

DRAFT

BARBADOS SARGASSUM ADAPTIVE
MANAGEMENT STRATEGY (SAMS)
VOLUME 1: ADAPTIVE STRATEGY



2021

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SUMMARY

Sargassum science, management and uses are all very dynamic. Information is soon outdated or contested. Typically, there is high uncertainty about what constitutes an undisputable fact. This Barbados Sargassum Adaptive Strategy (SAMS) treats the massive influxes of sargassum seaweed experienced in the Caribbean since 2011 as both hazards and opportunities. By setting out a framework for action based on resilience thinking and climate adaptation, it offers guidance to identified stakeholders in pre-influx, influx impact and post-impact phases of addressing sargassum comprehensively. The strategy should be converted into a dynamic website in which the many appendices are updated often, using new information and learning from monitoring and evaluation. The adaptive strategy (first volume) and action appendices (second volume) cover many aspects of sargassum marine science from open sea to shore, methods for responsible removal and use, financing, plus the roles and coordination of public sector, private sector and civil society actors at all stages and levels. Critical to the strategy are the appendices of site profiles that set out social and ecological characteristics, history of impacts and responses, vulnerabilities, opportunities and whatever other features are relevant to each site. The institutional arrangements for response have these site-level building blocks as their foundation, similar to community-based disaster management, while scaling up to national level to match the requirements of very massive influxes that call for major mobilisation. The frequently updated strategy fits within the intersectoral and multi-stakeholder scope of national adaptive management such as climate change adaptation, disaster risk management and blue economy initiatives. It is the exercise of collective responsibility and coordination of diverse actors that will determine SAMS success. Some aspects of this strategy must be completed for formal approval and authority according to the requirements of the key stakeholders in Barbados. Completion with formal approval will include the Ministry of Maritime Affairs and Blue Economy (MMABE) assuming full ownership of the Barbados SAMS such that it is continually updated and implemented as the strategy evolves, to build resilience regarding sargassum.

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However, responsibility for any errors, inaccuracies or omissions rests entirely with CERMES and not with any of the above-mentioned agencies which facilitated the work. The CERMES core team (Shelly-Ann Cox, Amina Desai, Carla Daniel and Patrick McConney) thanks colleagues and stakeholders in Barbados, too numerous to mention, for their invaluable observations and inputs. It is also fitting to thank the many other persons in the UWI, Barbados and Caribbean sargassum sphere of science and operations from whom we have drawn information and inspiration for the draft strategy. Special mention is made of the project on Climate Change Adaptation in the Eastern Caribbean Fisheries Sector (CC4FISH) of the Food and Agriculture Organization (FAO) which was highly influential in shaping the approach to the Barbados SAMS based on the similar work being implemented through CERMES under CC4FISH in four other Eastern Caribbean countries.

1 INTRODUCTION

The planning project on *Co-developing a Sargassum Adaptive Management Strategy (SAMS) for Barbados* sought to assist the government and people of Barbados to become resilient to threats from influxes of sargassum seaweed, adaptively addressing the potential threats with environmentally responsible responses that, where possible, turn sargassum into an opportunity for sustainable development (social, economic, environmental). Whether sargassum is treated mostly as a threat or an opportunity depends on several factors in each specific situation such as exposure (e.g. quantity, location), sensitivity (e.g. biodiversity, human health) and adaptive capacity to respond (e.g. disposal, use as raw material). Reasons for why excesses of sargassum seaweed pose problems for many economic sectors, some ecosystems and human health are well known, but information is constantly changing, such that a very active approach to keeping up with good practices and uses is required.

The Barbados SAMS (or just SAMS) is the main deliverable of the planning grant. This introduction sets out the background, approach and arrangement of the SAMS. Readers familiar with sargassum management and resilience concepts may benefit from a refresher review of the adaptive strategy text (this volume) but focus more on the many appendices (separate volume) that support the action oriented SAMS.

1.1 ENGAGING THE STRATEGY

To meet the challenge of on-going change, much of the knowledge on sargassum in this strategy is made available through references and links in appendices. SAMS users must be able to quickly find up-to-date resources on what they specifically need to know about sargassum, without wading through excess information. They can use the appendices to fill gaps in their knowledge sufficiently to take informed decisions and action. The SAMS should be integrated into the MMABE communication strategy to promote the benefits from its collective implementation and to support the blue economy (Figure 1).

KEY BENEFITS FROM IMPLEMENTING STRATEGY

- ❖ Reduction of the threats posed by the influxes of sargassum will have positive impacts on the social, ecological and built environment in Barbados.
- ❖ Increases in the opportunities to use sargassum in livelihoods and commercial enterprises should have positive impacts on the economy of Barbados.
- ❖ The strategy will provide the MMABE and other agencies with an adaptive framework for building resilience while developing learning institutions.
- ❖ Field monitoring and management planning capacities enhanced by science.

Figure 1. Benefits from implementing the SAMS are many at the societal level

In order to meet the dynamic needs of sargassum management, it is highly recommended that the SAMS be converted into interactive web pages rather than be used primarily as a print or electronic document. A SAMS website should be addressed early in implementation. A commercial contract to manage the website is

preferable. If the SAMS content is put on web pages that are actively maintained, then there will be no need to re-issue a formal print or electronic document every few months as sargassum science and technology is expected to continue rapidly evolving over several years. Select web pages and downloads can be printed by users on demand. Updating could be largely self-organised by a contributing community of SAMS users with oversight and validation/verification of information coordinated by MMABE (Figure 2).

