DRAFT

BRITISH VIRGIN ISLANDS SARGASSUM ADAPTIVE MANAGEMENT STRATEGY (SAMS)

VOLUME 2: ACTION APPENDICES





2023

DARWIN INITIATIVE
CANARI
DEPARTMENT OF NATURAL RESOURCES ANGUILLA
GOVERNMENT OF THE VIRGIN ISLANDS
MALHE
CERMES UWI
Organisation of Eastern Caribbean States

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Photo credits:

Top left- Burton Smith (Trellis Bay inundation, 2018)
Top middle- Todd Van Sickle, the VI Beacon (Dead Fish on the Beach at Handsome Bay, 2015)
Top right- Vincent Wheatley, Facebook (Aerial photos of Anegada's South Coast, 2019)
Bottom left- 2 of Us Photography (Sargassum Clean up at Road Town Ferry Dock, 2017)
Bottom right- Vincent Wheatley (Handsome Bay Sargassum accumulation, 2019)

PART A
COUNTRY SPECIFIC

1 NATIONAL LAWS, POLICIES AND STRATEGIES RELEVANT TO SARGASSUM MANAGEMENT

This section lists the existing legislation which provides the framework for sargassum management in The British Virgin Islands.

- National Sustainable Development Plan, 2021
- Protected Areas System Plan 2007-2017
- National Parks Act, 2006 and National Parks Regulations, 2008
- The Virgin Islands (UK) Climate Change Adaptation Policy, 2012
- Green Paper on Environmental Management Climate Adaptation Bill, 2019
- Virgin Islands (UK) Food Security and Sustainability Act, 2022
- Fisheries Act, 1997 and Fisheries Regulations, 2003
- Merchant Shipping Act, 2001
- VI Ports Authority Act (1990) and VI Port Authority Regulations 1995
- Beach Use Policy, 2019
- Beach Protection Act, 1982
- Marine Estate Administration Policy, 2021
- Strategic Blue Economy Roadmap 2020-2025
- Physical Planning Act, 2004
- National Physical Development Plan for the British Virgin Islands, 2019
- Public Health Ordinance (Cap. 194), 1977
- Tourist Board Ordinance. Act. Chapter 280.
- The Virgin Islands Comprehensive Disaster Management Strategy 2019-2025
- Disaster Management Act, 2003
- Disaster Management Policy, 2003
- Energy Policy, 2016
- Resilient National Energy Transition Strategy, 2019
- Waste Management Strategy for the British Virgin Islands, 2019
- The Waste Management Strategy, Final Report on Waste Characterisation 2019

2 INSTITUTIONAL ARRANGEMENTS FOR MANAGING SARGASSUM

The Ministry of Natural Resources and Labour is the lead agency for response to sargassum influxes, and is supported by the Ministry of Education, Culture, Youth Affairs, Fisheries and Agriculture along with other government agencies, businesses and community organisations (Government of the Virgin Islands, 2015). Although there is currently no sargassum management committee in place, it was recommended that issues related to sargassum can be included in discussions of the Climate Change Adaptation Committee (Hastings, 2022, pers. comm.).

The Strategic Blue Economy Roadmap proposes the development of the National Ocean Governance / Blue Economy Coordination Committee which will implement the blue economy roadmap and provide an overview of marine management. When established, this committee this committee may also deal with concerns regarding sargassum (Government of the Virgin Islands and the United Nations Development Programme, 2020). The committee will convene twice a year in accordance with its terms of reference, and a representative of the Office of the Premier will serve as chair. The following organizations will be represented on the Committee:

- Ministry of Natural Resources, Labour and Immigration
- Department of Agriculture and Fisheries

- Town and Country Planning Development
- Virgin Islands Shipping Registry
- Department of Disaster Management
- National Parks Trust of the Virgin Islands
- Virgin Islands Tourist Board
- H. Lavity Stoutt Community College
- Marine Tourism Industry Representative
- Fishing Industry representative
- Any other additional experts / observers invited as the need arises.

3 RELEVANT STAKEHOLDERS

This section lists the known relevant government, civil society and private sector stakeholders involved in sargassum management in The British Virgin Islands.

Table 1: *List of stakeholders with interest in sargassum management.*

Stakeholder organisation name	Brief description of stakeholder	Likely interest in Sargassum management
Government		
Ministry of Natural Resources, Labour and Immigration	Responsible for management of the natural resources	- Engaged in public education on Sargassum / its uses - Responsible for policy development and implementation to address Sargassum impact and influx. - Responsible for monitoring of coastlines - In need of sargassum management plan
Department of Agriculture and Fisheries - Ministry of Education, Culture, Youth Affairs, Fisheries and Agriculture	Ensures sustainable food security within agricultural and fisheries sector.	- Identifying removal methods for sargassum - Research into production of compost and sargassum based fertilisers - Public education/sensitisation on sargassum impacts and its uses - Provides support to the Ministry of Natural Resources, Labour and Immigration
Department of Disaster Management, Deputy Governor's Office	Coordinates disaster management policies/plans/programmes (disaster prevention/mitigation, preparedness, response/recovery)	- Sharing sargassum forecasts / CERMES bulletins
Environmental Health Unit, Ministry of Health and Social Development	Provides environmental health services in areas related to food hygiene, water quality, vector control, wastewater, general environmental sanitation, and port health.	- Assists in coordinating clean-up efforts - Public Education/Sensitisation

Stakeholder organisation name	Brief description of stakeholder	Likely interest in Sargassum management
Department of Waste Management, Ministry of Health and Social Development	Responsible for collection and disposal of solid waste	- Sargassum waste management
Virgin Islands Shipping Registry	Maritime administration	- Concerns related to impacts of sargassum on boats / fishing vessels
The Water and Sewerage Department	Manages water supply and sewage disposal	- Public Education/Sensitisation on sargassum impacts - Concerns related to sargassum impact on potable water supply
British Virgin Islands (BVI) Tourist Board	Statutory Board under Premier's Office; Promotes/markets tourism destinations and service providers within VI	- Concerns related to impacts of sargassum near popular tourist sites
BVI Ports Authority	Statutory Board under Premier's Office; Supports seaport facilities and services	- Concerns related to impacts of sargassum near docks/ports - Involved in planning clean-ups
H. Lavity Stoutt Community College (Statutory Board under Ministry of Education, Culture, Youth Affairs, Fisheries and Agriculture)	National Tertiary level educational institute	- Public Education/Sensitisation - Assists in clean-up activities
National Parks Trust of the Virgin Islands (Statutory Board under Ministry of Natural Resources, Labour and Immigration)	Preserves and manages designated natural and cultural protected areas	- Public Education/Sensitisation
Civil Society		
Seventh Day Adventist Church; Rotary and Rotaract Clubs; The Filipino Society	Various Community Groups	- Assisted in clean-up efforts
Unite BVI	A BVI registered non-profit that brings together people, great ideas and resources to tackle community and environmental challenges	- Bridging public-private partnerships and utilizing business-based solutions to meet the challenges and opportunities presented by Sargassum in the BVI. - Hosted a 2016 Sargassum Conference on partnership and business opportunities. - Special interest on sargassum's effect and impact on endangered sea turtle populations in the BVI

Stakeholder organisation name	Brief description of stakeholder	Likely interest in Sargassum management
Jost van Dyke Preservation Society	Promotes the conservation of Jost Van Dyke, British Virgin Islands, its adjacent smaller cays and marine system through research and monitoring, education and restoration	- Concerns related to impacts of sargassum on these coastal/marine areas; can provide local knowledge on sargassum impacts and can also benefit from communication of knowledge on best practices.
Green VI	Waste disposal, recycling	- Involved in planning clean ups - Waste disposal and management - Public Education/ Sensitisation
Virgin Gorda Fishermen's Cooperative	Fishing group in Virgin Gorda; Hosts youth summer programmes and Fishing tournaments	- Livelihood can be possibly impacted by sargassum influxes; can provide local knowledge on sargassum impacts and can also benefit from communication of knowledge on best practices
Jost Van Dyke Fisherfolk Association	Represents the interests of Jost Van Dyke fishers	Livelihood can be possibly impacted by sargassum influxes ; can provide local knowledge on sargassum impacts and can also benefit from communication of knowledge on best practices.
Tortola fishers	Represents the interests of Tortola fishers	Livelihood impacted can be possibly by sargassum influxes; can provide local knowledge on sargassum impacts and can also benefit from communication of knowledge on best practices.
Anegada Fishers	Represents the interests of Anegada fishers	Livelihood impacted can be possibly by sargassum influxes; can provide local knowledge on sargassum impacts and can also benefit from communication of knowledge on best practices.
BVI Sport Fishing Association	Represents the interest of sport fishers	Livelihood impacted can be possibly by sargassum influxes; can provide local knowledge on sargassum impacts and can also benefit from communication of knowledge on best practices.
Marine Association of the BVI	Non-profit organisation representing interests of marine industry; including assisting promoting employment/training within marine industry, and assisting in identifying marine shelters during hurricane season	Concerns related to impacts of sargassum on marine sector.
Private Sector		
Tidal Roots Farm, Tortola	Private organic farm	- Has been experimenting with the seaweed as fertilizer for the organic farm operation; can contribute / benefit from knowledge exchange and development of plan.
Farm at Paraquita Bay; various farms	Privately owned farms	- Has been processing sargassum to be used as fertilisers; can contribute /

Stakeholder organisation name	Brief description of stakeholder	Likely interest in Sargassum management
		benefit from knowledge exchange and development of plan.
Drake's Traders, Clarence Thomas Ltd, Alfonso Warner Insurance, Trident Trust	Various Businesses	- Has assisted in clean-up efforts
BVI's Ferries and Taxi Services	Inter-island sea transportation	- Impacted by sargassum accumulation at docks
Virgin Gorda Yacht Harbour	Privately owned yacht harbour in Virgin Gorda	- Impacted by sargassum accumulation at docks
BVI Yacht Charters	Privately owned company focused on bareboat charters	- Impacted by sargassum accumulation at docks
BVI Scuba Organisation / Dive Operators Association	Representing interests of dive shop owners and involved with the upkeep and funding of marine parks and protecting the environment	- Activities impacted by sargassum influxes
The BVI Chamber of Commerce & Hotel Association	Association representing interests of local businesses and hotel owners	- Hotels/businesses along coastal areas can potentially be impacted by sargassum influxes

4 FINANCING

The hiring of contractors to remove and dispose of sargassum for the months of May through September for 2021 and 2022 at priority sites, was considered under key performance strategies for the Ministry of Natural Resources, Labour, and Immigration in the budget summary and estimates. However, details of budget allocations were not provided (Government of the Virgin Islands, 2021c; Government of the Virgin Islands, 2022).

