effective spatial and land use planning and decision-making related to fisheries and other sectors. See Figure 12 for the GIS map developed through digitisation of the 3D model.

Figure 12. GIS map of Anguilla developed through digitisation of the completed 3D model



5.1.4 Identification of key climate change impacts and vulnerabilities for Anguilla's fisheries

Stakeholders identified a range of climate change hazards that they had experienced or which will pose a significant risk to Anguilla's fisheries sector, including coastal communities, fishing grounds, landing sites and important coastal and marine ecosystems that support fisheries, during the P3DM exercise. These hazards include:

- Coastal erosion and flooding due to sea level rise, which especially affects beaches and coastal cliffs and results in groundwater salinization.
- More extreme weather, including hurricanes, tropical storms and storm surge. Stakeholders noted that the Category 5 Hurricane Irma in 2017 was much stronger than other previous major hurricanes (e.g. Category 4 Hurricane Luis in 1995 and Category 4 Hurricane Donna in 1960), with maximum sustained winds of 180 mph and storm surge reaching 200 feet (61 m) inland.
- Sargassum influx that inundates beaches and coves, affects boat engines and limits access to nesting sites by sea turtles.
- Coral bleaching with warmer sea temperatures that affects reef-based fisheries, marine biodiversity and dive tourism.
- Ocean acidification that will result in reduced health of coral reefs and shellfish and affect reef-based fisheries and dive tourism.
- Erratic rainfall and more dry periods that affects access to rainwater, which is the main source of safe, drinking water on the island.
- Inland flooding that affects agricultural lands, increases sedimentation in the coastal zone and damages infrastructure including in the capital, The Valley.

These identified climate change hazards have begun to trigger a range of biophysical and socio-economic impacts on fisheries in Anguilla, which are compounded by existing pressures. These pressures include coastal development, sand mining and beach nourishment that alters coastal dynamics, pollution and sedimentation from land based sources, spread of diseases and invasive species such as the lionfish and non-native sea grasses, and overfishing in nearshore reef fisheries leading to declines in species such as parrotfish and surgeonfish. These impacts are both negative, such as loss of coastal areas, and positive, such as opportunities to diversify the economy and fisheries sector.

Stakeholders identified specific impacts and vulnerabilities to climate change hazards within a number of key areas, which are outlined below in Table 2.

Table 2: Key climate change impacts and vulnerabilities identified by stakeholders using P3DM

Climate change hazards	Key climate change impacts	Vulnerable groups and areas
Coastal and marine biodiversity and ecosystems		
• Sea level rise • Warmer sea temperatures • More extreme hurricanes/ storms and storm surge • Sargassum influx • Ocean acidification • Inland flooding leading to increased siltation and polluted runoff	• Erosion of beaches and cliffs and flooding of low-lying coastal areas, including mangroves • Coral bleaching and die-off • Shifts in fish distribution from warmer to cooler waters in temperate latitudes • Increase in alien invasive species, such as non-native sea grass (*Halophila stipulacea*) displacing native "Turtle grass" (*Thalassia testudinum*) • Damage to and loss of coral reefs, seagrass beds and mangroves that are critical fish habitats and provide coastal defence and other key ecosystem services • Beaches, including turtle nesting sites, clogged by sargassum and coastal and marine species entangled and impaired • Increase in toxic algal blooms leading to fish kills and adverse impacts on coral reefs and associated species • Loss of biodiversity	• Coral reefs off the north and south coasts, and associated reef-based fisheries • Seagrass beds and mangroves which are nurseries for inshore fish and critical habitat for Green sea turtles and other marine species • Offshore cays and islets, where all current marine parks are located, which range in height from 1-30m above sea level • Nesting beaches for endangered sea turtles, including Leatherback, green and hawksbill turtles, that are prone to erosion and affected by sargassum influxes • Coastal cliffs of clay marls prone to erosion, such as Katouche Bay • Low-lying areas in the west and south of the island and Sandy Ground which are less than 30m above sea level, including fresh and salt water ponds that are important bird habitats
Cultural heritage, values and social networks		
• Sea level rise • More extreme hurricanes/ storms and storm surge • Erratic rainfall resulting in increased drought and flash flooding • Sargassum influx • Warmer sea temperatures and increased coral bleaching • Ocean acidification	• Loss of coastal lands and displacement of population (inland or abroad) • Damage and possible loss of important cultural and natural heritage, including old heritage buildings like the Bethel Church, popular beaches like Rendezvous Bay, coral reefs, offshore	• Low-lying coastal communities and other areas in the west and south of the island and Sandy Ground on the north coast which are less than 30m above sea level • Coral reefs off the north and south coasts, and associated reef-based fisheries and dive sites

Climate change hazards	Key climate change impacts	Vulnerable groups and areas
	cays and shipwrecks like The Oosterdiep • Decline in traditional livelihoods and associated knowledge and values, such as agriculture, fishing and beach-based tourism that are climate-sensitive sectors • Increased conflicts over resource use in terrestrial, coastal and marine areas and access to freshwater • Psychological stress and impacts from loss and damage, conflicts and uncertainty within economy, environment and society	• Offshore cays and islets, which are important traditional fishing, diving and recreational sites like Dog, Sandy and Scrub islands, which range in height from 1-30m above sea level • Old heritage buildings like churches, including the Bethel Church that is a key landmark and approach marker for boats • Shipwrecks and related dive sites
Livelihoods and socio-economic practices		
• Sea level rise • Warmer sea temperatures and increased coral bleaching • Warmer air temperatures and increased heat stress • More extreme hurricanes/ storms and storm surge • Erratic rainfall resulting in increased drought and flash flooding • Sargassum influx • Ocean acidification	• Increased impact and frequency of damage to fishing boats and gear, pots, FADs and facilities (e.g. landing sites, wharfs, fueling stations) due to more extreme hurricanes/ storms and storm surge, sargassum influx and sea level rise and lack of proper insurance coverage • Reduced ability to fish and earn income due to storminess, rough seas and sargassum influx • Reduced employment and income earning opportunities due to damage and decline in visitors at hotels and tour operations due to beach erosion, more extreme hurricanes/storms and storm surge and sargassum influx • Decline in reef-based fisheries and dive tourism	• Coastal communities that are heavily dependent on fisheries sector, including Island Harbour, Cove Bay and Sandy Ground/Road Bay • Fisherfolk particularly dependent on reef-based fisheries for their livelihoods and income, and limited access to credit and financing to shift to demersal and deep slope fisheries • Fisherfolk that work part-time in fisheries and tourism sectors (approximately 60% of seasonal fishers) and have limited education and skills to work in other sectors • Small-scale farmers with limited access to credit, land and equipment/ technologies to diversify

Climate change hazards	Key climate change impacts	Vulnerable groups and areas
	due to coral bleaching and ocean acidification • Possible decline in pelagics due to shifting fish distribution from warmer to cooler waters in temperate latitudes • Water shortages due to more dry spells and groundwater salinisation affecting tourism, agriculture and aquaculture • Increased public health risks and decline in productivity due to rising incidence of mosquito-borne diseases (e.g. dengue, zika and chikungunya) and heat stress • Increased incidence of disease and pests, including alien invasive species like the Giant African snail, and heat stress affecting agricultural crops and livestock Positives: • Growing investment in alternative livelihoods and practices (e.g. climate-smart agriculture and aquaculture/aquaponics) and new sectors (e.g. arts)	
Settlements and infrastructure		
• Sea level rise • More extreme hurricanes/ storms and storm surge • Erratic rainfall resulting in increased drought and flash flooding • Warmer air temperatures and increased heat stress • Sargassum influx	• Damage to and loss of coastal settlements, hotels and infrastructure, including roads, ports, wharfs and fueling stations, due to sea level rise and more extreme hurricanes/storms and storm surge • Damage to and disruption of inland settlements,	• Low-lying coastal communities, particularly in the west and south of the island and Sandy Ground on the north coast which are less than 30m above sea level • Hotels and businesses (e.g. bars, restaurants and shops) built right on the beachfront

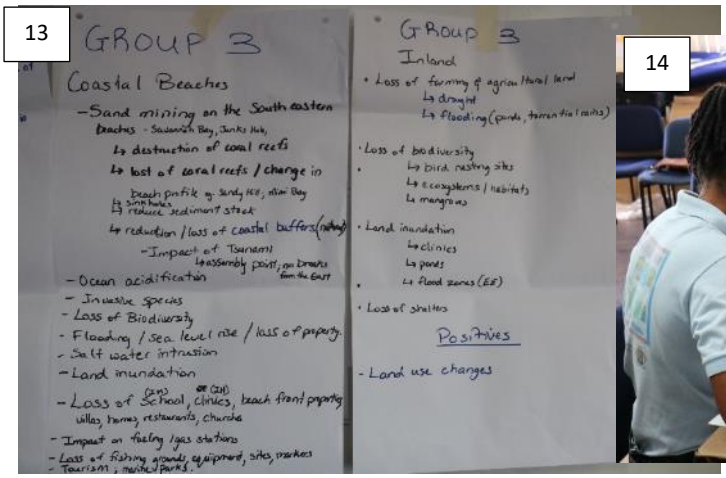
Climate change hazards	Key climate change impacts	Vulnerable groups and areas
	public services and infrastructure, including schools, hospitals and health centres, fire and police station and communication towers, due to inland flooding and high winds from more extreme hurricanes/storms • Damage to septic tanks and soakways due to coastal and inland flooding resulting in increased health risks from poor sanitation and water quality • Heat stress and heatwaves leading to increased demand for air conditioning and water • Reduced access to coastal facilities and infrastructure, and increased clean up and maintenance costs, due to sargassum influx Positives: • Growing investment in high quality, resilient and green buildings and infrastructure	• Buildings not built to code, and that do not conform to style where one-storey with concrete walls and roof and underground cistern that can withstand up to Category 4-5 hurricane (e.g. recent immigrants tend to build out of wood with galvanised roofs, while Anguillans shifted to one-storey, concrete houses after Hurricane Donna) • The Valley, which is capital and has bulk of public services, is prone to inland flooding • Corito Bay area with landfill, bulk station that receives and distributes national gas from tankers, and power station that is low-lying and exposed to multiple climate change hazards
Safety at sea and emergency response		
• More extreme weather, including high winds, rough seas, hurricanes/ storms and storm surge • Sargassum influx	• Increased difficulties with navigation and damage to boats at sea, resulting in increased incidence of fisherfolk and boats lost at sea • Increased need and associated costs for search and rescue efforts at sea • Reduced ability to fish and earn income due to safety concerns with increased storminess and rough seas • Damage and disruption to telecommunication infrastructure and signals (e.g. cell phone and radio	• Fisherfolk that are dependent on offshore pelagics, demersals and deep slope fisheries for livelihoods and income and travel on average 25-35 nautical miles (45-65 km) into open sea to fishing grounds • Lower income fisherfolk, who do not have access to or use GPS and other telecommunication devices for navigation, early warning and emergency alerts

Climate change hazards	Key climate change impacts	Vulnerable groups and areas
	towers) that support communications for navigation and early warning systems and increased costs for repair and maintenance • Damage to and loss of navigational lights and lanes (e.g. shipping lanes, approach lanes and markers for ports and landing sites) and increased costs for repair and maintenance Positives: • Increased appreciation of, and need to utilise/ revitalise, traditional knowledge and skills of dead reckoning for navigation and not rely totally on telecommunications and other technologies	• Dive operators and divers, yachtsmen and sport fishers engaged in recreational activities in open sea • Government agencies, including the DFMR and marine police in Anguilla, and Dutch and French coast guard from St. Maarten engaged in search and rescue efforts at sea • Telecommunications businesses and government agencies, such as DFMR, Disaster Management Department and Port Authority, that establish and maintain telecommunications infrastructure and navigational lights and lanes for shipping/fishing
Water resources		
• Erratic rainfall resulting in increased drought and flash flooding • Sea level rise • More extreme hurricanes/ storms and storm surge • Warmer air temperatures and increased heat stress	• Reduced access to freshwater through rainwater harvesting due to more dry spells • Reduced access to freshwater through groundwater aquifers due to sea level rise and groundwater salinization • Damage to and disruption to water supply and infrastructure, including desalination plant, piped system, water bottling plant and rainwater harvesting systems) due to more extreme hurricanes/storms and storm surge • Reduced water quality in groundwater aquifers due	• Communities, including a number of fishing communities, where there is no piped water system and heavy reliance on groundwater wells or rainwater harvesting and cisterns • Small-scale crop and aquaculture farmers that rely on rainwater harvesting or groundwater wells for irrigation or water supply for ponds • Water-intensive sectors, including tourism and construction, that will have added difficulties and costs to access water for drinking and other uses

Climate change hazards	Key climate change impacts	Vulnerable groups and areas
	to increased flooding, siltation and contamination with sewage and other pollutants • Increased demand for freshwater in tourism, agriculture and potential aquaculture farms with heat stress • Increased conflicts over water use and allocation with decreased supply and increased demand	

Figures 13 and 14: Participants working in small groups to identify key climate change impacts and vulnerabilities for specific areas of the island of Anguilla

13



14

5.1.5 Priorities for CCA in Anguilla's fisheries

Priorities and specific adaptation actions for the fisheries sector were jointly identified by stakeholders based on the P3DM exercise and participatory analysis of the key impacts and vulnerabilities from climate change. In particular, stakeholders highlighted the need for a multi-hazard approach that takes into account not only the multiple impacts from climate change, but existing pressures on fisheries and coastal and marine resources from adhoc coastal development, resource overuse, pollution and invasive species and other natural hazards including earthquakes and tsunamis. They also noted the need for adaptation actions to both address negative impacts and take advantage of positive impacts and opportunities that may be derived from climate change.

