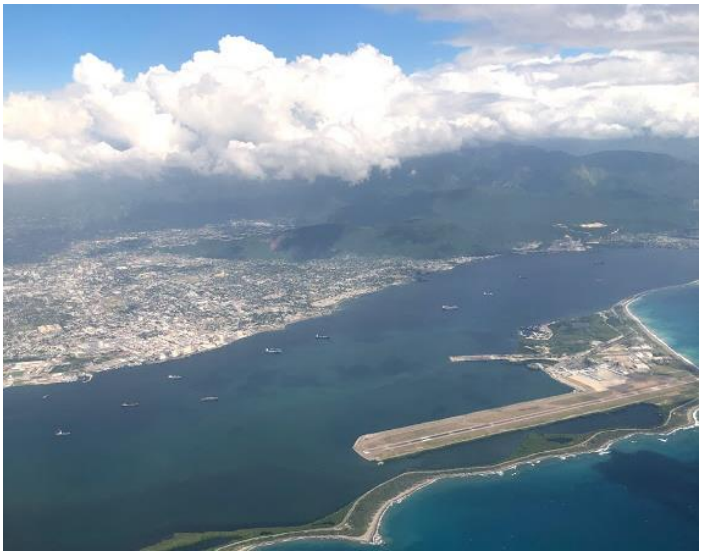
IAEA
International Atomic Energy Agency

INT0093

Applying Nuclear Science and Technology in Small Island Developing States in Support of the Sustainable Development Goals and the SAMOA Pathway

Report of the Interregional Workshop on the Use of Nuclear Techniques to Address Sargassum

5 – 7 November 2019



University of the West Indies, UWI
Kingston, JAMAICA

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1. BACKGROUND

Small Island Developing States (SIDS) share a suite of serious and unique sustainable development challenges, including for example, heightened vulnerability to climate- and anthropogenic-change, rapidly growing populations, finite terrestrial and marine resources, extreme remoteness, particular vulnerability to extreme natural disasters, and general disparate and challenged socio economic conditions. Their growth and development may be further challenged by poor communication and a lack of infrastructure. The SAMOA Pathway identifies several priority areas, which may impede socio-economic progress, and when addressed correctly will advance sustainable developmental and general well-being. Some of these priority areas include: sustainable energy; disaster risk reduction; marine ecosystem health; food security and nutrition; water and sanitation; the management of chemicals and waste including, hazardous waste; health and non-communicable diseases; education, science, technology and innovation; desertification, land degradation and drought; invasive alien species; data and statistics and institutional support.

Several organizational meetings with participation from experts, potential partners, stakeholders as well as SIDS Member States were conducted in mid-2016 at the IAEA Headquarters in Vienna. At these meetings, the need for strengthened cooperation with SIDS Member States was clearly identified. Those preparatory meetings led to the Meeting on Interregional Cooperation 2018-2021 in November 2016, with attendance of more than 40 representatives from 21 SIDS Member States, seven regional organizations and several UN representatives. The outcome of the interregional meeting was the identification of prioritized SIDS development challenges where IAEA can directly contribute in the medium term, as well as clearly defined objectives, outputs and activities for a 2018-2021 Interregional Project, which was subsequently approved by the IAEA.

According to the meeting outcome, one of the needs that is being addressed by this Interregional Project is to strengthen of capacities of SIDS Member States in the application of nuclear science and technology that can be used in the management of coastal and marine ecosystems, as explicitly outlined in Output 5 of the Project description. As a consequence and in accordance with the 2018 meeting in Cienfuegos, CUBA, a second interregional coordination meeting and workshop was organized in November 2019 at the University of the West Indies (UWI) in Kingston, JAMAICA.

2. MEETING OBJECTIVES

The purpose of this *Interregional Workshop on the Use of Nuclear Techniques to Address Sargassum* was to bring together representatives from several SIDS regions, i.e., the Caribbean and the Pacific, to further discuss Project activities and objectives, and to stimulate opportunities for intra-regional networking and collaboration. A common theme of this workshop was to highlight current activities on recent sargassum outbreaks in the Caribbean Sea, to share existing data and interpretations, and to discuss strategies to help ameliorate the widespread sargassum issue that is becoming a vast blight for many Caribbean Sea Member States.

This workshop was organized under the framework of IAEA Interregional Technical Cooperation Project INT0093 *Applying Nuclear Science and Technology in Small Island Developing States in support of the Sustainable Development Goals and the SAMOA Pathway*.

3. MEETING SUMMARY

The meeting commenced as per the agenda (Annex 1), which was developed by IAEA, CRFM and UWI.

At the start of the meeting, welcoming remarks were provided Ms Mona Webber (UWI), Mr Perez Pijuan (IAEA), Mr Peter Swarzenski (IAEA) and Mr Milton Haughton (CRFM), after which there was *tour de table* of all attendees (List of Participants in Annex 2). The meeting was very effectively hosted at UWI by Ms Mona Webber and her skilled team.

The 3-day workshop consisted of a series of keynote lectures that were delivered by experts and stakeholders including the University of Groningen, the University of South Florida, the University of Southern Mississippi, the Caribbean Regional Fisheries Mechanism (CRFM), the Caribbean Agricultural Research & Development Institute (CARDI), the United Nations Environment (UNEP), Intergovernmental Oceanographic Commission of UNESCO (IOC-UNESCO), the Jamaica National Environment and Planning Agency (NEPA), the IAEA, the International Centre for Environmental and Nuclear Sciences at UWI (ICENS), and the University of the West Indies at Mona, Jamaica (UWI).

Representatives from participating SIDS Member States then provided brief country updates and some also elected to record their updates as short reports (Annex 3). An afternoon of site visits to UWI' ICENS and a field trip to nearby Port Royal and surrounding mangrove forests, as well as a UN presentation completed day-two. The last day of the meeting was devoted to two science presentations after which a discussion ensued on mutually agreed-upon next steps.

The INT0093 2020 workplan as it relates to Output 5 "*Capacities increased for using radio tracer and isotopic techniques for conservation and sustainable use of ocean sea and marine resources"* was discussed by the IAEA. Furthermore, the framework of the Interregional Project and its marine environment topics and potential venues and mechanisms for implementation of project activities were also introduced and discussed.

Based on discussions that occurred during the 3-day meeting, participants reached consensus on the following topics:

- The INT0093 project marine workplan and logical framework is presented in Annex 4 and 5, respectively. The IAEA advised on project activities and expectations, and an implementation strategy contingent also on available funds.

- SIDS Member States are encouraged to explore synergies with UN Environment and IOC-UNESCO, which address sargassum, marine pollution and other algal blooms via several existing initiatives.

- Regional analytical facilities, such as Cuba' Centro de Estudios Avanzados de Cuba (CEAC), and Jamaica' UWI and UWI' ICENS are encouraged to also provide regional expertise to address sargassum and other priority marine topics.

- Sargassum sampling will be expanded in 2020 to include key endmember samples (e.g., Sargassum Sea, off Brazil' Amazon River delta, and off west Africa) and from more SIDS Member States, including from geographically diverse Caribbean islands. The IAEA will assist in the coordination of sample retrieval across the Atlantic Ocean basin through its Technical Cooperation Programme and Member States. Ms Mona Webber to provide a sargassum ID field key. Additionally, a sampling protocol will be developed so that all samples can be collected in a consistent and correct manner.