Additionally, districts have the option to allocate a percentage of their budget to sargassum-related initiatives. In 2019, an unspecified portion of the US$14,881,44 budget alloted under undefined activities, for District 9 (Virgin Gorda and Anegada), was disbursed to fund sargassum clean-up efforts in Handsome Bay (Durand, 2020).

5 PAST OR CURRENT MANAGEMENT RESPONSES

Reducing sargassum accumulation along key coasts and beaches has been the main objective of the national management response to allow for natural dispersion or decomposition and minimize any possible harmful effects (Government of the Virgin Islands, 2015). The government is leading management initiatives that include ongoing cleanup operations as well as public education and sensitization campaigns.

Public education campaigns for have included handing out pamphlets, sending alerts to the public, and organizing public talks to explain the history of sargassum, its benefits and negative impacts, as well as how to safely remove it from beaches. Workshops aimed at the tourist industry have also been incorporated in public education efforts to offer knowledge on practical approaches and feasible actions (Conservation

and Fisheries Department, n.d.; Government of the Virgin Islands, 2015; Department of Conservation and Fisheries, Government of the Virgin Islands, 2016; Government of the Virgin Islands, 2019e).

The government has planned community-based cleanup initiatives in collaboration with a number of enterprises and community organizations. Due to the need for people and resources, the government's primary response to sargassum is to continue working in collaboration with community groups, fisherfolk, and businesses on clean-up initiatives. Additionally, locals have been urged to give their time to clean up coastal regions. These cleanup efforts have concentrated on using hand tools and small machinery to minimize beach sand removal. However, when necessary, the government has coordinated cleanup initiatives utilizing heavy equipment; this has happened at Virgin Gorda's Handsome Bay (Government of the Virgin Islands, 2015). Contractors have been used to support cleanup operations in dire situations, such as following the passage of Hurricane Dorian in August 2019. Previously, coastlines were monitored to identify regions that needed to be prioritised for cleaning up. However, since Hurricane Irma, priorities have changed, and coastal monitoring and surveillance have decreased (Claxton-Smith, 2021).

In addition to the conventional clean-up methods, other mitigative techniques were attempted, for example, flushing marina channels of sargassum to minimize impacts. This has been done by utilising docked boats as mobile flushing stations by continuously running their engines over a period of time. This has proven effective but was not a cost-efficient long-term solution. Nanny Cay marina has been piloting the use of marine de-icers or circulators from Canada to assist in removing sargassum from the marina. Other private businesses such as ' Swim with Dolphins' have conducted water testing after sargassum influxes and have also utilised pumps to remove water from inside the facility. This business also utilised heavy machinery to remove tonnes of sargassum, and initial clean-up efforts in 2015.

A commitment to regional cooperation was also a part of the government's response. In 2016, the Government, Virgin Unite, The Caribbean Council, the UK Foreign & Commonwealth Office, and the Organisation of Eastern Caribbean States collaborated to host a two-day regional sargassum conference on Moskito Island. Various specialists and stakeholders conducted discussions that focused on sargassum research and prospective applications for sargassum. (Sargassum Information Hub, n.d.). At the First International Conference on Sargassum in 2019, which was organised by the Regional Council of Guadeloupe, VI signed the statement to create a "Caribbean Programme for Sargassum" alongside several organizations, territories, and nations from the Wider Caribbean Region. (ACS, n.d.).

6 LIST OF KEY INFORMANTS

Table 2: Key representatives of government and non-governmental organisations involved in sargassum management

Organisation	Name / Position	Gender
1. Ministry of Natural Resources	Mervin Hastings (Marine Biologist)	Male
2. Environmental Health Unit	Lionel Michael (Chief Environmental Health Officer)	Male
3. Department of Agriculture and Fisheries	Tessa Smith-Claxton (Assistant Secretary)	Female

	Abbi Christopher (Fisheries Specialist)	Female
4. Department of Waste Management	Neville Allen (Acting Manager)	Male
5. Department of Disaster Management	Melanie Daway (Senior Technical Planning Manager) Sheniah Armstrong-Jones (Deputy Director)	Female Female
6. Unite BVI	Kim Takeuchi (Foundation Manager)	Female
7. Green VI	Charlotte McDevitt (Executive Director) Natasha Harrigan (Senior Project Manager)	Female Female

7 EXPOSURE AND VULNERABILITY ASSESSMENTS

Setting Point dock and Pomato Point on Anegada were among the locations affected by sargassum influxes, according to an assessment carried out after Hurricane Dorian passed through in 2019. It was noted that sargassum has infrequently affected these sites in the past. The Environment Systems, UK's satellite data was used to determine the extent of the sargassum impact at Setting Point (via a data sharing agreement for post hazard impact analysis).

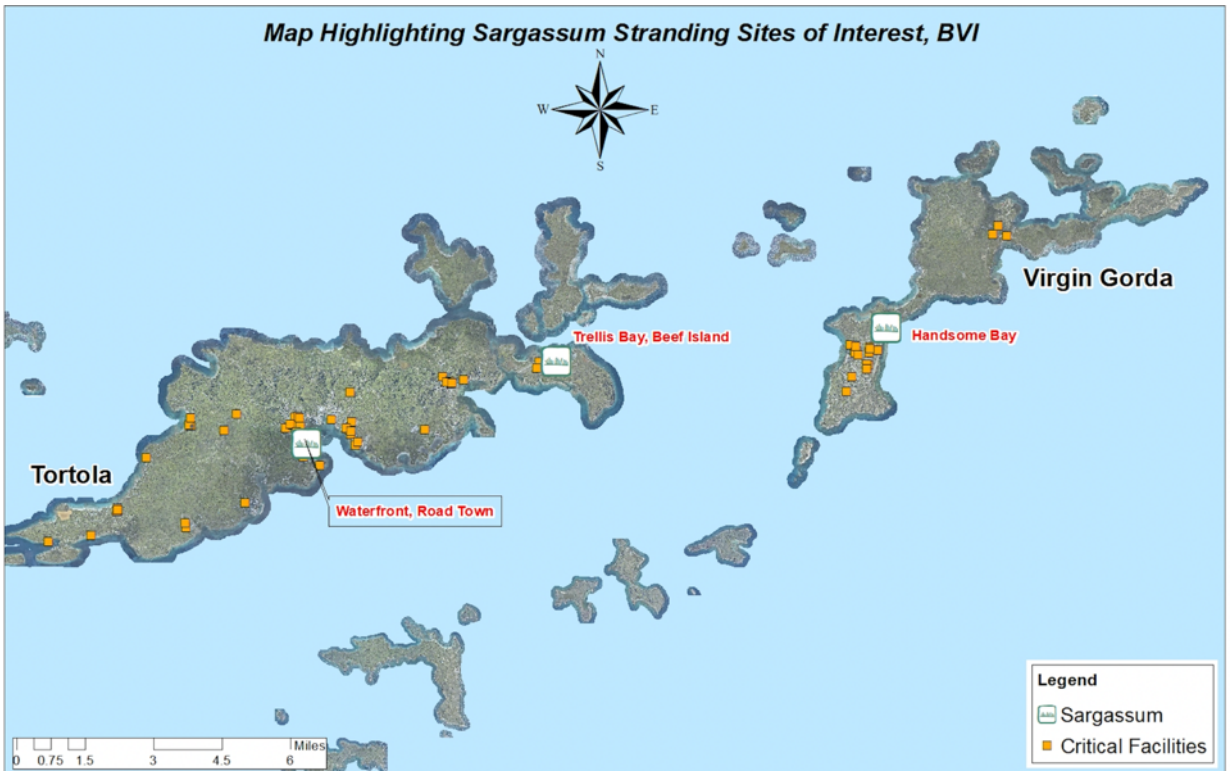
Satellite imagery was processed to differentiate vegetation and was compared to previous imagery capture in November 2018 and to unimpacted sites post Hurricane Dorian (e.g. Eastern point). GIS analysis then determined the extent of sargassum impact at Setting and Pomato points. At Setting Point, it was estimated that 589 meters of coastline extending over an area of 39,059 square metres was affected, and 187 meters of coastline extending over 8,368 square metres was impacted at Pomato Point. In total, 776 meters of shoreline with an area of 47,427 square metres was impacted by sargassum influxes caused by the passage of Hurricane Dorian (Ministry of Natural Resources, Labour and Immigration, n.d). The use of this method to quantify the area impacted by sargassum reduced the amount of site visits required and allowed for effective estimation of clean-up costs (Smith-Claxton, 2021).

Seven site profiles have been conducted as part of the project's scoping (see Appendix 3). The data analysis has to be completed, and information has to be verified by key VI stakeholders. However, strategic adaptive management can start once there is a regular schedule for updating all site profiles.

8 LOCATION PROFILES OF SARGASSUM STRANDING SITES

Sargassum influxes impact the entirety of the Virgin Islands (UK). However, three (3) sites were identified by the Ministry of Natural Resources (Hon. Vincent Wheatley, 2 April 2022, pers. comm) to be of most concern for sargassum management. These, as shown on the map, are:

