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Polycentric Governance, Coordination and Capacity: The Case of Sargassum Influxes in the Caribbean

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ABSTRACT

The merits of polycentric climate governance have attracted considerable discussion. On the one hand, polycentric governance offers an alternative to top-down state-centric forms that have so far proven elusive. On the other, highly networked systems increase coordination challenges. Less attention has been paid to the varying capacities required to achieve coordination. In this article we explore the coordination of polycentric governance via a case study of sargassum influx management in the Caribbean. Since 2011, large quantities of sargassum seaweed have been washing up on Caribbean beaches with adverse socio-economic impacts. Our analysis of sargassum management policies reveals that a nascent polycentric system has generated significant cooperation in policy development and application across the region. However, there remain national capacity deficits to engage in this form of governance and to implement agreed actions. We conclude that advocates of a polycentric climate governance regime need to consider how capacity shapes participation, to the advantage of the largest and strongest. Polycentric governance can be useful for solving disparate cross-border environmental problems, but it also imposes a cost on the smallest that has thus far been unacknowledged and undertheorized.

KEYWORDS

Caribbean; climate change; polycentric governance; sargassum; small island developing states

Introduction

Since 2011, large quantities of sargassum seaweed have been appearing in the waters of countries in the Wider Caribbean Region (WCR). The sargassum has been washing up on beaches in large quantities and has affected fishing, tourism operations and maritime transport at sea with adverse socio-economic impacts (Oxenford et al. 2019, UNEP-CEP 2021). In this paper we explore the governance responses to this emerging phenomenon by countries and regional organizations. Our aim is to determine where the set of responses fits within conceptual frameworks for governance of transboundary issues and to recommend how they may be shaped to provide more effective governance.

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The causes of increases in strandings of *Sargassum fluitans* and *Sargassum natans* (henceforth, “sargassum”) in the Caribbean over recent years remain uncertain (Wang et al. 2019), but hypotheses for the influxes include a wind and surface current anomaly in 2009-2010, nutrient enrichment, and changes in ocean upwelling, and wind and surface circulation patterns in the Atlantic (Johns et al. 2020; Lapointe et al. 2021). The majority of research has focused on sargassum at sea as opposed to the geography, frequency and duration of landing events, impacts and opportunities thereof, and effective mitigation actions (Fidai et al. 2020). Nevertheless, sargassum has caused emergencies in several Caribbean countries, especially through its ecological effects e.g., negative impacts on nearshore ecosystems and onshore turtle nesting; and socio-economic impacts e.g., sargassum beaching events affecting fisheries, waterways, shorelines and tourism (UNEP-CEP 2018). The severity of sargassum influxes differs across the WCR, and although there has been an observed “season” for the strandings (peaking in June-July) the annual variability in volume landing remains poorly understood (Johns et al. 2020). This sudden onset transboundary problem provides an opportunity to examine how a region (WCR) has responded to a problem that may become commonplace as the emergent risks driven by climate change become more prevalent.

Transboundary environmental challenges, including those due to climate change, require interstate cooperation. Conventional understandings of collective action anticipate that these issues will be resolved through top-down multilateral regulatory frameworks at global and regional levels, with necessary actions passed down to national and local levels (Ostrom 2010). We refer to these systems as centralized. However, the challenges of implementing such regimes has led to the governance of climate change, biodiversity and oceans being labeled as fragmented (Wright et al. 2017) or as polycentric, defined by dispersed centers of decision-making across multiple spatial scales (Carlisle and Gruby 2019; Heikkila, Villamayor-Tomas, and Garrick, 2018; Ostrom 2010). From a disaster governance perspective, governance regimes have also increasingly been found to be polycentric and multiscale, yet lacking in integration across hazard types, and embedded and dependent upon context-specific societal governance systems (Tierney 2012).

Several scholars have sought to clarify the governance terms *centralized*, *fragmented* and *polycentric* in order to differentiate between them (Heikkila et al. 2018). Pahl-Wostl and Knieper (2014) propose a two-dimensional space with four quadrants where the dimensions are coordination and cooperation versus lack thereof, and centralized versus distributed power. Systems with low centralization and low coordination are *fragmented*, those with high centralization and high coordination are *centralized*, and those with low centralization and high coordination are *polycentric*. Other scholars define polycentrism based on system characteristics. Jordan et al. (2018), describe five characteristics that a system should exhibit to qualify as polycentric: overarching rules, mutual adjustment of activities to foster collaboration and avoid conflict, willingness for experimentation, trust, and local action. Carlisle and Gruby (2019) also emphasize the first and last of these characteristics.

We favor a governance modality spectrum with five stages: (1) centralized, (2) polycentric fragmented, (3) polycentric bricolage, (4) polycentric codesigned and (5) functional polycentric (Mahon and Fanning 2019). *Polycentric bricolage* is found when one party

unilaterally attempts to coordinate a set of fragmented arrangements, *polycentric codesigned* is found where the parties within the system collaborate to establish a coordination process, and *functional polycentric* is an endpoint that is achieved when the coordination process has become an established operational mechanism accepted by all parties. Efforts to improve governance may seek to move the system toward the spectrum end points of centralized and functional polycentric. Mahon and Fanning (2019) apply this spectrum to analyze twenty regional ocean governance systems and conclude that functional polycentricity appears to be the intended direction for most systems; few ocean governance regions explicitly aim to be hierarchical with centralized authority. Our assessment of regional governance for the sargassum influxes in the WCR uses this governance modality spectrum because of its relevance to ocean governance (Figure 1).

Numerous scholars have pointed out the advantages of polycentric systems. Some have even argued that polycentric governance is preferable because of opportunities for experimentation, learning, interactions, building of trust and cooperation, improved institutional fit across scales, and enhanced adaptive capacity (Carlisle and Gruby 2019; Cole 2015). Nevertheless, polycentricity is by no means a panacea to social and environmental management (Ostrom, Janssen, and Anderies 2007), and faces drawbacks, including the unequal playing field of representation between stakeholders, greater costs and time to produce solutions, favoring politically viable rather than environmentally optimal solutions (Bakker and Morinville 2013), accountability gaps, and coordination problems given multiple projects, institutions and regulations operating across diverse scales (Zelli and van Asselt 2013). Both monocentric and polycentric perspectives downplay the extent to which the international system is made up of stakeholders of differing sizes, with varying capacities to engage in conventional multilateral or polycentric systems. The impact of capacity problems on conventional multilateral diplomacy is well established (Corbett et al. 2021; Scobie 2019).