Key priorities for CCA in the fisheries sector included:

- Organisational strengthening of key government agencies, in particular the DFMR, for effective fisheries management and conservation and sustainable use of coastal and marine resources through:
    - Capacity building for staff to integrate new approaches, such as EAF and marine spatial planning, and technologies for sustainable fisheries management, such as smart FADs[31], aquaculture and aquaponics;
    - Provision of adequate resources, including manpower, boat and equipment for research, monitoring and enforcement as well as for early warning and emergency response; and
    - Strengthening the legal and policy framework, including integrating CCA and disaster management into the Anguilla Fisheries Development Plan and finalising it and addressing gaps in other relevant legislation and regulations;
- Building the adaptive capacity of fisherfolk through:
    - Training on safety at sea and use of GPS, VHF radio and other telecommunication technologies to assist with navigation, access to early warnings and emergency response;
    - Training and support to adopt sustainable fishing practices and technologies to develop sector, including smart FADs, use of underutilised species and alien invasive species (e.g. lionfish), and development of value added products (e.g. smoked tuna);
    - Promotion of alternative livelihoods, including aquaculture, aquaponics and seamoss cultivation, through training and mentoring on technical skills and development of small and micro-enterprises (SMEs); and
    - Improved access to insurance to cover costs of damage and loss of boats, gear and other equipment;
- Strengthening the system of MPAs, including raising public awareness of MPAs and improving monitoring and enforcement of regulations, to protect critical coastal and marine habitats, including coral reefs, mangroves and seagrass beds, to conserve biodiversity and sustain fisheries;
- Ensuring sustainable financing through mobilization of resources via budgetary allocations, grants, public-private partnerships and corporate investment to adequately manage fishing and other marine uses spanning Anguilla's EEZ;
- Improved management and sharing of data from Anguilla Marine Monitoring Programme (AMMP), Beach Monitoring Programme (BMP) and other relevant research and monitoring initiatives to inform adaptation planning and decision-making by the DFMR, fisherfolk and other key stakeholders through web-based applications (e.g. DFMR website, knowledge

[31] FADs, which are temporary or permanent structures used to lure primarily pelagic fish such as tuna, marlin and mahi mahi, can be equipped with geographic positioning system (GPS) and sonar capabilities to allow fisherfolk to contact it remotely to determine fish abundance and track its location and other biophysical conditions. These are known as smart FADs.

platforms, online databases, social media) and effective public awareness and outreach programmes;

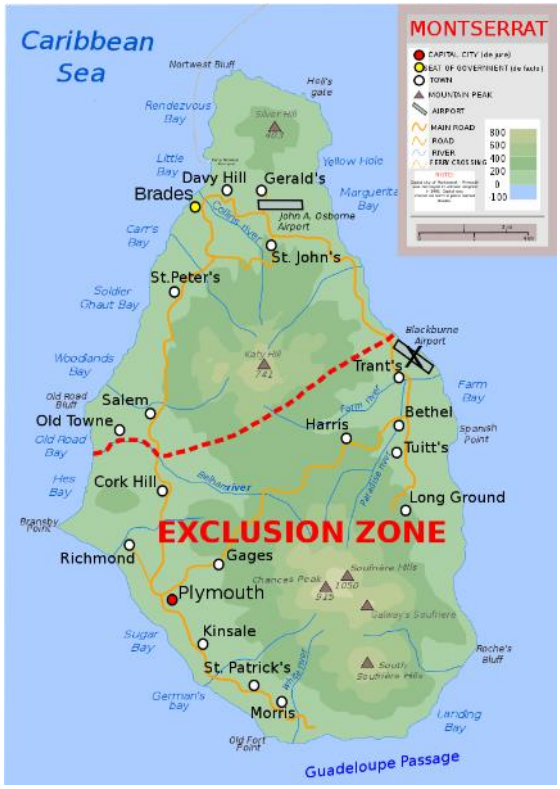
- Revising building codes, as well as legislation and regulations related to coastal setbacks and physical planning, to climate proof existing and future coastal infrastructure, including fishing facilities, slipways, landing sites, and telecommunications infrastructure and ensure these can withstand more extreme weather, including Category 3 to 5 hurricanes and associated storm surges; and
- Developing and implementing an Integrated Coastal Zone Management (ICZM) plan to address in particular adhoc coastal development and land based sources of pollution, including untreated sewage, industrial waste and sediments, that degrade coastal and marine ecosystems and associated fisheries and increase their vulnerability to climate change.

Additionally, these priorities for CCA are consistent with strategic directives outlined in the draft Climate Change Policy (2011) and Anguilla Fisheries Development Plan (2015-2025), and will facilitate implementation of specific actions identified in these national policies and plans.

5.2 Montserrat

5.2.1 Context

Montserrat is a British Overseas Territory in the Eastern Caribbean. It includes 102 km^2 of land area, 40 km of coastline, and a 7,587 km^2 EEZ (see the map in Figure 15). Montserrat is formed from three volcanoes—Soufriere Hills, Centre Hills, and Silver Hill, the first of which is active. The terrain of Montserrat is generally steep, and the ocean depth increases quickly from the shoreline. As a result, the continental shelf area is just 168 km^2. The island has numerous coral reefs extending off the western and north-western shores of the island. The main coral reefs are patch reefs.



National economic development is constrained by factors such as high exposure to natural hazards, limited physical size, limited natural and human resources and an open, fragile and remote economy[32]. Notably, the volcanic island has undergone significant economic and ecological change over the past three decades due to two major natural disasters. Hurricane Hugo struck the island in 1989, leading to widespread defoliation, destruction of property and loss of livestock. In 1995, the Soufrière Hills volcano became active and subsequent eruptions destroyed half of the island, including the former capital, Plymouth, key infrastructure and the main economic sectors of agriculture, fishing and tourism. Consequently, there has been an over 50% decline in the population, from approximately 12,000 in 1995 to approximately 5,200 in 2017, which is now largely located in the north. Prolonged volcanic activity up to 2010 has limited the potential for recovery. Currently, the economy is centred on government services, which is the main source of employment, with the construction, financial, mining and tourism sectors also contributing significantly. Total GDP in 2016 was US$57 million, compared with US$105 million in 1994[33]. The fisheries sector, which is valued at about US$0.3 million[34], contributed 0.53% to Montserrat's GDP in 2016.

Due to the ongoing seismic and volcanic activity, substantial areas of the island and marine environment were designated as exclusion zones where access was prohibited or restricted. Maritime Exclusion Zones cover the waters around the southern part of the island out to a distance of 4 km offshore because of the danger of volcanic activity. Day-time transit is permitted to access sites outside the zones, but boats are not allowed to stay in the zones for more time than is necessary for transit.[35]

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[32] Gray, G. A. L., 2010. Montserrat National Climate Change Issue Paper, Montserrat: Ministry of Agriculture, Land, Housing and the Environment http://www.eldis.org/document/A60751

[33] MacDonald, M. 2017. Economic growth strategy and delivery plan for Montserrat (draft). http://www.gov.ms/wp-content/uploads/2012/06/Growth-Strategy-Delivery-Plan-2017-DRAFT-.pdf

[34] Ponteen, A. 2016. Presentation - Training workshop on Value Chain Approach in Fisheries, CRFM/UNU-FTP PROJECT, 18 –22 July 2016, Suriname.

[35] Sustainable Fisheries Group. 2015. A Review of the Ecology and Economics of Montserrat's Marine Resources. http://waittinstitute.org/wp-content/uploads/2016/11/3_Review-of-the-Ecology-and-Economics-of-Montserrat%E2%80%99s-Marine-Resources.pdf

5.2.2 Montserrat fisheries profile

A fisheries profile for Montserrat is included below, including a brief description of the fisheries sector, governance arrangements, key stakeholders, and opportunities and challenges within the sector of relevance to climate change.

Sector overview:

In Montserrat, fishing provides an important source of income and food security and is culturally significant, although its contribution to national GDP is small. Montserrat's fisheries are small-scale, employing about 100 full-time and part-time fishers who target over 200 species of fish and invertebrates. Most fishers do not depend entirely on fishing for their income, fishing only one or two days per week. Most are involved in other economic activities including construction, government services, livestock rearing and hospitality working in bars or restaurants. About half of fishers are members of the Montserrat Fishers and Boaters Association and Montserrat Fishermen's Cooperative, which help coordinate bulk purchase of equipment and supplies and distribute government subsidies.

About 90% of the fishing activity occurs in the nearshore area, within three miles of the coast, focusing on reef fish and coastal pelagics[36]. The remainder of activity takes place outside of Montserrat's territorial waters around the nearby islands of Antigua, Nevis, and Redonda[29]. Needlefish, known locally as gar fish, are the most commonly landed species. Other important species in terms of volumes landed include reef fish such as red hind, triggerfish, and squirrelfish, as well as coastal pelagic species such as ballyhoo. Although lobsters are only caught as bycatch in fish pots, they are the most valuable species in terms of unit price. Fishers use traps, drop lining, spearfishing, shore fishing, trolling and seining.

Fish landing sites on the island include Bunkum Bay, Carr's Bay, Isle's Bay and Little Bay, which is the principal landing site. The former capital city, Plymouth, was historically the principal fishing port, with Carr's Bay, Bunkum Bay and Isles Bay serving as minor ports. Volcanic activity destroyed the fisheries facilities at Plymouth and the Isle's Bay facility was abandoned as it fell within the then restricted zone. Landings are substantially lower than they were prior to the onset of volcanic activity, reflecting the lower number of fishers and the loss of access to productive fishing grounds. Prior to the 1995 volcanic activity, fishers were able to access pelagic fisheries on the southern coast in addition to trap and line fisheries along the western coast and pelagic fisheries around Redonda Island. Since 1995, fishing activity has shifted northwards, with the new principal fishing port located at Little Bay and the southern fishing grounds closed due to safety concerns and siltation. The majority of fishermen are now located at Little Bay and Carr's Bay with a small number operating from Bunkum Bay. Fishing grounds on the eastern side of the island are less accessible due to rough ocean conditions, and sedimentation from pyroclastic flows is believed to have decreased the area's productivity.[37]

All catch is either sold at local markets or utilised for subsistence. Montserrat's main fish market was destroyed in the 1995 volcanic eruption and smaller facilities provided at the market in Carr's

[3636] Ponteen, A. 2014. Montserrat national fisheries report. Fisheries Division, Government of Montserrat, Brades.

[37] Sustainable Fisheries Group. 2015. A Review of the Ecology and Economics of Montserrat's Marine Resources. http://waittinstitute.org/wp-content/uploads/2016/11/3_Review-of-the-Ecology-and-Economics-of-Montserrat%E2%80%99s-Marine-Resources.pdf

Bay are not fully utilised. As a result, fishers sell their fish directly to locals, including hotels and restaurants. Due to a lack of facilities to handle and store fish, they are sold immediately upon landing to prevent spoilage. Large amounts of fish are imported each year, especially frozen fish, shrimp, and conch. Nevertheless, local catches are an important food source for locals and tourists. Montserrat does not export its fish products.

