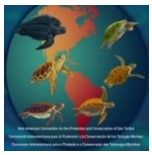

Inter-American Convention for the Protection and Conservation of Sea Turtles
21st Meeting of the IAC Scientific Committee
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CIT-CC21-2024-Tec.26

Technical Document

The current and potential implications of Sargassum for the Caribbean region of the Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC)

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2024

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Acronyms

Name	Acronym*
Association of Caribbean States	ACS
Caribbean Tourism Organization	CTO
Caribbean Alliance for Sustainable Tourism	CAST
Caribbean Natural Resource Institute	CANARI
Caribbean Regional Fisheries Mechanism	CRFM
Center for Resources Management & Environmental Studies	CERMES
Inter-American Convention for the Protection and Conservation of Sea Turtles	IAC
Secretariat of Environment and Development	SED
Mesoamerican Reef System	MBRS
Specially Protected Areas and Wildlife	SPAW
Sub-Commission for the Caribbean and Adjacent Regions	SCCAR
University of West Indies	UWI
Wildlife Conservation Society	WCS
World Wildlife Fund	WWF
United Nations Environment Programme	UNEP
Belize Expressive Art Foundation	BEAF
Belize Fishermen Cooperative Association	BFCA
Belize Fishermen Cooperative Association	BFCA
Belize Tourism Industry Association	BTIA
Ministry of Environment	MiAMBIENTE
La Amistad Caribbean Conservation Area	LACC
National Animal Health Service	SENASA
University of Costa Rica	UCR
National University	UNA
Center for Research in Marine Sciences and Limnology	CIMAR
Natural Resources and Wildlife Laboratory	LARNV
Tortuguero Conservation Area	TCA
National System of Conservation Areas	SINAC
National Coast Guard Service	SGC
Tropical Scientific Center	CCT
South Caribbean Fishermen Association	ASCAR
Regional Institute for Studies on Toxic Substances	IRET
Costa Rican Tourism Institute	ICT
National Learning Institute	INA
Ministry of Environment	MiAMBIENTE
National Council for Protected Areas	CONAP
Guatemalan Tourism Institute	INGUAT
Secretariat of Environment and Development	SED
National Council for Protected Areas	CONAP
United Nations Environment Programme	UNEP
National System of Protected Areas of Honduras	SINAPSIS
Bay Island Conservation Association	Bica
Caribbean Alliance for Sustainable Tourism	CAST
National Council for Protected Areas	CONAP
Department of Marine Environment Protection	DEPMA
General Directorate of Biodiversity	DGB

General Directorate of Merchant Marine	DGMM
Cayos Cochinos Foundation	FCC
Roatan Marine Park	RMP
Institute of Forestry Conservation and Wildlife Protected Areas	ICF
Ministry of Environment and Natural Resources of Nicaragua	MARENA
North Caribbean Coast Autonomous Region	RACN
Nicaraguan Institute of Fisheries and Aquaculture	INPESCA
South Caribbean Coast Autonomous Region	RACS
National Tourism Institute	INTUR
Institute of Agricultural Health and Protection	IPSA
Ministry of Health	MINSA
Caribbean Coral Restoration	ARAP
Mar Alliance	AMP
ProMar Foundation	FPMR
Smithsonian Tropical Research Institute	STRI
Caribbean Coral Restoration	CCRC
Mar Alliance	MA
Association of Artisans and Marine Services	ARSEMAR
Association of Caribbean States	ACS
Association of Hotels and Tourism Projects in the Eastern Zone	ASHOTEL
Dominican Republic National Association of Hotels and Restaurants	ASONAHORES
National Authority for Maritime Affairs	ANAMAR
Association of Artisans and Marine Services	ASEMAR
Association of Caribbean States	ACS
Association of Hotels and Tourism Projects of the Eastern Zone	ASHOTEL
Dominican Republic National Association of Hotels and Restaurants	CODOPESCA
Dominican Council of Fisheries and Aquaculture	FA
Floating Algae	FUNDEMAR
Foundation for Marine Studies	FGPC
Punta Cana Group Foundation	INTEC
Santo Domingo Institute of Technology	MEPyD
Ministry of Economy, Planning and Development	MESCyT
Ministry of Higher Education, Science and Technology	MMAyRN
Ministry of Environment and Natural Resources	MMAyRN
Ministry of Public Works and Transportation	MOPC
Ministry of Foreign Affairs	MIREX
Ministry of Tourism	MITUR

I. Introduction and Background

Background: At the 20th Meeting Scientific Committee of the Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC) in 2024, the Costa Rican delegation made a presentation highlighting the importance of the Committee's attention to the issue of Sargassum in the IAC region. The Scientific Committee agreed to create a Working Group coordinated by Costa Rica, with the objective of preparing a technical document highlighting the Sargassum problem in the IAC region and potential ways of managing the situation and sharing of lessons learned. The members of the WG are Ms. Kirah Foreman from Belize, Dr. Julia Horrocks from Caribbean Netherlands, MSc. Didiher Chacón from Costa Rica (Coordinator), Ms. Jennifer Suarez from Ecuador and Ms. Skarleth Pineda from Honduras. The coordinator prepared a proposal for a Technical Document which is based on a diagnosis developed for the Central American Integration System (SICA) in 2023 by MSc. Didiher Chacon for consideration by the WG-Sargassum and the 21st IAC Scientific Committee (SC21). The Technical Document CIT-CC21-2024-Tec.26 "Current and Potential Implications of Sargassum for the Region of the Inter-American Convention for the Protection and Conservation of Sea Turtles" was adopted at SC21, and its recommendations were presented at the 12th Meeting of the IAC Conference of the Parties in June of 2026. The Technical Document will be shared as appropriate with IAC member countries national agencies working on the mitigation of Sargassum impacts, as well as with entities with which IAC has collaboration agreements, such as the SPAW Protocol to promote joint actions.

Introduction

The Caribbean coast of Central America and Mexico, the Dominican Republic and the Caribbean Netherlands, possess rich and extensive marine-coastal environments that provide important ecosystem services in terms of scenic beauty, supply of marine resources, transport services, water sports, among others. These services allow connectivity with other regions of the world and support very important economic activities such as coastal tourism and fishing. These conditions are associated with a relatively stable political landscape, legal security, and opportunities for foreign investment, which strengthens the regional economy.

Pelagic Sargassum species are, marine brown algae, first recorded in the logs of European navigators who arrived in America, and crossed what was later called the Sargasso Sea (Torrent 2022). The Sargasso Sea, located east of the southern coast of the United States, is a recognized and important pelagic ecosystem, key for several marine species (e.g., sea turtles, birds, crustaceans, fish developmental stages of these and other faunal groups, as well as epibiont fauna associated with the collection of Sargassum in the sea) (Suarez & Martínez 2018, Guzmán, 2019, Aldana *et al.* 2020, Trinanes *et al.* 2023, Corbin *et al.* 2024). It is estimated that this ecosystem harbors about 10 million tons of biomass (Johnson *et al.* 2013, Cabrera *et al.* 2021). According to Mansfield et al. (2014), Olabarría & Vázquez (2018), Suarez & Martínez (2018) and Cabanillas et al. (2019)., Sargassum aggregations can harbor a large number of species, some with very particular adaptations, and juvenile stages of fish and sea turtles.

