UPDATED DRAFT

GRENADA SARGASSUM ADAPTIVE MANAGEMENT STRATEGY (SAMS)

VOLUME 2: ACTION APPENDICES

April 2023

SargAdapt
Adapting to a new reality: Managing responses to influxes of sargassum seaweed in the Eastern Caribbean as ecosystem hazards and opportunities

CARIBBEAN BIODIVERSITY FUND

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Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection
based on a decision of the German Bundestag

IKI INTERNATIONAL CLIMATE INITIATIVE
KFW

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CERMES. 2023. Updated Draft Grenada Sargassum Adaptive Management Strategy. Volume 2: Action Appendices. University of the West Indies (UWI) Centre for Resource Management and Environmental Studies (CERMES), Barbados.

Photo credit:

Top: Left- Now Grenada, right- Davon Baker

Bottom: Left- Davon Baker, right- Reginald Joseph

PART A:
COUNTRY SPECIFIC

1 INSTITUTIONAL ARRANGEMENTS

1.1 AUTHORITY

This section lists some existing documentation which provides the framework for sargassum management in Grenada.

- Abatement of Litter Act (1973)
- Act No. 23 Physical Planning and Development Control Act (2016)
- Bathing Places Act (1903)
- Birds and Other Wildlife Act (1964)
- Coastal Zone Management Act (2019)
- Draft Climate Resilience and Environment Bill
- Emergency Powers Act No. 17 (1987)
- Environmental Levy Act (1997)
- Fisheries Act, 1986, as amended by the Fisheries (Amendment) Act of 1999
- Fisheries (Amendment) Regulations (2001)
- Fisheries and Fisheries Products Regulations (1999)
- Fisheries (Marine Protected Areas) Regulations (2001)
- Fisheries Regulations (1987)
- Forest, Soil and Water Conservation Act (1947)
- Marine Insurance Act (1960)
- National Disaster (Emergency Powers) Act (1984) Revised (1990)
- National Park and Protected Areas Act (1991)
- Oil in Navigable Waters Act Cap 206
- Planning and Development Control Act (2002)
- Public Health Act, 1925, as amended by Act No. 40 of 1981
- Regional Disaster Vulnerability Reduction Project Loan Authorisation Act (2011)
- Solid Waste Management Act (1995)
- Territorial Sea and Marine Boundaries Act (1989)
- Town and Country Planning Act (2002)
- Waste Management Act (2001)
- Wild Animals and Birds Sanctuary Act (1963)

Note: This list reflects the national legislation enacted before the publishing date of this document.

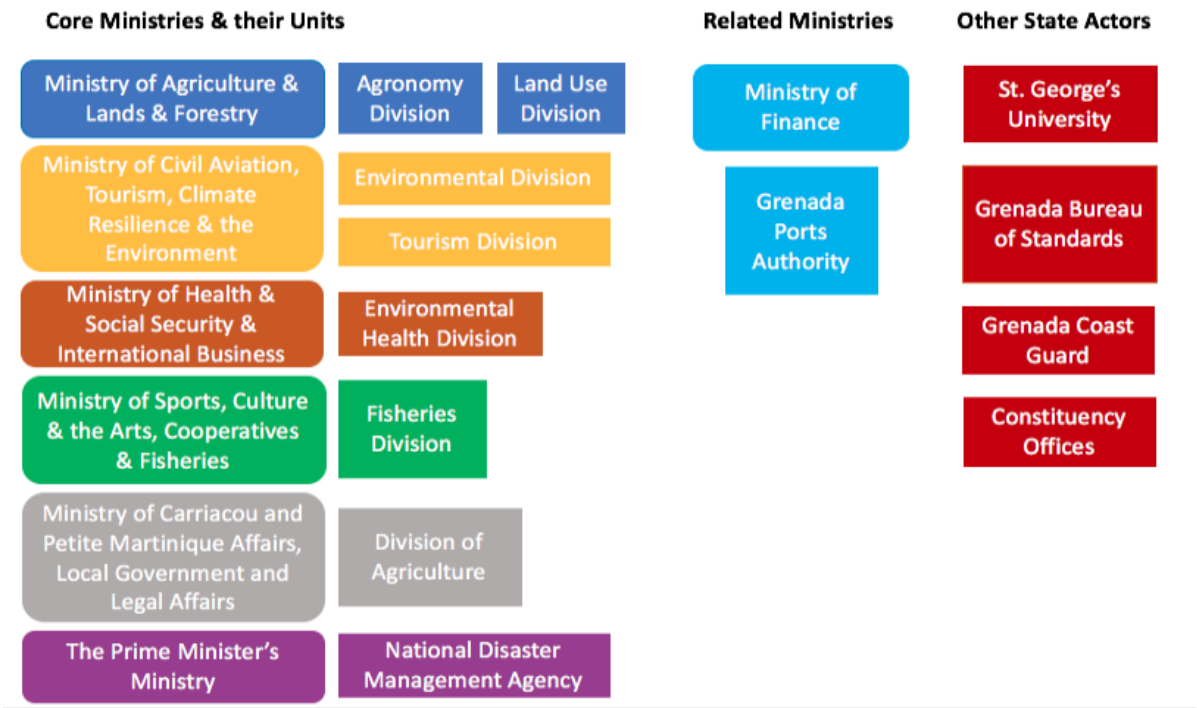
1.2 INSTITUTIONS

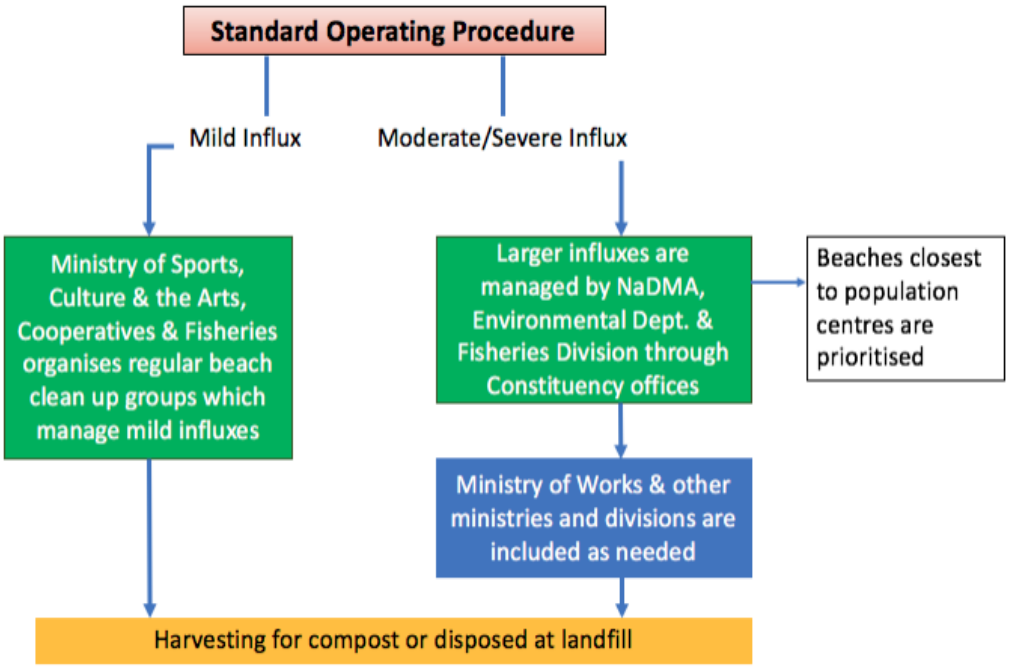
In the 2021 draft SAMS it was said that Grenada's sargassum management arrangements were aimed at following a CRFM Technical Advisory Document setting out a generic regional protocol. Paraphrasing, it said that a committee shall be established for the management of issues related to deposited sargassum, with the National Disaster Management Agency (NaDMA) as the lead agency. As issues associated with the management of Sargassum encompasses the main responsibilities of NaDMA, the Environment and the Fisheries Divisions have also been identified as co-leads. This is a problem that has affected coasts in the past and although the phenomenon has occurred, the quantity of deposited material has increased considerably in the last few years. It is recommended that the members of the Committee should include the following agencies, groups or entities:

- NaDMA - as lead agency on behalf of the State, utilizing funds allocated by Government in the annual [estimates of expenditure of total budget].

- Environment Division (co-lead) - as lead agency that would supervise most pre and post disaster management, utilizing funds allocated by Government in the annual [estimates of expenditure of total budget].
- Fisheries Division (co-lead)
- Physical Planning
- Agronomy Division
- Environmental Health Division
- Grenada Ports Authority
- Ministry of Tourism, Civil Aviation and Culture
- Grenada Tourism Authority
- Royal Grenada Police Force
- Grenada Solid Waste Management Authority
- St. George's University
- Ministry of Works, Physical Development and Public Utilities o Ministry of Carriacou and Petite Martinique Affairs
- Government Information Services

In 2023 it appears as if the institutional arrangements are malfunctioning and mostly ad hoc responses to influxes prevail. The 2021 draft SAMS attempted to illustrate the actual arrangements at that time in the following figures:





1.3 Roles of some stakeholders in management

Management institutions can comprise a mix of actors and roles. The table provides a limited example such as can be constructed following stakeholder identification and analysis.

Fisherfolk or similar coastal area users	General public or civil society organisations	Sargassum authority (e.g. Fisheries Division)
Attend, contribute, participate in the information and education sessions Provide use of boats and seine nets towards the cleanup of offshore areas Participate actively in beach cleanups. Form fisher groups specifically to assist in the beach cleanups	Attend, contribute, participate in the information and education session Identify groups and clubs to sign up for the volunteer beach clean- up sessions. Promote the formation of new clubs and help strengthen weak groups.	Ensure project structure is well defined and in place Discuss and help plan beach clean- up activities with the communities Inform the communities of ecological advantages of sargassum (climate adaptation, sustainable & innovative project opportunities)

Fisherfolk or similar coastal area users	General public or civil society organisations	Sargassum authority (e.g. Fisheries Division)
Report location and possible size of Sargassum sightings at sea Promote the importance of good practices when removing sargassum	Provide support and volunteer to ensure project is a success Share information on the project with individuals and households Ensure the safety of project assets – tools, equipment, supplies Ensure cleanup is done thoroughly and diligently Encourage innovation to create sustainable livelihoods among community, specifically the youth	Ensure communities have the information, supplies, equipment to carry out the tasks at hand. Carry out monitoring and evaluation of project processes and procedures to ensure compliance with funding agency Ensure proper utilization and allocation of resources Work with community to encourage innovation, research and development to create sustainability after end of project

(Examples adapted from Sealys and Felix (2017))

2 MONETARY MATTERS

Line ministries, statutory corporations, non-governmental organisations and private sector managers and financial staff will have several different ways of presenting and analysing sargassum-related costs and earnings. It is not suggested that there should be a standard format, but there should be a simple means of estimating equivalence in order to easily determine and compare the costs and benefits of various operations at whatever scale is appropriate. The figures given below are entirely fictitious, but illustrate the kinds of information required.

EXAMPLES OF VALUE TYPES	AUTHORITY FOR VALUE ESTIMATE	UNITS AND NOTES	VALUE (EC)
Cane loader rental	Ministry of Agriculture	Average hourly rate	250.00/hr
Beach restoration	CZMU	Estimated contractor fee	1,300.00/day
Biofuel production value	Energy Division	From xx biogas digester	6,500/ton wet weight
Decline in fish harvest	Fisheries Division	Based on ex-vessel price	1,000,000.00/ season

For a more thorough treatment see the journal article:

Rodríguez-Martínez, R.E., Torres-Conde, E.G. and Jordán-Dahlgren, E., 2023. Pelagic Sargassum cleanup cost in Mexico. Ocean & Coastal Management, 237, p.106542.

3 KEY SARGASSUM CONTACTS

Key personnel of state and non-state entities involved in sargassum management and research:

NAME	POST	ORGANISATION	EMAIL	PHONE
Aria St. Louis	Head of Division	Environmental Division	environment.sec@gmail.com	1 (473) 440-0366
Clare Morrall	Professor	St. George's University	cmorrall@sgu.edu	1(473) 444-4175 ext.3360
Justin Rennie	Chief Fisheries Officer	Fisheries Division	justinar6019@gmail.com	1(473) 440-3814

This table should be expanded and updated to include other sectors and actors (public sector, private sector and civil society) such as renewable energy, tourism, coastal management, etc.

4 SARGASSUM EXPOSURE AND VULNERABILITY ASSESSMENT

It must be noted that generally, there has been little systematic monitoring of sargassum inundations and therefore lack of data on spatial and temporal distribution. However, under the Caribbean Biodiversity Fund (CBF) project *'Adapting to a new reality: managing responses to influxes of sargassum seaweed in the Eastern Caribbean' (SargAdapt),* hazard risk assessments of sargassum inundations were created using a combination of the tools of hazard risk response and spatial planning[1].

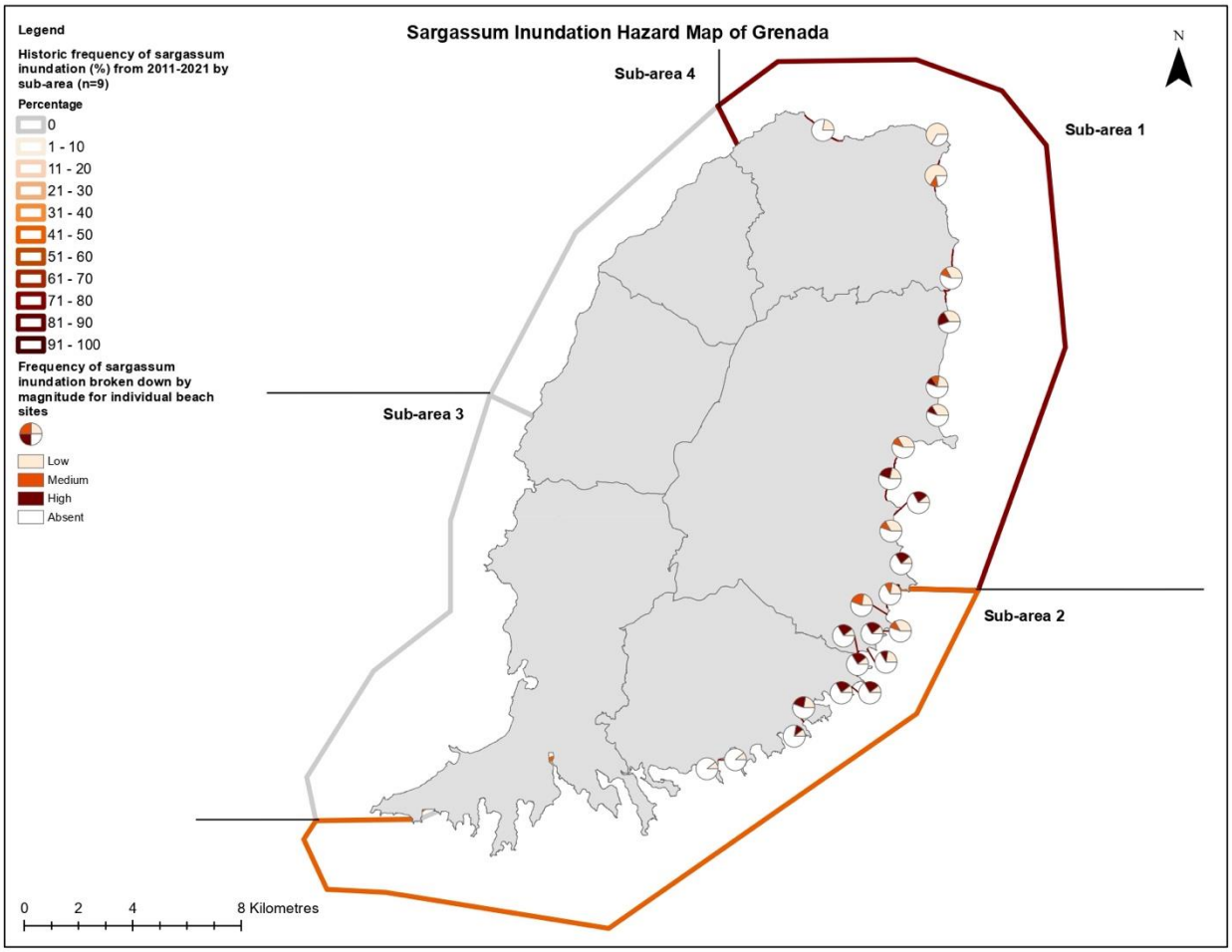
Sargassum inundations occur mainly on the southeast, east, northeast and north coasts of Grenada. Twenty-five (25) sites were identified as being prone to sargassum influxes in Grenada while five (5) sites were identified on Carriacou. For the study, four coastal zone sub-areas were delineated for Grenada, since there is no existing framework with coastal sub-regions. The levels of sargassum inundations for these four coastal sub-areas and are shown in the map below. The findings from the study revealed based on available Google Earth imagery from 2010 to 2021, beaches exposed to sargassum inundation make up 15km (12%) of the coastline of Grenada. Only sub-area 1 and sub-area 2 have been exposed to sargassum inundations over the years.

The frequency and magnitude of inundations varies between the two sub-areas, with sub-area 1 experiencing sargassum inundation 78% of the time while sub-area 2 experiences sargassum inundation

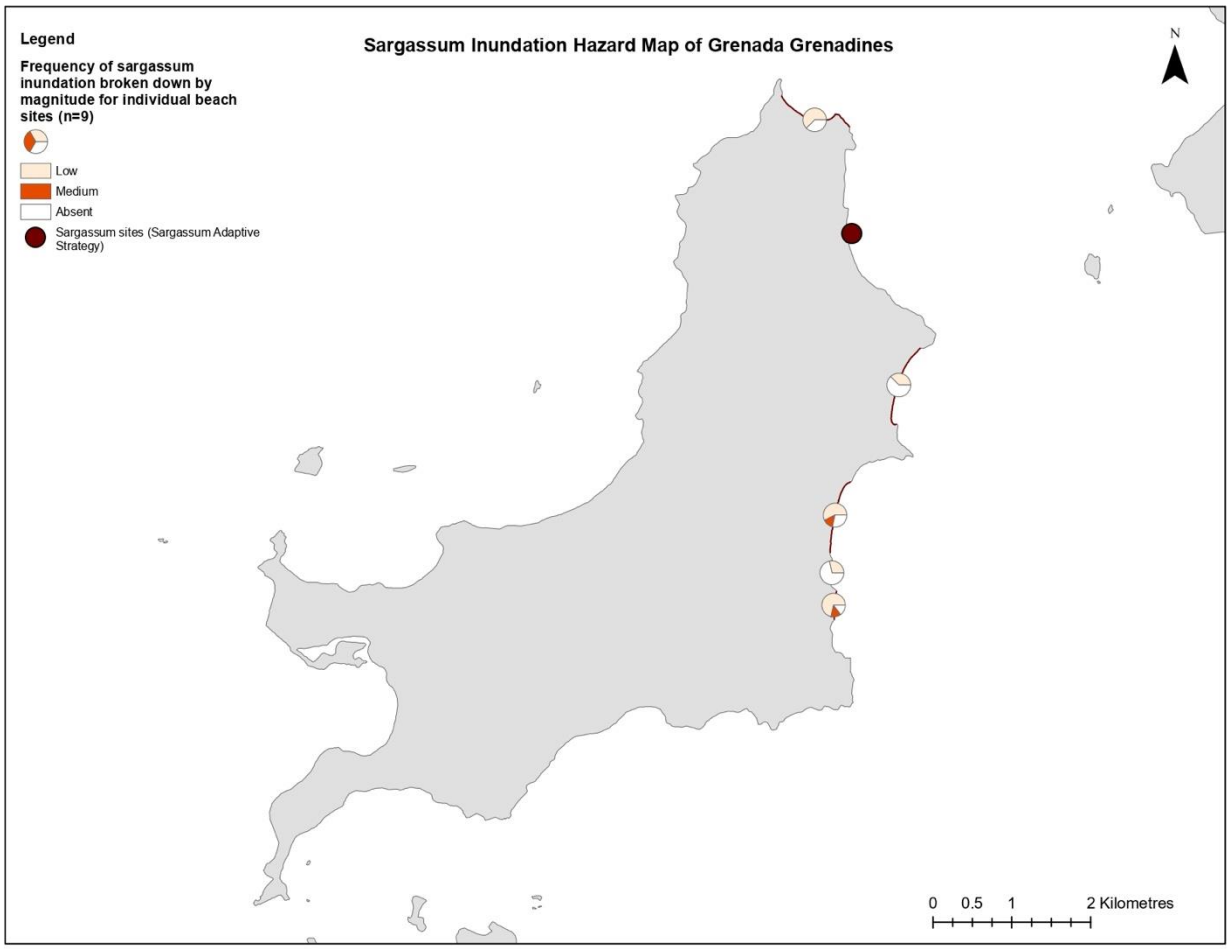
[1] Degia. A.K., M. Small, H.A. Oxenford, 2022. Applying Hazard Risk Assessment and Spatial Planning Tools to Sargassum Inundations in the Eastern Caribbean Small Island States as a basis for improving response. SargAdapt Project Report, FINAL DRAFT. Centre for Resource Management and Environmental Studies (CERMES), University of the West Indies, Cave Hill, Barbados, 72pp

44% of the time. Similar to sub-area 1, Carriacou experiences sargassum 78% of the time. However, exposed beaches in Carriacou mostly experience lower frequency and magnitude of sargassum inundations.