SOME BENEFITS FROM USING A WEBSITE FORMAT FOR STRATEGY

- Ease of keeping contents updated via links and extracted text (only where necessary)
- Simple to share selected information via print, links, social media, audio-visual aids
- Accessibility features available to address literacy, visual and audio impairment, etc.
- Social networking to overcome internet access constraints builds community of action
- Cost-effective format for dissemination, while possible to restrict parts if necessary

Figure 2. A website format for the SAMS benefits all users, with social networking including those not formally using internet

SAMS users are expected to span local to national levels of governance in society (including academia and the private sector as knowledge mobilisers) such that better informed decisions and action can be taken at the most appropriate and lowest institutional or geographic level practicable, but also for these to be easily scaled up to match sargassum response needs. This addresses scale mis-matches which cause ecosystem-based action to be inefficient and ineffective. The SAMS cannot address all known or unforeseen circumstances. Hence social and institutional learning and adaptation are critical features for which adaptive capacity will need to be built in order to confer resilience.

Since the aim of the SAMS is primarily to frame and enable action planning, it is meant to be accessible and understandable by people in specialised agencies as well as the general public. Some technical terminology and features are necessary for the SAMS to be concise and practical. The appendices are useful for guiding what new knowledge and information they should seek via regular online updates. The strategy is guided by the presentations and discussions at the 2018 Second Sargassum Symposium¹ and many other knowledge resources including guiding concepts² and management matters³ presented at the symposium, plus the adaptive approaches reviewed in the next subsection.

1.2 REVIEW OF ADAPTIVE APPROACHES

The SAMS addresses sargassum influxes primarily as threats, but also as potential opportunities especially for livelihood innovation and entrepreneurship (Figure 3). Both threats and opportunities must be addressed via inter-sectoral coordination and stakeholder collaboration (Figure 4).

¹ <https://www.cavehill.uwi.edu/cermes/projects/sargassum/2018-symposium.aspx>

² https://www.cavehill.uwi.edu/cermes/getdoc/3b827943-4010-4cdd-821b-ad53cb2ef4d2/2018_sargassum_symposium_presentation_pmccconey.aspx

³ https://www.cavehill.uwi.edu/cermes/getdoc/289a3541-5b80-4c22-9148-f7a160890a8b/2018_sargassum_symposium_presentation_ksabir.aspx



Figure 3. Balancing threats with opportunities

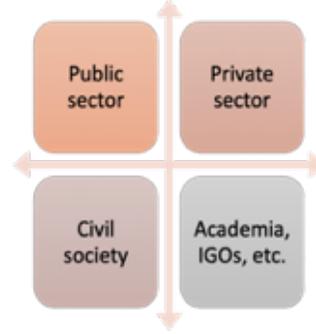


Figure 4. Coordination and collaboration are critical

Key stakeholders (Figure 5) differ by level of governance and location, but they must be identified in order to develop sound institutional arrangements. These arrangements must be considered when applying a disaster cycle (Figure 6) approach to sargassum.



(Source: GCCA training presentation)

Figure 5. Key stakeholders need to be identified early



Source: Wikimedia Commons (all rights waived)

Figure 6. The classic disaster cycle is useful, with limitations, for sargassum

Sargassum is not always a hazard, while its high frequency and extended duration of impact make it different from some other hazards. However, for threats, despite some limitations, most guidance from disaster risk management (DRM) is relevant. This includes the assessment of vulnerability and adaptive capacity; risk assessment; hazard monitoring; threat level decision-making; vulnerability mapping; community-based, but multi-level, management; and planned sequences of proactive and responsive interventions in a DRM cycle. Vulnerability is a function of exposure and sensitivity, modified by adaptive capacity that builds resilience (Figure 7). Adaptation and maladaptation are respectively the good and bad outcomes of our actions to learn and intervene to change the environment and/or society. Several human dimensions interact in complex ways to determine all of the above components of vulnerability.

For opportunities, the appropriate guidance is less in scientific literature than in industrial engineering, commerce, marketing, knowledge mobilization etc. However, all of these need to be supported by scientific data and information (natural science, social science, interdisciplinary and transdisciplinary). At the 2018 Second Sargassum Symposium participants recognised the need to include opportunities and benefits along with threats, which both require cross-cutting management responses (Figure 8). The key to proceeding systematically is through adaptive management (Figure 9).