As Sargassum is carried by ocean currents from one point to another, its biomass increases because it is a living and growing "entity." The median thickness of drifting aggregations of Sargassum in the Sargasso Sea is 0.4 m (Gulick et al 2023), but once it approaches the coast can accumulate to several meters thick. The morphotype and percentage composition of Sargassum species recorded for Costa Rica: are *Sargassum natans* VIII (65% of dry weight), *S. natans I* (25% of dry weight) and *S. fluitans* (10% of dry weight). The two are also reported on the Mexican coast (Guzmán 2019), as well as in other areas of the Caribbean (Suárez & Martínez 2018). The total dry biomass documented in 2019 was approximately 95 kg/m², which is close to the records of some sites in Mexico (87 kg/m², Rodríguez-Martínez *et al.* 2016), Van der Geest et al (2024) estimated aerial cover (m2) of Sargassum affecting Bonaire in the Caribbean Netherlands between 2017 and 2022, and used Sentinel- 2 satellite images and conversion equations to estimate dry weight. On average 950.9 ton dry weight of Sargassum (range 50.8 − 1751.8) washed up annually between 2017 and 2022 in Lac Bay and Lagun, Bonaire.

Sargassum strandings are a phenomenon that has been studied, documented, and analyzed by researchers from the Americas and Africa. In this context, a recent study (Payne, Greene & Oxenford 2024) that used predictive models, accounted for spatial variability in sea surface temperature and morphotype diversity, by quantifying biomass

accumulation in the Eastern Caribbean. The results of these simulations showed that the accumulation of the fastest growing morphotype, *Sargassum fluitans* var. *fluitans*, is very close to the profiles of the general prediction with a single morphotype. Mass strandings of Sargassum (*Sargassum spp.*) dragged by ocean currents and tides to different coastal areas of the Atlantic Ocean (Caribbean Netherlands, Mexico, Gulf of Mexico, African coast) (Fig. 1) have been recorded for more than a decade (2011) by researchers such as Moreira & Alfonzo (2013), Fernández *et al.* (2017), Van Tussenbroek *et al.* (2017), Olabarría & Vázquez (2018), Suárez & Martínez (2018), Aguirre, (2019), Cabanillas *et al.* (2019), Guzmán (2019), Wang *et al.* (2019), Zúñiga *et al.* (2019) Aldana *et al.* (2020), Barcena *et al.* (2020), Van der Plank *et al.* (2020), Cabrera *et al.* (2021), Oxenford *et al.* (2021), Grey *et al.* (2021), Robledo *et al.* (2021), Fraga & Robledo (2022) and Van der Geesr et al (2024). However, it appears that Sargassum became more abundant and frequent around 2014 -2015 on Caribbean coasts. Guzmán (2019) reported an extreme stranding in 2015, describing it as of great magnitude at the regional level. Although the biomass of strandings can vary from year to year (e.g., Van der Geest et al 2024), according to Cabrera *et al.* (2021) suggest that, from 2011 to date, there has been a generalized increase in the biomass of Sargassum. By 2018, a wet biomass of more than 20 million tons of Sargassum was estimated in the Caribbean Sea and Central Atlantic (Wang *et al.* 2019).

The strandings have caused massive accumulation of Sargassum on beaches, often more than a meter high and several meters wide over several kilometers in length, as frequently reported on the coasts of this region. In response to these stranding events, Silva (2022) estimated that Caribbean countries have each invested between US$ 445,000 and US$ 7,000,000 to address beach cleanups, with up to 100/day/country depending on the case. In 2015 alone, US$ 120 million was invested in cleanups (Robledo *et al.* 2021). Cleaning up these strandings as they increase in biomass is therefore a drain on the economies of these countries.

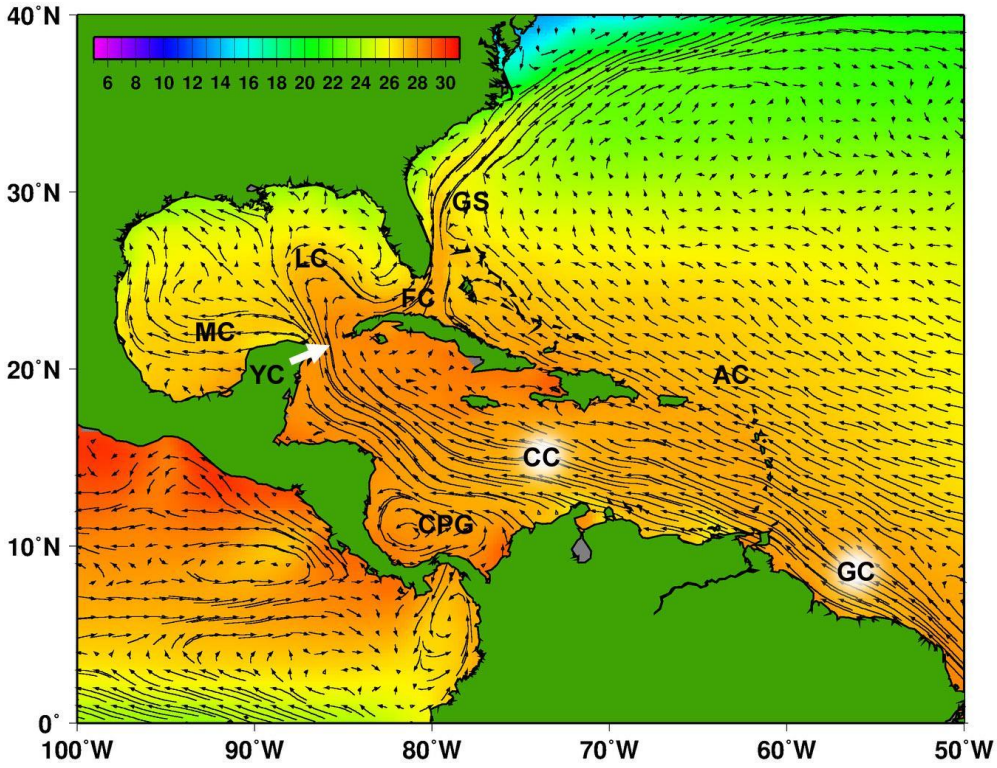

Figure 1. Main Surface Currents of the Caribbean.

GC = Guyana Current; CC = Caribbean Current; AC = Antilles Current; CPG = Colombia-Panama Gyre; YC = Yucatán Current; MC = Mexican Current; LC = Loop Current; FC = Florida Current; GS = Gulf Stream (Source: Smithsonian Research Institute).

The speculated origin of the massive production of Sargassum arriving on Caribbean coasts is the North Equatorial area, where thermal increase, nutrient contributions from upwelling and terrestrial sources, as well as changes in surface current patterns (Fig. 2), support production and transportation (Gower *et al.* 2013, Johnson *et al.* 2013, AEC 2015, Schell *et al.* 2015, Sissini *et al.* 2017, Suárez & Martínez 2018, Cabanillas *et al*. 2019, Wang *et al.* 2019, Fidai *et al.* 2020, Johns *et al.* 2020, Gray *et al.* 2021, Oxenford 2021, Robledo 2021, Fraga & Robledo 2022, Silva 2022, Tambutti & Gómez 2022, Alleyne *et al.* 2023) (Figure 3). According to Van der Plank *et al.* (2020) and others, climate change is creating the unique marine environmental conditions for Sargassum to thrive. While Suárez & Martínez (2018) report that the loss of cohesion of encircling currents in the Sargasso Sea, coupled with ocean temperature increases, pollutants, and nutrients (the latter possibly stimulated by the presence of dispersants applied to oil spills) are elements contributing to the excessive growth and dispersion of Sargassum. Tambutti & Gómez (2022) have determined that by 2030 the unified eutrophication indicator in the Caribbean Sea will be at a high level, which could further stimulate the growth of

Sargassum. It should be noted that recent research (Machado *et al.* 2024) determined that floating Sargassum and volcanic ash (product of La Soufrière volcanic activity in 2021) shared the sea surface for at least 50 days, approximately 100 days before reaching Jamaica, and this affected the elemental composition of the stranded biomass.