To view the entire Project Report visit:
https://iweco.org/sites/default/files/202204/IWEco_Project_C2_Final_Report_Applying_Hazard_Risk_Assessment_and_Spatial_Planning_Tools_to_Sargassum_Inundations_in_the_Eastern_Cbean.pdf



Map of St Grenada showing the level of sargassum inundations within the four coastal sub-areas. (Source: Degia et al. 2022)

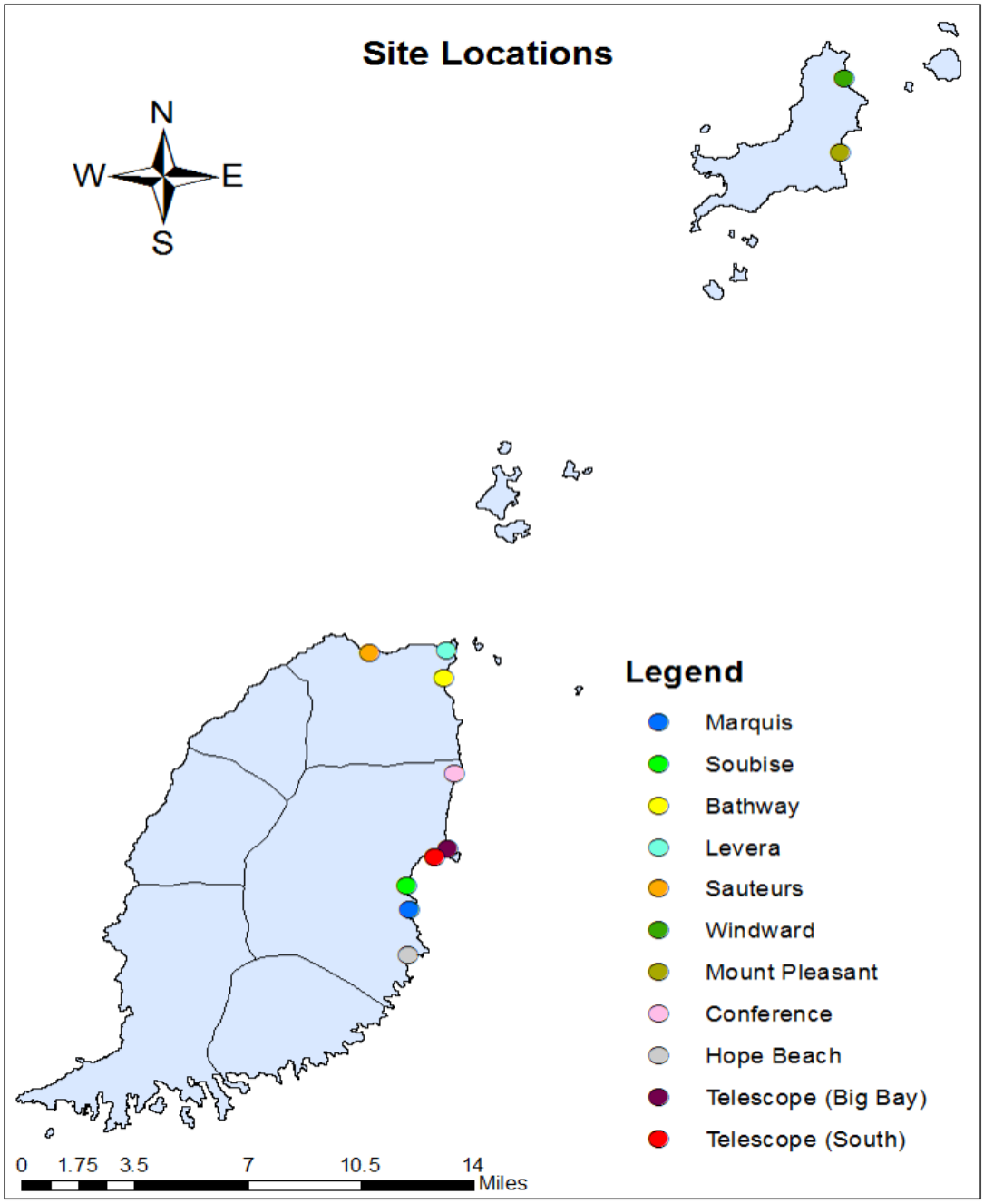


Map showing the level of sargassum inundations at exposed beaches on Carriacou. Source: Degia et al. 2022

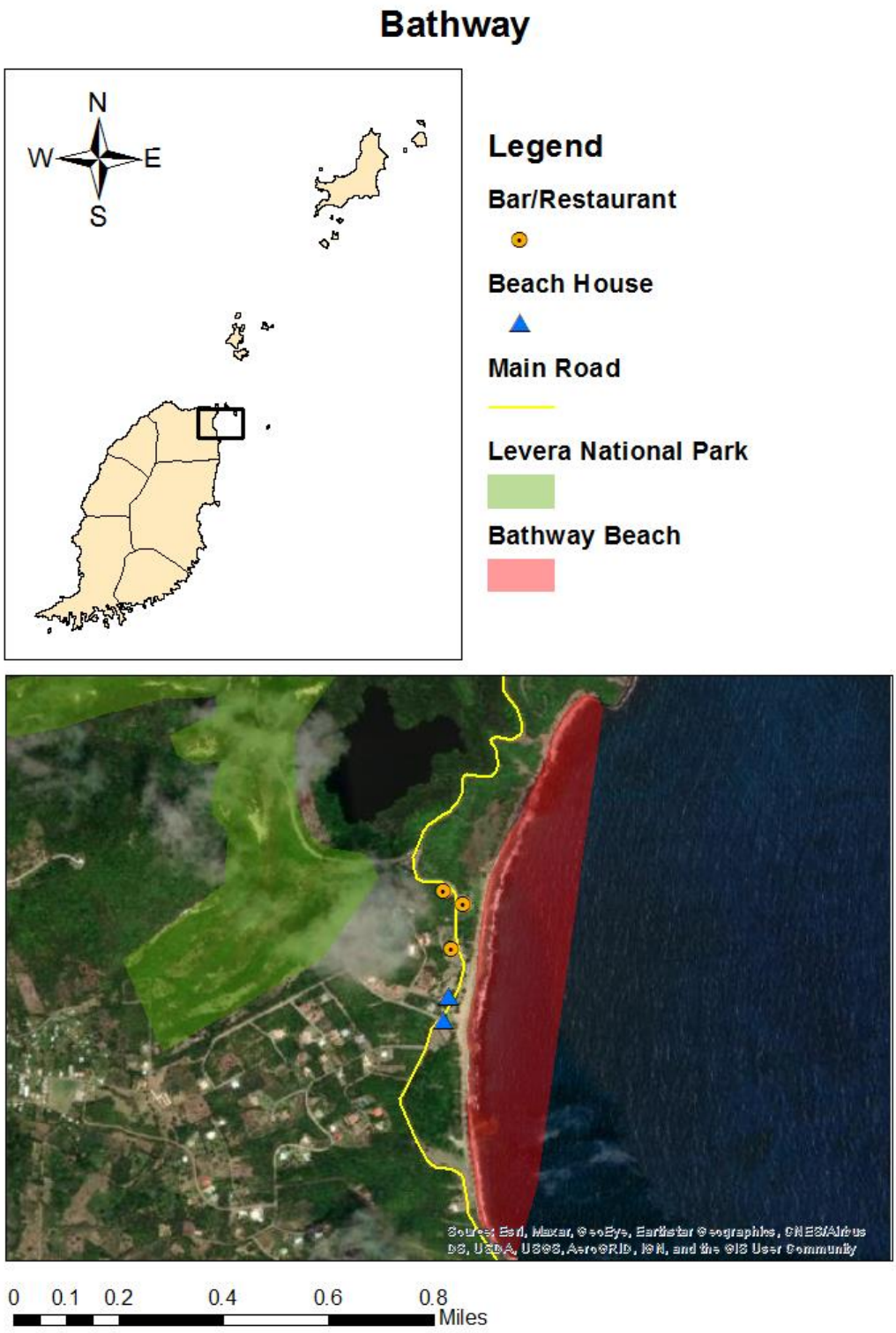
During the rapid scoping assessment exercise, 12 sites (10 on Grenada and 2 on Carriacou) were prioritized, based on their social and ecological characteristics and the severity of impacts in the past. This assessment provides useful information to support the design of targeted interventions for maximum impact. This is needed to inform decision making by assessing the most suitable interventions for each site to increase resilience and reduce vulnerability.

5 LOCATION PROFILES OF SARGASSUM STRANDING SITES

The twelve sites prioritized on Grenada and Carriacou are shown in the map below. Key physical, social and ecological features were identified for each site and a historical matrix was created to identify past sargassum impacts and responses.



5.1 BATHWAY


Bathway
N
W
E
S
Legend
Bar/Restaurant
Beach House
Main Road
Levera National Park
Bathway Beach
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
0 0.1 0.2 0.4 0.6 0.8
Miles

SELECT SOCIAL KEY FEATURES	SELECT ECOLOGICAL KEY FEATURES
• Beach • Restaurants • Bars • Shops • Cottages • Guest Houses • Seasonal rentals • Homes	The beach has coastal vegetation along its banks and a prominent deteriorating reef bar near shore that protected the shoreline in the past but is currently eroding.

DATE	SUMMARY OF IMPACTS	SUMMARY OF RESPONSES
2017-2018	Acute accumulation	unknown
2019	Acute accumulation	unknown
2020	Acute accumulation	unknown

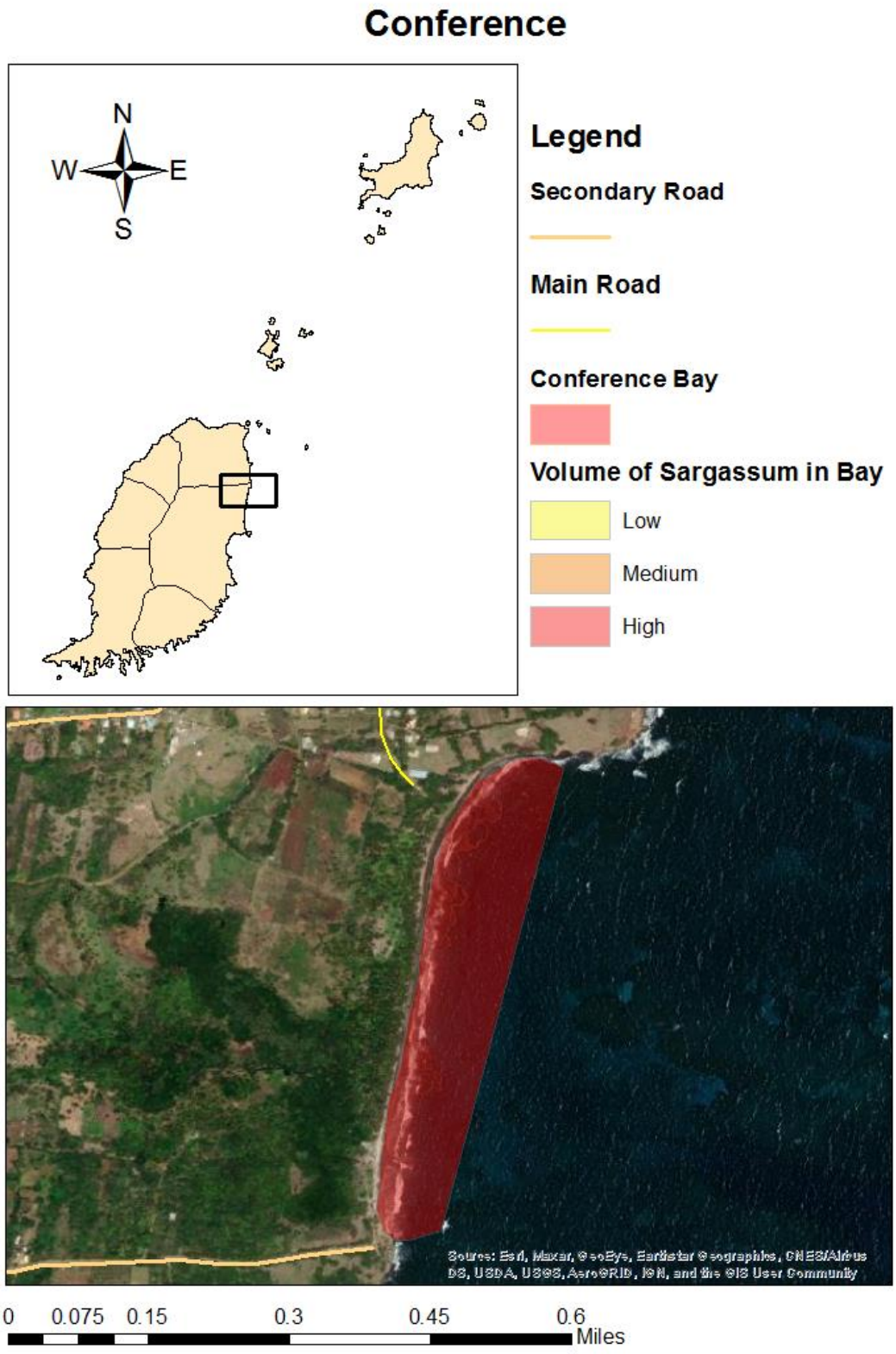
Vulnerability factors	
Geophysical features	A stretch of beach area with vegetation along the shore which decreases in areas where houses are present and recreational gatherings occur.
Is there adequate access to the bay to facilitate clean-up efforts?	There is a road along the coast with various points of access
Is the area important for fishing? (Presence of fish market and other infrastructure e.g. Jetty)	None
How close is the community to Bay?	The community (consisting of citizens by investment, returning nationals, small number of locals and immigrants) is close to the Bay.
Proximity of bay to schools and other infrastructure (e.g. polyclinics etc.).	They are within 80-100 metre radius of the bay.
Volume of sargassum during scoping assessment	Very minimal along the shore and in the water with no scent
Volume of sargassum historically (2011 – present)	There has been heavy build up with the characteristic pungent smell in the past
Is the beach heavily used by locals?	Yes, for recreation and livelihoods
Is the beach heavily used for tourism?	Yes, relatively
Evidence of resilience	
Is there evidence of community efforts to clean-up?	Yes, with community groups
Is there evidence of community efforts to use sargassum?	None

Presence of church and community groups that advocate for government assistance?	Ocean Spirits/ Specto

Photo credit: Top left - TripAdvisor review by NV_KYL (2015); Top right – sourced from instagram @isahjabjab (2019)

Bottom – Sourced from Instagram @sightofsavage (2021)

5.2 CONFERENCE



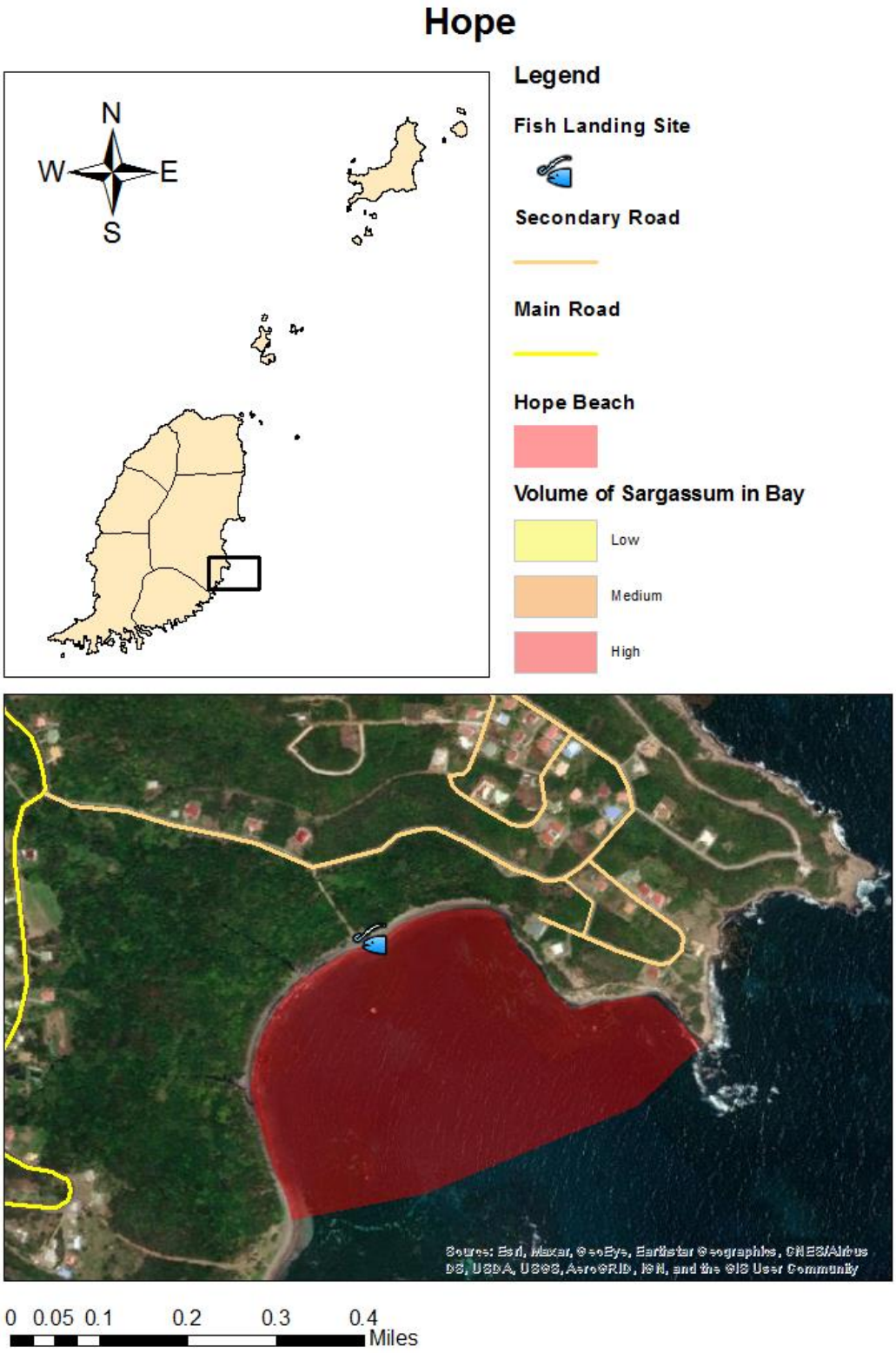
SELECT SOCIAL KEY FEATURES	SELECT ECOLOGICAL KEY FEATURES
• Homes	The beach has thick coastal vegetation along its bank.