There has been little work assessing the nature of the governance systems addressing these emerging transboundary. We explore the governance of the emergent threat posed by sargassum influxes in the WCR by asking three questions. First, where does the management of sargassum in the Caribbean lie on the governance modality spectrum? Second, would governance be best served by a centralized system or by a functional polycentric system? Third, what lessons can be learned to guide the movement of sargassum governance to the best achievable state?

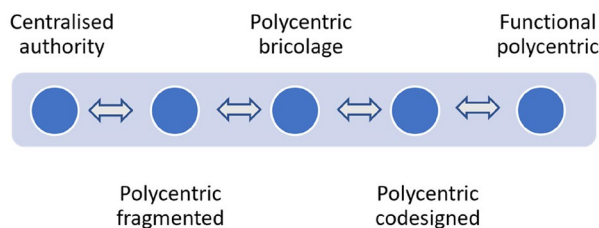


Figure 1. A governance modality spectrum indicating the relationship among some key stages, adapted from Mahon and Fanning (2019). Movements toward centralized authority may be driven by perceived complexity and dysfunctionality in the polycentric governance arrangements, whilst movement toward functional polycentrism may include actions to harmonize the system rules, facilitating learning and knowledge sharing, or establishing conflict resolution pathways.

To pursue these questions, we structure the article as follows. First, we consider the Caribbean context and discussions about the capacity of small states to engage with the international system. Next, we outline the methods and data that the analysis draws on. The bulk of the article is an empirical examination of how Caribbean small island developing states (SIDS) have sought to manage sargassum at the national and regional level, including a discussion on capacity constraints. We conclude by sharing lessons learned and reflecting on reforms for sargassum governance in the WCR.

Environmental vulnerabilities and governance in the Caribbean

While this study encompasses the entire WCR, defined as extending from North-eastern Brazil to the east coast of Florida and including all coastal countries between, the focus is on SIDS as delineated in [Figure 2](#). Caribbean SIDS have long been defined by their vulnerabilities to exogenous shocks ([Briguglio 1995](#)), although more recent work by [Siegel et al. \(2019\)](#) differentiates this social-ecological vulnerability dependent on sovereign status and regulatory frameworks, thus highlighting the role of governance and policy in climate and environmental management.

For much of the twentieth century the primary concern was economic viability ([Demas 1965](#)), and this concern remains politically salient in the postcolonial Caribbean ([Connell 2013](#)). Caribbean SIDS' economies rely heavily on tourism and an assortment of offshore services and sovereignty sales (financial services, economic passports, gaming, etc.); sectors that are volatile to external market fluctuations such as those caused by financial crises and pandemics ([Laframboise et al. 2014](#); [Mulder](#)

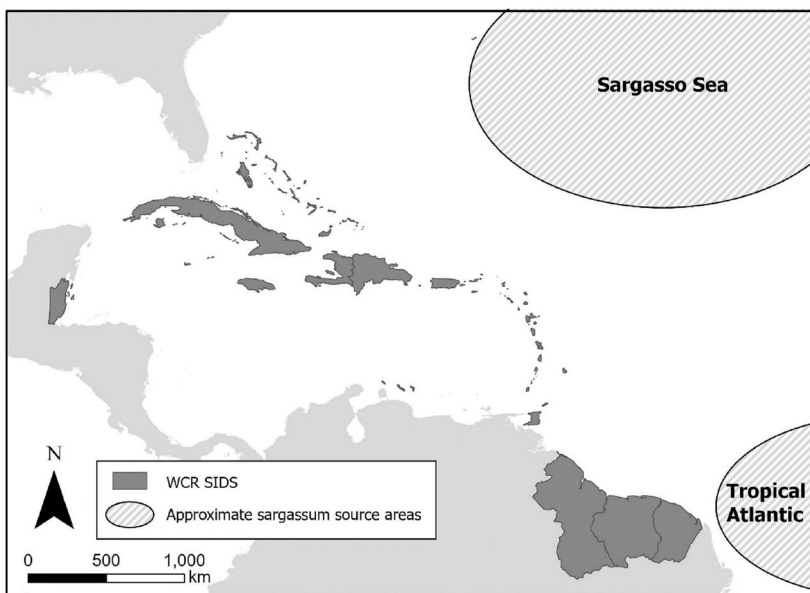


Figure 2. Small Island Developing States (SIDS) in the Wider Caribbean Region (WCR) and the approximate locations of the two dominant sources of sargassum for influx events experienced in the Caribbean.

2020). Access to international funds, including loans for climate change adaptation, is partly inhibited by the fact that numerous Caribbean territories, despite being classified as SIDS, are also high-income and upper-middle-income economies (Robinson 2018). The systemic nature of island vulnerabilities underscores the rise of the SIDS agenda across the multilateral system, including among the UN agencies, World Bank, IMF and the WTO (Corbett et al. 2021). These vulnerabilities are likely to be further exacerbated by climate change: property and environmental damage caused by an increased frequency and intensity of severe weather-related events, for example, may further disrupt the already volatile tourist sector and increase sovereign debt (Nurse et al. 2014). Caribbean SIDS have tended to focus adaptation on changing hurricane, rainfall and drought patterns across water, agriculture and coastal zone sectors (Robinson 2020), but adaptation to future risk is hindered by lack of training, enforceable regulations, concerns around maladaptation linked to insurance, and lack of access to finance (Nurse et al. 2014; Robinson 2020). A lack of climate change and socio-economic scenarios at the finer scale required for small islands further impedes the ability of Caribbean SIDS to plan for climate change adaptation (Nurse et al. 2014).

Four regional and sub-regional economic integration bodies facilitate functional co-operation within the region: the Association of Caribbean States (ACS), the Caribbean Community (CARICOM), the Organization of the Eastern Caribbean States (OECS), and the Central American Integration System (SICA). There are also numerous sector specific regional organizations that are affiliated to the above organizations, to United Nations agencies or stand-alone. Governance of transboundary coastal and marine ecosystems has been challenging within this context. Since 2001, the Global Environment Facility (GEF) funded Caribbean Large Marine Ecosystem (CLME) Initiative has sought to redress the deteriorating condition of the coastal and marine ecosystems, and enable the sustainable management of the shared living marine resources in the Caribbean and North Brazil Shelf Large Marine Ecosystems (Debels et al. 2017). Despite pre-existing regional and sub-regional fisheries and environmental mechanisms, prior to the CLME Initiative there was no ocean governance integration mechanism across sectors for the entire region (Fanning et al. 2021). The CLME + Strategic Action Programme (2015–2025) is focused on understanding and building a regional ocean governance framework across the WCR (Debels et al. 2017). It has been endorsed by thirty-five Ministers of government from twenty-five CLME+ countries and six overseas territories.

