
# Teleconnected SARgassum risks across the Atlantic: building capacity for TRansformational Adaptation in the Caribbean and West Africa (SARTRAC)

## Inception Report

20th July 2020

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# Executive summary

SARTRAC is a three year (Nov. 2019 - Oct. 2022) programme of research funded by the ESRC GCRF fund that is being delivered through a collaboration between the University of Southampton, University of Ghana, University of West Indies and University of York. Our focus is on the potential role of sargassum in offering a transformational opportunity to the poorest communities in sargassum affected areas in the Tropical Atlantic Basin. SARTRAC has started slowly due to the COVID pandemic, however, we anticipate being able to deliver multiple benefits from this programme of research.

The themes of 'transformation' and 'equitable resilience' lie at the heart of SARTRAC and provide the SARTRAC project a unique space to work, in an increasingly busy research field. This lens requires a focus on poverty and development, and the potential for sargassum to be used as a tool for delivering sustainable development in the poorest affected countries in the tropical Atlantic basin from central America, through the Caribbean and West Africa.

The SARTRAC project contains four work packages and a cross-cutting theme of stakeholder engagement. The first work package (Drivers) aims to develop a bespoke system to predict where and when Sargassum will be. Work has started on tracking particles in the Atlantic Ocean to replicate the movement of sargassum, to potentially identify a long-range forecasting system. Work package 2 (Monitoring) aims to develop an operational and near real time monitoring and dissemination system. Analysis of the current approaches to monitoring sargassum through remotely sensed data is being undertaken to highlight weaknesses and strengths, and to identify ways to improve current monitoring processes. Work package 3 (Transformational adaptation) Using algae to generate benefits for developing countries in the Caribbean and Western Africa. Plans for collection of beached sargassum have been made, and teams have been recruited to allow this to happen. Finally, work package 4 (Governance) aims to identify the existing and possible future national and regional governance of sargassum (both strandings and as a floating resource) and the political economy of different sargassum responses. Reviews of literature on legal frameworks affecting sargassum management have begun. Unfortunately, no stakeholder engagement has occurred yet partly due to delays in our partner institutions caused by the global COVID-19 pandemic, but also because some time has been required to develop Work Packages to the point where stakeholder engagement needs could be defined, as well as to develop clear and consistent messaging for stakeholders and associated communications materials.

In addition to starting to work on our main project deliverables, within the first six months of SARTRAC we have: added detail to our project plan, recruited our teams, developed our project governance and internal monitoring and reporting systems, established cross-work package interactions, produced our Theory of Change, and put in place rules surrounding the delivery of the Flexible Innovation Fund. This administrative work puts in place the foundations to allow us to deliver on our long term vision, i.e. to produce outputs from SARTRAC that have the potential to reshape the debate on sargassum, and achieve the following: identification of the atmospheric and oceanographic drivers of sargassum events; an operational sargassum monitoring system at local to regional scale; analysis of the biological composition of the Sargassum biomass and the implications of Sargassum re-use; a political economy analysis of issues associated with Sargassum re-use and management, recognising potentially conflicting access rights, and multiple perspectives amongst regional stakeholders on how to address this ; improved risk management and adaptation best practice guidelines; and transferable methods developed for use in other affected areas in the tropical Atlantic basin.

# 1. Introduction

## 1.1. SARTRAC Background and Aims

Since 2011, there have been major beaching events of the macro-algae 'sargassum' in the tropical Atlantic, from Central America, through the Caribbean, across to West Africa. Sargassum mats float in the Atlantic washing up on beaches and cause significant reported impacts, both during their landing (due to the significant volumes), and when the sargassum rots, giving off toxic gasses (see Figure 1). Sargassum landings on beaches in the Caribbean and Central America have been known to negatively affect human health, beach access, fishing, tourism and nearshore biota. There has been an explosion of research outputs into this new phenomenon since 2019, but there remain many unknowns in relation to sargassum.

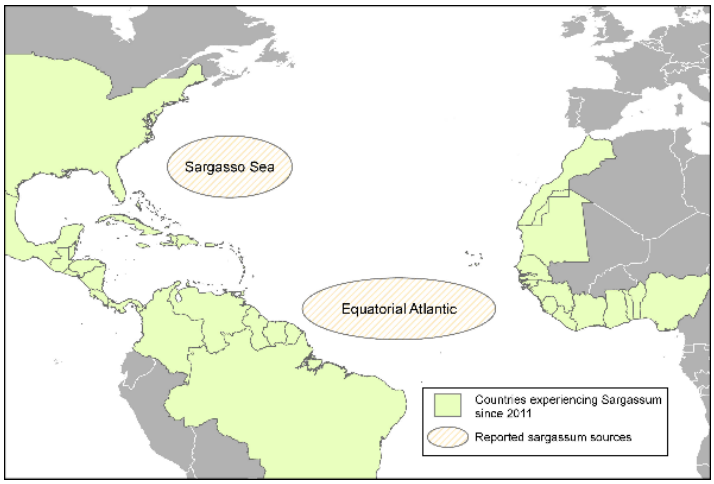


*Table 1: Map of sargassum affected areas in the Tropical Atlantic*

There is much ongoing research on sargassum, notably in relation to: tracking the sargassum at large scale, the biology of the seaweed (see Figure 2), nearshore monitoring, management approaches, and business opportunities that may arise from use of sargassum. Our project, SARTRAC, aims to complement and add value to this ongoing research. Through our well-connected multi-country team, we are in a position to take a different perspective, rather than compete and duplicate. Our specific focus is on the potential role of sargassum in offering a transformational opportunity to the most vulnerable communities in sargassum affected areas. Specifically, SARTRAC aims to identify what opportunities exist to exploit or manage Sargassum in such a way as to create equitable resilience across societies affected.

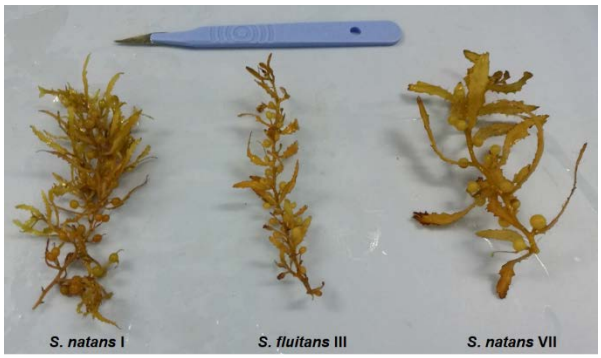


*Table 2: Common sargassum species found in the Tropical Atlantic*

## 1.2. Research problem evolution

### 1.2.1. Review of the rationale for the research questions addressed

At the time of development of the project proposal (April 2019), there were several important unanswered questions about sargassum.

*Q1: Do the sargassum crises across the tropical Atlantic basin have a common driver – or are there multiple sources/drivers of sargassum?*

We ask this question, as a better understanding of the drivers, and ongoing changes, must inform long-term predictions (decades) of the volumes of sargassum that may be expected to land at selected

locations. Post-SARTRAC award, there have been a number of papers published on this topic, and there are a number of further studies funded in this area. Nonetheless, the basic question remains valid. Much of the current problem, limiting understanding, is that there is substantial cloud cover across the equator which is preventing important hypothesized source regions from being visualized. Some publications essentially ignore this and so the potential accumulation areas, particularly off West Africa are being left out of model predictions and investigation of drivers.