Relevant governance/institutional arrangements:

- National fisheries authority: The Fisheries and Ocean Resources Unit in the Department of Agriculture, Ministry of Agriculture, Housing, Land, Trade, and the Environment (MATHLE) is responsible for fisheries management in all of Montserrat's marine waters under the Fisheries Act of 2011[38]. This Act along with the Turtle Act of 2002 make up the key national policies and regulations that influence fisheries management in Montserrat.
- A number of other government agencies, such as the Department of Environment, Department of Lands and Survey and Physical Planning Unit within MATHLE and the Disaster Management Coordination Agency, and CSOs, such as the Montserrat Fishers and Boaters Association and Montserrat National Trust, play an important role in managing the impacts of climate change on Montserrat's fisheries and coastal and marine resources.
- Montserrat currently does not have any ocean zoning aside from the Maritime Exclusion Zone, which restricts access to the waters adjacent to the volcano, but efforts are underway to develop a Marine Spatial Plan and revised Fisheries Regulations with the support of the Waitt Institute's Blue Halo Initiative[39].
- Under the amended Fisheries Act of 2011, local fisheries management areas (LFMAs)[40] may be designated by the Governor acting on the advice of Cabinet, which provides a legal basis for co-management of fisheries.
- Montserrat has a draft National Climate Change Policy (2015) and Action Plan[41,42]. Relevant policy goals for the fisheries sector, include promotion of EAF and climate smart practices in the sector, through investments in improved practices, technology and infrastructure that result in enhanced efficiency and capacity, increased resilience to climate change and natural disasters, and reduced dependency on food imports, etc. The need to strengthen the legal and policy framework to protect and enhance the resilience of coastal and marine resources and ensure evidence-based decision-making is also recognised.
- Several laws, policies and plans addressing environmental protection and land use and planning are relevant to the coastal and marine environment, including the Conservation and Environmental Management Act (CEMA) of 2014, that addresses fisheries-relevant issues, including marine protected areas and maritime pollution and the Physical Planning Act. Other relevant legislation, includes the Montserrat National Trust Act, Port Authority Act and Beach Protection Act. The Montserrat Sustainable Development Plan (2008-2020)[43] provides the overarching guidance for future development and recognises the need for effective management of the risks associated with natural hazards and climate change, and the

[38] See Montserrat Fisheries Act 2011 at: http://agc.gov.ms/wpcontent/uploads/2011/10/Fisheries-Act2.pdf
[39] http://waittinstitute.org/bluehaloinitiative/montserrat/
[40] LFMAs are to be managed by a local authority, fishermen's co-operative, fishermen's association, or other appropriate body representing fishermen, and if no such body exists, the Minister can promote the formation of such a body.
[41] Government of Montserrat. 2015. National Climate Change Policy (draft). Brades, Montserrat.
[42] Government of Montserrat. 2015. National Climate Change Action Plan (draft). Brades, Montserrat.
[43] Ministry of Economic Development and Trade. 2010. Montserrat Sustainable Development Plan 2008 – 2020. Government of Montserrat http://www.gov.ms/publications/SDP_MONTSERRAT.pdf

sustainable use of natural resources. A draft Physical Development Plan (2012-2022) also provides guidance for sustainable land management and zoning.

Opportunities:

- Implementation of CEMA and its associated regulations could serve as a tool to achieve an enforceable legal framework for sustainable ocean management.
- Efforts are being made for new infrastructure investments (port at Carr's Bay and New Town at Little Bay) to be climate proofed against storm surge and sea level rise[44], which will help support the growth of the fisheries sector.
- The fisheries sector is noted as having potential to contribute more to the economy. This may provide incentives for improvements and investments in the sector and motivation for building resilience to climate change impacts.
- Synergies with other relevant regional projects can assist in advancing, supporting or enhancing climate change assessments and adaptation within the fisheries sector – the FAO GEF-funded Climate Change Adaptation in the Fisheries Sector of the Eastern Caribbean Project (CC4FISH), EU-funded OECS iLAND Resilience project (Montserrat is one of the beneficiary countries) and the Waitt Institute's Blue Halo Montserrat project which is focused on assessment of the current status of fisheries and developing a new system for ocean zoning and fisheries management.

Challenges:

- Strengthening and revising the Fisheries Act of 2011 is critical as it provides limited authority for effective enforcement and implementation to ensure sustainable utilisation of fisheries and conservation of coastal and marine resources.
  There is also a need to develop and implement a National Fisheries Management Plan.
- Limited research and monitoring and available data on fish stocks, level of fishing effort and the health of critical coastal and marine ecosystems that support fisheries.
- Climate change impact and vulnerability assessments are needed that are fisheries specific[45]. In addition, there needs to be a better understanding of the interactive effects between climate and non-climate effects, such as changes in land use, on fish abundance and availability.
- Montserrat's population is very small and technical personnel are limited, so there is inadequate capacity for implementing CCA actions. Key agencies, including the Fisheries and Ocean Resources Unit, Department of Agriculture and Department of Environment in MATHLE, have very limited human, financial and technical resources for effective management of fisheries and coastal and marine resources.

[44] DFID. 2012b. Addressing Climate Change by Promoting Low Carbon Climate Resilient Development in the UK Overseas Territories. Needs Assessment: Montserrat Department for International Development July 2012 http://jncc.defra.gov.uk/pdf/2012-07-23%20Montserrat.pdf

[45] A vulnerability assessment was conducted focusing on the new capital, Little Bay, under the ECACC Project. The assessment covered critical infrastructure such as shelters, hospital, all key public buildings e.g. police station, fire and rescue service. A capacity assessment was also completed for the Public Works Department. A vulnerability and hazard study was also completed for Montserrat in June 2003, including preparation of island-wide GIS based multi-hazard map showing risks due to natural hazards. Detailed hazard mapping of the volcanic risks to the island was also done. Other assessments relevant to climate change include a beach erosion assessment study in 2008 and an economic valuation study of the Centre Hills relevant to climate change, but none specifically focus on the fisheries sector.

- The majority of fishers are men, and few are licensed or registered[46] (Ponteen 2014). Ensuring gender equity and sensitivity is an ongoing challenge for the sector.
- Most of the more regular fishers are at least fifty years old, with very few fishers under thirty. As the fishing population ages, Montserrat may lose valuable knowledge about its fisheries and marine environment.

Key stakeholders:

Public sector

- Key administrative offices - Governor's Office, Office of the Premier, Attorney General's Chambers
- Key climate change and environment-related ministries - MATLHE including the Department of Agriculture – Fisheries and Ocean Resources Unit, Department of Environment, Lands and Survey Department, Ministry of Communication, Works and Labour including the Montserrat Maritime Administration and John A. Osborne Airport – Meteorological Services, Ministry of Finance and the Disaster Management Coordination Agency
- Other relevant government agencies - Royal Montserrat Police Service – Marine Unit, Customs and Excise Department, Financial Services Commission, Montserrat Statistic Department and Montserrat Volcano Observatory, and Montserrat Utilities Limited

Civil society and private sector

- Civil society - Montserrat Fishers and Boaters Association, Montserrat Fisherman's Co-operative, Montserrat National Trust, Montserrat Red Cross, fisherfolk, farmers, coastal communities, WAITT Institute – Blue Halo Montserrat, and regional institutions (including CANARI and Caribbean Network of Fisherfolk Organizations)
- Private sector - Recreational fishers/water taxi operators, dive operators (including Aqua Montserrat, Scuba Montserrat, Island Dive Centre), cruise ship operators and agents, supermarkets, insurance companies and taxi and tour operators
- Academic and research institutions - Primary level (2 private schools – Lighthouse Academy and St. Augustine Roman Catholic Primary School and 2 public schools – Brades Primary School and Lookout Primary School); Secondary level (Montserrat Secondary School); Tertiary level (Montserrat Community College and UWI Open Campus)
- Media - Radio Montserrat ZJB, Montserrat Reporter, Golden Media

5.2.3 P3DM process

P3DM was used to conduct a vulnerability assessment of Montserrat to climate change and natural hazards, focusing on collection of knowledge on areas critical to the fisheries sector (e.g. fishing communities, landing sites, fishing grounds, supporting ecosystems such as coral reefs and mangroves, and to identify potential adaptation actions. The goal was to develop a scaled, geo-referenced 3D model of the island of Montserrat with spatial information and local knowledge from key stakeholders, including fisheries authorities and fisherfolk and their organisations.

A seven-day P3DM workshop was facilitated by CANARI and the Fisheries and Ocean Resources Unit, MATHLE at the Montserrat Cultural Centre from February 18-24, 2018 (see Appendix 3 for the workshop agenda). The target participants for the P3DM workshop included key government, civil

[46] Ponteen, A. 2014. Montserrat national fisheries report. Fisheries Division, Government of Montserrat.

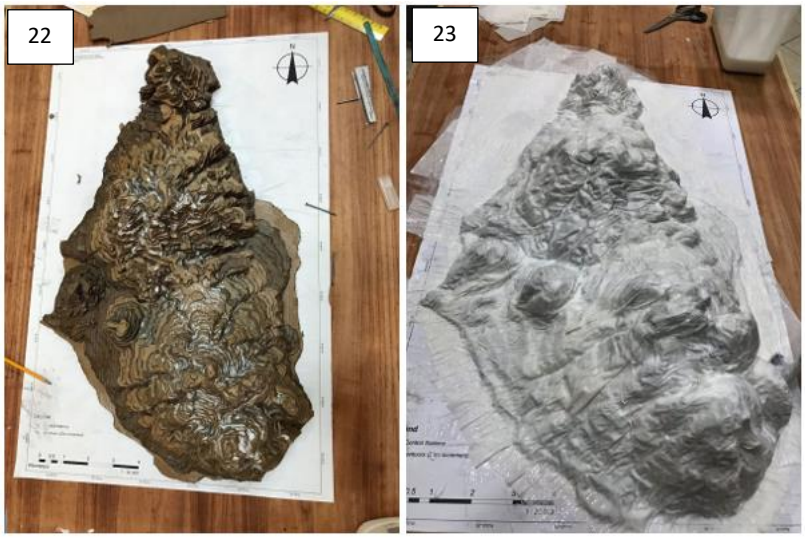
society and private sector organisations involved in CCA, disaster risk management and fisheries and natural resource management in Montserrat (see Appendix 4 for the full list of participants). A local mobiliser/administrative assistant was also engaged to support logistics and stakeholder mobilisation for the workshops.

The specific objectives of the P3DM workshop were to work with stakeholders to:

- capture and incorporate their local and scientific knowledge to assess the vulnerability of Montserrat, especially the fisheries sector, to climate change and natural disasters through engagement in building the model;
- analyse the potential impacts of various climate scenarios for Montserrat's fisheries and coastal communities and their livelihoods;
- identify priorities for action for CCA in the fisheries sector in Montserrat, including policy priorities as well as specific actions needed on-the-ground to address the impacts of climate change;
- improve their understanding of and appreciation for the value of local knowledge in decision-making about climate change; and
- enhance their capacity to use P3DM as a tool for vulnerability assessment and spatial planning and resource management to adapt and build resilience to climate change and natural disasters.

The P3DM workshop was conducted in a highly participatory and interactive manner, using a combination of facilitation techniques including plenary presentations and discussions, focus groups, informal interviews with specific target audiences (e.g. fisherfolk) and small group work (see Appendix 5 for slide presentations). The entire exercise was conducted over seven days from start to completion, including approximately three days to build the blank model and allow for drying, and two days to input information unto the model. Although planned, the tight timeline and availability of participants made it difficult to conduct a dedicated session with stakeholders to undertake participatory analysis of key vulnerabilities and priorities for CCA in the fisheries sector, using the completed model. This information was however garnered during the process of model building, in particular during development of the legend and as participants worked to input information on the model; a series of flexible, informal interviews and discussions was utilised. A dedicated focus group was held with several more experienced fishers to ensure the information that would be included and captured in the final model was representative of their knowledge and interests. The various steps of the P3DM process are depicted below.

Figures 16- 21: Participants in various stages of model building including tracing, cutting and stacking carboard contours to build the 3D model



Figures 22 and 23: Completed contours pasted with crepe paper and painted white to create blank model

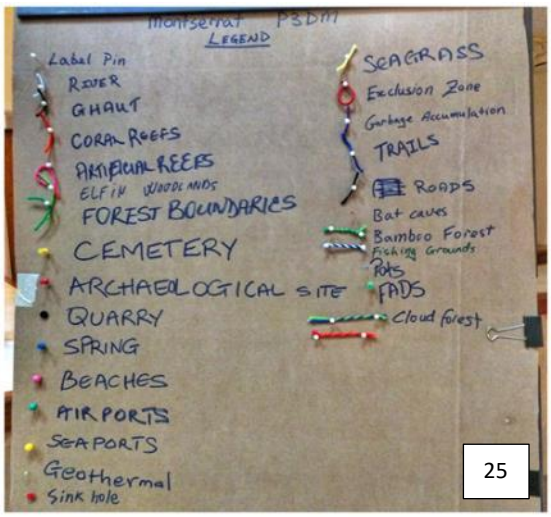


Figure 24 (Left): results of brainstorming information for the model legend. Figure 25 (Right): Participants start to decide on how features will be represented

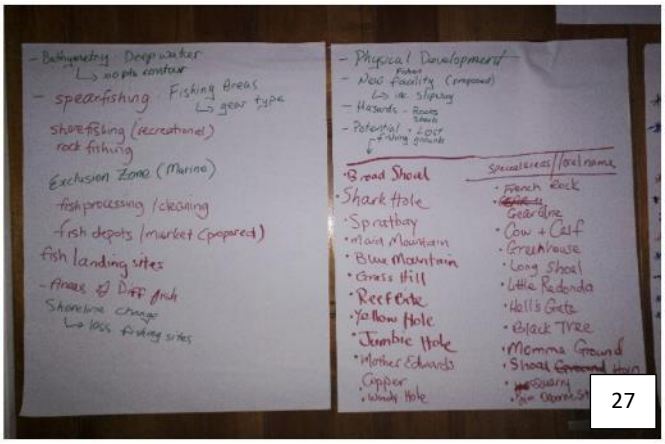


Figure 26 (Left): Special focus group session with fishers to discuss fisheries specific information for the model legend. Figure 27 (Right): Some results from the fishers' focus group showing local names for fishing areas

Figure 28 (Left): Participants work together to input their knowledge on the model. Figure 29 (Right): Participants painting features on the model.

