North and Latin America Region

Fact-finding Survey Regarding the Influx and Impacts of Sargassum Seaweed in the Caribbean Region

FINAL REPORT

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REPORT

Fact-finding survey regarding the influx and impacts of Sargassum seaweed in the Caribbean region

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Belize

LIST OF ACRONYMS AND ABBREVIATIONS

ACS	Association of Caribbean States
BMP	Biochemical Methane Production
CARICOM	Caribbean Community
CAR-SPAW-RAC	Caribbean Specially Protected Areas and Wildlife Regional Activity Center
CAST	Caribbean Alliance for Sustainable Tourism
CATS	Caribbean Aqua-Terrestrial Solutions
CC4FISH	Climate Change Adaptation in the Eastern Caribbean Fisheries Sector Project
CHTA	Caribbean Hotel and Tourism Association
CIA	Central Intelligence Agency
CERMES UWI	Centre for Resource Management and Environmental Studies
CNFO	Caribbean Network of Fisherfolk Organizations
COTED	Council of Trade and Economic Development
CRFM	Caribbean Regional Fisheries Mechanism
CTO	Caribbean Tourism Organization
EEZ	Exclusive Economic Zone
FADS	Fish Aggregating Devices
FAO	Food and Agriculture Organization of the United Nations
GCFI	Gulf and Caribbean Fisheries Institute
GEF	Global Environment Facility
GDP	Gross Domestic Product
IAEA	International Atomic Energy Agency
IOC	Intergovernmental Oceanographic Commission
JICA	Japan International Cooperation Agency
NASA	National Aeronautics and Space Administration
NEMA	National Emergency Management Agency
NERR	North Equatorial Recirculation Region
NGO	Non-Governmental Organization
OECS	Organization of Eastern Caribbean States
SVG	St. Vincent and the Grenadines
USD	United States Dollars

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EXECUTIVE SUMMARY

The Caribbean region has suffered a sudden increase in the influx of Sargassum seaweed since 2011, and several countries in the region have requested support to the Government of Japan and the Japan International Cooperation Agency (JICA). In response JICA with support from CRFM conducted a "Fact-finding survey regarding the influx and impacts of Sargassum seaweed in the Caribbean region" in order to gather information on the scope of damages and impacts and to determine the possibility of providing further support. The target countries included: Antigua and Barbuda, Barbados, Commonwealth of Dominica, Grenada, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, and Trinidad and Tobago.

The objectives of this survey were to: (i) review the existing literature and initiatives in the region; (ii) summarize the scope of damages and impacts caused by Sargassum seaweed in the target countries; (iii) suggest potential countermeasures and determine the scope of support that JICA may be able to provide in the future. In order to summarize the scope of damages and impacts caused by Sargassum influxes a number of methods were utilized including: 1) virtual meetings with the target countries; 2) development and circulation of questionnaires targeted at the fisheries divisions/departments; public sector agencies with responsibility for beach clean-ups; hotel associations; and innovators/entrepreneurs using Sargassum and; 3) field missions to gather more detailed country-level data, information and knowledge.

Findings

The Sargassum influxes have affected the fisheries in various ways including increased travel times to fishing grounds; relocation of fishing operations; reduced number of fishing days; increased catches of juvenile dolphinfish and changes in catch composition. Overall, the impacts on the ecosystems were identified as fish kills, die-off of coral and seagrass beds, beach erosion, and disruption turtle nesting sites.

Human health issues associated with decaying Sargassum accumulations both onshore and in the nearshore included asthma attacks, cough and other respiratory problems, vomiting, rash, headaches, and dizziness as well as skin aliments. The hydrogen sulphide associated with the decomposing Sargassum has also damaged electronics, boat engines, electrical wiring in houses, air-conditioner units, and paint on houses and boats.

Regarding tourism, hotels primarily on the East Coasts of the Islands, namely the Atlantic coast side, were affected and have borne the majority of clean-up cost. The Western and Southern Caribbean coasts of the islands were less affected. Within the last year the estimated costs of clean-ups for hoteliers, ranged from 400,000 – 500,000 USD.

Clean-ups have also been organized by Government agencies. Estimates for the expenditure by the public sector ranged between 1 - 7 million USD for clean-up, removal and disposal last year. Clean-up methods have included the use of front-end loaders, backhoes, and excavators; and 30-40 ft long-boom excavators and trucks. Issues identified with the transport of Sargassum included the distance to landfill which had cost implications, and the corrosive nature of the Sargassum which damaged equipment. Disposal of Sargassum was handled in different ways. In some countries, it was taken to the landfill while in others, it was dumped on private property.

The countries have been employing various measures to counteract the effects of Sargassum. These have included; tourism public education and marketing efforts, radio programs, community education and stakeholder engagement meetings. Some countries have established or were putting together Taskforces or National Committees comprised of different agencies to provide support and coordination in addressing the Sargassum issue. Draft Sargassum Management Plans have been or were being developed for some countries, however these needed to be approved by cabinet or other competent authorities and provided with resources to function.

Farmers have been using Sargassum on coconut trees and citrus fruit trees as fertilizers, however they were unable to take the quantities, which have been coming in. A successful plant tonic was also produced by Algas Organics. However, there were no quantitative studies of the associated benefits as a fertilizer. There was also concern about the presence of heavy metals in the Sargassum which could contaminate the soil if used as a fertilizer.

Recommendations

In the fisheries sector, countries should collect and monitor landings of dolphinfish and enforce the precautionary size limits. Special attention should also be given to the flyingfish and amber / crevalle catches which have changed significantly with the presence of Sargassum. Economic losses to the fisheries sector should be determined and opportunities available to the sector should be documented and supported including marketing and value addition of the species that are now available in greater quantities. Improved data collection and monitoring is needed to better understand the impact of Sargassum on fish stocks and livelihood of fishers. The economic losses of the influxes to the tourism sector also need to be quantified.

A management framework for systematic monitoring of the beaches is needed. Given the fact that Sargassum has been affecting nearshore ecosystems (coral reefs and seagrass) as well as mangroves, clean-up of accumulations associated with these important nursery areas should be a priority.

There is an urgent need to monitor hydrogen sulphide levels in affected communities and a protocol to determine the area as unsafe and what actions should be taken, e.g. clean-up or evacuation. The effects of heavy metals on human health needs to be investigated and used to inform the handling and disposal of Sargassum.

Support is needed to establish effective systems for safe collection, transportation and disposal of Sargassum in most countries. Further pilot projects should be conducted to identify appropriate off-shore technologies such as floating barriers and special boats, equipment for deflection, and methods for collection and transport of Sargassum.

Research and development of possible uses of Sargassum and business models should be promoted and shared. This should include potential use in agriculture, livestock, construction industry, energy sector, as well as at the household level.

Finally yet importantly, countries should utilize the Draft Management Plans and all available documents to guide their responses to the influxes. Support should be provided to assist countries to customize and implement national management plans in collaboration with local communities and stakeholders. There is an urgent need to mobilize resources to address the situation, since the countries and associated sectors are unable to sustain the levels of financial impacts of the influxes.

1. BACKGROUND

The Caribbean region has suffered a sudden increase in the influx of Sargassum seaweed since 2011, and several countries in the region have requested support to the Government of Japan and the Japan International Cooperation Agency (JICA). JICA provided funding for the CRFM Secretariat to conduct a "Fact-finding survey regarding the influx and impacts of Sargassum seaweed in the Caribbean region." The purpose of this survey was to gather information on the scope of damages and impacts of Sargassum influxes and to determine the possibility of providing further support. The target countries included; Antigua and Barbuda, Barbados, Commonwealth of Dominica, Grenada, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Trinidad and Tobago. Field missions were conducted in Antigua and Barbuda, Barbados, Grenada, Saint Kitts and Nevis, Saint Lucia, and Saint Vincent and the Grenadines to visit a sample of the affected areas and gather information from stakeholders. The Terms of Reference for the Fact-finding Survey is included as ***Appendix 1***.

1.1 Country Profiles

1.1.1 Antigua and Barbuda

Table 1: Country Profile of Antigua and Barbuda. Source: CIA World Factbook – Antigua and Barbuda (March 2019); EarthTrends Country Profiles.

Geographic coordinates	17° 03′ N, 61° 48′ W
Land area	442.6 km^2 (Antígua 280 km^2; Barbuda 161 km^2; Redonda 1.6 km^2)
Length of coastline	289 km (Source: Earth Trends Country Profile)
Shelf area (200 m contour)	3,568 km^2 (Source: FAO Country Profile)
Territorial sea (up to 12 nm)	7,147 km^2 (Source: Earth Trends Country Profile)
Claimed EEZ (up to 200 nm)	102,867 km^2 (Source: Earth Trends Country Profile)
Highest point	402 m Boggy Peak (now renamed Mount Obama)
Natural hazards	Hurricanes season from June to November, and periodic drought
Population	95,882 (2018 est)
Life expectancy at birth (total population)	76.9 years
GDP per capita (purchasing power parity)	US$26,400 (2017 estimate)
Per capita food supply for fish and fishery products	48.3 kg / person (2004) (Source: FAO)
Exports	US$86.7 million (2017 estimate)
Imports	US$560 million (2017 estimate)

Tourism continues to dominate Antigua and Barbuda's economy, accounting for nearly 60% of GDP and 40% of investment. The dual-island nation's agricultural production is focused on the domestic market and constrained by a limited water supply and a labor shortage stemming from the lure of higher wages in tourism and construction. Manufacturing comprises enclave-type assembly for export with major products being bedding, handicrafts, and electronic components.
Like other countries in the region, Antigua's economy was severely hit by effects of the global economic recession in 2009. The country suffered from the collapse of its largest private sector employer, a steep decline in tourism, a rise in debt, and a sharp economic contraction between 2009 and 2011. Antigua has not yet returned to its pre-crisis growth levels. Barbuda suffered significant damages after hurricanes Irma and Maria passed through the Caribbean in 2017.

Prospects for economic growth in the medium term will continue to depend on tourist arrivals from the US, Canada, and Europe and could be disrupted by potential damage from natural disasters. The new government, elected in 2014 and led by Prime Minister Gaston Browne, continues to face significant fiscal challenges. The government places some hope in a new Citizenship by Investment Program, to both reduce public debt levels and spur growth, and a resolution of a WTO dispute with the US.

1.1.2 Barbados

Table 2: Country Profile of Barbados. Source: CIA World Factbook – Barbados (March 2019); EarthTrends Country Profiles.

Geographic coordinates	13° 10' N, 59° 32' W
Land area	430 sq km
Length of Coastline	97 km
Shelf Area	213 sq km
Territorial Sea	3,383 sq km
Claimed EEZ	183,436 sq km
Highest point (m)	336 m (Mount Hillaby)
Natural hazards	hurricanes; periodic drought
Population	293.131 (July 2018 est.)
Life Expectancy at birth	75.7 years (2018 estimate)
GDP per Capita (PPP)	$18,600 (2017 est.)
Per Capita Food Supply from Fish / Fishery Products (2000)	42 kg / person
Exports	$485.4 million (2017); manufactures, sugar and molasses, rum, other foods and beverages, chemicals, electrical components
Imports	$1.52 billion (2017) consumer goods, machinery, foodstuffs, construction materials, chemicals, fuel, electrical components

Barbados is the wealthiest and one of the most developed countries in the Eastern Caribbean and enjoys one of the highest per capita incomes in the region. Historically, the Barbadian economy was dependent on sugarcane cultivation and related activities. However, in recent years the economy has diversified into light industry and tourism. Offshore finance and information services are important foreign exchange earners, boosted by being in the same time zone as eastern US financial centers and by a relatively highly educated workforce. Following the 2008-09 recession, external vulnerabilities such as fluctuations in international oil prices have hurt economic growth, raised Barbados' already high public debt to GDP ratio - which stood at 105% of GDP in 2016 - and cut into its international reserves.

1.1.3 Commonwealth of Dominica

Table 3: Country Profile of Commonwealth of Dominica. *Source:* CIA World Factbook – Commonwealth of Dominica (March 2019); EarthTrends Country Profiles.

Geographic coordinates	15° 25' N, 61° 20' W
Land area	751 sq km
Length of Coastline	152 km
Shelf Area	304 sq km
Territorial Sea	3,788 sq km
Claimed EEZ	24,917 sq km
Highest point (m)	1,447 m (Morne Diablatins)
Natural hazards	flash floods are a constant threat; destructive hurricanes can be expected during the late summer months
Population	74,679 (July 2019 est.)
Life Expectancy at birth	total population: 77.4 years
GDP per Capita (PPP)	$11,000 (2017 est.)
Per Capita Food Supply from Fish / Fishery Products (2000)	47 kg/person
Exports	$28 million - bananas, soap, bay oil, vegetables, grapefruit, oranges
Imports	$206.6 million - manufactured goods, machinery and equipment, food, chemicals

The Commonwealth of Dominica's economy was dependent on agriculture - primarily bananas - in years past, but increasingly has been driven by tourism, as the government seeks to promote the Commonwealth of Dominica as an "ecotourism" destination. However, Hurricane Maria, which passed through the island in September 2017, destroyed much of the country's agricultural sector and caused damage to all of the country's transportation and physical infrastructure. Before Hurricane Maria, the government had attempted to foster an offshore financial industry and planned to sign agreements with the private sector to develop geothermal energy resources. At a time when government finances are fragile, the government's focus has been to get the country back in shape to service cruise ships. The economy contracted in 2015 and recovered to positive growth in 2016 due to a recovery of agriculture and tourism. The Commonwealth of Dominica suffers from high debt levels, which increased from 67% of GDP in 2010 to 77% in 2016. The Commonwealth of Dominica is one of five countries in the East Caribbean that have citizenship by investment programs whereby foreigners can obtain passports for a fee and revenue from this contribute to government budgets.

1.1.4 Grenada

Table 4: Country Profile of Grenada. Source: CIA World Factbook – Grenada (March 2019); EarthTrends Country Profiles.

Geographic coordinates	12º 07' N, 61º 40' W (This is the location of the centre of the Island)
Land area	344 sq km
Length of Coastline	251 km
Shelf Area	629 sq km
Territorial Sea	4,504 sq km
Claimed EEZ	20.285 sq km
Highest point (m)	840 (Mount Saint Catherine)
Natural hazards	Hurricane season lasts from June to November and periodic drought
Population	112,207 (2018 est.)
GDP per Capita (PPP)	$15,100 (2017 est.)
Per Capita Food Supply from Fish/Fishery Products (2000)	32 kg/person
Exports	$39.9 million (2017); nutmeg, bananas, cocoa, fruit and vegetables, clothing, mace, chocolate, fish
Imports	$316 million (2017 est.) - food, manufactured goods, machinery, chemicals, fuel

Grenada relies on tourism and revenue generated by St. George's University - a private university offering degrees in medicine, veterinary medicine, public health, the health sciences, nursing, arts and sciences, and business - as its main source of foreign exchange. In the past two years the country expanded its sources of revenue, including from selling passports under its citizenship by investment program. These projects produced a resurgence in the construction and manufacturing sectors of the economy. In 2017, Grenada experienced its fifth consecutive year of growth and the government successfully marked the completion of its five-year structural adjustment program that included among other things austerity measures, increased tax revenue and debt restructuring. Public debt-to-GDP was reduced from 100% of GDP in 2013 to 71.8% in 2017.

1.1.5 Saint Kitts and Nevis

Table 5: Country Profile of Saint Kitts and Nevis. Source: CIA World Factbook – Saint Kitts and Nevis (March 2019); EarthTrends Country Profiles.

Geographic coordinates	17° 20' N, 62° 45' W
Total area	261 sq km (*Saint Kitts* 168 sq km; Nevis 93 sq km)
Land area	261 sq km
Length of Coastline	135 km
Shelf Area	845 sq km
Territorial Sea	12nm
Claimed EEZ	20,400 sq km
Highest point (m)	1,156 m (Mount Liamuiga)
Natural hazards	hurricanes (July to October)
Population	53,094 (2018 est.)
Life Expectancy at birth	total population: 76.2 years
GDP per Capita (PPP)	$28,200 (2017 est.)
Per Capita Food Supply from Fish / Fishery Products (2000)	*
Exports	$57.4 million - machinery, food, electronics, beverages, tobacco
Import	$335.3 million - machinery, manufactures, food, fuels

The economy of Saint Kitts and Nevis depends on tourism; since the 1970s, tourism has replaced sugar as the economy's traditional mainstay. Roughly 200,000 tourists visited the islands in 2009, but reduced tourism arrivals and foreign investment led to an economic contraction in the 2009-2013 period, and the economy returned to growth only in 2014. Like other tourist destinations in the Caribbean, Saint Kitts and Nevis is vulnerable to damage from natural disasters and shifts in tourism demand. Following the 2005 harvest, the government closed the sugar industry after several decades of losses. To compensate for lost jobs, the government has embarked on a program to diversify the agricultural sector and to stimulate other sectors of the economy, such as export-oriented manufacturing and offshore banking. The government has made notable progress in reducing its public debt, from 154% of GDP in 2011 to 83% in 2013, although it still faces one of the highest levels in the world, largely attributable to public enterprise losses. Saint Kitts and Nevis is among other countries in the Caribbean that supplement their economic activity through economic citizenship programs, whereby foreigners can obtain citizenship from Saint Kitts and Nevis by investing there.

1.1.6 Saint Lucia

Table 6: Country Profile of Saint Lucia. Source: CIA World Factbook – Saint Lucia (March 2019); EarthTrends Country Profiles.

Geographic coordinates	13º 53' N, 60º 58' W
Land area	606 sq km
Length of Coastline	166 km
Shelf Area	271 sq km
Territorial Sea	3,716 sq km
Claimed EEZ	11,483 sq km
Highest point (m)	950 m
Natural hazards	hurricanes; volcanic activity
Population	165,510 (July 2018 est.)
Life Expectancy at birth	total population: 78.1 years (2018 est.)
GDP per Capita (PPP)	$14,400 (2017 est.)
Per Capita Food Supply from Fish / Fishery Products (2000)	37 kg / person
Exports	$185.1 million (2017 est.) - bananas 41%, clothing, cocoa, avocados, mangoes, coconut oil
Imports	$600 million (2017 est.) - food, manufactured goods, machinery and transportation equipment, chemicals, fuels

The island nation has been able to attract foreign business and investment, especially in its offshore banking and tourism industries. Tourism is Saint Lucia's main source of jobs and income - accounting for 65% of GDP - and the island's main source of foreign exchange earnings. The manufacturing sector is the most diverse in the Eastern Caribbean area. Crops such as bananas, mangos, and avocados continue to be grown for export, but Saint Lucia's once solid banana industry has been devastated by strong competition.

Saint Lucia is vulnerable to a variety of external shocks, including volatile tourism receipts, natural disasters, and dependence on foreign oil. Furthermore, high public debt - 77% of GDP in 2012 - and high debt servicing obligations constrain the CHASTANET administration's ability to respond to adverse external shocks.

Saint Lucia has experienced anemic growth since the onset of the global financial crisis in 2008, largely because of a slowdown in tourism - airlines cut back on their routes to Saint Lucia in 2012. Also, Saint Lucia introduced a value added tax in 2012 of 15%, becoming the last country in the Eastern Caribbean to do so. In 2013, the government introduced a National Competitiveness and Productivity Council to address Saint Lucia's high public wages and lack of productivity.

1.1.7 Saint Vincent and the Grenadines

Table 7: Country Profile of Saint Vincent and the Grenadines. Source: CIA World Factbook – Saint Vincent and the Grenadines (March 2019); EarthTrends Country Profiles.

Geographic coordinates	13°10'N, 61°14'W
Land area	389 sq km
Length of Coastline	264 km
Shelf Area	1,074 sq km
Territorial Sea	6,124 sq km
Claimed EEZ	32,320 sq km
Highest point (m)	1,234 m (La Soufriere)
Natural hazards	hurricanes; Soufriere volcano on the island of Saint Vincent is a constant threat.
Population	101,844 (July 2018 est.)
Life Expectancy	total population: 75.8 years (2018 est.)
GDP per Capita	US$11,500 (2017 est.)
Per Capita Food Supply from Fish / Fishery Products	20 kg/person
Exports	$48.6 million (2017 est.) - bananas, eddoes and dasheen (taro), arrowroot starch; tennis racquets
Imports	$295.9 million (2017 est.) - foodstuffs, machinery and equipment, chemicals and fertilizers, minerals and fuels

Success of the economy hinges upon seasonal variations in agriculture, tourism, and construction activity, as well as remittances. Much of the workforce is employed in banana production and tourism. Saint Vincent and the Grenadines is home to a small offshore banking sector and continues to fully adopt international regulatory standards. This lower-middle-income country remains vulnerable to natural and external shocks. The economy has shown some signs of recovery due to increased tourist arrivals, falling oil prices and renewed growth in the construction sector. The much-anticipated international airport opened in early 2017 with hopes for increased airlift and tourism activity. The government's ability to invest in social programs and respond to external shocks is constrained by its high public debt burden, which was 67% of GDP at the end of 2013.

1.1.8 Trinidad and Tobago

Table 8: Country profile of Trinidad and Tobago. Source: CIA World Factbook – Trinidad and Tobago (March 2019); EarthTrends Country Profiles.

