DRAFT
NATIONAL SARGASSUM MANAGEMENT POLICY OF TRINIDAD AND TOBAGO

Version 6.0

February 5, 2026

PREPARED BY THE NATIONAL SARGASSUM TASK FORCE

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LIST OF ACRONYMS

IMA	Institute of Marine Affairs
EMA	Environmental Management Authority
CoPU	Coastal Protection Unit
ODPM	Office of Disaster Preparedness and Management
THA	Tobago House of Assembly
TEMA	Tobago Emergency Management Agency
MRDLG	Ministry of Rural Development and Local Government
COPE	Council of President of the Environment
CRFM	Caribbean Regional Fisheries Mechanism
SOP	Standard Operating Practice
R&D	Research and Development
PPE	Personal Protective Equipment
SaWS	Sargassum Watch System
AFAI	Alternate Floating Algae Index
MCI	Maximum Chlorophyll Index
SIR	Sargassum Inundation Risk
UTT	University of Trinidad and Tobago
UWI	University of the West Indies

NATIONAL SARGASSUM TASK FORCEDraft

Cabinet (*Cabinet Minute No. 1044 dated May 29, 2024*) appointed a National Sargassum Task Force (NSTF) in July 2024. The NSTF will act as a national, interagency coordination mechanism for the implementation of Sargassum Response for Trinidad and Tobago. The Task Force has developed the Draft National Sargassum Management Policy that seeks to encourage meaningful collaboration and communication among key stakeholders at all levels and throughout the process, from early warning to public education and awareness.

NAME	POSITION	Agency
Dr. Rahanna Juman	Chairperson	Institute of Marine Affairs (IMA)
Ms. Marcia Tinto	Member	Environmental Management Authority (EMA)
Mr. Linford Beckles	Member	Division of Environment, Climate Resilience and Energy, Tobago House of Assembly (THA)
Ms. Curmira Gulston	Member	Office of Disaster Preparedness and Management (ODPM), Ministry of Homeland Security
Ms. Renelle Bernard-Brown	Member	Coastal Protection Unit (CoPU), Ministry of Works and Infrastructure
Ms. Suzan Lakhan-Baptiste	Member	Nature Seekers
Mr. Barry Lovelace	Member	Council of President of the Environment (COPE) Tobago
Ms. Rayanna Sookoo	Member	Ministry of Rural Development and Local Government (MRDLG)
Mr. Recardo Mieux	Member	Fisheries Division, Ministry of Agriculture and Fisheries
Dr. Ryan S. Mohammad	Member	Council of President of the Environment (COPE) Trinidad

This Management Policy was developed using guidance from:

- CRFM (2016). Model Protocol for the Management of Extreme Accumulations of Sargassum on the Coasts of CRFM Member States.
- Dutch Caribbean Nature Alliance, Prevention and Clean-up of Sargassum in the Dutch Caribbean, (2019)
- Irvine *et al.* (2023). Managing sargassum shoreline inundations: A toolbox. SargAdapt Good Practice Guide Series 5.

BACKGROUND

Caribbean countries, including Trinidad and Tobago, have been battling with abnormally large influxes of holopelagic sargassum since 2011 (UNEP 2021). These floating mats of brown algae comprise mainly morphotypes of *Sargassum fluitans* and *S. natans*. These are not invasive alien species, but species found in the Atlantic and Caribbean and are now observed in atypically larger quantities. The unprecedented, massive, episodic influx of floating sargassum seaweed on coastlines has significant negative impacts, particularly on coastal communities and livelihoods, public health, tourism and fisheries (UNEP 2021). This issue therefore represents an emerging hazard for a region that is already exposed to multiple hazards. Countries and territories in the Wider Caribbean such as Mexico and US Virgin Islands have declared national states of emergency with respect to sargassum influxes (Desrochers *et al.*, 2020). This increased magnitude of sargassum is likely linked to broader underlying issues like climate change and ocean eutrophication and are likely to continue supporting significant sargassum blooms into the future (UNEP, 2021). As such, annual mass influxes of sargassum into the Caribbean Sea are now being considered as the 'new normal', requiring sustainable management responses and long-term adaptation (Desrochers *et al.*, 2020).

In typical quantities, floating sargassum mats are ecological assets providing mobile habitats harbouring high biodiversity and sought by commercial small-scale fisheries (Oxenford *et al.*, 2021). Before 2011, the typical quantities reaching Caribbean coasts were small enough to be removed manually, if at all, not harming tourism or coastal transportation, and being traditionally used in household and small-scale agriculture as fertiliser and mulch (Desrochers *et al.*, 2020). Presently, the large amount of seaweed influxes within Trinidad and Tobago's coastal waters requires large teams for daily removal. This proliferation of sargassum creates environmental hazards and economic disruptions prompting the government to appoint a National Sargassum Task Force to coordinate Sargassum management response nationally.

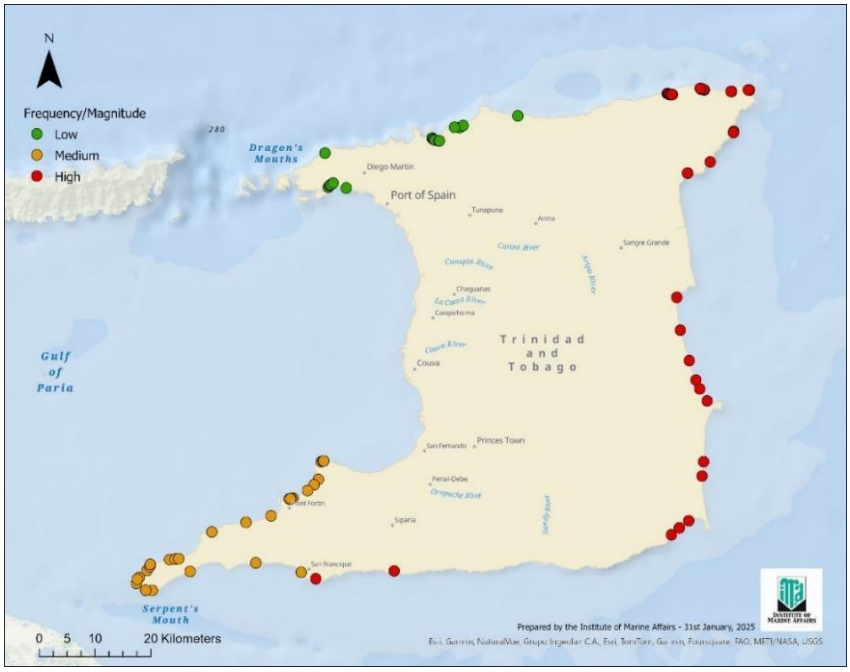

FIGURE 1: MAP OF TRINIDAD SHOWING AREAS IMPACTED BY SARGASSUM INUNDATION BASED ON QUALITATIVE ASSESSMENT OVER PAST 5 YEARS

In Trinidad and Tobago, sargassum influxes are being reported along most of our coastlines and the government has been expending funds annually to clean up and dispose of the large masses. In Tobago, the THA spent TT$1,723,000.00 in 2015, $678,290 in 2018 and $ 308,975 in 2020 to clean up sargassum on the coast.