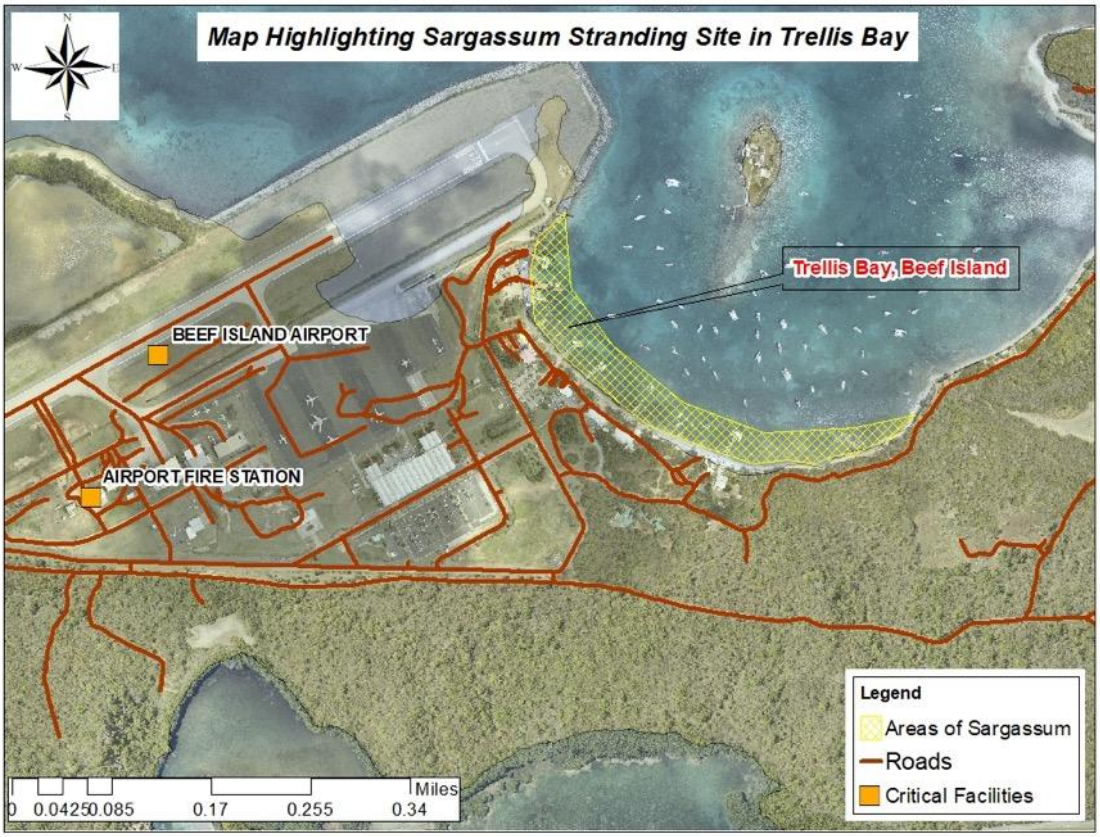
1. Trellis Bay, Beef Island
2. Handsome Bay, Virgin Gorda
3. Road Town Harbour, Tortola



Each profile includes a map of the area and briefly describes the location's social and ecological characteristics, vulnerability factors, and site accessibility. Ultimately, the profiles provide a basis for an adaptive management plan for sargassum that is acceptable to stakeholders and/or decision-makers, taking into account additional information and the fact that sargassum situations frequently exhibit a high degree of dynamicity.

Two of the profiles (Indigo, Camanoe Island and Sea Cow's Bay, Tortola Island) are incomplete due to lack of data. They can be completed as the sargassum adaptive management strategy is implemented.

8.1 TRELLIS BAY, BEEF ISLAND



SELECT SOCIAL KEY FEATURES	SELECT ECOLOGICAL KEY FEATURES
TRELLIS ● Barge and Ferry Access Point to Virgin Gorda from Western side of Trellis Bay smaller vessels provide ferry service to other outer-lying island (Guana Island and Scrub Islands, which both house resorts) and private boat service for the residential community of Great Camanoe Island; ● Mostly commercial: A series of restaurant, bars and other small tourism-related businesses line the waterfront; ● Close Proximity (~70 meters) to the Terrance B. Lettsome International Airport; ● During one severe sargassum influx, an ambulance boat from Virgin Gorda with a patient could not dock at their procedural drop-off zone due to the Sargassum blocking the dock and being forced to relocate to the other end of the Bay to dock. **LONG BAY** ● A series of vendors are set up to cater to visiting cruise ship guests. ● Government of the Virgin Islands (Ministry of Natural Resources, Labour and Immigration)	**TRELLIS** ● Gently sloping, fine-sand barrier beach; ● Seagrasses and some corals are contained within the bay; ● Typical beach vegetation (seagrape, coconut palm, buttonwood mangrove). Beach more 'natural' on eastern edge with more exotic/ornamentals found around businesses/areas of human settlement. **LONG BAY** ● Sandy barrier beach ● Known sea turtle nesting sites for Leatherback Sea Turtles. ● Adjacent Salt Ponds; ● Hurricane-damaged coastal mangroves.

is actively working to establish a Beach Management Plan (spring 2022).	

VULNERABILITY FACTORS	
Geophysical features	Prevailing Easterly trade winds and currents draw sargassum to the SW corner of the bay.
Is there adequate access to the bay to facilitate clean-up efforts	Yes: Adequate access for mechanical and manual clean-up efforts. Nearly every business on the bay had vehicular access.
Is the area important for fishing? (presence of fish market and other infrastructure e.g. jetty)?	No
How close is the community to the Bay?	Not Close. This is a commercial area with businesses.
Proximity of bay to schools and other infrastructure (e.g. polyclinics)	Far: >1km
Volume of sargassum during scoping assessment	None/Low (March 2022)
Volume of sargassum historically (2011-present)	Extremely High
Is the beach heavily used by locals?	Yes, this is a popular recreational site
Is the beach heavily used for tourism?	Yes, most persons using the beach are visit
EVIDENCE OF RESILIENCE	
Is there evidence of community efforts to clean-up?	Yes: Each business takes responsibility for clean-up in their own areas of the bay. It was recognised that this is easier for upwind/current businesses where accumulation tends to be less.
Is there evidence of community efforts to use sargassum	Some. One business owner also owns an organic farm and is experimenting with composting using vermiculture methods. Some businesses used as fertilizer in and around ornamental plants only.
Presence of church and community groups that advocate for government assistance?	Some. In October of 2015, the Rotary Club Sunrise partnered with the Department of Conservation and Fisheries to host a Sargassum Clean Up.

BEACH ACCESS	LOCATION	TERRAIN
Vehicular	Ferry Dock/Barge	Off main road (paved)
Vehicular	Trellis Bay Market -Loose Mongoose	Dirt Road just off of a paved main road
Vehicular	Long Bay Beach	Dirt Road.

NOTES

According to the on-site inspection, Trellis Bay has no protection against the inflow of Sargassum which is likely to accumulate given prevailing wind and current patterns in the VI. Business owners usually removes sargassum as it comes ashore, and the quantity of Sargassum removed varies based on their position in the Bay, with lower quantities accumulating on the Eastern edge and most of the sargassum being swept downwind/down current to the Southwestern corner of the Bay.

The problem severely effects the businesses at the Western End of the bay. When there is excessive sargassum accumulation, Speedy's Ferry has been forced to cease operations, diverting all ferry service into Roadtown. Trellis Bay Market reported business sales losses of approximately 50% of total revenue during period of sargassum accumulation.

While Trellis Bay acts like a "catcher's mitt," occasionally wind shifts will pull sargassum mats downwind and strandings will occur at Long Bay Beach. Department of Conservation and Agriculture Beach Wardens are responsible for clean up at Long Beach and remove sargassum strands manually with rake and wheelbarrows (see images below).

Trellis Bay – Sargassum Accumulation

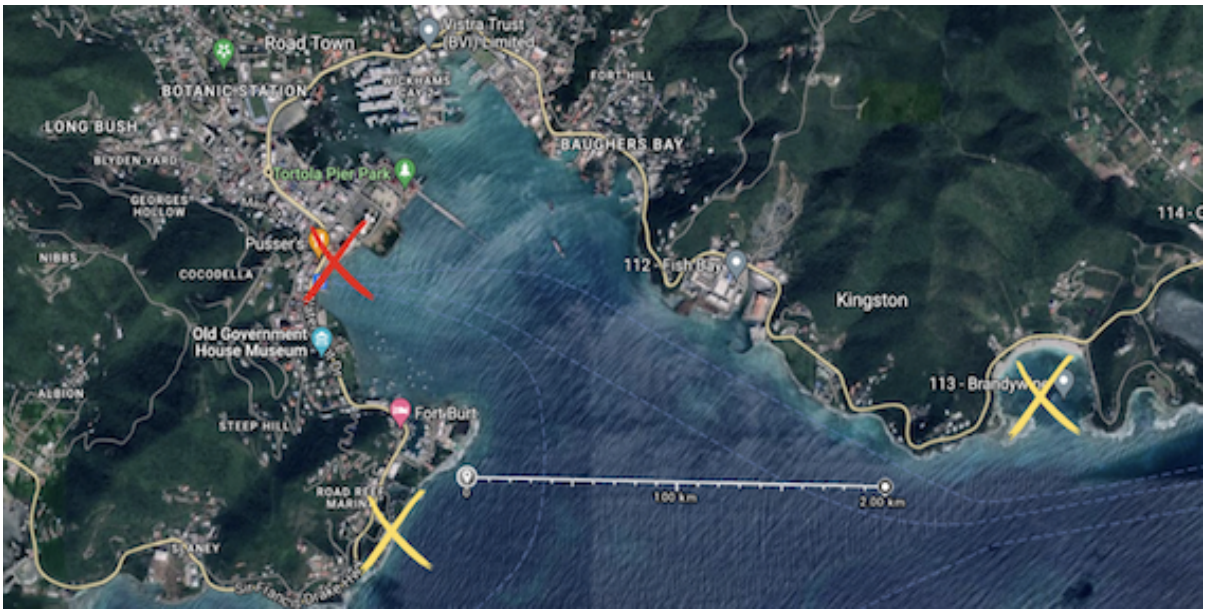
Above: (L) Trellis Bay inundation, July 2017; and (R): Trellis Bay inundation July 2018. (Photos: Burton Smith)


Above: (L) June 2019 inundation and (R): Clean up efforts by Government. (Photos: Vincent Wheatley).

Long Bay Beach- Sargassum Accumulation


Above: (L): Sargassum accumulates at Long Bay beach in June 2020 and (R): Beach Wardens from the Department of Fisheries and Agriculture clean up sargassum. (Photos: From Facebook video, Dean Sportsman Greenaway).

8.2 ROAD TOWN HARBOUR, TORTOLA



SELECT SOCIAL KEY FEATURES	SELECT ECOLOGICAL KEY FEATURES
● Business/Commercial Centre of Road Town ● Active (Domestic/International) Seaport /Ferry Terminal an Dock for Passenger Ferries to/from Anegada, Virgin Gorda and U.S. Virgin Islands.	● The greater Road Town area is heavily developed and there are few noteworthy ecological features. ● Fringing coastal mangrove communities were badly damaged during Hurricanes Irma and Maria and there are on-going efforts to restore degraded sites. Sargassum accumulation smothers and kills young newly-planted seedlings.