The current regional agreement to establish and maintain a coordination mechanism for ocean governance in the WCR recognizes the regional ocean governance system is polycentric. It has been categorized as *codesigned polycentric* based on the efforts of the CLME Initiative (Mahon and Fanning 2019) which aims to move it to Functional Polycentricity in the next phase. Nonetheless, the constraints typical of a polycentric system are evident, including challenges of engaging stakeholders and establishing networks, inequality of power dynamics, and lack of understanding of transboundary governance issues (Fanning et al. 2021). It is within this long-term initiative to enhance regional ocean governance that we evaluate recent efforts to guide sargassum management and appropriate responses (McConney and Oxenford 2021).

Methods and data

To shed light on this tension we have undertaken the first systematic collection, collation and analysis of English language policy documents related to sargassum management in Caribbean SIDS. Peer-reviewed literature is sparse, and regional and national sargassum policy briefs and reports emphasize the need for further research [14] (Cox, Oxenford and McConney 2019; UNEP-CEP 2018). Research has progressed in monitoring sargassum using satellite data and modeling the possible origins of the recent influxes (Johns et al. 2020; Wang et al. 2019), but there remains a significant dearth of governance research into the policy coordination of responses to this environmental phenomenon (Fidai et al. 2020).

Our inventory and analysis relies on two datasets: (1) sargassum management policies at national and island scales, with (2) regional conferences, technical sessions and other communication mechanisms held and established since 2011. In addition, several of the authors of this paper have served as consultants to develop some of the policy documents. We draw on their insider knowledge of how the policies were developed and the types of challenges they faced. The configuration of sargassum into a policy problem has not been studied to date, and so our policy-led approach allows us to explore how the problem is being framed and translated, with in-document references to coordinating mechanisms, events and stakeholders used to assess the involvement of different organizations, and learning and cooperation between them (Dorsch and Flachsland 2017). The absence of the type of data we have collected has been lamented (Jordan et al. 2015), and so in addition to our analysis we also provide an empirical contribution by constructing these consistent, replicable datasets for other researchers. The policy documents were analyzed on attributes outlined in Table 1; policy documents are numbered in square brackets corresponding to Table 3, with references provided in the annex.

The policy analysis builds on existing work on functional polycentricity (Carlisle and Gruby 2019; Dorsch and Flachsland 2017; Jordan et al 2018), whilst adapting the

Table 1. Categories for analysis of sargassum policy documents.

Feature of functional polycentricity	Category in document analysis	Specific attribute analyzed
Self-organization, specifically opportunities for regional organization	Country/territory characteristics	Official language Overseas Development Assistance recipient Population Sovereign status Membership of regional organizations
Experimentation and learning, specifically learning	Characteristics of sargassum experience	Years of sargassum influx impact Severity of sargassum influx impact Location of sargassum influx threat Causes of sargassum influx threat
Trust, specifically cooperation	Characteristics of policy	Policy specifically on sargassum influxes Listed relevant stakeholders Use of preexisting sargassum policy template
Site-specific conditions, specifically preferences of sargassum management	Framing of sargassum	Framing of the threat of sargassum influxes Framing of the opportunity of sargassum influxes Framing of the adaptation to sargassum influxes

variables of analysis to sargassum. We identify four categories of variables for analysis of the country-level policy documents. First, country/territory characteristics that indicate its situation within the complex Caribbean context; language, foreign aid, sovereignty, and membership of regional organizations (Fanning et al. 2021). Second, in the context of an emerging threat with sparse scientific certainty about cause, extent, severity and recurrence (Fidai et al. 2020), we examined how these hazard-specific variables are being captured in policy to identify emerging norms and knowledge diffusion. Third, we assessed opportunities for and examples of cooperation across policies, cataloging the stakeholders included in each policy and any cross-references between policy documents. Fourth, like many natural phenomena, sargassum is characterized as a hazard or an opportunity dependent on factors including the severity of the influxes, the perceived reuse value, and the market and institutional capacity to facilitate reuse. We therefore examined the policy preferences regarding sargassum, and how influx events were framed in terms of threat, opportunity and adaptation.

Sargassum management policies and practices

Regional action on sargassum influxes has included symposia, conferences, official statements, webinar series, podcasts, management briefs, tracking tools and outlook bulletins. An overview of these actions is in Table 2, which illustrates the wide range of media, approaches and forums being utilized in the WCR to address sargassum influxes. Since 2015, several national strategic documents have been developed (Table 3). We unpack these strategies through the lens of multilevel polycentric governance, analyzing the extent to which the multi-actor, multi-scale nature of sargassum policy development has benefited Caribbean SIDS in their response to sargassum influxes.

Immediate responses to the inundations of sargassum on Caribbean beaches in 2011 generally favored one of two approaches: either leave the sargassum to nature or remove it from the beach. The exception is Bermuda, who manages sargassum in the context of their proximity to a source area of sargassum and longer history of mild to moderate sargassum stranding events, with the Sargasso Sea designated as an area in need of conservation [8]. In the ensuing years, organizations and states developed more detailed plans for possible inundations. The Cayman Islands Department of Environment [12] specifically prefers leaving sargassum on the beach where possible; any form of mechanized clean-up requires consultation. Other states have developed longer-term strategies, with Dominica's plan outlining both current year and long-term (1-5 years) intentions [15]. While Table 3 illustrates the widespread uptake of management briefs by Caribbean states and territories, it also flags that there are states severely impacted by sargassum without a publicly available guidance document, including Belize and Suriname.

Even for those states with formalized national policy briefs, the contents and level of detail ranges from in-depth, country- and site-specific analysis and recommendations [15, 19], to the development and use of model protocols—model protocols which include Puerto Rico and Grenada's management briefs [27, 17], and CRFM Secretariat and UWI-CERMES briefs (CRFM 2016; Hinds et al. 2016) [17]. Some protocols remained in draft status for years before being updated to adaptive management

Table 2. Regional action on sargassum influxes since 2011.