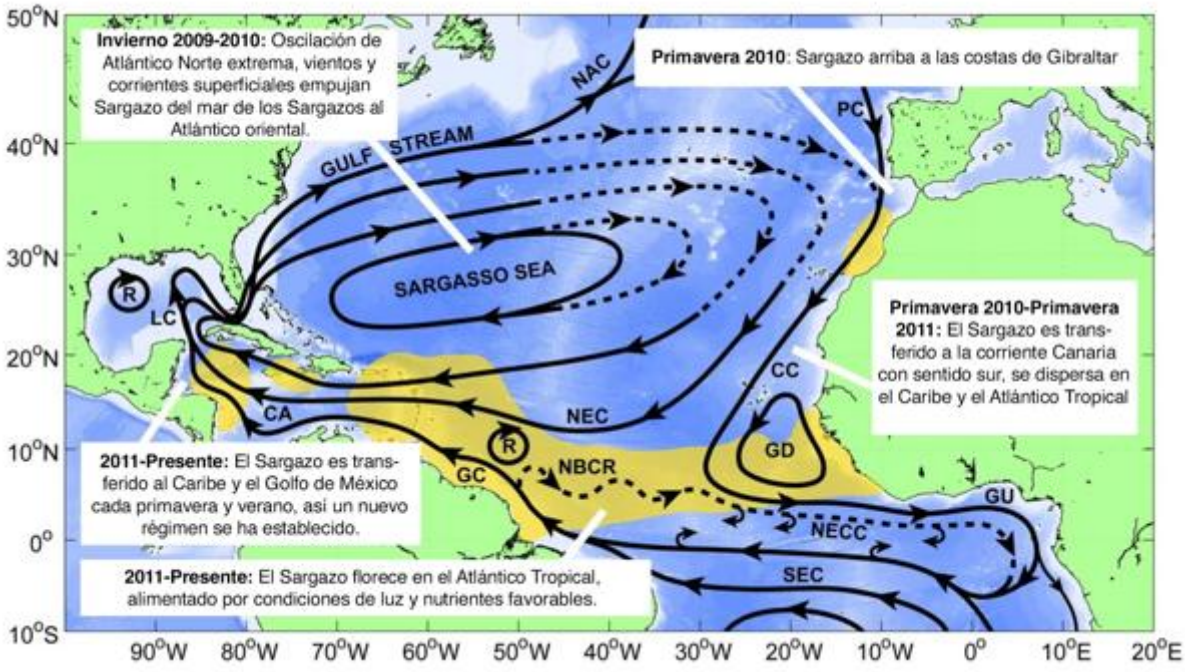

Figure 2. Main Ocean Currents and Dissemination of Sargassum towards the Caribbean (Source: John *et al*. 2020, own adaptation to Spanish).

Sargassum as a pelagic ecosystem is important, in its original latitudinal location, by contrast the consequences of this novel ecosystem in the waters of the Caribbean Sea are presumed to be largely negative. Its impacts on the composition, structure, and function of Caribbean ecosystems, as well as on ecosystem services, are still being quantified.

II. Recognized causes for the arrival of Sargassum

Researchers have proposed hypotheses to explain the causes of Sargassum seaweed arrivals on Caribbean coast and the Atlantic over the past decade, and the excessive growth of biomass *(*Djakouré *et al.* 2017, Miron *et al.* 2020, Gray *et al.* 2021, Oxenford 2021, Robledo 2021, Fraga & Robledo 2022, Alleyne *et al.* 2023*)*. These include changes in ocean currents in 2010 and 2011 *(*Aguirre 2019, John *et al.* 2020*)* (Fig. 2). Some of the hypotheses are:

1. The algal blooms blooms have been augmented by nutrient discharges from major basins in South America (e.g., Amazon and Orinoco) and Africa (e.g., Congo), possibly linked to deforestation processes.
2. Changes in the upwellings off northwest Africa are caused by increased aridity and strong northeast winds that induce seasonal marine upwellings, provide the algae with nutrients from the seabed.
3. Changes in marine upwellings related to changes in ocean currents, temperature increase, and wind patterns, which correspond to responses to climate change.
4. Changes in the frequency and patterns of dust deposition from the African continent that settles into the Atlantic Ocean and 'fertilizes' the water.
5. A positive North Atlantic Oscillation (NAO), linked to changes in winds and currents that have allowed the algae to reach marine areas off Africa.
6. A combination of some or all the above factors could be the cause, although there are no especific explanations *(*Sissini *et al.* 2017, Méndez-Tejeda 2019, Oviatt *et al*. 2019, Wang *et al.* 2019, Barcena *et al.* 2020, Van der Plank *et al.* 2020, Silva 2022, Torrent 2022*).*

It is important to highlight the role of currents in the deposition of Sargassum on the coast, including ocean currents, surface currents generated by easterly trade winds, tidal currents, littoral currents, and river currents (CCT 2013, Méndez-Tejeda 2019, Robledo *et al.* 2021, Trinanes *et al.* 2023). The situation in the lesser Antilles is that the Caribbean Current carries Sargassum from waters off the Amazon and Orinoco rivers, from South America to the northwest, crossing the Caribbean. In the case of the Dominican Republic, the currents are subject to the circulation of waters from different currents (Caribbean, Antilles, Canary), while in the case of Panama, Costa Rica, and Nicaragua, they are influenced by the Caribbean currents and the Colombia-Panama Gyre. By contrast, Honduras, Guatemala, and Belize are mainly influenced by the Caribbean Current directly (Davidson 2002, Cabrera 2014, Frost 2012), as is the case in the Caribbean Netherlands (Gallegos 1996, DCNA 2019). For the Mexican Caribbean region, the Yucatán Current has a major influence on the transport of Sargassum, with

slight influence from the Loop Current (located between the western Cuban coast and the central-eastern area of the Gulf of Mexico) (Pérez & Schneider 2011) (Fig. 2 and 3).

An increase in winds and the subsequent change in currents could be carrying Sargassum to the farthest extremes of the region. According to the review of data from local news sources, Sargassum arrivals have occurred in all the countries included in this report, but are more visibly and well-documented in tourist-use sites, specially where there are difficulties in its removal due to the presence of infrastructure or adjacent vegetation in the coastal area. The arrival processes in each country and the form of dispersion depend on the particularities of each coast, climate, and oceanography. Dispersion by currents and wind makes the forecasting, control, and containment scenario complicated, as the dissemination is broad and irregular in terms of intensity.

III. Findings of the situational diagnosis

During 2023, the Central American Integration System (SICA in Spanish) generated, with the support of the EU, diagnostics of the Sargassum situation in the countries of the region, as well as a regional analysis. This initiative is the preamble to the construction of this document. The methodology used was based on the qualitative and quantitative analysis of the latest diagnosed situation (SICA 2023).

The algae drift in the current and, while doing so, absorb nutrients, photosynthesize, grow, and spread in the region. Upon finding marine and coastal areas with abundant nutrients, it takes advantage of these conditions and grows without limitations, invading areas where, despite being reported as a common genus on coral reefs, its quantities were previously always limited.

Undoubtedly, the massive arrivals of Sargassum to the region's coasts has resulted in the immediate loss of ecosystem services, the most relevant being the scenic beauty of the coasts, so critical for attracting tourists to the region. Other less impactful but still important effects included disruption to navigation uses, fishing, water resource uses, among others.