VULNERABILITY FACTORS	
Geophysical features	
Is there adequate access to the bay to facilitate clean-up efforts	Yes, but requires heavy equipment.
Is the area important for fishing? (presence of fish market and other infrastructure e.g. jetty)?	No
How close is the community to the Bay?	This is a heavily populated area; but most of the buildings on the waterfront are commercial or government offices.
Proximity of bay to schools and other infrastructure (e.g. polyclinics)	There is no school located on the waterfront.
Volume of sargassum during scoping assessment	A no-low sargassum volume was observed during assessment (March 2022)
Volume of sargassum historically (2011-present)	Extremely High
Is the beach heavily used by locals?	NA (No beach); however, this is an important port for accessing sister islands and the USVI.
Is the beach heavily used for tourism?	No (No beach); however, the Roadtown Ferry terminal is port of entry for many visitors. There is concern about this impact that this situation as it is often visitors' first impression of the VI. This was documented: Seaweed Causing Ferry Dock Stink: Stench Welcoming Visitors
EVIDENCE OF RESILIENCE	
Is there evidence of community efforts to clean-up?	The Government of the Virgin Islands has supported clean up initiatives. As the site is a port, clean up needs to be accessed with heavy equipment and is an unlikely candidate for community-based initiatives which typically focus on beach and recreational areas.
Is there evidence of community efforts to use sargassum	N/A – Residents are more likely to take sargassum from beach areas.
Presence of church and community groups that advocate for government assistance?	N/A Probably not viable in this location for aforementioned reasons.

BEACH ACCESS	LOCATION	TERRAIN
Vehicular	Ferry Dock/Roadtown Ferry Terminal	Off main road (paved)
Vehicular	Brandywine Beach	Off main road (paved
NOTES		

Sargassum Accumulation – Road Town, Tortola

Above: (L-R): Sargassum Accumulation at Road Town Ferry Dock and Clean up, November 2014 (R) Photos: VI Beacon.

8.3 SEA COW'S BAY (INCLUDES NANNY CAY) TORTOLA

SELECT SOCIAL KEY FEATURES	SELECT ECOLOGICAL KEY FEATURES

• TBC	• TBC

VULNERABILITY FACTORS	
Geophysical features	N/A
Is there adequate access to the bay to facilitate clean-up efforts	N/A
Is the area important for fishing? (presence of fish market and other infrastructure e.g. jetty)?	No
How close is the community to the Bay?	N/A
Proximity of bay to schools and other infrastructure (e.g. polyclinics)	N/A
Volume of sargassum during scoping assessment	A no-low sargassum volume was observed during assessment (March 2022)
Volume of sargassum historically (2011-present)	Extremely High
Is the beach heavily used by locals?	No
Is the beach heavily used for tourism?	No
EVIDENCE OF RESILIENCE	
Is there evidence of community efforts to clean-up?	N/A
Is there evidence of community efforts to use sargassum	N/A
Presence of church and community groups that advocate for government assistance?	N/A

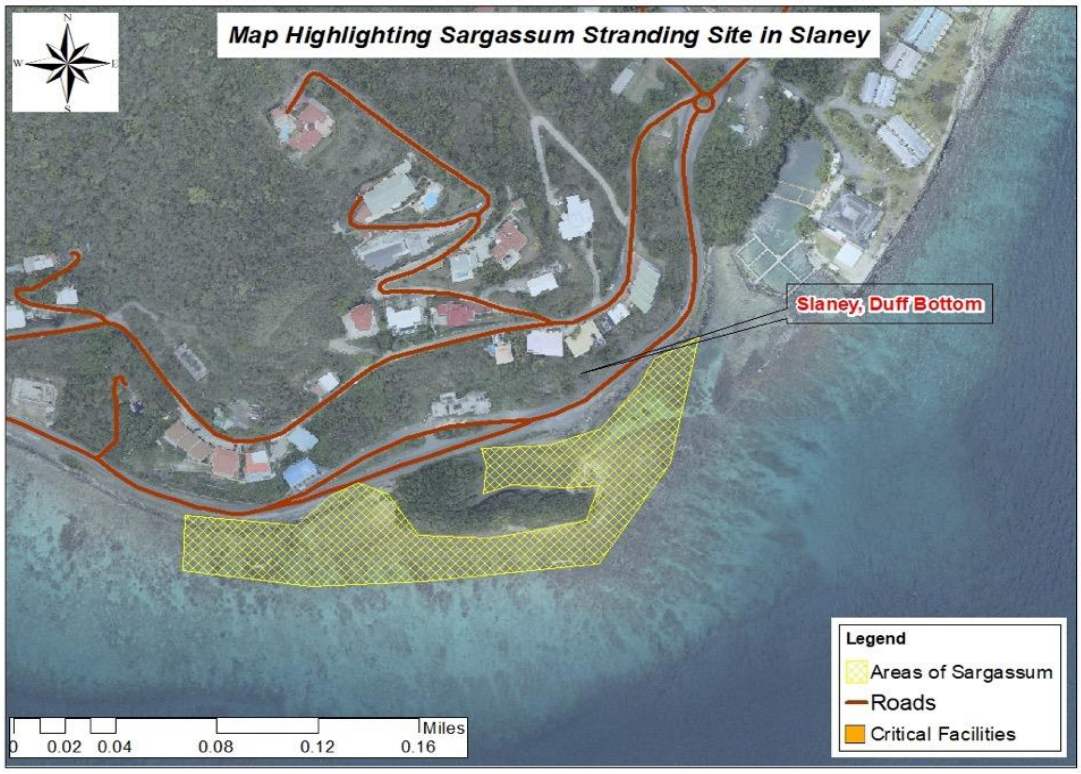
Sargassum Accumulation – Sea Cow's Bay & Vicinity

Above: (L-R) Sargassum inundation at Sea Cow's Bay, September 2015 (Photos: Virgin Islands News Online).

Sargassum Management – Nanny Cay Resort And Marina

Above: (L) Aerial view of Nanny Cay with Sea Cow's Bay in the Background and (R): Information Taken from Nanny's Cay's website about the Marina's efforts to manage the sargassum problem.

8.4 SLANEY, TORTOLA



SELECT SOCIAL KEY FEATURES	SELECT ECOLOGICAL KEY FEATURES
● A Bar and restaurant is located across the road. ● The site is adjacent to the Sir Francis Drake Highway.	● Coral rubble beach ● Small lagoon containing a red mangrove habitat with other coastal vegetation (e.g. seagrape, *Thespesia populnea*, etc.). ● The site is actively used by wetland birds and other shorebird species, possible nesting sites for plovers and sandpipers.

VULNERABILITY FACTORS	
Geophysical features	
Is there adequate access to the bay to facilitate clean-up efforts	Roadside access; however the berm is very narrow and located immediately on the Sir Francis Drake Highway. Site Clean-up would need heavy equipment and possible use of vessels.
Is the area important for fishing? (presence of fish market and other infrastructure e.g. jetty)?	No
How close is the community to the Bay?	N/A
Proximity of bay to schools and other infrastructure (e.g. polyclinics)	N/A
Volume of sargassum during scoping assessment	A no-low sargassum volume was observed during assessment (March 2022)
Volume of sargassum historically (2011-present)	Extremely High
Is the beach heavily used by locals?	No
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?	N/A

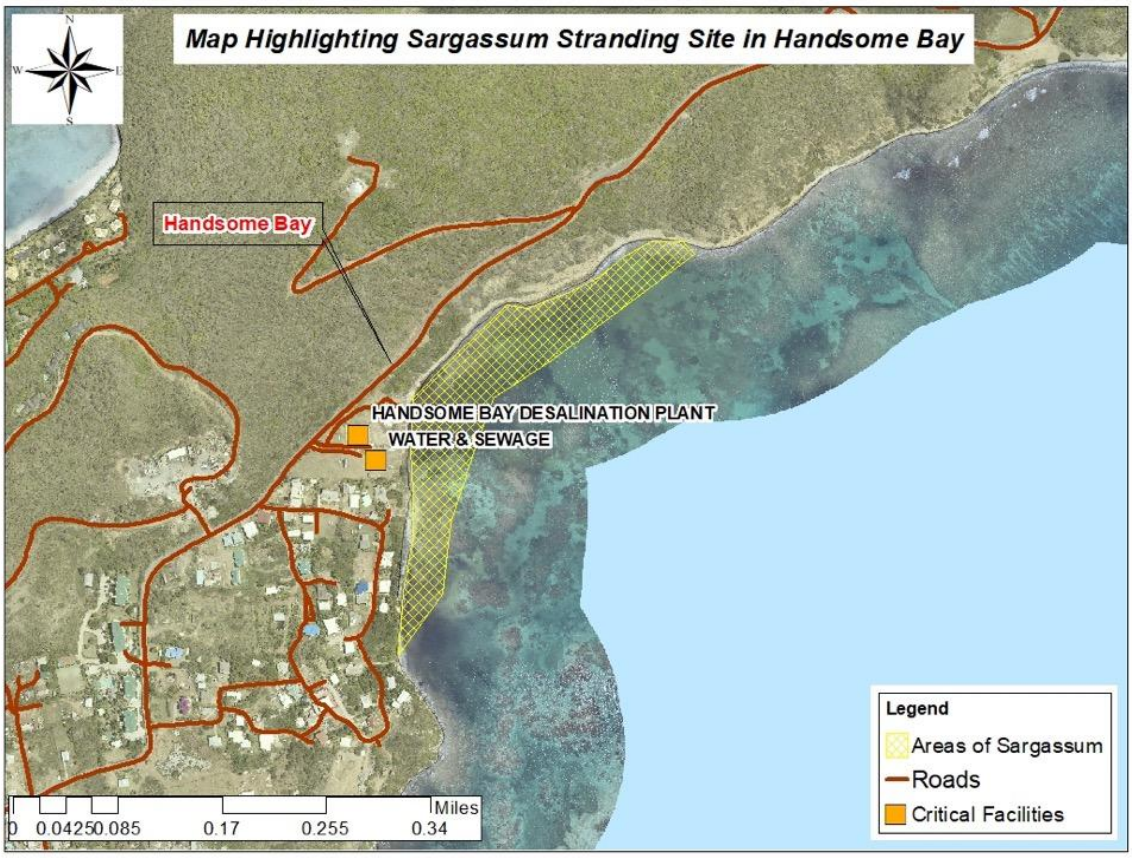
BEACH ACCESS	LOCATION	TERRAIN
Vehicular	Slaney	Off main road (paved)
NOTES		

Sargassum Accumulation – Slaney


Above: (L) Aerial view of Slaney in 2018 (Photo: Alton Bertie): and (R): Aerial view in May 25, 2022 (Photo: R. Smith).


Above(L): An owner from an adjacent business cuts a path through the mangroves at Slaney (September 2021) in an attempt to ease the accumulation of sargassum, which proved to be unsuccessful (May 25, 2022). (Photos: S. Zaluski).