Organization	Year	Action	Details
Texas A&M Galveston (TAMUG)	2013-ongoing	Prediction and detection system	Sargassum Early Advisory System (SEAS)
Caribbean Hotel and Tourism Association (CHTA)	2015	Webinar	"Sargassum and the effects of climate change"
Caribbean Sea Commission (CSC)	2015	Symposium / report	Identified sargassum as a threat for which management capacity, monitoring, commercial use, and best practices should be developed (CSC 2015)
Caribbean Hotel and Tourism Association (CHTA)	2015	Management brief	Guide detailing sargassum impacts on tourism, and proposed mitigation and management options (CHTA 2015)
GCFI	2015	Fact sheet	On influxes (Doyle and Franks 2015)
UWI-CERMES	2015	Symposium	First Sargassum Caribbean Symposium
SPAW-RAC	2015-ongoing	Online forum	Sargassum Online Forum, sharing best practice, and knowledge
Caribbean Regional Fisheries Mechanism	2016	Model management protocol	Management of influxes on the coasts of member states (CRFM 2016)
UWI-CERMES	2016	Management brief	Best practices for management of influxes (Hinds et al. 2016)
Government of the BVI, Virgin Group, and Virgin Unite, the Foreign and Commonwealth Office, the OECS, and the Caribbean Council	2016	Conference	Sargassum East Caribbean Conference
SPAW-RAC	2016	Technical session	Technical session on sargassum held at the 69 th GCFI Annual Conference
UNEP and Sargasso Sea Commission	2017	Memorandum of Understanding	Recognizing the importance of sargassum in ecosystems and need for exchange of information regarding influxes (UNEP and SSC 2017)
University of South Florida	2018-ongoing	Prediction and detection system, and bulletin	Sargassum Watch System (SaWS)
CARICOM	2018	Strategy	Biodiversity Strategy identifies sargassum as a transboundary issue (CARICOM 2018)
UWI-CERMES	2018-ongoing	Bulletin	Sargassum Subregional Outlook Bulletins
UWI-CERMES/FAO	2018	Symposium	Second Sargassum Caribbean Symposium
UNEP-CEP	2018	White paper	Sargassum White Paper (UNEP-CEP 2018)
Intergovernmental Oceanographic Commission (IOC), UNESCO	2018	Workshop	Workshop on Sargassum and Oil Spills Monitoring Pilot Project for the Caribbean and Adjacent Regions
Collecte Localisation Satellites (CLS)	2018-ongoing	Prediction and detection system	SAMtool
UWI-CERMES	2019	Management brief	Best practice guide for Caribbean fishers coping with sargassum (Speede, Cox and Oxenford 2019)
Florida International University	2019-ongoing	Electronic mailing list and Slack Workspace	SARGNET, mailing list to distribute sightings, data and knowledge across the Tropical Atlantic
OECS	2019	Conference	International Conference on Sargassum
OECS	2019	Trade show	Sarg'Expo, the first international trade show on sargassum seaweed monitoring, collection and recycling
OECS	2019	Declaration	Final Declaration of the International Conference on Sargassum: A commitment to Cooperation in the Caribbean (OECS 2019)
Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP)	2019	Task team	Task Team on Sargassum

(Continued)

Table 2. Continued.

Organization	Year	Action	Details
NOAA Atlantic Oceanographic and Meteorological Laboratory, University of South Florida	2020-ongoing	Weekly report	Experimental weekly inundation report
GEO Blue Planet, IOCARIBE of IOC-UNESCO, AtlantOS, and the Atlantic International Research (AIR) Center	2020-ongoing	Online platform	Sargassum Hub, online platform to share information about experts working on sargassum
Conservation without Borders IOC Ocean Best Practices System	2020-ongoing	Podcast Working group	Podcast series, "The Sargassum Podcast" Sargassum Working Group
European Algae Biomass Association	2020	Workshop	Workshop on Atlantic Sargassum Belt
UWI-CERMES/FAO	2020	Uses report	Sargassum uses guide for researchers, entrepreneurs and policy makers (Desrochers et al. 2020)
UNEP	2020-2021	Webinar series	Sargassum webinar series
UNEP	2021	White paper	Sargassum White Paper (UNEP-CEP 2021)
GEO Blue Planet, IOCARIBE of IOC-UNESCO, AtlantOS, and the Atlantic International Research Center	2021	Side event	Sargassum side event at All-Atlantic 2021 Conference
Algae-UK, BBNNet and EBNet	2021	Conference	Sargassum Golden Tides conference
Wageningen Food & Biobased Research	2021	Uses report	Valorization guide for Dutch Caribbean (López- Contretras et al. 2021)

strategies [5/6, 17/18, 36/37, 39/40]. From the outside it is unclear how many have been adopted by government departments or have received executive approval.

Most states and territories in the Caribbean have some form of sargassum management strategy in place, but there is a marked difference in detail among them. Several independent states have released (draft) management reports, including Dominica [15], Jamaica [24], Saint Lucia [32, 33], St. Vincent and the Grenadines [36, 37], St. Kitts and Nevis [30, 31], Grenada [17, 18], and Trinidad and Tobago [39, 40]. Other strategies were released by sovereign European states to encompass their Caribbean constituent territories. For example, the Dutch Caribbean Nature Alliance [3] released its prevention and clean-up strategy in 2019, which addresses the impacts in the Dutch Caribbean. Most of this strategy is based on the Hinds et al. (2016) brief, exemplifying the benefits of regional networks.

The documentation reveals that there is a lack of knowledge on sargassum influxes to support strategy development and management decisions. All the strategies studied here lament the dearth of evidence on which to base decision-making. Regional collaboration and investment in research are highlighted as priorities by Martinique [19], St Maarten [3], and Trinidad and Tobago [39], and developing and improving the monitoring of sargassum at sea is identified in almost all national policies. Of those policies hypothesizing the causes of the influxes, many rely on the Hinds et al. (2016) report [3, 15], point out the competing theories regarding the origins of sargassum influxes [17, 24, 39], and stress the need for further research to understand the effect of environmental parameters on the transport of sargassum [3, 15, 30, 32, 39].

Despite regional and national efforts to manage Sargassum, the limited resources for policy development and implementation hinder universal development and adoption of management strategies across the WCR. These limitations are identified in multiple

Table 3. National policy documents addressing sargassum influxes in Caribbean SIDS (adapted from van der Plank et al. 2020).