Geographic coordinates	11°00'N, 61°00'W
Land area	5,128 sq km
Length of Coastline	704 km (2000 est.)
Shelf Area	22,624 sq km (2000 est.)
Territorial Sea	12,974 sq km (2000 est.)
Claimed EEZ	60,659 sq km (2000 est.)
Highest point (m)	940 m (El Cerro del Aripo)
Natural hazards	outside usual path of hurricanes and other tropical storms
Population	1,215,527 (July 2018 est.)
Life Expectancy at birth	total population: 73.4 years (2018 est.)
GDP per Capita (PPP)	US$31,300 (2017 est.)
Per Capita Food Supply from Fish / Fishery Products	15 kg/person
Exports	$9.927 billion (2017 est.) - petroleum and petroleum products, liquefied natural gas, methanol, ammonia, urea, steel products, beverages, cereal and cereal products, cocoa, fish, preserved fruits, cosmetics, household cleaners, plastic packaging
Imports	$6.105 billion (2017 est.) - mineral fuels, lubricants, machinery, transportation equipment, manufactured goods, food, chemicals, live animals

Trinidad and Tobago rely on its energy sector for much of its economic activity, and has one of the highest per capita incomes in Latin America. Economic growth between 2000 and 2007 averaged slightly over 8% per year, significantly above the regional average of about 3.7% for that same period; however, GDP has slowed down since then, contracting during 2009-12, making small gains in 2013 and contracting again in 2014-17. Trinidad and Tobago is buffered by considerable foreign reserves and a sovereign wealth fund that equals about one-and-a-half times the national budget, but the country is still in a recession and the government faces the dual challenge of gas shortages and a low price environment.

Large-scale energy projects in the last quarter of 2017 are helping to mitigate the gas shortages. Energy production and downstream industrial use dominate the economy. Oil and gas typically account for about 40% of GDP and 80% of exports but less than 5% of employment. Trinidad and Tobago is home to one of the largest natural gas liquefaction facilities in the Western Hemisphere. The country produces about nine times more natural gas than crude oil on an energy equivalent basis with gas contributing about two-thirds of energy sector government revenue. The US is the country's largest trading partner, accounting for 28% of its total imports and 48% of its exports.

Economic diversification is a longstanding government talking point, and Trinidad and Tobago has much potential due to its stable, democratic government and its educated, English speaking workforce. The country is also a regional financial center with a well-regulated and stable financial system. Other sectors the Government of Trinidad and Tobago has targeted for increased investment and projected growth include tourism, agriculture, information and communications technology, and shipping. Unfortunately, a host of

other factors, including low labor productivity, inefficient government bureaucracy, and corruption, have hampered economic development.

2. OBJECTIVES OF THE ASSIGNMENT

The objectives of this survey are as follows: (i) to review the existing literature and initiatives in the region: (ii) to summarize the scope of damages and impacts caused by Sargassum seaweed in the target countries: (iii) to suggest potential countermeasures and determine the scope of support that JICA may be able to provide in the future.

3. METHODS

In order to summarize the scope of damages and impacts caused by Sargassum influxes a number of methods were utilized including: (1) virtual meetings with the target countries; (2) development and circulation of questionnaires targeted at the fisheries divisions / departments; public sector agencies with responsibility for beach clean-ups; hotel associations; and innovators / entrepreneurs using Sargassum and; (3) field missions to gather more detailed country-level data, information and knowledge.

3.1 Literature review

A literature review of the past studies conducted by major research institutions in the region and the existing initiatives by regional institutions, other donors, and the private sector was conducted.

3.2 Development and Circulation of Questionnaires

Four questionnaires were designed targeting (1) the fisheries sector; (2) the public sector agencies with responsibility for beach clean-ups; (3) the tourism sector; and (4) the innovative sector. The questionnaires were developed in collaboration with the Secretariat and key stakeholders from the Fisheries Divisions of the Target countries, Centre for Resource Management and Environmental Studies, University of the West Indies (CERMES-UWI), and the Caribbean Tourism Organization (CTO). The questionnaires were sent to the Fisheries Divisions/Department for circulation to the relevant national agencies. Additionally, the tourism questionnaire was sent to the Caribbean Tourism Organization (CTO) who developed an electronic version of the survey and circulated it to their Member States. These questionnaires are attached as ***Appendix 2***.

3.3 Virtual Meeting

Following the signing of the Contract for the Survey, the CRFM Secretariat informed the Target countries and stakeholders about the survey and invited representatives to a virtual meeting to discuss the arrangements. During the virtual meeting which was held on January 31, 2019, the target countries and key stakeholders were informed about the survey and the inputs and timeline for undertaking the activities were explained. The content of four questionnaires and the amount of information that could be provided by the target countries was also reviewed. The report of the virtual meeting is attached as ***Appendix 3***.

3.4 Field Mission

Field missions were conducted in (1) Antigua and Barbuda, (2) Barbados, (3) Grenada, (4) Saint Kitts and Nevis, (5) Saint Lucia, and (6) Saint Vincent and the Grenadines. During the field missions, there was engagement with stakeholders and key informants about their experience with Sargassum including (fisheries divisions, tourism, hoteliers, community organizations; fishers; fisherfolk; regional partners: FAO, CERMES, OECS Commission; innovators). The impacts of Sargassum influxes were also observed through field trips to badly affected sites. Photographs were taken of the sites and meetings with stakeholders. The list of resource persons who participated in the stakeholder meetings and interviews are attached as ***Appendix 4***.

4. FINDINGS / RESULTS

Completed questionnaires were received from the Fisheries Divisions / Departments in all of the target countries. However, there was limited response to the other questionnaires. The questionnaires sought extensive information from the countries and were intended to allow estimation of revenue losses for the fisheries, and tourism sector as well as costs of clean-ups. However, countries were not collecting this type information on a consistent basis and were unable to provide detailed feedback. Most of the information was therefore gathered through interviews with key stakeholders, and during the field missions. The interview results for each country are provided in ***Appendix 5***.

4.1 Literature Review

4.1.1 Summary of Impacts of Sargassum

Massive accumulations of the floating pelagic seaweed Sargassum (*Sargassum natans and S. fluitans*) occurred in 2011 on the coasts of several countries in the Wider Caribbean and West Africa (Kershaw, 2017). In terms of geographical scales and biomass quantities, this influx was unprecedented for the two regions. Sargassum influxes were experienced in subsequent years (2012, 2014, 2015, 2018), with significant impacts on the coastal and marine ecosystems and economies of CARICOM Member States. These events have triggered much consternation regionally about capacities to cope and adapt, and about the long-term implications for the fisheries and tourism sectors especially, given that such events seem to be a 'new normal' due in part to climate change and variability[1]. Influxes in the Wider Caribbean region have been accompanied by increased interest and communication on the subject.[2] At the global scale there has also been an overall increase in green and golden seaweed 'tides' within recent years (Smetacek and Zingone 2013).

These Sargassum influxes have affected national and regional economies through loss of livelihoods and economic opportunities to fishers, hoteliers and related businesses. Sargassum influxes disrupt fishing

[1] Franks, J.S., D.R. Johnson, D-S Ko, G. Sanchez-Rubio, J.R. Hendon, and M. Lay. 2011. Unprecedented influx of pelagic Sargassum along Caribbean island coastlines during summer 2011. Proceedings of the Gulf and Caribbean Fisheries Institute 64:6-8.

[2] **SPAW-RAC- Regional cooperation on the Sargassum issue:** http://www.car-spaw-rac.org/?Regional-cooperation,654

operations through gear entanglement and damage; impede fishing and other vessels at sea; reduce catches of key fisheries species such as flyingfish and adult dolphinfish; change the availability and distribution of coastal and pelagic fisheries resources; and disrupt coastal fishing communities and tourism activities. The influxes have also been associated with an increase in the abundance and catches of juvenile dolphinfish (Monnereau and Oxenford, 2017). The practice of capturing large quantities of immature dolphinfish can seriously impair the long-term sustainability of the stocks by reducing spawning stock biomass and affecting the stock's ability to replenish itself, and ultimately compromise the economic and social benefit from the fisheries in future years. The impacts of Sargassum influxes on fisher livelihoods have not yet been fully analyzed and documented. For e.g. within the fisheries sector there has been a loss of fishing days, reduced catches of flyingfish, and damage to fishers' engines. However, the economic losses associated with these events have not been quantified and calculated. Similarly, within the tourism sector, the economic impacts associated with the reduction in tourist arrivals due to the events have not yet been quantified.

Sargassum influxes have also negatively impacted coastal and marine ecosystems. Decomposing Sargassum releases hydrogen sulphide and causes oxygen depletion and eutrophication which threaten the health of coral reef and seagrass ecosystems. These impacts need to be fully investigated and quantified over time. Additionally, the unpredictable timing, frequency, extent and severity of massive Sargassum influxes constitute a natural hazard with potential for disaster.

4.1.2 Regional and International Deliberations on the Topic of Sargassum

At the regional level, the 6th Meeting of the CRFM Ministerial Council, 2012, for the first time discussed and expressed concern about the disruption of fishing activities that occurred during the influx of Sargassum in 2011. The 9th Meeting of the CRFM Ministerial Council, 2015 returned to the issue by again expressing concerns about the recurrence of large quantities of Sargassum and the increasing trend in capture and landing of juvenile dolphinfish and called for action. This led to the adoption of model precautionary fisheries management measures by the 10th CRFM Ministerial Council, 2016. The precautionary management measures are aimed at protecting the dolphinfish by establishing a minimum legal harvest size, however there has been limited implementation of these management measures due to lack of enforcement. The 10th Ministerial Council also endorsed a 'Model Protocol for the Management of Extreme Accumulations of Sargassum on the Coasts of CRFM Member States' which could serve as a guide to develop national level management plans.[3] The issue of juvenile dolphinfish captures associated with the Sargassum events was raised again at the 12th Ministerial Council, 2018, which endorsed the recommendation that the status of the fishery should be investigated, including an assessment of catches to determine whether further precautionary management measures are needed. The 'Model Protocol for the Management of Extreme Accumulations of Sargassum on the Coasts of CRFM Member States' is being used to guide the drafting of national management plans for Grenada, Saint Kitts and Nevis, Saint Lucia, and Saint Vincent and the Grenadines; with support from the CC4FISH project.

The Sargassum issue was discussed at the 59th Special Meeting of the COTED, 2015 and Member States were urged to take action to better understand the changes taking place and develop appropriate responses. CARICOM was instrumental in having the Sargassum problem recognized and debated at the 70th Session of the General Assembly of the United Nations in 2015. UN Resolution, A/Res/70/75 of 8 December 2015,

[3] CRFM, 2016. Model Protocol for the Management of Extreme Accumulations of Sargassum on the Coasts of CRFM Member States. Technical & Advisory Document, No. 2016 / 5. 15p.

paragraph 179 captures the United Nations General Assembly decision as follows: "*Expresses concern about the recent massive influx of Sargassum seaweed into the waters of the Caribbean and its impact on aquatic resources, fisheries, shorelines, waterways and tourism, and encourages States and relevant regional organizations to cooperate to better understand the causes and impacts of the influx, with a view to protecting the livelihoods of fishers and fishing communities and finding ways of beneficially utilizing the seaweed and environmentally friendly ways of disposing of Sargassum washed up on shore*."

The Ministerial Councils of the ACS and the OECS also discussed the Sargassum issue at several meetings, and Sargassum was included in the Plan of Action for the ACS 2016-2018[4]. The ACS hosted the first symposium of the Caribbean Sea Commission (CSC) which featured a session on the Sargassum threat.[5] The key actions foreseen for these two organizations included: materializing international cooperation; identifying potential siting locations for a regional virtual buoy observing network; creating a monitoring network with academic, governmental and NGO representatives; developing and implementing an engagement process to involve community stakeholder groups in the long term management of Sargassum; and examining the potential for using Sargassum as a source of biofuels for energy security on small and large scales. To date there have been initiatives addressing each of these actions, however there is a need to consolidate these outputs and effectively utilize them at the Member State level.

A side event on Sargassum was hosted by SPAW-RAC and USAID-WABICC Programmes during the second session of the United Nations Environment Assembly (UNEA-2) in 2016[6]. The objective of this event was to draw attention of the wider environment community on the severe impacts of Sargassum in West Africa and the Wider Caribbean States, and to mobilize resources for regional programmes with emphasis on "inclusive green-economy opportunities" which would contribute to UNEP's global environmental mandate.

The Joint Group of Experts on the Scientific Aspects of the Marine Environmental Protection (GESAMP) also held a meeting in 2017 to review the current state of knowledge on the causes and impacts of massive accumulations of the brown macro-algae Sargassum in the nearshore environment of the Caribbean and West Africa.

4.1.3 Responses and Countermeasures

Member States continue to respond to the influxes as they occur, and 2018 has been the worst year on record. Member States have been working with institutions such as UWI, the Gulf and Caribbean Fisheries Institute (GCFI), regional organizations and various universities to better understand the issue and begin adapting to the influxes.

The responses and countermeasures to the Sargassum influxes have been focused on: (i) investigating the causes and understanding the phenomenon; (ii) monitoring and forecasting; (iii) developing management approaches / responses; (iv) studying growth, transport, and implications for fishermen; and sharing information on best practices; (v) identifying impacts on marine ecosystem; (vi) analysis of heavy metal

[4] 7th ACS Meeting of Heads of State and/or Government, Havana, Cuba, June 4, 2016. Plan of Action for 2016-2018 http://www.acs-aec.org/sites/default/files/plan_de_accion_vii_cumbre_habana_engl.pdf

[5] Caribbean Sea Commission Symposium: Challenges, Dialogue and Cooperation towards the Sustainability of the Caribbean Sea, 23 - 24 November 2015, Trinidad and Tobago.

[6] SPAW-RAC- Regional cooperation on the Sargassum issue: http://www.car-spaw-rac.org/?Regional-cooperation,654

content; and (vii) researching possibilities for innovation, entrepreneurship and revenue generation. While it is agreed that these Sargassum influxes have caused significant impacts in the fisheries and tourism sector, there have been no quantitative analyses to determine the extent of the impacts on (i) the marine and coastal ecosystems; (ii) livelihoods associated with the fisheries and tourism sectors; (iii) human health; or (iv) benefits to be derived from innovation and entrepreneurship. This is critical information as this socio-economic knowledge is needed to effect change and will support the development and implementation of a coordinated regional response to Sargassum influxes. There is also a gap in the knowledge of the existing capacities of the various regional and national institutions and this information is necessary to inform realistic options for management responses. A summary of the various initiatives addressing Sargassum is provided in the following paragraphs.

4.1.3 (i) Investigating the causes and understanding the phenomenon

4.1.3 (i) (a) Ecology of Sargassum

Figure 1: The two species of Sargassum associated with the influxes. Source: Hazel Oxenford.

The two species of pelagic brown algae which have been arriving in the Caribbean are *Sargassum natans* and *Sargassum fluitans* (Figure 1). These pelagic algae have structures that enable them to float and be transported by the marine currents in contrast to those algae which are anchored to the sea floor. In the North Atlantic large masses of these algae are found concentrated in the Sargasso Sea which is located between 28°20'08" N and 66°10'30". Its area has been estimated at around 2 million square miles and although the depth of the species does not exceed 50 cm, its biomass has been calculated to be between 4 and 11 million tons of wet weight. The reason why such a large mass of algae remains in this specific region of the Atlantic Ocean is the ripple produced by the rising oceanic currents of the Gulf and the North Atlantic which run toward the east north of 40°north latitude and the descending ones of the Canary Islands and the North Equatorial drift which runs to the west below 20° north latitude.

In the open sea, the floating masses of Sargassum represent a rich habitat of over 120 species of fish and over 120 species of invertebrates. Below the Sargassum, turtle hatchlings, sea horses, and other small species can be found. It also serves as an area for the reproduction of species of singular importance such as the flyingfish (Exocoetidae sp.) and a great quantity of fish that in turn serve as food for larger fish such as dolphinfish (*Coryphaena hippurus*). The floating masses of Sargassum also have an important role as areas of nutrition and nurseries for juveniles of more than 100 species of important commercial and recreational fish such as saw fish, jacks, tuna, barracuda, wahoo, dolphinfish and billfish. Various species of marine turtles in danger of extinction utilise the Sargassum for food and protection during their first years of life. Once they arrive on the coast, many of the species that have utilised Sargassum as a habitat move towards mangroves, bays, estuaries and coral reefs to protect themselves from predators and continue their life cycles. The concentrations of Sargassum in the open sea provide a nursery area, food, and shelter for multiple species, particularly in their juvenile stages.

4.1.3 (i) (b) Origins and Causes of Sargassum Influxes

The recent influxes to the Caribbean Sea and West African coast have been attributed to massive Sargassum blooms occurring in the equatorial area of the Atlantic known as the North Equatorial Recirculation Region (NERR) (Hinds et al., 2016). The NERR is not directly associated with the Sargasso Sea and is considered as a new 'source' region for Sargassum (Hinds et al., 2016). These masses are transported by currents toward the east of the Atlantic Ocean, rise along the coast of Brazil until they arrive in the Caribbean region (Figure 2)

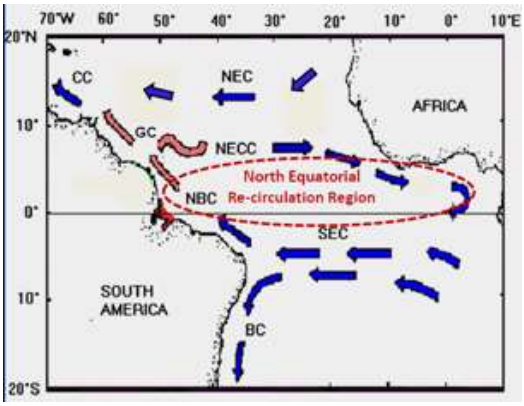

Figure 2: North Equatorial Recirculation Region and the Main Sea Surface Currents. NEC – North Equatorial Current; NECC – North Equatorial Counter Current; GC – Guinea Current; SEC – South Equatorial Current; NBC – North Brazil Current and CC – Caribbean Current. Adapted from Franks, Johnson and Ko (2015).

A number of physical factors and external nutrient inputs are influencing the occurrence of Sargassum and contributing to increased growth rates. These factors include: climate change; change in regional winds and ocean current patterns; increased sea surface temperature; increased supply of iron due the atmospheric deposition of Saharan dust linked to climate change and desertification; and nutrients from rivers (Figure 3), sewage and nitrogen-based fertilizers.

Figure 3: Possible sources of nutrients contributing to Sargassum blooms in the NERR include river outflows from the Orinoco River, the Amazon River and equatorial upwelling. Adapted from Oxenford and Franks (2015).

4.1.3 (ii) Monitoring and Forecast

Since the start of the Sargassum influx events, significant progress has been made in monitoring and forecasting the development and movement of blooms and predicting when they are likely to affect countries. The system used by Wang and Hu (2017) provides several months of notice for local residents and management agencies to better prepare for potential influx events. There are also several projects working on the identification and forecasting of Sargassum blooms including; Sargassum Watch (University of South Florida) and Sargassum Early Advisory System (Texas A&M). The Sargassum Early Advisory System can give up to two weeks' notice when there is no cloud cover.

The fourteenth session of the Intergovernmental Oceanographic Commission (IOC) Sub-Commission for the Caribbean and Adjacent Regions adopted the Recommendation SC-IOCARIBE-XIV.4-Sargassum Blooms and established a Working Group for Sargassum issues (IOC, 2017). The Working Group was tasked to design and develop a Sargassum tracking and forecasting system including a Pilot Project/ prototype to test the concept. IOCARIBE-GOOS (Global Ocean Observing System), GEO (Group on Earth Observations) Blue Planet, UNDP Barbados and the OECS, and the Government of Mexico convened a regional workshop in Mexico City, 2-4 May 2018, which developed an outline of a pilot project to support an integrated approach to monitoring concentrations of Sargassum seaweed and oil spills, which are both significant regional water-borne threats (IOC, 2018). The pilot project also seeks to develop a regional Sargassum Information System with the following goals (IOC, 2018):

1. Aggregate information from existing regional Sargassum identification / tracking / forecast systems;
2. Collaborate with regional interests to develop products and user interfaces for accessing information;
3. Develop a system to collect, store, and utilize local information (from fishermen, sailors, maritime interests, beaches, coastal managers) about Sargassum location and abundance both offshore and in the coastal zone;
4. Provide a widely accessible database and archive of regional Sargassum presence and impacts for integration with other regional environmental datasets for research;
5. Provide a regional framework for aggregating and delivering similar ocean observing products.

4.1.3 (iii) Developing Management Approaches

During the 69th GCFI session (2016), the SPAW-RAC and the SPAW Secretariat hosted a technical session- "Understanding and Management of the Pelagic Sargassum influx in the Caribbean" in collaboration with the ACS, the CERMES-UWI, the Sargasso Sea Commission, and the UNEP-Global Programme of action and Global Partnership on Nutrient Management. Studies presented during this session covered fisher impacts and responses (Ramlogan et al., 2016), Sargassum accumulations in response to anomalous oceanographic and meteorological forcing in the North Atlantic Ocean (Johns and Smith, 2016), predictions of coastal arrivals (Maréchal and Hu, 2016) and management recommendations for Sargassum strandings (Oxenford et al., 2016). GCFI also recently launched a new infographic guide for the tourism sector on how to respond to a Sargassum influx, and best practices to apply if cleaning beaches[7].

In 2015, UWI hosted a symposium which brought together natural and social scientists and key stakeholders from the Caribbean's tourism, business and fisheries sectors to discuss the Sargassum seaweed phenomenon.[8] UWI, CERMES has also produced a management brief on best-practices for Sargassum clean-ups (Hinds et al., 2016). The second Sargassum symposium was completed during November 2018. The Symposium was convened by FAO in association with UWI. The presentations were focused on the current state of knowledge and gaps; good practices for managing influxes; innovative uses, products and marketing; plans for managing Sargassum as a hazard and as an opportunity; and communication needs.