The model was officially unveiled and handed over to the people and government of Montserrat on Saturday 24, February.

Figures 30 and 31: Montserrat's Minister of Agriculture – the Honourable David Osborne, other key fisheries officials and fishermen view and discuss the P3DM model at the handover ceremony on February 24, 2018. Photo credit: Government of Montserrat

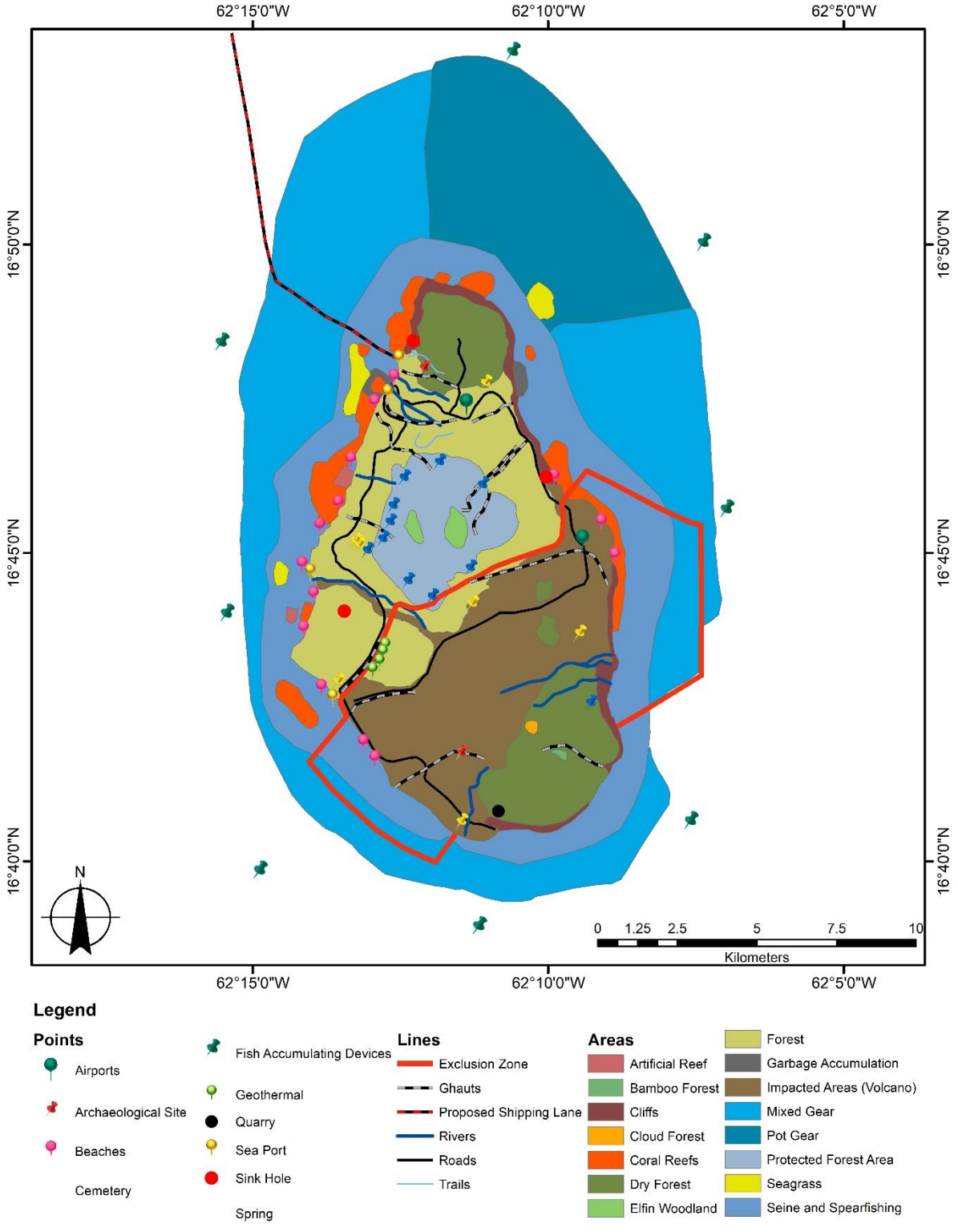
Overall, the exercise was fruitful in terms of participatory engagement of stakeholders in the vulnerability assessment process, including a fair number of experienced fishers (approximately 10), government stakeholders involved in land use planning, environmental management and closely involved in the fisheries sector–Fisheries department, civil society organisations including the local Red Cross and Montserrat Fishers and Boaters Association, as well as private sector stakeholders such as dive operators and tour-guides and others e.g. recreational ocean users.

> *''Over 50 years of invaluable information from Montserrat's indigenous fishers, supported by the local community facilitated the physical development of a P3DM of Montserrat and its adjacent ocean environment. This information will now assist GOM for the first time to utilize evidence based information from fishers to develop and update a geographical map of its adjacent ocean space, which could be used as a model globally.''*
>
> *– Alwyn Ponteen, Chief Fisheries and Ocean Governance Officer, Montserrat*

However, there were limitations to the process due to lack of participation of the following key government stakeholders, including the Disaster Management Coordination Agency (DMCA), Montserrat Tourist Board, The Ministry of Communications, Works & Labour and Public Works Department, and the Governor's Office. Given the persistent impacts of the volcano on the island and possible future risks, the participation of the DMCA is critical in doing a comprehensive vulnerability assessment which captures information relevant to climate change as well as other key hazards and reflects the multi-hazard profile of the island. In addition, as tourism is a central focus for future economic growth, the participation of stakeholders from this sector is key to identify features potentially vulnerable to climate change, especially those which may intersect with the fisheries sector as being of importance – key portions of coastlines, beaches, bays and other scenic coastal landscapes. Other stakeholders such as the Public Works department play critical roles in coastal protection and in addressing drainage and land slippage issues which can compound impacts from climate change.

The local knowledge captured through the P3DM exercise was further digitised and placed within a GIS for integration with scientific knowledge and other data. The GIS datasets and a map were provided to the Government of Montserrat to facilitate effective spatial and land use planning and decision-making related to fisheries and other sectors. See Figure 32 for the GIS map developed through digitisation of the 3D model.

Figure 32. GIS map of Montserrat based on digitisation of the 3D model



5.2.4 Identification of key climate change impacts and vulnerabilities for Montserrat's fisheries

Stakeholders identified a range of climate change and other hazards that they experienced, and which pose a significant risk to Montserrat's fisheries sector, including coastal communities, fishing grounds, landing sites and important coastal and marine ecosystems that support fisheries, during the P3DM exercise.

With respect to climate change hazards, the following were noted:

- More extreme weather, including hurricanes, tropical storms and storm surge. Stakeholders noted they also felt the effects of Category 5 Hurricane Maria in September 2017, although not as severe as in other islands, and highlighted the devastation caused by past events such as Hurricane Hugo in 1989 which resulted in erosion of shorelines and damage to corals.
- Flooding and coastal erosion related to extreme weather and to sea level rise, especially in low-lying coastal areas such as the proposed new capital, Little Bay, and the Carr's Bay area (i.e. where the already limited fishing activity on the island is concentrated).
- Intense rainfall events, which have also contributed to secondary hazards such as flash floods – as storm-water rushes down through ghauts (ravines running down hillsides), and mudflows or lahars as volcanic debris is picked up and washed down from slopes (e.g. Belham Valley area).
- Coral bleaching is thought to be limited currently, but expected to increase if sea temperatures continue to warm. This is a concern for coral reefs already threatened by other anthropogenic stressors, such as land based sources of pollution, coastal development and volcanic activity.
- Influx of sargassum, which was noted to be of concern for all coasts, hindering fishing activity and impacting turtle nesting sites and recreational beaches (e.g. Carr's Bay beach and Marguerite Bay).

Notably, climate change was often treated as secondary to other hazards, with a few participants alluding to it as a 'final nail in the coffin' with respect to threats already facing Montserrat. The climate change hazards identified above are expected to compound the effects of other key hazards such as volcanic activity, which is perceived to be the most serious threat by far to the island, inland flooding, landslides and rockfalls, and existing anthropogenic pressures. These pressures include coastal development, quarrying/sand mining, environmental degradation related to pollution and sedimentation from land based sources, spread of invasive species such as the lionfish, and intensified fishing practices in nearshore areas. Other key hazards that were specifically noted by participants as interacting with climate change include:

- The loss of local fishing grounds, especially in the south due to volcanic activity, which has led to intensified fishing activity in the north, including on remaining healthy reefs. This intensification is not perceived as a significant issue by fisherfolk as there are few fisherfolk in Montserrat, but could be problematic as population increases.
- Volcanic debris and upland land use changes have largely contributed to siltation and sedimentation of reef areas (e.g. in Woodlands Bay area), and affected marine water quality in the south.
- Accumulation of garbage and other pollutants from ghauts flowing out to the sea has resulted in nutrient overloading in coastal waters, and reduced water quality, where human activity is currently concentrated (e.g. in the northerly more populated areas) and coastal developments are taking place (e.g. Little Bay/Carr's Bay area in the north west and Margarita Bay in the north east).
- The role of past and current volcanic activity in shaping the coastline. For example, instances of accretion were noted related to deposited volcanic material (e.g. in the area of the old

airport). This was suggested as providing a possible counteractive effect to climate change induced coastal erosion and flooding due to sea level rise and storm surge.

- Heavy rains already result in flash flooding and landslides, especially given the island's steep topography and many ghauts radiating down hillsides.

These climate change and related hazards have triggered a range of biophysical and socio-economic impacts on fisheries in Montserrat. Stakeholders identified specific impacts and vulnerabilities to these hazards within a number of key areas, which are outlined below in Table 3.

Table 3: Key climate change impacts and vulnerabilities identified by stakeholders using P3DM

Climate change hazards	Key climate change impacts	Vulnerable groups and areas
Coastal and marine biodiversity and ecosystems		
• More extreme hurricanes/ storms and storm surge • Sea level rise • Warmer sea temperatures and increased coral bleaching • Sargassum influx • Intense rainfall and inland flooding leading to increased siltation and polluted runoff	• Erosion of beaches and bays • Flooding of low-lying coastal areas and habitats • Damage to and loss of coastal/marine habitats due to storms, bleaching and siltation e.g. seagrass beds and coral reefs that provide coastal defense and are critical fish habitats • Sargassum events more common; impacts beaches and turtle nesting sites • Loss of biodiversity related to the above • Possible impacts on water sources and resulting in saltwater intrusion due to sea level rise Positives: • Increased interest and support for ocean management, including incorporation of local knowledge	• Coastal communities with habitats and areas of high environmental and biodiversity significance, including as nesting sites for turtles and sea bird habitats e.g. Little Bay, Carr's Bay and Isles Bay beaches. These are prone to erosion, storm surge and flooding and affected by sargassum influxes • Coral reefs off the north and north-east coasts, and associated reef-based fisheries • Seagrass beds mostly to the north/north east which are nurseries and habitat for fish and other marine life • Fishing grounds (mostly to the north) already limited by past volcanic activity where pots, seine, spearfishing and mixed gear is used • Sea level rise could threaten the major aquifer in the Belham Valley area that is tapped into from time to time, as well as the abandoned well in Trants, resulting in possible saltwater intrusion.
Cultural heritage, values and social networks		
• More extreme hurricanes/ storms and storm surge • Sea level rise	• Erosion of coastal lands/bays • Risk of decline in traditional fishing livelihoods and associated knowledge and	• Small and ageing fishing population on the island; there is concern that knowledge and experiences of older fishers will