No.	State	Impact levels*	Document type	Report title	Year
1	Anguilla (UK)	VH	Management plan	Draft Sargassum management plan	2015
2	Antigua and Barbuda	VH	Invite for tender	Request for Expression of Interest for the Supply of Equipment and Machinery for Aquatic <i>Sargassum</i> seaweed removal in Antigua and Barbuda	2018
3	Aruba (NL)	M	Management brief (NL)	Prevention and clean-up of Sargassum in the Dutch Caribbean	2019
4	Bahamas	L	None found	N/A	N/A
5	Barbados	VH	Management brief	Barbados Sargassum Management Plan	2019
6			Management strategy	Barbados Sargassum Adaptive Management Strategy	2021
7	Belize	VH	None found	N/A	N/A
8	Bermuda (UK)	NA	Biodiversity conservation strategy	The protection and management of the Sargasso Sea: The golden floating rainforest of the Atlantic Ocean.	2011
9	Bonaire (NL)	H	Management brief (NL)	Prevention and clean-up of Sargassum in the Dutch Caribbean	2018
10			Presentation	Sargassum Bonaire	2018
11	British Virgin Islands	VH	Statements to parliament	Statement by Deputy Premier and Minister for Natural Resources and Labor Dr. The Honorable Kedrick D Pickering "Sargassum Seaweed Phenomenon"	2015
12	Cayman Islands (UK)	H	Removal guidelines	Guidelines on Removing Sargassum from Beaches	2015
13	Cuba	L	None found	N/A	N/A
14	Curaçao (NL)	H	Management brief (NL)	Prevention and clean-up of Sargassum in the Dutch Caribbean	2019
15	Dominica	H	Strategic preparedness plan	Strategic Sargassum Preparedness Plan	2019
16	Dominican Republic	VH	Technical uses guide	Informe sobre el estado de la técnica: tecnologías sobre la recolección del sargazo	2018
17	Grenada	M	Model protocol	Protocol for the Management of the Extreme Accumulations of Sargassum on the Coast of Grenada	2017
18			Management strategy	Grenada Sargassum Adaptive Management Strategy	2021
19	Guadeloupe (Fr)	VH	Training document	Creation of green brigades for collecting sargassum in Guadeloupe	2015
20			Report and recommendations (Fr)	Le phénomène d'échouage des sargasses dans les Antilles et en Guyane	2016
21	Guyana	L	None found	N/A (supposed to be modifying CRFM protocol)	N/A
22	Guyana (French Guiana)	NA	Report and recommendations (Fr)	Le phénomène d'échouage des sargasses dans les Antilles et en Guyane	2016
23	Haiti	L	None found	N/A (Coastal Sanitation Protection of the Great South Coast)	N/A
24	Jamaica	VH	Strategic preparedness plan	National Response Strategy: The Sargassum Threat	2015
25	Martinique (Fr)	H	Report and recommendations (Fr)	Le phénomène d'échouage des sargasses dans les Antilles et en Guyane	2016
26	Montserrat (UK)	H	None found	N/A	N/A
27	Puerto Rico	H	None found	N/A (Protocol for the management of extreme accumulation of Sargassum on the coasts of Puerto Rico)	2015
28	Saba (NL)	H	Management brief (NL)	Prevention and clean-up of Sargassum in the Dutch Caribbean	2019
29	St Eustatius (NL)	H	Management brief (NL)	Prevention and clean-up of Sargassum in the Dutch Caribbean	2019

(Continued)

Table 3. Continued.

No.	State	Impact levels*	Document type	Report title	Year
30	St Kitts and Nevis	VH	Management brief	Plan for the Management of the Accumulations of Sargassum on the Coastal and Marine Ecosystem of St. Kitts and Nevis	2017
31			Management brief	St. Kitts and Nevis Sargassum Adaptive Management Strategy	2021
32	St Lucia	VH	Management brief	Saint Lucia National Strategy for the Management of Sargassum Influxes on Beaches, Bays and Small Harbors	2017
33			Management strategy	Saint Lucia Sargassum Adaptive Management Strategy	2021
34	St Maarten (NL)	VH	Management brief (NL)	Prevention and clean-up of Sargassum in the Dutch Caribbean	2019
35	St Martin (Fr)	NA	Green Brigade and government statements	N/A	N/A
36	St Vincent and the Grenadines	VH	Management brief	Management of Extreme Accumulations of Sargassum on the Coasts of St. Vincent and the Grenadines	2018
37			Management Strategy	St. Vincent and the Grenadines Sargassum Adaptive Management Strategy	2021
38	Suriname	VH	None found	N/A	N/A
39	Trinidad and Tobago	H	Management brief	National Sargassum Response Plan [Trinidad]	2016
40				Tobago Sargassum Emergency Response Plan [Tobago]	2016
41	Turks and Caicos	VH	None found	N/A (draft in progress)	N/A
42	US Virgin Islands	H	None found	N/A	N/A

*According to UNEP white paper (UNEP-CEP 2018): VH Very High; H High; M Medium; L Low; NA not included in UNEP paper.

This table includes all identified policies/strategies, but only those in English were analyzed in depth. See [supplementary material](#) for reference list of all policy briefs. Fr: France, collectivity, NL: Netherlands, country or public body, UK: United Kingdom, overseas territory.

Note: All reports were found through online search, except: (i) Jamaica (2015) which was received directly from National Environment and Planning Agency, Jamaica, and (ii) Barbados, Grenada, St Kitts and Nevis, St Lucia, St Vincent and the Grenadines, Trinidad and Tobago which were all received from country contacts.

national strategies and reports [15, 32] (UNEP-CEP 2018). Furthermore, although the production of a single policy brief by the Dutch Caribbean Nature Alliance ensures Dutch constituent countries and special municipalities have a coordinated policy direction, this single brief is a generic report largely based on the work of Hinds et al. (2016) [3] and thus has limited island-specific information. It is evident that multi-level policy development has facilitated institutional buy-in, with various regional and state briefs drawing on information across levels and actors as well as through lateral linkages within levels to facilitate management processes nationally. Nevertheless, despite the benefits of partnership, questions remain as to whether (a) policy integration is stifling policy innovation, and (b) the policies are being effectively tailored to island-specific needs, and (c) WCR SIDS are better able to manage Sargassum because of the multi-scale governance.

Capacity constraints and the limits of coordination

Our policy analysis found limited evidence that capacity for regional organization as measured by sovereignty, population size, level of development, and regional organizational membership affected the presence or absence of a sargassum policy. States

with both relatively large populations in the region and those with small populations do not have a sargassum policy; for example, no briefs were identified for more populous Suriname [38] nor for less populous Turks and Caicos Islands [41]. Most ODA eligible countries [2, 7, 15, 16, 17/18, 24, 32/33, 36/37], excepting Cuba, Guyana, Suriname and Montserrat [13, 21, 38, 26], have some form of sargassum policy and plan. Despite the CRFM Secretariat releasing a framework protocol for member states, Suriname, Montserrat, the Bahamas and Turks and Caicos (CRFM members) appear to lack a sargassum management strategy [38, 26, 4, 41]. Of the CRFM members, Barbados, Suriname, Anguilla and Turks and Caicos were identified in the UNEP white paper on sargassum as experiencing very high impacts (2018)—half have policies, half do not. It is therefore unclear whether membership in regional bodies, including those that have produced sargassum advice, has had any effect on the intrastate development and implementation of management policies, highlighting the current lack of overarching policy frameworks to coordinate sargassum governance in the Caribbean.