DATE	SUMMARY OF IMPACTS	SUMMARY OF RESPONSES
2017- 2018	Acute accumulation	unknown
2019	Acute accumulation	unknown
2020	Acute accumulation	unknown

Vulnerability factors	
Geophysical features	Long stretch of beach with rocky terrain and vegetation along the shore.
Is there adequate access to the bay to facilitate clean-up efforts?	There is an access road that takes you close to the beach
Is the area important for fishing? (Presence of fish market and other infrastructure e.g. Jetty)	No
How close is the community to Bay?	
Proximity of bay to schools and other infrastructure (e.g. polyclinics etc.).	No
Volume of sargassum during scoping assessment	Very minimal along the shore
Volume of sargassum historically (2011 – present)	Heavy influxes reported.
Is the beach heavily used by locals?	Yes
Is the beach heavily used for tourism?	No
Evidence of resilience	
Is there evidence of community efforts to clean-up?	No
Is there evidence of community efforts to use sargassum?	No
Presence of church and community groups that advocate for government assistance?	No

Photo credit: Reginald Joseph (2021)

5.3 Hope Beach



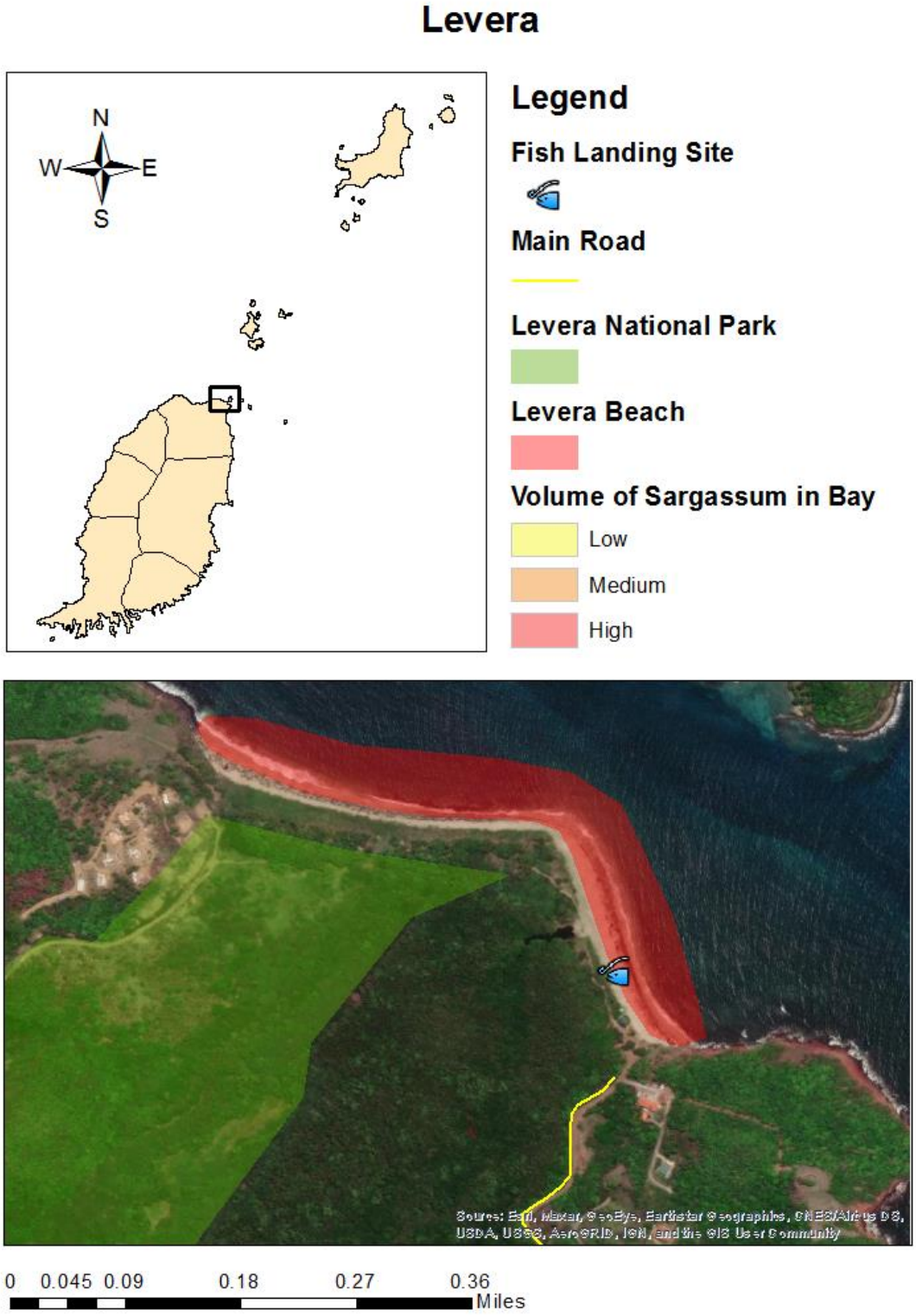
SELECT SOCIAL KEY FEATURES	SELECT ECOLOGICAL KEY FEATURES
• Homes • Beach • Playground • Tertiary landing site	The beach has coastal vegetation along its bank.

DATE	SUMMARY OF IMPACTS	SUMMARY OF RESPONSES
2017/8	Acute accumulation	unknown
2019	Acute accumulation	unknown
2020	Acute accumulation	unknown

Vulnerability factors	
Geophysical features	There is a very rocky terrain with vegetation along the shore.
Is there adequate access to the bay to facilitate clean-up efforts?	There is an access road.
Is the area important for fishing? (Presence of fish market and other infrastructure e.g. Jetty)	None
How close is the community to Bay?	Close
Proximity of bay to schools and other infrastructure (e.g. polyclinics etc.).	Not close
Volume of sargassum during scoping assessment	Very minimal along the shore
Volume of sargassum historically (2011 – present)	Heavy influxes reported.
Is the beach heavily used by locals?	Yes
Is the beach heavily used for tourism?	No
Evidence of resilience	
Is there evidence of community efforts to clean-up?	No
Is there evidence of community efforts to use sargassum?	No
Presence of church and community groups that advocate for government assistance?	No

Photo credit: Sourced from Instagram; left - @svlivethedream (2021), right - @peppthepup (2021)

5.4 LEVERA


Levera
N
W
E
S
Legend
Fish Landing Site
Main Road
Levera National Park
Levera Beach
Volume of Sargassum in Bay
Low
Medium
High
0 0.045 0.09 0.18 0.27 0.36
Miles

SELECT SOCIAL KEY FEATURES	SELECT ECOLOGICAL KEY FEATURES
• Beaches • Fish landing site • Tourist Attraction • Recreation Area	The beach consists of white sand with vegetation along the banks. The site is also a famous nesting site of the endangered Leatherback Turtle.

DATE	SUMMARY OF IMPACTS	SUMMARY OF RESPONSES
2017/8	Acute accumulation	unknown
2019	Acute accumulation	unknown
2020	Acute accumulation	unknown

Vulnerability factors	
Geophysical features	Generally long beach with vegetation along the shores and a lake inland.
Is there adequate access to the bay to facilitate clean-up efforts?	There is road access to the beach.
Is the area important for fishing? (Presence of fish market and other infrastructure e.g. Jetty)	Fishers land and store their boats on or near shore, but there is no infrastructure.
How close is the community to Bay?	The Beach is not very close to the community.
Proximity of bay to schools and other infrastructure (e.g. polyclinics etc.).	None nearby
Volume of sargassum during scoping assessment	Very minimal amounts visible during scoping.
Volume of sargassum historically (2011 – present)	There has been heavy build up with the characteristic pungent smell in the past
Is the beach heavily used by locals?	Yes, for recreation and livelihoods
Is the beach heavily used for tourism?	Yes
Evidence of resilience	
Is there evidence of community efforts to clean-up?	None
Is there evidence of community efforts to use sargassum?	None
Presence of church and community groups that advocate for government assistance?	SPECTO and Ocean Spirits

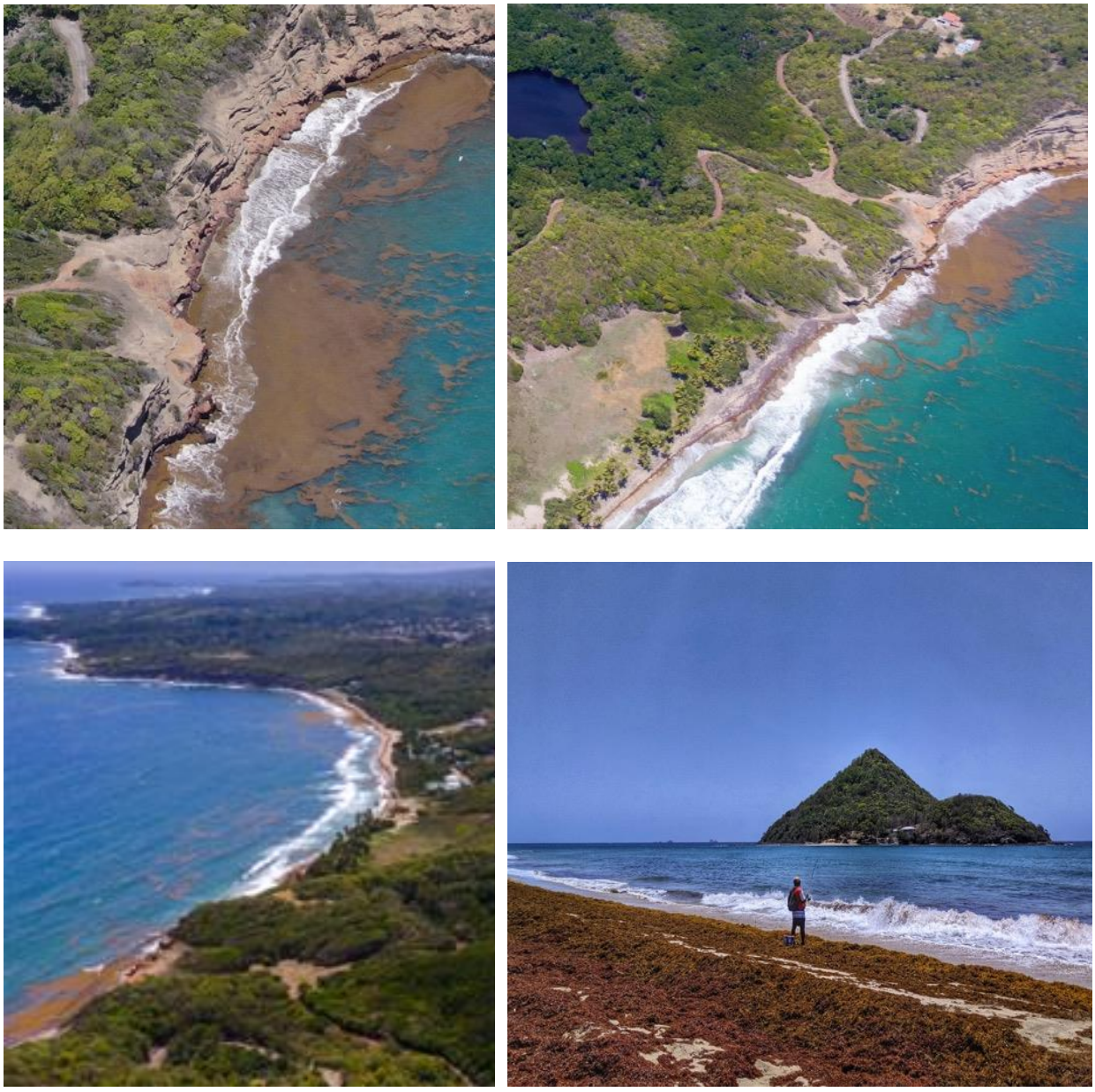
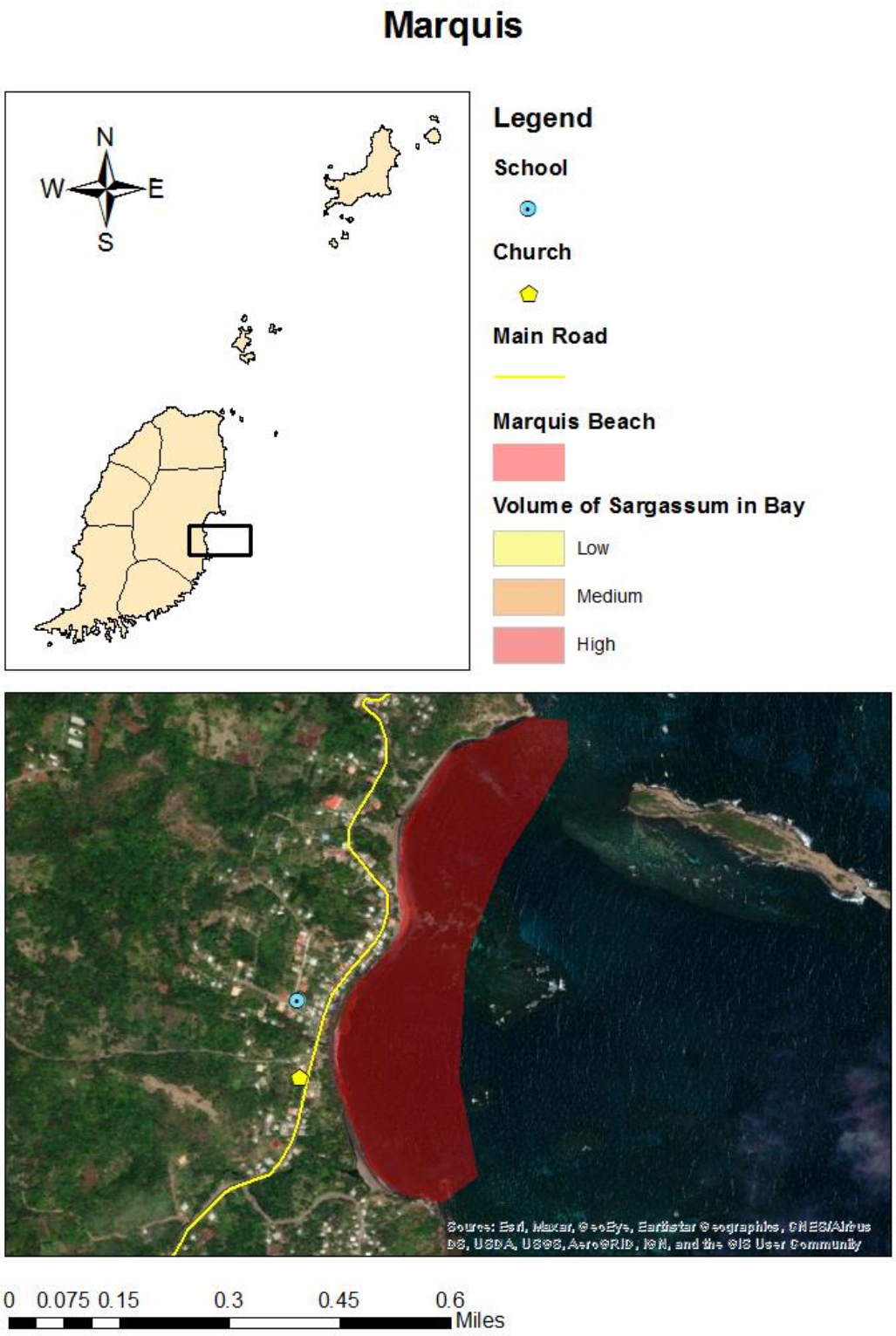


Photo credit: Top right & left -Reginald Joseph (2021)

Bottom: left – Reginald Joseph (2021), right – Candice Ramkissoon (2020)

5.5 MARQUIS


Marquis
N
W
E
S
Legend
School
Church
Main Road
Marquis Beach
Volume of Sargassum in Bay
Low
Medium
High
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
0 0.075 0.15 0.3 0.45 0.6
Miles

SELECT SOCIAL KEY FEATURES	SELECT ECOLOGICAL KEY FEATURES
• Homes • Shops • Food stalls • Fish landing site • Roadside vendors • Craft center	The beach has sparse coastal vegetation along its sandy bank.