Through IMA's National Coastal Conservation Monitoring Programme, observations were made on the beaches impacted by sargassum influx. Figures 1 and 2 represents the distribution and relative magnitude of sargassum influx. In Trinidad, communities on the northeast and southeast coasts from Matelot to Guayaguayare have been impacted by high sargassum influxes (Figure 1). More recently, there have been reports of sargassum influx on the southwest coast in Los Iros Bay and along the north coast in Las Cuevas, but in lesser quantities. Along Tobago's Atlantic coast, mats up to 0.6m thick have been observed in Tyrel's Bay in Speyside, Pinfold Bay, King's Bay, Hope Beach, Delaford Bay, Goldsborough Bay, Kilgwyn and Little Rockly Bay (Figure 2). Additionally, as of 2025, unprecedented mats were reported within the Bon Accord Lagoon, a marine protected area.

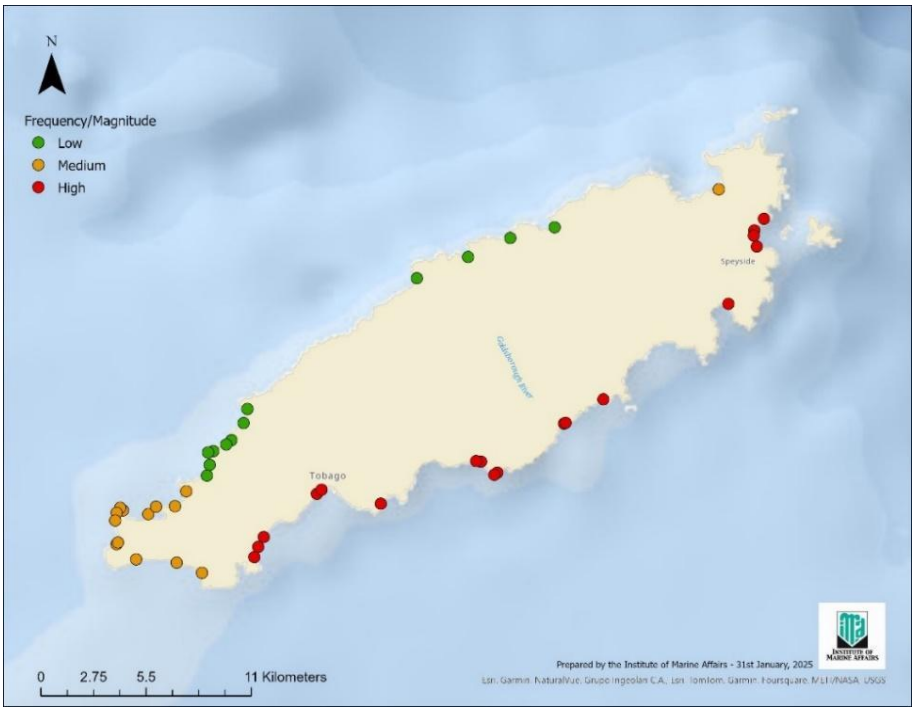

FIGURE 2: MAP OF TOBAGO SHOWING AREAS IMPACTED BY SARGASSUM INUNDATION BASED ON QUALITATIVE ASSESSMENT DURING THE PAST 5 YEARS

While Sargassum Response Plans were developed for Trinidad (2016) and for Tobago (2018), only the plan for Tobago is partly implemented. As a result, clean-up efforts remain ad hoc and costly. To this end, the Cabinet of the Republic of Trinidad and Tobago, in August 2024, appointed a multi-sectoral National Sargassum Task Force to coordinate sargassum management response. The primary role of the National Sargassum Task Force is to act as a national, interagency coordination mechanism for the implementation of Sargassum Response for Trinidad and Tobago and to offer guidance and assistance to the Regional Corporations of the Ministry of Rural Development and Local Government, the Tobago House of Assembly and other support agencies that serve as the first responders for clean-up efforts and management.

POLICY RATIONALE

The National Sargassum Management Policy is developed to ensure that sargassum influx within the coastal nearshore areas and onshore is managed and addressed in a timely and efficient manner, information is disseminated among all relevant stakeholders including coastal communities, and negative impacts are either prevented or minimised. The Policy provides adaptive strategies and guidance for the monitoring, collection, storage, disposal and valorisation of sargassum. It aims to encourage meaningful collaboration and communication among key stakeholders at all levels and throughout the process, from early warning to public education and awareness to clean up/removal. There are still many uncertainties associated with sargassum influx, so it is a good practice to be adaptive as there is no "business-as-usual" scenario yet.

GOALS AND OBJECTIVES

GOAL:

To foster a collaborative, environmentally responsible and economically beneficial approach to sargassum management through early warning, efficient removal, safe disposal and sustainable reuse, minimising adverse impacts on human health, ecosystems, and coastal economies.

GUIDING PRINCIPLES:

1. **Environmental Integrity**: All interventions will be based on minimising ecological damage.
2. **Inclusivity and Participation:** Stakeholders at all levels will be engaged and empowered.
3. **Transparency and Accountability**: Institutional roles and responsibilities will be clearly defined.
4. **Resilience and Adaptation**: Measures will account for climate change and future uncertainties, where sargassum can be managed as a resource.
5. **Alignment with Priorities 2, 5 and 6 of the National Environmental Policy, 2018** (Sustainably Managing Natural Resources, Fostering an Environmentally Responsible Society and Addressing Climate Change & Environmental and Natural Hazards, respectively).

STRATEGIC PILLARS:

- **Governance and Institutional Coordination**
  - Coordinate policy implementation through inter-agency task force and other key stakeholders.