The plethora of sargassum management approaches described in the documents, whether conducted privately and by government bodies across multiple scales, suggest that the governance of sargassum in the WCR lies somewhere in the middle of Mahon and Fanning's (2019) governance modality spectrum (Figure 1). The sargassum management policies include examples of local action (e.g., the establishment of green brigades in Guadeloupe to collect sargassum [19]), with evidence of experimentation across national sargassum policies (e.g., the Dominican policy citing different re-use cases of sargassum [15]), as well as of trust and collaboration in the regional conferences between diverse stakeholders (Table 2). But we did not find evidence for the fifth criterion—coordination and a common set of rules—which are deemed to be critical for functional polycentricity (Carlisle and Gruby 2019; Jordan et al. 2018; Pahl-Wostl and Knieper 2014). Organizations are making efforts at coordinating through regional symposia (Table 2), but without agreement about roles this suggests that sargassum governance is not at the stage of functional polycentricity.

Regional barriers and enablers in the governance of sargassum influxes

Several benefits of polycentric governance have been identified in this study. Regional bodies are developing model protocols to support intrastate policy development (Table 3). Conferences have been held by several organizations to support cross-state and industry discourse, such as the international conference and expo that resulted in an initial declaration on the commitment to cooperate in the Caribbean on sargassum (OECS 2019), and the establishment of the Sargassum Caribbean Programme (SARG'COOP). In these ways, governance of sargassum in the Caribbean exhibits signs of self-organization with multiple bodies encouraging experimentation and learning. The actors able to engage in the events and actions listed in Table 2 are largely pre-existing, established centers in ocean governance, including the science-policy interface (e.g., UWI-CERMES), livelihood lobby groups (e.g., CHTA, CRFM Secretariat), and international and regional institutions (SPAW-RAC, UNEP, IOCARIBE). Whilst this demonstrates the range of powerful actors engaged in sargassum governance, the ability of local artisans and smaller sectors to engage with the rules around sargassum management are less established, with public-facing mechanisms more limited to date. As

observed by Gruby and Basurto (2013) in the context of marine commons in Palau, while the interactions of stakeholders in adapting to sargassum influx events results in further embedding of existing polycentric arrangements, it may leave other actors overlooked or powerless to engage in the process. It remains to be seen whether this self-organizing mélange of decision-making centers will advance to develop overarching rules and coordination, also identified as characteristics of a functional polycentric system.

Leveraging regional ocean governance mechanisms

It is notable that no regional organization has yet proposed a coordinated approach consistent with the CLME Initiative despite: (1) the importance of regional organizations to the countries and territories in this study; (2) a focus on regional ocean governance in the WCR for at least two decades through the CLME Initiative; and (3) the adoption of a polycentric Regional Ocean Governance Framework with coordination and collaboration as a key component by the countries and organizations. It could be argued that none of the sectoral organizations have the mandate to address the full scope of sargassum, and while the economic integration bodies do have mandates that cover the relevant scope of impacts and responses, neither CARICOM nor SICA have comprehensive ocean policies under which a coordination role for sargassum could be mobilized. The OECS has an oceans policy and appears to have played a coordination role for its members (OECS 2013). This leaves only the ACS Caribbean Sea Commission with a mandate for region-wide coordination of oceans affairs. Yet, despite holding a conference on sargassum (CSC 2015) it has not taken on a formal regional coordinating role. Sargassum governance thus exhibits the advantages of polycentricity in terms of learning and collaboration but there is limited evidence of tangible outcomes from the interaction between the different bodies beyond the initial declaration of cooperation (OECS 2019).

Polycentric governance and SIDS

Another aspect of the polycentric approach to sargassum management is the extent to which limitations of small size and the complex government regimes of Caribbean SIDS has led to system dysfunctionalities. Polycentric governance should theoretically deliver greater policy innovation (Cole 2015); in some ways the Caribbean response to sargassum exemplifies that innovation, with varied local management approaches, including, e.g., St Lucia and Dominica both emphasize the economic opportunities to be gained from sargassum product development [15, 32/33], while the French Caribbean prioritizes rapid clean-up operations and the use of sargassum for agriculture [19/20, 22, 24, 34]. But for SIDS, engagement with a polycentric approach to governance has both advantages and disadvantages. The problem of low national capacity to engage effectively with regional and global processes has long been recognized in the WCR (Mahon et al. 2010). For example, National Intersectoral Coordination Mechanisms (NICs) are a requirement of all GEF Projects and strengthening them in WCR countries is an integral, funded, component of the CLME + Initiative (Debels et al. 2017). But progress with NICs has been slow, especially for SIDS, further limiting their

capacity to engage in regional ocean governance (Compton et al. 2020). Had these NICs been operational in most countries they may have questioned why sargassum governance was being pursued largely independent of regional institutions. One lesson could be to address the governance questions early so as to (a) identify and strengthen regional science-policy arenas into the work; (b) use existing national coordination mechanisms; and (c) build on existing regional ocean governance efforts.

National capacity gaps

Limited national capacity to implement agreed actions is also a problem. Despite state and regional policies outlining a multitude of management approaches encompassing prevention, clean-up, monitoring, public engagement, research, and reuse, much of that action is beyond the ability of many SIDS and thus remains dependent on external input; for example, the sargassum early-warning and monitoring systems, such as those generated by the University of South Florida (United States) and Collecte Localisation Satellites (France). The challenge of organizational capacity and accessing finance for climate change adaptation has been highlighted more generally, with (relatively high) national incomes often preventing access to loans and grants (Robinson 2018). Part of the challenge in addressing these capacity gaps may be aggravated by the power dynamics of sargassum governance in the Caribbean, with different stakeholders asserting their influence across the design, practice and framing of sargassum influxes. Morrison et al. (2017; 2019) identifies three forms of power to consider in polycentric analyses: power by design (formal, institutional, policy-making), pragmatic power (practical, social, day-to-day), and framing power (norms, discourse, construction). While states are leading sargassum policy development (power by design), private entities such as hotels on tourist-dominated coastlines often resource and oversee clean-up operations (pragmatic power), and regional bodies are driving the sargassum discourse, such as the UNEP white paper framing the influx events as an opportunity (UNEP-CEP 2021) (framing power). At best, this division of power further exemplifies the polycentric nature of sargassum governance in the Caribbean; at worst, it highlights its currently fragmented state.