Climate change hazards	Key climate change impacts	Vulnerable groups and areas
• Intense rainfall resulting in riverine/ghaut and flash flooding • Warmer air temperatures • Sargassum influx	values as especially older fishers engage in alternative or multiple livelihoods (also influenced by impacts of volcanic activity) • Difficulty sustaining fishing culture on the island as younger generations turn to more 'lucrative' alternative livelihoods; climate change presents further complications and disincentives • Key emerging economic sectors that are climate-sensitive, such as tourism, are at risk • Damage and possible loss of important cultural and natural heritage sites, including old estates e.g. Little Bay plantation estate and associated sugar mill, popular recreational beaches e.g. Rendezvous Beach, Woodland Bay and Isles Bay beaches, coral reefs e.g. in the north and north east. • Possible impacts to water supply from drought conditions and after hurricanes/storms Positives: • Investments in sustainable fishing techniques e.g. project promoting use of new type of fish trap to reduce ghost fishing, while encouraging youth involvement	be lost, especially as it relates to fishing practices, key fishing grounds and knowledge of changes in the coastal/marine environment over time. • Limited number of younger fishers, with disparity in terms of knowledge and values, practical techniques used and willingness to engage with/learn from more experienced fishers. • Low-lying coastal communities and other areas in the north of the island e.g. Brades, Little Bay and Carr's Bay which have key historical sites including with colonial relevance such as a Little Bay plantation site (archaeological site), as well as museum and National Trust which house historical artefacts • Important traditional fishing grounds and diving sites away from the volcano exclusion zone • Communities with high landscape value and socio-cultural significance for fishing - Little Bay, Carr's Bay and recreation – Woodland Bay and Isles Bay beaches (Note: There are no clear fishing villages or communities; instead fishing is conducted all around the island.) • Centre Hills forest reserve – recognising land-sea connections, and importance from biodiversity and watershed perspectives (contains the main water catchments on the island) as well as for tourism opportunities

Climate change hazards	Key climate change impacts	Vulnerable groups and areas
Livelihoods and socio-economic practices		
• More extreme hurricanes/ storms and storm surge • Sea level rise • Warmer sea temperatures and increased coral bleaching • Intense rainfall events resulting in flooding • Sargassum influx	• Further reduced ability to fish and earn income due to storminess, rough seas and sargassum influx (in addition to volcanic impacts – sedimentation, exclusion zone) • Increased potential for damage to fishing boats and gear, FADs and facilities (e.g. landing sites, port, jetty) due to more extreme events, storm surge, sargassum influx and sea level rise • Potential changes in fishing strategies and methods, such as types of gear to reflect changes in the abundance and distribution of different fish species, which may require financing and re-training • Shifts in balance between fishing and other livelihood activities; Increased interest in alternative/multiple livelihoods and practices (e.g. tours and taxi services, carpentry, construction, mining volcanic material). • Potential impact on growth in (eco)tourism and reduced income earning opportunities due to effects of extreme weather – ferries unable to dock, decline in reef-based fisheries and dive tourism due to coral bleaching, sargassum and coastal erosion affecting beaches	• Coastal communities and fisherfolk already affected by reduced fishing grounds due to past volcanic activity • Lower income fisherfolk without access to insurance, limited access to credit, equipment/ technologies or skills to diversify or change fishing strategies • Fisherfolk that work part-time in fisheries and hospitality/service/tourism sectors (e.g. as tour-guides, in restaurants and bars or providing taxi services) and have limited education and skills to work in other sectors • Impacts may present disincentive to younger generations with potential interest in fisheries
Settlements and infrastructure		
• More extreme hurricanes/ storms and storm surge • Sea level rise • Intense rainfall events resulting in	• Damage to and loss of coastal assets and infrastructure, including roads, ferry terminal and planned sea port facilities due to sea level rise and more extreme hurricanes/storms and storm surge	• The northern portion of the island in general where the majority of population and infrastructure on the island now exist due to past volcanic activity, including

Climate change hazards	Key climate change impacts	Vulnerable groups and areas
flash flooding, lahars and landslides • Sargassum influx	• Damage to and disruption of public services due to heavy rains, inland flooding and high winds from more extreme hurricanes/storms • Damage to inland settlements due to extreme weather - high winds and inland flooding; Flooding also impacts water quality and leads to health risks from poor sanitation • Reduced access to coastal facilities and infrastructure, and increased clean up and maintenance costs, due to sargassum influx or post-hurricane impacts	- Brades which currently has bulk of government/public services and retail and commercial services, including Little Bay, which is the intended new capital - low lying coastal communities – Little Bay, Carr's Bay, where main fish landing site is located and other facilities important for fisheries will be placed – port development; affected by coastal erosion and flooding - residential areas e.g. Davy Hill, Lookout, Salem • Businesses (e.g. bars, hardware, restaurants and dive shops) on the beachfront in Little Bay area can be impacted by extreme weather, sea level rise, flooding and coastal erosion • Critical infrastructure also at risk to sea level rise, affected by inland flooding from overflowing ghauts and storm surge/wave action resulting in the sea overtopping the main road include the island's bulk fuel storage at Carr's Bay, nearby building block business and properties adjacent • The Belham Valley has been subject to lahars (mud flows) during heavy rainfall in the past
Safety at sea and emergency response/disaster risk reduction		
• More extreme weather, including high winds, rough seas, hurricanes/ storms and storm surge	• Reduced ability to fish and earn income due to safety concerns with increased storminess and rough seas • Increased potential for damage to boats and incidence of fisherfolk and boats lost at sea; increased need and associated	• Lower income fisherfolk, or those not targeted for GPS vessel tracking • Fishers reliant on properly functioning early warning systems and emergency alerts • Dive operators and divers and sport fishers engaged in recreational activities in open sea

Climate change hazards	Key climate change impacts	Vulnerable groups and areas
	costs for search and rescue efforts Positives: • Increased need and interest in weather forecasting and other technologies for disaster risk reduction and to support sustainable ocean management e.g. investment in use of GPS technology/vessel monitoring system[47] • Regular testing of existing EWS mechanisms on island (primarily due to volcanic hazards but can be used for multi-hazards) and recent installation of tsunami signage • Growing interest in damage and loss assessments; comprehensive assessments were not conducted for significant hazards in the past	• Government agencies, including the Fisheries Department engaged in monitoring activities and search and rescue efforts at sea

5.2.5 Priorities for CCA in Montserrat's fisheries

From the P3DM exercise, priorities and specific adaptation actions were jointly identified by stakeholders. The majority of the actions identified were broad in focus, including coastal zone management and capacity building activities that have benefits for the fisheries sector, but also help to address the multiple hazards and pressures to coastal and marine resources. Stakeholders also recognised the need for economic diversification and improved environmental and natural resource management to build the resilience of key sectors including fisheries, government services and tourism.

Key practical actions identified to enable fisherfolk and the fisheries sector to adapt to climate change were noted as follows:

- **Promote participatory fisheries data collection and monitoring** through directly engaging fisherfolk in collecting data and monitoring changes in the coastal and marine environment. Specific recommendations include training for fishers on understanding climate change adaptation (CCA) and reporting needs, and further implementation of vessel monitoring systems using GPS technology, which is already in progress. Data collected by and from local fishers can be used to inform management and policies, and helps strengthen the knowledge base and climate change advisory capacity of fisheries extension workers.
- Put measures in place to **reduce other existing stressors affecting fisheries**. In particular, implement pro-active plans to:

[47] Ponteen, A. 2016. Presentation - A technical revolution in Montserrat's fisheries management and governance. Territory to territory Montserrat workshop, 14 –18 November 2016, Montserrat. http://jncc.defra.gov.uk/pdf/OT_T2T_2-1_iVMS_Presentation_APonteen_201611%20.pdf

    - address coastal and marine pollution from land based sources (e.g. garbage originating from ghauts flowing into the sea)
    - address alien invasive species (e.g. lionfish)
    - address loss of coastal vegetation (e.g. conduct a feasibility study to reintroduce mangroves to support migratory birds and fish nurseries, which could further act as a cheaper alternative to filtering outflows for sewage processing).
- **Promote public awareness and education on climate change** relevant to the fisheries sector, including leveraging lessons learned, insights and knowledge of older fishers on changes to the environment over time and developing fisheries-specific communications messages. This could include basic concepts of climate change, vulnerability of fisheries livelihoods, adaptation in fisheries, and improved safety and security at sea which could later be developed into more in-depth trainings/capacity building.
- **Deploy artificial reefs and FADs** as measures to adapt and offset habitat changes expected under climate scenarios for the Caribbean. Additionally, installing and maintaining low-cost FADs can help fisherfolk reduce costs and days at sea, as they would not need to travel widely in search of fish but can instead travel directly to FADs.
- Explore **measures to climate proof and protect fisheries assets** e.g. fish landing site in Little Bay from rough seas, or to address possible sea level rise impacts and coastline changes due to erosion or accretion.
- **Adopt a more holistic and integrated approach to fisheries management**, such as integrated coastal zone management (ICZM) or EAF, which recognises land-sea connections and relationships critical for fisheries in a small island context, and that can help address the limitations and difficulties associated with narrow sectoral approaches.

It was also suggested to build on the P3DM and results of the vulnerability assessment to:

- Foster continued knowledge sharing and engagement of stakeholders to address fisheries specific objectives and issues – ideas were suggested for using the model again to facilitate stakeholder discussions and inputs on marine spatial planning including designation of Marine Management Areas; coastal developments; and bathymetric surveys and maritime boundary delineation including establishment of new baselines.
- Conduct further modelling of specific communities or areas of interest for example, where key developments are to occur, or monitoring of conditions are required.
- Support further participatory resource mapping and management planning for both terrestrial and marine areas.

6. Lessons Learned in Applying P3DM for Climate Change Vulnerability Assessments

Overall, P3DM served as a valuable tool for conducting a climate change vulnerability assessment for the fisheries sector in Anguilla and Montserrat. It allowed for:

- integration of local knowledge, including traditional knowledge of fisherfolk;
- capture of varying stakeholder perspectives (i.e. it allowed for inclusion of inputs from fisherfolk and other stakeholders with different roles, levels of interest, knowledge and experiences, and with differing capacities and capabilities to engage and contribute information to the process);
- capture of quantitative and qualitative data relevant to EAF (e.g. data within ecologically relevant boundaries and considering multiple and integrated factors including biophysical, cultural, political and socioeconomic);
- identification of useful locations and spatial relationships, including where specific on the ground vulnerabilities exist and actions are needed; and
- engagement of stakeholders in the process to improve knowledge and use opportunities for negotiation and development of consensus on climate change issues.

Specific lessons learned and best practices in the application of P3DM to conduct vulnerability assessments to climate change include:

- Comprehensive stakeholder identification and analysis and effective mobilisation of target audiences are key. The breadth and usefulness of local knowledge captured as part of P3DM is highly influenced by the participation of stakeholders.
- The local context and culture must be factored in as important elements in design and planning of P3DM vulnerability assessments. As such, engaging a local community mobiliser who was familiar with the local participants, but also the local context and culture, was instrumental in helping to shape a locally and culturally relevant process. Community mobilisers can help advise on local needs and cultural preferences so facilitation of the process could be adapted to suit.
- Noting budget implications, field visits prior to and during the P3DM could have assisted with the mobilisation of stakeholders and ensured more meaningful participation of key target audiences.
- Participants' perception of who was responsible for or in charge of the P3DM exercise, as well as who would have eventual control on access and use of data generated, has the potential to influence the level and quality of participation and can even derail the process.
- The process of developing the legend is critical in ensuring relevant information is captured for the vulnerability assessment – this should be used as an opportunity to structure and focus the P3DM exercise to obtain the information required. For example, participants can be asked to directly identify features related to hazards/hazard impacts, exposure, sensitivity and adaptive capacity or other useful categories that should be captured on the model.
- Capacity building and coaching elements can be enhanced by including hands-on training with stakeholders in digitising the P3DM model after its completion and creating GIS outputs (e.g. datasets and maps) themselves. This could be part of the initial process or follow up exercise and could be extended to cover wider understanding of GIS requirements of the P3DM process on the whole, including steps to identify and effectively communicate GIS needs in the case where GIS expertise must be contracted externally.
- Follow up sessions using the model – presenting the final results to various target audiences can support, for example, further inputs and provide the necessary feedback to help validate the model and opportunity to solidify action plans if needed.

- P3DMs need to be scheduled with sufficient time that would allow for key steps, including model construction, inputting information on to the model and analysis of the final results with key stakeholders, to be completed comfortably. At least 8 days is required, but this will also be dependent on factors such as availability of materials to start work, the size of the model being constructed and the overall level of participation that is received.
- Locating the model close to key target audiences and in a highly accessible area to the public in general helped to garner participation, even on the fly. Depending on the key target audiences, location in a government office for example, has implications for perceived locus of control on the process and could have affected level and quality of participation.
- Informal interviews and meetings in the evenings in places where fishers usually congregated was useful in allowing them to access information on what was happening in a more relaxed manner and get comfortable with facilitators outside of formal settings.
- Specific focus group sessions with fisherfolk were useful in capturing fisheries specific needs and information to be included on the model. Focused sessions with these stakeholders helped increase their comfort level and willingness to share information that was not otherwise captured when wider audiences were in the room.