- **Early Warning** (Risk Knowledge, Monitoring/Forecasting, Warning Dissemination and Preparedness to Respond)
  - Sargassum Risk Mapping and Modelling
  - Formalise partnerships with national and international agencies for remote sensing and predictive analytics.
  - Develop a centralised sargassum tracking dashboard and alert system for national decision-making.

- **Environmentally Safe Collection and Disposal**
  - Develop Standard Operating Practices (SOPs) for manual, mechanised, and in-water collection.
  - Identify and assess disposal sites that comply with environmental regulations.
  - Collection and disposal of sargassum in accordance with national environmental regulations and international best practices

- **Public Health Safeguards**
  - Deploy air quality monitoring equipment near high-risk coastal zones.

- Equip clean-up crews with personal protective equipment (PPE) and hydrogen sulfide detectors.
- Develop certification programme for downstream products manufactured from sargassum for domestic consumption and export markets.

- **Valorisation and Economic Opportunities**
  - Support fiscal incentives for Research and Development (R&D) in sargassum use (e.g., bio-fertilisers, cosmetics, bioenergy and construction).
  - Enhance laboratory capacity for testing.
  - Support pilot projects and scale-up of proven technologies.

- **Community Engagement and Education**
  - Conduct targeted outreach through schools, civil society (non-governmental organisations and community-based organisations) as well as the tourism sector.
  - Enable strategic efforts in management of beaches.
  - Involve local communities in shoreline monitoring and cleanup.

- **Legal and Regulatory Measures**
  - Update existing legislation governing the Municipal Corporations to enable the removal of sargassum from the shorelines
  - Update existing environmental legislation to include sargassum biomass management.
  - Establish permitting system for sargassum treatment and disposal.
  - Support development of regional institutional and policy framework for sargassum management

STRATEGIC OBJECTIVES

1. Support safe, cost-effective and environmentally sound solutions for removing, transporting and disposing of sargassum, applying a circular economy principle

2. Provide guidance on which sites should be prioritised for cleanup based on impact on human health, livelihoods and ecological sensitivity.

3. Foster critical coordination and collaboration amongst stakeholders and coastal communities to manage sargassum influx adaptively.

4. Recommend the governance structure and roles of agencies in sargassum management.

5. Facilitate innovation, research, and investment in the valorisation of sargassum as a natural resource.

6. Promote public education and awareness among citizens by providing contextual information necessary to alleviate misconceptions about sargassum and to train people to adopt the most sustainable management practices.

7. Guide the development of an early detection and monitoring system for sargassum strandings.

ROLES AND RESPONSIBILITIES

Table 1 outlines the key government agencies and their expected roles in sargassum management.

TABLE 1: KEY GOVERNMENT AGENCIES AND THEIR ROLE IN SARGASSUM MANAGEMENT

INSTITUTIONS	ROLES/ RESPONSIBILITIES
Institute of Marine Affairs (IMA)	Research, monitoring, national focal point for sargassum matters/ management and public education
Ministry of Rural Development and Local Government (MRDLG)	Coordinate and oversee activities of Trinidad's Municipal Corporations
Municipal Corporations	Coordinate beach cleanup and sargassum disposal activities with jurisdiction, i.e. burial or spreading
Office of Disaster Preparedness and Management (ODPM)	Risk Assessment Coordination of national, large-scale clean-up efforts in Trinidad and Tobago that extends beyond one Municipal Corporation Early warning Public Education and Awareness
Environmental Management Authority (EMA)	Regulatory, permitting activities surrounding disposal and valorisation; communications, public awareness and education
Divisions under the Tobago House of Assembly (THA)	Clean-up and disposal of Sargassum along Tobago's coast Communication and co-ordination amongst agencies in Tobago Management of beaches
Fisheries Division, Ministry of Agriculture and Fisheries	The Fisheries Division shall respond to reports submitted by fisherfolk to the Division, regarding the adverse impacts of sargassum, engaging relevant agencies as appropriate to implement measures to address and mitigate these impacts.
Trinidad and Tobago Meteorological Services (TTMS)	Monitoring of Sargassum influxes Early warning forecasting
Ministry of Trade, Investment and Tourism	Business development, trade licences for export and promotion of manufactured products

	Management of Las Cuevas, Maracas, Vessigny and Manzanilla Beach Facilities
Coastal Protection Unit, Ministry of Works and Infrastructure	Numerical modelling to determine location deposits for early warning
Maritime Services Division (MSD), Ministry of Works and Infrastructure	Communicate on any disruption to navigation and entries to ports

POSSIBLE ROLES OF OTHER STAKEHOLDERS IN SARGASSUM MANAGEMENT

Fisherfolk or Other Marine Users

- Participate in and contribute to ongoing information and education sessions
- Assist with the deployment of booms and clean up of sargassum in offshore areas
- Participate actively in beach clean-ups and encourage groups specifically to assist in the beach clean-ups
- Report on location and possible size of sargassum sightings at sea
- Promote the importance of good, safe practices when removing sargassum

General Public or Civil Society Organisations

- Attend, contribute, participate in information and education sessions
- Identify groups and clubs to sign up for the voluntary beach clean- up sessions
- Ensure clean-up is done thoroughly and diligently
- Encourage innovation to create sustainable livelihoods among communities, specifically the youth

Private Sector Interest (Hoteliers, etc.)

- Invest in beach clean-up activities
- Invest in infrastructure for sargassum valorisation, e.g. biorefineries.
- Build partnerships for investment / attract investors

Universities and other Research Institutions

- Conduct applied research to quantity impacts of sargassum influx on the ecological, economic and public health systems to advise on appropriate interventions
- Research and development of sargassum derived products
- Upgrade laboratory capacity to conduct quality testing on sargassum products

WHEN TO TAKE ACTION?

The most sustainable practice is almost always to let nature take its course. If sargassum washes ashore in small quantities on inaccessible, non-tourist or non-critical locations, it is generally preferable to leave the seaweed where it is (Hinds *et al.*, 2016). This has proven to be the simplest and least costly approach and has the added benefits of potentially nourishing beaches and stabilising the shoreline. However, there are several scenarios which require immediate action in removing sargassum, but the site must be first assessed to determine level of impact as follows:

LOW: A small amount of sargassum-sparse, less than 2 inches (<5cm) in depth, may not require intervention.