III.A. Social Impact

The arrival of Sargassum in the region has led to concern about the use of beaches among tourists. Sargassum not only reduces the scenic beauty of the beach, it deters use of shallow bathing waters because of a general aversion to coming into contact with the algae, and it reduces access to the breaking wave zone. Skin contact can create irritation. Lac Bay in Bonaire is a major green turtle foraging area, and when Sargassum is present researchers are not able to work with the sea turtles due to the skin infections it causes (K. Schut, pers. Comm.). If it breaks down in situ, the odor and slime can also adversely affect health. These effects can potentially cause a reduction in tourist visitation, and therefore the demand for workers within the tourism sector. A decrease in capital flowing through value chains related to tourism inevitably impacts the societies connected to these coastal areas.

The loss of jobs affected the economies of coastal communities in several countries in the region. Additionally, for those who remain employed but are responsible for the cleanup and subsequent disposal of Sargassum, there are risks from the gases released by Sargassum during decomposition, which can endanger their well-being. Persons living near decomposing Sargassum biomass complain of adverse health impacts as well as corrosion of metal objects and damage to electronic devices.

Other social impacts mentioned by various authors included the contamination of coastal water bodies or disposal sites by leachate production. Sargassum tends to accumulate in enclosed bays and takes longer to wash away naturally. These bays are traditionally used as safe anchors for fishing boats and Sargassum has caused damage to boat engines and nets, made movement in and out of the bay difficult, and deterred persons from purchasing fish at the location.

III.B. Economic Impact

The high investment needed for coastal cleaning (machinery, boats, labor, protective gear, trucks, disposal sites, among others), monitoring of coasts, public awareness, and research, require significant investment against a background of reduced income from the tourism and fishing sectors.

Some areas in the region now also require investment for cleaning water intake sluices at power plants (e.g. the Dominican Republic), hotels must provide transportation to take tourists to unimpacted beaches, governments must find funds to invest in technology to allow prediction of approaching Sargassum rafts, and for cleaning; all unforeseen costs for local economies.

Countries of the Caribbean Community (CARICOM), which include 15 member states and five associate members that are territories or colonies, recorded economic losses of approximately US$102 million due to Sargassum in 2022 alone. Such costs were not anticipated in previous climate change scenarios, coastal zone management, or development planning, due to the recency of the problem. Very few cases were found where the arrival of Sargassum in the region was foreseen, which therefore required improvisation by unprepared Government agencies, leading to emergency investments through fund transfers, international loans, or donations or reallocation of funds.

III.C. Environmental Impact

Pelagic Sargassum mats provide habitat for a wide range of organisms, including invertebrates, fish, sea turtles and sea birds. If the mats remained at sea, the increased presence of pelagic Sargassum in the Caribbean could have some beneficial effects on biodiversity and productivity in otherwise substrate-poor, low-nutrient open-ocean waters. For instance, Sargassum has increased the catch of Almaco jack *Seriola rivoliana* in Barbados.

The arrival of “patches” or “rafts” of Sargassum were initially addressed as alien species within the Caribbean Sea. Subsequently, the presence of Sargassum was associated with changes in the physicochemical conditions of the sea, leading to changes in ecological communities, such as:

a. Change in light penetration to the water column and the ocean floor, clearly affecting coral communities and seagrass beds.

b. Siltation of estuaries with mangroves, depleting the chemical conditions of the water.
c. When Sargassum reaches the coast, it dies, increasing water acidity (lowering pH), producing hydrogen sulfide and methane, increasing turbidity due to algal particulates, depleting dissolved oxygen, and increasing biological oxygen demand, ultimately creating a deadly environment for coastal species and causing extensive mortalities.
d. According to various authors, this alga incorporates heavy metals in its structure, which could pose a risk to human health and the food chain. Some analyses confirm this, while others do not.
e. The release of methane increases greenhouse gas effects.
f. Rotting Sargassum on the beach raises the average temperature and causes feminization or mortality in newborn sea turtles. For other creatures inhabiting the intertidal zone and the beach, it can cause death.
g. It obstructs adult sea turtles from emergence onto the beach and hatchlings during sea finding.
h. It contaminates groundwater when the sea deposits it in river courses or it manages to spread through river mouths and estuaries, and has been sucked into desalination plants.
i. Recently, it is also blamed for warming the waters where it spreads abundantly, accelerating the effects of climate change in Caribbean waters.

Olabarría & Vázquez (2018) have identified 127 alien marine species in the Caribbean, of which 64 are harmful and 28 are considered highly invasive, including Sargassum.

IV. Comparative regional analysis

The construction of the seven diagnoses for the countries of the region prepared for SICA (Central American Integration System) allowed, among other aspects, the knowledge that:

A. Excessive Sargassum strandings or landings have been documented in the region since 2011, with an increase since 2014 and present almost every year and month of the year for the past decade.
B. Sargassum affects countries differently according to their climatic conditions, coastal morphology, and oceanographic characteristics.
C. The direct impact of Sargassum on the ecosystem services used by coastal tourism generated an immediate reaction from this sector and its leadership in management of the problem.
D. In areas where there was no state action to manage the landings, it was community action or the private sector that managed to handle it.
E. Public-private multi-level alliances were a key formula for solving part of the problem and its impacts.
F. It appears that multi-sector and multi-level alliances are the governance formula proposed by several countries (Mixed Commissions, Ministerial, high-level, Working Groups, Committees, among others).
G. Belize and the Dominican Republic are identified as the countries with the most significant advances in managing the problem. These countries are also those having the greatest amounts spread over the greatest extents of coastline.
H. Mexico reports significant impacts in one of the country's most important regions for tourism. Although there is a government strategy for management and contingency, it is acknowledged that governance to address the issue and manage knowledge by expert groups has not been achieved.
I. Guatemala and Nicaragua are the countries with the most incipient development on the issue.
J. Honduras, Costa Rica, and Panama have initial levels and actions for managing the issue. In each case, a state institution leads the management efforts.
K. In the Caribbean Netherlands, through the BONCIRC project (a government and private sector partnership) Bonaire is mapping and assessing amounts of Sargassum over the year, and looking at composition, current uses and potential uses, circularity of current uses and expected development over time.
L. Aruba is the least affected state, as its geographical position prevents massive Sargassum arrivals. Aruba, Curacao, and Sint Maarten manage the Sargassum

problem through local ministries, which are associated with continental ministries in the mainland territory, where the management and contingency of arrivals in these overseas states of the Kingdom of the Netherlands are handled. The continental ministries are also responsible for the issue in the Caribbean Netherlands (Bonaire, Saba, and St. Eustatius).

M. The situation, due to the nature of the landings, is changing over time, particularly concerning the volumes of Sargassum and the localities reached.
N. Of the nearly 60 thematic meetings about Sargassum held in the Atlantic and Caribbean from 2015 to 2023, there was discontinuous participation of representatives from all SICA countries.
O. There is evidence of leadership in the region by the Association of Caribbean States (ACS) and the SPAW protocol.
P. Belize and the Dominican Republic have platforms and agreements to develop prediction and monitoring through satellite information.
Q. Belize applied tariff reductions to the tourism sector as a mechanism to reduce the effects of Sargassum.
R. The Dominican Republic created financial funds to cover expenses caused by Sargassum landings.
S. There is potential for Sargassum to be a raw material for the production of goods (e.g., fertilizer, biofuel) or services. But it is important to recognize that its arrival on the coast is discontinuous and dispersed, which does not allow for secure investment, and it contains various and unpredictable amounts of heavy metals.
T. Regional collaboration has been hindered by legislative differences across borders.

Further details about each country can be found in Tables 1 and 2.