DATE	SUMMARY OF IMPACTS	SUMMARY OF RESPONSES
2017/8	Acute accumulation Coastal drained blocked	Sargassum clean up using heavy machinery
2019	Acute accumulation	2 cases of heavy influx
2020	Acute accumulation Coastal drained blocked	2 cases of heavy influx

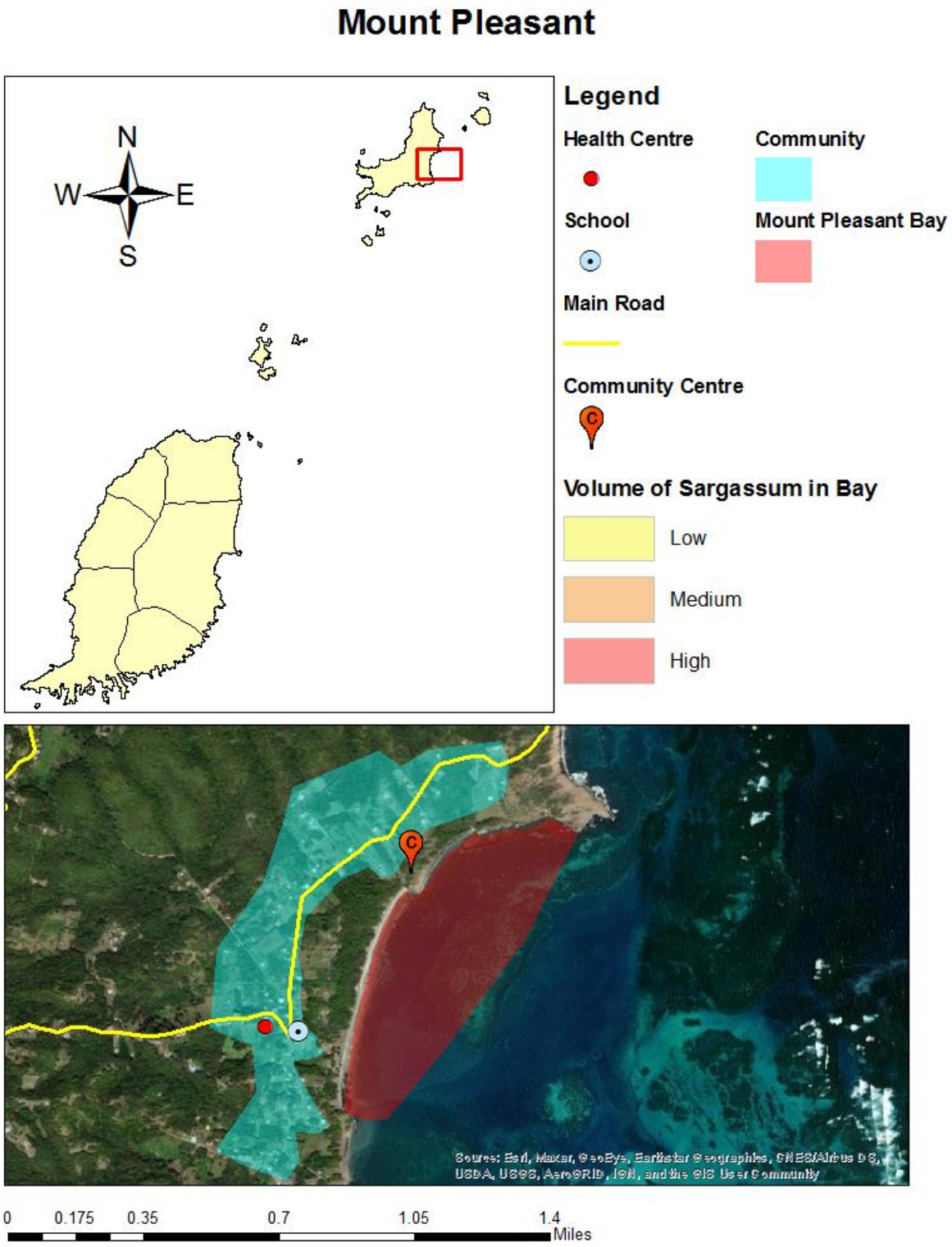
Vulnerability factors	
Geophysical features	Very rocky terrain with vegetation along the shore.
Is there adequate access to the bay to facilitate clean-up efforts?	There is an access road.
Is the area important for fishing? (Presence of fish market and other infrastructure e.g. Jetty)	None
How close is the community to Bay?	Very close
Proximity of bay to schools and other infrastructure (e.g. polyclinics etc.).	Preschool, Churches 100-250 metre radius
Volume of sargassum during scoping assessment	Very minimal along the shore
Volume of sargassum historically (2011 – present)	Heavy influxes reported.
Is the beach heavily used by locals?	Yes - livelihoods
Is the beach heavily used for tourism?	No
Evidence of resilience	
Is there evidence of community efforts to clean-up?	No
Is there evidence of community efforts to use sargassum?	No
Presence of church and community groups that advocate for government assistance?	Government Crew with tractors

Photo credit: top – sourced from Instagram @soucouyants (2018)

Middle – Neema Ramlogan (2018)

Bottom – Excavator tracks leading down to the beach. Andre Joseph-Witzig (2018)

5.6 Mount Pleasant



SELECT SOCIAL KEY FEATURES	SELECT ECOLOGICAL KEY FEATURES
• Recreational beach • Primary School (Mt. Pleasant Government School) • District Clinic • Harbour Light Christian Academy • Harbour Light of the Windwards Radio Station	Located in the Mt. Pleasant Bay, mix white & black sandy lined with coastal vegetation (heavily eroded). The structure traps sargassum in Tarleton point and the old fort area where it decomposes due to its slight curve

DATE	SUMMARY OF IMPACTS	SUMMARY OF RESPONSES
2018	Acute accumulation	Tractor was used to clear via government
2019	Acute accumulation	None
2020	Acute accumulation	None

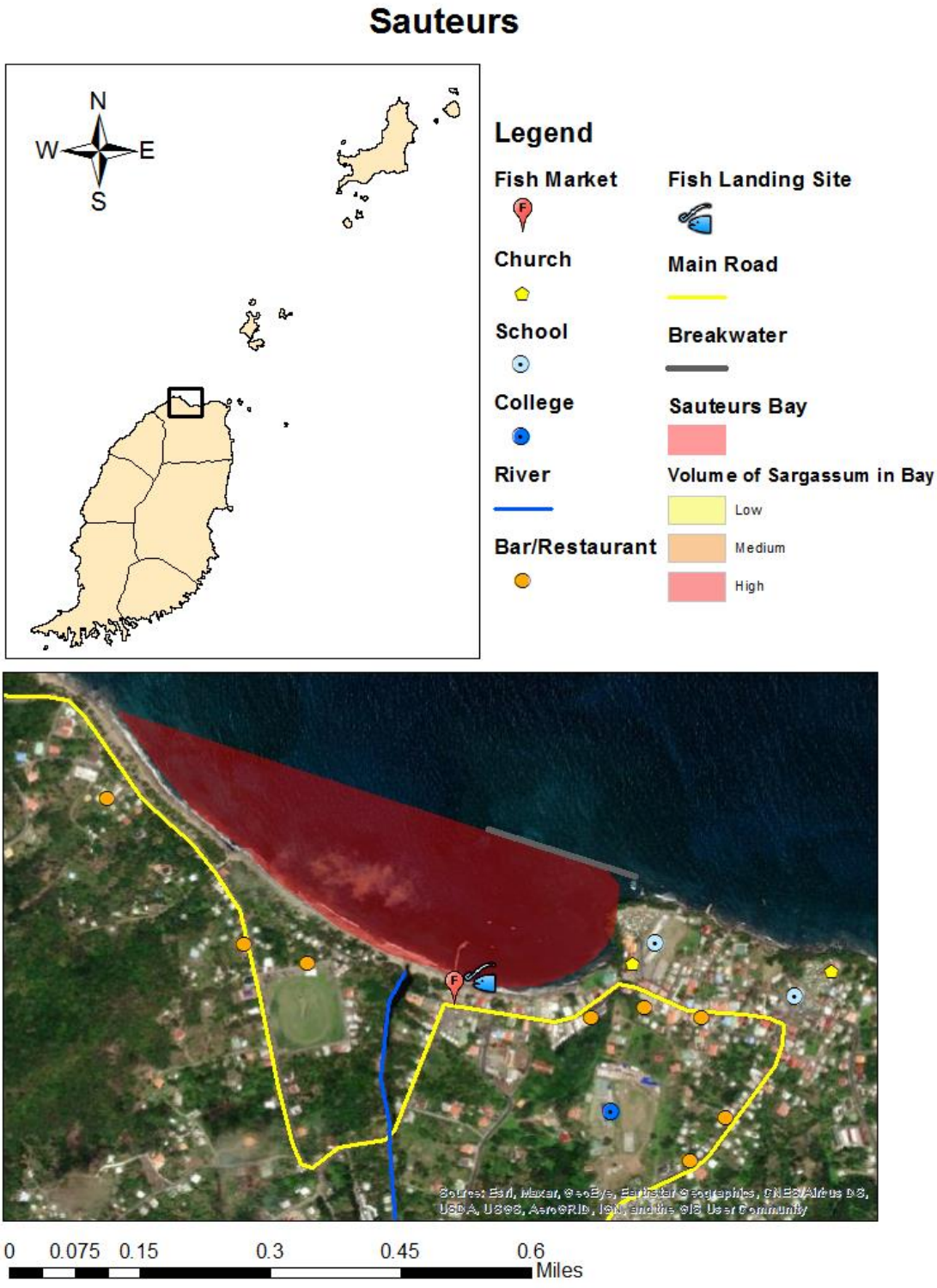
Vulnerability factors	
Geophysical features	Long bay with a point
Is there adequate access to the bay to facilitate clean-up efforts?	There is primary road access to the bay at two points with secondary access at various points. Point area is believed to be private land
Is the area important for fishing? (Presence of fish market and other infrastructure e.g. Jetty)	Docking of boats for fishers in the community
How close is the community to Bay?	The community is in very close proximity to the bay and are affected by the putrid scent.
Proximity of bay to schools and other infrastructure (e.g. polyclinics etc.).	There is 1 church, one clinic, and 2 schools within a 150 metre radius of the bay.
Volume of sargassum during scoping assessment	Very minimal
Volume of sargassum historically (2011 – present)	The two ends of the bay are areas know for acute accumulation when there is an influx of sargassum. The length of the beach is also usually lined with sargassum.
Is the beach heavily used by locals?	Yes, for recreation and docking
Is the beach heavily used for tourism?	Kite surfing is the only tourism activity
Evidence of resilience	
Is there evidence of community efforts to clean-up?	In 2015, a local community group removed the Sargassum from the water and into the wharf with the use of rakes.
Is there evidence of community efforts to use sargassum?	2019 - attempts made to use as fertilizer, but they were unsuccessful and more research is needed.

	The seaweed is left on the wharf to dry and washed by the elements until they are ready for transport to the Orange Hill Research and Development Station in to turn into compose or taken to the landfill in Diamond.
Presence of church and community groups that advocate for government assistance?	Mt. Pleasant and Grand Bay Development Organisation (Uncertain of activity status)

Photo credit: Top - Kerwin Noel (2021)

Bottom – Davon Baker (2021)

5.7 SAUTEURS


Sauteurs
N
W
E
S
Legend
Fish Market
Fish Landing Site
Church
Main Road
School
Breakwater
College
Sauteurs Bay
River
Volume of Sargassum in Bay
Low
Bar/Restaurant
Medium
High
0
0.075
0.15
0.3
0.45
0.6
Miles

SELECT SOCIAL KEY FEATURES	SELECT ECOLOGICAL KEY FEATURES
• Beaches • Landing site • Fish Market • Bus Terminal • Shops • Restaurants • Break water system (failed)	The bay has is characterised by a curve at one end with break water structures which allow for build up along the shores when the influx is high. Sand lines the area from with coastal vegetation.

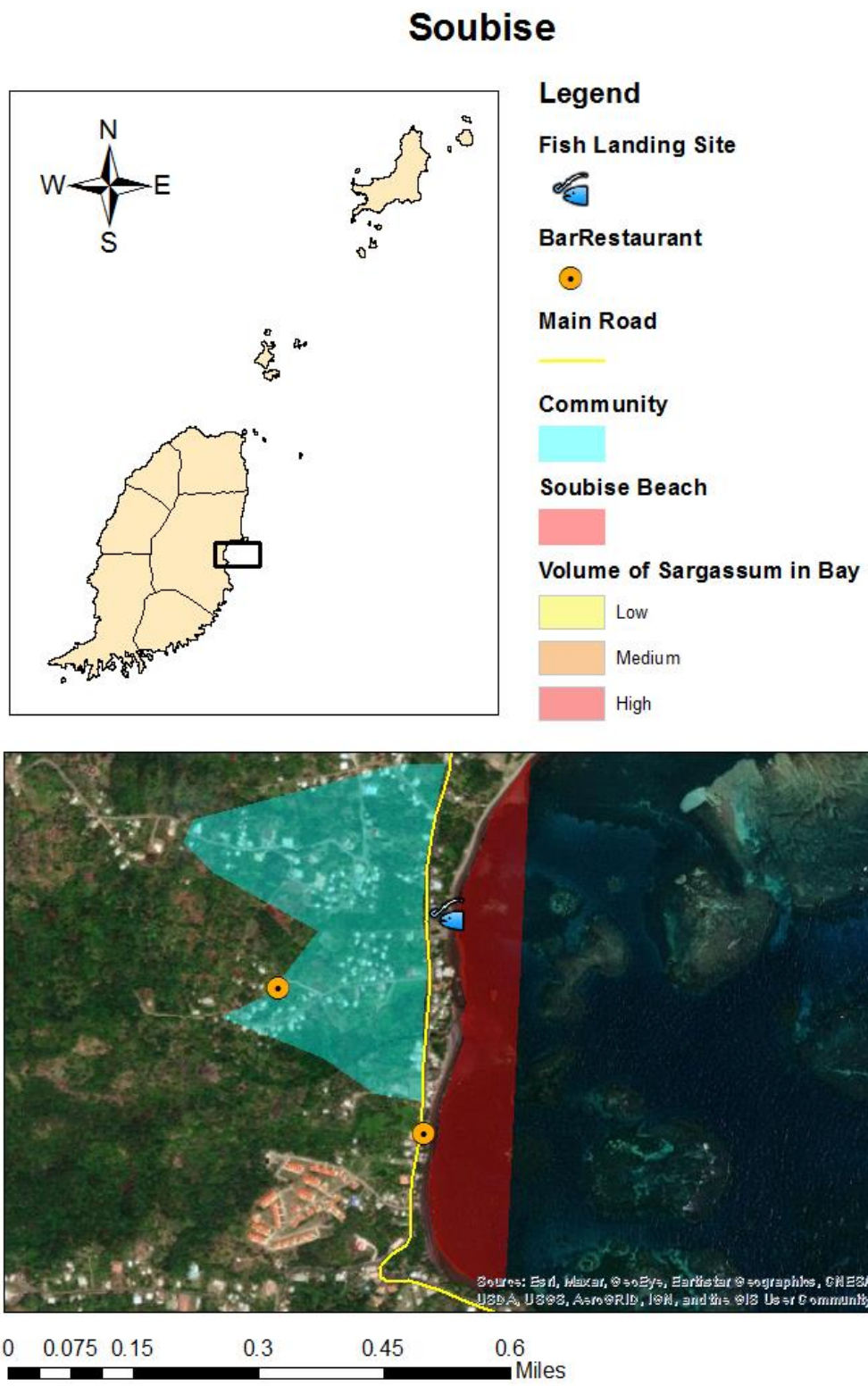
DATE	SUMMARY OF IMPACTS	SUMMARY OF RESPONSES
2017- 2018	Acute accumulation	unknown
2019	Acute accumulation	unknown
2020	Acute accumulation	unknown

Vulnerability factors	
Geophysical features	Long bay area with boats, shops and coastal vegetation
Is there adequate access to the bay to facilitate clean-up efforts?	There is a road along the coast along with various point of access
Is the area important for fishing? (Presence of fish market and other infrastructure e.g. Jetty)	A jetty and fish market is present
How close is the community to Bay?	The bay is within the main town of the parish and thus many businesses along with the rest of the community affected by the scent.
Proximity of bay to schools and other infrastructure (e.g. polyclinics etc.).	They are within 80-100 metre radius of the bay.
Volume of sargassum during scoping assessment	Very minimal along the shores and in the water with no scent
Volume of sargassum historically (2011 – present)	There has been heavy build up with the characteristic pungent smell in the past
Is the beach heavily used by locals?	Yes for recreation and livelihoods
Is the beach heavily used for tourism?	No
Evidence of resilience	
Is there evidence of community efforts to clean-up?	None

Photo credit: Top – Jesse Gill (2018)

Bottom – Petite Anse Hotel (2018)

5.8 SOUBISE


Soubise
N
W
E
S
Legend
Fish Landing Site
BarRestaurant
Main Road
Community
Soubise Beach
Volume of Sargassum in Bay
Low
Medium
High
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
0 0.075 0.15 0.3 0.45 0.6
Miles

SELECT SOCIAL KEY FEATURES	SELECT ECOLOGICAL KEY FEATURES
• Homes (most have been moved) • Shops • Food Stalls • Roadside vendors • Landing site	The bay area is lined with sparse vegetation and sand.

DATE	SUMMARY OF IMPACTS	SUMMARY OF RESPONSES
2017/8	Acute accumulation	Sargassum clean up response using heavy machinery: https://www.youtube.com/watch?v=it02bRNvoF0
2019	Acute accumulation	unknown
2020	Acute accumulation	unknown

Vulnerability factors	
Geophysical features	There is a very rocky terrain with vegetation along the shore
Is there adequate access to the bay to facilitate clean-up efforts?	The main road is along the bay area with multiple access points.
Is the area important for fishing? (Presence of fish market and other infrastructure e.g. Jetty)	Yes
How close is the community to Bay?	It is very close to the community (most of the families along the shores have been relocated due to encroachment of the sea)
Proximity of bay to schools and other infrastructure (e.g. polyclinics etc.).	Within 80-100metres
Volume of sargassum during scoping assessment	Very minimal amounts
Volume of sargassum historically (2011 – present)	Heavy influxes with multiple cases of damage
Is the beach heavily used by locals?	Yes for recreation and livelihoods
Is the beach heavily used for tourism?	no
Evidence of resilience	
Is there evidence of community efforts to clean-up?	No

Is there evidence of community efforts to use sargassum?	None
Presence of church and community groups that advocate for government assistance?	Government cleanup with tractors

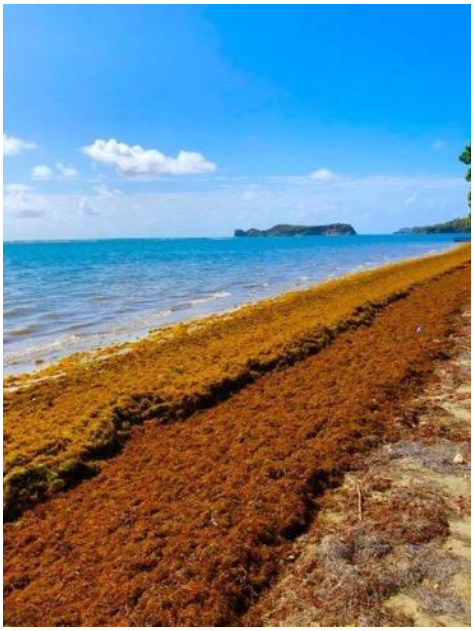
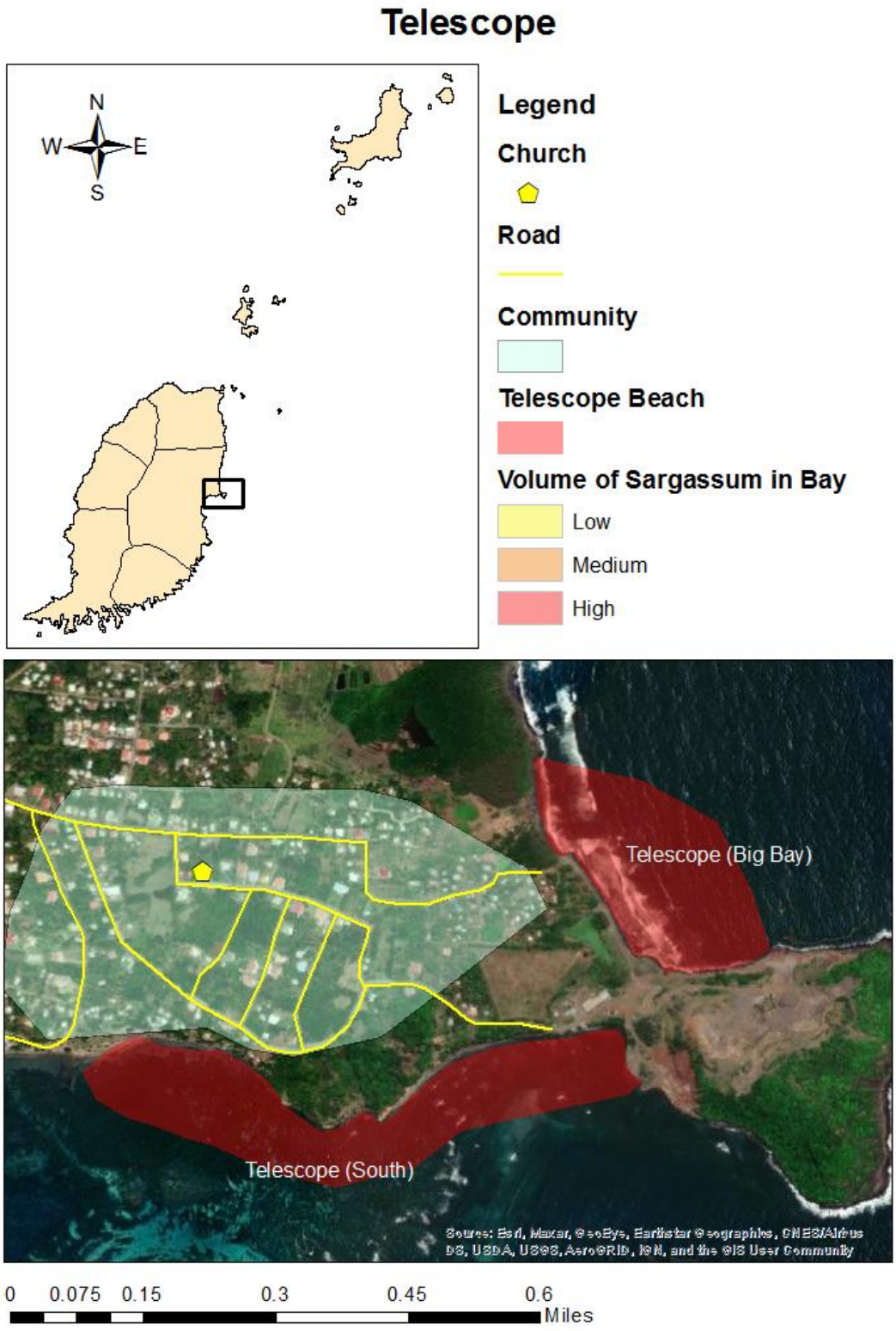


Photo credit: Top right– Now Grenada (2018); top left – Krisma McDonald-Moore (2021)

Bottom: Now Grenada (2020)

5.9 TELESCOPE (BIG BAY & SOUTH)



Telescope (Big Bay)

SELECT SOCIAL KEY FEATURES	SELECT ECOLOGICAL KEY FEATURES
• Homes	The beach has sparse coastal vegetation along its banks and a rocky terrain.