[7]Responding to a Sargasso influx, 2018. https://www.gcfi.org/timely-guidance-for-hotels-and-resorts-on-the-sargassum-influx/

[8]CERMES- Sargassum and Future Enterprises (SAFE)
http://www.cavehill.uwi.edu/cermes/projects/sargassum/home.aspx

The tourism sector has also been actively engaged in addressing the Sargassum influxes. The Caribbean Alliance for Sustainable Tourism (CAST) and the Caribbean Hotel and Tourism Association (CHTA) have published a Sargassum Resource Guide for the Caribbean which outlines its impacts, uses, best practices, and mitigation and management measures.[9]

In Member States, development of management appraoches have usually been ad hoc and led by different agencies. For e.g. in Barbados, the Sargassum clean-ups have been conducted by the National Conservation Commission, which has responsibility for cleaning parks and beaches and the Barbados Defense Force. Hoteliers have also undertaken the responsibility of cleaning beaches directly associated with their properties as necessary. Responses at the community level have been largely ad hoc as well and in response to the influxes as they occur. There have been community beach clean-ups with a view to sea-turtle protection in Saint Lucia and Barbados. The Caribbean Aqua-Terrestrial Solutions Program (CATS) implemented a project to support the protection of endangered Leatherback sea turtles in Saint Lucia. The CATS program's primary goal was to monitor Sargassum build up on the beach to make sure it was not interfering with hatchling survival in addition to inspiring the local community to be more involved with sea turtle conservation[10].

A number of resources are available to guide the management of Sargassum influxes including; (i) Sargassum-A Resource Guide for the Caribbean[11]; (ii) Model Protocol for the Management of Extreme Accumulations of Sargassum on the Coasts of CRFM Member States[12] (iii) Sargassum Management Brief [13]; (iv) Coping with Sargassum Strandings[14](e) Responding to a Sargassum Influx[15].

4.1.3 (iv) Studying Growth,Transport, and Implications for Fishers; and Sharing Information on Best Practices

The CC4FISH project is working on models of growth and transport of pelagic Sargassum invasions in the Eastern Caribbean and implications for pelagic fisheries through a collaborative venture with CERMES and GCRL[16]. The seven participating countries in CC4FISH are Antigua and Barbuda, the Commonwealth of Dominica, Grenada, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, and Trinidad and Tobago. Draft Plans for Management of Extreme Accumulations of Sargassum have been prepared under the CC4FISH project for Grenada, Saint Kitts and Nevis, Saint Lucia, and Saint Vincent and the Grenadines.

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[9] BHTA- The Sargassum Resource Guide. http://www.bhta.org/index/environment/sargassum-seaweed.html

[10] CATS (2015) Marine Turtle Conservation and Sustainable Livelihood Opportunities at Grand Anse Bay. http://caribbeancats.org/index.php/saint-lucia/turtle-conservation

[11] Caribbean Alliance for Sustainable Tourism and Caribbean Hotel Association, 2015. Sargassum-A Resource Guide for the Caribbean. https://www.onecaribbean.org/wp-content/uploads/SargassumResourceGuideFinal.pdf

[12] CRFM, 2016. Model Protocol for the Management of Extreme Accumulations of Sargassum on the Coasts of CRFM Member States. Technical & Advisory Document, No. 2016/ 5. 15p.

[13] Hinds, C., Oxenford, H., Cumberbatch, J., Fardin, F., Doyle, E. & Cashman, A. (2016) Golden Tides: Management Best Practices for Influxes of Sargassum in the Caribbean with a Focus on Clean-up. Centre for Resource Management and Environmental Studies (CERMES), The University of the West Indies, Cave Hill Campus, Barbados. 17 pp.

[14] Oxenford, H., Fardin, F., Doyle, E., Cumberbatch, J (2016) Management Recommendations: Coping with Sargassum Strandings. 69th Gulf and Caribbean Research Institute (GCFI), Grand Cayman, 7-11 Nov, 2016.

[15] Doyle, E. Franks, J. Oxenford, H. (2018) Responding to a Sargassum Influx. https://www.gcfi.org/wpfd_file/online-sargassumposter-2018/

[16] FAO (2017) Report of the launching workshop of the GEF/FAO Climate Change Adaptation in the Eastern Caribbean Fisheries Sector Project (CC4FISH). Bridgetown, Barbados, 7 - 9 February 2017.

In terms of sharing information on best practices, the CAR-SPAW-RAC Secretariat, developed a Sargassum on-line forum with approximately 250 members which allows exchange between scientists, fishers, coastal managers, policy experts and representatives of NGOs and governments. This "*Sargassum* on-line forum" provides easy access to information and experiences on management practices and research about the *Sargassum* influx.

GCFI, UWI, CRFM, CHTA, Gulf Coast Research Laboratory of the University of Southern Mississippi, and the Specially Protected Areas and Wildlife (SPAW) Regional Activity Center under the Cartagena Convention, have also produced a number of knowledge sharing products..

4.1.3 (v) Identifying Impacts on the Marine Ecosystem

When accumulated onshore, decomposing Sargassum results in the formation of toxic hydrogen sulphide and causes oxygen depletion and eutrophication in coastal waters. These events threaten the health of critical ecosystems such as coral reefs and seagrass beds, cause fish and invertebrate mortalities, affect sea turtle nesting and hatching, and impact human health. In removing Sargassum, beaches may also be compacted by heavy machinery and inadvertent sand removal may lead to depletion and possible shoreline instability (Kershaw, 2017). Anecdotal evidence of beach erosion is available in some Member States where people have observed significant changes in the beach slope after removal of Sargassum e.g. Barbados. Proliferation of algae in nearshore waters and increased sedimentation have also been observed after Sargassum influxes. These types of regime shifts can have substantial impacts on ecosystem services and human well-being but are typically difficult to predict and costly to reverse (Hastings and Wysham, 2010). It is therefore imperative to determine at what points (thresholds of unacceptable change) Sargassum becomes a hazard due to its abundance.

4.1.3 (vi) Analysis of Heavy Metal Content

In terms of research on the impacts of Sargassum influxes on human health, the French Agency for Food, Environmental and Occupational Health & Safety conducted an expert assessment on gaseous fumes emitted by decaying Sargassum (Anses, 2017). The Agency recommended preventive measures for exposure to hydrogen sulphide such as regular collection of accumulated Sargassum, informing the public of health risks, personal protective equipment and use of hydrogen sulphide detectors for workers, mechanical means of collection whenever possible, and implementation of a traceability system for exposed workers. The assessment also revealed that Sargassum can accumulate heavy metals such as arsenic and cadmium which may pose a risk to human health and to the environment. Therefore, the Agency recommended prohibiting any possible food or feed uses until more in-depth studies can be conducted (Anses, 2017).

Nuclear and isotopic techniques used by the IAEA can be applied to detect and characterize the extent and source of biotoxins, heavy metals, other contaminants and nutrients associated with Sargassum and transfers of these that may be taking place among fish and other living marine resources connected to the ecosystem. The CRFM in collaboration with the IAEA is currently conducting a pilot project to undertake a preliminary, rapid evaluation to determine if there are heavy metals, organic contaminants or radiation (polonium-210) in the Sargassum seaweed in CARICOM States. Samples of Sargassum were collected from the coastal waters of Antigua and Barbuda, Belize and Barbados, dried and sent by courier to the International Atomic

Energy Agency (IAEA) Marine laboratory in Monaco for testing. The results are expected by May 2019.

4.1.3 (vii) Possibilities of Innovation, Entrepreneurship and Revenue Generation

Innovative uses of Sargassum which have been identified include animal food, fertilizer, bioplastic, biofuel, alginate, building insulation and binding material. However further research is necessary in-order to convert the quantities of Sargassum which have been arriving into energy or other useful material. In Saint Lucia, the Algas Organic Company has successfully made a liquid plant tonic out of Sargassum. There has also been a small biochemical methane production (BMP) assessment of samples collected in Saint Lucia and Grenada. The assessment indicated that Sargassum had a low BMP and that an anaerobic digestive plant would not be able to run on Sargassum alone (Morrison and Gray, 2015). The study recommended that more work was needed to determine the best time-frame in which Sargassum should be utilized and which form gave the highest yield of biogas (e.g. dried versus fresh) (Morrison and Gray, 2015).

4.2 Affected Sites by Country

The main sites (fishing and landing) heavily affected by Sargassum influxes in Antigua and Barbuda were Mill Reef, Emerald Cove, Mamora Bay, Muddy Bay, Shell Beach, Willoughby Bay, Urlings and Dutchman Bay (Figure 4).

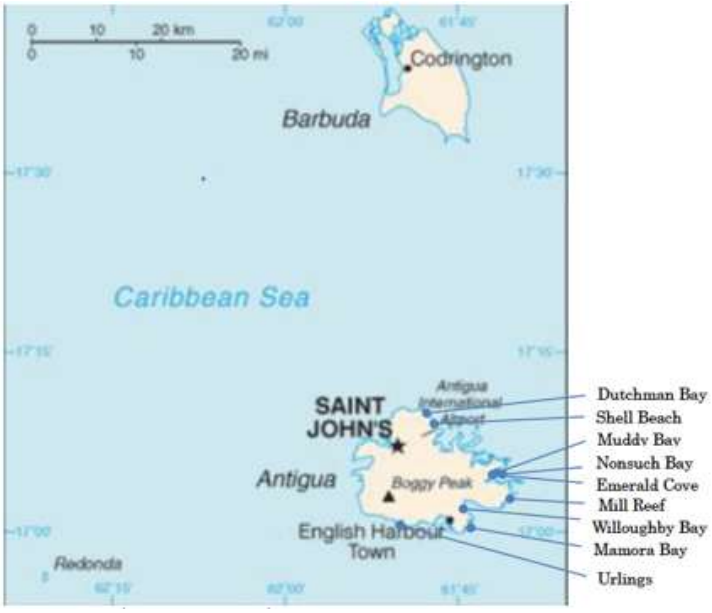

Figure 4: Map of Antigua and Barbuda showing the main areas affected by Sargassum influxes. Modified from CIA World Factbook – Antigua and Barbuda (March 2019); EarthTrends Country Profiles.

In Barbados, the affected beaches were on the North-East - River Bay; the East Coast - Consett Bay, Skeetes Bay, Tent Bay; the South Coast- Silver Sands and Oistins (Figure 5).

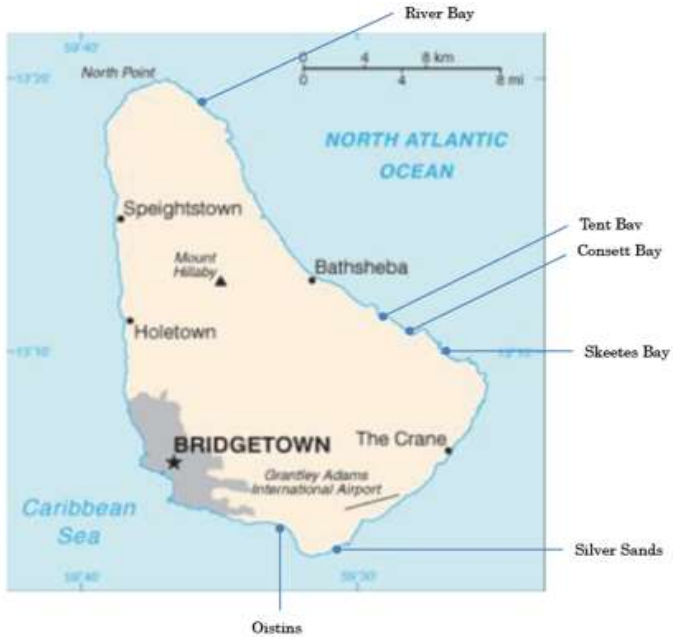

Figure 5: Map of Barbados showing the main areas affected by Sargassum. Modified from CIA World Factbook – Barbados (March 2019); EarthTrends Country Profiles.

In the Commonwealth of Dominica, Marigot was the only landing site where large influxes of Sargassum have been reported (Figure 6).

Figure 6: Source: Map of the Commonwealth of Dominica showing the main area affected by Sargassum. Modified from CIA World Factbook –the Commonwealth of Dominica (March 2019);EarthTrends Country Profiles.

In Grenada, primary landing sites affected included Grenville, while secondary sites included Soubise Beach, Woborn, Petit Baycye, Menere, and Conference Bay. Sauteurs on the North Coast was also affected (Figure 7).

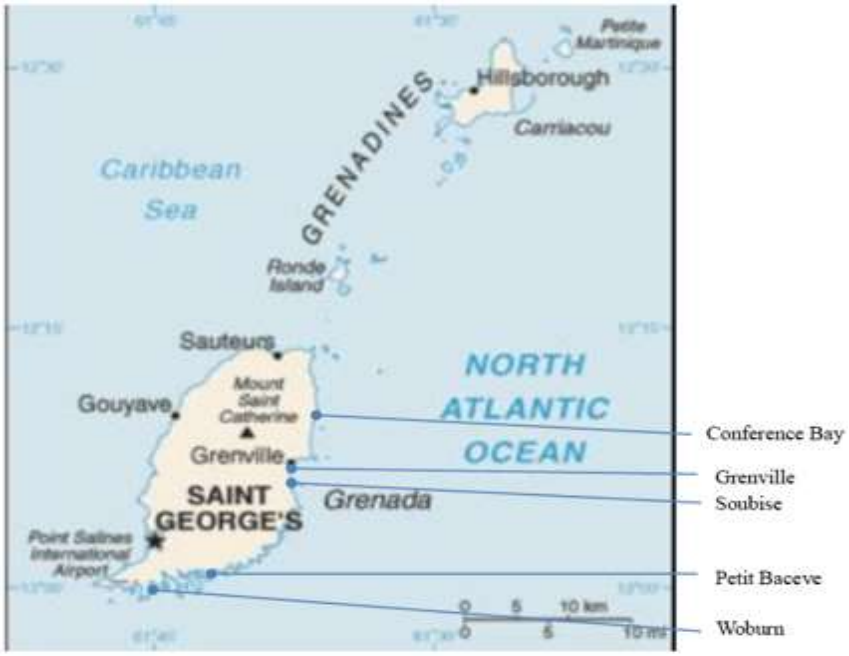

Figure 7: Map of Grenada showing the main areas affected by Sargassum. Modified from CIA World Factbook – Grenada (March 2019); EarthTrends Country Profiles – Grenada.

Dieppe Bay, Lynches Bay, and Frigate Bay were affected by the Sargassum influxes in Saint Kitts. In Nevis, the affected beaches were Indian Castle, Long Haul Bay, and Herberts Beach (Figure 8).

Figure 8: Map of Saint Kitts and Nevis showing the main areas affected by Sargassum. Modified from CIA World Factbook – Saint Kitts and Nevis (March 2019); EarthTrends Country Profiles.

The affected areas in Saint Lucia included Micoud, Dennery, Praslin, L'Anse Capitaine, Savannes Bay and Sandy Beach (Figure 9).

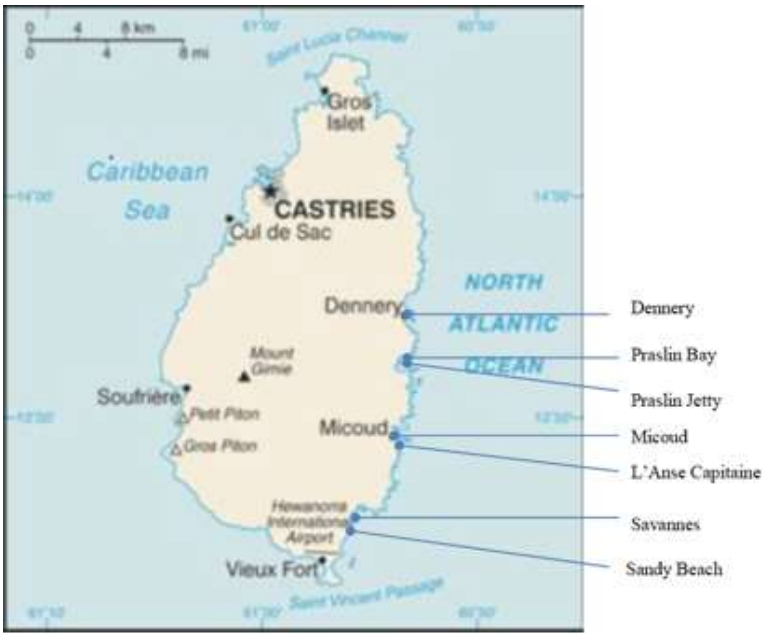

Figure 9: Map of Saint Lucia showing the main areas affected by Sargassum. Modified from CIA World Factbook – Saint Lucia (March 2019); EarthTrends Country Profiles.

The areas affected on the mainland Saint Vincent and the Grenadines included: Owia Bay, Big Sand & Boat

Bay (Sandy Bay), Langley Park, Shipping Bay, Rawacou (Figure 10). The main affected areas in the Grenadines included – Spring, Industry and Ravine (Bequia), Clifton (Union Island).

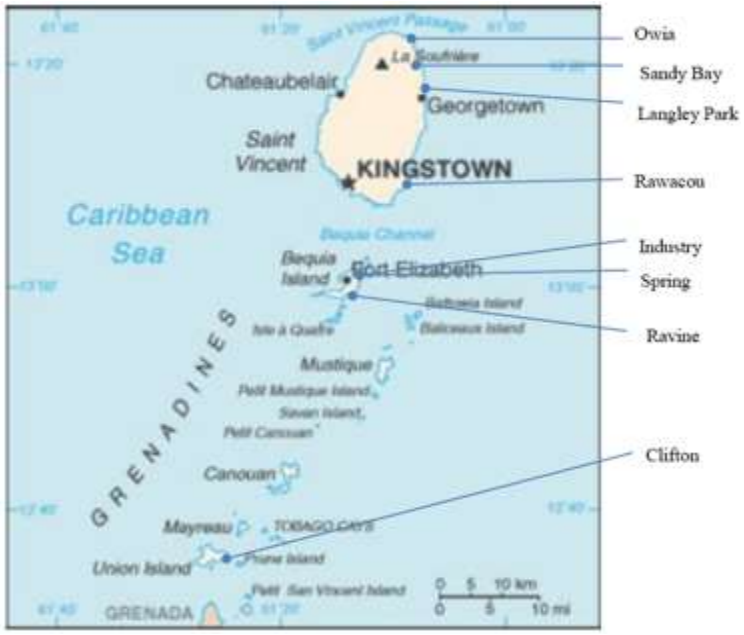

Figure 10: Map of Saint Vincent and the Grenadines showing the main areas affected by Sargassum. Modified from CIA World Factbook – Saint Vincent and the Grenadines (March 2019); EarthTrends Country Profiles.

In Trinidad and Tobago, the North East and South East coast of Trinidad were heavily affected by Sargassum influxes. On the North East Coast, the sites included Matelot, Grand Riviere, San Souci, Toco, Cumana, Balandra and Salybia. On the South East Coast, the sites included: Manzanilla; Mayaro; and Guayaguayare (Figure 11).

Figure 11: Map of Trinidad and Tobago showing the main areas affected by Sargassum in Trinidad. Modified from CIA World Factbook – Trinidad and Tobago (March 2019); EarthTrends Country Profiles.

4.3 Impacts on the Fisheries Sector

The Sargassum influxes have affected the fisheries in various ways. In terms of fishing operations, there have been increased travel times to fishing grounds; relocation of fishing operations; and reduced number of fishing days.

The increased catches of juvenile dolphinfish associated with the Sargassum have the potential to affect future recruitment and for this reason precautionary management measures were developed by CRFM. However, in many countries the dolphinfish size restrictions have not yet been enforced.

The changes in catch composition with increases in species such as amberfish / crevalle (caranx spp) and lobster; and decreases in flyingfish, dolphinfish, jacks and robins and the impacts on fisher livelihoods also deserve further investigation as this has livelihood implications for fishers.

In Antigua and Barbuda, there was a peak in dolphinfish landings in 2014 (59 tons) (Figure 12).

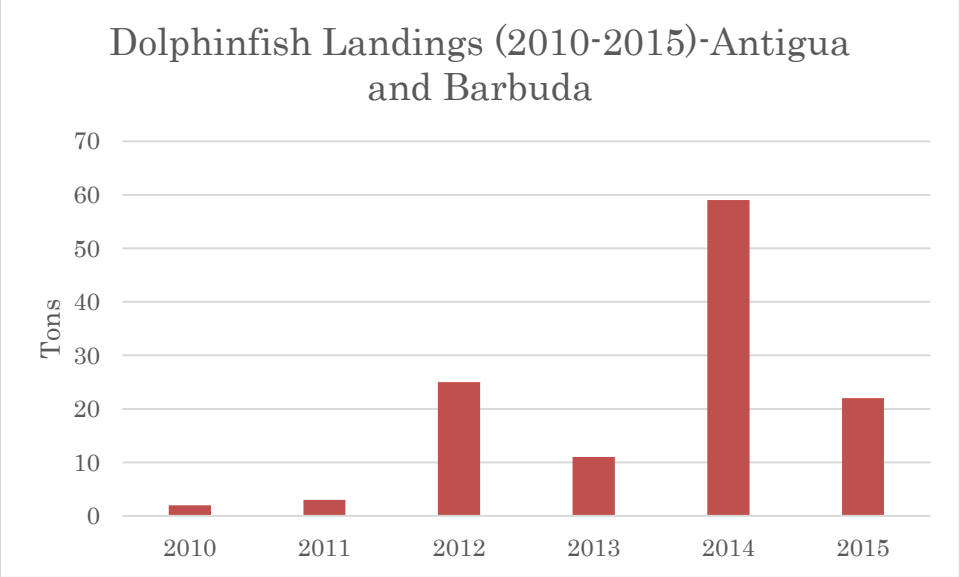

Figure 12: Dolphinfish landings in Antigua and Barbuda for the period 2010-2015.