*Q2: How can we improve monitoring of sargassum across the tropical Atlantic*

While regional systems have been brought to bear in monitoring at that scale, there remains a gap in down-scaling these models for the local context and making it more useful to local industries as end-users (UNEP 2018[1]). Finer-scale prediction tools are needed in forecasting where beaching will occur inshore, particularly where major exposure in tourism, shipping, recreational and fisheries industries may be impacted. Closer inshore, complexities in changing bathymetry complicates current dynamics, water quality and transport (Maxam and Webber, 2010[2]). These act as traps that catalyse proliferation and retention of sargassum mats. So far, there has been a growing partnership among civic, municipal, academic and commercial entities in trying to combat this phenomenon. This has, for example, culminated in mapping of beaching events by the Government of Jamaica. While this is a start towards building the historical record, more is needed to characterise conditions that lead to actual beaching. Basing predictions on the historical record requires a longer history to improve probability. On the other hand, capturing the mix of dynamics at play that force beaching allows greater predictability. Knowing this, governments are better armed in knowing where to deploy resources ahead of time, as well as community organisations can be more focused towards pro-active mitigation of the problem (instead of expensive, reactive solutions).

*Q3: Through what pathways can adaptation be transformational in the face of the sargassum risks?*

The past decade of sargassum invasions has impacted many peoples' lives. We ask, what opportunities there might be from these newly abundant natural resources for the poorest in society, for example through household level energy production, or through its use as compost for the most vulnerable affected communities? Is sargassum a hazard or a desirable resource? If benefits can be identified to reuse sargassum to create value, we ask whether the benefits can accrue to the poorest in society, and what institutional, social and political mechanisms need to be put in place to deliver these benefits? How can these findings be integrated to provide insight into the future role of sargassum in Caribbean and West African DAC countries?

*Q4: What are effective policy solutions to trans-regional teleconnected environmental risks?*

Sargassum affects most of the tropical Atlantic, including: North, South and Central American countries with a Caribbean coast, most Caribbean islands and many of the countries on the West African coast. The affected countries are geopolitically diverse, although our research focusses on the poorest affected countries that often lack the financial, technical and physical resources needed to deal with an onslaught of sargassum, often with over-stretched environmental policy and management units. Yet there are a

[1] UNEP, 2018. Sargassum Outbreak in the Caribbean: Challenges, Opportunities and Regional Situation. White Paper. Eighth Meeting of the Scientific and Technical Advisory Committee (STAC) to the Protocol Concerning Specially Protected Areas and Wildlife (SPAW) in the Wider Caribbean Region. Panama City, Panama, 5 - 7 December 2018 . SPAW Sub-Programme at the UN Environment CEP Secretariat. pp16.

[2] Maxam, A. & Webber, D.F., 2010. The influence of wind-driven currents on the circulation and bay dynamics of a semi-enclosed reefal bay, Wreck Bay, Jamaica. *Estuarine, Coastal and Shelf Science*. Vol 87 pp 535-544

myriad of actors at multiple scales across the tropical Atlantic basin involved in the science, management, and governance of the sargassum crisis. We ask: how can effective solutions to these teleconnected risks be developed across continents to generate benefits for the most vulnerable countries? Who are the key actors and what are the key policy frameworks that are shaping the response? Are there conflicts of interest or institutional overlaps, and what policy pathways could be followed to deliver equitable resilience for the most vulnerable affected communities?

The research objectives addressed in the original proposal were:

RO1: To develop a bespoke system to predict where and when sargassum events will be.

RO2: To develop an operational and near real-time monitoring and dissemination system.

RO3: To identify ways to use sargassum to generate benefits for the poorest in affected developing countries

RO4: To explore an inter-state network of actors that can influence people's ability to adapt to sargassum strandings.

These research objectives have been modified based on post-award advances in the science of sargassum, and on the narrower focus of this project on equitable resilience and transformational adaptation within the poorest affected societies.

### 1.2.2. Significant changes to the proposed work plan

The funded SARTRAC proposal was developed in April 2019, before many of the most recent influential publications on sargassum were published. Since April 2020, our knowledge about the sargassum events has changed in the following ways:

#### *1.2.2.1. New science on the sources / drivers of sargassum*

Johns et al. (2020) provide an extensive review and update on our understanding of the proliferation of *Sargassum* since 2011. A basin-scale, tropical-extratropical perspective is now established. The current thinking is that a historic climate anomaly in 2010 – an exceptionally negative phase of the North Atlantic Oscillation (weak Icelandic low and Azores high pressure centres) drove *Sargassum* from the western subtropics (the Sargasso Sea) to the northeast, as far as Gibraltar. Swept south in the Canary Current, the hypothesis is that the subsequent appearance of Sargassum in the eastern central tropical Atlantic was the trigger for spring growth and the first Caribbean inundation of summer 2011. The Sargassum has subsequently been recirculating in the tropical Atlantic, with a window across the northern tropical Atlantic, following the seasonal migration of the Intertropical Convergence Zone and seeding the bloom following year – with the exception of summer 2013, when low nutrient levels, attributed to anomalous winds, almost eliminated Sargassum that year. New simulations in Johns et al. (2020), corroborated with evidence from drifting buoys, include windage – emphasised as a crucial factor in explaining events. We introduced windage to our drift calculations prior to the start of SARTRAC, and we too find that this is important for drift predictions. It is evident in Johns et al (2020) that there is wide scope to develop more nuanced drift calculations, and our WP1 focus on regional predictions will be informed by this review. Our WP1 analysis of climate variability, in relation to the *Sargassum* events, will be likewise informed and finessed.

#### *1.2.2.2. New international projects considering sargassum and regional governance*

In our initial application we had proposed to establish a network that would connect policymakers working on Sargassum in the Caribbean with their counterparts in West Africa. The key mechanism for doing so was a series of deliberative workshops that would facilitate dialogue about the nature of the shared problem, highlight areas of best practice, and generate South-South exchange. In the time between the application and this report, this network has already been established. (e.g the UNEP Sargassum Working Group) and we have been attending their online workshops and webinars. As a result, we have remodelled WP4 to focus on emerging governance challenges as identified via our participation in these events and in collaboration with project partners. Specifically, we have reoriented our work towards understanding how different policy settings create risks and opportunities for transformational adaptation.

### 1.2.3. 'Transformation' and 'equitable resilience' in SARTRAC

At the heart of the SARTRAC proposal are two themes. One of 'transformation' and the other, 'equitable resilience' that provide the SARTRAC project a unique space to work, in an increasingly busy research field. This lens requires a focus on poverty and development, and the potential for sargassum to be used as a tool for delivering sustainable development in the most vulnerable affected countries in the tropical Atlantic basin from the Americas, through the Caribbean and West Africa.

In early feedback from the UK Economic and Social Research Council (GCRF-ESRC), Introducers commented on the lack of clarity in the initial SARTRAC proposal about 'transformation' and 'equitable resilience'. We provide more information in this Inception Report.

#### *1.2.3.1. 'Transformation'*

There are multiple definitions of transformational adaptation, which are frequently contrasted with incremental adaptation. Transformation is often associated with one or more of the following characteristics (Lonsdale et al, 2015):

- system-wide change or changes across more than one system;
- a focus on the future and long-term change;
- direct questioning of the effectiveness of existing systems, social injustices and power imbalances.

In contrast, incremental adaptation is articulated as small changes to existing approaches, or changes within one sector or location.

While there are many ways to conceive transformational adaptation, there is a distinct lack of clarity about the spatial scale (or scales) and sectoral scope at which transformational adaptation operates, as well as the level of control that can be exerted over the outcomes of the change process. As a result of this, the term transformational adaptation is still very vague and defined in different ways (Mustelin and Handmer, 2013). As O'Brien (2012) notes it means

> "*different things to different people or groups, and it is not always clear what exactly needs to be transformed and why, whose interest these transformations serve, and what will be the consequences*" (O'Brien, 2012: 670).