  It was suggested that the list of sample analyses could also be expanded to include emerging contaminants (POPs), genetic profiling, metal speciation (i.e., organic / inorganic As), and that sampling / data management be centrally organized. With available funding, sargassum sampling could possibly be extended to cover different seasons as well.

- Member States recognized the need for enhanced communication and coordination at all levels, which may be facilitated through regional entities such as UN Environment and IOC-UNESCO. For example, the SIDS Member States should capitalize on opportunities to engage in the Sargassum Declaration that was derived from the 2019 Guadeloupe Symposium, circulate and stay informed on the Sargassum White Paper, and actively participate in the Sargassum Working Group.

- With available resources, laboratory-based experiments (i.e., the IAEA Radioecology Laboratory uptake and depuration studies) and mesocosm-scale agricultural field experiments with CARDI are proposed to complement ocean sargassum sampling.

- A 2020 Technical Meeting is planned to be held in a Pacific region SIDS Member State country (i.e., Palau, Fiji, Papua New Guinea) to provide a platform to discuss new data and interpretations, to continue to network and to build regional capacities.

- Participants may contact respective IAEA NLOs to explore ongoing and planned national and regional IAEA TC projects, which may be able to better accommodate SIDS Member State's needs vis a vis marine environment topics. Procurement under INT0093 must be limited to essential equipment/consumables that are required to conduct interregional training courses and workshops, maximizing the use of existing infrastructures in host institutions.

- Commitments from all participating SIDS Member States, as country nominees for INT0093, to work in full coordination and to provide timely updates as is reasonable.

- To further facilitate regional sample exchange and analyses, the possibility of developing an IAEA Collaborating Centre with the University of the West Indies ICENS will be explored.

GROUP PHOTO

Photo taken on Wednesday, 6th November 2019 at Mona Visitor Center, University of the West Indies, Kingston, Jamaica *(Photo credit: UWI)*.

ANNEX 1: Meeting Agenda

TUESDAY November 5th

8:00-9:00	Commute from hotel to meeting venue; sign in / register
9:00-09:30	Welcoming remarks by: Mona Webber, Director Centre for Marine Sciences, UWI, Jamaica Saul Perez (IAEA Section Head TCLA, Vienna) Peter Swarzenski (IAEA Section Head Radioecology Laboratory, Monaco) Milton Haughton (Exec Dir CRFM) Tour de table, introduction of participants; logistics
9:30-10:15	Introduction to IAEA TC and NA Environment Laboratories Saul Perez, IAEA Vienna and Peter Swarzenski, IAEA Monaco
10:15-10:45	Coffee break
10:45-11:30	Remote sensing of Atlantic Basin Sargassum blooms (Chuanmin Hu- USF) by VC
11:30-12:15	Sargassum impacts on fishing and coastal communities, issues and responses (Milton Haughton, CRFM)
12:15-14:00	Lunch at the Mona Visitor' Center
14:00-15:30	Member State presentations on sargassum situation in each country, impact, issues, and challenges (<10min per country)
15:30-15:45	Coffee break
15:45-17:30	Member State presentations on sargassum situation in each country, impact, issues, and challenges (<10min per country)
18:00	Reception at the Mona Visitor's Lodge
20:00	Shuttle back to hotel

WEDNESDAY November 6th

8:30-9:00	Shuttle to conference venue
9:00 -09:45	Introduction to practical uses of isotopes (Harro Meijer, University of Groningen)
9:45-10:30	State of the science on sargassum (James Franks, University of Southern Mississippi) by VC
10:30-11:00	Coffee break
11:00-11:45	UN Environment-Jamaica presentation on sargassum in the Atlantic basin (Jodi Johnson, UN Environment - Ecosystems Division)
11:45-13:00	Site visit to the Centre for Environmental and Nuclear Sciences (ICENS) UWI-Jamaica Presentations from ICENS staff on linked sargassum capabilities (Jhenelle Williams, Johann Antoine and Leslie Ann Hoo Fung)
13:30-14:00	Box lunch at the Mona Visitor' Center
14:00-18:00	Afternoon site visit to Port Royal Marine Lab and surroundings Lectures at the Marine lab – Jamaica (Lorna Inniss, Coordinator Cartagena Convention Secretariat, Ecosystems Division, UN Environment) on sargassum issues in the wider Caribbean
19:00	Drive back to hotel

THURSDAY November 7th

9:00-9:45	Overview of on-going initiatives to understand and manage Sargassum and other harmful algal blooms (Cesar Toro, IOCARIBE of IOC UNESCO) by VC
9:45-10:30	Potential uses of sargassum in agriculture (Rasheeda Hall-Hanson and Gregory Robin, CARDI)
10:30-11:00	Coffee break
11:00-12:30	Recommendations / future directions
12:30-14:00	Lunch at the Mona Visitor' Center
14:00-17:00	Recommendations / future directions Discussion and drafting of the meeting report Official closing of meeting
14:00	Shuttle back to hotel

ANNEX 2: List of Participants

ME-INT0093-1901862
Interregional Workshop on the Use of Nuclear Techniques for Sargassum Control
Kingston, Jamaica
5 to 7 November 2019

List of Participants
(as of 2019-10-23)

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28	**Mr Cesar TORO (by VC)**	Head UNESCO IOC Regional Secretariat for IOCARIBE Secretaria Regional de la COI UNESCO para IOCARIBE Cartagena de Indias, Colombia Tel.: (575) 664 0955; Email: c.toro@unesco.org
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31	**Mr Dale F. St. G. Webber, CD**	Pro Vice-Chancellor and Principal University of the West Indies Office of the Campus Principal Senate Building, Main Annex, Mona Kingston 7, Jamaica
32	**Mr Gregory Robin** **Ms Rasheeda Hall-Johnson**	Country Representative, Manager Science, Technology, and Innovation Caribbean Agricultural Research and Development Institute (CARDI)
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ANNEX 3: SIDS Member States needs for marine environment topics (from 2019)

Country	Ocean acidification		Contamination								Harmful algae bloom					
			Trace metals		Persistent organic contaminants		Microplastic		Eutrophication		Ciguatera		Red tides		Sargassum	
	Carbon cycle	Retrospective trends	Monitoring	Retrospective trends	Monitoring	Retrospective trends	Monitoring	Retrospective trends	Monitoring	Retrospective trends	Identification	Toxicity	Identification	Toxicity	Identification	Toxicity
Barbados	X	X	X						X						X	X
Belize	X	X	X	X	X	X	X	X		X					X	X
Cuba	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Dominican Republic					X		X	X			X	X	X	X	X	X
Fiji	X	X					X	X								
Guyana	X	X	X		X		X								X	X
Jamaica	X	X	X	X			X	X							X	X
Mauritius	X	X	X	X			X	X			X	X				
Palau	X	X			X	X	X	X								
Papua New Guinea	X	X	X	X					X	X						

ANNEX 4: SIDS Member State reports

Dominica

Technical Meeting Report
INT0093 Interregional Workshop on Sargassum
Kingston, Jamaica, 5-7 November 2019

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Abstract

In the Caribbean Region, the islands have experienced this new phenomenon of sargassum inundations which began in the year 2011. While there have been many suggestions of possible uses and exploitation of this seaweed, some of the most common are in the use in soil enrichment (compost) and in animal feed. The island of Dominica has not been spared the impacts of the sargassum inundations, however, currently the island has not developed a national strategy in the management, useful exploitation, research and monitoring the impacts of sargassum. Notwithstanding this national limitation, on a regional scale there are many activities afoot. The Region, through its various government entities, regional organizations, environmental institutions and agreements, research and educational institutions, non-governmental organizations and private sector organizations, have taken a collaborative approach to address this sargassum phenomenon. This resultant regional efforts and products are what countries like Dominica will look to, to model and adapt on a national scale for the management of sargassum inundations.