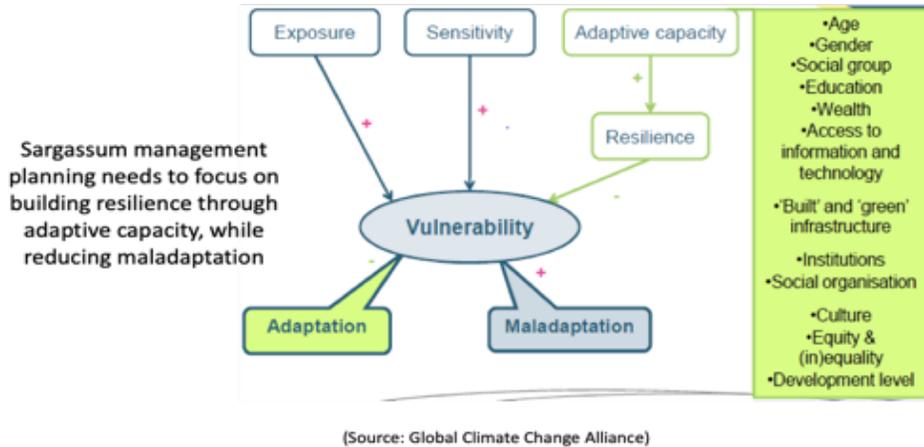


Figure 7. A vulnerability perspective on threats includes building adaptive capacity and resilience

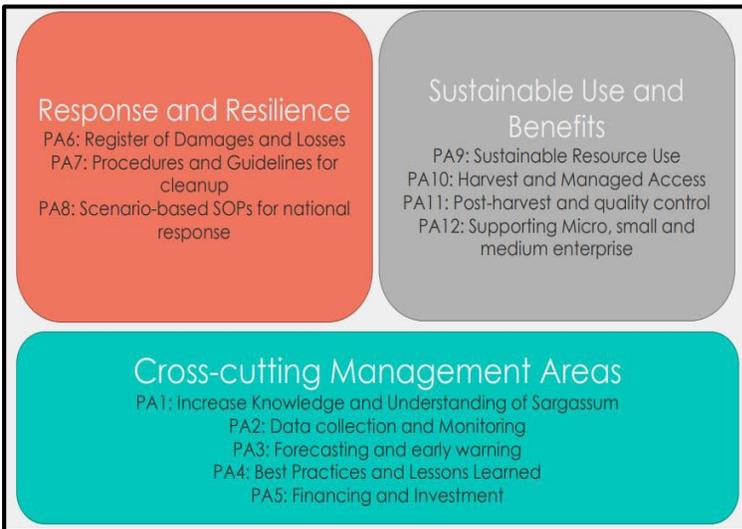


Figure 8. Threats and benefits call for cross-cutting management actions



Figure 9. Adaptive management is needed to address the uncertainties and complexity

Knowing these approaches (also from further reading) will facilitate better decision-making and adaptation compared to less informed perspectives. However, 'book knowledge' must be complemented by practical learning-by-doing ... a cross-cutting theme in this plan. Better and more collaborative planning and adaptive capacity, particularly for innovation, is needed to build resilience against sargassum influxes (Figure 10).

The reasons for repeatedly emphasising the above concepts throughout this plan is that short term, coping, reactive and uncoordinated responses to sargassum may have the appearance of being busy and productive, but in the medium to long term they may exhaust resources, do damage and erode stakeholder engagement without much real advancement. We must collaborate and adapt for the longer term, considering our inter-generational ecological and social responsibilities for stewardship. Appendix 1 has examples of other plans.

Collaborative planning and adaptive capacity for building resilience



Figure 10. Building social-ecological system resilience is a long-term goal in addressing sargassum influxes

1.3 ARRANGEMENT OF SAMS

This SAMS is arranged in a layout similar to that used by the Caribbean Disaster Emergency Management Agency (CDEMA) for disaster response mechanisms. It sets out the SAMS purpose followed by some guiding principles. The scope of the SAMS and its authority come next to clarify what it does or does not cover. Institutional arrangements are followed by financial considerations. Then actions and operations are addressed in detail by the many appendices that also cover the prior sections. Although action appendices in Volume 2 are cited for reference, note that the content and order of all appendices are subject to change.

2 PURPOSE AND PRINCIPLES

The purpose of this strategy is primarily to assist the government and people of Barbados to be resilient to threats from influxes of sargassum seaweed, turning the potential threats where possible into adaptive opportunities for sustainable development (social, economic, environmental).

The SAMS is based on guiding principles to inform users and others updating the SAMS on what to aim for:

- Using integrated, participatory, good practices such as ecosystem-based approaches, climate change adaptation, disaster risk management, sustainable and blue economic development, etc.
- Complying with all applicable global, regional, sub-regional and national agreements, policies and similar instruments of policy guidance whether binding or non-binding
- Establishing formal and informal arrangements for good and effective governance with strong links from local to national level in order to scale up and down responsive action
- Providing an enabling environment for local level networks, self-organisation, livelihood opportunities, socio-economic community development and building adaptive capacity
- Ensuring that sometimes necessary coping strategies do not unduly constrain the longer-term adaptive strategies necessary to maintain resilient social-ecological systems

Although extensive lists of guiding principles may be drawn from various instruments, the list for action will be kept short and high-level. Elaboration of principles can be pursued in the references and other documents.

3 SCOPE

The MMABE will articulate and revise the scope of the SAMS from time to time as part of its communications. It will aim for expectations that are realistic and limitations that are acceptable. Some examples follow.