In recent work, Suckall et al (2019) recognise that

> "'*Transformation' that is radical, rapid and revolutionary and that fundamentally changes the nature of a system may be a better way of adapting, by moving away from limiting behaviours and creating new opportunities*." (Suckall et al, 2019: 64).

In the SARTRAC project, following Suckall et al, 2019, we identify transformation as:

> "*an activity that seeks to challenge the current system by instigating ambitious change across larger scales, in new geographic regions or resource systems, and by transforming places (Kates et al., 2012). A change may be transformational at its conception, and then become part of a suite of incremental adaptation options. For example, the Thames Estuary barrier that protects London from flooding, and the engineered delta protection system in the Netherlands were both transformational in concept, but have been operationalised through traditional activities, such as community participation and introduction of coastal barriers (Kates et al., 2012; Ranger et al., 2013*)." (Suckall et al. 2019: 65).

We recognise the challenge of delivering this, and intend to focus on clarifying the opportunities for transformation in the first year of the project.

#### *1.2.3.2. 'Equitable resilience'*

Like transformation, resilience is a contested concept. Research papers have identified up to 16 different interpretations and meanings of resilience, within academic discourses. There is a body of literature which identifies linkages between transformation, adaptation and resilience, however, it is largely theoretical and lacks empirical underpinning (discussed in Brown, 2014). We acknowledge that resilience can refer to outcomes (which can be more or less desirable), or processes. However, we note that debates around resilience are akin to those surrounding 'sustainability'. Resilience is a malleable, plastic concept that has been co-opted for many different purposes. We will reflect on the meaning and application of resilience, and how it can be applied equitably throughout the project. As a starting point, we assume that resilience is simply: the capacity to recover quickly, or to bounce back quickly after a hazard.

However, consideration of resilience alone does not ensure addressing poverty and other equity elements of hazard risk. For example, while household resilience may mean being able to absorb the costs of hazard preparedness purchases by reducing the number of meals eaten for a week, that does little to promote equity and development (Béné et al. 2014). Equitable resilience is a more specific form of resilience, which emerges when resilience practice takes into account issues of social vulnerability and differential access to power, knowledge and resources (Béné et al. 2014; Matin et al. 2018). Resilience practice and outcomes that are also equitable, therefore, speak not only of systems but also acknowledge agency and power dynamics, while simultaneously remaining wary that resilience, in its political mobilisation, may encourage the abdication of power by collective stakeholders in favour of individual resilience and responsibility (Welsh 2014).

Ensuring equitable resilience will be explored further throughout SARTRAC, as outlined below, but as a starting point we recognise and work with the guiding principles of Matin et al. (2018) and Stringer et al. (2018) by:

- While acknowledging subjectivities and power relations are dynamic, SARTRAC investigates the **subjectivities and exclusion of certain groups from decision-making**, and seeks to integrate the discourses and knowledges of these groups also.
- The work of SARTRAC **crosses scale-boundaries** and specifically analyses, as a part of its stakeholder analysis, existing and the rise of potential scalar and stakeholder conflicts in managing *Sargassum*, thereby studying this system and agents across sectors, stakeholders, spatial and temporal scales, and tracing externalised costs.

- As discussed at above, we **share knowledge, experience and learning**, and co-develop the systems by which we seek to bring about transformational adaptation where desirable to empower communities and other stakeholders, with a focus on bringing about that change through learning platforms and forging new knowledge through joint learning and action.

#### *1.2.3.3. Embedding equitable resilience and transformation into SARTRAC*

To ensure that transformation and equitable resilience are embedded into the project, the PI will lead the integration of both concepts within the project, this will occur through 3 main tasks:

(i) Equitable resilience and transformation are standing issues on the PMB agenda, and ACM meetings.

(ii) PI convened initial 1-2-1 meetings with all WP leads (and will repeat these on a quarterly basis) to discuss how transformation and equitable resilience can be fully embedded within all work packages.

(iii) the UoS based PDRA (van der Plank) started her work by exploring what these terms could mean in relation to outcomes for the poorest communities in countries affected by sargassum.

### 1.2.4. Current impact of pandemic COVID-19 on SARTRAC research

From late March 2020 until early July 2020, all researchers in the UK, Jamaica, Ghana and Barbados were advised or mandated to stay home in a bid to reduce the impacts of the COViD-19 virus. This is having multiple impacts on the delivery of the SARTRAC project.

(1) Slow progress from researchers working at home, due to connectivity issues, and balancing caring responsibilities (due to school closures)

(2) Research support services: for the University of Ghana, UWI, and UOY have closed completely, which means that no support can be provided to the researchers in terms of reporting, gaining ethical approval for fieldwork, getting insurance and risk assessments for field work, releasing operating funds, hiring personnel etc…

(3) Delayed inception: The face-to-face inception meeting in Southampton has to be delayed as we cannot guarantee at this stage (when we need to pay to confirm the booking) that any of our partners will be able (or willing) to travel to the UK.

(4) Fieldwork: people affected by sargassum were not prioritising this during the acute phase of the pandemic impacts, and in most countries – the beaches were closed and tourism had ceased which meant that many people were not being directly affected by sargassum *per se*. The resumption of tourism in the Caribbean is currently tentative and uncertain. Any fieldwork undertaken in 2020, about people's opinions or the impacts of sargassum on people's lives, is likely to be affected by significant bias due to the coronavirus impact.

We ask that these impacts are taken into account, when considering the delivery of research in the Inception Phase of this project.

# 2. SARTRAC Consortium members, governance and management

SARTRAC has 3 main layers of organisation: at the highest level is the Project Management Board which makes all executive decisions about the delivery of the project. The second layer of management are the work package leads whose remit is to deliver specific work tasks and deliverables, all of which collectively deliver the project goal. Finally, there is the third layer – the external review, in the form of the Research Advisory Committee. These are now discussed.

## 2.1. Consortium members

### 2.1.1. Project Team

The project team comprises four universities: University of Southampton (UOS), University of Ghana (UOG), University of the West Indies (UWI) and University of York (UOY). Partners are located across four countries (UK, Ghana, Jamaica and Barbados) and three continents. Members within each institution, including their academic specialisation and % time contribution to the SARTRAC project (See Table 1).

*Table 3: SARTRAC team*

| University | Name | Specialisation | % of working week spent on SARTRAC |
|---|---|---|---|
| UoS | Prof Emma Tompkins | Geography | 10% |
| UoS | Prof Robert Marsh | Oceanography | 5% |
| UoS | Prof Jadu Dash | GIS/remote sensing | 5% |
| UoS | Prof Jack Corbett | Politics | 5% |
| UoS | Ms Lucy Graves | Administrative assistant | 20% |
| UoS | Ms Sien Van Der Plank | GIS/remote sensing /political science | 100% |
| UoS | Ms Yanna Fidai | PhD student: monitoring and mapping sargassum | Unfunded voluntary contribution |
| UOG | Prof Kwasi Appeaning Addo | Marine science, coastal geomorphology, GIS & RS | 10% |
| UOG | Dr Philip-Neri Jayson-Quashigah | Marine science, coastal geomorphology, GIS & RS | 50% |
| UOG | Dr. Winnie Sowah | Marine and fisheries science | Unfunded voluntary contribution |
| UOG | Mr Sumabe Issahaque | PhD student fisheries governance | Unfunded voluntary contribution |
| UWI-Mona | Prof Mona Webber | Biologist | 10% |
| UWI-Mona | Dr Ava Maxam | Zoology/GIS | 10% |
| UWI-Mona | Mr Shannon Hill | GIS Programmer | 80% |
| UWI-Mona | Mr Mouyton May | project manager | 40% |
| UWI-Mona | Ms Ajani Bissick | GIS/RS PDRA | 70% |
| UWI-Mona | PDRA | bio-geographer (WP3) | 70% |
| UWI-Mona | PDRA | Policy (WP2/4) | 70% |

| | | | |
|---|---|---|---|
| UWI-CERMES | Prof Hazel Oxenford | Fisheries science, ecology | 10% |
| UWI-CERMES | Dr Janice Cumberbatch | Participatory research, environmental management | 10% |
| UWI-CERMES | PDRA | interdisciplinary | 50% |
| UoY | Dr Thierry Tonon | biology | 10% |
| UoY | Mrs Carla Botelho Machado | WP3 technician | 100% for 29 months |

### 2.1.2. Work package staff allocation

To facilitate integration across work packages, we encourage PDRA researchers to work across WPs. Table 2 shows the distribution of staff time available to work on the four WPs.