In Barbados, by observation, there was a decrease in flyingfish size as well as a decrease in the amount of flyingfish landed. However, there were increases in Atlantic flyingfish, small dolphinfish, amberfish, lobster, billfishes, scads, and beardfish landed (Figure 13). Dolphinfish landings have fluctuated over the years with a peak of 189 tons in 2013 and notable decreases occurring in 2017 (84 tons) and 2018 (70 tons) (Figure 14). Flyingfish landings have also been fluctuating, with a peak of 847 tons in 2010 and the lowest landings being observed in 2012 (124 tons) (Figure 15).

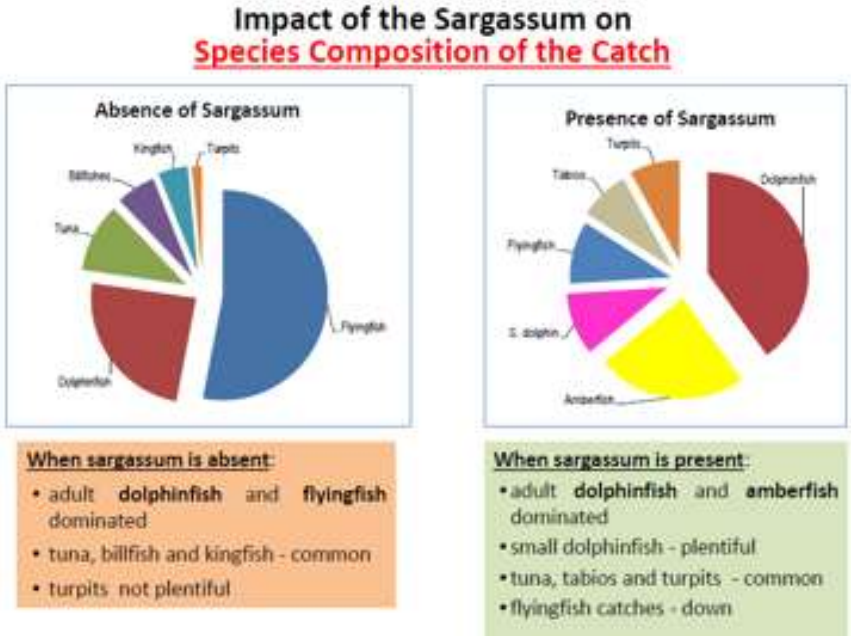

Figure 13: Changes in catch composition in Barbados (Fisheries Depart., 2015)

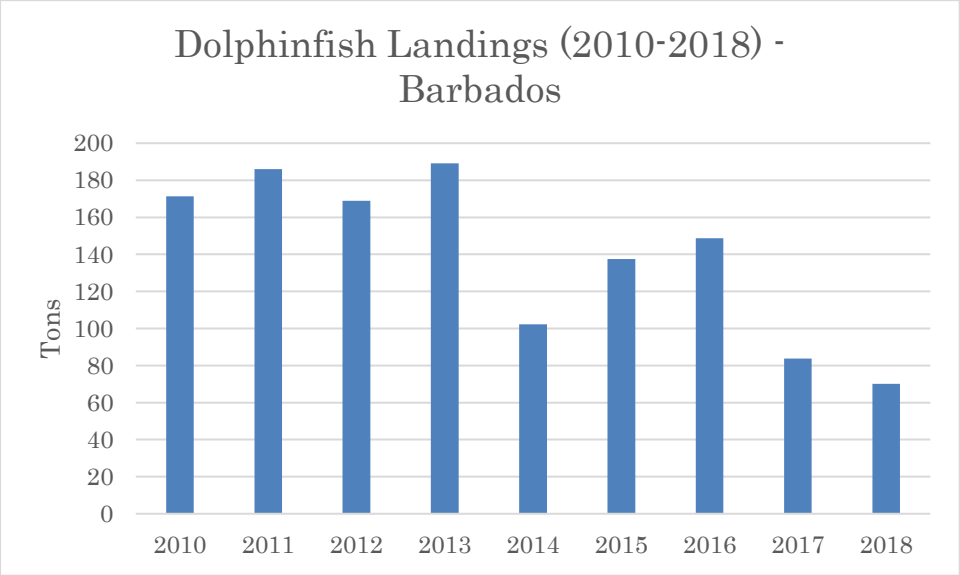

Figure 14: Dolphinfish landings in Barbados for the period 2010-2018.

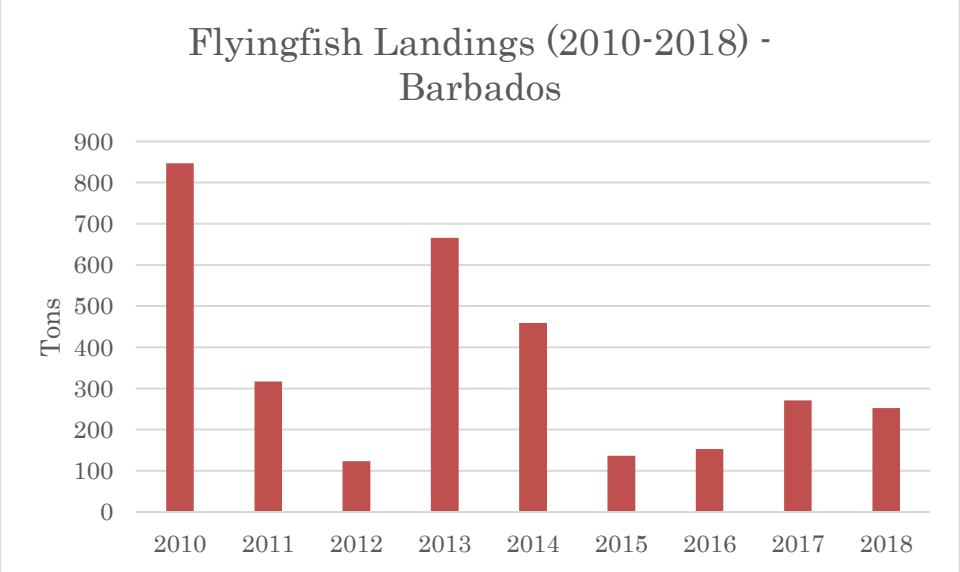

Figure 15: Flyingfish landings in Barabdos for the period 2010-2018.

In Grenada, fluctuations in dolphinfish landings have occurred with a peak of 112 tons in 2012 and the lowest occurring in 2014 (53 tons) (Figure 16). These landings were only for Grenville.

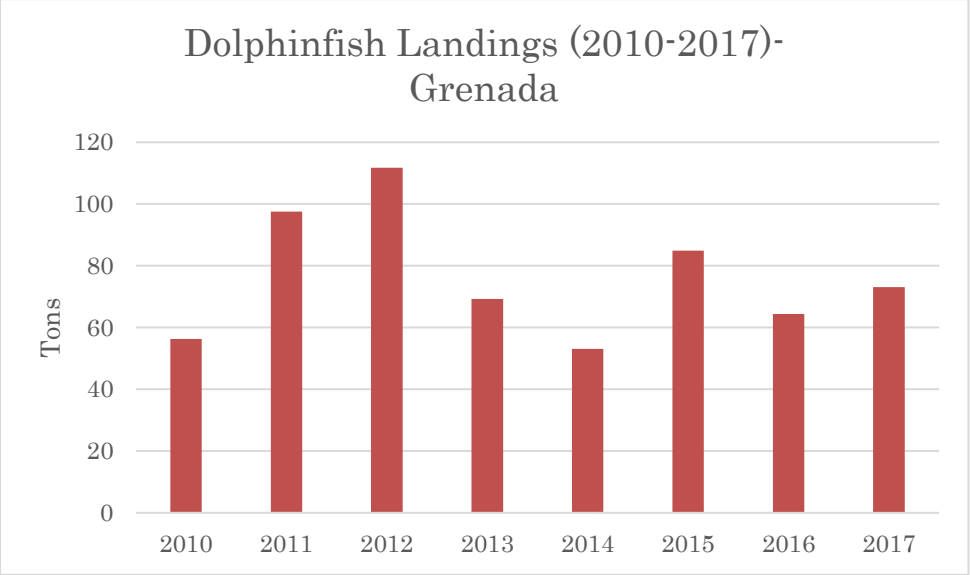

Figure 16: Dolphinfish landings in Grenada-Grenville for the period 2010-2017

In Saint Kitts and Nevis, dolphinfish landings have increased since 2010 (11 tons) to a peak of 74 tons in 2013, with fluctuations occurring across the years (Figure 17). Dolphinfish landings from Nevis were not included.

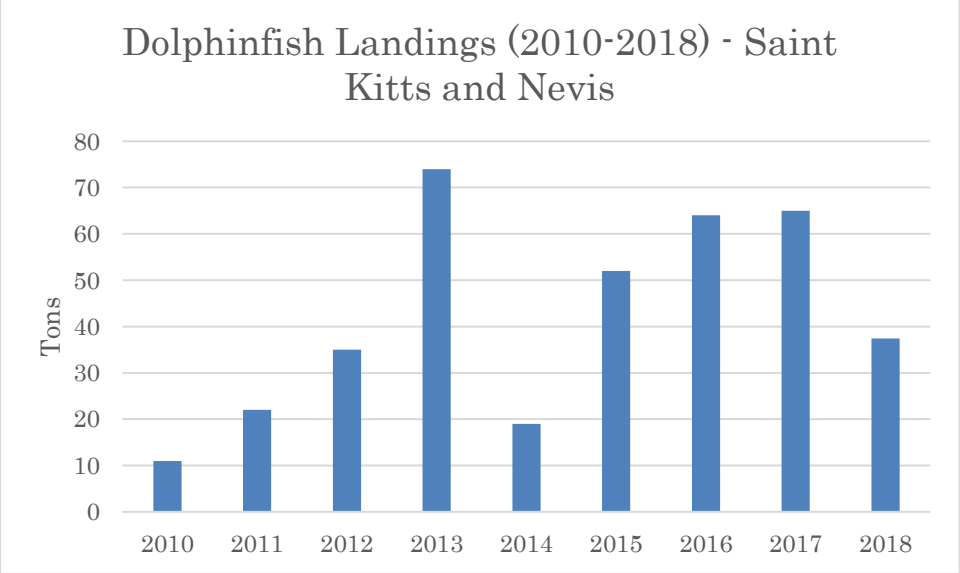

Figure 17: Dolphinfish landings in Saint Kitts and Nevis for the period 2010-2018. Landings from Nevis were not included.

In Saint Lucia, dolphinfish catches have fluctuated over the years, with peak catches occurring in 2015 (505 tons) (Figure 18). There has been a decline in flyingfish catches since 2014 (Figure 19).

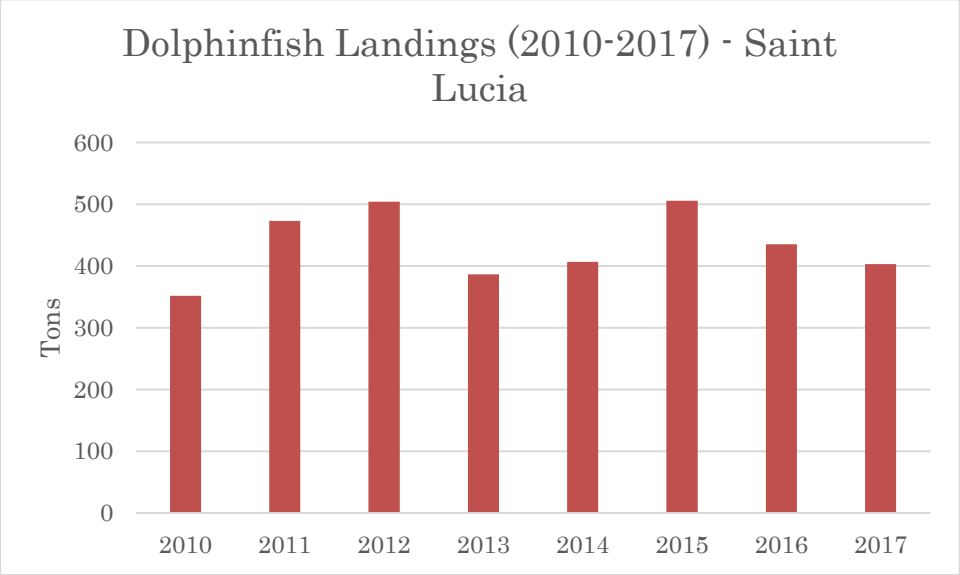

Figure 18: Dolphinfish landings in Saint Lucia for the period 2010-2017.

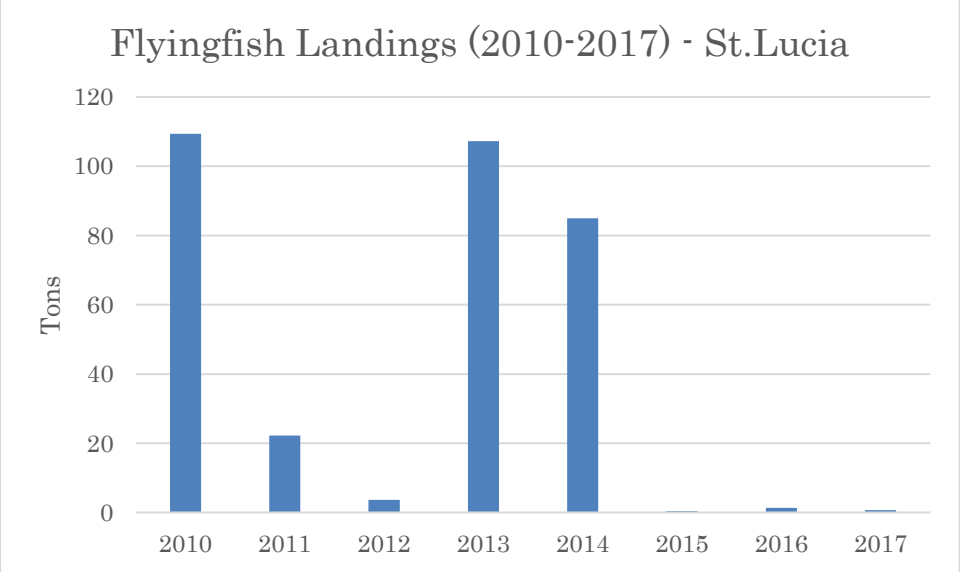

Figure 19: Flyinfish landings in Saint Lucia for the period 2010-2017.

In Saint Vincent and the Grenadines, dolphinfish landings have fluctuated over the period from 2010-2018, with peak landings in 2016 (94 tons) and the lowest landings being observed in 2017 (44 tons) (Figure 20).

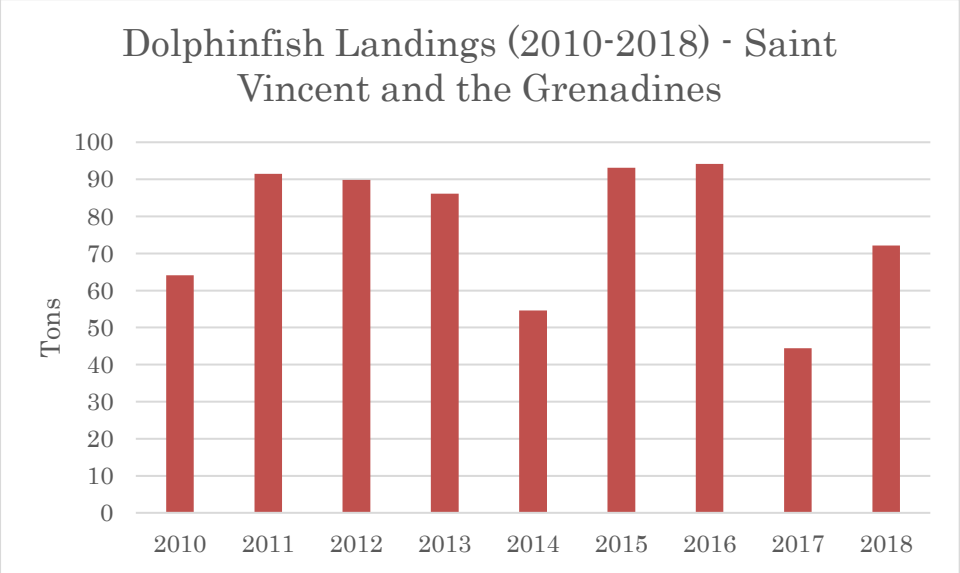

Figure 20: Dolphinfish landings in SaintVincent and the Grenadines for the period 2010-2018.

In Trinidad and Tobago, dolphinfish catches have fluctuated throughout the short time period for which landings were available with peak landings in 2015 (24 tons) , and the lowest landings in 2014 (1 ton) (Figure 21). Landings from Tobago were not included.

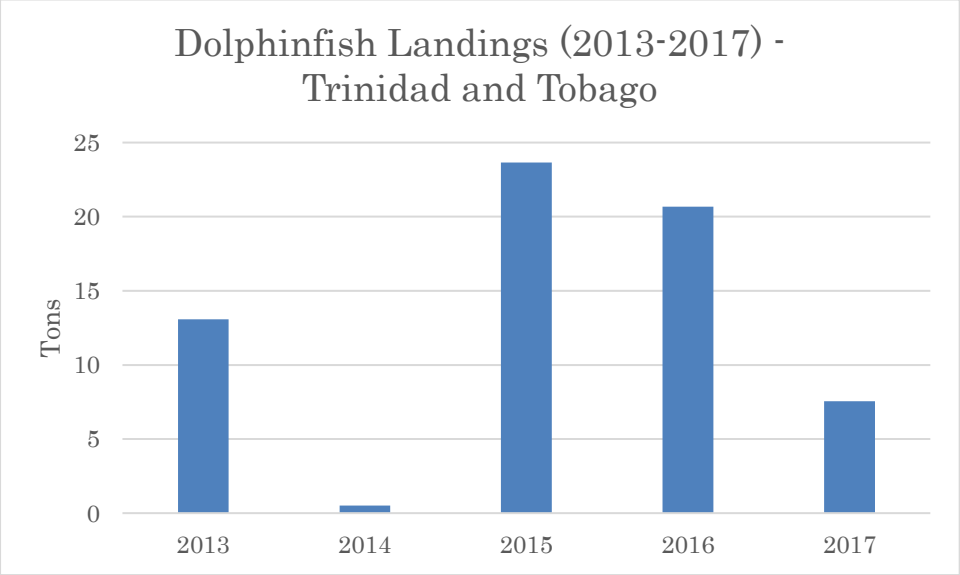

Figure 21:Dolphinfish landings in Trinidad and Tobago for the period 2013-2017. Landings from Tobago were not included.

4.4 Impacts on the Ecosystem

Overall, the impacts on the ecosystems were identified as fish kills, die-off of corals and seagrass beds, beach erosion, and disruption in turtle nesting sites. The possibility for invasive species to accompany the Sargassum mats was also identified. Therefore, monitoring and evaluation of water quality as well as habitat health was recommended.

Beach erosion appeared to arise from oceanographic changes (current and wave action) in some cases, and the use of heavy equipment which resulted in the removal of large quantities of sand during clean-up operations. Concerns were also expressed that large quantities of sand were being removed from beaches when heavy equipment was used to collect Sargassum.

4.5 Impacts on Human Health

Some communities were more heavily impacted than others, and some of the issues included asthma attacks, cough and other respiratory problems, vomiting, rash, headaches, and dizziness as well as skin aliments associated with wading in the water contaminated by decaying Sargassum. There were concerns that there may be long term effects on human health from prolonged exposure to the hydrogen sulphide gas from decomposing Sargassum. It was therefore recommended that a protocol and monitoring system is put in place for hydrogen sulphide.

There was a concern that on some beaches with limited potable water, fishers and vendors were using seawater collected from areas with decaying Sargassum to wash and clean their catch. Of particular concern was the status of drinking water, where it is harvested as rain water and the concern that hydrogen sulphide may be dissolved in the water.

4.6 Impacts on the Tourism Sector

Hotels primarily on the East Coasts of the Islands were affected and have been bearing the majority of clean-up cost. The Western and Southern Caribbean coasts of the islands were less affected. Within the last year the estimated costs of clean-ups for hoteliers ranged from 400,000 – 500,000 USD. Hotels have also experienced booking cancellations and there was concern about how the Sargassum could affect the tourism product which was integral to the economy of many of the islands. The fact that bookings could be made up to a year in advance, and that there was no way of knowing how Sargassum would affect the specific beaches in a one-year period was also a cause for concern.

4.7 Damage to Property

The hydrogen sulphide associated with the decomposing Sargassum has damaged electronics, boat engines, electrical wiring in houses, air-conditioner units, and paint on houses and boats. Influxes have also caused filters at a desalination plant to become clogged and affected the production of fresh water as well as water quality for live lobster storage tanks. Sargassum has also been a problem for sea-moss producers by becoming entangled in the lines.

4.8 Counter-measures and Management of the Influxes

A summary of the various measures which have been employed by the countries to counteract the effects of Sargassum are provided below.