In general, there is need to consider what target audiences get out of theP3DM process that may encourage mobilisation and participation (e.g. knowledge sharing, capacity building, etc.). Depending on the key target audience, such as a government department or national CSO, P3DM vulnerability assessments can be embedded as part of a wider training and capacity building context to encourage participation, uptake and sustainability of the process.

7. Conclusions and Recommendations

Climate change poses a significant, long term threat to the fisheries of Anguilla and Montserrat. Assessing vulnerability to the impacts of climate change is fundamental to guide decision-making and ensure that efforts to mainstream CCA into fisheries governance and management reflect local conditions and needs.

Using P3DM, key impacts and vulnerabilities to climate change and related hazards within the fisheries sector of Anguilla and Montserrat and priorities for CCA were identified using a participatory, multi-stakeholder process. This process ensured active participation from fisherfolk and other resource users, community residents and other CSOs that may not typically be engaged in decision-making, and enabled local and scientific knowledge to be incorporated into the assessment to identify key vulnerabilities and priorities for CCA. Building a 3D model of the entire islands of Anguilla and Montserrat and the surrounding marine areas also allowed for EAF, examining the biophysical, cultural and socioeconomic dimensions of vulnerability from 'ridge to reef' and recognising land-sea connections and relationships critical for fisheries in a small island context.

Key recommendations based on the P3DM for moving forward and ensuring effective mainstreaming of CCA into fisheries governance and management in Anguilla and Montserrat using EAF include:

- Presenting and validating the findings from the P3DM and the priorities for CCA in the fisheries sector through a series of community meetings with fisherfolk and other key community stakeholders in Anguilla and Montserrat in order to gain additional input and finalise action plans for CCA to guide next steps under the project.
- Ensuring that the final action plans for CCA not only reflect stakeholder priorities but make linkages to, and are aligned with, strategic priorities and commitments at the national, regional and international levels related to CCA, DRM and sustainable fisheries management.
- Enabling public access and use of the P3DM outputs, including public display of the 3D models of Anguilla and Montserrat for awareness raising and communication of the impacts of climate change and natural disasters and key vulnerabilities and use of GIS maps and datasets for further spatial planning and analysis in the fisheries sector and other sectors.
- Utilising participatory video[48] and other information and communication technologies (ICTs) to further document and share local and traditional knowledge, best practices and innovations in the fisheries sector that are relevant to CCA. There is particular need for documentation of traditional knowledge of fisherfolk which may be at risk of being lost given the aging fishing population, particularly in Montserrat, and value of traditional knowledge related to fishing practices and navigational skills such as dead reckoning for CCA and other sociocultural aspects.
- Empowering fisherfolk and coastal communities to address identified vulnerabilities to climate change and related hazards from P3DM and promote local stewardship of fisheries and coastal and marine resources through capacity building, including training, mentoring and access to grants to support implementation.
- Engaging and strengthening of national fisherfolk organisations (e.g. fishing associations and co-operatives) to improve dialogue and knowledge exchange between different generations of fishers, amongst fishers' representatives and with other key stakeholders, such as fisheries authorities and other government agencies and national CSOs. This will enable sharing of best practices and innovations (e.g. related to selection of gear and fish species and value added products in the context of changing climate). Active fisherfolk organisations

[48] For further details, see http://www.canari.org/cm1

can also improve representation of fisherfolk in sectoral and national decision-making processes and enable collective voice and action on key issues affecting fisherfolk and the fisheries sector.

- Promoting ecosystem based management, including EAF, to enable an integrated, multi-hazard and cross-sectoral approach and build resilience to climate change within the fisheries sector recognising that climate change is one of many challenges affecting the sector. Other key challenges include habitat degradation, pollution, resource overuse, invasive species and impacts from other natural hazards such as volcanic and seismic activity. Adaptation actions that offer co-benefits through addressing climate change and other key non-climatic stresses should be given particular consideration.
- Mainstreaming CCA as well as DRM considerations into fisheries management plans and policies in Anguilla and Montserrat to effectively address extreme climate events and reduce losses from climate-related hazards. This includes taking into account the comprehensive disaster management approach within any sectoral adaptation strategy, investments in early warning systems, safety at sea and insurance, and development of disaster preparedness plans as part of national fisheries management plans.
- Supporting sustainable and resilient livelihoods within fishing and coastal communities in Anguilla and Montserrat through development of value added fish products and SMEs related to aquaculture, aquaponics and seamoss cultivation. This could provide opportunities for increased income generation and livelihood diversification as well as incentives for sustainable utilisation of fisheries and coastal and marine resources.
- Strengthening regional cooperation and partnerships to improve management of shared resources and exchange knowledge and experiences on climate change impacts, vulnerabilities and potential adaptation options for fisheries and coastal and marine resources more broadly. Synergies with other relevant regional projects need to be explored, such as the Climate Change Adaptation in the Fisheries Sector of the Eastern Caribbean project (CC4FISH) that seeks to improve vulnerability assessments in the fisheries sector, build adaptive capacity among fisherfolk and aquaculturists and mainstream CCA into fisheries policies and plans using EAF. The Joint Nature Conservation Committee (JNCC) is also conducting a number of initiatives that support ICZM and marine spatial planning in both OT's.

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Appendix 1

CLIMATE CHANGE ADAPTATION IN THE FISHERIES OF ANGUILLA AND MONTSERRAT

Vulnerability assessment of Anguilla's fisheries sector using participatory three-dimensional modelling (P3DM)

March 1-7, 2018

Anguilla Community College, George Hill, Anguilla

Agenda

Workshop objectives

The Caribbean Natural Resources Institute (CANARI), Department of Fisheries and Marine Resources – Anguilla, the Fisheries and Ocean Resources Unit - Montserrat and the Centre for Resource Management and Environmental Studies (CERMES) of the University of the West Indies are implementing the three year Darwin Plus funded project ***Climate change adaptation in the fisheries of Anguilla and Montserrat*** to mainstream climate change adaption (CCA) into fisheries governance and management in Anguilla and Monserrat using an ecosystem approach to fisheries (EAF).

Under the project, participatory three-dimensional modelling (P3DM) will be used in this workshop to conduct a vulnerability assessment of Anguilla to climate change and natural disasters and identify potential adaptation actions, focusing on areas critical to the fisheries sector (e.g. fishing communities, landing sites, fishing grounds and supporting ecosystems such as coral reefs and mangroves). This P3DM workshop will be a key step in supporting mainstreaming of CCA in the fisheries sector and improving livelihoods at the community level.

By the end of the P3DM workshop, participants would have:

- captured and incorporated their local and scientific knowledge to assess the vulnerability of Anguilla, especially the fisheries sector, to climate change and natural disasters through engagement in building the model;
- analyzed the potential impacts of various climate scenarios for Anguilla's fisheries and coastal communities and their livelihoods;
- identified priorities for action for CCA in the fisheries sector in Anguilla, including policy priorities as well as specific actions needed on-the-ground to address the impacts of climate change;
- improved their understanding of and appreciation for the value of local knowledge in decision-making about climate change; and

- enhanced their capacity to use P3DM as a tool for vulnerability assessment and spatial planning and resource management to adapt and build resilience to climate change and natural disasters.

Target group

The target audience for the P3DM workshop are government, civil society and private sector stakeholders, including fisheries authorities, fisherfolk and their organisations and local communities, involved in CCA, disaster risk management and sustainable utilization of fisheries and related natural resources in Anguilla.

Workshop Agenda

Model Building (Days 1-3)	
Thursday March 1st, 2018	
8:30 am	Registration
9:00 am	Welcome and introductions Overview of the ***CLIMATE CHANGE ADAPTATION IN THE FISHERIES OF ANGUILLA AND MONTSERRAT*** project and P3DM Workshop Objectives
9:30 am	Model building starts
12:00 pm	**Lunch**
1pm	Model building continues Drafting of the legend
3:30 pm	**Snack break**
5:30 pm	End of Day 1
Friday March 2nd, 2018	
8:30 am	Registration
9:00 am	Model building continues
12:00 pm	**Lunch**
1:00 pm	Model building continues
4:00 pm	End of Day 2
Saturday March 3rd, 2018	
8:30 am	Registration
9:00 am	Model building continues
12:30 pm	**Lunch**
1:30 pm	Model building continues
4:30 pm	End of Day 3
Sunday March 4th, 2018 Day 4 - Model drying (No activity/workshop)	
Model Population (Days 5-6)	
Monday March 5th, 2018	
9:00 am	Orientation of participants (session 1) Inputting information on the 3-D model
12:00 pm	**Lunch**
1:00 pm	Orientation of participants (session 2) Inputting information on the 3-D model

3:30 pm	**Snack Break**
4:00 pm	Orientation of participants (session 3) Inputting information on the 3-D model
7:00 pm	End of Day 5
Tuesday March 6th, 2018	
9:00 am	Orientation of participants (session 4) Inputting information on the P3DM model
12:00 pm	**Lunch**
1:00 pm	Orientation of participants (session 5) Inputting information on the P3DM model
4:00 pm	**Snack break**
4:30 pm	Finalisation of 3-D model (painting in features)
7:00 pm	End of Day 6
Analysis of Model Results (Day 7)	
Wednesday March 7th, 2018	
8:00 am	Registration
8:30 am	Overview of P3DM objectives and completed model
9:00 am	Participatory analysis of key climate change vulnerabilities and potential adaptation actions for the fisheries sector
12:00 am	**Lunch**
Handover Ceremony	
1:00 pm	Welcome and introductions
1:10 pm	Opening remarks
1:20 pm	Presentation of key findings and stakeholder recommendations from P3DM
1:45 pm	Showcase of completed 3-D model and media interviews
2:30 pm	Closing remarks (End of workshop)

Appendix 2: List of Participants for Anguilla P3DM Workshop

#	First and Last Name	Organisation	Position/Title	Email/Phone
Thursday 1st March 2018 - Model Construction				
1	Javed Woods	Anguilla Air and Sea Port Authority (AASPA)	Port Officer	Javed.Woods@gov.ai 581-8858
2	Melissa Hodge	Department of Health Protection	Senior Environmental Health Officer	Melissa.hodge@gov.ai 476-5552
3	Remone Johnson	Department of Fisheries and Marine Resources (DFMR)	Fisheries Officer	Remone.johnson@gov.ai 523-1497
4	Mikayja Carty	Albena Lake Hodge Comprehensive School (ALHCS)	Student	
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6	Keyoniques Hendross	ALHCS	Student	
7	Reba Stott	ALHCS	Student	Reba.Stott@gmail.com
8	Genius Carty	ALHCS	Student	
9	Ajani Hodge	ALHCS	Student	
10	Lennick Richardson	Immigration	Task Force/ Immigration Officer	lennickr@hotmail.com 235-1863
11	Rohan Forbes	Immigration	Immigration Officer II	Rohan_29@hotmail.com 584-0992
12	Julisha Connor	AASPA	Port Officer	Julisha.Connor@gov.ai 729-3882
13	Kerriel Lewis	Department of Lands and Survey	Land Information Services Technician	Kerriel.lewis@gov.ai 476-5893
14	Jesile Duncan	Department of Health Protection	Senior Water Lab Technologist	Jesile.duncan@gov.ai 729-1504
15	Alma Gumbs	Department of Lands and Survey	Assistant Registrar	Alma.gumba@gov.ai 584-8555
16	Silvia Erni	Department of Physical Planning	Senior Planner	Silvia.erni@gov.ai 584-1620
17	Julian Hughes	Department of Physical Planning	Senior GIS Officer	Julian.hughes@gov.ai 497-5392
18	Stafford John	Department of Physical Planning	Senior Planner	Stafford.John@gov.ai 497-5392
19	Sharmer Fleming	Department of Environment	Coordinator of Environment and Sustainable Development	Sharmer.fleming@gov.ai
20	Mya Martin	ALHCS	Student	
21	Smailyn Carter	ALHCS	Student	
22	Rahkim James	ALHCS	Student	Rahkimjay@gamil.com
23	Rhon Connor	DFMR	Acting Director	Rhon.connor@gov.ai 584-3332