Table 1. Comparative Analysis of Sargassum situation in Central America and Mexico

Aspects of the diagnosis	Panamá	Costa Rica	Nicaragua	Honduras	Guatemala	Belize	Mexico
Main affected areas	Bocas del Toro, Colón, Kuna Yala, Armila	Tortuguero, Matina, Moin, Cahuita, Puerto Viejo	Cayos de la Región Autónoma Caribe Norte	Islas de la Bahía, Costa Norte	Punta Manabique, Izabal, Livingston	San Pedro, Ambergris, Belize City, Placencia, Hopkins, and Caye Caulker	The entire coast in the states of Quintana Roo and Yucatán, along 1000 km of beach.
Responses to the stranding	Documentation, manual cleanings	Documentation, manual cleanings	Manual cleanings	Documentation, manual cleanings	Limited manual cleanings	Documentation, manual cleanups, mechanized cleanups	Documentation, manual cleanups, mechanized cleanups, sargassum vessels, barriers
Key actors in management	MiAmbiente, Dicomar, ARAP, Canal Authority, NGOs, Smithsonian, Universities, local organizations	MINAE, SINAC, ICT, SENASA, UCR, UNA, INCOPESCA, Coast Guard Service, and others from the national commission	Ministry of Environment and Natural Resources (MARENA), National System of Protected Areas (SINAP), Nicaraguan Institute of Fisheries and Aquaculture (INPESCA), University of the Autonomous Regions of the Nicaraguan Caribbean Coast (URACCAN), University of the Autonomous Regions of the South	Secretariat of Natural Resources and Environment, Directorate of Biodiversity (Dibio), General Directorate of Merchant Marine, Department of Marine Environmental Protection, Tourism Authorities (e.g., Zolitur),	National Council of Protected Areas (CONAP), Urban and Rural Development Community Councils (COCODES), Universities and Institutes (University of San Carlos, USAC, Technical Institute for Training and Productivity, INTECAP), NGOs (Foundation for the Conservation of Natural Resources and the Environment of Guatemala FCG, Blue	Ministry of Tourism and Civil Aviation (Presidency), Belize Tourism Board, Belize Tourism Industry Association, Belize Hotel Association, Department of the Environment, Belize Fisheries Department, Ministry of Health, Belize National Meteorological Service, National Emergency Management Organization, Coastal Zone Management	Secretariat of the Navy, Secretariat of the Environment and Natural Resources, National Institute of Ecology and Climate Change, National Council of Humanities, Science, and Technology, National Environmental Management System, Secretariat of Tourism

			Caribbean Coast (URACCANS), National Autonomous University of Nicaragua, and NGOs (Project WOO).	Directorates of protected areas with coastlines in the Caribbean (e.g., Roatán Marine Park)	World, Hunger Relief Foundation HRI, Foundation for Eco-Development and Conservation FUNDAECO)	Authority and Institute, Belize NGO Network, Belize Port Authority, Local Governments	
Presents research	No	Yes	No	No	No		
Presents national policies, plans, and strategies	No	A plan was mentioned but could not be found	No	No	No	Yes	Yes
Coordination mechanisms	No	Yes	No	Yes	No	Yes	Yes
Tracking, forecasting, and monitoring	No	No	No	No	No	Yes	Yes
Containment, collection	No	Yes	No	Yes	No	Yes	Yes
Treatment, recovery, and use	No	No	No	No	No	Yes	Yes

International initiatives	Participate	Participate	Participate	Participate	Participate	Participate	Participate
Regional actions	No	No	No	No	No	Participate	Participate

Table 2. Comparative analysis of the Sargassum situation in the region of the Dominican Republic, Caribbean Netherlands, Aruba, Curazao and Sint Maarten

Aspects of Diagnosis	Dominican Republic	Overseas territories of the Netherlands			
		Aruba	Curazao	Sint Maarten	Bonaire
Key Areas Affected	In the east: Altagracia and La Romana In the south: Barahona, Azua, National District, San Pedro de Macorís, Pedernales, and to a lesser extent in the northern zone in Samaná and Puerto Plata.	Sargassum has little impact in Aruba. The bays and beaches have escaped the flow of Sargassum because currents and winds are not a major means of transport for pelagic Sargassum in this part of the Caribbean	Shete Boka, Boka Ascension, Boka Mansalina, Boka Dejgu, Un Boka, Dos Boka.	Guana Bay, Pointe Blanche	Lagun, Lac Bay, Washikemba
Responses to the arribazones	Documentation,manual cleaning,mechanized cleaning,marine barriers,testing with sargassum boats	The Sargassum that strands on the beaches is generally removed with heavy machinery as soon as reports of the presence of the algae are made.	Manual cleaning on the beaches by the hotel sector. Documentation.	Documentation, manual cleaning.	Booms in Lac Bay to stop Sargassum affecting the mangroves; heavy machinery used to clear Sargassum in Lagun; no cleaning is done in Washikember

Key Actors in Management	Ministry of Environment and Natural Resources (MARENA), Ministry of Tourism (MITUR), Ministry of Foreign Affairs (MIREX), National Maritime Authority (ANAMAR), Ministry of Economy, Planning and Development (MEPYD), Ministry of Higher Education, Science and Technology (MESCYT), National Council for Climate Change and the Clean Development Mechanism, Dominican Council for Fisheries and Aquaculture (CODOPESCA), Ministry of Public Works and Communications (MOPC), Dominican Republic Navy, National Office of Industrial Property (ONAPI), National Association of Hotels and Restaurants (ASONAHORES),	Ministry of the Environment of Aruba, Ministry of Agriculture, Nature Conservation, and Fisheries, Ministry of Public Health, Welfare, and Sport, Ministry of the Interior and Kingdom Relations, Ministry of Housing, Spatial Planning, and the Environment, NGOs, Netherlands Water Partnership, Netherlands Organization for Applied Research.	Ministry of the Environment of Curaçao (part of the Ministry of Health, Environment, and Nature), Ministry of Agriculture, Nature Conservation, and Fisheries, Ministry of Public Health, Welfare, and Sport, Ministry of the Interior and Kingdom Relations, Ministry of Housing, Spatial Planning, and the Environment, NGOs, Netherlands Water Partnership, Netherlands Organization for Applied Research, Sea Turtle Conservation Curaçao.	Ministry of the Environment of Sint Maarten (part of the Ministry of Housing, Spatial Planning, and the Environment), Ministry of Agriculture, Nature Conservation, and Fisheries, Ministry of Public Health, Welfare, and Sport, Ministry of the Interior and Kingdom Relations, Ministry of Housing, Spatial Planning, and the Environment, Netherlands Water Partnership, Netherlands Organization for Applied Research, Nature Foundation St. Maarten.	STINAPA Bonaire monitors and cleans sargassum under a contract (Sargassum Response Plan) with the Ministry of Agriculture, Fisheries, Food Security and Nature.

	Association of Hotels and Tourism Projects in the Eastern Zone (ASOLESTE), Punta Cana Foundation, Algae Nova, SOS Carbón, Santo Domingo Technological Institute (INTEC), Autonomous University of Santiago (UASD), University of Action for Education and Culture (UNAPEC), Federico Henríquez y Carvajal University (UFHEC), Pedro Henríquez Ureña National University (UNPHU), Center for the Conservation and Eco-development of Samaná Bay (CEBES), Marine Studies Foundation (FUNDEMAR), Iberoamerican University Pontificia Universidad Católica Madre y Maestra, Centro de Investigaciones de				

	Biología Marina (CIBIMA-FC-UASD)				
Presents Research	Yes	Yes	Yes	Yes	Yes
Presents National Policies, Plans, and Strategies	Yes	Yes	Yes	Yes	Yes Sargassum Response PLan
Coordination Mechanisms	Yes	Yes	Yes	Yes	Yes
Monitoring, Forecasting, and Tracking	Yes	Yes	Yes	Yes	Yes
Containment, Collection	Yes	Yes	Yes	Yes	Yes
Treatment, Value and Use	Yes	No	No	No	Yes
International Initiatives	Participate	Participate	Participate	Participate	Participate
Regional Actions	Participate	Participate	Participate	Participate	Participate

V. Current Management of the Problem

Actions found in the region are grouped into three major themes (fig.3):

- Prevention of the problem
- Mitigation of impacts
- Compensation for damage

In the area of prevention, some countries have managed to develop intersectoral and public communication actions, allowing for the preparation or coordination of actions. Additionally, normative changes have been made to facilitate expedited actions. Some research is proposed as part of the solution processes, but other research is more academic than proactive or solution oriented regarding the environmental problem of Sargassum. Monitoring, forecasting, and modeling actions are present and functioning in Belize and the Dominican Republic, although other regional efforts operating from Mexico and the USA are recognized. At this point, it is important to explore the possibility of cooperation between the SICA area and the European Union's Copernicus program as a platform for early warning, among other aspects also cooperation with the SPAW Protocol and its Sargassum Working Group.