4.8.1 Clean-ups, Removal and Disposal

Clean-ups have been organized by Government agencies and the private sector. Estimates for the expenditure by the private sector and the public sector ranged between 445,000 - 7 million USD for clean-up, removal and disposal last year.

Based on feedback from countries, costs of clean-ups and transportation can vary widely depending on the extent of the accumulation and the distance to the disposal site. An estimate for 45,569 USD using data from Saint Lucia is provided in Figure (22). The estimate was based on the removal from a beach where the accumulation covered an approximate length of 225 m with the deposits as high as 0.9 m at most and covering 40% of the beach profile. The estimated volume of Sargassum in the area was approximately 1,886 m^3 and the distance to the disposal site was between 500 – 1,000 m. The equipment utilized included (1) excavator, (1) backhoe and (1) 20 tonne truck. The estimated timeline for collection and disposal was two weeks.

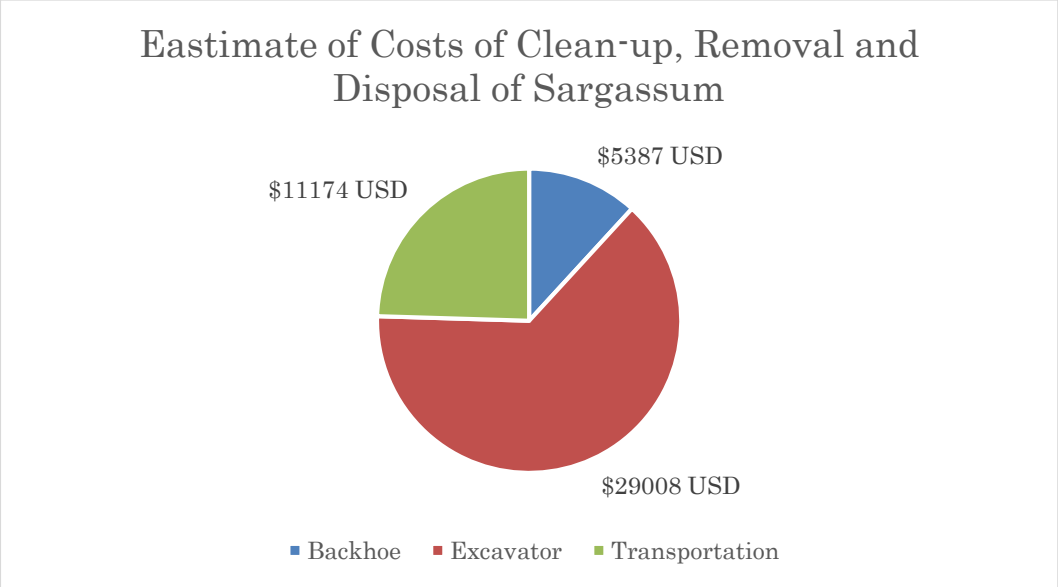

Figure 22: Estimate of costs for clean-up, removal and disposal of Sargassum.

Clean-up methods have included the use of front-end loaders, backhoes, and excavators; 30-40 ft long-boom excavators and trucks. The estimated costs of a back hoe and excavator were 300,000 USD and 500,000 USD respectively. The types of equipment needed to clean up the Sargassum were not readily available to the public sector, and in many cases the equipment had to be provided by the private sector. Rental or purchase of these types of equipment was considered to be an expensive investment for governments, especially when there was no budget specifically allocated to clean- up and removal of Sargassum.

Unsupervised beach clean-ups were identified as an issue since heavy equipment was being used in many cases, and sand was being removed which was causing beach erosion. Some hoteliers have been allowing the piles of Sargassum to decompose for periods ranging from 21-90 days and re-distributing the remaining sand on the beaches associated with their properties. Removal of fresh Sargassum was considered to be easier and there was less odour.

Disposal of Sargassum was handled in different ways. In some countries, it was taken to the landfill and in others, it was dumped on private property. It was estimated that the amounts arriving at the landfill could reach up to 1,000 tonnes per day during peak influx periods and this was not sustainable given that many landfills did not have space to accommodate these amounts. In some countries, the landfills were not taking Sargassum because of the odour, as well as the possibility of a fire risk due to the production of methane. In situations, where there were no designations of official dumping sites there was the issue of illegal dumping and there was a need to take into account the possibility of soil and fresh water contamination. During the peak 3-month period (May – July 2018), it was estimated that approximately 1,000 tonnes could be received daily at the landfill in Antigua.

Transport of Sargassum has many issues including the distance to landfill, and the corrosive nature of the Sargassum. In many cases, it was not economically feasible to take the Sargassum to the landfills since they were located a long distance from the sites. Contractors were not very willing to utilize their equipment for removal and transport given the marine conditions, and the corrosive nature of decomposing Sargassum.

4.8.2 In-water Removal and Barrier Booms to Prevent Sargassum from Coming Onshore

It was found that during in-water collection using a barge and treadmill, some of the Sargassum was either displaced or sunk. It was also found that this equipment could only be used in bay areas and was not suitable for rough conditions.

In order to prevent the Sargassum from coming onshore, some hotels have been considering the use of modified oil-containment booms to prevent the influx of Sargassum. However, the depth of the waters, the quantities of Sargassum and the rough conditions have been considered to be prohibitive for functional barrier booms (e.g. a 1,500 ft length, at a cost of 400,000 USD was estimated to be necessary for protection of one hotel property). There was also the challenge of removing a boom in preparation for hurricanes.

4.8.3 Public Education and Community Outreach

Radio programmes have been used to provide information exchange with the general public as well as community education and stakeholder engagement meetings. With regards to the tourism sector, there have also been public education and marketing efforts, to communicate that in most instances, only Eastern beaches were mainly affected and that most beaches on the South and West were pristine.

4.8.4 Establishment of National Sargassum Committees and Management Plans

Some countries have established or are putting together Taskforces or National Committees comprised of different agencies to provide support and coordination in addressing the Sargassum issue. However, in many cases, the abilities of the Taskforces/Committees to function have been limited by funding. There are also

draft Sargassum Management Plans that have been or are being developed for some countries, however these need to be approved by cabinet or other competent authorities and provided with resources to function.

4.8.5 Utilization of Sargassum Forecasts and Preventative Measures Implemented in Martinique and Guadeloupe

The outlooks and bulletins produced by NASA and the University of South Florida have been utilized for general information purposes, although it was recognized that the scale was too wide and could not be used to predict which bays would be affected. The French Meteorological forecasts which also cover Sargassum were found to be more useful in Antigua and Barbuda.

4.8.6 Technological Innovations

In order to avoid overheating and engine damage associated with maneuvering through the Sargassum, some fishers have placed a strainer over the water intake on engines without adequate filters, to avoid the intake of the Sargassum and this has been successful so far.

4.9 Innovative Uses

Farmers have been using it on coconut trees and citrus fruit trees as fertilizers, however they were unable to take the quantities, which have been coming in, and there are no quantitative studies of the associated benefits. There was also concern about the presence of heavy metals in the Sargassum which could contaminate the soil if used as a fertilizer.

In Barbados, some consider that within the context of the sugar cane industry Sargassum could be used as a fertilizer to increase the yield by 20%. There was also interest in the use of Sargassum as a means of generating fuel, so that it can be placed into the national grid. However, initial studies show that Sargassum did not produce sufficient biofuel on its own. There has also been a small biochemical methane production (BMP) assessment of samples collected in Saint Lucia and Grenada.

Algas Organics in Saint Lucia has been producing a liquid plant tonic, and originally there was collaboration with the fisherfolk to collect Sargassum. However, the current status of production is unknown.

The need for the collection of fresh Sargassum with no sand was also identified for innovative use. It was also considered that having more than one outlet to utilize the Sargassum and multiple options for collection was important.

5. SUGGESTED COUNTER-MEASURES FROM THE FACT-FINDING SURVEY

5.1 Fisheries

1. As stated in Section 4.3, there have been increased travel times to fishing grounds; relocation of fishing operations; and reduced number of fishing days. It is therefore recommended that the economic losses to the fisheries sector should be determined.
2. As stated in Section 4.3, it has been reported that more juvenile dolphinfish have been caught during Sargassum influxes. This might cause concern for the future sustainability of the population, so it would useful if countries collect and monitor landings of dolphinfish and enforce the precautionary size limits. Improved data collection and monitoring is needed to better understand the impact of Sargassum on fish stocks and livelihood of fishers. Dedicated research geared towards assessing the impact on fish stocks given implications for recruitment, natural mortality, migration etc. is recommended.
3. As stated in Section 4.3, changes in catch composition have occurred. This suggests that opportunities available to the sector should be documented and supported including marketing and value addition of the species that are now available in greater quantities, e.g. amberfish.

5.2 Ecosystems

1. As stated in Section 4.4, Sargassum accumulations and decomposition have been affecting nearshore ecosystems (coral reefs and seagrass) as well as mangroves. Therefore, clean-up of accumulations associated with these important nursery areas should be a priority.
2. As stated in Section 4.4, Sargassum accumulations have resulted in beach erosion in some areas, therefore a management framework for systematic monitoring of the beaches is needed.

5.3 Impacts on Human Health

1. As stated in Section 4.5, there have been various health complaints including respiratory problems, and headaches associated with the hydrogen sulphide released from decomposing accumulations. This indicates that there is an urgent need to monitor hydrogen sulphide levels in affected communities. There is also need for a protocol to determine the area as unsafe and what actions should be taken, e.g. clean-up or evacuation.

5.4 Tourism

1. As stated in Section 4.6, given the high costs of clean-up for hoteliers and the occurrences of booking cancellations, it is recommended that the economic losses of the influxes to the tourism sector should be quantified.
2. As stated in Section 4.6, it is mostly the Atlantic coast in the East that is affected by Sargassum in most islands, it is recommended that the marketing of the tourism product should focus on the pristine beaches available on the Caribbean West coast.

5.5 Damage to Property

1. As stated in Section 4.7, emissions of hydrogen sulphide from decomposing Sargassum has been causing damage to electrical equipment, it is recommended that Sargassum should be collected fresh and not allowed to decompose especially near to human settlements.

5.6 Countermeasures and Management of Influxes

1. As stated in Section 4.8.1, collecting and removing Sargassum from beaches and other coastal habitats has a significant financial and institutional challenge for most states. Specific equipment and infrastructure are needed to collect, transport and store the seaweed. Support is needed to establish effective systems for safe collection including use of protective gear, transportation and disposal of Sargassum in most countries.
2. As stated in Section 4.8.1, given that the types of equipment needed to clean-up the Sargassum were not readily available to the public sector, there is need for public-private partnerships as well as community participation to tackle the problem. A public-private partnership is also recommended to cover purchase of equipment, operational costs, and maintenance.
3. As stated in Section 4.8.1, in many cases, there was no budget specifically allocated for clean-up and although estimates of the amount of removed Sargassum have been provided by the various countries, quantitative information on the accumulation amounts is needed to allow proper planning for clean-up, removal and disposal and there is also the need for predictions of Sargassum arrivals to be ground-truthed.
4. As stated in Section 4.8.1, unsupervised beach clean-ups were identified as an issue since heavy equipment was being used in many cases, and sand was being removed which was causing beach erosion. Therefore, beach clean-ups using heavy machinery, should be technically guided by engineers in order to avoid beach erosion. Where accumulations are not as heavy, manual raking of the beaches is suggested as an option, and removing any inadvertently collected sand, through sifting has been identified as a possible livelihood option.
5. As stated in Section 4.8.1, it is best to remove Sargassum while fresh in order to avoid accumulations, decomposition and release of hydrogen sulphide. This is especially important where there are human settlements. It is also recommended that more action be taken by the communities and fisherfolks for clean-ups.
6. As stated in Section 4.8.1 disposal of collected Sargassum was handled in different ways, however landfills had limited space, and distances to landfills increased transport costs. It is therefore suggested that empty lands around the islands should be identified, and sectioned off for disposal. It is also suggested that the sites for disposal should be rotated. It is recommended that the dumping areas should be fenced off and not located near to human settlements. Given the concern about soil and water contamination, it is recommended that dumping areas should be modified to include a small-detention pond, which would allow the leachate to settle out and a simple filter system of charcoal, sand, and stones could be used. Where possible the use of liners should also be used.
7. As stated in Section 4.8.2, in order to avoid Sargassum accumulations onshore, decomposition and release of hydrogen sulphide, the best option for clean-up would be to prevent or minimize the Sargassum coming on to the beaches. This may minimize the impacts on coastal communities and ecosystems. A few countries have reported trials by private sector operators of booms and collectors at sea, but these have so far not been very successful. Further pilot projects should be conducted to

identify appropriate off-shore technologies such as floating barriers and special boats, equipment for deflection, collection and transport of Sargassum.

8. As stated in Section 4.8.3 radio programmes have been used to provide information exchange with the general public, as well as community education, stakeholder engagement meetings. However, it was suggested that a communication mechanism including the hotels for reporting on a daily basis is necessary. This could be done through telephones, hotlines, or a WhatsApp group. There should also be a central depository for photos, and this would allow the extent of the influxes to documented overtime.
9. As stated in Section 4.8.4, some countries have also prepared draft Sargassum Management Plans, however these still need to be approved by cabinet or other competent authorities and provided with resources to function. However, in the meantime countries should utilize their Draft Management Plans and all available documents to guide their responses to the influxes. Support should be provided to assist countries with customizing and implementing national management plans in collaboration with local communities and stakeholders. There is also an urgent need to mobilize resources to address the situation, since the countries and associated sectors are unable to sustain the levels of financial impacts of the influxes.
10. As stated in Section 4.8.5, Guadeloupe and Martinique have developed various measures to address the Sargassum influxes e.g. a meteorological forecast system which includes Sargassum coverage and preventive measures for exposure to hydrogen sulphide such as regular collection; and informing the public of health risks. It is therefore recommended that there is more collaboration with these countries.

5.7 Innovative Uses

1. As stated in Section 4.9, the most successful use of Sargassum has been fertilizer. However, there is limited information on viable options for innovative uses of Sargassum. Therefore, it is recommended that research and development of possible uses and business models should be promoted and shared. This should include potential use in agriculture, the livestock industry, construction industry, energy sector, as well as at the household level.
2. It is also recommended that further investigation is needed regarding the use in agriculture and animal feed, taking into account the possible negative impacts such as presence of heavy metal and contaminants.
3. It is recommended that viable innovative uses should be promoted via education campaigns and trainings.

5.8 Good Practices Identified in the Study

A number of good practices have been identified during the study and these are provided below:

1. Formation of national and multisectoral Taskforce/Committees to oversee the development and implementation of management and response activities for Sargassum influxes.
2. Discouraging the harvest and sale of juvenile dolphinfish through the establishment of minimum legal harvest sizes of 6 lbs (2.7 kg) or 25 inches (65 cm) fork length.

3. Utilization of the various documents prepared to guide the management of Sargassum influxes including: (a) Sargassum - A Resource Guide for the Caribbean[17]; (b) Model Protocol for the Management of Extreme Accumulations of Sargassum on the Coasts of CRFM Member States[18] (c) Sargassum Management Brief [19]; (d) Coping with Sargassum Strandings[20]; (e) Responding to a Sargassum Influx[21].
4. Avoiding the removal of sand where possible in clean-up efforts. In cases where it has occurred, collection and redistribution of sand on the beach, after decomposition of the Sargassum.
5. Daily removal of Sargassum to avoid the smell associated with decomposition and the release of hydrogen sulphide.

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Appendix 1: Terms of Reference

Fact-finding survey regarding the influx and impacts of Sargassum seaweed in the Caribbean region

1. Background

For the last few years, the Caribbean region has suffered a sudden increase in the influx of Sargassum seaweed, and several countries in the region have requested support to the Government of Japan and the Japan International Cooperation Agency (JICA). Since JICA does not possess coherent information on the overall situations of the problem, it decided to conduct a basic fact-finding survey to determine the possibility of providing further support.

2. Objectives of the Assignment

The objectives of this survey are as follows: (i) to review the existing literature and initiatives in the region: (ii) to summarize the scope of damages and impacts caused by Sargassum seaweed in the target countries: (iii) to suggest potential countermeasures and determine the scope of support that JICA may be able to provide in the future.

3. Scope of Services and Tasks

3.1 Survey Locations

Target countries

Antigua and Barbuda, Barbados, Commonwealth of Dominica, Grenada, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Trinidad and Tobago

Target countries of Field Studies

Antigua and Barbuda, Barbados, Grenada, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines

Key Stakeholders

During the field visits, the Consultant will meet with public and private sector stakeholders in fisheries, tourism, environment, as well as with coastal communities and other related sectors and development partners such as FAO, UN Environment, University of the West Indies and University of Belize that have been working on Sargassum.

3.2 Survey Duration and Schedule

The survey periods shall not exceed 1.7 months (51 days) excluding legal holidays. It includes 18 days of field studies in aforementioned 6 countries. The survey shall be conducted according to the schedule presented in the following figure.

Table 1. Work Schedule

week	1st	2nd	3rd	4th	5th	6th	7th	8th	9th
Preparatory Works and Literature Review Kick-off meeting with target country governments and key stakeholders Circulation of the questionnaire	―	―	（8days）						
Field Studies (3 days each in 6 countries)			―	―	(18days)				
Compilation and analysis of responses to the questionnaire					―	(5days)			
Drafting of the Final Report						―	―	(10days)	
Circulation of the Final Report to Target Countries Feedbacks on the Report								―	(3days)
Finalization and Submission of the Report							(7days)		―●

● Submission of the final report

3.3 Survey Method and Items

Virtual Meeting

- Once the contract is signed, the Consultant will contact the target countries and key stakeholders to inform them about the survey and explain the inputs and timeline for undertaking the activities
- The Consultant will also explain the content of survey questionnaire and ask the target countries how much of the information can be collected by themselves

Preparatory works / Literature review

- The results of the past studies conducted by major research institutions in the region
- The existing initiatives by regional institutions, other donors, and the private sector

Circulation of survey questionnaire to all target countries

- The current situation and impact of the accumulated Sargassum (identification of the heavily affected areas, the amount of accumulation in such areas, estimated economic damage to the surrounding tourism and fisheries industry etc.)
- The policies and countermeasures adopted by the governments (both national and municipal)
- The current means of collecting, managing and disposing the accumulated seaweed (if any)
- Potential facilities that could be utilized to dispose the accumulated seaweed (if any) and its capacity

Field studies

- The detailed scope of the impact of accumulated Sargassum
- The current means of collecting, managing and disposing the accumulated seaweed (if any)
- Potential facilities that could be utilized to manage the accumulated seaweed (if any) and its capacity
- Other possible methods of collection and disposal in the target area

Analysis of Data and Report Preparation

- The Consultant will analyze the collected data and prepare a draft report, which will be circulated to the countries and key stakeholders for review.
- A regional consultation will be held by teleconference during which the report will be presented by the Consultant. Target countries and key stakeholders will provide feedback regarding the content of the draft
- The draft will then be finalized taking into account the comments received from the participants

4. Submission of a Final Report

The Consultant will submit a final report which includes all the required items specified in the Section 3.3 by 11 March 2019.

The report should be written in English in Letter / A4 size, (8.5 by 11 inches) and submitted to the JICA Saint Lucia Office both in paper and PDF forms. Five (5) physical copies should be provided.

The Consultant will share pictures and other materials collected during the survey with JICA. They could be included in the final report or shared separately.

Appendix 2: Questionnaires

Fact-finding survey regarding the influx and impacts of Sargassum seaweed in the Caribbean region

Questionnaire for Fisheries Divisions/Departments

Date:
Name and Designation:
Email:
Organization:
Country:

1. Identify the main sites (fishing and landing) that have been heavily affected by Sargassum influxes for each of the following years: 2011, 2012, 2014, 2015, 2018.
2. For each site identified in the previous question, what was the estimated quantity in tonnes (t) of the accumulations by year (2011, 2012, 2014, 2015, 2018)?
3. Were any of the affected sites inaccessible during the years of the Sargassum influxes (2011, 2012, 2014, 2015, 2018)? If yes, i) indicate the number of days during which they were inaccessible by year; ii) estimate the number of fishing days which were lost by year; and iii) estimate the number of fishers by gender who were in operation at each site by year.
4. Have fishers reported an increase in fishing time due to Sargassum influxes (e.g. increased time for gear setting/retrieval; increased navigation time etc.).
5. Indicate the months during which the influxes have affected the country by year (2011, 2012, 2014, 2015, 2018).
6. What were the annual total landings for the following pelagic species from 2010 to 2018? (i) Dolphinfish
   (ii) Flyingfish
   (iii) Almaco jacks (*Seriola rivoliana*)
   (iv) Ocean triggerfish (*Canthidermis sufflamen*)
   (v) Have there been any reports or studies on the components associated with the Sargassum accumulations (e.g. fish species, debris, plastics etc.)?

(vi) What research initiatives have been taken in the fisheries sector to address the Sargassum influxes (e.g. data collection and monitoring of landings, water quality, fish kills etc.)?

(vii) What counter-measures have been taken to address the Sargassum influxes (e.g. economic exploitation, clean-ups, public education, community outreach, disposal methods, modified fishing methods/gears) and which ones have been successful?

(viii) Were the Sargassum outlooks and bulletins produced by the University of South Florida and NASA utilized by the fisheries sector in preparation for the influxes during 2018?

(ix) Is there any information on the impacts of Sargassum accumulations on human health or coastal communities? If so, provide details.