3.1 EXPECTATIONS

Incorporating the preceding guiding principles, the governance scope of the strategy is from the local to national level with weaker links to sub-regional and regional levels. It encompasses all state and non-state actors in Barbados whether formally considered stakeholders or not. Unless it is given legal or administrative authority the strategy is for guidance only and is hence non-binding regarding both threats and opportunities. The public may expect “the government” to handle sargassum without their involvement, or for “their beach” to be cleaned of sargassum regardless of the severity of stranding or its location. Entrepreneurs may expect major funding and technical assistance for sargassum uses. These and other expectations are not realistic. They should not be allowed to develop or persist as this distorts the information for decisions and action. Instead, the MMABE communications campaign will foster confidence in multi-stakeholder partnership that includes non-state actors by raising awareness about potential opportunities and correctly prioritises sargassum management action based on agreed criteria.

3.2 LIMITATIONS

As a framework for planning, the strategy is not prescriptive. Instead, it guides good practices and no-regrets high-level action with the aim of having these updated through testing, monitoring, evaluating, learning and adapting. It cannot guide all good practices or anticipate the most appropriate practices for every eventuality. Site and situation-specific action will improve from learning-by-doing, good monitoring and evaluation, and with frequent updating of knowledge in electronic format, also incorporating user contributions and local knowledge. It is important for actors to be aware of the adaptive design of the strategy so that changing content as implementation proceeds is appreciated as a desirable feature of adaptation to which users can contribute, rather than perceive a deficiency. The SAMS requires managing expectations and limitations with attention to transparency and accountability in decision-making and action which may not be equal for all.

4 AUTHORITY

This SAMS derives its authority from key policy documents and laws, but it will also receive direct high-level endorsement via the MMABE. Due to the complexity of sargassum threats and opportunities, the strategy cuts across several sectoral policies, plans and laws (e.g. coasts, tourism, fisheries, energy, manufacturing, etc.) in the blue economy that integrate ecosystem-based and participatory approaches. Some of the most relevant legal and administrative documents at this time are listed in Appendix 2. This list must be regularly updated to maintain coherence as they change. There need not be legislation specifically for sargassum, but it must be clear what pieces of legislation are relevant. Ideally, extracts and explanations should be combined into a new communication product suitable for all actors (state and non-state) and types of response (hazard and use).

5 INSTITUTIONAL ARRANGEMENTS

The SAMS must engage the public in good and effective governance for multi-level action and updating. The institutional, geographic, jurisdictional and ecological scales of decisions should match sargassum threats and opportunities to the extent possible. The institutional arrangements should be comprehensive but agile

enough to take quick and informed authoritative decisions and delegate actions as necessary at the most appropriate level from national to local. This will be challenging. Adaptive approaches to governance will be needed to change institutional arrangements for sargassum, after sufficient evaluation and learning, until they fit. Such changes are not system failures. Very frequent adjustment or abandonment without sufficient learning is unproductive. A large pool of committed stakeholders can be sampled and reconfigured into *ad hoc* task forces or working groups to meet situation-specific demands without becoming cumbersome or mired in administrative bureaucracy. A suggested large pool is in the box below extracted from Appendix 3.

- 1) MINISTRY OF MARITIME AFFAIRS AND THE BLUE ECONOMY (LEAD AGENCY FOR SAMS)**
 - a) Core technical administrative staff ... officers responsible for sargassum management
 - b) Coastal Zone Management Unit ... scientific-technical input from ocean to shore, MSP
 - c) Fisheries Division ... scientific-technical input, fishing industry engagement in all phases
- 2) MINISTRY OF ENVIRONMENT AND NATIONAL BEAUTIFICATION**
 - a) Core technical administrative staff ... officers for overall environment, links to tourism
 - b) National Conservation Commission ... prioritized coastal clean-up, disposal, some uses
 - c) Environmental Protection Department ... all environmental impacts, uses, link to health
- 3) MINISTRY OF SMALL BUSINESS, ENTREPRENEURSHIP AND COMMERCE**
 - a) Core technical administrative staff ... officers assist conditions enabling growth in uses
 - b) Small Business Development Unit ... support diverse, informed, financed, sustained use
 - c) The Co-operatives Department ... promote collectives for small enterprise use benefits
- 4) OTHER STATE, PRIVATE SECTOR, CIVIL SOCIETY AND ACADEMIC ACTORS**
 - a) Barbados Defence Force, private equipment and transport companies
 - b) University, polytechnic, community college, secondary school actors
 - c) Tourism, agriculture, energy, manufacturing, etc. commercial groups
 - d) Health, communication, science, innovation, etc. supporting groups
 - e) Youth, gender, wellness, social protection, etc. special interest groups
- 5) EXTERNAL PARTNERS AND INTERESTS**
 - a) International and regional technical assistance organisations (e.g. FAO)
 - b) International and regional financial institutions (e.g. CDB, grant sources)
 - c) International and regional investors and networks (e.g. SARGNET, NOAA)

The sargassum committee previously created by MMABE for decision coordination can be improved. It was not optimally utilised as the national focus was on emergency beach clean-up by the Barbados Defence Force (BDF) and National Conservation Commission (NCC) with some involvement of the Fisheries Division and private sector. As the agencies had a very specific mandate, readily implemented once labour and equipment were available, use of the committee was minimal. However, participants concluded that better coordination, by the committee, making a wider range of more informed decisions with authority, was worthy of pursuit. For example, the acquisition of beach and nearshore sargassum equipment with limited use and versatility could have been avoided or factored into a strategy that acknowledged limitations and offered alternatives.