Finally, within the framework of prevention, most of the sargassum in these massive strandings are in the water and therefore much of the mitigation requires collection of the biomass before it enters and chokes bays and estuaries. This requires collection at sea and there are various boats designed to do this. However, the sheer tonnage of biomass overwhelms the capacity in this regard.

It is also known that traditional mechanical cleaning mechanisms could be causing beach erosion, as sand is also removed along with the Sargassum, increasing problems related to rising sea levels and the loss of coastal tourism space. Often Sargassum is removed from the intertidal area and deposited above the high-water mark, where it has a more significant impact on sea turtle nesting habitat.

Regarding mitigation actions, they share initiatives related to information and research with prevention, but focus on cleaning actions through inter- and multisectoral alliances (public and private sectors), the selection of appropriate technologies, as well as tested protocols for the collection, transport, and correct disposal of Sargassum. Efforts are being made to transform and monetize Sargassum with local and international support. In this mitigation area, economic and financial tools also emerge, such as reducing import taxes on cleaning equipment, other tariffs, as well as managing and creating funds to finance the remedial costs of Sargassum reaching the coast.

The third group of actions recognized in the region are compensation actions, which are less undertaken. These include work on regenerating damaged ecosystems (e.g., coral reefs, seagrasses, mangroves) and reducing the impacts of Sargassum decomposition on sea turtle nesting beaches. Ecosystem restoration actions are also grouped here, where actions are developed to allow the most affected ecosystems to recover from Sargassum, anticipating its arrival or reducing the time of the impact. Finally, as proposed in Belize for affected fishing communities, efforts are made to change target species and/ or encourage mariculture. In other countries with heavy coastal tourism usage, creation of a more inland tourism product is proposed as a measure to compensate for the temporary solution of Sargassum on the beach, in some places hotels impacted by Sargassum will transport tourists to other coasts, using arrangements negotiated with other hotels.

In the recent analysis of the situation in the Caribbean in Mexico (Durand, Sundberg & Rodríguez 2024) indicates that the government strategies for management not only should consider to answer the human interest and to sustain the tourism industry, but rather they should consider also the interaction between human component and non-human component inside a socioecological system. In all the geographical scenarios of impact by Sargassum arrivals, Degia, Small & Oxenford (2024) state that the collection of data from the arrivals is a fundamental process to support the planning necessary to deal with this emerging marine hazard.

Torrent (2022) lists a series of observations related to the Dominican Republic but generally applicable to the region, along with others that are part of the analysis of this process, such as:

- Lack of a national diagnosis of the problem in some countries.
- Absence of a response plan to the situation.
- Lack of articulation for sectoral and regional work.
- Need for the creation of a national management body for Sargassum.
- Appropriate regulatory framework.
- Advancing or starting in monitoring and follow-up.
- Perception of fragmented and inadequate collection and disposal issues.
- Limited progress in the valorization and use of Sargassum.
- Limited research and development.
- Absence of patent presentation.
- Limited utilization of available initiatives such as the European Union's Copernicus Program.

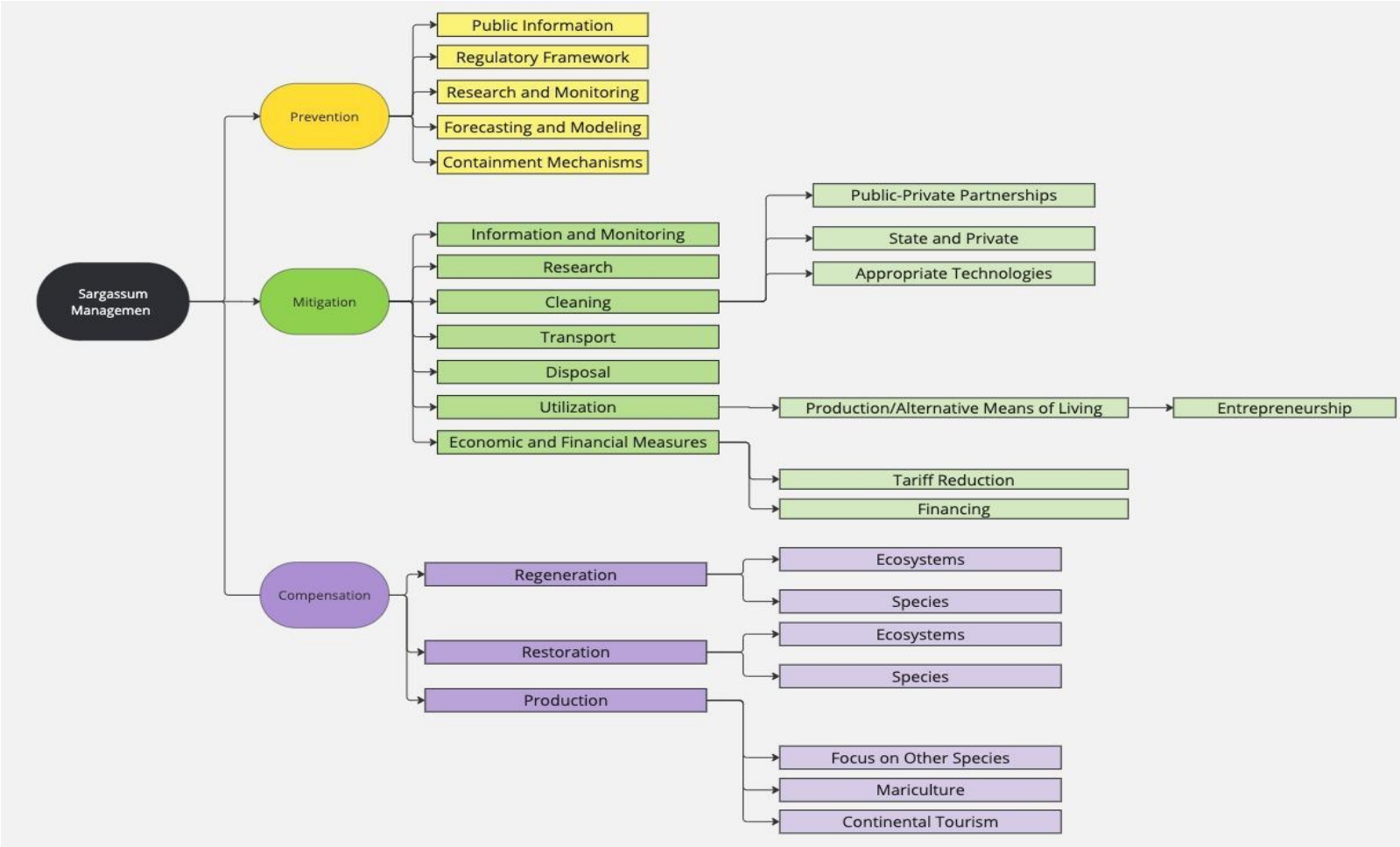

Figure 3. Actions undertaken to resolve the Sargassum problem in the Central American region, Mexico and the Caribbean region: Dominican Republic and centralized unitary states (overseas) of the Netherlands (Aruba, Curaçao and Sint Maarten). Source: Prepared by Didiher Chacon for this document.