Small amounts of sargassum on the beach will do no harm and may even provide benefits to foraging shorebirds, and invertebrates. Over-cleaning a beach can be harmful to the environment.

MEDIUM: About 6-9 inches (15cm - 23cm) in depth. Strong odour, several insects.

Moderate amounts may not require intervention, especially where the sargassum can dry out naturally, becoming dark and brittle and incorporated into the beach sand, or washed back out to sea.

HIGH: More than 10 inches (>25cm) in depth piled along the shoreline or trapped in the nearshore, especially in inlets, estuary and wetland areas, that can result in rapid ecosystem damage, human health impacts and severe socio-economic consequences, requires interventions.

There are several scenarios which require immediate action in removing sargassum. These are as follows:

- Sargassum influx into areas that have high ecological value and where large amounts of sargassum can have a negative impact. This is especially the case for sea turtle nesting beaches, or fragile ecosystems like coral reef, seagrass beds and mangrove forests.
- Sargassum influx in areas where hydrogen sulfide released by decomposing sargassum can put the health of the community at risk.
- When floating sargassum blocks important access to and from harbours, preventing the deployment of fishing vessels.

Leatherback turtle adult and hatchling within sargassum mat on Matura Bay (Photos by Suzan Lakhan, Nature Seekers)

SITE ASSESSMENT

It is important to note that there is simply no 'one solution that fits all' for either onshore or in-water collection. In determining type and method of response, including the selection of equipment, consideration must be given to the local context, site conditions that will affect how the operation is execute and the risks or potential impacts of the operation at the site. These include:

- **Physical considerations**: prevailing winds and sea conditions; water depth; sea floor substrate (rock, rubble, sand, living); shoreline type (rocky, sandy, cliff, artificial); beach slope, length and width; site access; presence of infrastructure (jetties, piers, breakwaters, moorings).

- **Environmental considerations**: presence and type of nearshore marine habitats (e.g. coral reefs, seagrass meadows, seaweed); shoreline vegetation (e.g. mangroves, dune vegetation, coastal thicket); and wildlife using the area (e.g. shore birds, crabs and endangered species such as sea turtles, sharks, dolphins and manatees).

- **Socio-economic considerations**: typical uses of beach and nearshore areas (e.g. recreational, religious or commercial activities) and adjacent land areas (e.g. tourism, fisheries, residential, commercial, government facilities).

- **Institutional and legal considerations**: the landownership (e.g. ability to access a site); the local laws, regulations and permit requirements (e.g. governing collection of sargassum and operation of equipment on site); the availability of labour, equipment and funding; and existing capacities.

Fishing boats caught in sargassum mat in Speyside, Tobago

SARGASSUM REMOVAL

It is very likely that a combination of equipment and methods will be needed to remove sargassum, and ultimately the choice of which to use will be strongly influenced by logistical considerations at the site. The development of a site-level '**operational plan**' by the agency leading cleanup efforts whether on land or nearshore, that would map out exactly how the equipment should be used for effective and efficient collection, transport and storage or disposal of sargassum, whilst minimising environmental damage is **considered a good practice**. Local stakeholder knowledge must be used to help inform the choice of appropriate methods and equipment and the development of the operational plan.

ONSHORE COLLECTION - MANUAL

Manual removal of sargassum is most suitable when there is low to medium inundation, low frequency of events and when the area being inundated has high ecological sensitivity such as turtle nesting beaches. The sargassum should be collected when fresh because it is lighter and much easier to handle *than* when it compacts and starts to rot. Health issues and damage to environment are reduced if collected fresh, and fresh sargassum may have more potential for valorisation.

Manual removal of sargassum is impractical when there are high volumes of beached sargassum and long inundation events with continuous high supply daily. Wet sargassum decomposing at site will produce high levels of toxic gases that may pose a health risk to manual labourers.

Manual removal uses low technology equipment such as hand tools that are available locally and easy to maintain. It is time consuming and labour intensive, but most practical when volunteers are engaged.

A. Hand Tools

Manual onshore removal of sargassum using rakes/pitch forks and wheelbarrows/buckets is:

- The least environmentally damaging onshore method of sargassum removal as it does not compress beach sand or damage turtle nesting sites, can selectively avoid beach vegetation and can manually assist trapped wildlife;
- The least intrusive in terms of disturbing tourists and other beach users;
- The most versatile with regard to the physical conditions (It can be applied regardless of beach width and slope, sea conditions, site access, or presence of infrastructure.);
- The least expensive with regard to equipment (uses only relatively low-cost available technology);
- Suitable for volunteer stakeholder involvement to offset high labour costs.

B. Beach Seine

Manual onshore removal of sargassum using a beach seine or other net operated by wading into the nearshore is not recommended. It takes a large number of people, is very heavy, easily damages the net and is potentially harmful to nearshore marine flora and fauna.

ONSHORE COLLECTION - MECHANISED

Mechanised onshore removal of sargassum can be done using a variety of standard and/or customised machinery and heavy equipment and is:

- the best or perhaps the only option for removing large quantities of beached sargassum quickly and effectively;
- potentially damaging to the beach due to incidental removal of beach vegetation and large amounts of sand which can lead to serious beach erosion, as well as deep rutting and compaction of the beach sand which can destroy turtle nests and the habitat of other beach dwelling fauna;
- the most intrusive with regard to disturbing tourists and other beach users;
- costly to purchase and maintain equipment, especially in a harsh environment (wet, salty and/or sandy);
- dependent on dedicated access to the beach;
- unsuitable for involving public volunteers because the equipment requires trained operators;
- subject to prior permission from the Environmental Management Authority (EMA) for Environmentally Sensitive Areas, the Tobago House of Assembly (THA) and Local Government Bodies (Regional Corporations);
- only used after the local context and environmental impact are carefully considered, despite the appeal of the mechanised approach because of its speed and efficiency.

A. Mechanical Rakes

The use of mechanical rakes onshore is an option when there is long, wide, flat or gently sloping sandy beach with no or little beach infrastructure and when volumes of sargassum are low to medium and inundations are frequent, making investment in the equipment worthwhile. It should only be operated when beach use is low (early morning, late evening) and is most effective when tide is falling or low and sargassum is fresh.

It is **not recommended** for high levels of beached sargassum piled thicker than 30-40 cm deep, as the top layer would have to be removed first by other means. It **should not** be used on narrow, short or steeply sloping beaches or those comprising pebbles and on beaches with high-density beach infrastructure or vegetation.