*Table 4: Distribution of staff and % of their SARTRAC time across work packages*

| **WP** | **Lead name (institute) and % time on WP** | **Co-lead name (institute) and time on WP** | **PDRA (1) name (institute) and time on WP** | **PDRA (2) name (institute) and time on WP** |
|---|---|---|---|---|
| 1 | Robert Marsh (UOS) 5% (1.88 hours/week) | Kwasi Appeaning - Addo (UOG) 5%<br>Hazel Oxenford (UWI) 5% | Nikolas Skliris (UOS) 25% | Jayson Quashigah (UOG) 20%<br>PDRA GIS/RS (UWI Mona) 20%<br>PDRA UWI Cave Hill 15% |
| 2 | Jadu Dash (UWI) 5% | Ava Maxam (UWI) 10%<br>Kwasi Appeaning-Addo (UOG) 5% | Van der Plank (UOS) 50% | PDRA GIS/RS (UWI) 80%<br>Jayson Quashigah (UOG) 20%<br>Shannon Hill (UWI Mona) 80% |
| 3 | Thierry Tonon (UOY) 5% | Mona Webber (UWI) 10% | Botelho-Machado (UOY) 100% | PDRA Biogeographer (UWI Mona) 80%<br>PDRA - policy (UWI Mona) 25% |
| 4 | Jack Corbett (UOS) 5% | Janice Cumberbatch (UWI) 5% | Van der Plank (UOS) 25% | Dr Kerrine McDonald Senior (UWI Mona) 25%<br>PDRA (UWI Cave Hill) 15%<br>Jayson Quashigah (UOG) 10%<br>Dr Winnie Sowah (UOG) – as needed |
| X-WP/ SHE/ ER* | Emma Tompkins (UOS) 5% | Janice Cumberbatch (UWI) 5% | Van der Plank (UOS) 25% | PDRA (UWI Cave Hill) 20% |

Note: * X-WP refers to cross-work package activity. There are two cross-cutting themes: Stakeholder Engagement (SHE) and Equitable Resilience (ER).

The role of stakeholder engagement and integration of equitable resilience cross all work packages. The stakeholder engagement champion is based at UWI Cave Hill (CERMES).

### 2.1.3. Co-I champions

There are multiple administrative roles that need to be undertaken with SARTRAC, these are small roles, and are allocated as follows:

#### 2.1.3.1 Monitoring & Evaluation (M&E)

Champion: Emma Tompkins

Role: i) to develop a monitoring and evaluation structure (monthly, annual and mid-term/final); ii) to identify and recruit the external Research Advisory Board (RAC) and to develop their terms of reference; iii) to take on board feedback from the RAC. Feedback from the RAC will be circulated to WP leads by the PI. WP leads will be asked to evidence their response to that feedback, either in a written response to the PI, or through annotated modification of this Inception Report work plan.

Deadlines: M&E structure: Jan 2020; recruit external RAC: Feb 2020; take on feedback from RAC - annually

#### 2.1.3.2 Risk and Ethics

Champion: Mona Webber

Role: i) to develop a first draft ethical application for human data related to the SARTRAC Project, for use as a template for wider team; ii) to undertake a first draft Risk Assessment for all fieldwork related to SARTRAC to roll out to the wider team.

Deadlines: ethics application drafted: July 2020; risk assessment drafted: July 2020; ethics application finalised and submitted: August 2020.

#### 2.1.3.3 Pathways to Impact/Theory of Change

Champion: Emma Tompkins

Role: i) to develop a theory of change for SARTRAC; and ii) to monitor impact of the research through the delivery of the Theory of Change throughout the project, and at its completion.

Deadlines: TOC drafted for comment: March 2020; monitoring for TOC through monthly reporting: March 2020. Inclusion of TOC in Inception Report: July 2020.

#### 2.1.3.4 Publications/Further Funding/Legacy

Champion: Janice Cumberbatch/Thierry Tonon

Role: i) to collate all publications from SARTRAC from the monthly reports (for internal communications, and for reporting purposes), circulate the updated list at the monthly PMB meetings, and keep up to date on Project outputs; ii) to explore other funding opportunities to support SARTRAC; iii) to consider how to deliver a lasting legacy from the project.

Deadlines: monthly reporting of progress at PMB: from March 2020; search for funding opportunities to PMB from May 2020; legacy for project identified by June 2021.

#### 2.1.3.5 Dissemination/high level SH/policy engagement

Champion: Janice Cumberbatch/Bob Marsh/Jack Corbett

Role: i) to undertake high level stakeholder mapping (started in Annex V); ii) to identify which stakeholders will be the focus of SARTRAC outputs; iii) to consider how best to communicate and disseminate SARTRAC outputs, understanding that stakeholder engagement is a dynamic and cross cutting activity across all WPs; iv) develop and use appropriate high level engagement tools e.g. flyers, website, blog, tweets.

Deadlines: first draft stakeholder mapping and analysis: July 2020; ongoing stakeholder mapping:; initial identification of stakeholders to engage: August 2020; communication and dissemination plan (September 2020).

#### 2.1.3.6 Capacity building/pastoral care of wider SARTRAC team

Champion: Kwasi Appeaning Addo and Ava Maxam

Role: i) to ensure effective team working; ii) encourage engagement and development of junior researchers within consortium; iii) development/engagement of junior researchers at ACMs; iv) capacity building both within and outside of the consortium.

Deadlines: This is a rolling task, suggested that activities are considered every 2-3 months. Events will be organised for each Annual Consortium Meeting.

## 2.2. Governance and Management

### 2.2.1. Project Management Board (PMB)

The Project Management Board (PMB) is the internal advisory body that makes decisions on the governance, management and delivery of the Project. It also assesses risks and identifies solutions. The PMB comprises Lead PIs from each partner (UoS, UoY, UWI, and UoG) and communicates monthly via internet or phone conversation. The PMB considers scientific coordination, planning and monitoring and takes responsibility for the conceptual design / fine-tuning of all project activities, e.g. taking into account emerging knowledge. The PMB will agree: a theory of change, an operational planning and monitoring system, linked to project deliverables, resource requirements. A project progress database will be set up online by the lead PI (Southampton), and all project progress / updates / outputs will be recorded. The PMB will meet in person annually at consortium workshops, and remotely at the regional workshops. Membership includes one lead representative from each institute (Table 3).

*Table 5: PMB members and alternates*

| **Name (affiliation)** | **Role** | **Alternate** |
|---|---|---|
| Emma Tompkins (UOS) | Chair | Bob Marsh or Jadu Dash (UOS) |
| Kwasi Appeaning Addo (UOG) | UOG Member | Jayson Quashigah (UOG) |
| Ava Maxam (UWI Mona) | UWI-M Member | Mona Webber (UWI-M) |
| Janice Cumberbatch (UWI Cave Hill) | UWI-C Member | Hazel Oxenford (UWI-C) |
| Thierry Tonon (UOY) | UOY Member | Carla Botelho-Machado (UOY) |

In the event of unavailability, alternates for the PMB will be used.