There should be a single lead agency that is authoritative (MMABE) while others collaborate. A multi-level institutional arrangement, worth testing and learning from, is for sargassum to be under a national intersectoral coordination mechanism (NIC)⁴ led by the MMABE with additional sargassum expertise and technical-scientific capacity recruited as needed. More stakeholders and skills would be drawn from other

⁴ Compton, S., P. McConney, I. Monnereau, B. Simmons and R. Mahon. 2020. Good practice guidelines for successful National Intersectoral Coordination Mechanisms (NICs): Second Edition. Report for the UNDP/GEF CLME+ Project (2015-2020). Centre for Resource Management and Environmental Studies, The University of the West Indies, Cave Hill Campus, Barbados. CERMES Technical Report. No. 88 2nd edition. 21pp.

public sector agencies, civil society and commercial interests in key sectors such as tourism and fisheries. It would be preferable for the new SAMS committee to be composed of members from sectoral bodies rather than be entirely new. This should assist in more effective networking that also helps to enhance efficiency. Another critical institutional design feature is to have good linkages from local coastal site to national level by dividing the country into zones by clustering the areas with similar sargassum stranding risks to the extent feasible. Several appendices set out various institutional options and operational alternatives to be tested, monitored and evaluated for adaptation. Successes must be valued. For example, the operating procedures used for prioritised sargassum hazard management since 2018 (Figure 11) seem to be working fairly well according to the agencies involved, although still subject to improvement through their adaptive learning.

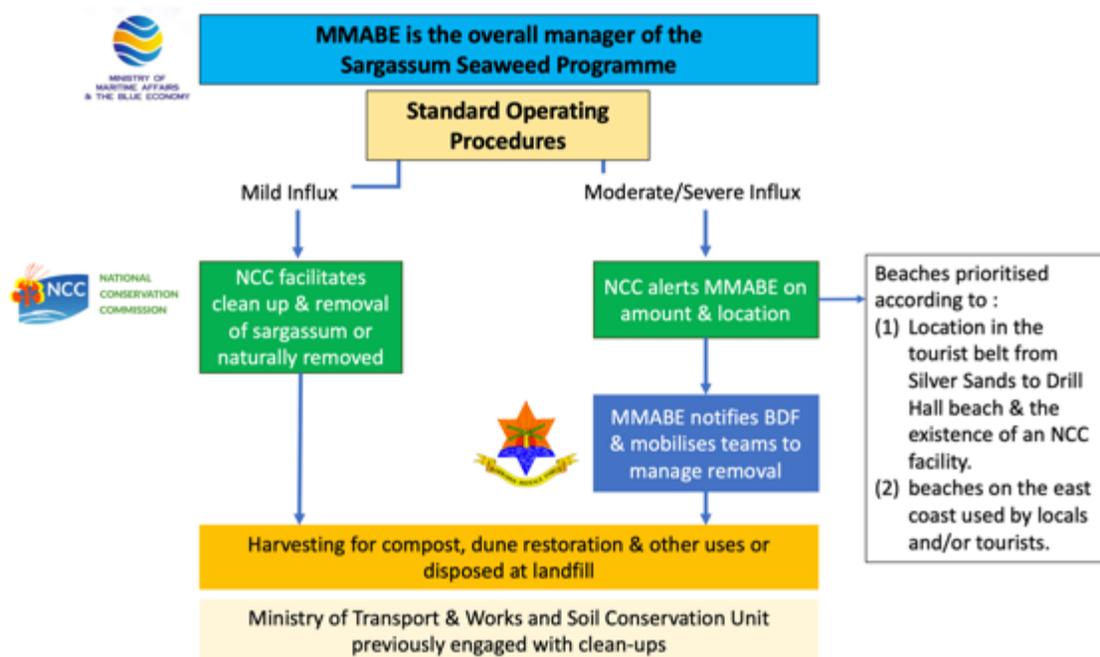


Figure 11. Existing standard operating procedures enacted by the MMABE based on the severity of the influx event (Compiled and verified by sargassum leaders at MMABE, NCC and Fisheries Division)

6 MONETARY MATTERS

Monitoring and measuring sargassum; mobilising knowledge to inform others; and responding to influxes by nearshore harvesting, beach clean-ups and other means all have costs e.g. salaries and wages, equipment, etc. There are also costs to taking no action e.g. loss of earnings, public health risks, biodiversity loss, etc. Some of these costs are direct and borne by clearly identified actors e.g. affected businesses, coastal residents and users, etc. Others are indirect social costs borne by society at large or in-kind costs shared by a number of actors each contributing a little e.g. via community organisation and researcher volunteer time. Some data on beach clean-ups with which to compute costs has been collected by the BDF and NCC in particular. Economic sector costs, particularly in fisheries and tourism, are also being documented through academic research. All of these will need attention regarding cost management as data collection is not yet sufficiently systematic, and the data are not yet processed into information for monitoring, evaluation, learning and adaptation.