One best practice is to utilise an on-site storage/drying area to retrieve sand for beach nourishment or for creation of small sand dunes. A strict maintenance schedule for equipment, including freshwater washing, must be implemented. Only trained personnel should use equipment, and one driver would be required to operate machinery that can cover a large area.

Mechanical beach rakes come in a variety of forms from towed rakes with automatic emptying mechanisms, to sit-on machines, to autonomous cleaners. This equipment was designed for cleaning beach litter and has been tried and tested and used effectively for this purpose for decades. Some designs have now been tested and effectively employed for clearing/collecting sargassum. A few examples of tractor-towed mechanical rakes that work well for sargassum are *Barber* Surf Rake, *Unicorn Scarbat* Rake and *Flozaga Gutern Rake* (Irvine *et al.*, 2023).

B. Other Mechanical Equipment

Other mechanised equipment such as light weight tractors can be used when excessive volumes of sargassum inundation make manual collection or use of mechanical rakes initially impractical, and where fast removal of huge accumulations is determined essential to avoid environmental and health impacts. Heavy equipment should only be used in exceptional circumstances when the shoreline is able to bear the heavy weight of the machinery. Heavy tracked vehicles should not be used on sandy beaches as experience has shown that this results in damaging compaction and beach erosion. Vehicles should have large pneumatic tyres to spread load, and mechanical bucket or front scoop should be used to remove only the top layer of sargassum to avoid beach damage and sand removal as much as possible. The remaining sargassum can be removed by mechanical or manual rakes. A perforated/screening bucket or claw attachment is recommended to minimise sand removal. Always implement environmental monitoring.

Mechanised equipment such as tractors should not be used on narrow beaches/rocky shoreline, where there is dense beach infrastructure or where there is no vehicular access to shoreline. It should not be used on ecologically sensitive beaches such as turtle nesting sites. A maintenance schedule is required for this equipment and only trained personnel should use it.

IN-WATER COLLECTION

In-water collection of sargassum nearshore, where possible, is preferred to beach collection as this approach can avoid many of the negative impacts of sargassum inundations and will provide higher quality sargassum for potential uses. Recent research in the Caribbean has determined that the species composition of the clinging fauna to the sargassum raft does not change with distance from shore (tested up to 1.5 km from shore) (Corbin *et al., 2024*). This indicates that distance from shore (0 - 1.5 km) for operation of sargassum collection vessels and equipment makes little difference regarding species biodiversity loss. However, special care should still be taken, especially off sea turtle nesting beaches during the nesting season, as turtle hatchlings leaving the beach will hide and remain in the sargassum

and can be captured. In this situation, observers should be used to pick out and release any captured hatchlings immediately

For in-water collection, a physical barrier is required to accumulate sargassum for collection and prevent it from coming ashore, or to deflect it to a suitable extraction point. A harvest boat will be needed to collect the consolidated sargassum rafts. For this to be effective, local knowledge of sea conditions is required.

A. Nearshore Barriers

Nearshore barriers can be used:

- when the sea has relatively calm conditions (e.g. lagoons protected by offshore barrier reef, semi-enclosed bays);
- in shallow water with suitable anchoring substrate (e.g. sand, rock);
- where there is accessible by sea and it is relatively close to safe harbour/docking facilities;
- if they are being used for deflection, where a constant current almost parallel to the barrier can ensure sargassum moves in the intended direction; and
- at river mouth areas to prevent stranding of sargassum during high tides.

The following should be considered when using nearshore barriers:

- optimal barrier orientation and anchoring points based on local geomorphic and hydrodynamic conditions - use research and local knowledge;
- ensure ample anchoring points, preferably with Halas-type moorings drilled into seafloor to avoid damage to living substrates from anchor chains or drag;
- barrier must be cleared frequently to avoid build-up of large amounts of sargassum that can result in over-topping or breaking the barrier, as well as to prevent decomposition;
- sinking of sargassum can smother benthic habitats and form a 'brown tide';
- barrier and netting (skirt) require frequent cleaning to keep away settling organisms to maintain water flow and extend life of barrier;
- barrier should be removed during periods of low or no sargassum inundation and during storm conditions; and
- engaging with local communities and fisherfolk as observers to assist escape of turtle hatchlings.

Barriers cannot be used in prevailing rough sea conditions with high or breaking waves, in deep water and sensitive substrates for anchoring (e.g. coral reefs). Sufficient storage space must be available for periods when the barriers are dismantled prior to storms or low sargassum periods.

In selecting suitable nearshore barriers, the following features must be considered:

- Above surface 'fence' to prevent over-topping;
- Multiple detachable segments for easy deployment and removal (also allows shore side repair or replacement of damaged pieces);
- Underwater sturdy net 'skirt' to allow water flow but not entrap wildlife;
- Multiple anchors to withstand weight.

Harvest Boats

Harvest boats are most effective when used in tandem with a containment boom, to aggregate the material and reduce the surface area to be cleaned. They typically have a catamaran hull for stability, speed efficiency and space. They are used with a conveyor belt to pick up the sargassum as the vessel moves forward. Sargassum is temporarily stored onboard in a hopper or large bags and/or offloaded directly to another vessel or shore facility.

Harvest boats can be used in relatively calm seas in tandem with a containment boom allowing for aggregation of sargassum for easier collection. They must have easy access from safe harbour/docking facilities and must have dock/ beach facility for frequent unloading. Observing the conveyor system will allow for easy removal and release of trapped organisms such as turtle hatchlings.

Harvest boats are not suitable for rough seas or oceans. There is a cost to purchase purpose-built vessels and the running and maintenance cost in the marine environment is usually high. It must be operated by a licensed captain who is a skilled operator. A matrix for choosing the appropriate method/ equipment for sargassum removal is provided in Table 2 below.