(x) Are there any gaps which you can identify in the management of Sargassum influxes, and are there specific recommendations which could improve them?

Fact-finding survey regarding the influx and impacts of Sargassum seaweed in the Caribbean region

Questionnaire for Public Sector Agencies with Responsibility for Beach Clean Ups

Date:
Name and Designation:
Email:
Organization:
Country:

1. Have any of the following resources been used to guide Sargassum removal: a.) Sargassum-A Resource Guide for the Caribbean[22]; b.) Model Protocol for the Management of Extreme Accumulations of Sargassum on the Coasts of CRFM Member States[23] c.) Sargassum Management Brief [24]; d.) Coping with Sargassum Strandings[25]; e.) Responding to a Sargassum Influx[26].

2. Is there a national plan for the management and removal of Sargassum accumulations? If yes, was the Model Protocol for the Management of Extreme Accumulations of Sargassum on the Coasts of CRFM Member States used as a guide?

3. Were the Sargassum outlooks and bulletins produced by the University of South Florida and NASA utilized by the fisheries sector in preparation for the influxes during 2018?

4. Is there legislation regarding removal of sand from beaches?

5. What were the beaches from which Sargassum was removed during 2011, 2012, 2014, 2015, and 2018?

6. For each beach, how often were removals conducted by year (2011, 2012, 2014, 2015, 2018)?

7. For each beach, estimate the size of each area in km^2 from which Sargassum was removed by year (2011, 2012, 2014, 2015, 2018).

[22] Caribbean Alliance for Sustainable Tourism and Caribbean Hotel Association, 2015. Sargassum-A Resource Guide for the Caribbean. https://www.onecaribbean.org/wp-content/uploads/SargassumResourceGuideFinal.pdf

[23] CRFM, 2016. Model Protocol for the Management of Extreme Accumulations of Sargassum on the Coasts of CRFM Member States. Technical & Advisory Document, No. 2016/ 5. 15p.

[24] Hinds, C., Oxenford, H., Cumberbatch, J., Fardin, F., Doyle, E. & Cashman, A. (2016) Golden Tides: Management Best Practices for Influxes of Sargassum in the Caribbean with a Focus on Clean-up. Centre for Resource Management and Environmental Studies (CERMES), The University of the West Indies, Cave Hill Campus, Barbados. 17 pp.

[25] Oxenford, H., Fardin, F., Doyle, E., Cumberbatch, J (2016) Management Recommendations: Coping with Sargassum Strandings. 69th Gulf and Caribbean Research Institute (GCFI), Grand Cayman, 7-11 Nov, 2016.

[26] Doyle, E. Franks, J. Oxenford, H. (2018) Responding to a Sargassum Influx. https://www.gcfi.org/wpfd_file/online-sargassumposter-2018/

8. For each beach, what was the estimated quantity (in tonnes) of the accumulations that have been removed by year (2011, 2012, 2014, 2015, 2018)?
9. For each beach, provide an estimate of the percentage of the total accumulation that was removed by year (2011, 2012, 2014, 2015, 2018)?
10. What were the methods used to remove Sargassum from the beaches?
11. Was specialized equipment and machinery used for Sargassum? If yes, specify the types.
12. If you answered yes to the previous question, what was the cost of each piece in USD of equipment/machinery (e.g. cost of purchase, rental etc.)?
13. For each beach, what was the total cost in USD of removal of Sargassum by year for your agency (2011, 2012, 2014, 2015, 2018)?
14. How was the collected Sargassum disposed of?
15. What disposal methods are used for solid waste (e.g. landfills, incinerators, biomass power plants etc.)?
16. For each disposal method identified in the previous question, provide details on the capacities of the facilities (e.g. tonnes / year, size etc.).
17. Was there any collaboration between the public sector and the private sector (e.g. hoteliers, NGOs, community organizations, entrepreneurs) regarding beach clean-ups or innovative use of Sargassum? If so, please provide details.
18. Is there any information on the impacts of Sargassum accumulations on human health or coastal communities? If so, provide details.
19. What counter-measures have been taken to address the Sargassum influxes (e.g. public education, community outreach etc.) and which ones have been successful?
20. Are there any gaps which you can identify in the management of Sargassum influxes, and are there specific recommendations which could improve them?

Fact-finding survey regarding the influx and impacts of Sargassum seaweed in the Caribbean region

Questionnaire for Hoteliers/Hotel Associations

Date:

Name and Designation:

Email:

Organization:

Country:

1. Which hotels have been affected by the Sargassum influxes during 2011, 2012, 2014, 2015, and 2018?

2. Which of the beaches have been affected by the Sargassum influxes by year (2011, 2012, 2014, 2015, 2018)?

3. Which of the beaches have been closed due to Sargassum influxes and for what time-period by year (2011, 2012, 2014, 2015, 2018)?

4. Which hotels have been closed due to Sargassum influxes and for what time-period by year (2011, 2012, 2014, 2015, 2018)?

5. For each hotel closure, what was the estimated loss of revenue due to closures by year (2011, 2012, 2014, 2015, 2018)?

6. Have there been any cancellations of bookings associated with Sargassum influxes? If yes, quantify the total number of cancellations by year (2011, 2012, 2014, 2015, 2018).

7. Have there been any reports of illnesses or complaints by visitors associated with Sargassum influxes? If yes, provide a brief description of the illnesses and complaints.

8. What were the total tourist arrivals for the country by month from 2010-2018?

9. Have any of the following resources been used to guide Sargassum removal: (a) Sargassum-A Resource Guide for the Caribbean[27]; (b) Model Protocol for the Management of Extreme

[27] Caribbean Alliance for Sustainable Tourism and Caribbean Hotel Association, 2015. Sargassum-A Resource Guide for the Caribbean. https://www.onecaribbean.org/wp-content/uploads/SargassumResourceGuideFinal.pdf

Accumulations of Sargassum on the Coasts of CRFM Member States[28] (c) Sargassum Management Brief [29]; (d) Coping with Sargassum Strandings[30](e) Responding to a Sargassum Influx[31].

10. What are the clean-up methods that have been used by the hotels?

11. Were any specialized equipment/machinery used for Sargassum removal? If yes, please specify which ones and their costs in USD (e.g. cost of purchase, rental etc.).

12. What preventative measures have been used by the hotels (e.g. booms)? If booms were used, provide brief construction details and lengths by beach and hotel.

13. What was the total cost in USD of preventative measures regarding Sargassum influxes for hoteliers by year (2011, 2012, 2014, 2015, 2018)?

14. What was the total cost in USD of Sargassum removal for hoteliers by year (2011, 2012, 2014, 2015, 2018)?

15. How was the collected Sargassum disposed of?

16. Was there any collaboration between the public sector and the private sector (e.g. hoteliers, NGOs, community organizations, entrepreneurs) regarding beach clean-ups or innovative use of Sargassum? If so, please provide details.

17. What counter-measures have been taken to address the Sargassum influxes (e.g. public education, tourism marketing strategies etc.) and which ones have been successful?

18. Were the Sargassum outlooks and bulletins produced by the University of South Florida and NASA utilized by hoteliers in preparation for the influxes in 2018?

19. Are there any gaps which you can identify in the management of Sargassum influxes, and are there specific recommendations which could improve them?

[28] CRFM, 2016. Model Protocol for the Management of Extreme Accumulations of Sargassum on the Coasts of CRFM Member States. Technical & Advisory Document, No. 2016/ 5. 15p.

[29] Hinds, C., Oxenford, H., Cumberbatch, J., Fardin, F., Doyle, E. & Cashman, A. (2016) Golden Tides: Management Best Practices for Influxes of Sargassum in the Caribbean with a Focus on Clean-up. Centre for Resource Management and Environmental Studies (CERMES), The University of the West Indies, Cave Hill Campus, Barbados. 17 pp.

[30] Oxenford, H., Fardin, F., Doyle, E., Cumberbatch, J (2016) Management Recommendations: Coping with Sargassum Strandings. 69th Gulf and Caribbean Research Institute (GCFI), Grand Cayman, 7-11 Nov, 2016.

[31] Doyle, E. Franks, J. Oxenford, H. (2018) Responding to a Sargassum Influx. https://www.gcfi.org/wpfd_file/online-sargassumposter-2018/

Fact-finding survey regarding the influx and impacts of Sargassum seaweed in the Caribbean region

Questionnaire for Innovators / Entrepreneurs Using Sargassum

Date:

Name and Designation:

Email:

Organization:

Country:

1. How long has your business been in operation?
2. How long have you been using Sargassum to manufacture products?
3. What products are manufactured from Sargassum?
4. Is your business development regarding the use of Sargassum supported by research, and if so provide the details.
5. How many people by gender and age groups (16-24; 25-44; 45-64; 65+) are employed in your business?
6. What was the total amount (e.g. weight, liters, numbers) of each product produced by year since the start of your operation?
7. What was the total value in USD of each product manufactured by year since the start of your operation?
8. For each product manufactured, indicate the total weight of Sargassum which was utilized by year.
9. How is Sargassum obtained for your products?
10. Who are the main consumers of your products?
11. For each of your products indicate the amounts consumed locally and exported by year since the start of your operation.
12. What is the maximum weight of Sargassum which can be processed by your business on a daily basis?
13. Are there any gaps which you can identify in the management of Sargassum influxes, and are there specific recommendations which could improve them?

Appendix 3: Report of the First Virtual Meeting for the Fact-Finding Survey Regarding the Influx and Impacts of Sargassum Seaweed in the Caribbean Region.

The aim of this first virtual meeting was to clarify the proposed study aims, and to identify and agree on the best approach and timing for the planned field visits, as well as sources of data, information and knowledge within each country to be visited. The provisional agenda is attached as ***Appendix 1***.

Item 1 - Call to order: The meeting was called to order at 10:00 am Eastern Caribbean time and the provisional agenda was accepted.

Item 2 - Introduction of participants, election of Chair: The participants introduced themselves and a list is provided as Appendix 2. Mr. Milton Haughton chaired the Meeting.

Item 3 - Review of the TOR, study aims and the questionnaires: The Chair presented the TOR of the study and the aims. Maren Headley presented the draft four questionnaires which were targeted at (1) the fisheries divisions / departments; (2) public sector agencies with responsibility for beach clean-ups; (3) hotel associations; and (4) innovators / entrepreneurs using Sargassum. The Meeting provided feedback for improvement of the questionnaires.

Item 4 - Agreement on timeline for activities to be undertaken and approaches for field visits: The countries agreed on timelines for in-country visits. There was also discussion on the approach for completing the questionnaires and activities to be undertaken in-country. It was agreed that the attendees of the meeting would be the Sargassum focal point for their countries and would be responsible for circulating the questionnaires to the various sectors. It was also agreed that these questionnaires should be returned to the Secretariat by 15 February 2019.

Item 5 - Provision and review of information sources and key informants: The countries did not identify specific Sargassum information sources during the meeting, however they agreed that they would share any information electronically with the Secretariat. The participants also agreed that they would follow up on the circulation of the questionnaires to the various sectors and also provide assistance to the Secretariat with identifying key informants and setting up visits in country.

Item 6 - Any other Business: There were no matters under AOB.

Item 7 - Adjournment: The Chair thanked the participants for attending the meeting and acknowledged the support being provided by JICA to complete this study. It was noted that there were many initiative seeking to address the Sargassum issue and the need for collaboration with all sectors was highlighted. The meeting was adjourned at 11:45 am.

Appendix 1: Agenda of the Virtual Meeting.

CARIBBEAN REGIONAL FISHERIES MECHANISM

SECRETARIAT

FIRST VIRTUAL MEETING FOR THE FACT-FINDING SURVEY REGARDING THE INFLUX AND IMPACTS OF SARGASSUM SEAWEED IN THE CARIBBEAN REGION

Electronic Meeting

Thursday 31 January 2019
(10.00 AM - 12.00 PM EC Time)

Document date: 28 January 2019

	DRAFT ANNOTATED AGENDA
ITEM 1	**Call to order** *The Meeting Convener will call the meeting to order and present the provisional agenda for the acceptance of the meeting.*
ITEM 2	**Introduction of participants, election of Chair** • *Participants will introduce themselves.* • *The Meeting will agree on a country representative to chair the current meeting.*
ITEM 3	**Review of the TOR, study aims and the questionnaires** • *The Convener will briefly present the ToR, the study aims and inform the Meeting about the survey questionnaires.* • *The Meeting Convener will present the questionnaires and explain the content. The four questionnaires are targeted at 1.) the fisheries divisions/departments; 2.) public sector agencies with responsibility for beach clean-ups;3.) hotel associations; and 4.) innovators/entrepreneurs using Sargassum.*
ITEM 4	**Agreement on timeline for activities to be undertaken and approaches for field visits** • *The Meeting Convener will seek the feedback of the countries for timelines regarding completion of the questionnaires and field visits (Antigua and Barbuda, Barbados, Grenada, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines). This will include approaches for field visits and tentative/indicative schedules; in country introduction meetings; logistics for visiting key informants, data offices, badly affected sites; and wrap-up sessions.* • *The Meeting Convener will also seek the feedback of the countries which will complete the questionnaires on their own (Commonwealth of Dominica and Trinidad and Tobago) about timelines for submission.*
ITEM 5	**Provision and review of information sources and key informants** • *Countries will provide the Meeting Convener with the specific Sargassum information sources (e.g. national reports, reports on clean-up effort).* • *Countries will also advise about Ministry contacts and provide lists of key informants from the public/private sector, and civil society who may have good experience and knowledge about the influxes. Countries will also be asked to assist in establishing these additional contacts. It is expected that these contacts will participate in the next virtual meeting concerning country-level activities.*

ITEM 6	**Any other business** *The Meeting will consider any other business brought to its attention of relevance to the fact-finding survey.*
ITEM 7	**Adjournment**

Appendix 2: Participant List

Country	**Participant**
Saint Kitts and Nevis	Orisia Williams
Trinidad and Tobago	Shane Durgah
Grenada	Crafton Issac
Saint Lucia	Anthony Philgence
Antigua and Barbuda	Ian Horsford
Commonwealth of Dominica	Kurt Hilton
Barbados	Stephen Willoughby
Saint Vincent and the Grenadines	Kris Isaacs
CERMES	Patrick McConney
	Janice Cumberbatch
CRFM Secretariat	Susan Singh-Renton
	Milton Haughton
	Maren Headley
	Sherlene Audinett
CNFO	Mitchel Lay

Appendix 4: List of Resource Persons who participated in country meetings and interviews.

Table 1: Contact Information for Resource Persons who Participated in the Saint Lucia Meeting, 11 February 2019.

Name	Designation / Organization	Email	Tel. No.
Zachary Frangos	General Manager-Coconut Bay Resort		
Maren Headley	Research Graduate-CRFM Secretariat		
Joanna Melville	Manager- Gros Islet Fishermen's Co-op Society Ltd.		
Barrymore Felicien	Permanent Secretary-(Ag)Ministry of Agriculture, Fisheries, Natural Resources and Cooperatives		
Wendell McQuilkin	Ministry of Agriculture, Fisheries, Natural Resources and Cooperatives		
Kerjaki Francois	Soufriere Marine Management Area		
Marie Dalson	Saint Lucia Solid Waste Management Authority		
Peter C. Joseph	Chairperson-East Coast Fisheries Cooperative		
Victor Theodore	Police Marine Unit		
Shirlene Simmons-James	Conservation Manager-Saint Lucia National Trust		
Anthony Philgence	Sargassum Coordinator- Ministry of Agriculture, Fisheries, Natural Resources and Cooperatives		
Julian Alexii	Soufriere Fishermen's Cooperative		
Kaygianna Toussaint Charley	Operations Manager-Goodwill Fishermen's Cooperative		
Donette Ismael	Liaison Officer-Saint Lucia Hotel & Tourism Association		
Junior Mathurin	Senior Water Officer-Water Resource Management Authority		
Eulampius Frederick	Science & Technology Officer-Department of Sustainable Development		
Sarita Williams-Peter	Chief Fisheries Officer-Department of Fisheries		

Figure 1: Meeting participants during the “Fact-finding survey regarding the influx and impacts of Sargassum seaweed in the Caribbean region” in Saint Lucia.

Table 2: Contact Information for Resource Persons who Participated in the Saint Vincent and the Grenadines Meeting, 11 February 2019.

Name	**Designation / Organization**		
Andrew Lockhart	Superintendent – Marine & Terrestrial Parks- National Parks, Rivers & Beaches Authority		
Kris Isaacs	Senior Fisheries Officer-Saint Vincent and the Grenadines Fisheries Division		
Jeremy Searles	Senior Fisheries Assistant-Saint Vincent and the Grenadines Fisheries Division		
Dillon Morris	Engineering Assistant-Roads, Buildings & General Services Authority		
Hayden Billingy	National Project Coordinator -CC4FISH Project - FAO		
Herman Belmar	Department of Grenadines Affairs		
Kikkawa Katsutaka	Project Formulation Advisor-JICA		
Milton Haughton	Executive Director-CRFM Secretariat		
June Masters	Statistics and Information Analyst-CRFM Secretariat		

Table 3: Contact Information for Resource Persons who Participated in the Grenada Meeting, 14 February 2019.

Name	**Designation/Organization**		
Luis Acosta	Fisher-Grenville FAD Fishers		
Nealfa Charles	Data Operator-Grenville FAD Fishers		
Francis Calliste	Extension Officer-Fisheries Division		
Raymond Toussaint	Ministry of Fisheries		
Crafton Isaac	Private		
Bernard Williams	Environmental Health		
Carvel Frederick	Environmental Health		
Jason Fletcher	Grenada Marina		
Sywan McIntyre	NADMA		
Nydanu Josiph	Gouyave Fish Market		
Lyndon Marrast	Grenville FAD Fisher Organisation		
Shaddi Noel	Grenville FAD Fisher Organisation		
Patrick Chetram	Grenville FAD Fisher Organisation		
Royan Isaac	Grenville FAD Fisher Organisation		
Donald Henry	Grenville FAD Fisher Organisation		
Donny Nedd	Grenville FAD Fisher Organisation		
Michael Faarroway	Grenville FAD Fisher Organisation		
Moran Mitchell	Chief Fisheries Officer (Ag)-Fisheries Division		

Figure 2: Meeting participants during the "Fact-finding survey regarding the influx and impacts of Sargassum seaweed in the Caribbean region" in Grenada.

Table 4: Contact Information for Resource Persons who Participated in the Antigua Meeting, 18 February 2019.

Name	**Designation/Organization**		
Garry Gore	Mapa Trust		
Eldefield George	Fisher at Willkies		
Craig Lubin	Fisher at Market Wharf		
Aushaun Browne	Antigua and Barbuda Defense Force-Coast Guard		
Niccolo Bertelli	Ocean Point		
Patrice Simon	Antigua Hotel & Tourism Authority		
Trish Lake	Antigua and Barbuda Defense Force-Coast Guard		
Ishema Heurns	Senior Accounts Clerk - ShellBeach Seafood		
Michael Mouse Josiah	ShellBeach Marina		
Ian Horsford	Chief Fisheries Officer - Fisheries Division		
Mark Archibald	Fisheries Division		

Figure 3: Meeting participants during the "Fact-finding survey regarding the influx and impacts of Sargassum seaweed in the Caribbean region" in Antigua.

Table 5: Contact Information for Resource Persons who Participated in the Saint Kitts Meeting, 21 February 2019.

Name	**Designation/Organization**		
Eardley Nisbit	Parks and Beaches Unit		
Geraldo Herbert	Parks & Beaches Unit		
Doan Ferdinand	Agriculture Department		
Derrick Huggins	Capisterre Corp.		
Iroy Marshall	Capisterre Corp.		
J. Steve O'Garro	Frigate Bay Development Corp.		
Sandra Tyson	Frigate Bay Development Corp.		
Ivor Keithley Phillip	Solid Waste Management Corp.		
Yakima Daniel	Policy & Planning Unit-Ministry of Agriculture		
Vesta Southwell	National Emergency Management Agency		
Slieh Boncamper	Frigate Bay Development Corp.		
Derjonne Edmeade	Department of Environment		
June Hughes	Department of Environment		
Orisia Williams	FAO Consultant		
Calricia Langley-Stevens	National Emergency Management Agency		

Table 6: Contact Information for Resource Persons who Participated in the Nevis Meeting, Feb 22nd, 2019.

Name	Designation / Organization	
Randy Morton	Fisheries Division	
Stephen Messi	Fisher	
Andrew	Fisher	
Wilmot Broadbelt	Fisher	
Tim Thuell	Nisbet Plantation Resort	
Titlon Douglas	Department of Physical Planning	
Lemmuel Pemberton	Department of Marine Resources	
Rhosyll Jeffers	Assistant Permanent Secretary - Ministry of Agriculture	
Randy Elliott	Director of Agriculture - Ministry of Agriculture	

Figure 4: Meeting participants during the "Fact-finding survey regarding the influx and impacts of Sargassum seaweed in the Caribbean region" in Nevis.

Appendix 5: Interview Results Summarized by Areas of Impact for Each Country

Fisheries Impacts Summarized by Country

Antigua and Barbuda

1. Increased travel times to fishing grounds have been reported.
2. Fishers have relocated their operations to sites that are less affected. Some fishers have been fishing around Sargassum mats to target certain species (e.g. dolphinfish).
3. When influxes are massive, no fishing is done. The conch, lobster and spearfish fisheries operating on the East Coast were notably affected. Fishers also had to move their boats to areas with less Sargassum.
4. The Sargassum was also considered to be a navigation hazard for fishers at night.
5. There was an increase in dolphinfish catches in 2014 after which a decrease occurred.