### 2.2.2. Research Advisory Committee (RAC)

The Research Advisory Committee (RAC) provides input into the direction of the research, relevance to other parts of the world, and advice in regard to policy impact. The RAC ensures widespread engagement with project outputs by the wider community. The RAC will be convened after the annual ACM. SARTRAC invited four experts to sit on the external Research Advisory Board. Their fields of expertise are: Sargassum, climate change adaptation, Caribbean development, and West African environmental management. The advisors (see Table 3) will participate in one or more of four ways.

*Table 6: Research Advisory Committee*

| Name | Role | Location | Status |
|---|---|---|---|
| Dr Emma Hennessey | Deputy Head, US, Canada and Caribbean Department, Foreign and Commonwealth Office | London, UK | ACCEPTED |
| Dr Lorna V Inniss | Coordinator, Cartagena Convention Secretariat, Ecosystems Division, UN Environment | Kingston, Jamaica | ACCEPTED |
| Mr Ebenezer Appah-Sampong | Deputy Executive Director, Environmental Protection Agency | Ghana | ACCEPTED |

- Read a draft of our inception report (2020), interim report (2021) and final project report (2022) and provide feedback;
- Participate in one or more conference calls about each report;
- Provide feedback on policy recommendations to improve community resilience;
- Provide advice on how to best communicate the findings to improve research uptake.

## 2.3. Monitoring and Evaluation

### 2.3.1. M&E (Internal progress monitoring)

All staff are expected to complete An online monthly progress report to ensure that all activities, risks, outputs, impact and dissemination activities are recorded.

### 2.3.2. M&E (External progress evaluation)

Three key project outputs will receive the scrutiny of the external committee of experts, the Research Advisory Committee (RAC). The RAC will provide input into the next steps of the research.

- The inception report (July 17, 2020)
- The interim report (July, 2021)
- The final report (August 2022)

The RAC will be asked to report on progress, to provide guidance on: improving impact, clarifying deliverables, integration of work packages, improving research uptake and impact, clarifying progress, how to improve community resilience in the face of sargassum; how to transform 'opportunities for some' into 'opportunities for many' in the poorest affected communities, overall project quality and outcomes.

In terms of timing, we anticipate the following schedule:

#### 1.5.2.1 Inception report (internal deadline for submission, July 13, 2020)

The inception report will describe the initial development of the project from inception to month 8 (November 2019 – June 2020). The report contains: clarification of work tasks and deliverables; details of the proposed fieldwork; details of stakeholder engagement methods including locations; the proposed pathway to impact; ethical issues associated with the research; delivering integrated research across 4 universities in 4 countries.

The report should be circulated to the RAC, by July 13th 2020 along with guidance on areas of feedback, for example, improving impact, clarifying deliverables, integration of work packages.

*Feedback on the report from the RAC would be appreciated before August 30th 2020.*

Conference call with RAC on the feedback to be arranged for September 2020.

#### 1.5.2.2 Interim report (internal deadline for submission, July 2021)

The interim report is the mid-term report for the SARTRAC project. This report will document: progress on delivery of work packages; preliminary findings and early outputs; the pathway to impact; any problems arising in the project; actions taken in response to the feedback on the inception report.

The report should be circulated to the RAC, by mid July 2021 along with guidance on areas of feedback, for example, improving research uptake and impact, clarifying progress, how to improve community resilience in the face of sargassum; how to transform 'opportunities for some' into 'opportunities for many' in the poorest affected communities.

*Feedback on the report from the RAC would be appreciated before August 30th 2021.*

Conference call with RAC on the feedback to be arranged for September 2021.

#### 1.5.2.3 Final project report (internal deadline for submission, August 2022)

The final report for the SARTRAC project will document the key findings and outputs from the research. This report will also contain: a summary of delivery of all work tasks; evidence of impact from the research; problems arising in the project; actions taken in response to the feedback on the inception and interim reports.

The report should be circulated to the RAC, by early August 2020 in order to receive feedback from the RAC before the final report is submitted. As before, this will be accompanied with guidance on specific areas of feedback.

*Feedback on the report from the RAC would be appreciated before September 14th 2022.*

Conference call with RAC on the feedback to be arranged for 1st October 2022.

### 2.3.3. Risk management

The consortium lead has developed a risk register (Annex VI) which is reviewed monthly in the SARTRAC Management Board (PMB) meeting.

The risk register covers generic project risks that could be relevant to a large consortium, and also specific project risks that are known (e.g. COVID) and possible in SARTRAC. The specific risks are addressed in the monthly PMB meeting, with the likelihood and severity reviewed and any action that might be needed discussed. This process captures formally what has often already raised in informal discussions. Relationships have been developing between the leads in each country and work package, enabling open and honest discussions to take place.

The monthly reporting form, first used in January 2020, enables all partners to report on progress and any issues that have arisen. These reports are reviewed by both country leads and work package leads so they can bring any potential or emerging risks to the attention of the PMB that month.

### 2.3.4. Ethical approval for research involving human participants

At the start of SARTRAC, fieldwork was planned around the Annual Consortium Meetings. However, as a result of the COVID-19 pandemic, all fieldwork has been postponed, until it is safe to travel. Nonetheless, ethical approval is required for any fieldwork. We will apply for ethical approval for the SARTRAC project through the University of Southampton. All universities that plan to collect or use human data, will also need to gain ethical approval through their own universities. This includes: University of Southampton, University of the West Indies, and University of Ghana. The ethical and risk assessment will be driven by the risk champion.

### 2.3.5. Budget re-analysis and contracts

To govern SARTRAC partnerships each member has set up contracts as needed, and these partnerships are governed by a consortium agreement. The Research Innovation Services at the University of Southampton drafted the main 'Consortium Agreement' which was circulated for signature. Certain clauses were highlighted as being imperative. Due to various rounds of changes being requested during the review of the Consortium Agreement, this document was not signed off by all parties until 23rd March 2020 - the same day as the COVID-19 lockdown in the UK.

UWI Mona and UWI CERMES were not able to undertake key mobilisation activities such as contracting of project funded personnel until the contract was signed, and their progress was then affected by the COVID pandemic. Budget reprofiling work has begun (June 2020) to consider how the delays to the start of the project could be managed to create extra life at the end of the project. For UWI Mona and UWI CERMES, this could involve invoicing based on time contributions and work achieved rather than on stated time allocated to the project in the proposal for the first year.

## 2.4. Reporting

### 2.4.1. Internal reporting

As the consortium grows in size, and research gets underway, the PMB members will receive progress updates on a monthly basis through the monthly reporting forms (see section 1.5.1). Using Google Forms, SARTRAC asks for a brief monthly report from all its partners across the 4 teams. Reports are submitted per person per institute, and collated centrally by the consortium coordinator (Lucy Graves), who distributes them to the PMB. This system has been trialled for January (reporting for November '19 – January '20) feeding into the February 2020 PMB meeting. The Google Form also asks for specific information that correlates directly to ESRC reporting requirements, e.g. communications, dissemination and training.

### 2.4.2. External reporting to ESRC UKRI GCRF programme

External reporting to the ESRC will take place through 'researchfish' (https://esrc.ukri.org/funding/guidance-for-grant-holders/reporting/)

ESRC guidance states:

"*You are required to complete Researchfish every year your grant is active and usually for five years after it has ended. This period can vary depending on the type of grant you hold. If you do not make a submission you will be ineligible to apply for further funding from UK Research and Innovation (UKRI) and may have your active funding suspended until the issue is resolved*."