Table 2: Matrix for choosing appropriate method/ equipment for removing sargassum (Adapted from Chereau et al 2019)

Condition	Description of condition	Manual onshore collection	Mechanised onshore collection	Nearshore barriers	Custom-built harvest boats	Leave alone
Biomass of sargassum	Small to medium biomass					
	High biomass					
Accessibility	No vehicle access point					
	Vehicular access					
	Rough sea / far from docking facilities					
	Relatively calm / near to docking facilities					
Beach morphology	Wide beach (shallow and calm)					
	Wide beach (deep nearshore)					
	Narrow / short beach (shallow and calm)					
	Narrow/short beach (deep nearshore)					
Ecological sensitivity	Low ecological sensitivity					
	Medium-high ecological sensitivity					
Beach structures	High density of beach groynes / other structures					
Available resources	Low finance					
	Adequate finance					
	Limited labour					
	Adequate labour					

Key: **Red squares** - collection method not recommended; **Green squares** - suitable collection method

REMOVAL, TRANSPORT, STORAGE AND DISPOSAL

Once collected, sargassum will need to be flushed with freshwater, allowed to air dry and stored on site or transported to an alternative storage site. Collected sargassum can be removed and transported with a variety of equipment commonly used in construction and agriculture, often with custom-built accessories. These include pitch forks and small trailers, backhoe and large trucks, caterpillar excavator operating at roadside to load trucks and sugar cane grabs which have been used successfully for lifting sargassum. There must be vehicular access to the beach/coastline and planned storage area.

Collected sargassum is bulky and large accumulations are potentially toxic (high in trace metals such as arsenic, and capable of producing toxic gases if allowed to decompose without oxygen). As such, appropriate disposal sites or storage sites will need to be identified, if it is to be used, ensuring all requisite statutory approvals are provided. This will require selection and preparation (e.g. lining with geo-membranes to prevent escape of leachates) of suitable on-site temporary holding areas or permanent storage locations on or off-site. Storage/disposal sites must allow sargassum to dry out to prevent anaerobic decomposition and production of toxic and flammable hydrogen sulphide (H_2S), ammonia and methane. These sites must also ensure that sargassum leachates do not contaminate the environment, including groundwater. As transport is a high cost of sargassum collection, it is important that storage sites be erected close to collection sites.

The following guidelines must be adhered to:

- Use a single dedicated access route to minimise damage to beach areas by either compaction or furrowing;
- Close public access areas of the beach whilst operating heavy equipment to ensure the safety of beach users;
- If sargassum has been collected from the beach, dry and separate the sand before removal wherever feasible;
- Sand must be effectively separated from sargassum using specialised shaker conveyor belts or tumblers;
- Never operate heavy equipment over turtle nesting areas;
- To avoid compactions, do not use machinery with metal caterpillar tracks on beaches;
- Make provisions for frequent maintenance and freshwater wash-down of the equipment after use;
- Lifting sargassum piles from the beach with grabs or perforated buckets removes less sand than solid buckets or scoops;

- Storage sites should allow sargassum to be spread out to dry and should not be near drinking water supply as leachates from decomposing sargassum are likely to be high in arsenic and possibly other elements that are damaging to the environment (Alleyne et al 2023; Devault et al. 2022).
- Monitor storage and disposal sites to ensure no environmental impacts occur from these activities;
- Hydrogen sulphide and methane meters should be installed around storage sites to monitor air quality.

Burying and Spreading Sargassum

The consensus to date is that burying the collected sargassum is not a good idea as this will turn sand beaches into slime-like dirt. It can also negatively impact sea-turtle nesting by changing the organic composition of the sand. However, if the beach is large and the amount collected small, sargassum can be buried further up the beach or in the dunes or semi-vegetated berms. In low enough volumes, sargassum will fertilise beach vegetation and help combat beach erosion. If spread, it is vital that the sargassum be spread in a thin layer – approximately 10 cm thick – to allow it to oxidise and therefore prevent the release of hydrogen sulphide. Sargassum should never be piled up, and the spreading zone must be far from ecologically valuable areas.

SAFETY OF WORKERS

The release of hydrogen sulphide (H_2S) by decomposing sargassum and its potential health impacts on workers and/or volunteers who clean up the impacted zones must be monitored and managed. Not only should collection take place as quickly as possible after each stranding (preferably within 48 hours), but workers should be equipped with hydrogen sulfide portable meters to ensure that H_2S levels stay within healthy limits.

The minimal detectable concentration of H_2S is 0.05 ppm and this level can be used as a warning signal. Workers collecting rotting algae should always be equipped with respiratory masks. These masks must be worn when H_2S levels reach 5 ppm. When levels reach 10 ppm, the impacted area must be evacuated.

Workers who operate heavy machinery must also have hydrogen sulfide detectors within the vehicle's cabin. Other recommendations to ensure the safety of workers include personal protective equipment (PPE), appropriate protective clothing and mandatory training in safe practices and emergency response. If communities cannot afford to obtain hydrogen sulphide portable meters, the odour released by decomposing sargassum can be used as an indicator of harmful effects.

EARLY WARNING - WHEN, WHERE AND HOW MUCH?

Early warning for sargassum events in Trinidad and Tobago should be strengthened to enable timely and coordinated action to reduce damage, loss and disruption to livelihoods. A strengthened system will serve not only to trigger immediate response actions but also to inform long-term planning, investment, and public awareness, particularly for vulnerable sectors.

While it may not be possible to prevent these invasions, prior knowledge of sargassum occurrence, magnitude, and movement will help prepare the most impacted locations and guide response. Several regional warning systems have emerged over recent years using satellite imagery. However, satellite images alone are not always sufficient, especially in small bays and lagoons that are difficult to detect due to their limited resolution. Therefore, supplemental information from coast guard officers, fishermen, community observers, and even aerial reconnaissance is invaluable for local verification and early action.

Once a sargassum influx is forecasted to affect local beaches, this information must be communicated rapidly to all relevant stakeholders so that plans can be put in place for clean-up and risk mitigation. The channels for such communication shall be guided by the Trinidad and Tobago Meteorological Service (TTMS), the Office of Disaster Preparedness and Management (ODPM) and the Tobago Emergency Management Agency (TEMA).

To ensure a structured, multi-agency response, the Strategic Framework for the Sargassum Early Warning System (EWS) is aligned with the four internationally recognised pillars:

Pillar 1: Disaster Risk Knowledge

To build a foundation for risk-informed decision-making, the ODPM, in collaboration with the Institute of Marine Affairs (IMA), the Ministry of Rural Development and Local Government (MRDLG), the Tobago House of Assembly (THA) and academic partners, shall develop national sargassum hazard susceptibility maps, conduct vulnerability and capacity assessments, and produce risk maps.