DATE	SUMMARY OF IMPACTS	SUMMARY OF RESPONSES
2017/8	Acute accumulation	unknown
2019	Acute accumulation	unknown
2020	Acute accumulation	worst

Vulnerability factors	
Geophysical features	There is a very rocky terrain with vegetation along the shore
Is there adequate access to the bay to facilitate clean-up efforts?	There is an access road.
Is the area important for fishing? (Presence of fish market and other infrastructure e.g. Jetty)	None
How close is the community to Bay?	25feet away from the community
Proximity of bay to schools and other infrastructure (e.g. polyclinics etc.).	Not within close proximity
Volume of sargassum during scoping assessment	Very minimal along the shore
Volume of sargassum historically (2011 – present)	Heavy influxes reported.
Is the beach heavily used by locals?	Yes for recreation and livelihoods
Is the beach heavily used for tourism?	no
Evidence of resilience	
Is there evidence of community efforts to clean-up?	Yes, volunteers
Is there evidence of community efforts to use sargassum?	Community members have experiments with it's use as a fertilizer
Presence of church and community groups that advocate for government assistance?	None

Telescope (South)

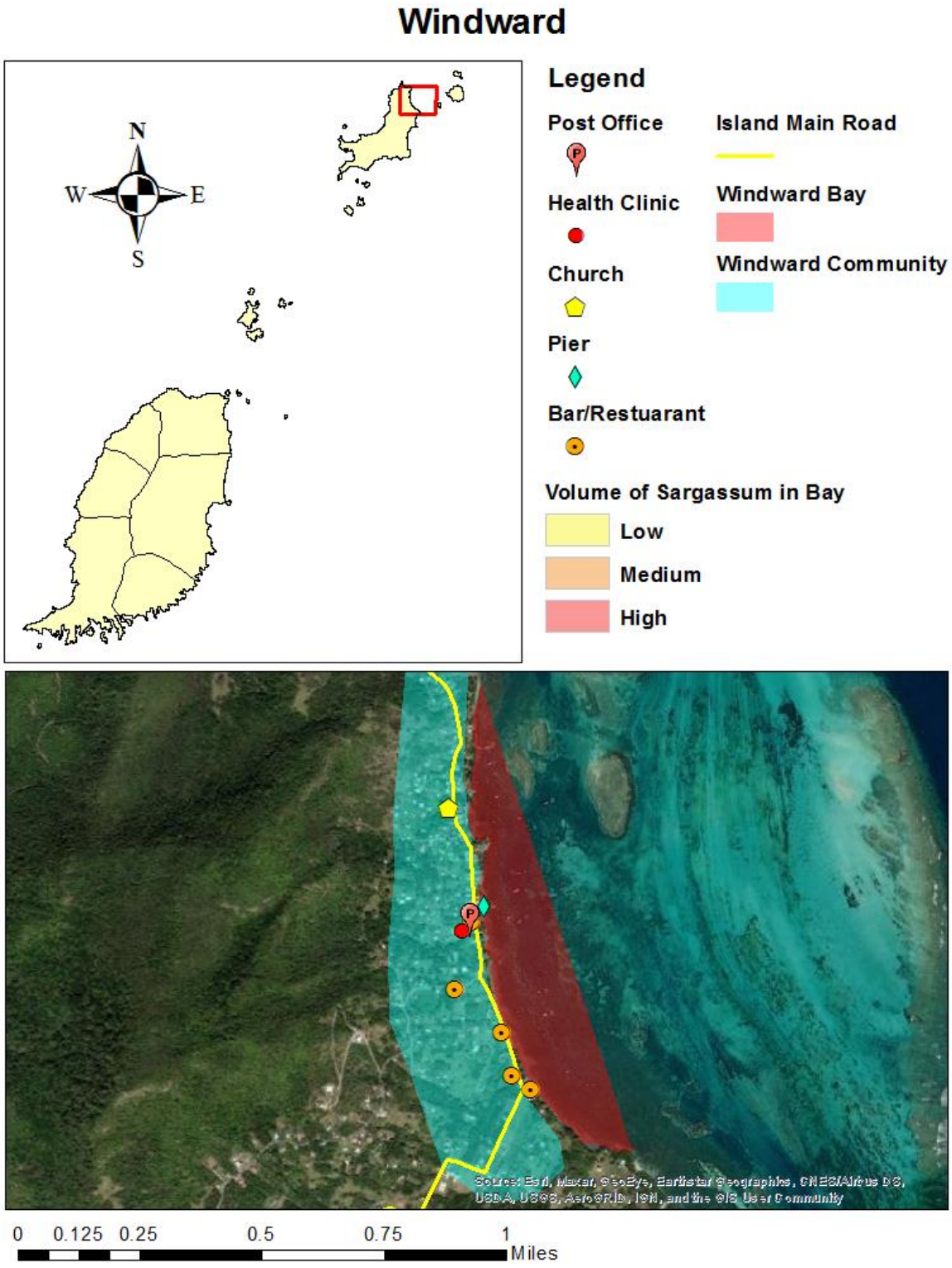
SELECT SOCIAL KEY FEATURES	SELECT ECOLOGICAL KEY FEATURES
• Beach • Bars • Shops • Fish Market • Church • Businesses • Homes	The beach has some coastal vegetation along the bay.

DATE	SUMMARY OF IMPACTS	SUMMARY OF RESPONSES
2017/8	Acute accumulation	unknown
2019	Acute accumulation	unknown
2020	Acute accumulation	unknown

Vulnerability factors	
Geophysical features	Bay area with lined with an access road and various coastal vegetation in most areas.
Is there adequate access to the bay to facilitate clean-up efforts?	Road allows for access at various points.
Is the area important for fishing? (Presence of fish market and other infrastructure e.g. Jetty)	Fish market, Jetty
How close is the community to Bay?	The community is along the bay in some areas with the sea coming up into the access road and other areas during rough seas.
Proximity of bay to schools and other infrastructure (e.g. polyclinics etc.).	They are within 10-50 metre radius of the bay.
Volume of sargassum during scoping assessment	Minimal amounts during scoping assessment
Volume of sargassum historically (2011 – present)	There has been heavy build up in the past affecting multiple stakeholders
Is the beach heavily used by locals?	Yes for recreation and livelihoods
Is the beach heavily used for tourism?	No
Evidence of resilience	
Is there evidence of community efforts to clean-up?	No

Is there evidence of community efforts to use sargassum?	Attempts to use for fertilization
Presence of church and community groups that advocate for government assistance?	Government clean-up crew

5.10 WINDWARD



SELECT SOCIAL KEY FEATURES	SELECT ECOLOGICAL KEY FEATURES
• Beaches • Pre-Primary School (Government) • District Clinic • Church • Shops • Pizzeria	From the fisheries centre to the lagoon/bird sanctuary Located in Windward, white sandy lined with coastal vegetation and mangroves. The shape of the bay allows for sargassum to remain trapped both along beach and at the end points.

DATE	SUMMARY OF IMPACTS	SUMMARY OF RESPONSES
2017/8	Acute accumulation	Most of it remained on the beach to rot and few persons used for manure
2019	Acute accumulation	Nothing was done
2020	Acute accumulation	None

Vulnerability factors	
Geophysical features	Long bay area with houses, shops and sparse coastal vegetation
Is there adequate access to the bay to facilitate clean-up efforts?	The main road is along the coast so there are various point of access
Is the area important for fishing? (Presence of fish market and other infrastructure e.g. Jetty)	Building and Docking of boats for fishers in the community
How close is the community to Bay?	The community is in very close proximity to the bay and are affected by the scent.
Proximity of bay to schools and other infrastructure (e.g. polyclinics etc.).	They are within 80-100 metre radius of the bay.
Volume of sargassum during scoping assessment	Very minimal along the shores and in the water with no scent
Volume of sargassum historically (2011 – present)	
Is the beach heavily used by locals?	Yes, for recreation and livelihoods
Is the beach heavily used for tourism?	
Evidence of resilience	
Is there evidence of community efforts to clean-up?	None
Is there evidence of community efforts to use sargassum?	In 2017/2018 some community members gathered some for use as fertilizer
Presence of church and community groups that advocate for government assistance?	None

Photo credit: Davon Baker (2021)

PART B:
CARIBBEAN GENERAL

6 LOCAL LEVEL SARGASSUM MANAGEMENT PLANS

Context

An adaptive management strategy, rather than a more site-specific management plan, is needed at the national level. This is due to the many uncertainties associated with sargassum and responses to it at the geographic, ecological, social and institutional scales of an entire island. However, at the local or site level, it is usually possible and desirable to specify management plans at much finer detail. People will usually seek and depend on this plan first for guidance.

Coherence

In order for a national strategy to be coherent, local management plans must be closely linked to each other and to the strategy for ease of rep and execution. Thus, plans contribute to the strategy by using a similar layout, but with detailed content relevant to specific locations. If most of the response and use is scaled to be nationally decided and implemented, then there may be limited or no need for local level plans. Avoid making local plans that are unnecessary.

Management unit

What is considered “local” will differ, even within the same country. The planning unit could be a single bay with its one community, or perhaps a stretch of well-connected villages that form a cluster. For sargassum, the main aim is for the local unit to be practical. It need not coincide with other units such as village or town boundaries, watersheds, parishes, enumeration districts or other national divisions. However, there are often benefits to using well accepted functional boundaries, and associated resources, to take advantage of harnessing what is already working.

Annotated outline

The following is an annotated outline of a generic local sargassum management plan. It has to be customised and evolves like, and with, the national strategy. Stakeholders and others may prefer to put the plan on paper or use in electronic form, rather than as a website. The plan should be updated annually, or more often if there have been changes that affect responses to the sargassum hazard or opportunities for its use. As with the national strategy, the content below is not intended to be prescriptive. Hence the annotations are general suggestions. Local formal (documented) and informal (people just know) knowledge will provide specific content. Matters such as literacy and language, formatting preferences (text, tables, charts, diagrams, maps), print size and font, colours, overall length, bound or loose leaf etc. may influence use.

INTRODUCTION

- Remind the reader how the plan is set out, will be kept updated, and how to use it
- Don’t repeat the adaptive approaches unless some are very site critical, e.g. DRM

PURPOSE AND PRINCIPLES

- Mainly to align the plan with the national strategy and any critical local initiatives
- Highlight any local social or ecological considerations critical to sargassum such as protected areas, highly valuable or vulnerable assets or sargassum opportunities

SCOPE

- Clearly identify the geographic or spatial scope of the plan, including demarcation of boundaries covering the terrestrial, coastal and marine areas addressed in the plan
- Boundaries can be 'fuzzy' if they are functional (e.g. "to just beyond the reef" or to "where farmland turns into forest in the hills") rather than specifying precise areas
- Identify the key sargassum-related features within the area in a broad profile, noting intersections with other bounded areas and the agencies that have jurisdiction within

AUTHORITY

- Identify authority linkages to the national strategy, describing what powers for decisions and action have been formally delegated so that there can be no misunderstanding of who the leader is, and with what authority to do what. This is key for conflict management.
- If there is legislation, a policy or another plan that impacts sargassum operations, then these should be listed with the operative extracts from them extracted for reference, e.g. laws or regulations for a specific protected area, economic activity area or beach.

INSTITUTIONAL ARRANGEMENTS

- A detailed, downscaled counterpart to the national strategy including making links to the strategy and its actors so there is a clear chain of accountability and responsibility
- Fit the leader(s) of the management plan, identified in the authority section, into the institutional arrangements of the strategy as such leaders cannot operate in isolation
- Chains of command for different aspects of local sargassum operations must be clear
- List local contact information along with expected roles and responsibilities (in a table)
- Similarly set out resources (e.g. labour, equipment, expertise) available at local level

MONETARY MATTERS

- Set out the local estimated budget elements, sources of funds and likely main expenses
- Include not only cash (e.g. funds transfer, subventions) but values of in-kind resources
- Estimate the limits of local support for both the hazard responses and sargassum uses
- Identify financing available locally for innovation, technical assistance, entrepreneurship

LOCAL MAP AND PROFILE

- Build on the site profile map and other content in the appendix of the national strategy
- Use the same content categories, but add as much site-level detail as practically useful
- Focus on the vulnerabilities and responsible responses, including for sargassum uses
- There should be no large contradictions between information in the strategy and plan
- Provide accurate plan information to update the national strategy as situations change
- Consider this section as requiring the most investment in accuracy to prioritise action

ACTIONS AND OPERATIONS

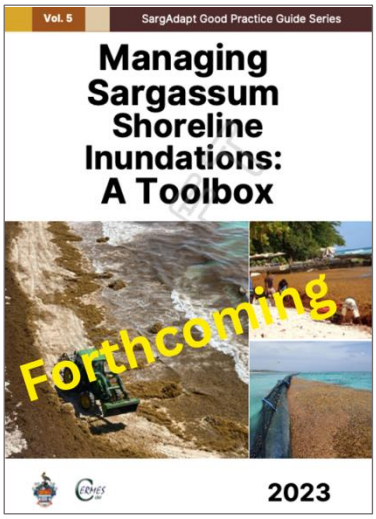
- Set out only the details of pre-impact, impact and post-impact specific to the local level
- Set out practical ecosystem measures for nearshore marine habitats, shoreline vegetation and wildlife
- To avoid being overwhelmingly extensive refer to guidance in the strategy or elsewhere
- Consider limitations in local capacity to manage and adapt, including building capacity

7 ACTIONS AND OPERATIONS

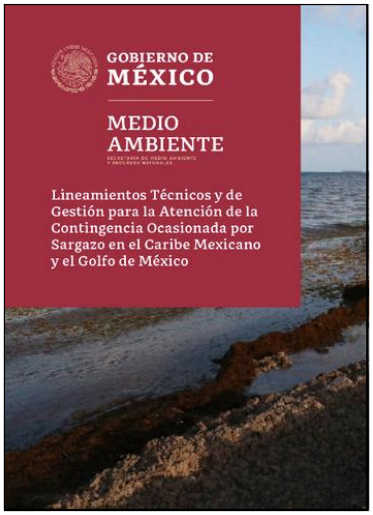
Several diverse types of knowledge products have been developed and made accessible throughout the years, mostly related to sargassum monitoring, management, coping and adaptive mechanisms for key sectors, removal and uses. Post 2021, the number of protocols and guidelines on sargassum-related actions and operations continues to grow slowly. Most territories in the Caribbean have sargassum management strategies in place, however, few have a publicly available policy institutionalised by national government. This section highlights some of the resources for responsible responses.

7.1 RESOURCES FOR RESPONSIBLE RESPONSES

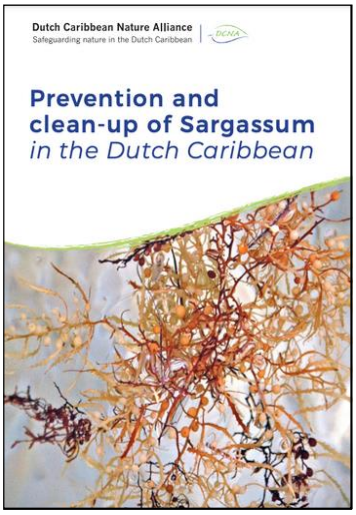
Guidance documents on **sargassum removal** have been produced at the national and regional levels. Click on the images below to peruse the documents!



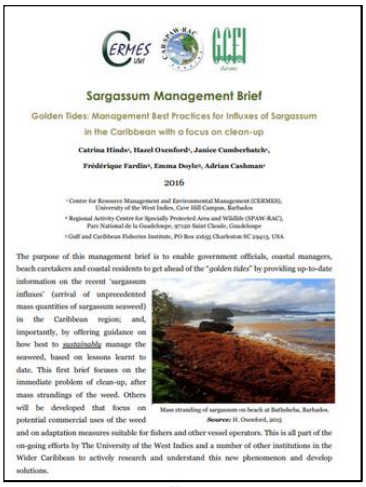
Tags: good practices, onshore and in-water collection, containment barriers



Tags: onshore and in-water collection, containment barriers, turtle nesting beaches, disposal, health and safety, monitoring, uses



Tags: good practices, onshore and in-water collection, containment barriers, disposal, health and safety

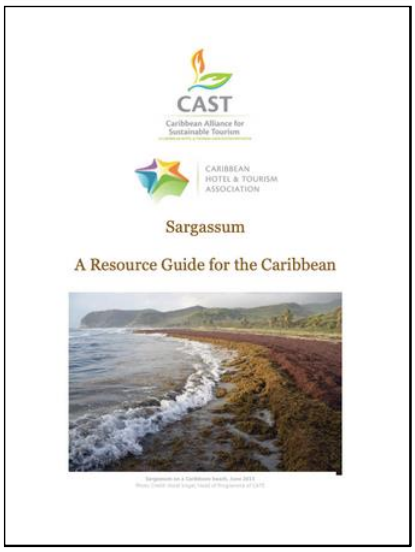


Tags: good practices, onshore and in-water collection, public awareness, uses

Tags: template, national-level management plans

Tags: good practices, public awareness, onshore and in-water collection, disposal

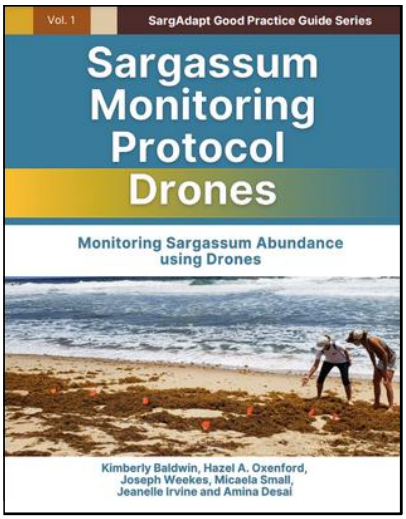
A few of the **sector specific** guidance resources are shown below. Click on the image to visit the website!