8.5 HANDSOME BAY, VIRGIN GORDA



SELECT SOCIAL KEY FEATURES	SELECT ECOLOGICAL KEY FEATURES
● Residential Community ● A Reverse-Osmosis Water generation facility is located on the bay.	● Seagrape and beach morning glory/goat's foot (*ipomoea pes-caprae*) ● Some shorebirds observed during visit ● Turtles reported to infrequently nest on this beach.

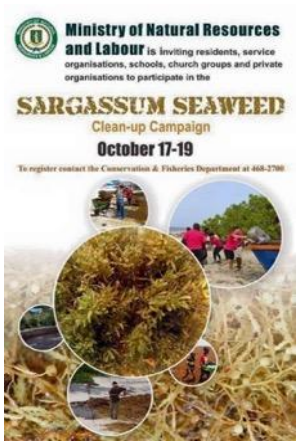
VULNERABILITY FACTORS – Handsome Bay, Virgin Gorda	
Geophysical features	Prevailing winds and current lead to heavy sargassum accumulations
Is there adequate access to the bay to facilitate clean-up efforts	Yes, heavy equipment can access the bay.
Is the area important for fishing? (presence of fish market and other infrastructure e.g. jetty)?	No
How close is the community to the Bay?	This is a residential community, the community is immediately adjacent to the stranding site.
Proximity of bay to schools and other infrastructure (e.g. polyclinics)	The R.O water plant is located at the site; The airport is ~ 1km way; Valley Day School is ~1km; Clinic is about 1.5 km away;
Volume of sargassum during scoping assessment	A "low" accumulation of sargassum (April 2022) was observed; however, the beach still contains large mounds of the decaying seaweed).
Volume of sargassum historically (2011-present)	Extremely High
Is the beach heavily used by locals?	This is a residential neighbourhood.
Is the beach heavily used for tourism?	No
EVIDENCE OF RESILIENCE	
Is there evidence of community efforts to clean-up?	Some. MNRL has spearheaded government-community initiatives (see flyer below) and other groups (Green Sprouts) report carrying out small scall clean ups.
Is there evidence of community efforts to use sargassum	Minimal. Sargassum was piled on site and believed to help address erosion issues at the beach (*pers communication, V. Wheatley*).
Presence of church and community groups that advocate for government assistance?	There are some local community groups and churches. These groups may not be immediately located on Handsome Bay; however, Virgin Gorda is a small island. Groups include Lion's and Leo's Clubs, Green Sprouts and VG Rock.

BEACH ACCESS	LOCATION	TERRAIN
Vehicular	Handsome Bay	Beach
NOTES Handsome Bay is primarily a residential area situated along the southern coast of Virgin Gorda. Recreational use of this beach is mainly by locals who live on or near the bay, some residents report spearfishing in this area. The bay, which is exposed to the Atlantic Ocean to the East, receives extreme amounts Sargassum yearly, and often is the first location to indicate the arrival of Sargassum in mass		

quantities for the Virgin Islands. Initially, Sargassum was manually/mechanically removed from the bay and transported to dumps by trucks. Due to the damage to the beaches, the method has been revised. The current solution is to pile the Sargassum onto the beach and bury it beneath the soil and sand on the beach. As the Sargassum decomposes, the piles offer protection from storm surges and act as buffers for the beach. In terms of community involvement, most times Sargassum is just left on its own until it piles up and becomes a nuance. However, there are small-scale beach cleanups done by a local environmental youth advocacy group, Green Sprouts. Some notable impacts of the sargassum problem include:

- There was one instance in which Sargassum clogged the intake pipe of the desalination plant. The facility was in operational for nearly a year. The pipe has been extended further out to prevent this. (Interview, Hon. Vincent Wheatley, April 2, 2022).
- One resident with a severe respiratory had to be repeatedly sent to the clinic. Her physician has recommended that she move from her home.
- Decomposing sargassum is correlated with the rusting of metallic objectics such as vehicles and pipes etc. in nearby homes.

Sargassum Accumulation Events– Handsome Bay, Virgin Gorda



Above (L): Dead Fish on the Beach at Handsome Bay, 2015 and (Center): Sargassum accumulation, 2015. Photos: Todd Van Sickle, the VI Beacon, Octobe 2, 2015. (R): MNRLI Flyer Calling for Community Members to support Sargassum Clean-up Efforts at Handsome Bay.

8.6 INDIGO, CAMANOE ISLAND

SELECT SOCIAL KEY FEATURES	SELECT ECOLOGICAL KEY FEATURES
• Private residential community, comprised mainly of vacation homes.	• N/A

VULNERABILITY FACTORS – Great Camanoe Island	
Geophysical features	N/A
Is there adequate access to the bay to facilitate clean-up efforts	N/A
Is the area important for fishing? (presence of fish market and other infrastructure e.g. jetty)?	No
How close is the community to the Bay?	Camanoe

Proximity of bay to schools and other infrastructure (e.g. polyclinics)	N/A
Volume of sargassum during scoping assessment	N/A
Volume of sargassum historically (2011-present)	N/A
Is the beach heavily used by locals?	N/A
Is the beach heavily used for tourism?	No
EVIDENCE OF RESILIENCE	
Is there evidence of community efforts to clean-up?	N/A
Is there evidence of community efforts to use sargassum	N/A
Presence of church and community groups that advocate for government assistance?	There is a homeowner's association.

BEACH ACCESS	**LOCATION**	**TERRAIN**
Private Vessel	Great Camanoe Island	Marina
NOTES Great Camanoe is a private island comprised of vacation and luxury homes. Sargassum mainly collects at the deep marine at Indigo Plantation.		

Sargassum Accumulation – Great Camanoe Island

Above: Sargassum inundation at Great Camanoe Island, May 2018. (Photo: Yacht Shots VI).

8.7 SETTING POINT/SOUTH COAST, ANEGADA

SELECT SOCIAL KEY FEATURES	SELECT ECOLOGICAL KEY FEATURES
• Main Point of access for the community (Ferry/Barge access); • Heavily settled area; • Numerous small tourist-related businesses (Bars/Restaurants and small hotels/inns; • Mooring field which provides access for visiting charter yacht tourists • Fisherman's Wharf near the Settlement.	• Anegada is one of the most ecologically sensitive areas in the VI; • Horseshoe Reef, one of the Caribbean's largest barrier reefs, extends outward from Anegada to the SE. • Extensive coastal fringing mangroves on the island's south coast.

VULNERABILITY FACTORS – Anegada	
Geophysical features	
Is there adequate access to the bay to facilitate clean-up efforts	Yes
Is the area important for fishing? (presence of fish market and other infrastructure e.g. jetty)?	Yes. Fisherman's wharf and Setting point are the departure/arrival locations for residential fisherman. Fishing is an important part of the community.
How close is the community to the Bay?	The Settlement, which contains the majority of residential homes is just inland from Anegada's southern coastline.
Proximity of bay to schools and other infrastructure (e.g. polyclinics)	The ferry dock is located in Setting Point
Volume of sargassum during scoping assessment	N/A Did not visit (Presumably Little/None)
Volume of sargassum historically (2011-present)	Low; however, Following the passage of Hurricane Dorian, Anegada experienced an extreme inundation.
Is the beach heavily used by locals?	Yes
Is the beach heavily used for tourism?	Yes
EVIDENCE OF RESILIENCE	

Is there evidence of community efforts to clean-up?	N/A – Volume too high for community-based efforts.
Is there evidence of community efforts to use sargassum	N/A
Presence of church and community groups that advocate for government assistance?	N/A

BEACH ACCESS	**LOCATION**	**TERRAIN**
Vehicular	Setting Point	Sandy Beach
NOTES Anegada is not typically a Sargassum inundation site for the VI; however, following the passing of Hurricane Dorian, the island experienced a massive influx of Sargassum. While Sargassum invasions may threaten beach tourism and ecologically sensitive areas elsewhere in the Caribbean, in the VI, many of the sites where sargassum accumulates in the VI are built up areas of human settlement. Although invasions may only be episodic in Anegada, the island should be considered very vulnerable to sargassum invasions due to the high economic reliance on beach tourism and fishing.		

Sargassum Accumulation – Anegada

Above: Sargassum inundation at Anegada (Setting Point), August 29, 2019, Following Hurricane Dorian. Photos: Andrew Fahie, Facebook.

Above (L-R) Aerial photos of Anegada's South Coast August 29, 2019 Following Hurricane Dorian. Photos: Vincent Wheatley, Facebook.

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PART B:
CARIBBEAN GENERAL

10 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

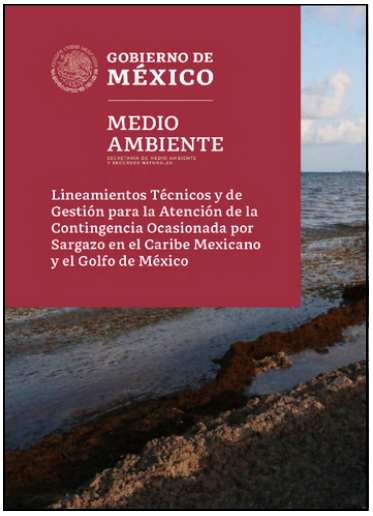
11 ACTIONS AND OPERATIONS

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.