Currently, the only spatial dataset publicly available is sargassum sightings from Tobago, captured via the Tobago Emergency Management Agency's (TEMA) **ArcGIS dashboard**. This dashboard collects community reports through an online survey and visualises the location, condition, and quantity of seaweed on beaches. However, it does not assess associated hazard conditions, vulnerabilities, or coping capacities. The data is view-only and does not provide real-time insights into sargassum drift or environmental conditions.

To support national risk mapping and assessment, the ODPM shall compile and organise hazard, vulnerability, risk, and coping capacity information from all relevant agencies, including geospatial data. A national public-facing data information system should be developed to house this information,

with data governance and sharing protocols. Spatially disaggregated data must be prioritised to guide early action in the most affected communities.

Pillar 2: Detection, Monitoring, Analysis and Forecasting

The TTMS, in partnership with IMA, ODPM and TEMA, shall lead the national monitoring and forecasting system for sargassum influxes. This will include operational use of remote sensing tools and satellite-based forecasting platforms that track floating algae density and bloom probability.

Key publicly available platforms include:

- **Sargassum Watch System (SaWS)** – hosted by the University of South Florida (USF), provides forecast bulletins and floating algae density (FAD) maps, including coverage of the Eastern Caribbean and Trinidad and Tobago.
- **Sargassum Tracker** – also by University of South Florida, offers short-term forecasts and satellite imagery using the Alternate Floating Algae Index (AFAI) and Maximum Chlorophyll Index (MCI).
- **NOAA's Ocean Observing System (AOML)** – provides AFAI and MCI satellite imagery for regional ocean monitoring.
- **Sargassum Inundation Risk (SIR)** – a weekly bulletin developed by NOAA/USF and available for use by IMA, however, this tool remains experimental and should be used cautiously in formal forecasting and alerts.

Although these tools provide a strong foundation for early detection, they require integration with locally-generated ocean circulation data and trajectory modelling. At present, the environmental conditions that influence sargassum bloom formation and coastal transport (e.g. wind patterns, currents, sea surface temperature) are not actively monitored in real time within the national framework. TEMA's community-based dashboard helps bridge this gap by collecting observational data from residents. Although it is limited in scope and functionality, it should be replicated for Trinidad.

To enhance forecast reliability, collaboration with regional institutions, national research agencies, and community observers (including fishers and local responders) is encouraged to supplement remote sensing with nearshore confirmation of sargassum landings.

Pillar 3: Warning Dissemination and Communication

The TTMS, in collaboration with the ODPM, shall issue public alerts related to sargassum events using national CAP-enabled platforms and other media. Impact thresholds (e.g. low, moderate, severe) shall be clearly defined and trigger timely alerts across multiple communication channels including SMS, social media, and community-level communication platforms.

The Ministry of Trade, Investment and Tourism, together with the Ministry of Agriculture, Land and Fisheries, and the Ministry of Rural Development and Local Government, will ensure that these messages are tailored for specific stakeholder groups such as fishers, tourism operators, and residents in coastal communities. Communication must be accessible, inclusive, and actionable, particularly for vulnerable populations who rely on early information to protect livelihoods and health.

Pillar 4: Preparedness and Response Capabilities

First response to sargassum influx would be led by the impacted municipal corporation in collaboration with the Ministry of Rural Development and Local Government (MRDLG). If the capacity of the municipal corporations and MRDLG or TEMA becomes overwhelmed, preparedness and response efforts shall be coordinated by the ODPM.

In parallel, the Ministry of Trade, Investment and Tourism will advance innovation and support public-private partnerships for the valorisation of sargassum, promoting its conversion into environmentally sustainable products such as compost, biofertiliser and packaging material. This approach aligns with the broader goals of the circular economy and reduces the ecological burden of unmanaged sargassum accumulation.

Capacities and capabilities for preparedness and response shall be tested annually through exercises and drills with the relevant State representatives and community members.

OUTREACH AND EDUCATION

It is essential to keep coastal communities, coastal stakeholders, policy-makers, visitors and the general public informed with relevant, up-to-date, and easy-to-understand information about sargassum - what is it, where it comes from, why is it here, is it safe to touch, and what it can and can't be used for?

Stakeholder engagement and continued collaboration with affected stakeholders are critical to ensure the continued success and support of clean-up initiatives. Fostering engagement to meet the wide range of needs and interests of different coastal users, from tourists to fisherfolk, must be central to management decisions. Each stakeholder group affected by the sargassum invasion will have distinct issues, concerns and questions.

Communication methods and materials used must therefore be targeted at these specific stakeholders. Stakeholders should be consulted directly so that concerns may be addressed. Local knowledge, expertise and opinions must be included in decision-making. This will also help gather feedback on key decisions that will impact them, past clean-up activities and gauge the level of involvement desired. Consultations can take the form of meetings and presentations or through individual communication.

Community outreach and education should take place prior to, during and after sargassum clean-up activities to ensure awareness, understanding, support and sustainability of actions. Picking the right communication method is critical in ensuring that sargassum information reaches its intended audience. These can include:

- Signage at beaches and coastal areas
- Flyers/posters at hotels
- Radio and TV announcements/interviews
- Newspaper notices and articles
- SMS alert
- Dedicated website or social media

While communication methods will vary depending on a wide range of factors such as location, infrastructure and available media outlets, some suggested targeted communication methods include:

- Frequently Asked Questions factsheets about sargassum and its various impacts, as well as other information material, in key tourist locations and popular local spots (such as the local post offices, shops and supermarkets).

- Public announcements on current sargassum volume and which beaches are open for recreation should be available on the local radio and television as well as popular social media platforms.

- Website with updated information on seagrass volume and hydrogen sulfide level.

- Signage on beaches that are closed due to large sargassum volumes. The wording on these signs should be very clear in explaining why the beaches are closed.

- In case of mass strandings, a telephone hotline with information on current sargassum volume and hydrogen sulphide level should be set up.

Key performance indicators (KPIs) for outreach and education programmes will include:

- Feedback and satisfaction surveys
- Strong community engagement and awareness measured by participation in clean-up and outreach events
- Level of engagement measured by the number of community-led sargassum events and initiatives
- Improved public perception measured by survey instruments

RESEARCH AND MONITORING

Research and monitoring are the two most fundamental areas in the management of sargassum and both aspects feed into each other. They are important as decisions regarding collection and disposal are dictated by the frequency and volume of sargassum stranding and/or volume of sargassum collected from shorelines, which are also critical at the national level to:

- help validate and improve forecasts;
- inform appropriate collection methods; and
- understand the variability.