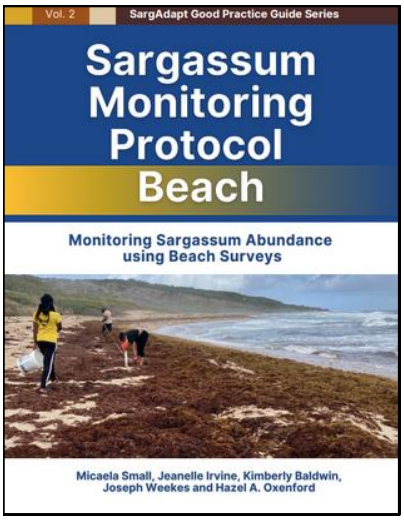


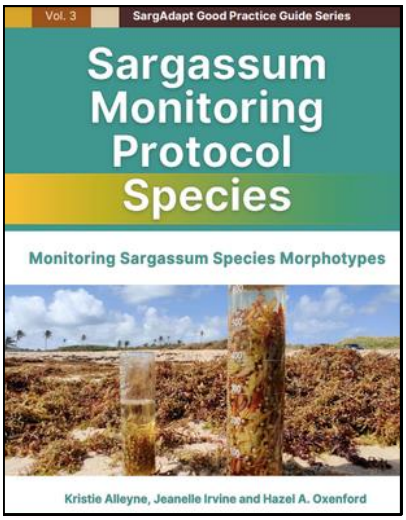
Tags: tourism, public awareness, impacts, good practices, onshore collection

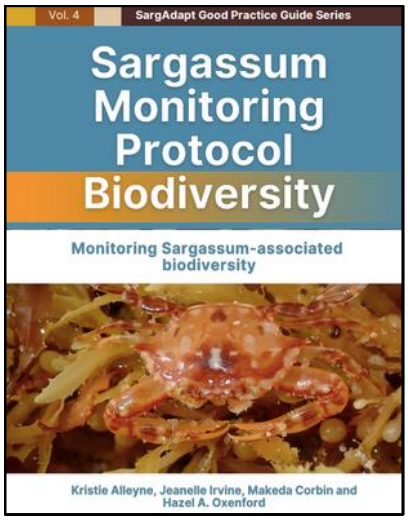
Tags: good practices, impacts, small-scale fishers, coping mechanisms

UWI-CERMES has developed a range of protocols on **sargassum monitoring**. Check out the [UWI-CERMES Good Practice Guide Series] for more information!



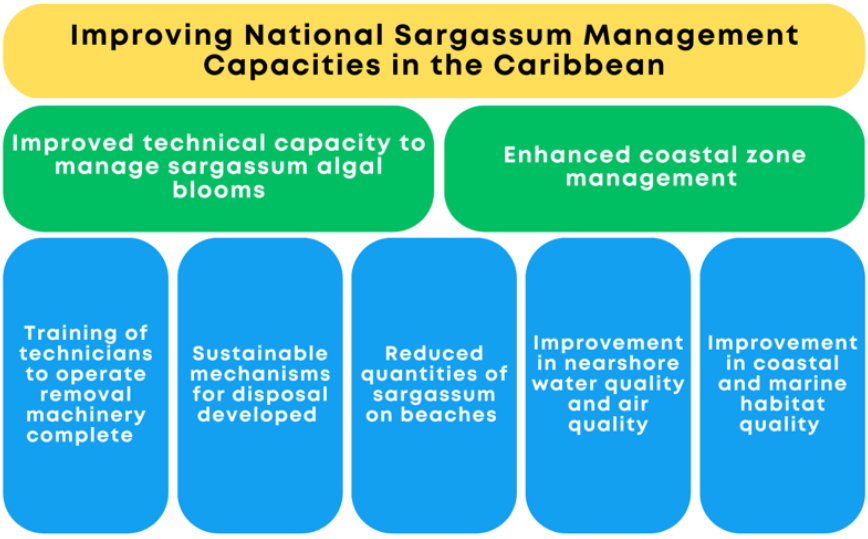






7.2 MANAGEMENT OF SARGASSUM INFLUXES

Over the years various collection techniques were tried and tested, with many lessons learned, as highlighted in the various guidance documents presented in the previous section. A systems approach is essential for improving national capacities for sargassum management. It is assumed that if mechanisms to support the effective and continuous collection of sargassum seaweed are implemented, and the technical capacity for sargassum removal is increased, then the resilience of coastal areas will be improved[2]. The figure below illustrates further[3].



Source: UNDP. 2022. Project Document- Improving National Sargassum Management Capacities in the Caribbean.

It is important to note that there is not a "one-size-fits-all-solution" and best practice will require site-specific solutions, but general guidance for removal of sargassum is as follows:

[2] United Nations Development Programme. 2022. Project Document- The Project for Improving National Sargassum Management Capacities in the Caribbean.

[3] The images and names of commercial merchandise in this appendix do not constitute an endorsement or product review. They are for information only as explanatory examples.

STEP 1: Assess the level of impact first to determine if conditions are:

Low- just a small amount of sargassum. Sparse, less than 2 inches in depth. Faint seaweed odor. Small amounts of sargassum on the beach will do no harm and may not require intervention.

Medium– About 6 – 9 inches in depth. Strong odor, several insects. Moderate amounts may also not require intervention.

High– more than 10 inches in depth. Pungent odour, significant impairment of movement of vessels and use of beachfront. Large inundations need to be cleared quickly (within 24-72 hours).

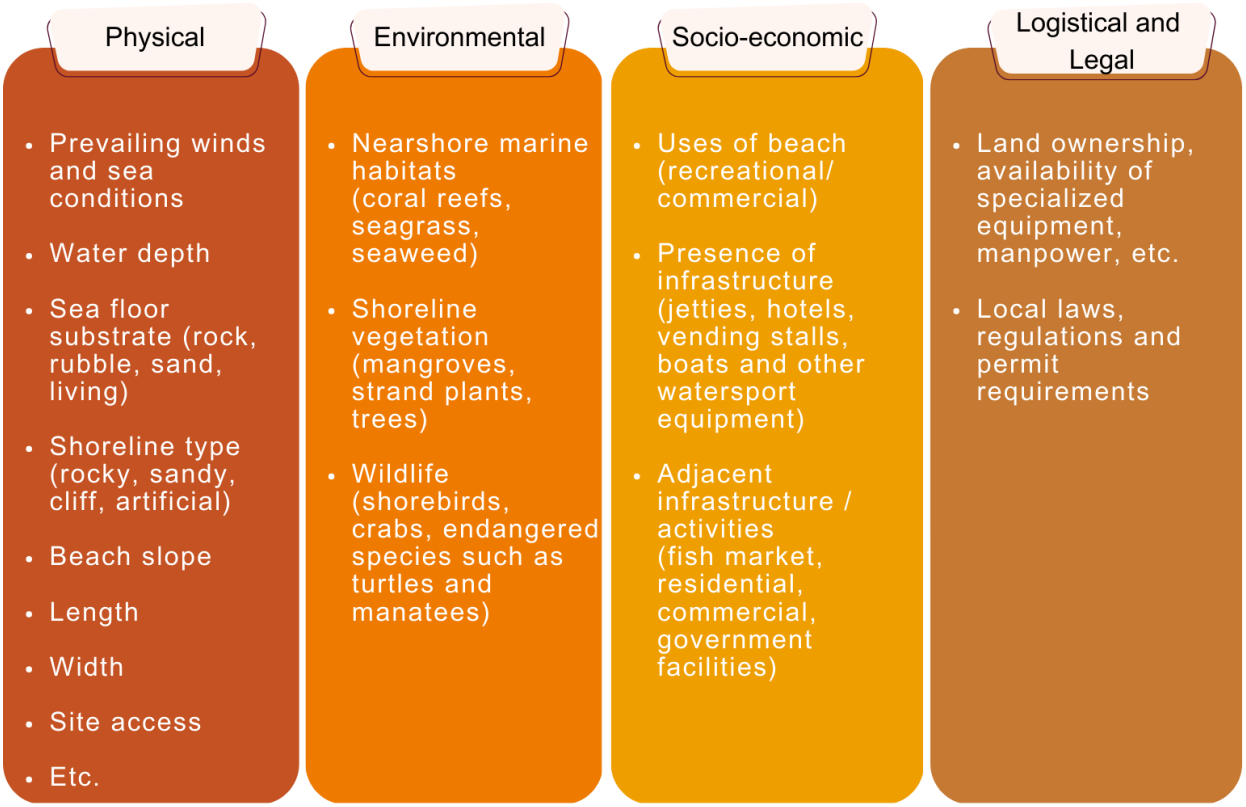
STEP 2: Communicate with coastal stakeholders and the wider public

Communication is key! Stakeholder collaboration and engagement is critical to ensure the continued success and support of clean-up initiatives.

- Stakeholders should be informed of interventions both at the local and national levels, to manage their expectations.
- They should know who the lead agency is for executing clean-ups and other partners that will be involved.
- Each stakeholder group will have distinct concerns, therefore a range of media targeted to the specific needs of the various groups is needed.
- Use effective methods of communication to ensure the intended messages are received.
- Encourage public participation in clean-up initiatives. It is acknowledged that each affected community will require equipment support, some training, assistance in removing and transporting aggregated material from the beaches.

STEP 3: Consider the physical, environmental, socio-economic, logistical and legal conditions:

It may not always be necessary to collect or clear up after all sargassum beaching events. Before investing in a specific method and/or type of collection equipment, the local context and potential environmental impact must be considered. Physical, environmental, socio-economic, logistical and legal conditions vary at any given site which should inform the appropriate response.



(Adapted from the CERMES SargAdapt Good Practice Guide Series: *Managing Sargassum Shoreline Inundations: A Toolbox*)

STEP 4: Determine method of collection (onshore or in-water)

Onshore collection

Removal can either be manual using rakes, pitch forks, wheelbarrows and buckets, or mechanized using machinery such as surf rakes, excavators and other heavy machinery. While manual removal is a preferred method, mass strandings will require the use of mechanical equipment, or a combination of both.

Belize (2018). Credit: Caribbean Press Releases

The Barber Surf Rake at Playa Paraiso, Tulum, Mexico (2018). Credit: Marc Bruxelle

Bath Beach, St. John, Barbados (2018). Credit: The Barbados Advocate

The table below provides further guidance and considerations on the removal methods.

	Manual onshore collection (rakes, pitch forks, wheelbarrows, buckets)	Mechanised onshore collection (mechanised rake)	Mechanised onshore collection (excavator & other heavy machinery)
Suitable conditions	Volume is low to medium Low frequency events Beach with high ecological sensitivity	Volume is low to medium Frequent inundations Long, wide, flat or gently sloping sand beach No or little beach infrastructure	Huge accumulations of sargassum where other onshore methods are initially impractical Public health and the environment may be at risk Sediment that can bear the weight of heavy machinery Available dedicated access for heavy equipment
Unsuitable conditions	High amounts of beached sargassum Long inundation events with continuous high supply daily Decomposing sargassum producing high levels of toxic gases posing a health risk to workers	Piles of sargassum more than 30-40 cm deep Narrow, short or steeply sloping beaches or those comprising pebbles Beaches with high density of beach infrastructure or vegetation	Narrow beach, rocky shoreline Presence of dense beach infrastructure No vehicular access Ecological sensitive beach
Good practice	Collect sargassum as fresh as possible. This minimizes heath issues and maximizes valorisation potential	Operate when beach use is low Operate during low tide Retrieve sand for beach nourishing where possible Implement a equipment maintenance routine, including freshwater cleaning	Always avoid use of heavy tracked vehicles on sandy beach Use vehicles with large pneumatic tyres to spread load Use a mechanized bucket to remove only the top layer of sargassum Use an environmental monitor to keep an eye on the operation
Operating costs	Low (Low cost, low technology equipment, cost determined largely by cost of labour, time needed and transport and disposal costs)	High (cost to purchase, ongoing maintenance, driver to operate machinery, transport and disposal costs)	Very High (cost to purchase, ongoing maintenance, machine operators require training)

(Adapted from the DRAFT CERMES SargAdapt Good Practice Guide Series: *Managing Sargassum Shoreline Inundations: A Toolbox*)

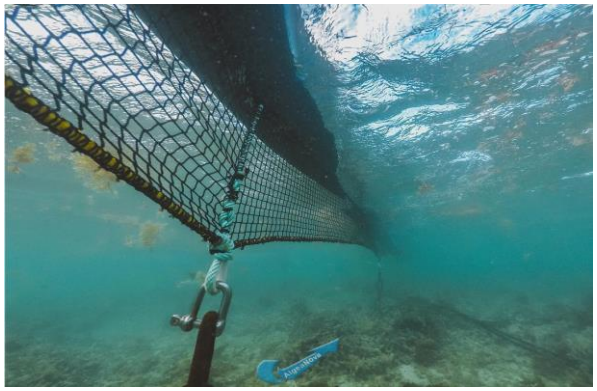
The Barber Company is a distributor of the surf rake, with three models, Optimized for different-sized beaches. The largest rake cleans sand up to nine acres an hour. The three cubic yard hopper can hydraulically lift up to 4,500 pounds of material to a clearance height of nine (9) feet and dump its contents. For more information visit The Barber Company webpage.

To see the surf rake in operation in Mexico click here.

In-water collection

In-water collection close to shore, where possible and permitted, is often preferable to beach collection as it avoids removal of sand and damage to coastal vegetation. It may also prevent sargassum from rotting in the water (Hinds et al. 2016). Offshore barriers and boat harvesters are the methods commonly used for in-water collection. A combination of the offshore barrier and harvest barge yield optimal results.

Offshore barriers work either through diversion away from sensitive areas or through storage and containment.



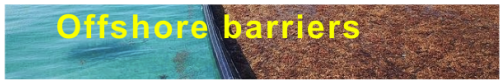
Source: Algeanova- Offshore barriers designed and deployed by Algeanova in the Dominican republic.

Boat harvesters are motorised vessels (often barges) which harvests sargassum mats offshore (close to the coast) on a tilted conveyor belt as the barge moves through the water (Chereau 2019).

Source: Algeanova- Custom built Algeanova boat harvester operating in Dominica Republic

Source: The Ocean Cleaner- Custom built boat harvester operating in Mexico, designed by The Ocean Cleaner

The table below provides further guidance and considerations for in-water collection.

		
Suitable conditions	Relatively calm sea conditions Shallow waters with suitable anchoring substrate (sand, rock) Good accessibility at sea, and relatively close to safe harbour/docking facilities	Relatively calm sea conditions Easily accessed from safe harbour/docking facilities Must have other vessel(s), dock or beach facility for frequent unloading
Unsuitable conditions	Prevailing rough seas Deep water Sensitive substrates for anchoring (coral reefs) Not easily accessible from sea or far from docking facilities	Rough seas or open ocean No transport vessels available or nearby onshore offloading facility
Good practices	Thorough investigation of the local geomorphic and hydrodynamic conditions Ensure ample anchoring points, preferably with Halas-type moorings Frequent cleaning of barrier to avoid sargassum build up Keep barrier and netting (skirt) clean of settling organisms Consider openings for boat traffic and nesting turtles. Use observers to assist escape of turtle hatchlings Consider barrier removal during periods of low or no sargassum inundation. Ensure adequate storage space	Works best in tandem with barrier to aggregate the material Have observer(s) watching the conveyor system to remove and release any turtle hatchlings and other larger marine organisms
Operating costs	High Cost of suitable barrier, continuous maintenance, harvest boat to continuously remove sargassum from barrier and maintenance and skilled vessel operator(s)	High Cost for purchase of custom-built vessel(s), running and maintenance costs, skilled operators and others required to operate the collecting system

(Adapted from the DRAFT CERMES SargAdapt Good Practice Guide Series: *Managing Sargassum Shoreline Inundations: A Toolbox*)

AlgaeNova is a distributor of both offshore barriers and boat harvesters. The offshore barriers (ProjiNova patent) have been successful in retaining sargassum at sea in the Dominican Republic and Mexico. The AlgaeNova boat harvesters can collect approx. 200 tons of fresh seaweed per day and sail in the open sea as well as shallow water.

For more information visit the AlgaeNova webpage.
To see videos of the AlgaeNova offshore barrier and boat harvester in operation click here.

The Ocean Cleaner is another distributer of offshore barriers and boat harvesters. The patented 'Sargaboat' works with the Sargabarrier to collect sargassum seaweed. One Sargaboat can harvest about 500m³ of sargassum in 8 hours and the autonomous Sargatrailer has a capacity of 8m³. For more information visit The Ocean Cleaner webpage.

To see The Ocean Cleaner offshore barrier and boat harvester in operation click here.

STEP 5: Transport to an appropriate disposal/storage site

Collected sargassum must be transported to an appropriate disposal or storage site. This is likely to require the selection of a suitable temporary or permanent on-site location and/or some kind of transport mechanism to move it directly from the collection site. Where possible, the costs of routine transportation of the sargassum to the dump sites should be incorporated into contracts created between the SSA and the Waste Removal Company. This may be the most cost-efficient way to manage routine transportation to the dump site.

Equipment commonly used in construction and agriculture (backhoe, caterpillar excavator, cane grabs, etc.) have been used to collect and transport sargassum to disposal/storage sites. However, machinery with a solid digger, bulldozer or backhoe bucket can inadvertently damage the beach. Instead, lifting sargassum using grabs, or screening and claw buckets remove less sand and minimise damage to the beach. Machinery with metal caterpillar tracks on beaches should also be avoided.

Cane grabs used for lifting sargassum. Credit: erosionpollution.com
Disposal/storage sites should:

- Allow sargassum to dry out to prevent anaerobic decomposition and production of toxic hydrogen sulphide and ammonia gases. After drying separate the sand before removal, wherever practical.
- Not be near drinking water supply as leachates from decomposing sargassum are likely to be high in arsenic and possibly other elements that are damaging to the environment. Lining with geomembranes to prevent escape of leachates should be considered where possible.
- Be outfitted with hydrogen sulphide and methane meters to monitor air quality.

Note: In- country inundation removal responses and results vary

There is no "one size fits all" solution and sometimes equipment may not function as anticipated. For example, in Barbados the seaweed harvester and offshore barrier were deployed, however, due to prevailing ocean conditions including rough waters and strong currents, the desired results were not achieved.

Lessons learned

- Can be costly
- Highly repetitive
- Often ineffective
- Sometimes futile
- Needs a system

Factors to be considered

- Environment
- Technology
- Ecology
- Humans
- Funding

Seaweed harvester

Crane Hotel's offshore barrier

The Japanese Government in collaboration with UNDP, has embarked on a three-year (2022-2025) project *"The Project for Improving National Sargassum Management Capacities in the Caribbean"* to support the enhancement of national capacities for the management of sargassum. Under the Project, beneficiary countries including Barbados, Saint Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines and Trinidad and Tobago will be provided with removal equipment, technical expertise and gender responsive training for removal, transport and disposal and overall long-term management of sargassum[4].

4 https://www.undp.org/barbados/sargassum#:~:text=The%20project%20aims%20to%20support,to%20mitigate%20the%20reoccurring%20threat

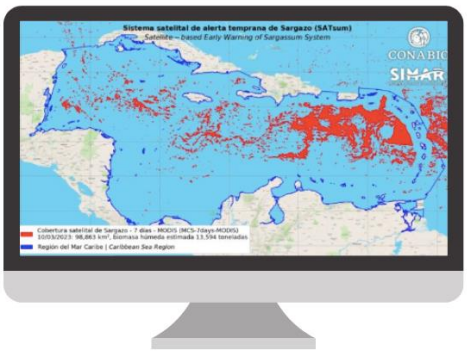
7.3 SARGASSUM FORECASTING AND MONITORING

Sargassum monitoring has been gaining much attention, especially at the regional and international levels. Below features a few platforms that monitor sargassum influx events and collect reports of sargassum strandings. Click on the images to visit the websites for more information!