Sargassum Inundation Challenges

Similar to the other islands within the Eastern Caribbean chain, Dominica had begun experiencing sargassum inundations in the year 2011. While there was great concern locally of the impact of the high volume of seaweed landings on the island coasts, there has been no coordinated effort to address this phenomenon on a national scale. Currently, there is no national policy existing in the Commonwealth of Dominica to manage and/or exploit the useful benefits of sargassum seaweed. The lack of national policy to address the sargassum events, has left a gap, in that there is no government department which has been assigned specifically with the establishment of management programmes for sargassum. There is a general lack of baseline data on sargassum arrivals in Dominica, and no evidence of interdepartmental cooperation for sargassum management exists.

The Climate Change phenomenon has seen a regular arrival of sargassum seaweed on our coastlines and therefore the need arises for regular monitoring activities both in the aquatic environment and the coastal environments especially where there may be communities and business establishments that may be affected from the decaying sargassum. Thus it is essential to equip the various monitoring departments with the technical capacity to track, sample and analyse data related to sargassum arrivals, determine its impact on marine biota, economic impact on affected hotels and other business establishments by calculating the economic burden and the related public health impact of the decaying seaweed on nearby communities.

Seaweed image captured in the North East village of Marigot. [1]

Opportunities

Many opportunities exist and have been exploited in the management of sargassum seaweed inundations. In this region, one of the most popular activities is the composting of the product to improve soil characteristics for agriculture. However, there are many other uses to be explored. These include *inter alia,* its use in the rehabilitation of coastal beaches to guard against coastal erosion, uses in livestock feed, pharmaceuticals and production of biogas as has been highlighted in documents such as the Sargassum Management Brief by UWI, CERMES [2];[3]. Pharmaceutical exploitation of sargassum seaweed material due to its antibacterial and antioxidant property could provide a potential response to the emerging concern and public health threat of antimicrobial resistance [5]. There have been many explorations of sargassum use for example as a source material for alginates due to the gel-like and viscous characteristic, however the seasonal variation does not lend itself to being a regular source of raw material for industrial production and would therefore need to be explored further [4].

Achievements

The Caribbean Region has taken a coordinated, collaborative approach to the management of the Sargassum phenomenon being experienced in recent times. All of the initiatives that have been started have been to ensure the Caribbean region responds to this phenomenon as a grouping. The initiatives to address and manage the sargassum inundations have been a fair amount and demonstrates the seriousness with which the regional governments have taken this inundation event on the coastal environments of the Caribbean region. Some of these initiatives are highlighted in Table 1. One of these which merits highlighting is the 2019 International Sargassum Conference hosted by the French Department of Guadeloupe. This activity has brought together heads of states from the region, academics and researchers, private and civil sector and other relevant stakeholders who will all share their knowledge and experiences in the process of forecasting, managing and useful exploitation of the sargassum seaweed. It is from such collaborative work that small islands such as Dominica will look upon to model and formulate the country's national strategy to address the sargassum inundations.

Table 1. Various Caribbean Response Activities to Sargassum [6]

Year	Activity/Response
2015	1st Caribbean Sea Commission (CSC) Symposium, Trinidad and Tobago
2015	Sargassum Caribbean Symposium, UWI CERMES, Barbados
2015 to present	Sargassum on-line forum, SPAW-RAC and SPAW Secretariat UNEP/CEP
2015	Sargassum A Resource Guide for the Caribbean - CAST/CHTA
2016	Sargassum Management Brief, CERMES, SPAW-RAC, GCFI
2016	CRFM Sargassum Management Protocol
2017	CC4Fish Project (Support in drafting sargassum management plans, fish population study, development of an early warning system) by FAO, GEF, CRFM along with partners - CRFM, UWI, CNFO, TNC,5Cs, CDEMA, countries Antigua and Barbuda, Dominica, Grenada, St. Lucia, St. Vincent and the Grenadines and Trinidad and Tobago

2016	The Integrating Water, Land and Ecosystems Management in Caribbean Small Island Developing States (GEF-IWEco) Project - involves 10 countries: Antigua & Barbuda; Barbados; Cuba; the Dominican Republic; Grenada; Jamaica; Saint Kitts & Nevis; Saint Lucia; Saint Vincent & the Grenadines, and; Trinidad & Tobago Component 2 of the project is focused on research, where the sargassum phenomenon has been chosen as one of the main focus areas.
2018	Protocol on Climate Change Adaptation and Disaster Risk Management in Fisheries and Aquaculture by CRFM, FAO and signed by CARICOM
2019	The International Conference on Sargassum 2019, October 24 to 26, 2019, Guadeloupe

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Saint Vincent and the Grenadines

Technical Meeting Report
INT0093 Interregional Workshop on Sargassum
Kingston, Jamaica, 5-7 November 2019

Kris Isaacs

Fisheries Division, Ministry of Agriculture, Forestry, Fisheries, Rural Transformation, Industry and Labour

Kingstown, Saint Vincent and the Grenadines

Introduction

In 2011, between the months of March and August, unprecedented quantities of *Sargassum* seaweed begun arriving on the eastern coasts of Saint Vincent and the Grenadines. It begun as small waves but then increased in frequency and amonths until there was an excessive accumulation of the marine algae on some of the beaches frequented by nationals and tourists.

Early research had suggested that due to low air pressure and high sea temperatures in 2010, along with the high nutrient inputs (possibly from the Amazon and Orinoco rivers), the seaweed may have flourished to a huge mass in the North Equatorial Recirculation Region (NERR) and then released into currents that flowed from the south into the Caribbean. The unusual nature of that Sargassum event, and the coincidental relationship with other climate conditions suggest that the invasions, starting in 2011 and then continuing in 2015 and 2018, would have been caused by large swings in ecosystem dynamics due to global temperature increases.

Sargassum impact on St. Vincent and the Grenadines.

The invasion of the *Sargassum* into the waters of St. Vincent and the Grenadines has had adverse impacts on a variety of sectors. The fishing industry was one of the first to be affected as the *Sargassum* mats pose a physical hindrance to the pirogues which the fishers use. The seaweed becomes tangled in the propellers and can even clog the intake on the outboard engines. The drifting *Sargassum* also tend to become tangled in the fishing lines and nets of the fishers. The inability of Fisherfolk to carry out normal day to day operations has adverse effects on the livelihoods of the families as well as the national economy. A reduction of fish landings at the various landing sites and fish markets equates to less earnings and productivity for the fishing industry.

The tourism industry is also affected as floating debris tends to be concentrated among the buoyant fronds of the *Sargassum* which form the floating mats. This creates an eye sore and a general loss in amenity as well as recreational use of the coastal areas. This *Sargassum* invasion has unfortunately coincided with the “summer months,” which is when most locals and tourists spend time on the beaches throughout St. Vincent and the Grenadines. Once established in an area, the presence of these dense *Sargassum* mats deters patrons from visiting these beaches and in cases where a massive proliferation of the *Sargassum* occurs in Bays, they may even act as deterrent for yachts to moor. The invasion also poses concerns for the human settlements which are situated in and around affected sites. The *Sargassum* washes into these areas and becomes trapped. As the seaweed

stagnates, the *Sargassum* dies and rots creating H2S (Hydrogen Sulphide gas) which emits a "rotten egg" smell and can cause symptoms of vomiting, headaches and respiratory ailments in humans. The Hydrogen sulphide gas has also had adverse effects on electrical equipment, corroded jewellery and metal objects within homes even stripped the paint off of houses in some areas.