The reporting period is usually February - March, covering the preceding 11-12 months.

### 2.4.3. ESRC Grant Holder Guidance on publications

The ESRC Grant Holder is required to supply the ESRC on request with a copy of all of its publications including books, monographs and journal articles arising from its work and to notify the ESRC of publicity or coverage in the media. In the case of the printed media, the Grant may be asked to supply the ESRC with a copy of the coverage. The Council requires that the ESRC corporate logo is displayed on all promotional and corporate material (including publications, reports, presentations, websites, and stationery) in line with ESRC's identity guidelines.

The ESRC grant must acknowledge ESRC's support in any publication or announcement. The Council asks that the following form of words be used:

"*The support of the Economic and Social Research Council (ESRC) is gratefully acknowledged* ".

Where international publication takes place, the attribution should be to the Economic and Social Research Council (UK). In a book acknowledgement the ESRC must appear prominently in the preliminaries. In a journal article, it should preferably appear on the first page (as Footnote 1 where footnotes are set throughout the text or as an independent line if the footnotes are accumulated at the end of the text). If this is impossible for reasons of house style, the acknowledgement should appear as

prominently as is reasonably practicable. The grant holder should also try to ensure, where feasible, that any journalist, radio or television programme makes similar acknowledgement.

The work should not be described as being 'Government-funded' i. e. under the direct sponsorship of Government.

The ESRC requires to be given advance notice and sight of press releases at least two working days before they are distributed and, where possible, advance notice of all opinion pieces, blogs and likely newspaper articles or media appearances. Failure to comply with this requirement will be viewed as a serious matter which could lead to action being taken in respect of the Research Organisation's ability to hold further research grants.

Subject only to the ethics of confidentiality, as they relate both to individual subjects of research and to the contractual relationship between non-academic clients and the Grant, the Grant will not enter into any agreement, whether explicitly or implicitly, giving any other person the ultimate right to suppress research results which the investigator or the Council might wish to publish. Special care must be taken to omit, from any public statement, details which may prejudice commercial exploitation.

## 2.5. Annual Consortium Meetings

A whole consortium workshop (5 days, 20 people), in person or virtual (depending on COVID-19) will be held every 12 months in each year of the project (see Table 5).

*Table 7: Annual Consortium Meetings in SARTRAC*

| Name | Location, dates | Activities |
|---|---|---|
| ACM1 | Virtual 13-16 July 2020 | **Virtual** project inception meeting: chart the timing of project events; identify project management issues e.g. bottleneck activities; develop cross-WP linkages; review progress in first 6 months; develop work plan for year ahead. |
| ACM2 | Jamaica, 28 June-02 July 2021 | **Face-to-face**. WP progress updates, capacity building, review status of results, and agree plan for next 12 months; agree publications plan, finalise Interim report. Field trip. |
| ACM3 | Jamaica, June/July 2022 | **Face to face** final project meeting. Focus on finalising outputs, capacity building, and sustaining legacy. Field trip. |

Field-trips will be integral to see the impacts of, and solutions to the Sargassum issue in ACM 2 and 3. How these will be undertaken, will depend on the management of COVID-19.

Regional teams (UK and Caribbean) will meet (in person or virtually) at least once between each ACM, providing six-monthly meetings to monitor progress and develop plans. If COVID-19 can be managed successfully, and it is possible to undertake fieldwork, to keep costs down, fieldwork, stakeholder meetings, and PMB meetings will occur before and after each consortium meeting. Each research workshop will be followed by a half day project management meeting and two days capacity building activities. How this will occur will depend on the COVID-19 scenarios that unfolds.

# 3. SARTRAC Scope, Work Packages, and Activities

## 3.1. SARTRAC timeline

The project runs for 36 months from November 1st 2019 - October 31st 2022.

Year 1 –comprises three main activities: i) inception planning; ii) development of fieldwork plan; iii) identification and engagement of key stakeholders

Year 2 – Stakeholder engagement, fieldwork, capacity building and data collection

Year 3 - Stakeholder engagement, data analysis, capacity building, write up, and project legacy.

## 3.2. SARTRAC aim, objectives and planned outputs

Our aim is to identify new transformational developmental opportunities that build resilience equitably, for people affected by changing biomes/ecosystems in least developed countries. Specifically, we will identify the opportunities for transformational adaptation that can be generated through the management and re-use of the invasive sargassum seaweed increasingly found across the Caribbean, Central America and West Africa. We will accomplish our aim through four objectives (in priority order):

O1. DRIVERS. Evaluate large-scale drivers, oceanic transport, frequency and predictability of sargassum events. Using the best available science, co-develop with stakeholders an effective means of communicating and disseminating the underlying science of seaweed sources, transport, accumulations, and future flows. Improve long term prediction of flows to create benefits for the poorest in affected societies.

O2. DISTRIBUTION. Monitor and map (local to regional) intra-Caribbean and West African sargassum flows and impacts, to identify appropriate risk management strategies for the poorest affected communities. Using Satellite imagery and drones co-develop an operational near real-time early warning system for Jamaica countries and Ghana for the benefit of the most vulnerable in society. Develop impact pathways for different coastal archetypes for Jamaica, focussing on the most marginalised and poorest communities impacted.

O3. TRANSFORMATION. Evaluate the biotechnological and political economy potential for Sargassum re-use, to inform transformational adaptation pathways for Sargassum-receiving communities. Undertake seaweed collection, drying, preliminary analysis to identify opportunities for re-use in different products. Identify the demand for products from Sargassum, and identify success stories where opportunities have been developed from re-use.

O4. GOVERNANCE. This WP will investigate opportunities and risks associated with different policy settings for transformational adaptation. We will analyse existing policy settings, compare and contrast differences between countries and regions, consider different scenarios under regional and international legal frameworks, and propose *how* sargassum can be managed to the benefit of the poorest depending on whether it can be used as a resource or remains a pollutant. In doing so we will assess the extent to which different governance frameworks--local, national, regional and global--are best placed to respond to each scenario.

These objectives will all be applied in the context of transformational adaptation, i.e. what can be achieved to generate equitable resilience outcomes for the poorest and marginalised communities affected by Sargassum.

## 3.3. Work Package principles

This research will be delivered according to three principles embedded in all SARTRAC work packages:

*(1) Effective communication*: documenting, making accessible and communicating the underlying science and political economy of seaweed sources, flows and accumulations to inform risk management and long-term sustainability of Sargassum. We will also disseminate science at relevant conferences, and produce journal papers describing the methods and results.

*(2) Co-development of science*: co-developing locally appropriate monitoring, early warning and risk management of existing Sargassum strandings through a participatory dialogue led by our UWI partners. The participatory approach will allow regional and local stakeholders to both input relevant experience and disseminate the results as project champions. We will also co-develop potential transformational adaptation pathways that deliver opportunities for equitable resilience.

*(3) Capacity building*: facilitating sustained research capacity within partner institutions in the Caribbean and West Africa after the end of the project and the opportunity to self-propagate capacity to a wider set of institution across the regions. The wide-ranging skills available in the SARTRAC consortium will promote significant north-south and south-south interaction and learning. A skills and training needs inventory, led by University of Southampton, undertaken in July-August 2020 will shape training. Training will be provided attached to annual consortium events, within UK institutions and through a webinar series.

## 3.4. Work Packages and Work Tasks

We deliver our principles through four objectives (O) (Figure 8) which are mapped onto four work packages.