24	Orlando Salisbury	DFMR	Fisheries Officer	Orlando.salisbury@gov.ai
25	Adam Jehu	CANARI	GIS Consultant	adamjehu@hotmail.com
26	Ainka Granderson	CANARI	Senior Technical Officer	ainka@canari.org
27	Ruiz Phillip-Thomas	CANARI	Local mobiliser	Ruizphillipthomas7@ gmail.com/ 772-6894
Friday 2nd March 2018 - Model Construction				
1	Ashton Sivnarine	ALHCS	Student	
2	Lanzy Vanterpool	D.O.P.	Student	
3	Patrick Liburd	ALHCS	Student	
4	Shemar Connor	ALHCS	Student	Sconnor_@live.com
5	Malone Fleming	Workshop Initiative for Support in Education (WISE)	Student	Malfleminga11@gmail.com
6	Smailyn Carter	ALHCS	Student	
7	Ajani Hodge	ALHCS	Student	
8	Jahrell Phillips	ALHCS	Student	Jahrell_Phillip@yahoo.com
9	Rahkim James	ALHCS	Student	Rahkimjay@gamil.com
10	Allen Johnson	VPS	Student	
11	Nandi Edwards	ALHCS	Student	Nandi.edwards8008@ gmail.com/ 235-0667
12	Reba Stott	ALHCS	Student	Reba.Stott@gmail.com
13	Genius Carty	ALHCS	Student	
14	Jesile Duncan	Department of Health Protection	Senior Water Lab Technologist	Jesile.duncan@gov.ai 729-1504
15	Javed Woods	AASPA	Port Officer	Javed.Woods@gov.ai 581-8858
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17	Lavie Lake	Department of Probation	Intern Case Worker	Lavielake5112@gmail.com
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23	Orlando Salisbury	DFMR	Fisheries Officer	Orlando.salisbury@gov.ai
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25	Ainka Granderson	CANARI	Senior Technical Officer	ainka@canari.org
26	Ruiz Phillip-Thomas	CANARI	Local mobiliser	Ruizphillipthomas7@ gmail.com/ 772-6894
Monday 5th March 2018 - Model Population				

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5	Silvia Erni	Department of Physical Planning	Senior Planner	Silvia.erni@gov.ai 584-1620
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7	Stafford John	Department of Physical Planning	Senior Planner	Stafford.John@gov.ai 497-5392
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9	Lennick Richardson	Immigration	Task Force/ Immigration Officer	lennickr@hotmail.com 235-1863
10	Julisha Connor	AASPA	Port Officer	Julisha.Connor@gov.ai 729-3882
11	Javed Woods	AASPA	Port Officer	Javed.Woods@gov.ai 581-8858
12	Melissa Hodge	Department of Health Protection	Senior Environmental Health Officer	Melissa.Hodge@gov.ai 476-552
13	Janice Hodge	Ebenezer United Sisters	Vice President	Janiceahodge@gmail.com 476-2379
14	Joy Gumbs	Ebenezer United Sisters	President	476-3922
15	Violet Brooks	Ebenezer United Sisters	Member	729-3737
16	Lily Moses	Anguilla Chamber of Commerce and Industry	Administrative Assistant	info@anguillachamber.com 497-2839
17	Samantha Henderson	Public Administration	Administrative Officer	Samantha.henderson@gov.ai 584-6303
18	Donna Mussington	Public Administration	Passport Officer	Donna.mussington@gov.ai 497-3041
19	Brianna Gumbs	DFMR	Trainee	Briannagumbs9000@gmail.com / 276-6066
20	Elridge Richardson	Fire Services	Trainee	235-3323
21	Linsford Richardson	Fire Services	Trainee	Mitchum.336@hotmail.com 729-3559
22	Agnes Payne Fleming	Girls Brigade	Captain	Aggup7@gmail.com 594-2115
23	Yolande Richardson	Methodist Women's League	Member	hodgerichardson@gmail.com
24	Elrick Hughes	Bethel Church – Men's group	Steward	584-9177

25	Karissa Rogers	Commercial Registry	Clerical Officer	Ladyka_14@hotmail.com
26	Allan Ruan	Prickly Pear Restaurant	Manager	Pricklypearanguilla@ yahoo.com / 235-5864
27	Sam Webster		Fisherman	729-1169
28	Alwyn Richardson	Department of Disaster Management	Programme Officer - Mitigation	Alwyn.richardson@gov.ai 235-7443
29	James Freddy Hughes		Retired Seaman	476-3133
30	Annette Richardson	Anguilla Red Cross	Administrator	551-6583
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38	Adam Jehu	CANARI	GIS Consultant	adamjehu@hotmail.com
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4	James Freddy Hughes		Retired Seaman	476-3133
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11	Rohan Forbes	Immigration	Immigration Officer II	Rohan_29@hotmail.com 584-0992
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13	Lily Moses	Anguilla Chamber of Commerce and Industry	Administrative Assistant	info@anguillachamber.com 235-2840
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16	Ethan Ray	Pupil Referral Unit	Student	
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22	Julian Hughes	Department of Physical Planning	Senior GIS Officer	Julian.hughes@gov.ai 497-5392
23	Stafford John	Department of Physical Planning	Senior Planner	Stafford.John@gov.ai 497-5392
24	Sharmer Fleming	Department of Environment	Coordinator of Environment and Sustainable Development	Sharmer.fleming@gov.ai
25	Julisha Connor	AASPA	Port Officer	Julisha.Connor@gov.ai 729-3882
26	Javed Woods	AASPA	Port Officer	Javed.Woods@gov.ai 581-8858
27	Kerriel Lewis	Department of Lands and Survey	Land Information Services Technician	Kerriel.lewis@gov.ai 476-5893
28	Tristan Smith		Fisherman	583-2434
29	Wayne John		Fisherman	772-3458
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36	Nesta Brooks	ALHCS Environmental Club	President	Nesta_brooks@hotmail.com 772-4993
37	Joselyn Theophile-Richardson	ALHCS Environmental Club	Coordinator	jtheophilerichardson@ gmail.com / 581-5038
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40	Remone Johnson	Department of Fisheries and Marine Resources (DFMR)	Fisheries Officer	Remone.johnson@gov.ai 523-1497
41	Adam Jehu	CANARI	GIS Consultant	adamjehu@hotmail.com
42	Ainka Granderson	CANARI	Senior Technical Officer	ainka@canari.org
43	Ruiz Phillip-Thomas	CANARI	Local mobiliser	Ruizphillipthomas7@ gmail.com/ 772-6894
Wednesday 7th March 2018 – Participatory Analysis & Handover Ceremony				
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4	Brianna Gumbs	DFMR	Trainee	Briannagumbs9000@gmail. com / 276-6066
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6	Carlos Sasso	DFMR	Fisheries Officer	Carlos.Sasso@gov.ai 497-2871
7	Violet Brooks	Ebenezer United Sisters	Member	729-3737
8	Janice Hodge	Ebenezer United Sisters	Vice President	Janiceahodge@gmail.com 476-2379
9	Yolande Richardson	Methodist Women's League	Member	hodgerichardson@gmail.com
10	Lennick Richardson	Immigration	Task Force/ Immigration Officer	lennickr@hotmail.com 235-1863
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17	Javed Woods	AASPA	Port Officer	Javed.Woods@gov.ai 581-8858
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21	Trenton Roach	Department of Agriculture	Horticulturist	Trenton.roach@gov.ai 476-3236
22	Deniscio Samuel	Organix	Tilapia Farmer	Niscio21@gmail.com 476-9141
23	Charmaine Fleming-Liburd	DFMR	Executive Secretary	Cfleming@gov.ai
24	Tacumba Duncan	DFMR	Fisheries Assistant	Tacumba.Duncan@gov.ai
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27	Melissa Meade	Department of Disaster Management	Director	Melissa.meade@gov.ai 497-2926
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29	Orlando Salisbury	DFMR	Fisheries Officer	Orlando.salisbury@gov.ai
30	Remone Johnson	DFMR	Fisheries Officer	Remone.johnson@gov.ai 523-1497
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33	Ruiz Phillip-Thomas	CANARI	Local mobiliser	Ruizphillipthomas7@ gmail.com/ 772-6894

Appendix 3

CLIMATE CHANGE ADAPTATION IN THE FISHERIES OF ANGUILLA AND MONTSERRAT

Vulnerability assessment of Montserrat's fisheries sector using participatory three-dimensional modelling (P3DM)

February 18 – 24, 2018
Montserrat Cultural Centre, Little Bay, Montserrat

Agenda

Workshop objectives

The Caribbean Natural Resources Institute (CANARI), Department of Fisheries and Marine Resources – Anguilla, the Fisheries and Ocean Resources Unit - Montserrat and the Centre for Resource Management and Environmental Studies (CERMES) of the University of the West Indies are implementing the three year Darwin Plus funded project ***Climate change adaptation in the fisheries of Anguilla and Montserrat*** to mainstream climate change adaption (CCA) into fisheries governance and management in Anguilla and Monserrat using an ecosystem approach to fisheries (EAF).

Under the project, participatory three-dimensional modelling (P3DM) will be used in this workshop to conduct a vulnerability assessment of Montserrat to climate change and natural disasters and identify potential adaptation actions, focusing on areas critical to the fisheries sector (e.g. fishing communities, landing sites, fishing grounds and supporting ecosystems such as coral reefs and mangroves). This P3DM workshop will be a key step in supporting mainstreaming of CCA in the fisheries sector and improving livelihoods at the community level.

By the end of the P3DM workshop, participants would have:

- captured and incorporated their local and scientific knowledge to assess the vulnerability of Montserrat, especially the fisheries sector, to climate change and natural disasters through engagement in building the model;
- analysed the potential impacts of various climate scenarios for Montserrat's fisheries and coastal communities and their livelihoods;
- identified priorities for action for CCA in the fisheries sector in Montserrat, including policy priorities as well as specific actions needed on-the-ground to address the impacts of climate change;
- improved their understanding of and appreciation for the value of local knowledge in decision-making about climate change; and
- enhanced their capacity to use P3DM as a tool for vulnerability assessment and spatial planning and resource management to adapt and build resilience to climate change and natural disasters.

Target group

The target audience for the P3DM workshop are government/public, civil society and private sector stakeholders, including fisheries authorities, fisherfolk and their organisations and local communities, involved in CCA, disaster risk management and sustainable utilization of fisheries and natural resources in Montserrat.

Workshop Agenda

Model Building (Days 1-3)	
Sunday February 18, 2018	
2:30 pm	Registration of participants Brief orientation
3:00 pm	**Model building starts** (Students/youth groups, other volunteers start building blank model including tracing, cutting and gluing contours unto base map)
7:00 pm	End of Day 1
Monday February 19, 2018	
8:00 am	Registration of participants
8:30 am	Opening remarks, welcome and introductions Overview of the Climate change adaptation in the fisheries of Anguilla and Montserrat project and P3DM Objectives
9:00 am	Model building Drafting of the legend
12:30 pm	**Lunch**
1:30 pm	Resume model building
5:30 pm	End of Day 2
Tuesday February 20, 2018	
8:00 am	Registration of participants
8:30 am	Model building (continued)
12:00 pm	**Lunch**
1:00 pm	Resume model building
5:30 pm	End of Day 3
Wednesday February 21, 2018 Day 4 - Model drying (No activity)	
Model Population and Analysis of Results (Days 5-6)	
Thursday February 22, 2018	
8:30 am	Registration
9:00 am	**(1st cluster scheduled appointments)** Orientation of participants Inputting information on the model
12:00 pm	**Lunch**
1:00 pm	**(2nd cluster scheduled appointments)** Orientation of participants Inputting information on the model
3:30 pm	**Snack Break**
4:00 pm	**(3rd cluster scheduled appointments)** Orientation of participants Inputting information on the model
7:00 pm	End of Day 5
Friday February 23, 2018	
8:30 am	Registration
9:00 am	**(4th cluster scheduled appointments)** Orientation of participants

	Inputting information on the model
12:00 pm	**Lunch**
1:00 pm	Participatory analysis of key climate change vulnerabilities and potential adaptation actions for the fisheries sector
4:00 pm	**Snack Break**
4:30 pm	Finalisation of model (painting in features)
7:00 pm	End of Day 6 (Model drying)
Handover Ceremony (Day 7)	
Saturday February 24, 2018	
9:30am	Registration
10:00 am	Opening remarks, welcome and introductions
10:30am	Showcase of completed 3-D model and presentation of key findings and stakeholder recommendations
11:30 am	End of Workshop

Handover Ceremony

February 24th, 2018
Montserrat Cultural Centre, Little Bay, Montserrat

Agenda	
10:00 am - 10:10am	Welcome and introductions by Chair – Alwyn Ponteen, Chief Fisheries & Ocean Governance Officer
10:10 am – 10:30 am	Opening Remarks - Minister of Agriculture, Trade, Lands, Housing and the Environment, Honourable David Osborne
10:30 am – 11:00 am	Sharing of findings and experiences - Summary key findings and stakeholder recommendations – Caribbean Natural Resources Institute - Sharing of experiences by participants
11:00 - 11:30 am	Official handover and showcasing of the model Participant viewing and photos