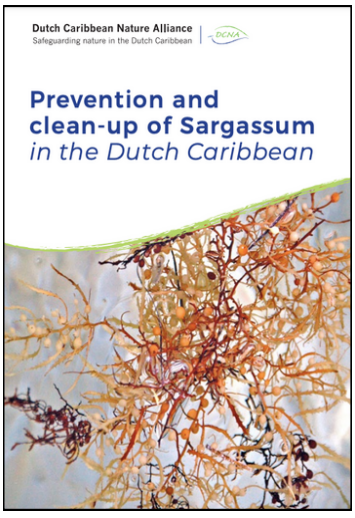
11.1 Resources For Responsible Responses

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

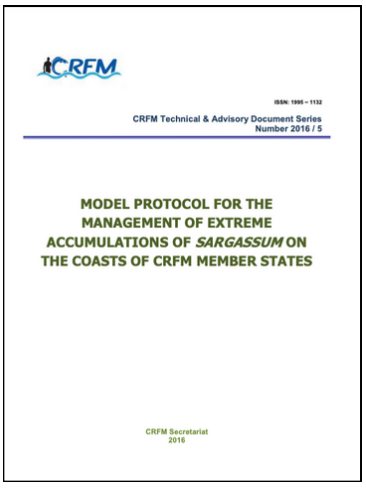


Tags: onshore and in-water collection, containment barriers, turtle nesting beaches, disposal, health and safety, monitoring, uses



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

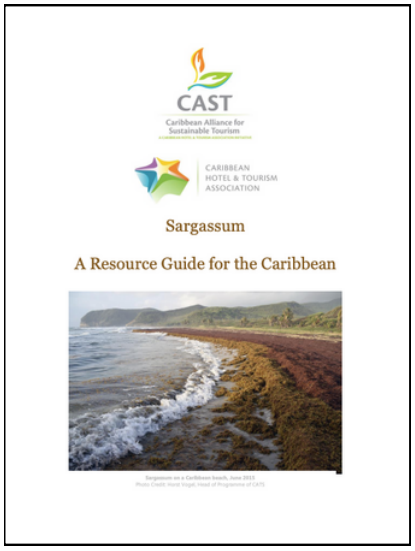
Tags: good practices, onshore and in-water collection, public awareness, uses



Tags: template, national-level management plans

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

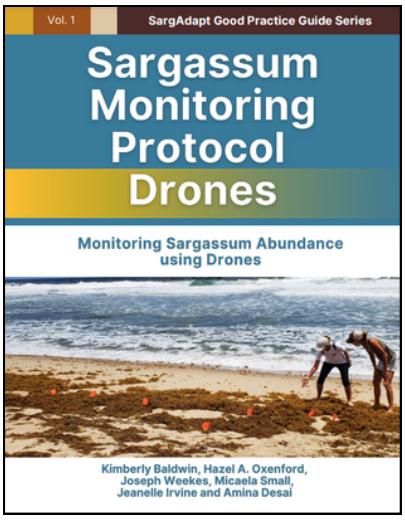
A few of the **sector specific** guidance resources are shown below. Click on the image to visit the website!

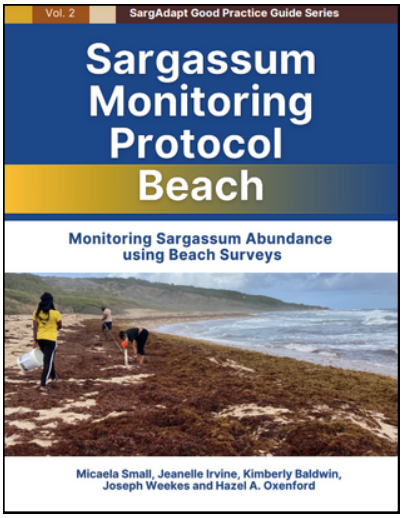


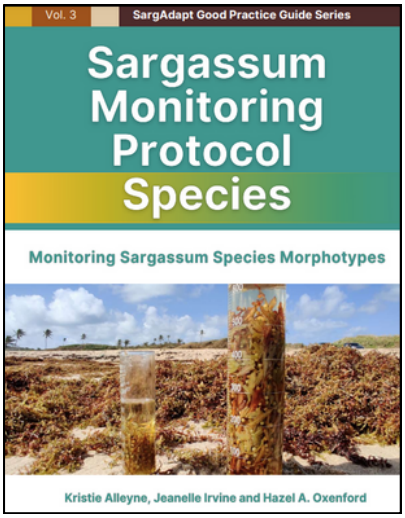
Tags: tourism, public awareness, impacts, good practices, onshore collection

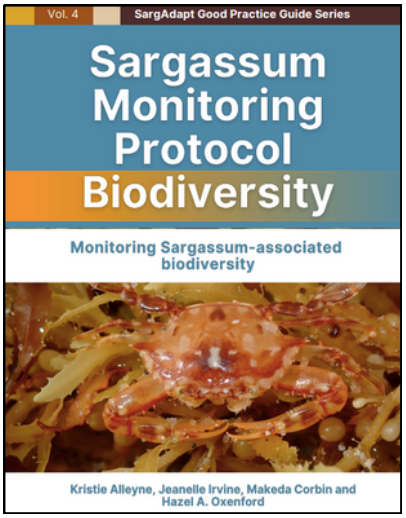
Tags: good practices, impacts, small-scale fishers, coping mechanisms

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



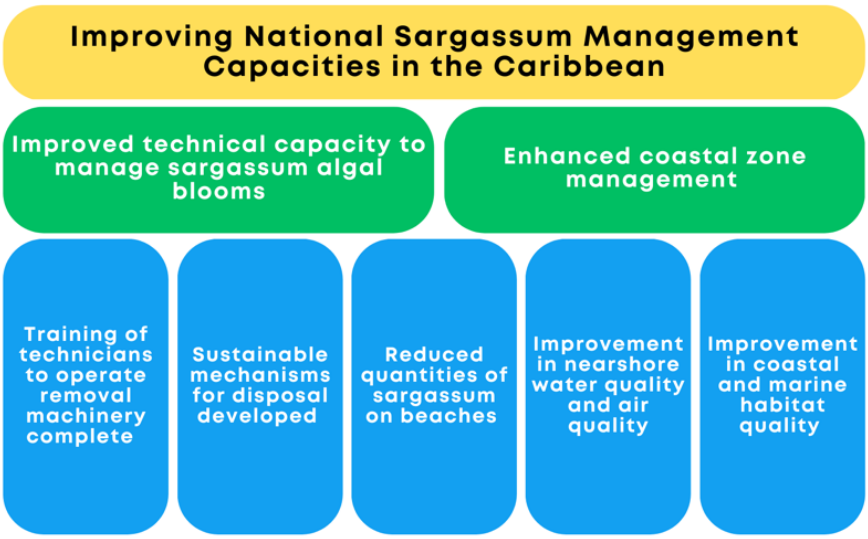






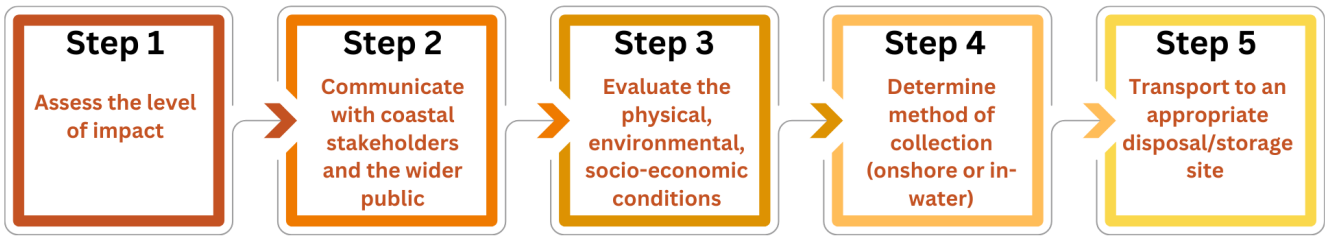
11.2 MANAGEMENT OF SARGASSUM INFLUXES

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. The figure below illustrates further. [1]



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:



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

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

Minor- just a small amount of sargassum. Sparse, less than 2 inches in depth. Faint seaweed odor.

Moderate – About 6 – 9 inches in depth. Strong odor, several insects.

Massive – more than 10 inches in depth. Pungent odour, significant impairment of movement of vessels and use of beachfront.

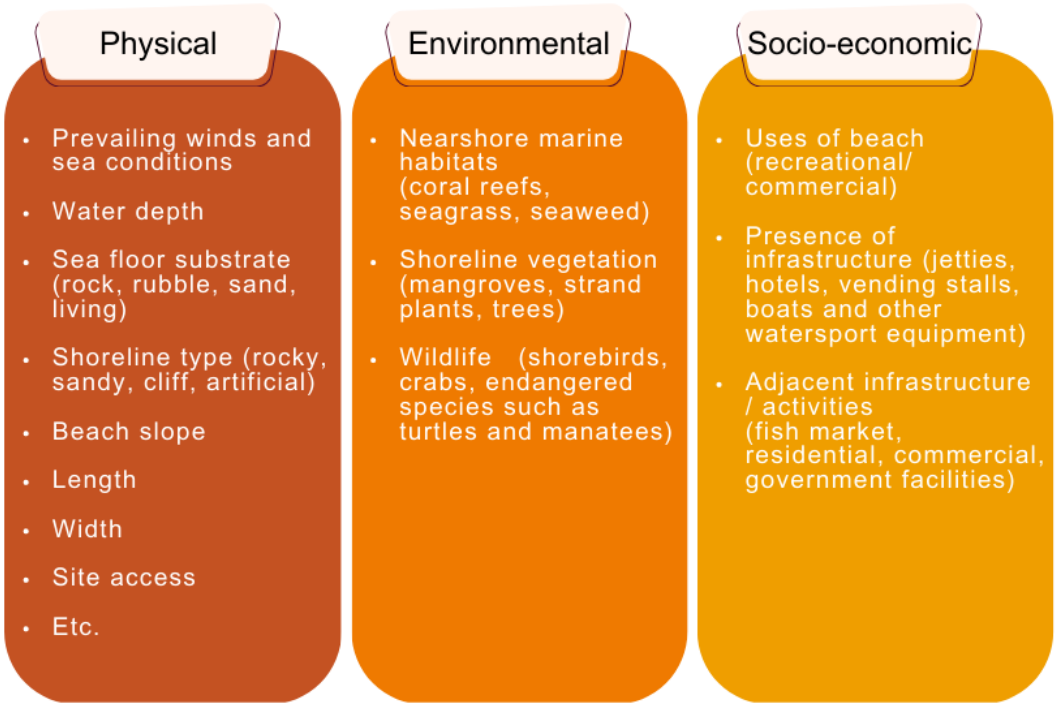
STEP 2: Communicate with coastal stakeholders and the wider public

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 conditions:

It may not always be necessary to collect or clear up after all sargassum beaching events. Physical, environmental, socio-economic 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, 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	Mechanised onshore collection (mechanised rake)	Mechanised onshore collection (excavator & other heavy machinery)
Suitable conditions	Volume is moderate to high (very high volumes require a combination of manual and mechanised methods) Beach with high ecological sensitivity	Volume is moderate to high Manual collection is not feasible (very high volumes require a combination of manual and mechanised methods) Beach with low ecological sensitivity	Great to extraordinary volumes where other onshore methods are initially impractical Sediment that can bear weight of heavy machinery Medium to high beach use Beach with low ecological sensitivity
Unsuitable conditions	Great to extraordinary amounts of beached sargassum	Great to extraordinary amounts of beached sargassum	Narrow beach, low to moderate amounts of seaweed, greater chance of erosion, indiscriminate use on beach with known ecological sensitivity
Considerations	While on the beach, workers will likely contend with natural elements and possibly toxic gases from decomposing seaweed which will affect productivity	Works best on beaches with low relief, and when sargassum volume is moderate. Sand collection is low so it is suitable for regular cleaups	Works best on beaches with low relief, and when sargassum volume is moderate Sand collection is low so it is suitable for regular cleaups
Operating costs	Low (rakes, wheelbarrows, buckets)	High (cost to rent and purchase, workers needed to operate machinery, transport and disposal)	High (cost to rent and purchase, workers needed to operate machinery, transport and disposal, wildlife monitor for biodiversity checks)