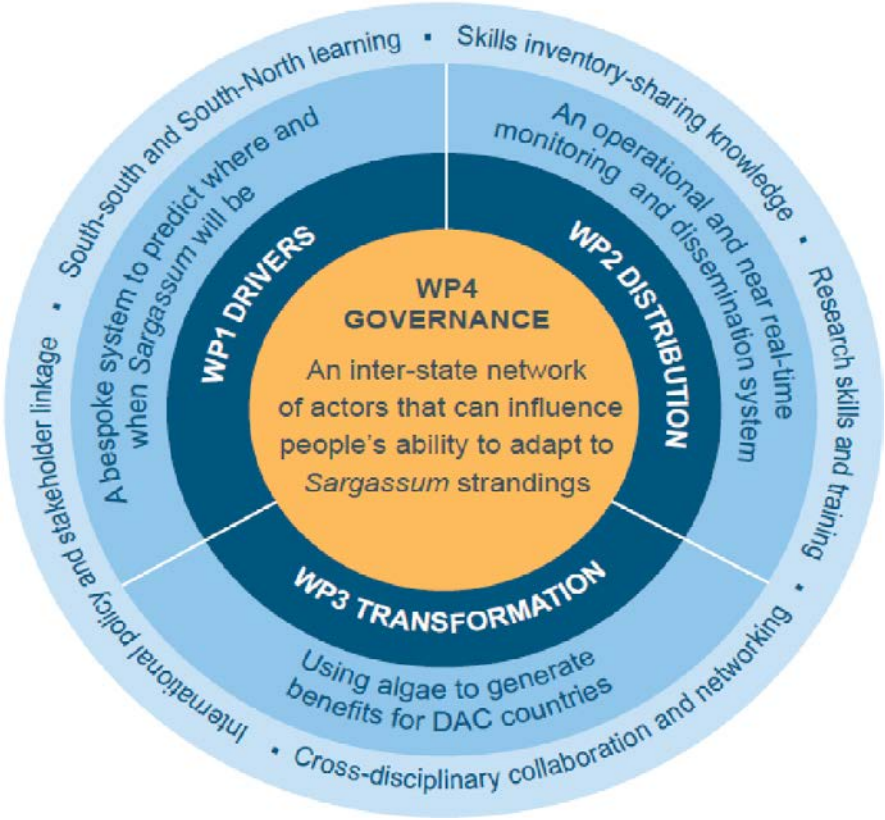


*Table 8 Work Package Structure*

### 3.4.1. Work Package 1: Drivers of Sargassum

| | |
|---|---|
| **WP Title** | **WP1 A bespoke system to predict where and when *Sargassum* will be** |
| **Short title** | **WP1 Drivers** |
| **Rationale** | WP aim: Improved prediction to better inform marginalised and poor communities of *Sargassum* beaching events.<br>WP1 contains 4 work tasks relating to identification of the drivers of *Sargassum* i.e.: i) Large-scale physical drivers; ii) Seeding system development; iii) Tracking system development; iv) Framework development |
| **Co-leads** | Robert Marsh (UOS)<br>Hazel Oxenford (UWI CERMES)<br>Kwasi Appeaning Addo (UOG) |
| **Contribution to SARTRAC objectives** | O4. DRIVERS. Evaluate large-scale drivers, oceanic transport, frequency and predictability of *Sargassum* events. Using the best available science, co-develop with stakeholders an effective means of communicating and disseminating the underlying science of seaweed sources, transport, accumulations, and future flows. Improve long term prediction of flows. |

*Table 9: WP1 overview*

**WP1 Work tasks**

WT1.1. Analysis of ocean and atmospheric observations, spanning equatorial and subtropical Atlantic, to better understand and predict the post-2011 seasonal proliferation of *Sargassum* at basin scale

WT1.2 Download (from USF SaWS) daily-available 7-day averaged, FA_density (Floating Algae) maps for Eastern Caribbean area (10-23°N, 60-75°W), the Central Atlantic area (38-63°W, 0-22°N) and equivalent data for the eastern tropical Atlantic (area to be determined); digitize/grid these to "seed" *Sargassum* for tracking

WT1.3 Development of efficient, probabilistic tracking with high-resolution ocean hind cast surface currents and winds to predict the approach of *Sargassum* to coastal Jamaica and Ghana, from weeks to months ahead

WT1.4 Co-development of an integrated system (interactive website) for end-users in Jamaica and Ghana.

**Key outputs of WP1**

O1.1 Research papers outlining physical drivers of *Sargassum* during past and next decade, assessing interannual variability and long-term changes in these drivers

O1.2 Data extracted from satellite maps of *Sargassum* fraction for the Eastern Caribbean, Central Atlantic and eastern tropical Atlantic areas, converted to initial particle density for O1.3

O1.3 Tested tracking system, for predicting drift of virtual *Sargassum* particles seeded according to maps (O1.2), given plausible ranges of regional currents and winds, with preliminary forecasts from spring 2020; research paper describing the forecast system and testing

O1.4 Bespoke framework (interactive website) to predict when, and in what quantify, *Sargassum* will approach within 10 km of coastlines, on timescales from weeks to months, tested for selected coastal

locations in Jamaica, the Lesser Antilles and Ghana; research paper describing the framework and local applications.

*Table 10: WP1 work task detail*

| | | | | | | |
|---|---|---|---|---|---|---|
| **WT1.1** | **Large-scale physical drivers** | | | | | |
| | Description: | The **aim** of this WT is to analyse ocean and atmospheric observations, spanning the equatorial and subtropical Atlantic, to better understand and predict the post-2011 seasonal proliferation of *Sargassum* at basin scale<br>**Deliverables** will be: research papers outlining physical drivers of *Sargassum*, assessing interannual variability and long-term changes in these drivers | | | | |
| | WT Leads: | **Nikolaos Skliris**, Robert Marsh (UOS) | | | | |
| | Duration: | 1 Nov 2019 - 31 Oct 2022 | | | | |
| | Skills required to deliver WT: | ● Experience with reanalysis datasets (atmosphere, ocean) and other data (runoff, etc.)<br>● Experience of time-space analysis<br>● Scientific writing | | | | |
| | Sub-tasks | WT1.1.1 | Source data and analyse climate variability in the tropical Atlantic of relevance to the *Sargassum* crisis | 1 Nov 2019 | | 31 Oct 2020 |
| | | WT1.1.2 | Source data and analyse variability of runoff and nutrient fluxes, in relation to changing hydrological cycle | 1 Aug 2020 | | 31 Oct 2021 |
| | | WT1.1.3 | Source data and analyse variability of ocean currents and winds that influence *Sargassum* transport | 1 Aug 2021 | | 31 Oct 2022 |
| | | WT1.1.4 | Based around ongoing season-to-decadal climate forecasts, assess long-term climate variability and change in the tropical Atlantic | 1 Nov 2020 | | 31 Oct 2022 |
| | Deliverables | D1.1 | Paper on climate variability in the tropical Atlantic of relevance to the *Sargassum* crisis | | | Q3, 2020 |
| | | D1.2 | Paper on variable runoff and nutrient fluxes, in relation to changing hydrological cycle | | | Q3, 2021 |
| | | D1.3 | Paper on variable ocean currents and winds that influence *Sargassum* transport | | | Q3, 2022 |
| | | D1.4 | Annual synthesis reports on tropical Atlantic conditions, based on available seasonal-to-decadal climate forecasts | | | Q1, 2021,22 |
| | Internal Milestones (if useful / needed) | M1.1<br>M1.2 M1.3 | Complete analysis of climate variability<br>Complete analysis of variable runoff and associated nutrient supply<br>Complete analysis of variable ocean currents and winds | | | Q2, 2020<br>Q2, 2021<br>Q2, 2022 |