In St. Vincent and the Grenadines, mounds of *Sargassum* have accumulated along principal bays and piers and some instances have completely covered entire beaches. The offensive odours emanating from the *Sargassum* has affected beach goes as well as guest at hotels in St. Vincent as well as Bequia. In Union Island, the Ashton Bay was saturated with large quantities of *Sargassum*, affecting guest hotels and costumers along the sea front. Clifton beach was reported to have lesser impact. On the island of St. Vincent, most of the *Sargassum* can be seen in the north-eastern quadrant from Mt Grennan to Owia – including Georgetown, Sandy Bay and Old Sandy Bay. Other beaches affected including Drip, Rabacca, Lanley Park, Georgetown, Byrea, Colonarie and Mount Grenan beaches, Shipping Bay and Brighton Salt pond. Spring, Industry and Hope beaches were also affected by Sargassum on the island of Bequia.

Achievements

Cabinet requested the establishment of a National Task Force on *Sargassum* in July 2015 to investigate the extent of the problem caused by the proliferation of the seaweed on the coastlines of St. Vincent and the Grenadines and the impacts on the communities in close proximity to the masses of *Sargassum*. The Task Force is chaired by the Minister of Transport and Works and is comprised of the following representative Ministries: Ministry of Agriculture, Forestry, Fisheries, Rural Transformation, Industry, and Labour, Ministry of Transport , Works , Urban Development And Local Government, The National Parks, Rivers and Beaches Authority in the Ministry of Tourism, Sports and Culture, Ministry of Health ,Wellness and the Environment, Ministry of Housing, Informal Human Settlements, Land and Surveys and Physical Planning. There are also representatives of the Hotel and Tourism Association, the National Fisherfolk Cooperative, the National Emergency Management Organization, and representatives from the Office of Grenadines affairs.

Although a formal protocol has not been adopted through legislation, the Task Force was established to disseminate information on the *Sargassum* influx and to promote the adaptation of best management practices in dealing with the issue. The Task Force was also mandated to clear beaches and bays of *Sargassum*, especially in areas where there is potential for development of serious problems to local ecosystems and critical industries such as the fisheries and tourism sectors, and the general health of citizens in communities adjacent to intense build-up of the seaweed. This was done through the formulation of working crews in local communities. The taskforce also sought to address the sustainable use of *Sargassum* seaweed, exploring local enterprises that can be developed around the seaweed, thereby creating socio-economic benefits for local communities. Some local farmers used the seaweed as fertilizer in crop production and the Research and Development Unit in the Ministry of Agriculture is exploring the use of Sargassum in the making of compost.

Saint Vincent and the Grenadines has also benefitted from projects developed in relation to aspects of the the Sargassum influx and impacts it has had on the Caribbean islands. These projects include the Food and Agricultural Organization (FAO) project on Climate Change Adaptation in the Eastern Caribbean Fisheries Sector (CC4Fish) and the joint project between the Caribbean Regional Fisheries Mechanism (CRFM) and the Japan Internation Cooperation Agency (JICA). Both projects have provided support to St. Vincent and the Grenadines in building national awareness of the Sargassum influx, documenting the scope of impacts which the influx has had on the island and suggesting potential counter measures to the Sargassum invasion.

Challenges

The annual fluctuation of *Sargassum* arrivals on the shores of Caribbean islands is still not clearly understood by national management agencies, as such it is extremely difficult for governments to prepare sufficient annual budgets. There is therefore a need for greater multiagency and multilateral collaboration, especially in exploring possible solutions for *Sargassum* use in the face of unprecedented costs for coastal cleanup operations.

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Jamaica I

Technical Meeting Report
INT0093 Interregional Workshop on Sargassum
Kingston, Jamaica, 5-7 November 2019

Sargassum update from Jamaica 2; The UWI response

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1. Introduction and Background

Large mats of *Sargassum* seaweed blanketed coastal areas of especially the north coast of Jamaica at the end of 2014 and the start of 2015 (Webber 2015). These algal blooms were first seen in 2011 (Webber and Aiken, 2018). However, the 2014/15 occurrence had a greater effect on Jamaica and led to our environmental regulatory agency (National Environment and Planning Agency- NEPA) having to respond to mitigate the deleterious effects of the inundation on Jamaica's beaches and coastal waters. By 2018, Jamaica and the rest of the Caribbean saw the greatest and most continuous inundation of *Sargassum* seaweed as the Caribbean and adjacent areas became part of the Great Atlantic *Sargassum* Belt (Wang et al. 2019). In August 2018, NEPA contacted the Faculty of Science and Technology (FST) at the University of the West Indies (Mona) with a request for partnership to explore what to do with the large volumes of *Sargassum* seaweed being collected from the Jamaican coastline. In response, the FST established a *Sargassum* research group (September 2018) whose mandate was to "*Explore the potential commercial uses of Sargassum*".

2. Species and forms of *Sargassum* around Jamaica

A preliminary step in the development of technologies to valorize the algal biomass was the determination of the species/forms of *Sargassum* found in the masses and their chemical/elemental profile. Two holopelagic species of *Sargassum* have been reported from the Atlantic;

Sargassum fluitans and *S. natans* (Schell et al. 2015). These species can have several morphological forms as described by Parr (1939) with *S. fluitans* having two possible forms (III, X) and *S. natans* having four (I, II, VIII, IX). The species and forms identified by the FST research group in the *Sargassum* mats surrounding Jamaica were *S. natans* I and VIII, and *S. fluitans* III. Unlike reports of the dominance of a previously rare form of *S. fluitans* (VIII) by Schell et al. (2015) and Amaral-Zettler et al. (2017), the blooms sampled around Jamaica in 2018/19 were dominated by *S. fluitans* III (by ~70%), followed by *S. natans* I (~20%) while *S. natans* VIII was ~10% of the mass. Indeed it was difficult to find enough of the latter (previously dominant form) to conduct chemical analyses.

3. Valorizing *Sargassum*

As the research group sought to valorize/use the material concept papers have been developed (Reid 2019; Tonon and Reid 2019) whereby approaches were categorised as follows:

1. **"*High volume / low value*"** uses based on the scale of the collections:

- Use of *Sargassum* biomass for anaerobic digestion and production of methane which can be used as a source of energy.
- Use of *Sargassum* in soil amelioration directly after collection from the shores (mulching), or after composting; the aim being to enhance growth of crops while achieving weed control and enhance restoration of mangrove and sand-dune ecosystems with nursery grown seedlings.

2. **"*High volume / medium value*"** uses based on extraction of **complex carbohydrates**:

- Extraction of Alginates: these cell wall polysaccharides, used as texturising agents, have a wide range of industrial applications, including in the food industry. They also have the potential to be used for biosorption of heavy metals, and for the production of biomaterials.
- Extraction of laminarin, a polysaccharide produced by brown algae (Phaeophyceae), is used in modern agriculture, as a bio-fungicide that stimulates natural defence mechanisms in plants/crops.