Appendix 4: List of Participants for Montserrat P3DM Workshop

#	Name	Organisation/Position	Email/Phone
Sunday 18th February 2018 – Orientation and Demos			
1	Alwyn Ponteen	Chief Fisheries & Ocean Governance Officer, MATHLE	ponteena@gov.ms alwyncmrm@gmail.com
2	Sirah James	M.A.N.	
3	Jahmal Ryan	M.A.N.	JaiJai1308@gmail.com
4	Rhion Malcare	M.A.N.	rhionmalcare@gmail.com
5	Jahfique Ryan	M.A.N.	
6	Kimari Kirnon	M.A.N.	kimarikirnon@gmail.com
7	Nehemiah Younge	M.A.N.	www.neosso@gmail.com
8	Joshua Peireira	M.A.N.	
9	Kenville WInspearel	M.A.N.	
10	Aidan Livan	M.A.N.	Aidanlivan11@gmail.com
11	Alvin Lee	M.A.N.	DeejayGreyz14@gmail.com
12	Orin	Student	jahrin22@gmail.com
13	Jermaine Wade	M.A.N.	jermainewade@live.com
14	Doron Cassell	Montserrat Community College	dorycas@gmail.com
15	Karina Galloway	Montserrat Secondary School	
16	Keturah Daley	Montserrat Secondary School	keziko@outlook.com
17	Trevor Howe	Montserrat Secondary School	
18	Korah Galloway	Attorney/Parent	korah.alks@gmail.com
19	Adwani Wade	Montserrat Secondary School	
20	James Weekes		
21	Asma Muhammed		asmamuhammed141@gmail.com
22	Jada John		
23	Norman Cassell	NAMCAS (tour guide) / community mobiliser	namcas@yahoo.com

Monday 19th February 2018 - Model Construction			
1	Leandra Lee	Data Collector, Agriculture Department	leel@gov.ms
2	Javiere Adams	Agriculture/Fisher	adamsj@gov.ms
3	Thiffanie WIlliams	Environment Officer, Department of Environment (D.O.E.)	williamst@gov.ms
4	Hawwa Hassan	Physical Planning Officer, Physical Planning Unit (PPU)	hassanh@gov.ms
5	Kenaud Ryan	R.E. Advisor, Montserrat Utilities Limited (MUL)	kenaud.ryan@mul.ms
6	Stephen Mendes	Environmental Technician, Department of Environment (D.O.E.)	mendess@gov.ms
7	Charley Bartlett	Montserrat Island Dive Centre	info@islanddivecentre.com
8	Eugene	Fisher/Truck Driver	
9	Alwyn Ponteen	Chief Fisheries & Ocean Governance Officer, MATHLE	ponteena@gov.ms alwyncmrm@gmail.com
10	Sheldon Carty	President, Montserrat Boater's and Fisher's Association	sheldoncarty@hotmail.com
11	Deidre Allen	Environmental Health Officer	allendr@gov.ms
12	Cleo Cassell	Teacher	cleo.cassell@yahoo.com
13	Chloe Cassell	Student	
14	Dr Samuel Joseph	Member of Parliament	
15	Tavis Weekes	Environment worker, Department of Environment	weekest@gov.ms
16	Kelvin Duberry		
17	Melissa O'Garro	Director, Department of Agriculture	ogarrom@gov.ms
18	Candice Ramkissoon	Workshop facilitator, CANARI	candice@canari.org
19	Adam Jehu	Workshop facilitator, CANARI (GIS consultant)	adamjehu@hotmail.com
20	Norman Cassell	NAMCAS (tour guide) / community mobiliser	namcas@yahoo.com
Tuesday 20th February 2018 - Model Construction			

1	John F. Howes (Captain)	Fisherman	SAFE500@hotmail.com
2	Leandra Lee	Data Collector, Agriculture Department	leel@gov.ms
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5	Tavis Weekes	Environment worker, Department of Environment	weekest@gov.ms
6	Stephen Mendes	Environmental Technician, Department of Environment (D.O.E.)	mendess@gov.ms
7	Javiere Adams	Agriculture/Fisher	adamsj@gov.ms
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10	Jirah James		
11	Candice Ramkissoon	Workshop facilitator, CANARI	candice@canari.org
12	Adam Jehu	Workshop facilitator, CANARI (GIS consultant)	adamjehu@hotmail.com
13	Alwyn Ponteen	Chief Fisheries & Ocean Governance Officer, MATHLE	ponteena@gov.ms alwyncmrm@gmail.com
14	Norman Cassell	NAMCAS (tour guide) / community mobiliser	namcas@yahoo.com
Wednesday 21st February 2018 (AM) - Model Construction and Drying			
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5	Kenaud Ryan	R.E. Advisor, Montserrat Utilities Limited (MUL)	kenaud.ryan@mul.ms

6	Thiffanie Williams	Environment Officer, DOE	williamst@gov.ms
7	Candice Ramkissoon	Workshop facilitator, CANARI	candice@canari.org
8	Adam Jehu	Workshop facilitator, CANARI (GIS consultant)	adamjehu@hotmail.com
9	Sheldon Carty	President, Montserrat Boater's and Fisher's Association	sheldoncarty@hotmail.com
10	Tavis Weekes	Environment worker, Department of Environment	weekest@gov.ms
11	Stephen Mendes	Environmental Technician, Department of Environment (D.O.E.)	mendess@gov.ms
12	David Osborne	Minister of Agriculture	
13	Shirley Osbourne	Speaker of the National Assembly	
14	Norman Cassell	NAMCAS (tour guide) / community mobiliser	namcas@yahoo.com
15	Alwyn Ponteen	Chief Fisheries & Ocean Governance Officer, MATHLE	ponteena@gov.ms alwyncmrm@gmail.com
16	Norman Cassell	NAMCAS (tour guide) / community mobiliser	namcas@yahoo.com
Wednesday 21st February 2018 (PM) - Fisherfolk focus group (development of fishers' legend)			
1	Abraham Greenaway	Fisher	
2	Ivason (Jim) Fagan	Fisher	
3	Norman Cassell	NAMCAS (tour guide) / community mobiliser	
4	Leon White	Port Authority	
5	Carlton (John) O'Garro	Fisher	
6	Sheldon Carty	(President of Montserrat Fishers and Boaters Association)	
7	John F. Howes (Captain)	Fisherman/tour guide	

8	James (Tarmmy) Weekes	Fisher	
9	Alwyn Ponteen	Chief Fisheries & Ocean Governance Officer, MATHLE	ponteena@gov.ms alwyncmrm@gmail.com
10	Candice Ramkissoon	Workshop facilitator, CANARI	candice@canari.org
11	Adam Jehu	Workshop facilitator, CANARI (GIS consultant)	adamjehu@hotmail.com
Thursday 22nd February 2018 - Model population			
1	Leandra Lee	Data Collector, Agriculture Department	leel@gov.ms
2	Candice Ramkissoon	Workshop facilitator, CANARI	candice@canari.org
3	Adam Jehu	Workshop facilitator, CANARI (GIS consultant)	adamjehu@hotmail.com
4	Leon White	Port Authority	Leon.White@mpa.ms
5	Sonja Smith	Librarian	smiths@gov.ms
6	Melissa O'Garro	Director, Department of Agriculture	ogarrom@gov.ms
7	Hawwa Hassan	Physical Planning Officer, Physical Planning Unit (PPU)	hassanh@gov.ms
8	Thiffanie Williams	Environment Officer, DOE	williamst@gov.ms
9	Clement Meade	Director, Land Management, Physical Planning Unit (PPU) / Land Surveys	meadecj@gov.ms
10	Deidre Allen	Environmental Health Officer	allendr@gov.ms
11	Tavis Weekes	Environment worker, Department of Environment	weekest@gov.ms
12	Stephen Mendes	Environmental Technician, Department of Environment (D.O.E.)	mendess@gov.ms
13	Javiere Adams	Agriculture/Fisher	adamsj@gov.ms
14	Kenaud Ryan	R.E. Advisor, Montserrat Utilities Limited (MUL)	kenaud.ryan@mul.ms
15	Charley Bartlett	Montserrat Island Dive Centre	info@islanddivecentre.com

16	Steve Christiansen	Pilot/CEO, Emerald Isle Helicopters	info@helicopter.ms
17	Albrun Semper	Red Cross	sempera@gov.ms
18	Steadroy Meade	Montserrat Football Association/ Private sector	steadmed@hotmail.com
19	James Scriber Daly	Forest ranger/tour guide	scriber14@hotmail.com
20	Isaiah J. Allen	Farmer	
21	Nicolas Tirard	Project Officer, Montserrat National Trust	nicolas.tirard@gmail.com
22	Alwyn Ponteen	Chief Fisheries & Ocean Governance Officer, MATHLE	ponteena@gov.ms alwyncmrm@gmail.com
23	Teresina Bodkin	Lecturer, Montserrat Community College, Statistician	mstere@me.com
24	Easton Taylor	Opposition Leader	
25	Daphne Cassell	Permanent Secretary, Office of the Premier	
26	Daniel Sweeney	President, Montserrat Fishermen's Cooperative/ Fisher	dsweeney@candw.ms
27	Cameron Yearwood	Technician, Digicel Group	cameron.yearwood@digicelgroup
28	Alyssa Ponteen	Student, Montserrat Community College	alyssa.ponteen@hotmail.com
29	Norman Cassell	NAMCAS (tour guide) / community mobiliser	namcas@yahoo.com
Friday 23rd February 2018 - Model Population and Participatory Analysis			
1	Leandra Lee	Data Collector, Agriculture Department	leel@gov.ms
2	Candice Ramkissoon	Workshop facilitator, CANARI	candice@canari.org
3	Adam Jehu	Workshop facilitator, CANARI (GIS consultant)	adamjehu@hotmail.com
4	Leon White	Port Authority	Leon.White@mpa.ms
5	Alwyn Ponteen	Chief Fisheries & Ocean Governance Officer, MATHLE	ponteena@gov.ms alwyncmrm@gmail.com

6	Norman Cassell	NAMCAS (tour guide) / community mobiliser	namcas@yahoo.com
7	Tavis Weekes	Environment worker, Department of Environment	weekest@gov.ms
8	Clement Meade	Director, Land Management, Physical Planning Unit (PPU) / Land Surveys	meadecj@gov.ms
9	Hawwa Hassan	Physical Planning Officer, Physical Planning Unit (PPU)	hassanh@gov.ms
10	Thiffanie Williams	Environment Officer, DOE	williamst@gov.ms
11	Kenneth Farrell	Carpenter/Taxi Driver	
12	Javiere Adams	Agriculture/Fisher	adamsj@gov.ms
13	Kenaud Ryan	R.E. Advisor, Montserrat Utilities Limited (MUL)	kenaud.ryan@mul.ms
14	John F. Howes (Captain)	Fisherman	SAFE500@hotmail.com
15	Norman Ryan	Supermarket, Cudjoe Head	
16	Roderick Stewart	Director, Montserrat Volcano Observatory	rod@mvo.ms
17	Albrun Semper	Red Cross	sempera@gov.ms
18	Tracy Lewis	Environment Officer, Department of Environment	lewist@gov.ms
19	Raymond Allen		
Saturday 24th February 2018 - Handover Ceremony			
1	David Osborne (Minister of Agriculture)	Ministry Agriculture Trade Lands Housing & Environment (MATLHE)	491 2075
2	Daphne Cassell (Permanent Secretary, Office of the Premier)	The Office of the Premiere	491 3378
3	Melissa O'Garro (Director, Ministry of Agriculture)	MATLHE	491 3529

4	Alwyn Ponteen (Chief Fisheries and Ocean Governance Officer)	Fisheries Division	496 1996
5	John Howes	Fisher/Tour Guide	491 5229
6	Albrun Semper	Red Cross	491 7379
7	Mary Allen	Retiree/Farmer	
8	Norman Ryan	Private Sector	491 4626
9	Doron Cassell (Student)	Montserrat Community College	491 7654
10	Kenneth Farrell	Carpenter/Taxi & Bus Operator	4964336
11	Norman Cassell	Namcas Enterprises	492 1672
12	Herman Sargeant (Manager)	Radio Montserrat	491 2885
13	Shauna Harley	Public Relations Officer	491 2066
14	McDonald Government Information Unit	Audio/Videographer Lana	
15	Bennet Roach	Montserrat Reporter	491 2233

Appendix 5: Slide Presentations for Anguilla and Montserrat
P3DM Exercises

1. Overview of the vulnerability assessment under the Darwin Plus Climate Change Adaptation in the Fisheries of Anguilla and Montserrat Project
2. Participatory three-dimensional modelling (P3DM) process and key steps
3. Creating a legend for the three-dimensional model