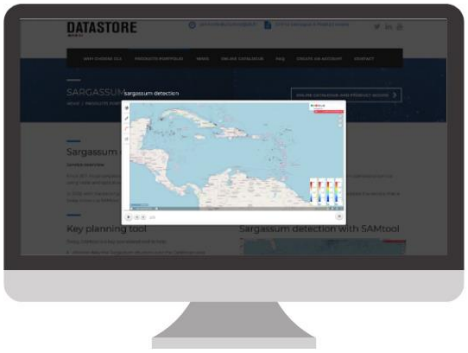
Sargassum Monitoring- Detection using on satellite imagery

NOAA Coastwatch Oceanviewer

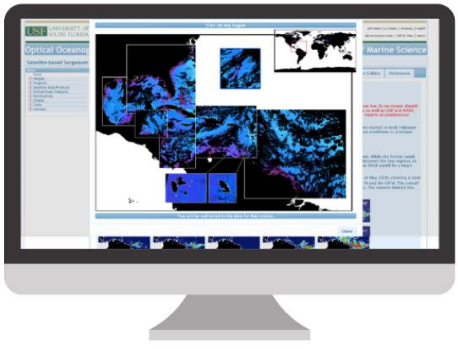
Caribbean Coastal Ocean Observing System (CariCOOS)



Sargassum Satellite Early Warning System (SATsum)

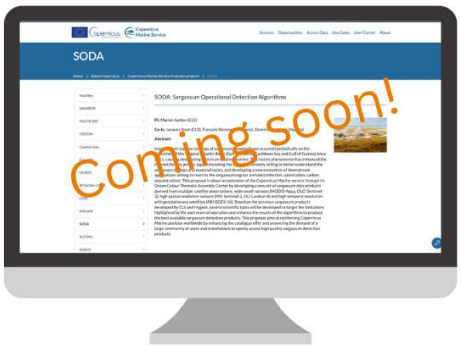


CLS Sargassum Detection and Monitoring Tool

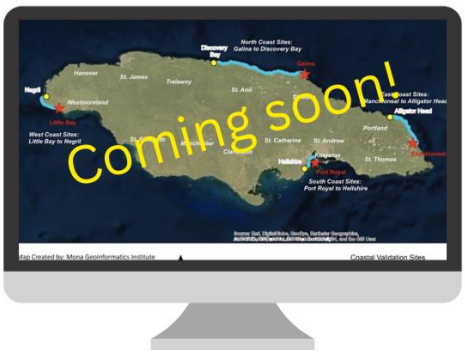


Sargassum Watch System (SAWS)

Sargassum Monitoring



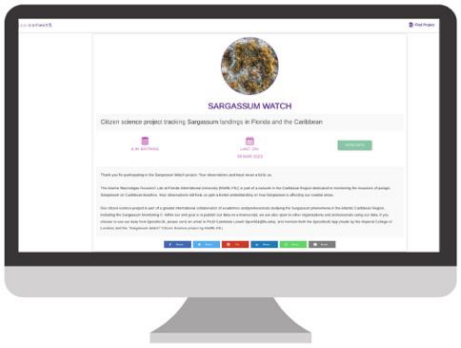
Sargassum Operational Detection Algorithms (SODA)



SARTRAC Sargassum Detection Algorithm

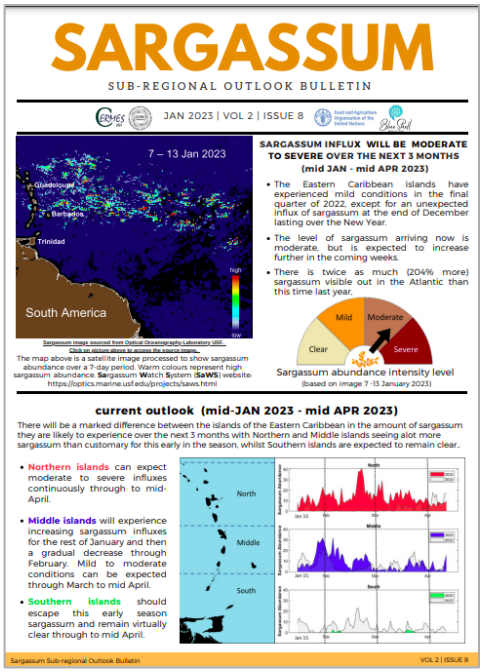
Sargassum Monitoring- Citizens Science

SargSNAP

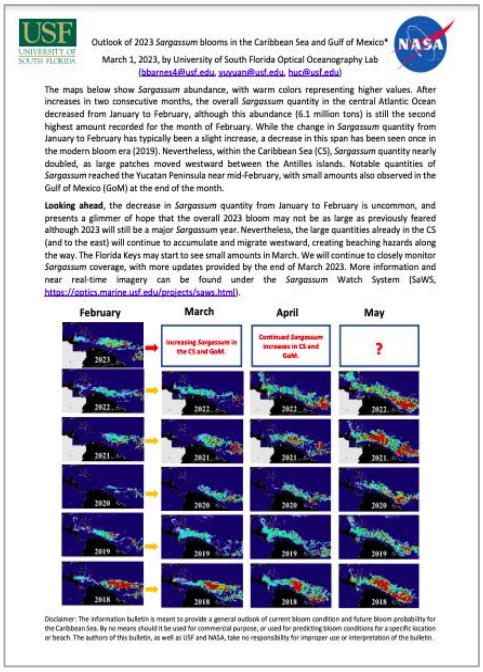


Epicollect Sargassum Watch

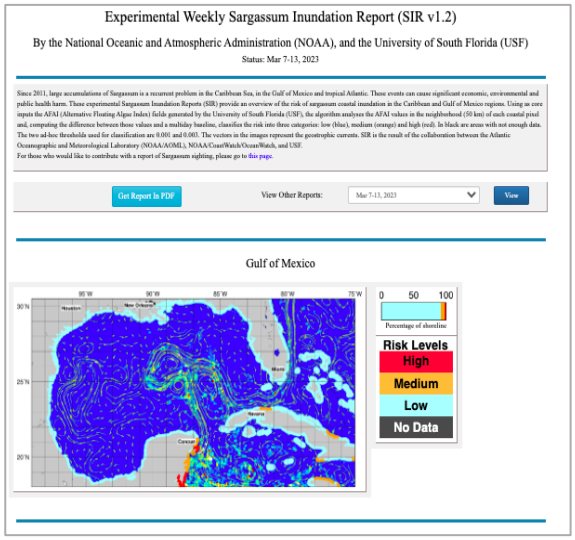
Sargassum Reporting- Bulletins and Reports



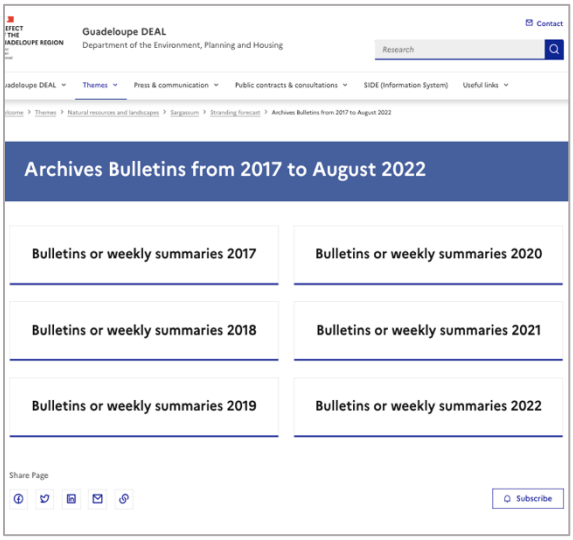
UWI-CERMES Sub-regional Sargassum Outlook Bulletin



USF Sargassum Outlook Bulletin

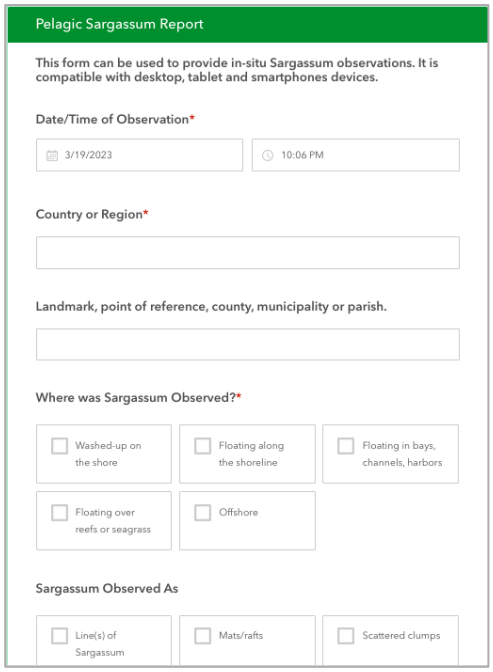


NOAA Experimental Weekly Sargassum Inundation Report

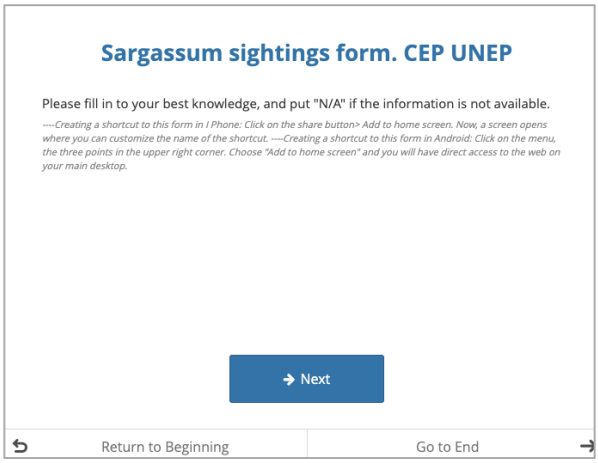


Sargassum Surveillance Bulletin for Guadeloupe

Sargassum Reporting- Citizens Science



Sargassum Pelagic Report



Sargassum Sightings Form

7.4 RECOMMENDED ACTIONS FOR KEY SECTORS

HEALTH

Impacts

1) Hydrogen sulphide (H_2S) can **affect the air quality** for individuals, especially those with asthma or other respiratory conditions.

Recommended Actions

1) **H_2S Detection Equipment** should be carefully positioned in communities, to prevent high exposure of H_2S taking into consideration wind levels, humidity and temperature. Emergency plans should be set in place if levels exceed acceptable standards.

2) **Installation of Wi-Fi video camera – CCTV** across beaches, bays and coastlines commonly affected by sargassum. Surveillance equipment should include night-time surveillance capabilities, operation without infrastructure support, long range and resistance motors for resistance to harsh weather.

3) **Prioritising removal of sargassum seaweed** in high-risk areas using data from surveillance and H_2S equipment. This will guide & increase the effectiveness in determining areas for frequent collection of the seaweed from the various beaches.

4) **More bioprocessing sites** should be identified for composing of seaweed. Locations should not be located close to human settlements and have adequate areas of unused land with soil properties useful in leaching heavy metals in the seaweed. Sites should also be rotated.

5) Beaches and bays should be classified as high and low risk areas of seaweed exposure. This can be done through **public notification and risk communication** using easy to read signs for beaches.

Capacity and Resource Needs

- Procurement of monitoring equipment including H_2S detectors
- Wi-Fi video cameras.
- Dedicated funding to develop/support consistent monitoring.
- More technical personnel to carry out monitoring measures.
- Training of staff in the use & maintenance of H_2S
- equipment.
- Engagement with community representatives, fisherfolk and
- tourism operators.
- Development of a clear health early warning and reporting syst
- Procurement of drying or ensiling technology/equipment, mate
- needed for treatment of biomass.
- Dedicated funding to facilitate operation of the bioprocessing sites.
- Procurement and training of workers to operate in the bioprocessing facility.
- Structured public education and communication plan.

TOURISM

Impacts

1) The main impact on tourism is caused by **negative guest perception** and reaction to sargassum. In addition to the **visual impact** on beaches, there is also the **unpleasant smell** (caused by decaying organisms trapped in the seaweed) that is generated as it decomposes in the sun.

2) Large sargassum influxes can lead to a **lack of beach access** and a **decline in ocean and beach-based activities and business**. In severe cases, it can also lead to **vacation cancellations**, **closure of beachfront accommodations and businesses**, with a rollover effect on staff layoffs and reduced economic activity.

Recommended Actions

1) **Provide guests with as much educational material as possible.** Forecasting websites can help with predicting where and when the sargassum will be located. This is bolstered by the placement of signage along beaches and frequented coastal areas with quick fact sheets on sargassum and the country's commitment to removing the seaweed quickly & safely.

2) Where there are low to moderate influxes, beachgoers can be provided with buckets and fact sheets to go on **"sargassum scavenger hunts".** This strategy was employed in Galveston, Texas where it was popular with guests and positively changed perceptions of the sargassum.

3) **Develop a comprehensive beach cleaning programme** to be enacted at the national level during heavy influxes. This involves partnering with hotels, the tourism associations, other beach front businesses and local communities to have appropriate sargassum removal equipment and agreement on regular cleaning and maintenance schedules.

Capacity and Resource Needs

- Better engagement of tourism and hotel operators as well as other related enterprises in adaptation planning.
- Improved communication and data sharing from Sargassum Management Authorities to the tourism sector, e.g. increased use of The Sargassum Outlook Bulletin.
- Capacity building programme for hotel staff, lifeguards and tourism operators.
- Sargassum public education programme.
- Communication through both print and electronic mediums.
- Greater use of social media and/or the development of an easy platform for sharing information (e.g., through a mobile application).
- Procurement of appropriate clean-up equipment.

FISHERIES

Impacts

At landing sites fishers battle with impeded access, difficulty maneuvering vessels through bays and the unpleasant smell as sargassum decomposes. Challenges encountered at sea include engine overheating, loss of steerage, entangled fishing gear, poor visibility and skin irritation**.** In addition to disrupted fishing operations, fishers have reported that the behaviour of target species e.g. flying fish in Barbados.

The impacts to the harvest sector also extend to those working in the post-harvest sector and beyond, e.g. fish vendors & processors, restauranteurs and general consumers.

Recommended Actions

1) **Removal of severe onshore and nearshore sargassum mats** mitigates against loss of access to boats for fisherfolk.

2) **Public education on the availability of new fish stocks** will lessen the impact of reduced fish sales. Amberjacks are plentiful and viable for sale in the Barbados market, have begun to replace flying fish and the usual dolphinfish catches during acute sargassum events.

3) **Ensuring boat insurance policies cover damage** caused by sargassum entanglement gives boat owners some financial coverage during large sargassum events.

4) Promote citizen science.

Capacity and Resource Needs

- Budget for sargassum clean-up and management.
- Financial support for an Early Warning System (EWS) at the national level to mobilise resources and equipment before influx arrives.
- Improved communication and engagement between Fisheries Management Authorities and fishers to support monitoring and early warning.
- Greater use and sharing of free or inexpensive early detection, warning and forecasting data on influxes, e.g. increased use of The Sargassum Outlook Bulletin. Also, more guidance on risk mitigation.
- Marketing strategy to maximise the economic opportunities associated with increased catches of species such as the almaco jack.
- Better loss and damage data collection on fishing gear, loss of revenue/fishing days.
- Risk insurance for fisherfolk for sargassum.

Environment

Impacts

In addition to the strong odour from sargassum onshore, high quantities of sargassum impact **biodiversity** which can lead to:

- **Loss of some marine species** - Barbados has seen a near depletion of some marine life such as its seasonal flying fish and dolphin
- **Key processes become affected** – large quantities of sargassum can hinder light from reaching marine plants
- **Eutrophication** – excessive quantities of nutrients such as nitrogen are brought to marine ecosystems resulting in large growth within these areas.
- **Entangled marine life**

Recommended Actions

1) The environmental impact of removing sargassum must always be considered. **Where it is possible, it is always best to leave the sargassum on the beaches**.

2) When removal is necessary, it must be done in a way that **preserves the coastline and the does the least damage to marine life.** Mechanical removal poses the highest risk in this regard, and so **removal should be done manually whenever possible.** Mechanical rakes and cranes that remove sand can disturb sand dwelling critters, nests, sea turtles and sea turtle nests. Consult sargassum removal guidance documents for appropriate responses.

3) **Avoid burying sargassum** on turtle nesting beaches. Transport sargassum away from these sites.

Capacity and Resource Needs

- A management framework for systematic monitoring of the turtle nesting beaches is needed.
- Greater public awareness of safe removal and disposal practices on turtle nesting beaches.

7.5 SARGASSUM PROJECTS IN THE WIDER CARIBBEAN

In order to keep abreast of sargassum initiatives, and develop an effective SAMS, there must be dedicated persons and agencies networking online to make contacts and obtain the most current and appropriate information. It is possible to do some of this networking through subscription mail, podcasts and webinars, but reaching out to key contacts in person will be necessary if resources are to be mobilised sufficient to keep the country in the forefront.