3. **"*Low volume / high value*"** uses based on extraction of **bioactive compounds** with potential production of pharmaceuticals and cosmetics. Extraction of pigments e.g. carotenoids and sulfated polysaccharides e.g. fucoidans. This approach would require separation of the different species and forms contained in the mass.

The FST *Sargassum* research group would also consider technologies to efficiently predict *Sargassum* landings around Jamaica and accurate determination of the quantities in the environment.

4. Findings of UWI/FST (Mona) Research to date

Having identified the species and forms, and based on the need to explore commercial applications the chemical profile was determined for each *Sargassum* spp. by analysis of elements, nutrient compounds, toxins, fatty acids as well as calories, moisture content and pH (Table 1). These analyses revealed that each species/form had very different chemical profiles for some constituents. *S. natans* VIII contained high concentrations of Nitrate, followed by *S. fluitans* III; while *S. natans* I, contained very small concentrations of the nutrient. Iron was also very unequally distributed as were Alginates and Fucoidans; with *S. natans* VIII containing almost twice as much of these high value compounds as the other species/form (Table 1).

Additional (on-going) research activities undertaken by the FST group in response to the need to develop commercial applications of *Sargassum*, and with part funding from NEPA, include:

- Use of *Sargassum* in soil amelioration by producing *Sargassum* compost and adding it in a range of concentrations to crops like Corn (FIG. 1 from Plummer 2019) and in seedling production for coastal plant restoration projects (McCalla 2019). There are plans to explore different techniques of composting e.g. unaided vs. use of Bokashi (e.g. from Costa Rica) which aids the break-down.

- The use of *Sargassum* extract on breast cancer cell lines being done by the Natural products Institute (NPI) and the application of the extract in horticulture as an antimicrobial agent (Department of Life Sciences- DLS).

- Alginates extracted from *Sargassum* (mixed with other carbohydrates) have been used to make bioplastics by Biotechnology student (Jordan Freeman).

- Identification and synthesis of Bioactive Compounds (Chemistry student- Doleasha Davis).

This is all to be underpinned by pre-feasibility studies that guide product development (MIAS).

5. Challenges

The episodic occurrence of the *Sargassum* and variability in abundance could pose a problem for commercializing the product (especially for large-scale application like bio-methane production). The potential for storage of the dried material or ensilage (storage in fermented form) will also need to be explored along with developing appropriate technologies to protect beaches while efficiently harvesting *Sargassum*. Development of technologies to predict when and where the mats are likely to come ashore is needed. **However, the greatest challenge for SIDS is the development of affordable technologies to harvest large masses without damaging the environment/species; as we further recognise that it is ideal for the *Sargassum* to be collected at sea before it comes ashore.**

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Figures and Table:

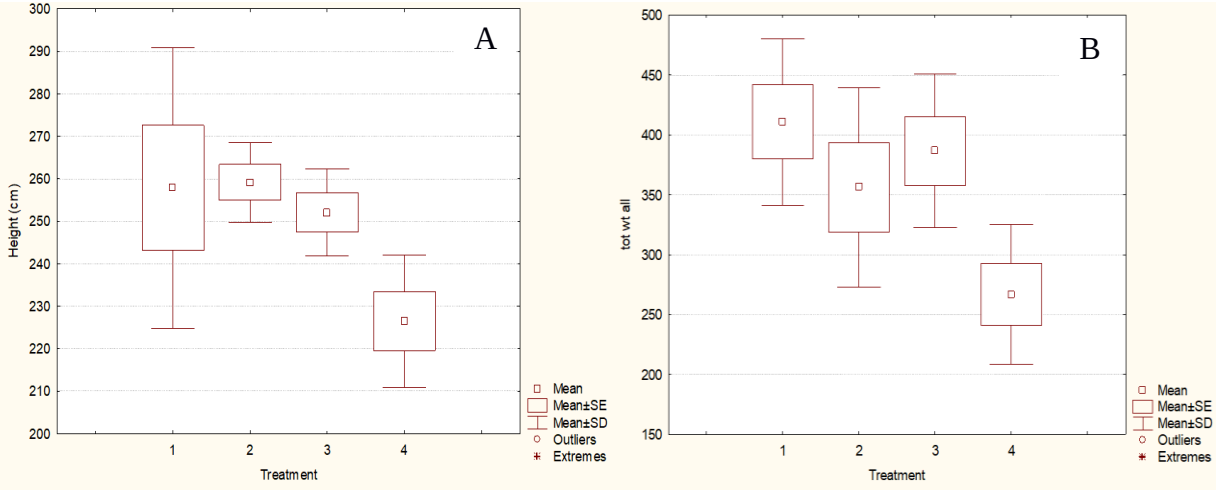

FIG. 1 A & B. Height (A) and Weight (B) of Corn treated with *Sargassum* compost mixed with soil in equal amounts (*Sargassum* only treatment). Treatments: 1- *Sargassum* only; 2- *Sargassum* and Grass; 3- Grass only; 4- Control (no amelioration).

Table 1. Chemical/Elemental profile of *Sargassum* species and forms (analysis by MIAS).

Parameter group 1.	***S. natans I***	***S. natans VIII***	***S. fluitans III***
Phosphate (mg/kg)	12.39	89.96	0.00
Nitrate (mg/kg)	< 0.59	2995.52	1757.89
Calcium (mg/kg)	2710.19	1167.74	2226.37
Magnesium (mg/kg)	447.77	221.67	343.90
Potassium (mg/kg)	335.83	427.51	280.18
Sodium (mg/kg)	115.67	106.87	103.76
Copper (ug/kg)	294.59	199.00	298.18
Iron (ug/kg)	1728.24	557.21	397.75
Manganese (ug/kg)	< 20.0	< 20.0	< 20.0

Parameter group 2.	***S. natans I***	***S. natans VIII***	***S. fluitans III***
Calories (Cal)	109.02	141.35	210.98
Calories from fat (Cal)	2.94	1.35	3.06
Total fat (%)	0.32	0.15	0.34
Protein (%)	2.35	2.24	2.03
Total Sugar (%)	0.00	0.00	0.00
Total Carbohydrates (%)	23.99	14.59	22.20
Moisture (%)	85.92	87.32	87.32
Vitamin C (mg)	3.07	1.97	1.79
Carotenoids (ug/g)	0.114	0.122	0.110
Alginates (%)	16.16	30.66	14.38
Fucoidans (%)	18.83	30.55	11.65
Fatty Acids	***S. natans I***	***S. natans VIII***	***S. fluitans III***
Dodecanoic Acid (g/100g)	4.13	5.28	6.00
Tetradecanoic Acid (g/100g)	2.99	3.10	3.31
Palmitic Acid (g/100g)	4.67	4.67	
Docasadienoic (g/100g)	5.66	2.87	
Heptadenoic Acid (g/100g)	2.95	2.92	3.69
Heneicosanoic (g/100g)			3.35
Other	***S. natans I***	***S. natans VIII***	***S. fluitans III***
Cobalt (ug/kg)	< 40.0	< 40.0	< 40.0
Arsenic (ug/kg)	< 20.0	< 20.0	< 20.0
Lead (ug/kg)	< 40.0	< 40.0	< 40.0
Mercury (ug/kg)	< 0.40	< 0.40	< 0.40
pH	7.75	7.31	7.81
Dry matter (%)	14.1	12.7	13.4

* % refers to dried material. * < indicates below detection limit of the method.