Conclusions

The case of sargassum in the WCR exemplifies the advantages of polycentric governance whilst simultaneously demonstrating the difficulty of achieving levels of regional coordination required for it to be fully functional. The sargassum case also illustrates the challenges faced by SIDS in participating effectively in regional polycentric governance, while highlighting their dependency on external financial and technical support. Sargassum is also affecting West African states and the issues we raise are relevant to those countries and regions too. In both the context of managing sargassum specifically and the more general governance challenges that will be posed by future emergent threats, our work highlights the importance of rapidly establishing clarity in the governance of transboundary threats. Quickly establishing clear governance collaboration and support structures can be enabled by leveraging existing regional coordinating bodies for ocean governance and agreeing on—at least an initial—set of rules. Similarly, by coordinating across and within existing policy arenas, such as disaster

management or climate change adaptation, the governance of emergent threats can be embedded into areas with existing resources and expertise.

In this article we have explored the governance of the sargassum challenge from the perspective of Caribbean SIDS. We found intensive efforts by institutions at national and regional levels to understand the problem and formulate a response since 2011, with a particularly marked increase since 2015. A number of private and public players across these scales are being engaged to adapt to these influxes, treating the seaweed inundations both as a threat and opportunity. In many cases there is evidence of a desire for cooperation to create a collaborative approach that maximizes shared strengths and resources. We also found examples where that desire had been realized in practice. The policies we examined evidence how sargassum management is being tailored to local needs, as well as drawing from regional learning and experiencing support from UWI-CERMES, SPAW-RAC and the OECS, thus demonstrating how power differentials between regional, national and local bodies are not inherently detrimental to polycentric governance (Gruby and Basurto 2013; Morrison et al. 2017). Despite these successes, we noted the highly complex nature of the response, the multiplicity of actors, and the scalar dynamics in a region made up of sovereign and non-sovereign states and territories, regional institutions and extra-regional academics and technocrats. In these circumstances, the ability of individual islands, states and territories to navigate the system, effectively engage to ensure their interests are considered, and to coordinate assistance to their benefit, is curtailed by well-documented capacity constraints.

Our findings reveal that there are benefits to be found in the multilevel, polycentric system that emerged to deal with sargassum influxes, but also that the lack of a critical coordinating component linked to an identified political process imposed further limitations and emphasizes the importance of addressing the structure and function of polycentric systems explicitly rather than letting them emerge organically. Specifically, we highlight that unless this type of regime is explicitly designed to intersect with related processes such as a regional ocean governance, the burden of coordination falls on those with the least resources to undertake that task. The characteristics of the emergent threat of sargassum influxes—cross-sectoral, cross-boundary impacts of an as-yet unpredictable recurrence—challenges efforts at adaptation at all scales, and a durable governance mechanism to coordinate and facilitate the effort is yet to be established.

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Appendix 1. Reference list for Table 3 of National policy documents addressing sargassum influxes.

No.	State	Reference	Open access
1	Anguilla (UK)	Government of Anguilla. 2015. <i>Draft Sargassum management plan</i> . The Valley, Anguilla.	Accessed through personal correspondence.
2	Antigua and Barbuda	Government of Antigua and Barbuda. 2018. <i>Request for Expression of Interest for the Supply of Equipment and Machinery for Aquatic Sargassum seaweed removal in Antigua and Barbuda</i> . Available at: https://environment.gov.ag/assets/uploads/attachments/68574-expression-of-interest-sargassum-removal-in-antigua.pdf	Open access
3	Aruba (NL)	Dutch Caribbean Nature Alliance. 2019. <i>Prevention and clean-up of Sargassum in the Dutch Caribbean</i> . Available at: https://www.dcnanature.org/wp-content/uploads/2019/02/DCNA-Sargassum-Brief.pdf	Open access
4	Bahamas	None found.	N/A
5	Barbados	Husbands, F., and N. Rouse. 2019. <i>Barbados Sargassum Management Plan</i> . Barbados National Oil Company Limited. Woodbourne, St. Philip.	Accessed through personal correspondence.
6		CERMES and Ministry of Maritime Affairs and Blue Economy. 2021. <i>Draft Barbados Sargassum Adaptive Management Strategy. Volume 1: Adaptive Strategy</i> . Bridgetown, Barbados. 15 pp.	Open access
7	Belize	None found. For information on sargassum management advice in Belize, see <i>Sargassum Resource</i> . n.d. Belize Tourism Board. Available at: https://belizetourismboard.org/tourism-resources/sargassum-resource	N/A
8	Bermuda (UK)	Laffoley, D.d'A., Roe, H.S.J., Angel, M.V., Ardron, J., Bates, N.R., Boyd, I.L., Brooke, S., Buck, K.N., Carlson, C.A., Causey, B., Conte, M.H., Christiansen, S., Cleary, J., Donnelly, J., Earle, S.A., Edwards, R., Gjerde, K.M., Giovannoni, S.J., Gulick, S., Gollock, M., Hallett, J., Halpin, P., Hanel, R., Hemphill, A., Johnson, R.J., Knap, A.H., Lomas, M.W., McKenna, S.A., Miller, M.J., Miller, P.I., Ming, F.W., Moffitt, R., Nelson, N.B., Parson, L., Peters, A.J., Pitt, J., Rouja, P., Roberts, J., Roberts, J., Seigel, D.A., Siuda, A.N.S., Steinberg, D.K., Stevenson, A., Sumaila, V.R., Swartz, W., Thorrold, S., Trott, T.M., and V. Vats. 2011. <i>The protection and management of the Sargasso Sea: The golden floating rainforest of the Atlantic Ocean. Summary Science and Supporting Evidence Case</i> . Sargasso Sea Alliance and Government of Bermuda, 44 pp. Available at: http://www.sargassoseacommission.org/storage/documents/Sargasso.Report.9.12.pdf	Open access

(Continued)

Appendix 1. Continued.