Cost-offsetting opportunities for income generation by new sargassum-based industries must be relentlessly pursued. Sargassum use in plant fertiliser products and cosmetics is becoming established, but these are not enough to either absorb huge influxes or to spread the socio-economic benefits of sargassum through diverse enterprises. Regionally, many new productive uses of sargassum are not as yet appropriately regularised with regard to product safety standards, with potential health consequences being a concern. A recent sargassum 'Uses Guide'⁵ (Figure 12) contains information on innovation and many opportunities for budding sargassum entrepreneurs, of which there are several emerging in Barbados among both young women and young men. A persistent issue is the scarcity of grants, low-interest loans, venture capital and equity investment for small to micro-enterprise development which also needs to be informed by scientific research to make good decisions. For example, the uses guide cautions that sargassum for food chain and food handling products may need to be declared safe from heavy metals and harmful chemicals prior to and during commercialisation. These costs are not trivial, whether public or private, and financial institutions will require guidance on addressing them.



Figure 12. Sargassum Uses Guide presents many opportunities for informed innovation and entrepreneurship (Source: Desrochers et al. 2020 and presentations)

MMABE aims for the removal of large amounts of seaweed to be economically viable through local use while distributing the profits across more firms linked to the blue economy. Information on earnings, or sargassum benefits more generally, is scarce especially at national and sub-national levels, but include the value of living marine resource biodiversity associated with sargassum rafts in the exclusive economic zone (EEZ) as well as ecosystem benefits ashore. Such benefits require more measurement and monitoring in applied research as a part of the SAMS concerned with sustainable financing, especially for blue ventures with green accounting.

It is beyond the scope of this planning grant to provide more detailed recommendations on the economic and financial aspects of sargassum except to stress that the data and information for assessment must be included in the monitoring at all levels, especially to guide appropriate state and private sector spending, now seen

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

more in the context of blue economic development. Appendix 4 contains extracts from sources that should be useful in ensuring these aspects are not overlooked in the learning. The authority to direct public spending must be clearly set out for adaptive management such as the actions and operations in the next section.

7 ACTIONS AND OPERATIONS

This adaptive (preferably web-based) strategy places emphasis on being regularly updated. Separate sources of information can be combined as needed to be fit for the purpose at hand in any place or situation. For these reasons this section is short. Details are in Appendices 5 to 10, the need for which is mainly based on their utility. An overload of information is as counterproductive as too little, especially if the skills, time and criteria for sorting information are limited among the expected SAMS users.

In this section we summarise the strategy into three phases: pre-influx, influx impact and post-influx, but the classic disaster cycle does not apply fully to sargassum. Influxes can be prolonged and persistent such that they overlap in time and space rather than be distinct events. Here an 'influx' refers to the arrival of large amounts of fresh sargassum. 'Pre-influx' and 'post-influx' may both feature persistent or degraded sargassum. We use 'stranding' for sargassum that has washed ashore, but some authors use beaching or landing instead. 'Mats' or 'rafts' refer to free-floating masses of sargassum. A glossary of these and more specialized terms will evolve as another appendix to standardise use of terms. This is especially important for consistent protocols.

Influx uncertainties demand planned action. Sargassum uncertainties include event timing, location, landfall, amount, composition, impacts, responses and learning. The last is critical for reducing some uncertainties but, similar to climate change and variability, the limited options for mitigation argue for higher national priority being given to successful adaptation strategies rather than to prediction which will be obtained from science⁶.

7.1 PRE-INFLUX

Similar to some other poorly predictable natural hazards there needs to be an almost constant state of readiness and rapid adaptive response for sargassum. Critical components, with appendices, include:

- Monitoring sargassum accumulations and oceanic tracks from far offshore into the EEZ via remote sensing and early warning systems
- Receiving, perusing and sharing information from the Eastern Caribbean sargassum outlook bulletin and other web and email sargassum services including discussion groups
- Subscribing to news alerts and website RSS feeds that tag and share sargassum articles and stories
- Ensuring that guidelines covering sargassum adaptation, clean-up responses, uses for manufacturing and so on are disseminated to and easily accessible by all
- Establishing a sargassum phone hotline, using existing social media sites and other means for anyone to share information on sargassum throughout the disaster cycle

⁶ Sub-regional Sargassum Outlook Bulletin
<https://www.cavehill.uwi.edu/cermes/projects/sargassum/outlook-bulletin.aspx>

- Conducting vulnerability and capacity assessments (VCAs), hazard mapping and the like at all sites at medium to high risk of influx impacts and keep the information at hand
- Ensuring, where insurance is available as a mitigation measure, that premiums are paid up and that the coverage is adequate to cover loss and damage
- Checking that industries and enterprises (household to commercial) that customarily use or want to invest in sargassum as an input are tied into the preparedness and response systems to ensure efficient and effective production processes are on standby
- Identifying routes, areas and people where removal and inland storage of sargassum is likely, so that means of transportation, receiving areas and nearby residents are ready
- Determining trigger points, field protocols, record-keeping and other aspects of the system response that are most critical for consistency and have procedures for each
- Checking that the entire multi-level set of response mechanisms are working adequately, but do not rely entirely on self-assessment, include verification
- Testing, at least quarterly, these mechanisms via a forum or a simulation so as to reinforce readiness and maintain open communication

The list of pre-influx actions and operations can be extensive, but it is expected that readiness will be relaxed when there is no imminent threat. The lead agency (MMABE unless delegated) is responsible for ensuring that readiness can be rapidly ramped up to the appropriate level and scale in a reasonable time.

There are financial and other costs of maintaining readiness. However, if sargassum is integrated into the national to local level multi-hazard early warning systems and responses for hurricane, tsunami, earthquake and other rapid onset events, then sustainability is more likely. The Department of Emergency Management (DEM) is a critical actor to advise on hazard planning, early warning and responses.