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

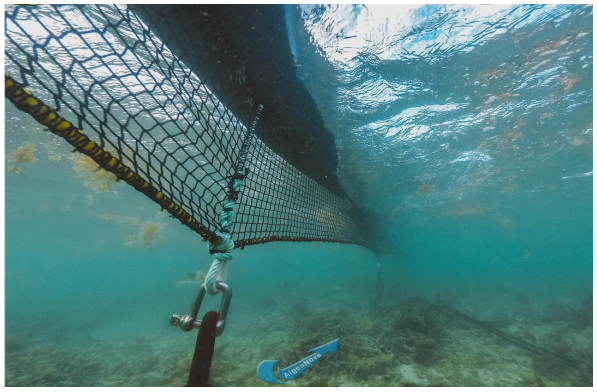
The Barber Company is a distributor of the surf rake, with three models, Optimized for different-sized beaches. The largest rake cleans sand up to nine acres an hour. The three cubic yard hopper can hydraulically lift up to 4,500 pounds of material to a clearance height of nine (9) feet and dump its 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	Calm and relatively shallow waters, good accessibility at sea, medium to high beach use	Calm, semi-enclosed bays, ideally used in tandem with the barrier
Unsuitable conditions	Prevailing rough and deep water, strong current, very deep water column, pocket beach, known sea turtle beach nearby	Prevailing rough seas, strong current, known turtle nesting beach nearby, no adjacent onshore offloading mechanism or facility
Considerations	An appropriately sized anchoring system Bathymetry, sea floor substrate A clear plan of where the sargassum will be directed to or regular removal of the built-up sargassum along the barrier	Works best in tandem with barrier to aggregate the material and reduce the surface area to be cleaned
Operating costs	Variable Depending on tier of equipment, (handmade or improvised), more workers needed for collection during inundation events, maintenance and cleaning of barrier (by hand or mechanised equipment)	Likely high Maintenance, fuel costs, skilled operators and others required to operate collecting system

(Adapted from the 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.

Storage sites must:

- ☑ Allow sargassum to dry out to prevent anaerobic decomposition and production of toxic hydrogen sulphide and ammonia gases.

Disposal sites must:

- ☑ Ensure that sargassum leachates do not contaminate the environment including the freshwater supply since they are likely to contain various toxins, especially high levels or arsenic.

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

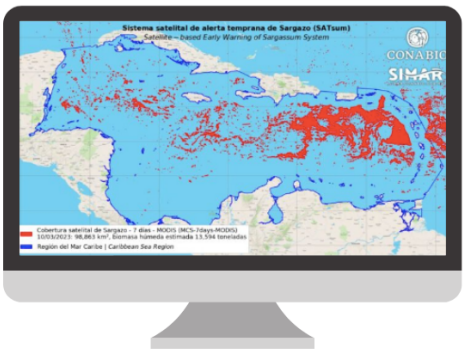
11.3 SARGASSUM FORECASTING AND MONITORING

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!

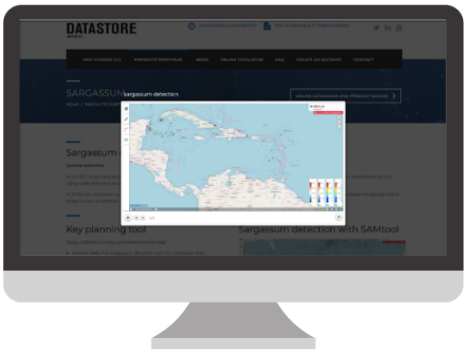
Sargassum Monitoring- Detection using on satellite imagery

NOAA Coastwatch Oceanviewer

Caribbean Coastal Ocean Observing System (CariCOOS)



Sargassum Satellite Early Warning System (SATsum)

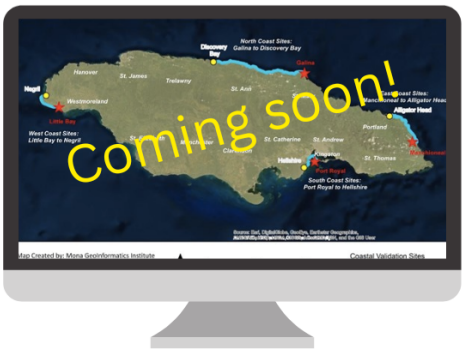


CLS Sargassum Detection and Monitoring Tool

Sargassum Watch System (SAWS)

Sargassum Monitoring

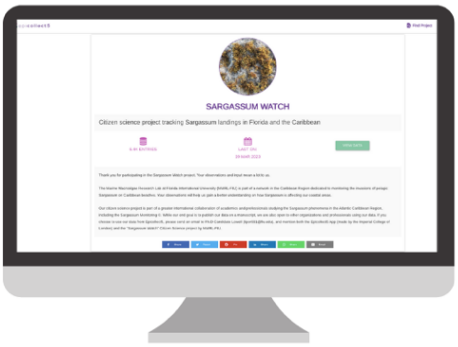
Sargassum Operational Detection Algorithms (SODA)



SARTRAC Sargassum Detection Algorithm

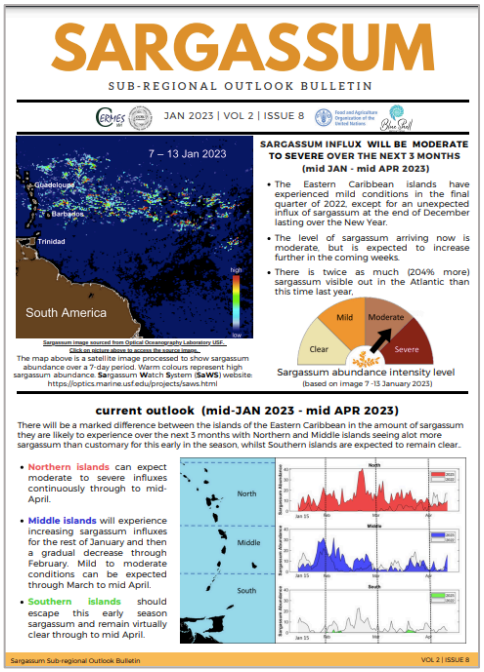
Sargassum Monitoring- Citizens Science

SargSNAP

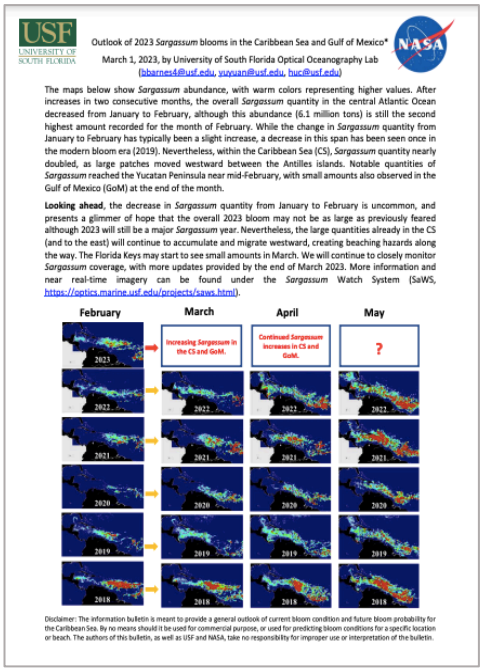


Epicollect Sargassum Watch

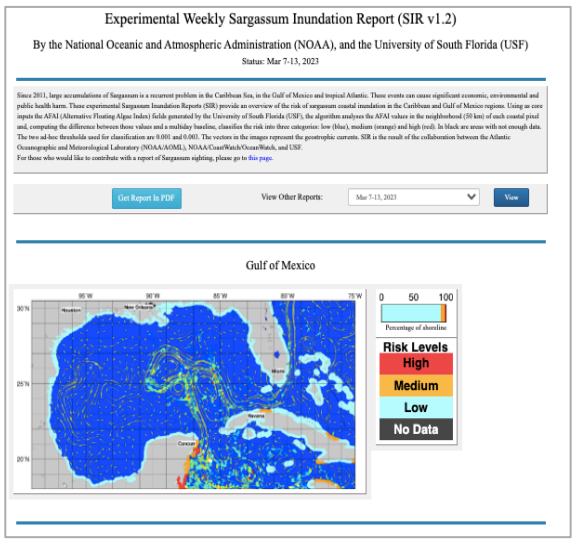
Sargassum Reporting- Bulletins and Reports



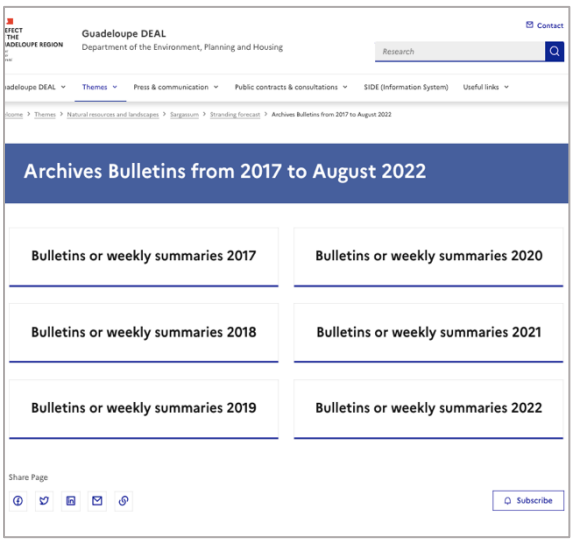
UWI-CERMES Sub-regional Sargassum Outlook Bulletin