Simple, standard monitoring protocols using drones, or simple field methods along beaches have been developed for easy sharing and comparison of data. Monitoring will also play a key role forecasting where coastal landings, bay strandings and estuarine trappings might occur. This will directly influence the methods and regions of collection. A collaborative effort will be needed to develop and implement early warning systems. This would include satellite imagery, fixed videography, drone footage as well as truthing of mats by pilots, sea fearers and coastal communities.

Validation of this datum could determine the influence of ocean currents, wind velocity and direction along with ocean temperatures on the stranding potential of sargassum mats.

Once predictive models are developed and suitable collection mechanisms are implemented, there may be potential to treat sargassum as a raw material and natural resource. However, research into valorization of sargassum is needed.

Additionally, research should be conducted to determine impacts of sargassum influx on coastal ecosystems, their biodiversity, any introduction of invasive alien species, socio-economic impacts, and environmental impacts of different strategies for sargassum collection and removal.

Given the myriad of problems associated with stranded sargassum, there is need to sustainably manage the seaweed and reduce management costs (Hinds *et al.*, 2016). Research and experimentation to date have revealed several potential value-added uses of sargassum, although further research is needed to identify and develop viable commercial uses of the algae that will offset the economic impact of the strandings. Additionally, sargassum is most useful when it is collected at sea when decomposition has not started. This will also reduce the issue of coastal collection where sand will also be taken up resulting in additional efforts for debris removal.

Use of sargassum for consumptive purposes will require careful biochemical analysis to determine the local levels of possible contaminants. It can absorb heavy metals and other pollutants depending on where it has travelled (Hinds *et al.*, 2016). Like several marine macro-algae, high concentration of arsenic in sargassum excludes use for animal or human nutrition and necessitates meticulous control of emitted gases.

Seasonality of strandings means that methods to preserve sargassum must be developed to ensure reliable and continuous supply. The strong salt content of sargassum means that there is risk of soil salinisation if it is not well flushed or cleaned.

Nonetheless, several organisations have ventured into various aspects of valorisation including developing fertilisers, biostimulants and bioelicitors for crop production in the agriculture sector. Additional work is being considered using sargassum for the manufacture of high protein feeds for the aquaculture sector, in the production of bioplastic, sealants and as an additive in cement. Internationally, there are existing technologies which utilise raw material such as sargassum for the generation of biofuel. These technologies can be evaluated to determine suitability for rural communities.

Figure 3 summarises the research and monitoring plan for sargassum.

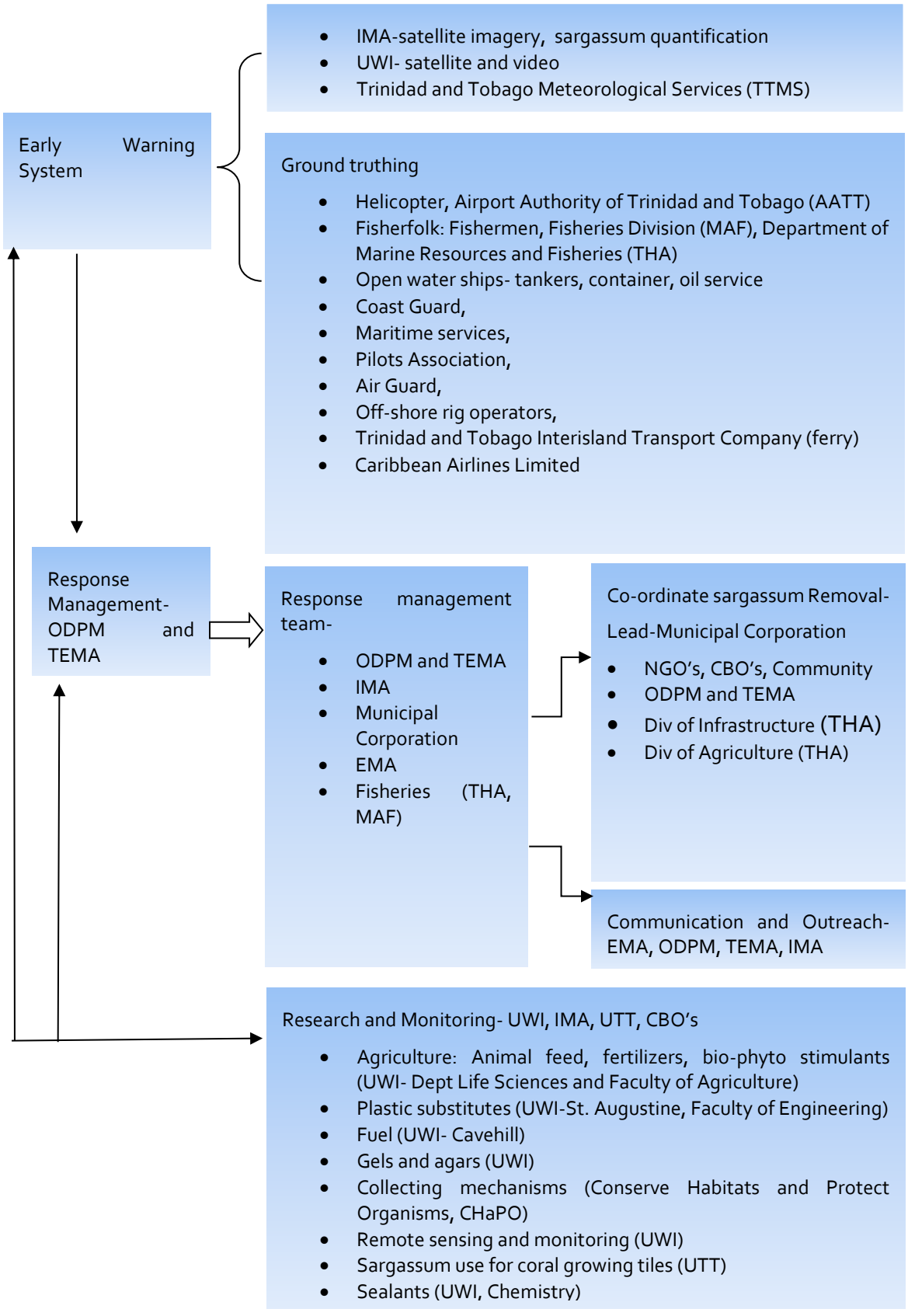

FIGURE3: RESEARCH AND MONITORING PLAN

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