Massive influxes of sargassum are often preceded by smaller strandings. The pre-influx phase practically ends when 'no action' is no longer an option. But it is much better to have site-specific action triggers, or indicators, agreed upon beforehand based on the site profile hazard and vulnerability monitoring in order to brace for impact.

7.2 INFLUX IMPACT

Although shipping, nautical tourism and pelagic fisheries may experience sargassum impacts far offshore, in areas beyond national jurisdiction (ABNJ or high seas), the geographic areas and distances used to legally define spaces of national influx impact should align with national instruments for fisheries and/or coastal management if practical. These are measured in water depth or distance seaward from an agreed shoreline benchmark. For sargassum, distance should be more suitable for public communication purposes, and the following areas with fuzzy boundaries can be considered:

- Coastal: from high water mark on beaches or cliffs to the surf zone
- Nearshore: from the coastal boundary to around one km seaward
- Offshore: from the nearshore boundary to around 20 km (12 miles) seaward

Validating the above categorisation with marine users is important since, just as one needs to consider impact and response sequences over time, one also has to consider sequences over space. In fisheries, for example, offshore influx impact concerns may focus on fishing, but nearshore concerns may be about putting the boat to sea, while on the coast concerns are about health impacts from degrading heaps of sargassum. Similarly, the responses coming landward may be about gear technology, disentangling propellers and responsibly removing a beach stranding respectively. See Appendices 8 and 9 for these and additional considerations.

Impacts and responses have different costs and characteristics by location. All must be planned for as there will be differences due to the size of the sargassum influx (e.g. minor, moderate, massive influx). Appendix 9 provides guidance for responses depending on the volume of sargassum, but this guidance varies by the characteristics of the location. Evidence based, not arbitrary, judgement and decision-making is critical. Thus the detailed site profiles in Appendix 6 must be maintained as up-to-date and accurate as possible. The task of updating site profiles is best done in collaboration with nearby residents or site users.

Detailed site vulnerability and capacity assessments (VCAs) taking into account physical, ecological and social dimensions inform appropriate actions and operations. Within the umbrella of the SAMS, site-level sargassum management plans may be feasible where local-level coordinated response is feasible. Significant sargassum strandings are less frequent on the leeward west to southwest coasts which are heavily populated and commercialised. But strandings in these coasts of high economic activity and value may occur when currents reverse or curl around the ends of islands like the gyre or eddy pattern produced by rocks in a swift stream. Strandings on all coasts must be considered, but the threat levels and opportunities for sargassum use differ by site conditions and require regular updating. The use of drones and other technology can be invaluable for updating visible site information efficiently and effectively, including estimating the volume of strandings⁷.

Appendices contain profiles and maps of locations where strandings are common, as expected mainly on the east and southeast coasts. They show physical, ecological and limited social features. A threat ranking system, commonly used for many types of hazards, is recommended based on national practices. Examples are provided. There is potential for these maps and profiles to be integrated into the National Coastal Risk Information and Planning Platform (NCRIPP) managed by the Coastal Zone Management Unit (CZMU). These are to be refined by the time series of monitoring observations and data on all site characteristics. Some changes in marine biodiversity (e.g. seagrass beds, fringing reefs) or profiles of nearby communities (e.g. proximity to coast, number of asthmatics) for example, can alter threat assessments and inform appropriate response.

Critical components of impact influx include all those listed as examples for pre-influx plus these (see appendices):

- Using the agreed pre-influx systems and protocols (e.g. drone monitoring protocol being developed under the SargAdapt project⁸) for actions and operations rather than *ad hoc* and reactive responses, the exceptions being new responsible innovations for addressing threats and opportunities that need to be tested for learning and adaptation
- Maintaining monitoring and evaluation for learning and adaptation as a priority rather than secondary option, especially when and where new rapid responses are called for

⁷ <https://www.cavehill.uwi.edu/cermes/projects/sargassum/research.aspx>

⁸ Adapting to a new reality: Managing responses to influxes of sargassum seaweed in the Eastern Caribbean as ecosystem hazards and opportunities <https://www.cavehill.uwi.edu/cermes/projects/sargassum/sargadapt.aspx>

- Prioritising the health and well-being of people (field staff, nearby residents, users) and the environment (marine, coastal, terrestrial) while managing trade-offs between them
- Exchanging information, in as close to real time as possible, data and information with the established sargassum networks in order to contribute to, and be informed by, the responses and uses in other places for mutual knowledge and financial benefits
- Ensuring that the learning network established pre-influx is working well and that lessons are communicated for decision-makers as well as the general public to be informed
- Paying special attention to new or emerging vulnerabilities (ecological and social) that require shifts in action or longer-term adaptive capacity in order to build resilience

The list for influx impact is intentionally short as the focus should primarily be on implementing, monitoring and learning from what was set up pre-influx. While experimentation in impacts will be necessary, doing so must still be well thought out rather than impulsive and reactive. It is possible to make good decisions quickly if the decision-makers are well-informed beforehand and well versed in making evidence-based or influenced decisions through prior experience.