Jamaica II

Technical Meeting Report
INT0093 Interregional Workshop on Sargassum
Kingston, Jamaica, 5-7 November 2019

SARGASSUM SEAWEED INFLUX: THE JAMAICAN CONTEXT

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Introduction

Sargassum is a type of free floating fleshy brown alga that forms large floating mats, the movements of which is solely dependent on ocean currents. The mats create a functional habitat for numerous species of fish and invertebrates as nurseries for juveniles, feeding grounds, and shelter. *Sargassum* also plays an important role for particular endangered and migratory species such as sea turtles. Three morphologically different types (species) have been observed in Jamaica, *S. natans* I, *S. natans* VIII, *S. fluitans* III.

Since 2011, the Caribbean has been overwhelmed by the massive and unprecedented influx of *Sargassum* that has negatively impacted the environmental, tourism and fisheries sectors. The influx was put on the radar of the Jamaican government in 2014 based on experiences of other Caribbean territories and reports received from hoteliers on the north coast of the island. To date, the greatest and most debilitating influx was experienced during 2015 and 2018. Appendix 1 shows the high influx areas observed for 2018 and prediction for 2019 based on satellite imagery from the CLS Sargassum Monitoring Platform.

Challenges

Major Impacts include:

- Decomposition of the algae which produces hydrogen sulphide (smelly nuisance- rotten egg),
- Reduction of available oxygen in coastal areas,
- Interrupts aesthetics – high build-up of decomposing organic material,
- Trapping of small organisms,

- Trapping/transport of solid waste, microplastics,
- Threat on some sea turtle nesting beaches,
- Erosion of beach,
- Loss of sand during clean-up activities,
- Fishery – entangled lines and engine overheating.

Case Study- Hellshire Beach, St. Catherine Experience 2018

- 3rd September 2018: Hellshire Beach was visited for a routine inspection to confirm site suitability to host the annual International Coastal Cleanup day activities. The beach was covered in *Sargassum* showing varying stages of decomposition.
- 7th September 2018: Resources were expended for mobilization of a cleanup crew by way of personnel and equipment.
- 15th September 2018: International Coastal Cleanup Day activities at Hellshire Beach amidst beached *Sargassum*.
- 27th September 2018: Hellshire Beach visited for quarterly beach erosion monitoring activities, covered in decomposing *Sargassum*.

Opportunities

Jamaica could tackle independent scientific studies into the source of *Sargassum*, such as, the application of dye tracing technology to create elemental profiles of samples of beached *Sargassum* for comparison with samples taken directly from the Sargasso Sea and the North Equatorial Recirculation Region to determine the genetic similarity and thus verify the source of the alga.

Additionally, from a regional perspective, the Caribbean Community (CARICOM) Secretariat could host an expo to highlight the research and lessons learned, best practices and experiences of countries being affected and research institutions that may be doing independent studies. This could include:

- Presentations/exhibits of research from countries and institutions into applications and use of *Sargassum* seaweed to benefit the economy,
- Innovation in harvesting, storage and methods of keeping the *Sargassum* offshore,
- Quantification of influx, rate of growth and toxicity,
- Valuation of *Sargassum* ecologically and potentially, economically,
- Cumulative cost of clean-up exercises and barrier methods.

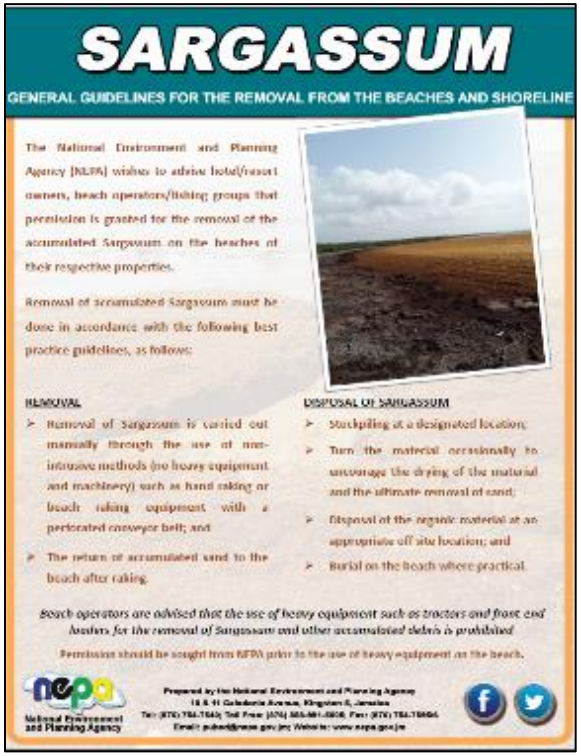
Achievements

To date, Jamaica's response has been through execution of:

- Mobilization and clean-up through Tourism Enhancement Fund (TEF) Project funding using beach clean-up guidelines, manual and heavy machinery (Appendix 2),
- Public sensitization including media releases (TV, newspaper, social media) and radio interviews and targeted sensitization of beach operators & hoteliers through the Tourism Product Development Company (TPDCo),
- *Sargassum* webpage featured on NEPA's website https://www.nepa.gov.jm/new/services_products/subsites/beach_guide/sargassum.php
- Tracking and monitoring of beached *Sargassum* (Appendix 3),
- Further research and product development via Memorandum of Understanding with University of the West Indies Faculty of Science and Technology.

Appendices

Appendix 1: Sargassum influx 2018 compared to prediction for 2019



SARGASSUM

GENERAL GUIDELINES FOR THE REMOVAL FROM THE BEACHES AND SHORELINE

The National Environment and Planning Agency (NEPA) wishes to advise hotel/resort owners, beach operators/fishing groups that permission is granted for the removal of the accumulated Sargassum on the beaches at their respective properties.

Removal of accumulated Sargassum must be done in accordance with the following best practice guidelines, as follows:

REMOVAL

- Removal of Sargassum is carried out manually through the use of non-intrusive methods (no heavy equipment and machinery) such as hand raking or beach raking equipment with a perforated conveyor belt; and
- The return of accumulated sand to the beach after raking.

DISPOSAL OF SARGASSUM

- Stockpiling at a designated location;
- Turn the material occasionally to encourage the drying of the material and the ultimate removal of sand;
- Disposal of the organic material at an appropriate off site location; and
- Burial on the beach where practical.

Beach operators are advised that the use of heavy equipment such as tractors and front end loaders for the removal of Sargassum and other accumulated debris is prohibited.

Permission should be sought from NEPA prior to the use of heavy equipment on the beach.