	Sargassum Caribbean Projects, Programmes and Initiatives	Brief Description	Organisation/agency	Start Year
1.	**Sargassum hub** Click here to visit website!	Website that integrates information from multiple sources. Items featured include monitoring systems, in-situ observations, bulletins issued and good practices for management & use.	Geoplanet, IOCaribe, Atlantos, Air Centre	2020
2.	**SargNet** Click here to visit website!	A listserv and online network of sargassum stakeholders hosted by Florida International University (FIU).	Florida International University (FIU)	2019
3.	**SPAW-RAC/UNEP-CEP Sargassum on-line forum** Click here to visit website!	Online forum that provides easy access to relevant documents on awareness, management and research about the Sargassum influx, as well as direct exchanges between stakeholders to share their experiences.	UNEP-CEP	2015
4.	**Caribbean Cooperation Programme against Sargassum (SARG'COOP)** Click here to visit website!	The Caribbean cooperation programme for the monitoring of sargassum seaweed' is bringing together regional partners to share knowledge and expertise and foster collaboration across language barriers.	Regional Council of Guadeloupe	2019

	Sargassum Caribbean Projects, Programmes and Initiatives	Brief Description	Organisation/agency	Start Year
5.	**SargAdapt** (Adapting to a new reality: Managing responses to influxes of sargassum seaweed in the Eastern Caribbean as ecosystem hazards and opportunities) Click here to visit website!	The ultimate goal of SargAdapt is to reduce the impacts of and improve adaptation to sargassum influxes in the Eastern Caribbean with emphasis on converting a climate-linked ecosystem hazard into an asset that supports opportunities for socio-economic development.	UWI-CERMES, Caribbean Natural Resources Institute (CANARI)	2019 - 2022
6.	**SARTRAC** (Teleconnected SARgassum risks across the Atlantic: building capacity for TRansformational adaptation in the Caribbean and West Africa) Click here to visit website!	SARTRAC identifies new transformational developmental opportunities that build resilience equitably, for people affected by changing biomes/ecosystems in developing countries.	University of Southamptom, UWI-CERMES, University of Ghana, University of York	2019 - 2022
7.	Climate Change Adaptation in the Eastern Caribbean Fisheries Sector **(CC4FISH)** Sargassum Subproject Click here to visit website!	This sub-project aims to increase resilience and reduce vulnerability to climate change impacts including sargassum influx events in the Eastern Caribbean fisheries sector.	FAO, UWI-CERMES, USM	2017-2021
8.	**SASAMS** (SAtellite SArgassum Monitoring System) Click here to visit website!	This project aims to develop a near real-time service for monitoring pelagic sargassum seaweed beaching, initially aimed at Mexico's Caribbean Coast	University of Nottingham, Specto Natura Ltd, Triple Line Consulting Ltd. CONABIO, UNAM, CentroGeo, Planet Inc.	2020
9.	**Sargassum Products for Climate Resilience in the Caribbean** Click here to visit website!	The overall aim of the project is to mitigate the environmental and economic impacts of Sargassum seaweed influxes in affected Caribbean countries through the creation of inclusive value chains for Sargassum seaweed.	CRFM, Plant and Food Research, A New Zealand Crown Research Institute	2020 - 2023
10.	**Activated Carbon: A successful multi-lateral**	This research project is investigating different activation	Université des Antilles (Guadeloupe)	2019

	Sargassum Caribbean Projects, Programmes and Initiatives	Brief Description	Organisation/agency	Start Year
	and multi-national research project	methods and different pyrolysis temperatures (600 – 900 ^{o}C) to obtain activated carbon using sargassum.	(COVACHIMM2E laboratory), Instituto Tecnológico de Santo Domingo (INTEC) (Dominican Republic),	
11.	**CESAR** (Coastal environment under sargassum crisis) Click here to visit website!	This project seeks to develop tools and methods to manage sargassum influxes in the Caribbean, particularly in the French West Indies.	Coordinator and collaborators can be found here	2019
12.	**CORSAiR** (Atmospheric and marine corrosions) Click here to visit website!	The main aim of this project to investigate the corrosion rate of exposure sites and modelling the phenomenon of corrosion and its natural inhibitory solution. It also seeks to characterize of biofilms and compile legal tools	Coordinator and collaborators can be found here	2019
13.	**FORESEA** (Forecasting of sargassum stranding in the Tropical Atlantic) Click here to visit website!	The purpose of the FORESEA research proposal is to advance the current understanding of Sargassum bloom and drift in the open and coastal ocean and help transfer this understanding into a seasonal forecast of the quantity of Sargassum and probability of stranding at the coast.	Coordinator and collaborators can be found here	2019
14.	**PYROSAR** (Valorisation of sargassum by pyrolosis-application for food safety) Click here to visit website!	This project aims to optimize the production of biochar and activated carbon from sargassum at laboratory and industrial scale using the solar microwave process of NST	Coordinator and collaborators can be found here	2019
15.	**Sarg As Cld** (Environmental impacts of sargassum leachate due to arsenic and chlordecone: quantification) Click here to visit website!	The initiative seeks to improve knowledge on sargassum contamination by arsenic (marine origin) and chlordecone (terrestrial origin).	Coordinator and collaborators can be found here	2019

	Sargassum Caribbean Projects, Programmes and Initiatives	Brief Description	Organisation/agency	Start Year
16.	**SARGACARE** (Human health effects of chronic exposure to gaseous fumes from decomposing brown algae in the French West Indies) Click here to visit website!	Goal: Conduct a detailed study of the clinical, biological, functional and socio-anthropological consequences of gaseous emissions produced by decomposing sargassum in the Caribbean.	Coordinator and collaborators can be found here	2019
17.	**SARGASSUM ORIGINS** (Identity and origins of pelagic sargassum) Click here to visit website!	This project aims to identify sargassum species growing in the North Atlantic (co-occurrence) by studying the connectivity of sargassum at the Atlantic scale.	Coordinator and collaborators can be found here	2019
18.	**SARGOOD** (Holistic approach to sargassum valorisation) Click here to visit website!	The project will conduct an assessment of the sargassum life cycle and develop innovative materials and technologies	Coordinator and collaborators can be found here	2019
19.	**SARGSCREEN** (Pharmaco-toxicological screening of molecules extracted from Caribbean sargassum: highlighting their impact on certain pathologies widespread in the Caribbean) Click here to visit website!	The project aims to detect pharmacological potential of sargassum extracts against pathologies spread over the Caribbean	Coordinator and collaborators can be found here	2019
20.	**SARtrib** (Tribological and electrochemical valorisation of sargassum) Click here to visit website!	Aim: Valorisation of vacuum pyrolysis by-products of sargassum: electrodes for lithium batteries and new generation of lubricant	Coordinator and collaborators can be found here	2019
21.	**SAVE** (Sargassum agricultural valorisation and energy production) Click here to visit website!	This project seeks to identify non-destructive sargassum harvest methods and develop a social and environmental approach to integrating the treatment of sargassum and local bio wastes.	Coordinator and collaborators can be found here	2019

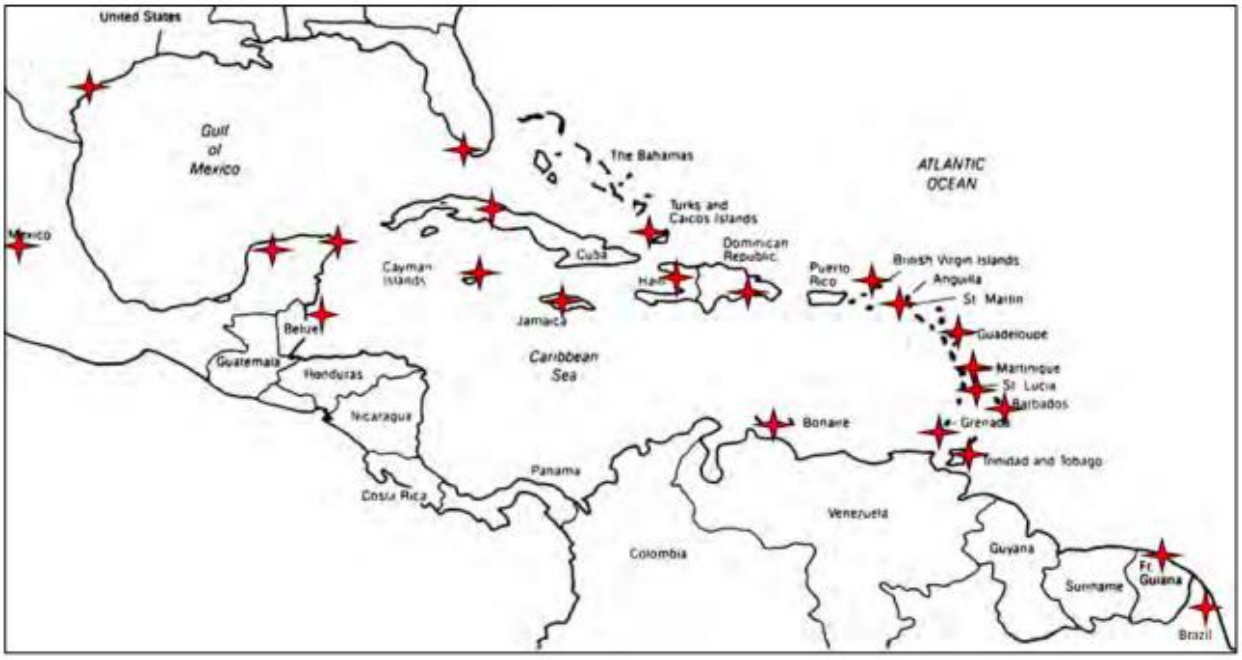
	Sargassum Caribbean Projects, Programmes and Initiatives	Brief Description	Organisation/agency	Start Year
22.	**SAVE-C** (Study of holopelagic sargassum responsible of massive beachings: valorisation and ecology on Caribbean Coasts) Click here to visit website!	This project aims to better understand the diversity and the functioning of pelagic sargassum, from the drifting rafts until their beaching	Coordinator and collaborators can be found here	2019
23.	**Developing a sustainable sargassum value chain**	Research project seeking to identify sustainable business opportunities utilizing sargassum seaweed that could lead to the development of a sustainable sargassum value chain, easy to replicate and scaled- up in other areas or countries	Polytechnic University in Quintana Roo (UPQRoo)	2019
24	**SOS** (Sargassum Ocean Sequestration) of Carbon Click here to visit website!	This project supports the production of a specialized machine used as an alternative way to manage pelagic sargassum strandings. The machine pumps sargassum to a critical depth where it becomes negatively buoyant. Also exploring carbon credit or carbon trading opportunities.	Massachusetts Institute of Technology (MIT)	2019
25	**EnergYAlgae** Click here to visit website!	Multi-sectoral and multi-national initiative developing sustainable sargassum uses with a focus on bioenergy.	AlgaeNova, Grupo Puntacana, University APEC (UNAPEC), Y.A. MAOF Holdings & Management Ltd.	2019
26.	**Closing the Circle Programme** Click here to visit website!	Exploring challenges and advancing potential solutions to marine debris, Sargassum threats and marine spatial planning in Small Island Developing States with a particular focus on the Eastern Caribbean region.	World Maritime University	2020

	Sargassum Caribbean Projects, Programmes and Initiatives	Brief Description	Organisation/agency	Start Year
27.	**Sargassum Podcast** Click here to visit website!	A podcast hosted by marine educators and scientists with a range of expertise in Sargassum and Coastal Communities. The podcasts interviews a variety of stakeholders about how they experience Sargassum, a floating algae that has caused severe problems when beaching in the wider Caribbean and West Africa.	Marine conservation without borders	2021
28.	**Sustainable Sargassum Management in Anguilla, British Virgin Islands, and Montserrat** Click here to visit website!	The project aims to enhance the knowledge, institutional frameworks, experience and commitment of coastal and marine resource managers and users in Anguilla, BVI and Montserrat to manage the ecological and socio-economic risks from sargassum influxes.	CANARI, UWI-CERMES and OECS Commission	2021-2024
29.	The Project for Improving **National Sargassum Management Capacities in The Caribbean** Click here to visit website!	This project aims to support the enhancement of the national capacity for the management of sargassum inundations by providing five small island developing states in the Eastern Caribbean with equipment, expertise, and technical knowledge to collect, remove, transport, and dispose of sargassum accumulated on shore and/or in the nearshore.	Government of Japan and UNDP	2022-2025
30.	**Sargasse Project** Click here to visit website!	This project involves converting sargassum into a useful, ecological biomaterial, which will become an ecological packaging product of the future.	Coordinator and collaborators can be found here	

	Sargassum Caribbean Projects, Programmes and Initiatives	Brief Description	Organisation/agency	Start Year
31.	Building capacity to monitor and manage sargassum seaweed inundations in Western Africa **(SARCAP)** Click here to visit website!	This project aims to build capacity within West African schools, local communities, research institutes and environmental management organisations to monitor, manage and use sargassum.	Tecnológico de Monterrey, the University of Ghana, the University of Southampton and the University of York	
32.	Monitoring a large Sargassum bloom subject to a major volcanic eruption **(MONISARG)** Click here to visit website!	This project aims at understanding variations in Sargassum inundation within the Caribbean region following the eruption of the La Soufrière volcano in St. Vincent.	The Mona Geoinformatics Institute (MGI), the University of Southampton (UoS) and CERMES	
33.	**Half Moon Bay (HMB) Sargassum Project** Click here to visit website!	This project aims to mitigate the environmental damage caused by sargassum influxes through the construction and deployment of an offshore barrier outside the reef of Half Moon Bay, Mexico.	Mexican Secretariat of the Environment & Natural Resources (The Yucatan Environmental Fund (YEF) and Ecoproteccion Akumal (EPA)	2021

8 SARGASSUM USES

There continues to be a rapidly growing interest across the Caribbean region in utilizing sargassum as a primary resource for developing value-added compounds for varied industries, to help to mitigate damage caused by repeated strandings. Entrepreneurs and research teams across the region have been working over the last few years to develop innovative projects and businesses using sargassum seaweed including agricultural uses, biofuels, bioplastics, alginates, cosmetics and environmental restoration. Below is a map showing the sargassum entrepreneurs and researchers across the Wider Caribbean (last update was 2020).



(Extracted from The Sargassum Uses Guide (2020))

Applications of sargassum for example agriculture, have been explored in Grenada. The Environmental Division in collaboration with St. Georges University has been researching the chemical composition of sargassum, especially its heavy metal content, to determine its safe usage as fertiliser.

8.1 KEY RESOURCES

The Sargassum Uses Guide[5] remains the most comprehensive and authoritative resource on potential applications of sargassum biomass. Potential uses were identified across 14 different sectors, including

[5] Desrochers, A., S-A. Cox, H.A. Oxenford and B. van Tussenbroek. 2020. Sargassum uses guide: a resource for Caribbean researchers, entrepreneurs and policy makers. Report funded by and prepared for the Climate Change Adaptation in the Eastern Caribbean Fisheries Sector (CC4FISH) Project of the Food and Agriculture Organization (FAO). Centre for Resource Management and Environmental Studies (CERMES), University of the West Indies, Cave Hill Campus. Bridgetown: Barbados. CERMES Technical Report No. 97, 172 pp.

agriculture, biofuels, cosmetics, bioplastics, construction, pharmaceutical, among others. Below shows Sargassum Biomass Index, illustrating the relative product yields that could potentially be produced from one metric tonne (1000 kg) of fresh sargassum. Click here to access the full document.

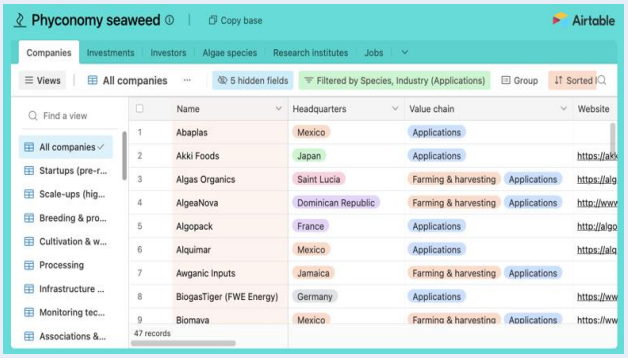
Other highlights of the document include:

In addition to the Sargassum Uses Guide, below are some useful open access (free) seaweed databases and a podcast on sargassum uses ranging from micro, small and medium sized enterprises (MSMEs) to larger scale ventures.

The Phyconomy Seaweed Database

This database contains extensive information about over 1000 organisations in the global seaweed industry. Of these, 50 focus particularly on sargassum in the Wider Caribbean region and beyond (at the time of writing). The database also tracks investments in the seaweed economy, as well as information on algae species, harvesting volumes and more.

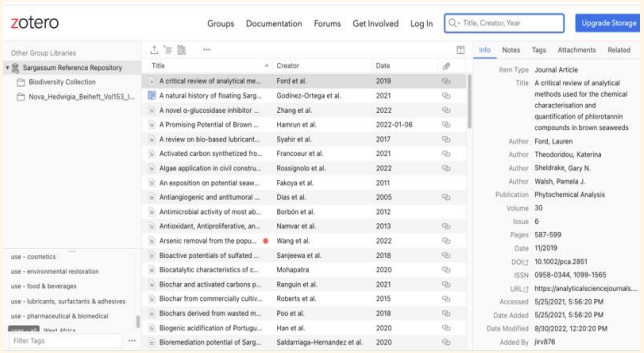
Click here to visit the database!



The UWI-CERMES Sargassum Reference Repository

This is a living and growing collection of scientific works related to the biology, impacts and uses of sargassum within the Wider Caribbean Region and beyond. The references are organised and searchable based on a predetermined set of tags, including uses. At the time of writing, 92 entries were compiled under the uses tag.

Click here to visit the database!



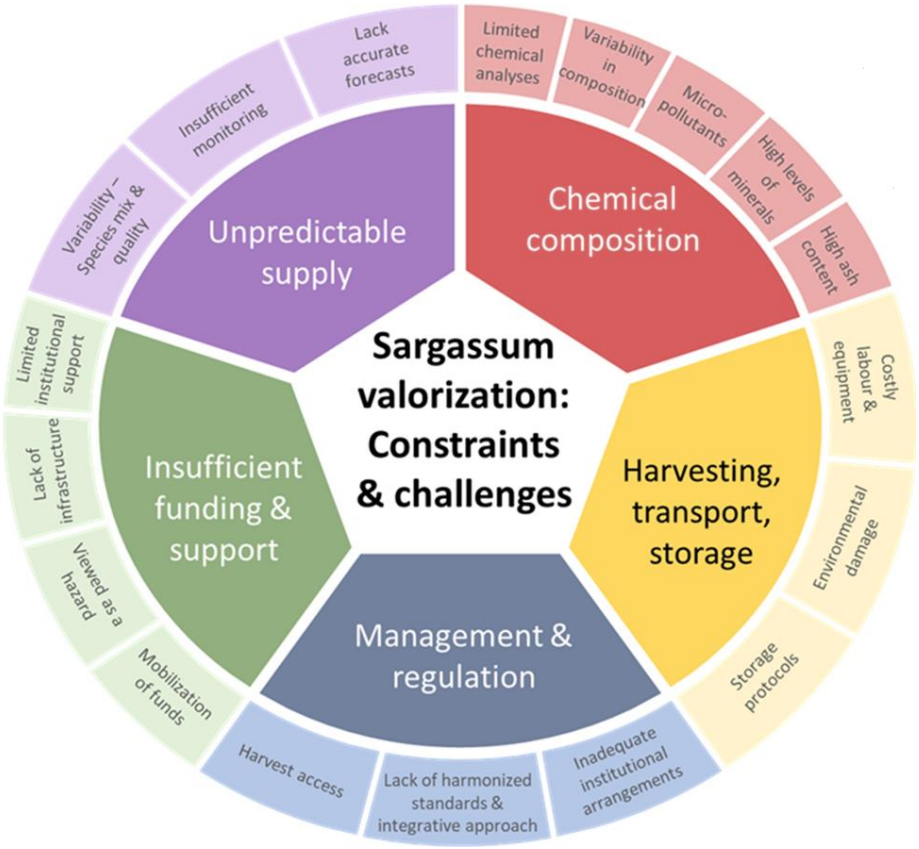
The Sargassum Podcast

The podcast is hosted by marine educators and scientists with vast expertise in sargassum and coastal communities. The sargassum podcast hosts interviews with a wide range of stakeholders including scientists and innovators with information exchange on where the science is headed based on new emerging information, including uses.

Click here to visit the website!

8.2 Challenges and considerations

Although strides have been made in exploring ways to valorize this feedstock, converting sargassum biomass into value-added does not come without its constraints and challenges. Oxenford et al. (2021) [6]conducted a comprehensive investigation of the challenges and constraints to starting up, expanding, and scaling-up existing sargassum-related ventures, as summarized in the following image. Click here to access the publication.



Source: Oxenford et. al (2021)

[6] Oxenford, H., S-A. Cox, B. Tussenbroek, A. Desrochers. 2021. Challenges of Turning the Sargassum Crisis into Gold: Current Constraints and Implications for the Caribbean. *Phycology* 1(1), 27-48.

Due to the widespread use of sargassum in agriculture, the chemical composition of sargassum, in particular the concentration of heavy metals, has drawn more and more attention over time. Emerging studies cautioned its use in animal feed and fertilizer for consumables due to **elevated levels of arsenic and cadmium**, which can be toxic to humans and animals. Notably, some companies e.g. Algas Organics have reportedly found successful methods of extracting heavy metals during their production process.

Notwithstanding, more research is needed to understand impacts of these higher levels of heavy metals and the long -term effects when ingested. The door is open for sargassum to be used as building material, biofuel or perhaps fertilizer for decorative plants or construction material, such as bamboo.

Click in the links below to view some of the studies on heavy metal concentration in sargassum:

- Element concentrations in pelagic Sargassum along the Mexican Caribbean coast in 2018-2019
- Sargassum Fertilizer Transfers Heavy Metals to Vegetables
- Opportunities for Valorisation of Pelagic Sargassum in the Dutch Caribbean