Barbados

1. At Silver Sands, the boats have been moved as fishers cannot operate from the area.
2. The number of fishing days has decreased at Consett Bay, as fishers do not leave when the channel is covered with Sargassum.
3. The number fishing days may not only be determined by accumulations onshore but also Sargassum offshore. When fishers leave to fish, and encounter Sargassum they may return to shore.
4. Fishers have indicated that it has damaged their engines.
5. By observation, there has been a decrease in fish size, a decrease in the amount of flyingfish landed, and increases in Atlantic flyingfish, small dolphinfish, amberfish, lobster, billfishes, scads, and beardfish landed. Dolphinfish catches have fluctuated over the years with notable decreases occurring in 2017 and 2018. Flyingfish catches have also been fluctuating, with the lowest catches being observed in 2012.

Commonwealth of Dominica

1. Fishers have seen the influxes as beneficial, since it acts as a floating FAD.
2. There have been no reports of engine damage since fishers operate farther offshore at the FADs and can usually avoid the mats.

Grenada

1. Fishers have reported entanglement of lines and are unable to fish during large influxes. This results in loss of fishing days; however, the number of days has not been quantified.
2. If fishers do go out fishing during influxes, in many cases they return with little or no fish and would have incurred the cost of fuel.
3. The influxes also caused difficulty in accessing the boats, and fishers have to wade through the decomposing Sargassum, which causes skin irritation and infections especially when they have cuts, bruises or scratches on their bodies.
4. At sea, it is difficult to maneuver through the patches, and causes the engine to overheat.

5. Fishers reported problems with stripping of paint from their boats, damage and fouling of nets and additional time and effort spent cleaning and repairing the nets, and increased corrosion of their engines associated with the presence of decaying Sargassum.
6. There was a concern that on some beaches with limited potable water, fishers and vendors were using seawater collected from areas with decaying Sargassum to wash and clean their catch.
7. Fluctuations in dolphinfish catches have occurred with the lowest occurring in 2014.

Saint Kitts and Nevis

Saint Kitts

1. Fishers had to wade through Sargassum accumulations to access their boats.
2. During large influxes, fishers cannot get out to the fishing grounds as it is difficult to launch the boat
3. The brown plumes and sedimentation associated with decomposing Sargassum have also affected the trap fishery and in some cases fish traps are lost.
4. There was a limited availability of pelagic fish such as dolphinfish and wahoo, since influxes interfered with the setting of lines.
5. Spear-fishers and the lobster fishers have also been affected due to the sedimentation of decomposed Sargassum in nearshore areas and they now needed to go farther out to fish.
6. The lobster traps are set at approximately 100 ft and on retrieval the pots are filled with Sargassum, and no lobsters or fish.
7. It was reported that Sargassum was not only a problem on the surface but was also present on the bottom of the ocean when it decomposed and settled, it reduced visibility for divers and was filled the traps.
8. Catches of the reef fish e.g. doctor fish, parrot fish, snappers have decreased due to reduced fishing days. However, after the influxes, increases in landings are observed.
9. Fishers have reported that the mats act as FADs, and in Saint Kitts there have been a lot of juvenile dolphinfish e.g. 2 lbs., being caught.
10. Increased travel time to fishing grounds have also been reported due to the influxes, as navigation was difficult, and fishers had to keep stopping to clear the propellers. In some instances, it was estimated that whereas it would normally take an hour to arrive at a fishing ground, with the influxes the time could increase up to 3-4 hours.
11. Most fishers did not go out to fish during the influxes in order to save gas, and traps were only checked when the current changed.
12. Dolphinfish catches have increased since 2010, with fluctuations occurring across the years.

Nevis

1. The bait fishing industry was being affected by the influxes since seine fishers are unable to operate.
2. Lobster catches have been reported to increase after the Sargassum influxes.
3. The issue of diver safety and reduced visibility due to the influxes was also noted especially given that an increased number of nurse sharks have been observed in the nearshore.

Saint Lucia

1. Some fishers have been unable to fish at the FADs.
2. Fishers operating in the Soufriere area cannot utilize their seine nets due to the presence of Sargassum. It was affecting the SMMA for the past two years and for the time this year it has occurred in the Chasnet area, and snorkel tours could not operate.
3. There have been increased catches of *cawa*, which fishers have considered to be beneficial.
4. Dolphinfish catches have fluctuated over the years, with peak catches occurring in 2015. There has been a decline in flyingfish catches since 2014.

Saint Vincent and the Grenadines

1. Fishers have reported an increase in fishing time due to Sargassum and have had to circumvent the Sargassum patches while trolling for large pelagics, or when using seine nets for small coastal pelagics.
2. Fishers have also reported loss of fishing days at sea.
3. Impacts on fishing gears, engines and fishing grounds (damaged and losses) have also been reported.
4. Negative impacts on target species – since 2011 mostly juvenile dolphinfish (which is a major target species in SVG) are appearing in the catches. The large dolphinfish seem to be low in abundance, and there could possibly be a shift in the migration pattern of dolphinfish. Some fishers see this as a positive because they are experiencing large catches of dolphinfish. However, the catches are of mostly juveniles and this could lead to depletion of the stock. The Saint Vincent Fish Market has been enforcing a minimum size limit of 5lbs for dolphinfish purchased to discourage harvesting of the smaller specimen. There have been fluctuations in landings over the years with the lowest catches occuring in 2017.

Minimum size Notice at Saint. Vincent Fish Market

5. There has been a large increase in the landing of crevalle (Caranx spp), which is depressing cost of other fish species.
6. The seine fishers of Bequia are also heavily affected as the target fishery for robins and jacks (the national dish) operates from the bays around Bequia.
7. Livelihood, the economy, regional trade and food security in Saint Vincent and the Grenadines and particularly in Bequia are being negatively affected by the arrival onshore of these vast amounts of Sargassum.


Increased landings of Jacks at Saint Vincent Fish Market

Trinidad and Tobago

1. The impacts include damage to fishing gear and equipment; increased difficulty in marine navigation resulting in difficulty to access fishing grounds; and loss of earnings.
2. Dolphinfish catches have fluctuated throughout the short time period for which catches are available, and the lowest catches were observed in 2014.

Ecosystem Impacts Summarized by Country

Antigua and Barbuda

1. Research is needed regarding the fauna associated with the Sargassum mats, e.g. flyingfish eggs and the impacts on future recruitment.
2. The brown plumes that occur in the water after a Sargassum influx have also caused fish kills.

Barbados

Beach Clean-up in Barbados (photo – S. Willoughby)
Clean-up methods used to remove Sargassum.

1. Beach erosion due to Sargassum influxes have been reported.
2. Blooms of green algae have also been reported after Sargassum influxes.
3. Removal of sand was reported to be a problem when Sargassum is collected by heavy equipment

Commonwealth of Dominica

1. There is no available information on the ecosystem impacts.

Grenada

1. Fish kills have occurred inshore and the sea urchins have moved farther offshore.
2. Die-offs of benthic organisms, coral, and seagrass have also been reported.
3. There was also concern that the coral reef and seagrass ecosystems are nursery areas for shrimps, lobsters, conch and snappers and accumulations of Sargassum in these areas along with eutrophication would affect future recruitment.

4. The disruption of turtle nesting and hatchlings was listed as a concern.
5. The role of Sargassum as a floating ecosystem was recognized, and the possibility for the introduction of invasive species was highlighted.
6. Significant beach erosion and loss of sand was reported and observed in Grenada at both Pearls Airport/ Great River Bay and Soubise Beach. Beach erosion appears to arise from oceanographic changes (current and wave action) in some cases, and the use of heavy equipment which result in the removal of large quantities of sand during clean-up operations.


Erosion at Pearls Airport / Great River Bay, Grenada

7. Concerns have been expressed that large quantities of sand are being removed from beaches when heavy equipment is used to collect Sargassum.

Saint Kitts and Nevis

Saint Kitts

1. Beach erosion has been occurring at Frigate Bay.

Nevis

1. The influxes have also affected the turtle nesting beaches, where it can reach piles of up to 6 ft, which makes it difficult for turtles to maneuver.
2. Drowning of turtles has also been reported since the Sargassum mats make it difficult to surface and can extend down for two to three feet.

Saint Lucia

1. There was no available information on the ecosystem impacts.

Saint Vincent and the Grenadines

1. There was concern for how cleanup activities affected turtle nesting sites, as heavy machinery could destroy the sites the turtles use, as well as eggs.
2. There was concern that turtles might have problems finding nesting sites as well as they are unable to navigate through the Sargassum in the bay as well as the beach.
3. Minor beach erosion has been reported and observed.
4. There was concern that large quantities of sand are collected and removed with the Sargassum during cleanup.

Bequia

1. Loss of coastline from erosion - in some places as much as 10-15 ft of coastline in approximately one year have been lost. As the Sargassum piles up the water finds its way around the mound cutting into the beach as it does so.
2. There was concern that turtles are having difficulty accessing beaches for nesting. Turtles have been reported to be nesting at new sites
3. Concern was also expressed about the impacts of Sargassum on the coral reefs

Trinidad and Tobago

1. Information on ecosystem impacts was not available.

Human Health Impacts Summarized by Country

Antigua and Barbuda

1. There was no information available on health impacts.

Barbados

The following human health impacts have been reported by the Fisheries Department (2015):
1. Itching of the skin and ear infection;
2. A rash that may become infected;
3. Sore muscles from hauling gear laden with Sargassum.
4. Decaying Sargassum gives of a foul-smelling gas (hydrogen sulphide) which affects the throat and cause coughing, burns of the nose and eyes, upsets the stomach, and triggers respiratory problems.

Commonwealth of Dominica

1. The affected areas are not highly populated and there have not been any complaints about health issues. However, it is possible that there are health impacts, however this needs further investigation.

Grenada

1. A survey was done regarding respiratory problems, especially in people with pre-existing conditions e.g. asthma to determine the effects regarding long-term effects of exposure to hydrogen sulphide. However, findings of the survey were not made available.
2. There was also concern about dumping sites for Sargassum and the possible impacts for human health related to hydrogen sulphide and heavy metals.
3. In Grenville Bay, there was concern about the release of raw sewage, inadequately treated sewage and grey water which could negatively impact the nearshore ecosystems, and also cause human disease.
4. There were also health concerns from residents situated inland, where farmers have stockpiled Sargassum in garbage bags, and when the Sargassum begins to decompose, there is the bad smell associated with the release of hydrogen sulphide.

5. In Soubise Beach, anti-malarial drains which lead to the sea have been blocked with Sargassum accumulations which has resulted in the stagnation of inadequately treated sewage and grey water and could encourage breeding of the Anopheles mosquito. This represents a public health risk.
6. It was noted that some communities were more heavily impacted than others, and some of the issues included asthma attacks, vomiting, and rash. It was reported that some people had left the communities due to health challenges.

Saint Kitts and Nevis

1. Sargassum was reported to have contributed to the death of one fisher at sea, when they were unable to maneuver the vessel in order to avoid a wave.
2. In some fishing communities e.g. Parsons, accumulations of 10 -12 ft have been reported and the entire village was affected by the odour.
3. The issue of bad odour was also reported for the Frigate Bay area, however there has been no conclusive study on the impacts to human health.

Saint Lucia

1. Some of the fishers had rashes, skin pitting with tiny holes question of nausea.
2. There was an urgent need to monitor hydrogen sulphide levels in affected communities., There was also need for a protocol to determine the area as unsafe and what actions should be taken, e.g. clean up or evacuation.
3. The effects of heavy metals on human health need to be investigated.

Saint Vincent and the Grenadines

1. Coastal communities reported increased respiratory complications as well as nausea, headaches, dizziness. There are concerns that there may be long term effects on human health from prolonged exposure to the hydrogen sulphide gas from decomposing Sargassum.
2. The Owia community reported elevated levels of cancer among community members, but there has not been any research to identify if this is connected to the issue of Sargassum.
3. It was reported that colds have been lasting for long periods, sinus problems, respiratory illnesses, nausea and headaches seem to be prevalent, and more children needed nebulization.


Community meeting – Owia Bay, Saint Vincent

Bequia

1. The greatest impact is the stench coming from the rotting Sargassum particularly affecting the Spring, Industry, and Port Elizabeth areas.
2. Of particular concern is the status of drinking water on Bequia. Water is harvested and there is concern that the gas may be dissolving into the harvested drinking water used by citizens.
3. It should be noted that the mosquito population seems to have decreased on the Bequia as there seem to be less mosquito breeding in harvested water.

Trinidad and Tobago

1. There is no information available on human health impact.

Tourism Impacts Summarized by Country

Antigua and Barbuda

1. Hotels primarily on the East Coast were affected including: St. James Club; Verandah Resort; Jumby Bay Resort; Dutchman's Bay Cottages; Willoughby Bay Heights Apartments; Mill Reef Club; Harmony Hall; NonSuch Bay Resort; Ocean Point Resort, and Blue Waters Hotel.
2. Jabberwoch Beach, Shell Beach, Mamora Bay, and the beaches on the offshore islands, Half Moon Bay, and Brown's Bay were affected by the influxes.
3. No beaches were officially closed. However, visitors and locals did not visit the affected beaches during the periods of influxes.
4. St. James Club was closed for a three-month period in 2018.
5. There have been cancellations and it is estimated that approximately 10 to 20% of the total bookings at the St. James Club and Verandah Resorts were canceled during last year.
6. Hotel bookings are made up to a year in advance and this also has implications for planning depending on where the location of the hotel is and the Sargassum influxes.
7. There is concern about how the Sargassum affects the tourism product and it was suggested that this be considered in marketing, since not all beaches are usually affected.

Barbados

1. Hotels have been doing clean-ups of the beaches associated with their properties. Affected hotels include The Crane, Bougainvillea, Sandals, and Divi Southwinds.
2. There is no information available on costs of clean-ups and the methods utilised.

Commonwealth of Dominica

1. No hotels are located on the East Coast; therefore, the tourism sector has not been affected.

Grenada

1. Sargassum has not been affecting tourism, since most of the hotels are situated in the South where influxes have not occurred.

Saint Kitts and Nevis

1. Hotels in Saint Kitts and Nevis have been covering the costs of clean-ups for the beaches associated with their properties.
2. The Marriott in Saint Kitts has had some cancellations associated with the Sargassum. Nesbitt Plantation in Nevis has not had any cancellations so far.

Saint Lucia

1. Coconut Bay has also received bad reviews online which has caused trip cancellations because the beach is not the "Caribbean Blue" due to the influxes.
2. It was noted that during the uncharacteristic influx on the West Coast last year, the clean-up expenses were borne by the hotels.

Saint Vincent and the Grenadines

1. Hotels on mainland SVG are not affected (or minimally affected if at all) as they fall outside of the affected areas, whereas hotels in the Grenadines are severely affected.
2. Affected hotels include: Firefly (Bequia), Sugar Reef (Bequia), Blue Lagoon (Mainland Saint Vincent), Paradise Beach Hotel (Mainland Saint Vincent), Bougainvillea (Union Island), Kings Landing (Union Island).
3. Beaches on the eastern end of the island chain were most heavily affected. The entire east coast of Mainland Saint Vincent had Sargassum at one point or another.
4. In Bequia, the affected beaches are Ravine, Friendship, Paget Farm, Spring, Industry, Mt. Pleasant Bay. In Mayreau, Salt whistle bay was affected and in Union Island, Clifton and Ashton were affected.
5. Sugar Reef (Bequia), Firefly Villas (Bequia) and Kings Landing (Union Island 2018) were closed in 2015 and 2018 (for 4-5 months).
6. There have been cancellations at Sugar Reef and Firefly Villas.
7. At the Firefly Villas, booms were set up to try to stop the Sargassum from arriving onshore. However, the Sargassum was too much for the booms and they were overwhelmed and destroyed. Booms have also been used at Sugar Reef in Bequia, however, there is no available information on their effectiveness. Booms have generally not been effective.

Trinidad

1. The tourism sector in Trinidad has not been affected.

Clean-up, Removal and Disposal Approaches and Challenges Summarized by Country

Antigua and Barbuda

Approaches

1. Clean-ups have been organized by Government agencies and the private sector. The Ministry of Works assisted with providing equipment for the hoteliers and there were also community led clean ups.
2. A conservative estimate of 44,4025.08 USD was given for the cost of clean-up, removal and disposal last year for the public sector.
3. The Ministry of Works and the affected hotel properties were guided by the Department of Environment regarding clean ups.
4. Jumbie Bay has estimated that they have spent approximately 44,4025.08 USD dollars during 2018 for equipment, cleanup and removal.
5. It is estimated that the clean-up cost per hotel was 37,002.09 USD during peak periods.
6. In total, between the public sector and the private sector, it was estimated that the cost of clean-up during 2018 was in the range of 5 million-7 million USD.
7. The estimated amount spent in clean-up for 2018 was 11,1006.27 USD for the St. James Club and the estimated loss was 3 million USD for the three-month closed season.
8. Clean-up at NonSuch Bay was estimated at 185010.45 USD last year, and during the peak period in May last year, the amounts being removed were estimated at 120 tonnes per day for two weeks.
9. Equipment included backhoes; 30-40 ft long-boom excavators; excavators.
10. Removed Sargassum was bagged and dumped in the Sanitary Landfill.
11. It was believed that removal on land was more efficient than in the water.
12. A boom has been installed by NonSuch Bay hotel and is made of 6-inch PVC pipe glued together and capped at each end. The boom is anchored with sand bags and is approximately 40 ft in length. The water depth in the area is between 5 to 9 ft. The Sargassum is diverted into a small area and daily collection occurs. It is taken to land nearby where it is left to dry for approximately 3 weeks, after which it is sieved, and the sand collected and returned to the beach.

Challenges

1. The Sargassum is a solid waste and given that the influx is heaviest on the Eastern side of the island, it is not economically feasible to be taken to the landfill.
2. The landfill has been taking Sargassum since the beginning of the influx and last year, during the peak 3-month period (May-July), it was estimated that approximately 1000 tonnes were being received daily.
3. Contractors are not very willing to utilize their equipment for removal and transport given the marine conditions, and the corrosive nature of decomposing Sargassum.
4. In water removal has been conducted by the Jumbie Bay Hotel utilizing a barge with a tread-mill, however it was found that during collection, some of the Sargassum was either displaced or sunk. It was also found that this equipment could only be used in bay areas, and was not suitable for rough conditions.
5. Estimated costs of a back hoe was 300, 000 USD and 500, 000 USD for an excavator. This was considered to be an expensive investment for governments.
6. There was also the issue of sand being removed from the beaches and being sold.

7. Given the conditions of the marine environment, the lifetime of the equipment was considered to be short which has monetary implications.
8. While it was agreed that there was a possibility of getting custom built it was agreed that this was costly.
9. In terms of barrier booms, the depth of water was considered to be prohibitive since in some areas it was up to 3000 ft and would need anchors between 6-7 tonnes. Meanwhile, when placed within the continental shelf, the Sargassum overwhelms the boom.

Barbados

1. There have been a number of clean-up efforts, involving the National Conservation Commission and new employees have been hired by the Ministry of Maritime Affairs and Blue Economy.

Commonwealth of Dominica

1. There have been no beach clean ups, and Sargassum has not affected any of the swimming beaches.

Grenada

Approaches

1. Mostly heavy machinery has been used and clean-ups have not been regular and removal of decomposing Sargassum is more difficult. Removal of fresh Sargassum was considered to be easier and there was less odour.
2. Clean-up methods have included the use of front-end loaders, and excavators and trucks.
3. In the estimates of revenue and expenditure, approximately 37,0020.90 USD was spent last year on clean-up, removal, and disposal, however, there is uncertainty regarding this amount.

Challenges

1. It was agreed that communities could be mobilized for Sargassum clean-ups in a similar manner as for hurricanes through NEMO; however, there needs to be a plan or framework for this.
2. There has been no designation of an official dumping area and there are also challenges associated with transporting it long distances.
3. The current dumping site is Pearl's airstrip. However, there is the issue of illegal dumping at the site.

Saint Kitts and Nevis

Saint Kitts

Approaches

1. At Kittian Hill fishers were doing general clean up, drying and burning the Sargassum.

2. The Marriott hotel conducted daily clean-ups during peak periods with an excavator and truck at an estimated cost of 500 000 USD last year.

Challenges

1. Disposal of Sargassum was an issue and it was not currently accepted at the landfill.
2. The types of equipment needed to clean-up the Sargassum were not readily available to the public sector, and in many cases the equipment had to be provided by the private sector.
3. The issue of piled up Sargassum during a hurricane was also raised as it represented a risk during high winds, and high tide for the nearby development, especially that it is expected to be an over-average season for hurricanes.
4. Unsupervised beach clean-ups being undertaken by the private sector was identified as an issue since heavy equipment was being used in many cases, and sand was also being removed.
5. The landfill was not taking Sargassum that was decomposing because of the odour, as well as the possibility of a fire risk due to the production of methane and given the biomass nature, it can easily catch fire.
6. There was also an issue of space at the landfill and the quantities of Sargassum.
7. It was suggested that appropriate areas for disposal should be designated, and there was a need to take into account the possibility of soil and fresh water contamination.
8. It was noted that NEMA has the largest volunteer pool spread across the communities which are affected. However, how the emergency mechanism would be triggered regarding Sargassum needed to be determined and would need to be included in the National Disaster Management Plan which has legal implications.
9. There is an issue with beach erosion, and it was estimated that at least 30 ft of beach associated with the Marriott hotel has been lost since the Sargassum influxes have started.