National Environment and Planning Agency

Prepared by the National Environment and Planning Agency
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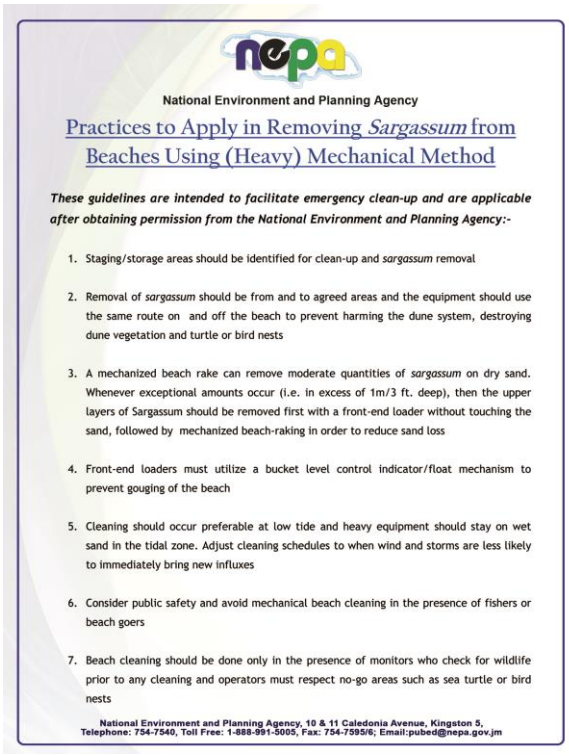

National Environment and Planning Agency

Practices to Apply in Removing *Sargassum* from Beaches Using (Heavy) Mechanical Method

These guidelines are intended to facilitate emergency clean-up and are applicable after obtaining permission from the National Environment and Planning Agency:-

1. Staging/storage areas should be identified for clean-up and *sargassum* removal
2. Removal of *sargassum* should be from and to agreed areas and the equipment should use the same route on and off the beach to prevent harming the dune system, destroying dune vegetation and turtle or bird nests
3. A mechanized beach rake can remove moderate quantities of *sargassum* on dry sand. Whenever exceptional amounts occur (i.e. in excess of 1m/3 ft. deep), then the upper layers of Sargassum should be removed first with a front-end loader without touching the sand, followed by mechanized beach-raking in order to reduce sand loss
4. Front-end loaders must utilize a bucket level control indicator/float mechanism to prevent gouging of the beach
5. Cleaning should occur preferable at low tide and heavy equipment should stay on wet sand in the tidal zone. Adjust cleaning schedules to when wind and storms are less likely to immediately bring new influxes
6. Consider public safety and avoid mechanical beach cleaning in the presence of fishers or beach goers
7. Beach cleaning should be done only in the presence of monitors who check for wildlife prior to any cleaning and operators must respect no-go areas such as sea turtle or bird nests

National Environment and Planning Agency, 10 & 11 Caledonia Avenue, Kingston 5,
Telephone: 754-7540, Toll Free: 1-888-991-5005, Fax: 754-7595/6; Email:pubed@nepa.gov.jm

Appendix 2: NEPA Sargassum clean-up guidelines

SARGASSUM SURVEY REPORT FORM

Parish	
Community	
Name of Beach	
GPS Coordinates N (DD.dddddddd) W (-DD.dddddddd)	
Date of Inspection	
Time of Inspection	
Sea / Weather Conditions	
Amount of beached Sargassum (m)	□ severe (> 1 m) □ above-normal (0.2 - 1.0 m) □ normal (< 0.2 m)
Amount of Sargassum in water - to be beached (m)	□ severe (> 5 sqm) □ above-normal (1 - 5 sqm) □ normal (< 1 sqm) none
Length of beach (m)	
Percentage of beach affected by Sargassum	
State of Decomposition	□ no scent noticeable □ mild stench □ strong stench
Dead/stranded animals observed in Sargassum mat?	□ Yes □ No List: _____ _____

Plastic-based solid waste observed trapped in Sargassum?	□ <100 items □ 100 – 1000 items □ >1000 items
Recommended Action	□ None □ Manual clean-up □ Mechanical clean-up
Name of Community Group and Contact Person (If Applicable)	
Pictorial	

Appendix 3: NEPA/UWI MOU Sargassum Survey Report Form

ANNEX 5: Work Plan (WP) for Interregional Project INT0093 as it relates to Output 5

Outputs	Activity	Input	Host Country	Target Countries	WP Budget (EUR)	Budget Year	Start Quarter	Actions	Comments
5 Capacities increased for using radio tracer and isotopic techniques for conservation and sustainable use of ocean sea and marine resources.	5 .1 To assess SIDS environmental capabilities	5 .1 .1 MEET to review existing regional policies and programmes for environmental assessment in the Pacific			0	2019	Q2		Actions in this regard can be accomplished under expert missions to every region to assess capabilities
5 Capacities increased for using radio tracer and isotopic techniques for conservation and sustainable use of	5 .1 To assess SIDS environmental capabilities	5 .1 .2 MEET to review existing regional policies and programmes for environmental assessment in the African region			0	2019	Q4		Actions in this regard can be accomplished under expert missions to every region to assess capabilities

ocean sea and marine resources.									
5 Capacities increased for using radio tracer and isotopic techniques for conservation and sustainable use of ocean sea and marine resources.	5 .1 To assess SIDS environmental capabilities	5 .1 .3 EX to assess laboratory capabilities needs organizations and networks for environmental monitoring in Africa **(NEW: HBA TO DESIGN QUESTIONNAIRE, COLLECT AND COMPILE INFORMATION; REPORT OF RESULTS COVERING THE THREE REGIONS)**		ALL	€ 5 250.00	2019	Q1		QUESTIONNAIRE DESIGN AND VALIDATION WITH REGIONAL ORGANIZATIONS, **IDENTIFICATION OF RELEVANT INSTITUTIONS AT COUNTRY LEVEL TO REACH OUT**, GATHERING AND COMPILATION, REPORT AND RECOMMENDATIONS ON ACTION PLANNING. INCLUDING THE REGIONAL POLICIES AND PROGRAMMES FOR ENVIRONMENTAL ASSESSMENT IN THE REGIONS

5 Capacities increased for using radio tracer and isotopic techniques for conservation and sustainable use of ocean sea and marine resources.	5 .1 To assess SIDS environmental capabilities	5 .1 .4 EX to assess in the Caribbean region laboratory capabilities needs organizations and networks asses possible capacity building centers and establish the baselines for environmental monitoring		Caribbean?	€ 15 000.00	2019	Q1	IAEA TO RECEIVE EXPERT MISSION REQUEST FROM SELECTED COUNTRIES	3 IEX (one per region) with a broad-scope expertise on applications in marine environment . EXPERT TEAM TO VISIT SELECTED COUNTRIES: **JAMAICA, TRINIDAD & TOBAGO, ANTIGUA?**
5 Capacities increased for using radio tracer and isotopic techniques for conservation and sustainable use of ocean sea and marine resources.	5 .1 To assess SIDS environmental capabilities	5 .1 .5 EX to assess in the Asia the Pacific region laboratory capabilities needs organizations and networks asses possible capacity building centers and establish the baselines for environmental monitoring		Pacific?	€ 15 000.00	2019	Q1	IAEA TO RECEIVE EXPERT MISSION REQUEST FROM SELECTED COUNTRIES	3 IEX (one per region) with a broad-scope expertise on applications in marine environment (one per region). **EXPERT TEAM TO VISIT SELECTED COUNTRIES: FIJI**

5 Capacities increased for using radio tracer and isotopic techniques for conservation and sustainable use of ocean sea and marine resources.	5 .1 To assess SIDS environmental capabilities	5 .1 .6 EX produce a roster of SIDS experts on marine environment review literature on most critical threats identified and available baseline data list of existing networks organizations and NGOs acting in environmental monitoring. **(NEW TARGET: EX to assess in Africa the SIDS laboratory capabilities needs organizations and networks asses possible capacity building centers and establish the baselines for environmental monitoring)**	Seychelles/ Mauritius	Seychelles/Mauritius	€ 15 000.00	2019	Q2	IAEA TO RECEIVE EXPERT MISSION REQUEST FROM SELECTED COUNTRIES	3 IEX (one per region) with a broad-scope expertise on applications in marine environment (one per region). EXPERT TEAM TO VISIT SEYCHELLES AND MAURITIUS