VI. Current Regional Scenario

As previously mentioned, nearly 60 events related to Sargassum have been documented across the Atlantic Ocean area from 2015 to date. Several of these events specifically involve countries included in this report, such as Belize or the Dominican Republic. It is noteworthy that state representatives were almost always present, although national actions do not show state initiatives to address the problem, indicating no correlation between attending regional meetings and preparedness for these events.

Leadership in addressing the Sargassum problem can be seen in Mexico, Barbados, and the Dominican Republic, regarding thematic proactivity, action development, and proposals. The Centre for Resource Management and Environmental Studies (CERMES) at the University of the West Indies (UWI) in Barbados has generated protocols, manuals, research, and proposed monitoring mechanisms. Other regional projects and initiatives include the following:

SARG'COOP

Caribbean Cooperation Programme Against Sargassum

The Caribbean Cooperation Programme for the monitoring of Sargassum algae brings together regional partners with the intention of sharing knowledge and experiences and fostering collaboration on this species of algae.

Funding: European Union – AFD

Implementing Organization/Agency: Regional Council of Guadeloupe

Implementation Period: 2019-2022

Website: https://interreg-caraibes.eu/sargcoop

SARGOOD

Holistic Approach to Sargassum Valorization

Holistic Approach to Sargassum Valorization

The project will conduct a life cycle assessment of Sargassum and develop innovative materials and technologies for its valorization in the region.

Funding: European Union and ANR

Implementing Organization/Agency: University of the Antilles, Fouillole Campus, Guadeloupe

Implementation Period: 2019-2022

Website: https://interreg-caraibes.eu/sargood

SARGADAPT

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

The project aims to reduce impacts and improve adaptation to Sargassum influxes in the Eastern Caribbean, focusing on turning a climate-related ecosystem hazard into an asset that supports socioeconomic development opportunities for the involved states.

Funding: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety of Germany - KfW.

Implementing Organization/Agency: UWI-CERMES, Caribbean Natural Resources Institute (CANARI).

Implementation Period: 2019-2022

Website: https://www.cavehill.uwi.edu/cermes/projects/sargassum/sargadapt.aspx

SARTRAC

Teleconnected SARgassum risks across the Atlantic: building capacity for Transformational adaptation in the Caribbean and West Africa

SARTRAC identifies new transformational development opportunities that generate resilience equitably for citizens affected by changing biomes/ecosystems in the involved developing areas.

Funding: UK Research and Innovation

Implementing Organization/Agency: University of Southampton, UWI-CERMES, University of Ghana, University of York

Implementation Period: 2019-2022

Website: https://www.sartrac.org/

SPCRC

Sargassum Products for Climate Resilience In The Caribbean

The project aims to mitigate the environmental and economic impacts of Sargassum influxes in affected Caribbean countries by creating inclusive value chains for Sargassum management.

Funding: New Zealand Foreign Affairs & Trade Aid Programme

Implementing Organization/Agency: Caribbean Regional Fisheries Mechanism (CRFM), Plant and Food Research, New Zealand Crown Research Institute

Implementation Period: 2020-2023

Website:https://www.crfm.net/index.php?option=com_k2&view=item&id=667:sargassum-products-for-climate-resilience-in-the-caribbean&Itemid=175

SASAMS

Satellite Sargassum Monitoring System

This project was implemented with the aim of developing a near real-time service for monitoring Sargassum strandings, initially targeting the Caribbean coast of Mexico.

Funding: UK Space Agency

Implementing Organization/Agency: University of Nottingham, Specto Natura Ltd, Triple Line Consulting Ltd. CONABIO, UNAM, CentroGeo, Planet Inc.

Implementation Start Period: 2020

Website: http://sasams.org/site/proyectos/id/0.html

PINSMCC

Project for Improving National Sargassum Management Capacities in the Caribbean The objective is to support the region in its quest to find solutions to the growing problem of Sargassum algae.

Funding: Government of Japan

Implementing Organization/Agency: UNDP

Implementation Period: 2022-2026

Project Update Link: https://erc.undp.org/evaluation/evaluations/detail/13916

MISISTCWA

Multi-partner initiative to study the impacts of Sargassum tides in the Caribbean and West Africa

Based on the results of the recent International Conference on Sargassum (Guadeloupe, October 2019), a series of webinars is being held to present the key challenges and responses to Sargassum tides in the Caribbean and West Africa, highlighting the potential for international cooperation.

Funding: Unknown

Implementing Organization/Agency: UNESCO's Intergovernmental Oceanographic Commission (IOC), United Nations Environment Programme (UNEP), the Global Partnership on Nutrient Management (GPNM), the IOC-SCOR GlobalHAB Programme, and the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP).

Implementation Start Period: 2020

Link: Multi-partner initiative to study the impacts of Sargassum tides in the Caribbean and West Africa | UNESCO

The conclusions that some of these international meetings and initiatives have managed to reach are relevant, particularly those that have sought to highlight the core points in the resolution of this problem. The 26 conclusions of the high-level meeting held in 2019 in Mexico City to address the Sargassum problem are important:

1. Build a cooperation agenda on the analysis of the Sargassum arrival phenomenon to generate comprehensive solution proposals in the international context.
2. To disseminate knowledge and advances, the website internationalsargassumsystem.com is available, a collaborative platform.
3. Include on the site specific and open information that includes: monitoring, Sargassum biology, arrival and collection cycles, social research and public health, industrialization, education, among others.
4. Create protocols based on existing regional, state, and national guidelines. Interdisciplinary groups conducting specific research can enrich the platform.
5. Enrich the website with information each region can contribute, thus generating easily accessible and understandable indicators.
6. Disseminate the status of Sargassum through documentaries produced by international television networks showcasing various perspectives and actions taken on the issue.
7. Define how and under what conditions financial mechanisms will operate to address the problem.
8. Work by leveraging existing networks.
9. Bring the issue to a technical session at the CBD (Convention on Biological Diversity) or at the COP (Conference of the Parties) as a framework agreement to implement international policies.
10. Work on a declaration to define the Sargassum emergency plan.
11. Establish a platform accessible to all countries.
12. Develop the work plan and define a global project to request funding.
13. Resume south-south cooperation between countries, strengthening knowledge, exchanging experiences and capabilities.
14. Involve cruise companies.

15. Establish action lines and map out the type of projects being developed, identifying projects that can be linked, generating bilateral and multilateral alliances.
16. Focus funding to solve immediate problems.
17. The first funding should focus on understanding the phenomenon.
18. Consider diverse options for economy.
19. Resources and budget for cultural matters and information to the population.
20. Continue work through the ACS (Association of Caribbean States) and arrive at the Guadeloupe meeting with a defined work plan.
21. Create a discussion space to define the governance mechanism, how actions will be coordinated, and what the specific proposal is needed to move forward.
22. The ACS already has the mandate from countries, only the work plan is needed, to advance to October in a technical manner.
23. Follow up with the activities and projects at the Caribbean Sargassum Forum and an alert center, and sharing information.
24. Coordinate existing initiatives, leveraging the working group established under the Cartagena Convention, to guide national and regional initiatives to optimize funding sources.
25. Recognize the role and importance of local and coastal communities, as they are the first affected, but are key to solving the problem.