Nevis

Approaches

1. The Ministry of Agriculture has assisted with beach clean ups at Indian Castle, Long Haul Bay and Herbert's Beach.
2. Over the past three years, approximately 225 000 USD was spent on clean up and removal of Sargassum between Herberts Beach and Long-Haul Bay.
3. A front-end loader was contracted for two days last year to clean up Indian Castle at a cost of, 740.04 USD. This was an initiative between the public sector and the Nevis turtle group.
4. Clean-up at Nesbitt Plantation was done on a daily basis and involved 3 staff a day at 42 hours a week and including the truck and the gas the estimate came up to 555.03 USD a week, which was modest.

Challenges

1. No budget has been specifically allocated to the clean-up and removal of Sargassum.
2. It was noted that Nesbitt Plantation Hotel was losing beach because of the buildup of Sargassum onshore, causing the underlying sand to be washed away. It was estimated that about a third of the beach (20-40 yards) had been lost and black sand was now intermixing with the white sand.

3. In terms of disposal, the water table also needed to be taken into account during excavation for burial since it is high in some areas.
4. When Sargassum is disposed of on the backshore, when there were high waves, the water would become trapped and these stagnant pools contributed to the bad smell.

Saint Lucia

Approaches

1. Some of the information from the CRFM Model Protocol for the Management was used to guide clean-ups undertaken by the government last year. Last year, intense clean-up efforts were undertaken because of the smell, and inaccessibility to the boats.
2. In Dennery, 99% of the accumulation was removed; in Praslin-80%; Praslin jetty-25% and in Micoud-30-35%.
3. An excavator was used in all cases. The protocol identified a long-boom excavator (50ft), ideally for protection of the beaches. A long-arm boom excavator was used to clean out the Dennery Bay, however, in Micoud and Praslin a longer boom is required (over 50ft), and therefore clean-up has not been successful.
4. Rental and transportation of the equipment was $ 1480.08 USD and the excavator was paid 138.76 USD/hr. depending on the size of excavator. Transportation from beach to disposal site was estimated at 55.50-166.51 USD depending on distance for each trip. On average, the number of trips ranged from 4-15 a day depending on the distance between the beach and the disposal site.
5. For Dennery, the cost of clean-up was approximately 59, 203.34 USD and was done over 6 days, and involved about 40 truck trips to the dumping site. The distance to the dumping site also added to the cost.
6. Estimated cost at Praslin Bay was 14, 430.82 USD and clean up was incomplete.
7. Estimated cost of clean-up for Micoud Bay was 9,250.52 USD, however clean-up was incomplete.
8. In Dennery a private dumping site was utilized; and in Praslin beach, an area at the back of the beach was chosen for dumping. For Praslin jetty, the cost to transport it was prohibitive, and therefore a hole was dug near the beach. In Micoud, some people allowed the Sargassum to be dumped on their farm.
9. Some Village Councils did attempt to do small-scale clean ups. However, in 2015-2017, there has been higher inundations and inability to finance the clean-ups.
10. The Coconut Bay Hotel undertakes daily clean ups around the clock in order to remove Sargassum before decomposition. Three years ago, heavy equipment was used which resulted in sand needing to be replaced at a cost of 40,7022.99 USD last year which was covered by the hotel
11. Coconut Bay utilizes a front-end loader and dump trucks. The Sargassum is dropped in rows, after 60-90 days, the Sargassum decomposes and the remaining sand is replaced along the beach. It was estimated that the total cost of clean-up last year was 400,000 USD.

Challenges

1. In attempts not to remove sand, the speed at which work can be done is restricted.
2. The reef barrier in some areas has encouraged nearshore stagnation of Sargassum accumulations.

3. There was reluctance of the private sector to rent equipment and trucks given that Sargassum was considered to be corrosive to the trucks. Pressure washing and greasing of machinery after each work day also had additional costs. Care was also taken to avoid leaking of fluid onto the road when transporting Sargassum.
4. At the time of clean-up last year, the hazards associated with heavy metals were unknown as well as the guidelines used by the French which indicate that Sargassum should not be accumulated at a height of more than 30 cm above the ground, as it could affect the soil for agricultural purposes. This protocol was now being implemented.
5. It was considered that clean-up led by the fisherfolk was beyond their capacity given the quantities of Sargassum.
6. Disposal of collected Sargassum has always been a problem, and in addition, dredging of bays and removal of silt have implications for where the material can be disposed of.
7. In terms of disposal, it was recommended that the water authority should be involved since there are underground aquifers and this would have implications for where Sargassum could be disposed.
8. The landfill has not been taking Sargassum.
9. It was recommended that the clean-up should be ongoing, and that government should be responsible for this.
10. The communities have agreed to disposal sites which are on private as well as public lands. However, there is an urgent need to take the possibility of leaching into account.
11. It was recommended that dumping areas should be modified to include a small-detention pond to allow the leachate to settle out and a simple filter system of charcoal, sand, and stones could be used. Where possible the use of liners should also be used.

Saint Vincent and the Grenadines

Approaches

1. Community groups were used for cleanups in the communities of Owia and Sandy Bay on mainland Saint Vincent.
2. Private sector (especially hotel operators) played a pivotal role in clean ups in the Grenadines.
3. Sargassum was removed from beaches using rakes on mainland Saint Vincent and then trucked away. Some of the bays in the Grenadines required heavy machinery to assist in the Sargassum removal.
4. On mainland Saint Vincent Sargassum were removed using rakes, wheel barrows and sacks. Ground teams raked the Sargassum from the water at Owia Bay and heaped them on the wharf for transportation by truck. On the beach at Big Sand, the Sargassum was taken from the beach where they had been deposited by the sea water and heaped further up on the shoreline before they were transported by truck.
5. In Bequia, a combination of heavy equipment (tractors) and ground crew with rakes were used. In Union Island, ground crews as well as a metal “rake” pulled by a pirogue was used. The one case of “specialized equipment” was in Union Island where a local welded pieces of steel together to form a “rake” which was then pulled through the waters of the harbor.
6. In 2015, 13,320.75 USD was incurred by the Ministry of Transport and Works to pay ground crews to remove Sargassum for a 10-day period. This does not take into account trucking, visits by the taskforce or the work done in the Grenadines.

7. Most of the Sargassum was taken to the landfill, some was kept at the Ministry of Agriculture Research and Development station (used for compost) and some was taken by nationals for use in home gardens.
8. The costs associated with the cleanup were as follows: Each trip of a truck of Sargassum taken from Owia to the Research and Development Station in Orange Hill or to the landfill cost 111.01 USD. Each gang of workers (9-10 persons) cost 155.41 USD per day.

Challenges

1. In terms of funding for cleanup etc. this is not an item covered by the government's budget, and so most of the cleanup or preventative efforts have be funded privately (where the owner is affected), or through the collaborative work by the Sargassum Action Task Force.
2. The salt associated with the Sargassum also affected the trucks used (rotting of the metal body).

Trinidad

1. Information was not available on clean-up efforts.

Damage to Property Summarized by Country

Antigua and Barbuda

1. Electronics, and jewelry have become damaged due to the hydrogen sulphide exposure.
2. Influxes have also caused filters at the desalination plant to become clogged and this has affected the production of fresh water for the island.
3. With respect to fisheries, the issues of engine damage due to corrosion and overheating were pointed out.
4. Lobster exporters have had to purchase additional lines, since the influxes were negatively affecting the water quality. Most of the establishments where live lobsters are stored for export are located near to the airport. The operators had to make provisions for a closed water circulation system instead of an open one and this had cost implications.

Barbados

1. Damage to boat engines has been reported due to overheating when manoeuvring through Sargassum as well as corrosion of engine parts due to exposure to hydrogen sulphide.
2. Exposure to hydrogen sulphide has also caused damage to boat paint.

Commonwealth of Dominica

1. There is no information available on damage to property.

Grenada

1. The hydrogen sulphide released from the decomposing accumulations also caused damage to the paint on the boats on land, as well as engine corrosion.

2. The Sargassum influxes have also been affecting the production of sea moss, by reducing the water quality and entangling in the sea moss lines.
3. Coastal residents have complained about damaged televisions and other electronic equipment.
4. Some truck and equipment operators are reluctant to use their vehicles for clean-up due to increased corrosion and high maintenance costs after transporting Sargassum.

Saint Kitts and Nevis

1. The Sargassum influxes have also affected the sea moss lines, which now require cleaning two to three times a week instead of once a week.

Saint Lucia

1. There have been reports of damage to jewelry and electronic equipment due to hydrogen sulphide.

Saint Vincent and the Grenadines

1. The Grenadines Island of Bequia was more affected than mainland SVG. Along with the health issues, the gas (hydrogen sulphide) also affects electronics, jewelry and metal products found in homes and even the paint on homes are being affected in the Grenadines Islands.
2. Hydrogen sulphide has damaged electrical equipment such as television sets; silverware; metal including jewelry; paint on walls have become softened and discolored then peel away from the wall. There was a case where a child got an electrical shock from a disconnected wire. On investigation it was discovered that the severed connection had been reconnected by a buildup of material influenced by the hydrogen sulphide in the air.
3. Houses have had to be rewired as the hydrogen sulphide destroyed wiring.

Trinidad

1. Information was not available on damage to property.

Counter-measures Summarized by Country

Antigua and Barbuda

1. Through tourism public education and marketing efforts, it was communicated that only a few beaches on the Eastern side were affected and that all the beaches on the South and West were as pristine as they were before.
2. The outlooks and bulletins produced by NASA and the University of South Florida were utilized by other agencies who then passed on the information to the Ministry of Tourism and then on to the hoteliers in simple terms.
3. The French Meteorological forecasts which also cover Sargassum is utilized by one hotelier in order to prepare for Sargassum clean-ups. It was recommended that there should be more collaboration with Guadeloupe and Martinique.

Barbados

1. The Office of the Prime Minister has developed a Blue economy team to deal with the Sargassum influxes, which includes: the Coastal Zone Management Unit; Fisheries Division; Ministry of Agriculture; and the Barbados Defense Force.
2. Some fishers have placed a strainer over the engine propeller, to avoid the intake of the Sargassum which leads to engine overheating and this has been successful so far.

Commonwealth of Dominica

1. There is no information available on damage to property.

Grenada

1. A number of radio programs have been hosted where the issue has been discussed and this has increased public awareness.

Saint Kitts and Nevis

1. The Marriott Hotel was investigating the use of modified oil-containment boom 1,500 ft in length, at a cost of 400,000 USD. The challenge with this was removal during a hurricane.

Saint Lucia

1. Community education, stakeholder engagement meetings have been held.

Saint Vincent and the Grenadines

1. The first influx of Sargassum arrived in 2011, and the Saint Vincent and Grenadines response was to put together a Seaweed Invasion Task Force, comprised of representatives from: The Ministry of Agriculture, Industry, Forestry, Fisheries and Rural Transformation, the Ministry of Transport, Works, Urban Development and Local Government, the Ministry of Health, Wellness and the Environment and the Ministry of Housing, with the expectation that the Task Force would be further expanded to include more Ministries and Agencies as the need arose.
2. However, there is no budget allocation for clean-up, but the Task Force tries to pull support from the existing budget of different agencies to deal with the situation.
3. The Ministry of Transport, Works, Urban Development and Local Government has been assigned lead responsibility for beach clean-up.
4. Under the CC4Fish Project a number of knowledge products including a short video documentary on Sargassum - exploring the opportunities associated with it, particularly to the agriculture industry; a booklet and other knowledge-based products were being developed.
5. The National Sargassum Plan is also slated to be completed and approved this year. There is a tentative budget in the Plan to remove Sargassum from a beach and deposit it at the Research and Development Station in Orange Hill to be turned into compost, or to the landfill in Diamond for disposal.

6. There has been community outreach and a general public education drive, especially after the 2011 influx.
7. Sargassum Outlook bulletins were used as public outreach material.

Trinidad

There was no information on counter-measures.

Innovative Uses Summarized by Country

Antigua and Barbuda

1. Farmers have been using it on coconut trees, however they are unable to take the quantities, which have been coming in.
2. It has also been found to work as a deterrent for African snails, when placed around the property.
3. There is also concern about the presence of arsenic in the Sargassum which could contaminate the soil if used as a fertilizer.
4. It was recommended that further investigation is needed regarding use in agriculture.

Barbados

1. There is a team working on research and development of innovative Sargassum products. The team comprises representatives from the Barbados Sugar Cane Industry; Biomass -Biomethane Development Team- Biogen; Residents and Fishing Communities at Consett Bay and Skeetes Bay; and the Barbados Agricultural Development and Marketing Corporation.
2. It is thought that within the context of the sugar cane industry Sargassum could be used as a fertilizer to increase the yield by 20%.
3. Preliminary experiments have also shown that it is not ideal for the production of biogas.
4. One of the challenges so far has been that based on oversupply of seaweed and a low demand for a product that has high logistic cost, Sargassum has no substantial commercial viability at this time.

Commonwealth of Dominica

1. It has not been used on a large scale. Some persons have used the dried and rinsed Sargassum as fertilizer for mature citrus trees.

Grenada

1. The farming communities have been using Sargassum as mulch and fertilizer, however, the results have not been documented.
2. The need for the development of products using Sargassum was identified and use as potting material for ornamental plants was suggested.
3. It was emphasized that there was a need for caution if cadmium is present and it is used in cocoa fields, as this could have implication for meeting the EU standards.

Saint Kitts and Nevis

1. It was recognized that studies are necessary for innovation products.

2. There was interest in the use of Sargassum as a means of generating fuel, so that it can be placed into the national grid. However, it was pointed out that Sargassum was not a good for biofuel.
3. Although there had been some small trials for use as compost, it has not been done on a continuous basis given that it is a long-process and requires a lot of rinsing and drying.

Saint Lucia

1. Consideration should be given to using Sargassum as biogas, and how can Sargassum be collected at sea however a lot of the work is still trial and error. It has also been used in mulching and nematode control.
2. The high salt content and the need for processing of Sargassum was also identified as a challenge for use as a fertilizer. There were also plans to conduct biogas experiments using existing units previously used by pig-farmers.
3. In terms of usage, Algas Organics, has been producing a liquid plant tonic, and originally there was collaboration with the fisherfolk to collect Sargassum. However, the current status of production was unknown.
4. The need for the collection of fresh Sargassum with no sand was also identified for innovative use. It was also considered that having more than one outlet to utilize the Sargassum and multiple options for collection was important.

Saint Vincent and the Grenadines

1. The Research and Development Unit in the Ministry of Agriculture, Forestry, Fisheries, Rural Transformation, Industry and Labor has been tasked with trialing Sargassum Bio-Fertilizer in Agriculture.
2. Some persons on Bequia are using the Sargassum as mulch etc. in agriculture. However just a small quantity is used in this way, and it would be good to find out what is the best way to use the Sargassum or to find ways in which it can be used.

Trinidad

1. Farmers have been using dried Sargassum as fertilizer.

Recommendations for Management of the Influxes, Clean-up and Disposal Summarized by Country

Antigua and Barbuda

1. It was found that the information in the Outlook Bulletins was too general for mitigation action (not site-specific).
2. There was a general lack of basic quantitative information on the extent of the problem. Dedicated research geared towards assessing the impact on fish stocks have not been conducted (implication for recruitment, natural mortality, etc.) and was therefore recommended.
3. A multi-sectoral approach was recommended to address all aspects of the problem from monitoring and surveillance to clean-up and disposal.

4. There is need for public-private partnerships as well as community participation to tackle the problem. A public private partnership was also recommended to cover purchase of equipment, operational costs, and maintenance.
5. A special taskforce, with dedicated equipment is needed for clean ups.
6. There is a need to also have mechanisms at the national level, since different strategies are needed for different areas.
7. The role of currents, wind and eddies in determining how fast bays filled up and cleared was also pointed out and it was suggested that there was a need for input from coastal engineers.
8. It was recommended that more community and fisherfolk action was needed for clean-ups.
9. In terms of beach clean-ups, it was noted that it should be technically guided by engineers in order to avoid beach erosion.
10. The need for permission by the relevant maritime authority was noted for the deployment of booms, as well as to inform marine traffic.
11. A management framework for monitoring the beaches is needed.
12. Given the limited human and financial resources of the Fisheries Division, it was recommended that there should be a coastal zone monitoring unit which would be dedicated to issues such as Sargassum.
13. It was recommended that research and development of business models was required for identifying feasible uses of Sargassum and the energy sector should be considered.
14. In terms of disposal, it was suggested that empty lands around the island should be identified, and sectioned off for disposal. It was also suggested that the sites for disposal should be rotated.

<u>Barbados</u>

1. The smell is coming from the stagnated water pools, and to deal with this, channels between the accumulated Sargassum should be cut to allow water exchange.
2. Quantitative information on the accumulation amounts was needed.
3. A management plan was not considered to be effective in the field, since clean-up effort depends on the geography of the beach and presence of nesting turtles. Each beach needed to be dealt with on an individual basis.
4. It was recommended that response plans rather than management plans were needed due to the unpredictability of the quantities and accumulations. There was also a need for predictions of Sargassum arrivals to be ground truthed.
5. It was recommended that the response plan should identify sources of people and machinery and could be through private and public sector collaboration. The response plan should also be flexible enough to be adapted as necessary.
6. A national coordinating entity was also needed to take the lead for coordination and implementation of the response plan.
7. In terms of equipment for beach clean-ups, it was recommended that a source should be identified from which they could be hired when necessary as this would be preferable to buying them.
8. Improved sharing of information among stakeholders was recommended.
9. A communication mechanism including hotels for reporting on a daily basis was necessary. This could be done through telephones, hotlines, or a WhatsApp group.
10. There should also be a central depository for photos.

Commonwealth of Dominica

1. There were no recommendations regarding Sargassum.

Grenada

1. Grenada has a draft Management Plan based on the CRFM Model Protocol; however, it has not been approved by cabinet and there is also no dedicated budget for Sargassum. It was recommended that this plan should be approved, and the Task Force identified within it should be mobilized.
2. It was recommended that a lead entity should be identified with responsibility for the Task Force. The need for a defined plan of action for the Task Force was also identified.
3. It was recognized that fishers are usually the first to report the arrival of the Sargassum mats, and that it was critical to have them involved in the activity of the Task Force.
4. There is an urgent need to mobilize resources to address the situation, since Grenada is unable to sustain the levels of financial impacts of the influxes.
5. It was recommended that the dumping areas should be fenced off and not located near to human settlements.
6. It was recommended that workers should also wear protective gear when cleaning up and removing Sargassum.
7. There was a need for more inputs from the communities regarding clean ups. It was suggested that Soubise Beach be used as a pilot area for a fisherfolk led clean-up project.
8. It was recommended that clean-up efforts should be focused on where there are human settlements.
9. Where accumulations were not as heavy, manual raking of the beaches was recommended as the preferred option, and removing the sand, through sifting was identified as a possible livelihood option.
10. It was also suggested that the Sargassum should be collected and removed while it is still in the water and before it accumulates on the beach as this is easier and less damaging.

Saint Kitts and Nevis

1. It was agreed that there should be clean-up initiatives led by the communities and fisher folk as it was affecting their livelihoods.
2. Although there was the Draft Management Plan for Sargassum and the DMR had been given responsibility for implementation, the Department did not have enough human or financial resources.
3. It was recommended that agencies should identify what they can offer in terms of resources to conduct clean-ups e.g. human, financial, equipment.
4. It was recommended that a cabinet submission should be drafted jointly by the Department of Marine Resources and the Department of Environment and Planning and circulated to the members of the committee identified in the Draft Sargassum Management Plan for their inputs and this should be done as quickly as possible and submitted to the Minister for immediate action.

Saint Lucia

1. The Outlook Bulletins help by alerting the network about the impending arrival. They are usually shared with stakeholders such as the SLHTA, NEMO, Ministry of Tourism, and Dive Associations.

2. There is already a taskforce, and a focal person working on Sargassum, however it was recommended that a permanent body with responsibility for clean-up on a weekly basis was necessary. It was recommended that the government should coordinate this entity, and activities should be budgeted on a quarterly basis.
3. The need for a 4-wheel drive vehicle was also identified as it was needed to access some of the affected areas.
4. The need to understand the currents and how they change throughout the seasons was identified as this influences the movement of the Sargassum.
5. While the outlook bulletins from the University of South Florida and NASA were useful in predicting arrivals, it was recognized that the scale was too wide and could not be used to predict which bays would be affected.
6. It was noted that there was a committee that included the Nation Conservation Authority and the Department of Fisheries and was chaired by the Cabinet Secretary and The Minister of Agriculture. This would look at financing and budgeting for Sargassum clean ups.

Saint Vincent and the Grenadines

1. There is a need for closer cooperation between government, communities and the private sector in cleaning up.
2. The communities visited recommended more frequent meetings with government authorities to keep them up to date and share information and best practices for clean-up and disposal of Sargassum.
3. It is recommended that innovative uses of Sargassum should be identified and there is a need for the establishment of sustainable clean-up operations.

Trinidad

1. Presently, various government agencies or government supported agencies are developing management plans and action plans in response to Sargassum influxes. There appears to be a gap in the integration of these agencies and the inclusion of other key stakeholders in developing a National Management Plan.
2. To obtain funding was identified as a major contributing factor for the development of such a plan, consequently agencies are developing in-house plans as to mount a response to the influxes.
3. It is recommended that a National Committee be established to develop and operationalize a Sargassum Management Plan for Trinidad and Tobago, taking into account the specificities.