7.3 POST-INFLUX

This last phase, like the first, assumes that the influx impacts of sargassum are seasonal or intermittent (i.e. acute), even if somewhat prolonged, but not continuous (i.e. chronic). After an influx of fresh sargassum the seaweed and its degradation products may persist for months in the marine environment or ashore. As with impact, the variables influencing the consequences of this are many and interact in complex ways that shape the temporal and spatial extent of vulnerability as well as opportunities for sargassum use. Although uses are included in impact, especially if prolonged, in most situations they will be most important post-influx. Some uses are traditional or evolving (e.g. solid and liquid fertiliser) but many are now emerging (e.g. chemical extraction, bio-energy) as set out in the sargassum uses guide previously referenced. Sargassum uses and innovations contribute to 'blue growth' and should be integrated within the forthcoming blue economy road map. The entire blue economy relationship with sargassum must be kept under constant review and update.

Emerging commercial uses of sargassum are as dynamic as the science, hence requiring constant updating of useful links and resources such as on a dedicated website. Uses (and also simply disposal) will have different life cycles that determine the suitability of the different species and strains of sargassum as well as the condition of the sargassum input. For example, fresh wet sargassum is heavier, handles differently and has different chemical and ecological composition compared to degraded sargassum whether dry ashore or wet in the nearshore. Sharing information on the practical characteristics of sargassum is as critical as the science.

Large quantities of sargassum remaining stagnant in shallow, sheltered bays with sandy beaches that are near communities or tourism infrastructure are of particular post-influx concern for many reasons. Extended social and ecological impacts are inevitable. The critical components of the previous two phases still apply, but the following deserve special attention (see Appendices 5-10):

- Maintaining enabling policy and economic environments to support gender sensitive innovation and entrepreneurship for sargassum uses including credit, venture capital, research services and other facilities especially for small and medium scale enterprises
- Linking users with sources of science and technology to keep them well informed
- Assisting in market studies and creation of new markets for novel products, particularly those with high domestic value-added contributions that support local livelihoods

- Adjusting social security nets and local governance to address site-specific recovery
- Encouraging large private sector companies, investors and financial institutions to play active roles in sargassum entrepreneurship in periods between influxes with adequate provisions for risk management due to unpredictability and several other uncertainties
- Retaining the interest in sargassum as part of the national climate change and justice processes in order to keep or elevate attention on the world stage as a SIDS issue
- Sustaining learning, adaptation and readiness that transitions into the pre-influx phase

In many cases the post-influx phase may be short and virtually indistinguishable from pre-influx. However, the main distinction must be the opportunity to learn and adapt so the systems can be adjusted in pre-influx prior to the next influx impact. Reacting more than is essential during impact or immediate post-impact is not recommended. Good planning and management will often be compromised in the urgency to “do something”.

8 FURTHER ACTION

The MMABE approved sargassum adaptive management strategy will never be final in the sense of being shelved for use simply as a reference document. It must remain a dynamic, primarily electronic, document updated regularly and preferably maintained as a series of web pages with the most current data and information. Participatory geographic information system (PGIS) data with a citizen science component will be useful to engage a critical mass of island-wide collaborators. Consider the three-input process (Figure 11).

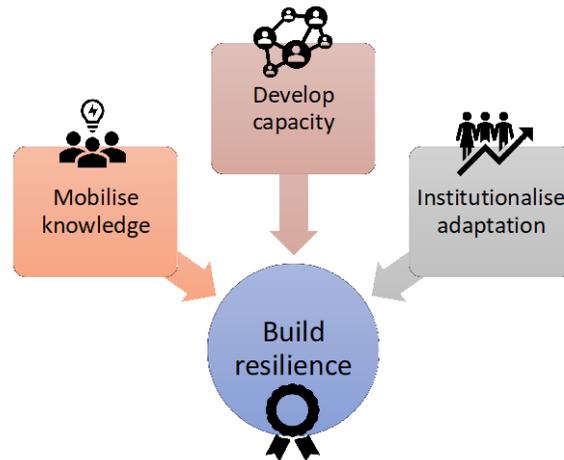


Figure 13. A three-step process for building resilience

For each of the inputs, the types of additional data, information systems, adaptive capacity development, collaborative planning, decision-making, social learning, institutional arrangements, etc. that could be employed are many (Appendices 11 and 12). The primary outcome is, however, to build societal social-ecological resilience in an iterative fashion through which the inputs are repeated in cycles of progress that keep a pace with the changing climate and other conditions affecting both sargassum influxes and social - ecological responses.

APPENDICES IN VOLUME 2

- 1 MANAGEMENT PLANNING APPROACHES AND PLANS
- 2 NATIONAL LEGISLATION AND ADMINISTRATION
- 3 INSTITUTIONAL ARRANGEMENTS FOR ADAPTATION
- 4 CONSIDERATIONS FOR MONETARY MATTERS
- 5 SARGASSUM HAZARD EXPOSURE AND VULNERABILITY ASSESSMENT
- 6 SARGASSUM STRANDING SITE MAPS AND LOCATION PROFILES
- 7 LOCAL LEVEL SARGASSUM MANAGEMENT PLANS
- 8 KEY SARGASSUM CONTACTS
- 9 ACTION AND OPERATION GUIDELINES
- 10 SARGASSUM USES
- 11 OTHER USEFUL ONLINE LINKS
- 12 USEFUL READING