USF Sargassum Outlook Bulletin

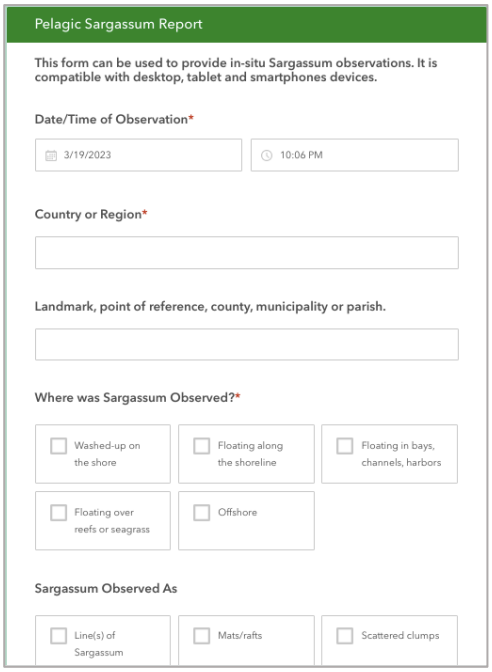


NOAA Experimental Weekly Sargassum Inundation Report

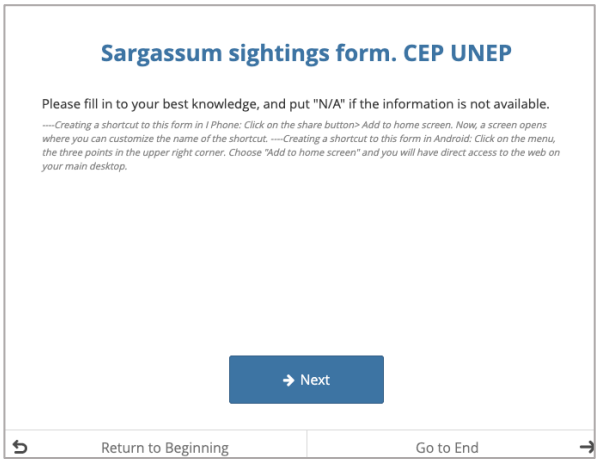


Sargassum Surveillance Bulletin for Guadeloupe

Sargassum Reporting- Citizens Science



Sargassum Pelagic Report



Sargassum Sightings Form

11.4 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 a
- Wi-Fi video cameras.
- Dedicated funding to develop/support consistent monitoring.
- More technical personnel to carry out monitoring measures.
- Training of workers 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 system.
- Procurement of drying or ensiling technology/equipment, materials 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. flyingfish 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. For example, almaco jacks are plentiful and viable for sale in the Barbados market and 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** – some countries have 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.

11.5 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 best 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

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 and multi-national research project**	This research project is investigating different activation methods and different pyrolysis temperatures (600 – 900 °C) to obtain activated carbon using sargassum.	Université des Antilles (Guadeloupe) (COVACHIMM2E laboratory), Instituto Tecnológico de Santo Domingo (INTEC)	2019

			(Dominican Republic), Institut National de la Recherche Agronomique (INRA) (Guadeloupe & Nancy, France), Queen Mary University (UK), Instituto Superior de Tecnologías y Ciencias Aplicadas (InSTEC) (Cuba), Centre Inter-universitaire de Recherche et d'Ingénierie des Matériaux (CIRIMAT) (Toulouse, France), Université d'État d'Haïti (Haiti), Université Quisqueya, NBC (French Guiana), TECMALAB (Dominican Republic), NUM SMO Technologies (NST) and Phytobokaz (Guadeloupe)	
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	Coordinator and collaborators can be found here	2019

		of Sargassum and probability of stranding at the coast.		
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
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

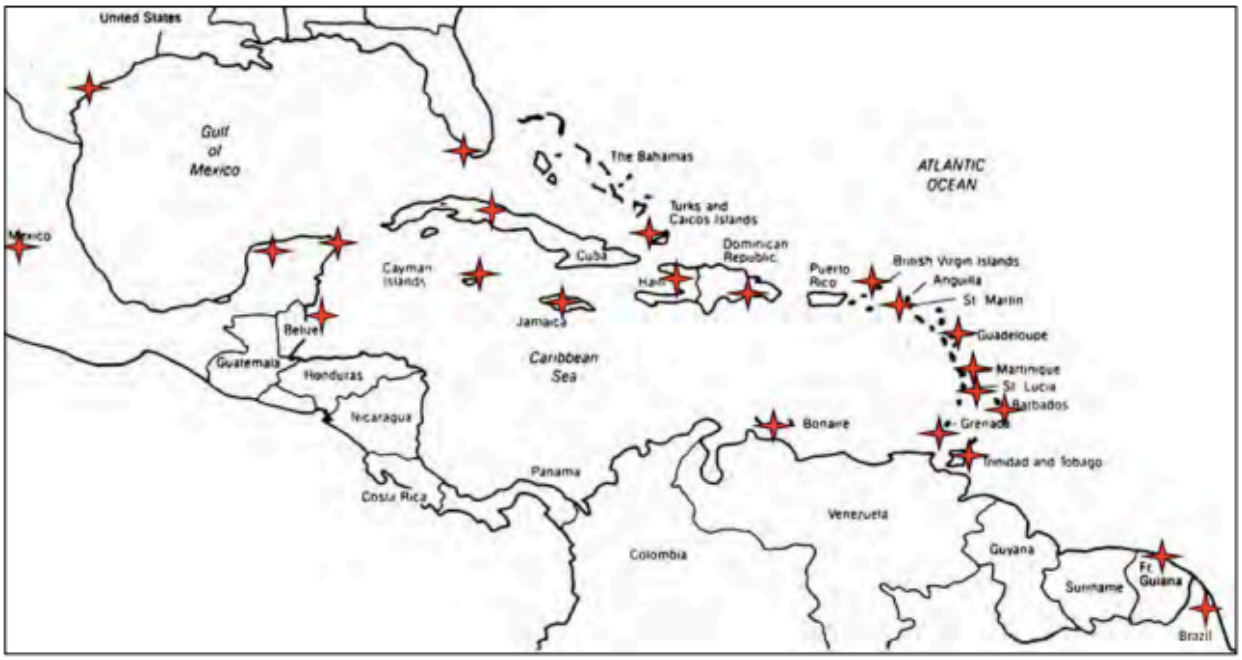
20.	**SARtrib** (Tribological and electrochemical valorisation of sargassum) Click here to visit website!	Aim: Valorisation of vacuum pyrolysis by-products of sargassum: electrodes for lithium batteries and new generation of lubricant	Coordinator and collaborators can be found here	2019
21.	**SAVE** (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
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**	Exploring challenges and advancing potential solutions to marine debris, Sargassum threats	World Maritime University	2020

	Click here to visit website!	and marine spatial planning in Small Island Developing States with a particular focus on the Eastern Caribbean region.		
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	

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

12 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. 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 the British Virgin Islands. Green VI has been working in collaboration with the Department of Waste Management, the Department of Agriculture and local entrepreneurs to explore the management of organics, including sargassum, and the potential agricultural and anaerobic digestion applications. The chemical composition of sargassum, especially its heavy metal content, has been an area of research.

12.1 KEY RESOURCES

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

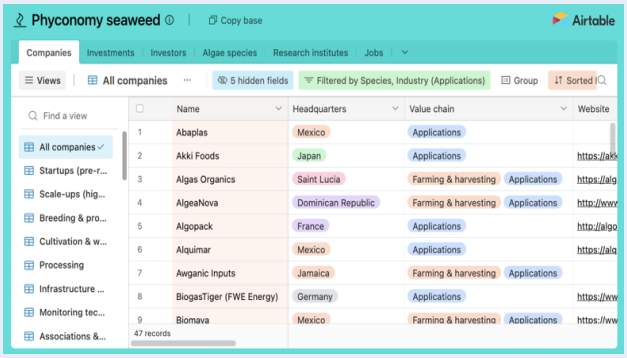
Other highlights of the document include:

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.

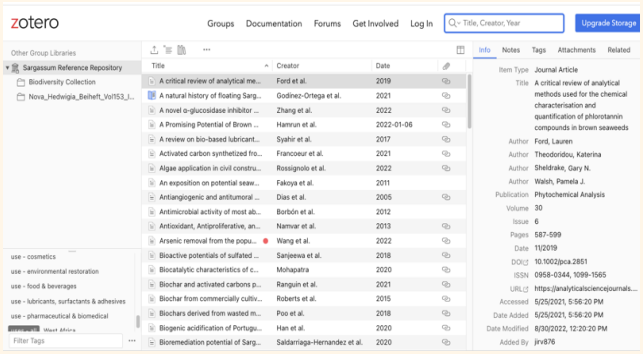
Click here to visit the database!



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!



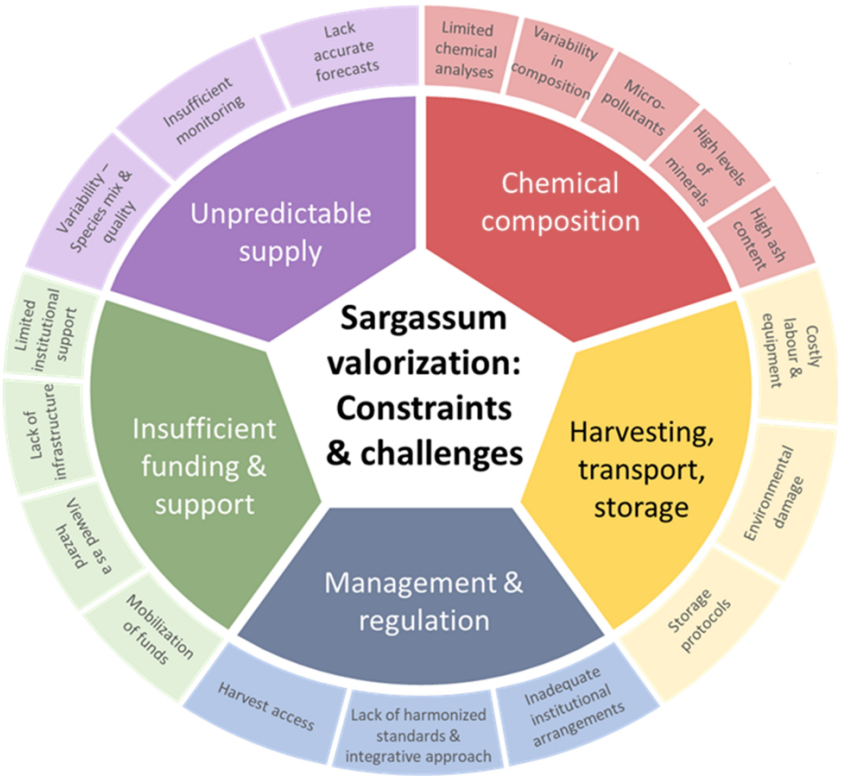
The Sargassum Podcast

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!

12.2 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) 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)

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