5 Capacities increased for using radio tracer and isotopic techniques for conservation and sustainable use of ocean sea and marine resources.	5 .1 To assess SIDS environmental capabilities	5 .1 .7 MEET Technical/Coordination on main findings key priorities focal SIDS actions roles and responsibilities. **(Marine Environment Meeting in Cuba)**	Cuba	ALL	0	2018	Q3		AIPS **EVT1802297**;
5 Capacities increased for using radio tracer and isotopic techniques for conservation and sustainable use of ocean sea and marine resources.	5 .1 To assess SIDS environmental capabilities	5 .1 .8 MEET to review existing regional policies and programmes for environmental assessment in the Caribbean. **(NEW: INT Training Course on OA, including data management)**	Mauritius	ALL	€ 60 000.00	2019	Q4		Venue proposed: Mauritius

5 Capacities increased for using radio tracer and isotopic techniques for conservation and sustainable use of ocean sea and marine resources.	5 .2 To establish a SIDS environmental observing network	5 .2 .1 FE (Group) to participate in other network meetings (10 persons)			€ -	2019	Q2		CANCELLED
5 Capacities increased for using radio tracer and isotopic techniques for conservation and sustainable use of ocean sea and marine resources.	5 .2 To establish a SIDS environmental observing network	5 .2 .3 SV (Group) Support to international conference on marine environment			0	2019	Q1		CANCELLED/On hold until results of OA research are obtained

5 Capacities increased for using radio tracer and isotopic techniques for conservation and sustainable use of ocean sea and marine resources.	5 .3 To strengthen SIDS capacities to collect and analyse environmental data	5 .3 .1 Interregional Training on sampling using isotopic and other analytical techniques **(NEW: INT Training Course on 210Po, trace metals (XRF, DMA), carbon stable isotopes and benthic toxic algae determination in sargassum)**	Cuba	ALL	60000	2019	Q3		Venue proposed: Cuba
5 Capacities increased for using radio tracer and isotopic techniques for conservation and sustainable use of ocean sea and marine resources.	5 .3 To strengthen SIDS capacities to collect and analyse environmental data	5 .3 .2 PROC EQ minimum necessary for laboratories to conduct small samples and analysis (~ 5000 EUR per country)			€ 23 000.00	2019	Q2		support with OA kit

5 Capacities increased for using radio tracer and isotopic techniques for conservation and sustainable use of ocean sea and marine resources.	5 .3 To strengthen SIDS capacities to collect and analyse environmental data	5 .3 .3 EX Develop simple methodologies to assess priority pollutants using nuclear and isotopic techniques and prepare a data synthesis product **(NEW: EX to asisst on coral core extraction)**		Belize, Palau, Mauritius	€ 5 250.00	2019	Q4	request from the country, ensure permits and drill import/export	Mesoamerican Barrier in Belize´s World Heritage Site
5 Capacities increased for using radio tracer and isotopic techniques for conservation and sustainable use of ocean sea and marine resources.	5 .3 To strengthen SIDS capacities to collect and analyse environmental data	5 .3 .4 LOC Periodic review and assessment of environmental baseline data at the national level to share with the SIDS et al.		ALL	0	2020	Q1		

5 Capacities increased for using radio tracer and isotopic techniques for conservation and sustainable use of ocean sea and marine resources.	5 .3 To strengthen SIDS capacities to collect and analyse environmental data	5 .3 .5 MEET Disseminate work done stakeholders in international conferences.			0	2021	Q1		
5 Capacities increased for using radio tracer and isotopic techniques for conservation and sustainable use of ocean sea and marine resources.	5 .3 To strengthen SIDS capacities to collect and analyse environmental data	**5 .3 .6 NEW: EX to asisst on coral core extraction**	Palau	Palau	€ 5 250.00	2020	Q2	request from the country, ensure permits and drill import/export	Palau

5 Capacities increased for using radio tracer and isotopic techniques for conservation and sustainable use of ocean sea and marine resources.	5 .3 To strengthen SIDS capacities to collect and analyse environmental data	**5 .3 .7 NEW: EX to asisst on coral core extraction**	Mauritius	Mauritius	€ 5 250.00	2020	Q3	request from the country, ensure permits and drill import/export	Mauritius
5 Capacities increased for using radio tracer and isotopic techniques for conservation and sustainable use of ocean sea and marine resources.	5 .3 To strengthen SIDS capacities to collect and analyse environmental data	**5 .3 .8 NEW: INT Training Course on Effects of OA in Corals**	France	ALL	€ 60 000.00	2020	Q3		Paris

5 Capacities increased for using radio tracer and isotopic techniques for conservation and sustainable use of ocean sea and marine resources.	5 .3 To strengthen SIDS capacities to collect and analyse environmental data	**5 .3 .9 NEW: PROC Shipment of coral drill**	Belize, Palau, Mauritius	Belize, Palau, Mauritius	€ 10 000.00	2019	Q4	request from the country, ensure permits and drill import/export	
5 Capacities increased for using radio tracer and isotopic techniques for conservation and sustainable use of ocean sea and marine resources.	5 .3 To strengthen SIDS capacities to collect and analyse environmental data	**5 .3 .10 NEW: INT Training Course on HAB species identification and the use of RBA**	Marshall Islands (TBD)	ALL	€ 60 000.00	2019	Q4		

5 Capacities increased for using radio tracer and isotopic techniques for conservation and sustainable use of ocean sea and marine resources.	5 .3 To strengthen SIDS capacities to collect and analyse environmental data	**5 .3 .10 NEW: INT Training Course on on sampling and analysis of trace elements (specially mercury) including analysis of surface sediment samples during the training/discussion of results**	Jamaica	ALL	€ 60 000.00	2019	Q4		

ANNEX 6: Logical Framework Matrix (LFM) as it relates to INT0093 Output 5

	Design Element	Indicator	Means of Verification	Baseline/Target	Assumptions
Outcome	Institutional capacities of SIDS in the application and dissemination of nuclear science and technologies to support the Sustainable Development Goals and the SAMOA Pathway established.	Cooperation agreements are signed by designated capacity building centres of SIDS regions in at least three of the thematic areas of the INT project (food security, human health and nutrition, marine environment, safety and nuclear information and knowledge management) by 2021.	Cooperative agreement documents signed and published.	No cooperation agreements are in place among SIDS regions to improve the pacific uses of nuclear sciences and technology.	National and regional authorities, partners and stakeholders remained committed throughout project implementation and after project closure to implement and sustain the cooperative agreements among SIDS regions.
Output	*Output 5:* Capacities increased for using radio tracer and isotopic techniques for conservation and sustainable use of ocean sea and marine resources.	At least one center in each region using radio tracer and isotopic techniques in marine environmental studies by 2021.	Expert monitoring and evaluation mission reports. Statistics from the Ministry of Environment. Statistics from regional marine environment centres.		Competent staff remain in the capacity building centres and sustainability of the technology is ensured by the centres. Appropriate infrastructure in place and operational. Preparatory fact-finding missions to conduct gap and needs analysis to provide the necessary data for the baseline implemented. Governments develop and implement national programmes and policies to achieve Zero Hunger targets.