No.	State	Reference	Open access
9	Bonaire (NL)	Stinapa Bonaire National Parks Foundation. 2018. Sargassum Bonaire. Available at https://stinapabonaire.org/wp-content/uploads/2018/09/20180315-STINAPA-Sargassum-ppt.pdf	Open access
10		See [3]	Open access
11	British Virgin Islands	Pickering, Kederick D. 2015. "Sargassum Seaweed Phenomenon". Statement at the Fourth Sitting of the First Session of the Third House of Assembly, Government of Virgin Islands. Available at: http://www.bvi.gov.vg/media-center/sargassum-seaweed-phenomenon	Open access
12	Cayman Islands (UK)	Department of Environment. 2015. <i>Guidelines on Removing Sargassum from Beaches</i> . Cayman Islands Government. Available at: http://doe.ky/wp-content/uploads/2015/01/DoE-Guidelines-on-Removing-Sargassum-from-Beaches.pdf	Open access
13	Cuba	None found	N/A
14	Curaçao (NL)	See [3]	Open access
15	Dominica	Resilify Inc. 2019. <i>Strategic Sargassum Preparedness Plan</i> . Fisheries Division, Ministry of Agriculture, Food and Fisheries, and Commonwealth of Dominica. Available at: https://repository.oceanbestpractices.org/handle/11329/1287	Open access
16	Dominican Republic	Centro de Apoyo a la Tecnología e Innovación, and OMPI. <i>Informe sobre el estado de la técnica: tecnologías sobre la recolección del sargazo</i> . Boletín Vigilancia Tecnológica No. 2. Domican Republic. Available at: http://www.registracionacional.go.cr/propiedad_industrial/Documentos/IVT%20TECNOLOGIAS%20SOBRE%20RECOLECCION%20DEL%20SARGAZO,%20RED%20CATI%20CARD%20REPUBLICA%20DOMINICANA.PDF	Open access
17	Grenada	Ince, D. 2017. <i>Protocol for the Management of the Extreme Accumulations of Sargassum on the Coast of Grenada</i> . CRFM Technical & Advisory Document. St George's, Grenada.	Accessed through personal correspondence.
18		CERMES. 2021. <i>Draft Grenada Sargassum Adaptive Management Strategy. Volume 1: Adaptive Strategy</i> . FAO CC4FISH project. 16pp.	Accessed through personal correspondence.
19	Guadeloupe (Fr)	Ministère des Outre-Mer, Ministère de l'Environnement, de l'Énergie et de la Mer, and Ministère de l'Agriculture, de l'Agroalimentaire et de le Forêt. 2016. 'Le Phénomène d'échouage Des Sargasses Dans Les Antilles et En Guyane'. Available at: https://www.interieur.gouv.fr/Publications/Rapports-de-l-IGA/Rapports-recents/Le-phenomen-e-d-echouage-des-sargasses-dans-les-Antilles-et-en-Guyane	Open access.
20		Department of Environment, Land Planning and Housing. 2015. <i>Creation of green brigades for collecting sargassum in Guadeloupe</i> . Available at: http://www.guadeloupe.developpement-durable.gouv.fr/IMG/pdf/anglais_sargasse.pdf	Open access.
21	Guyana	N/A	N/A
22	Guyane (French Guiana)	As of 2016, supposed to be modifying CRFM protocol. ¹	Open access.
23	Haiti	None found.	N/A
24	Jamaica	National Environment and Planning Agency. 2015. <i>National Response Strategy: The Sargassum Threat</i> . Kingston, Jamaica. www.nepa.gov.jm	Accessed through personal correspondence.
25	Martinique (Fr)	See [18]	Open access.
26	Montserrat (UK)	None found.	N/A
27	Puerto Rico	<i>Protocol for the management of extreme accumulation of Sargassum on the coasts of Puerto Rico</i> . Cited as template for CRFM Secretariat (2016) model protocol but not publicly available. ²	N/A

(Continued)

Appendix 1. Continued.

No.	State	Reference	Open access
28	Saba (NL)	See [3]	Open access
29	St Eustatius (NL)	See [3]	Open access
30	St Kitts and Nevis	Williams, O. 2017. <i>Plan for the Management of the Accumulations of Sargassum on the Coastal and Marine Ecosystem of St Kitts and Nevis</i> . Department of Marine Resources.	Accessed through personal correspondence.
31		CERMES. 2021. <i>Draft Saint Kitts and Nevis Sargassum Adaptive Management Strategy. Volume 1: Adaptive Strategy</i> . FAO CC4FISH project. 17pp	Accessed through personal correspondence.
32	St Lucia	Sealys, C. 2017. <i>Saint Lucia National Strategy for the Management of Sargassum Influxes on Beaches, Bays and Small Harbors</i> . Ed. M-L Felix. Department of Agriculture, Fisheries, Natural Resources and Co-operatives, Department of Fisheries.	Accessed through personal correspondence.
33		CERMES. 2021. <i>Draft Saint Lucia Sargassum Adaptive Management Strategy. Volume 1: Adaptive Strategy</i> . FAO CC4FISH project. 17pp.	Accessed through personal correspondence.
34	St Maarten (NL)	See [3]	Open access
35	St Martin (Fr)	See [18]	Open access
36	St Vincent and the Grenadines	Billingsy, H.K. 2018. <i>Management of Extreme Accumulations of Sargassum on the Coasts of St. Vincent and the Grenadines</i>	Accessed through personal correspondence.
37		CERMES. 2021. <i>Draft St Vincent and the Grenadines Sargassum Adaptive Management Strategy. Volume 1: Adaptive Strategy</i> . FAO CC4FISH project. 16pp	Accessed through personal correspondence.
38	Suriname	None found.	N/A
39	Trinidad and Tobago	Institute of Marine Affairs. 2016. <i>National Sargassum Response Plan</i> . Hilltop Lane, Chaguaramas, Trinidad.	Accessed through personal correspondence.
40		Robin, H. 2019. Tobago Sargassum Emergency Response Plan. Presentation at International Conference on Sargassum 2019. Available at: https://www.slideshare.net/CRGuadeloupe/howard-robin-tobago-house-of-assembly-tobago-sargassum-emergency-response-plan	Presentation on strategy available open access.
41	Turks and Caicos	None found (draft in progress). ³	N/A
42	US Virgin Islands	None found.	N/A

This table includes all identified policies/strategies, but only those in English were analyzed in depth.

According to UNEP white paper (UNEP-CEP 2018): VH Very High; H High; M Medium; L Low; NA not included in UNEP paper. Fr: France, collectivity, NL: Netherlands, country or public body, UK: United Kingdom, overseas territory.

Note: All reports were found through online search, except: (i) Jamaica (2015) which was received directly from NEPA, Jamaica, and (ii) Grenada, St Kitts and Nevis, St Lucia, St Vincent and the Grenadines, Trinidad and Tobago which were all received from country contacts.

¹See: <https://demerarawaves.com/2016/11/01/sargassum-seaweed-partly-responsible-for-guyanas-reduced-fish-production/>

²See http://www.sargassoseacommission.org/storage/FINAL_MODEL_PROTOCOL_FOR_THE_MANAGEMENT_OF_EXTREME_ACCUMULATIONS_OF_SARGASSUM.pdf

³Lead author informed through personal communication.