It is noteworthy that at the most recent thematic meeting held in Santo Domingo, Dominican Republic in July 2023, the following topics were addressed as a clear guide to the regional urgency:

- Impacts
- Management
- Research
- Funding
- Monitoring and prediction
- Containment and collection
- Valorization and uses
- Regionality (Planning and Management)

VII. Lessons Learned

A. Sargassum is the new reality of a global problem with local impacts, challenging the political sphere to propose solutions of similar scope.
B. Sargassum could be abundant in the future, but the irregularity of its arrival and volume risk its transformation from an industrial level.
C. More applied research is needed for the use of Sargassum, monitoring, and evaluating impacts, including environmental and economic impacts, from the point of view of certainty, comparability, and the long term.
D. The current regional strength is the creation of public-private alliances to remove Sargassum.
E. There are several political platforms working (e.g., AEC, SPAW, SICA), which represents an excellent base for regional initiatives.
F. The leadership of countries in the IAC area, as well as others (Barbados), allows for a robust and accurate exchange of knowledge and information.
G. The IAC should strengthen its work on this issue under the framework of the Letter of Intent with the SPAW protocol, particularly in seeking support for countries in aspects such as mitigation, compensation, and environmental restoration.
H. Knowledge exchange through participation in regional meetings, the actions of the CIT sphere, as well as the adoption of common and already applied tools are part of the critical immediate actions.
I. The common interest found in the face of the problem is key to the establishment of any regional initiative.

VIII. Possible Future Scenarios and Action Recommendations

Given the Sargassum arrivals, several future scenarios can be expected, although it is important to remember that exact prediction is difficult due to the variability of these events. Some possible scenarios are:

1. Increase in the volume and affected areas of Sargassum: Given the climatic conditions and nutrient contributions to the Atlantic and Caribbean, these would benefit the excessive growth of the algae.

2. Increase in scientific research: As Sargassum arrivals have become more frequent in some regions, we are likely to see an increase in scientific research to better understand the causes, consequences, and possible solutions to this problem.

3. Impact on tourism: Beaches affected by large amounts of Sargassum may experience a decrease in tourism, which could negatively affect local economies. Affected tourist destinations may need to implement cleaning and mitigation strategies to maintain their attractiveness.

4. Development of cleaning technologies: As Sargassum arrivals become more common, it is likely that more effective technology and methods for cleaning beaches and collecting Sargassum from the sea will be developed and invested in.

5. Impact on biodiversity: Sargassum arrivals can affect marine life and coastal ecosystems. We may see increased interest in protecting and restoring these ecosystems in response to the negative impacts of Sargassum.

6. Development of utilization projects: Some individuals and companies are looking for ways to utilize Sargassum, such as converting it into fertilizers or bioplastics. In the future. Sargassum farms may need to be developed to ensure a continuous supply of Sargassum biomass.

7. Regional cooperation: Since arrivals can affect multiple countries in the Caribbean and beyond, it is likely that regional cooperation to jointly address the problem will be strengthened. This could include agreements on managing and responding to Sargassum arrivals.

In summary, Sargassum arrivals are an ever-evolving environmental and economic challenge. Future scenarios will depend on a series of factors, including the magnitude

of the arrivals and the measures taken to address them. Research, regional cooperation, and technological innovation will play an important role in how this problem is addressed in the future. These scenarios can be organized into the six areas proposed by the conceptual model designed in Figure 9: all areas are interconnected by transversal actions and require multisectoral and multi-institutional work.

Comprehensive Sargassum management represents the minimization of its impacts on the coast, adjacent ecosystems, and therefore ecosystem services. This involves prevention, halting, collection, and disposal, with orderly actions within the proposed areas.

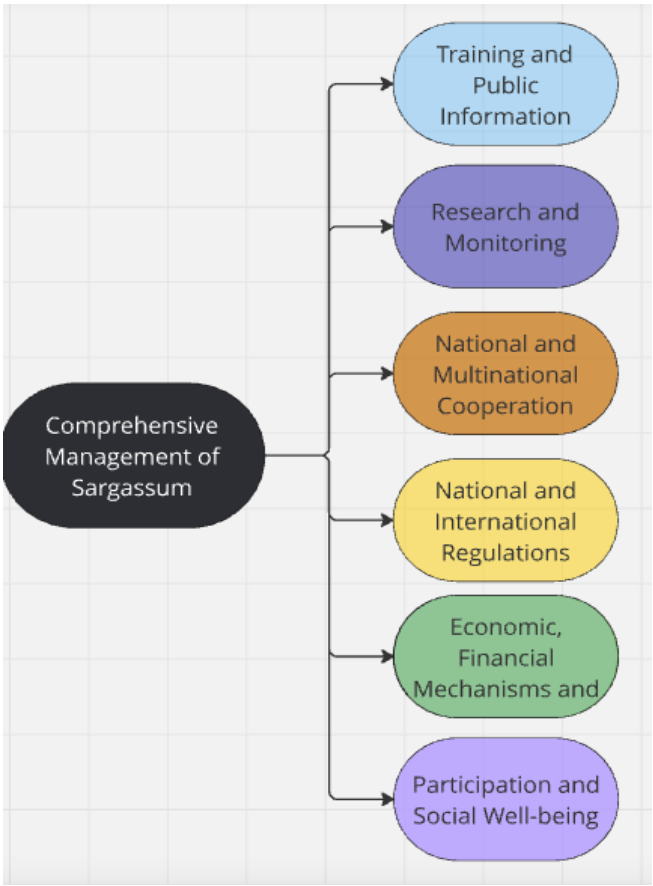

Figure 4. Conceptual Model of a Possible Approach to the Comprehensive Management and Handling of Sargassum in the Central American Region, Mexico, and the Caribbean Region: Dominican Republic, Caribbean Netherlands, Aruba, Curaçao, and Sint Maarten. Source: Prepared by Didiher Chacon for this document.

A list of urgent tasks in the region could be:

A. Establish mechanisms and/or agreements for standardized regional monitoring with early warning, through participation in regional structures (e.g., IOCARIBE, SPAW, SICA, etc.) and with a precautionary approach, a three-stage hierarchical approach (Prevention, Early Detection/Immediate Eradication, and Impact Minimization), and sustainable development. It is very important to leverage work platforms like Copernicus.
B. Define protocols that minimize the impact of Sargassum on the beach and establish institutional roles and key stakeholders.
C. Apply the recommendations proposed in Irvine et al. (2023) Manual or develop and disseminate their own version.
D. Agree on protocols for impact assessment, standardizing measures for recording arrivals.
E. Achieve international agreements that minimize the arrival of potential stimuli for algal growth from terrestrial sources in both the Americas and Africa (e.g., fertilizers, pollutants, sediments).
F. Develop technology that allows for local utilization, low-cost, and high contribution to the provincial economy, involving academia. Thinking of starting at the local level with an entrepreneurial and gender-focused approach.
G. Promote research that allows not only monitoring, prevention, and early warning but also efficient utilization that turns Sargassum stranding into an opportunity.
H. Examine options for valorizing Sargassum. López-Contreras et al (2021) have useful recommendations. They argue that Sargassum has the potential to contribute to energy and food security, but that there are important knowledge gaps that need to be filled first.
I. Evaluate the effects on the beach due to cleaning with machines (e.g., contribution to erosion) or the effects on Sargassum communities due to removal at sea.

J. Conduct economic assessments of the impact from environmental, social, and economic perspectives, using a standard methodology.
K. Promote economic and financial mechanisms that support sectors directly affected by Sargassum strandings.
L. Develop estimates of the cost of environmental regeneration of beach areas, especially those with significant ecosystem use by tourism.
M. Promote a regional platform to share data with standardized parameters or use an existing one such as Copernicus.

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