| | | | | |
|---|---|---|---|---|
| | | M1.4 | Draft synthesis reports | Q4, 2020,21 |
| | Interactions | ● Informs WT1.3 | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **WT1.2** | **Seeding system development** | | | | | |
| | Description: | The **aim** of this WT is to access FA_density (Floating Algae) maps for Eastern Caribbean area, the Central Atlantic area, and equivalent data for the eastern tropical Atlantic, and to digitize/grid these to "seed" *Sargassum* for tracking<br>**Deliverables** will be: a proven system for data extraction, from satellite maps of *Sargassum* fraction for the Eastern Caribbean, Central Atlantic and eastern tropical Atlantic areas, converted to initial particle density for subsequent tracking | | | | |
| | WT Leads: | **Robert Marsh** (UOS), Kwasi Appeaning Addo (UOG) | | | | |
| | Duration: | 1 Feb 2020 - 31 Jan 2021 | | | | |
| | Skills required to deliver WT: | ● Experience with remote sensing and satellite datasets<br>● Experience of image/data handling and time-space analysis<br>● Knowledge of particle tracking systems | | | | |
| | Sub-tasks | WT1.2.1 | Initial proof of concept, demonstrating the throughput from satellite image to initialised tracking calculation, using available FA_density data (Eastern Caribbean and Central Atlantic areas) | 1 Feb 2020 | | 30 Apr 2020 |
| | | WT1.2.2 | Identification and use of alternative satellite data for initialising particle density in the eastern tropical Atlantic | 1 May 2020 | | 31 Jul 2020 |
| | | WT1.2.3 | Development of a system for routine access to satellite data from different source regions, to prepare tracking calculations | 1 Aug 2020 | | 31 Jan 2021 |
| | Deliverables | D1.2.1 | Datasets and graphical output evidencing successful translation of satellite images to "seed" positions in the Eastern Caribbean and Central Atlantic regions | | | 30 Apr 2020 |
| | | D1.2.2 | Datasets and graphical output evidencing successful translation of satellite images to "seed" positions in the eastern tropical Atlantic | | | 31 Jul 2020 |
| | | D1.2.3 | Reliable, flexible and efficient software to allow users to choose a seeding area and time, for subsequent tracking calculations | | | 31 Jan 2021 |

| | | | | |
|---|---|---|---|---|
| | Internal Milestones (if useful / needed) | M1.2.1 | Working software system for selecting location and timing of particle seeding | 31 Oct 2020 |
| | Interactions | ● Informs WT1.3 | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **WT1.3** | **Tracking system development** | | | | | |
| | Description: | The **aim** of this WT is to develop an efficient tracking system, for predicting drift of *Sargassum*, given plausible ranges of regional currents and winds<br>**Deliverables** will be: a tested tracking system, for predicting drift of *Sargassum* seeded according to maps (WT1.2), documented in a paper; prototype forecasts from spring 2020, documented in a paper | | | | |
| | WT Leads: | **Robert Marsh** (UOS), Hazel Oxenford (UWI CERMES), Kwasi Appeaning Addo (UOG) | | | | |
| | Duration: | 1 Feb 2020 - 31 Oct 2021 | | | | |
| | Skills required to deliver WT: | ● Experience with satellite datasets (for evaluation of forecasts)<br>● Experience with particle drift data, time-space analysis and statistics (confidence, uncertainty, etc.)<br>● Knowledge or experience of particle tracking systems<br>● Scientific writing<br>● Stakeholder requirements and related work ongoing across the wider community | | | | |
| | Sub-tasks | WT1.3.1 | Development of prototype model system; preliminary forecasts for Jamaica and the Lesser Antilles | 1 Feb 2020 | | 30 Apr 2020 |
| | | WT1.3.2 | Extension of the system and forecast to Ghana | 1 Aug 2020 | | 31 Aug 2020 |
| | | WT1.3.3 | Testing of forecasts and refinement of the prototype forecast system | 1 Sep 2020 | | 31 Jan 2021 |
| | | WT1.3.4 | Co-development of the system as a framework for local application - Phase 1 (scoping, testing) | 1 Feb 2021 | | 31 Oct 2021 |
| | Deliverables | D1.3.1 | Prototype model system and preliminary forecasts for Jamaica and the Lesser Antilles | | | 30 Apr 2020 |
| | | D1.3.2 | Extension of the prototype system and preliminary forecasts to the Ghana coast | | | 31 Aug 2020 |
| | | D1.3.3 | Paper describing the prototype system and evaluation of preliminary forecasts | | | 31 Jan 2021 |

| | | | | |
|---|---|---|---|---|
| | | D1.3.4 | Paper describing the fuller framework, tested in local applications | 31 Oct 2021 |
| | Internal Milestones (if useful / needed) | M1.3.1 | Preliminary forecasts and evaluations (progress report) for Jamaica and the Lesser Antilles shared with partners in UWI and U Ghana | 31 Oct 2020 |
| | | M1.3.2 | Preliminary version of framework for local applications (forecasts) | 30 Jun 2021 |
| | Interactions | ● Informs WT1.4 | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **WT1.4** | **Framework development** | | | | | |
| | Description: | The **aim** of this WT is the co-development of an integrated system (interactive website) for end-users in Jamaica and Ghana - Phase 2 (implementation)<br>**Deliverables** will be: a bespoke framework (e.g. interactive website) to predict when, and in what quantify, *Sargassum* will approach within 10 km of coastlines, on timescales from weeks to months, tested for selected coastal locations in Jamaica and Ghana; a research paper describing experiences of these local applications. | | | | |
| | WT Leads: | **Robert Marsh (UOS)** and Kwasi Appeaning Addo (UOG) | | | | |
| | Duration: | 1 Feb 2021 - 31 Oct 2022 | | | | |
| | Skills required to deliver WT: | ● Knowledge or experience of particle tracking systems<br>● Interactive website design<br>● Stakeholder requirements and related work ongoing across the wider community<br>● Synthesising science, environmental management and communication to stakeholders | | | | |
| | Sub-tasks | WT1.4.1 | Co-development of bespoke frameworks for stakeholders in Caribbean and west Africa | 1 Feb 2021 | | 31 Jan 2022 |
| | | WT1.4.2 | Application of framework to provide forecasts for selected coastal locations | 1 Feb 2022 | | 31Oct 2022 |
| | Deliverables | D1.4.1 | Bespoke frameworks (interactive websites) for stakeholders in Caribbean and west Africa | | | 31 Jan 2022 |
| | | D1.4.2 | Paper describing application and utility of frameworks | | | 31 Oct 2022 |
| | Internal Milestones (if useful / needed) | M1.4.1 | Interim report on development of bespoke frameworks | | | 31 Jul 2021 |
| | | M1.4.2 | Interim report on spring 2022 forecasts, per coastal location, of *Sargassum* arrivals in early summer of 2022 | | | 31 Jul 2022 |

| | | |
|---|---|---|
| | Interactions | ● Links to Work Package 2 |

### 3.4.2. Work Package 2: Monitoring and dissemination

*Table 11: WP2 overview*

| | |
|---|---|
| **WP Title** | **WP2 An operational and near real time monitoring and dissemination system** |
| **Short title** | **WP2 Distribution** |
| **Rationale** | WP aim: Co-develop a monitoring and dissemination system with stakeholders, to provide information on *sargassum* strandings to create transformational adaptation opportunities for the most vulnerable in affected communities.<br><br>WP 2 contains 6 work tasks relating to the monitoring and dissemination of a *sargassum* early-warning system, i.e. i) detection of stranding events; ii) early-warning system development and dissemination; iii) understanding the physical and social distribution of stranding events; iv) framework to assess resilience to future stranding events; v) co-development of a risk management strategy; vi) training and transfer of early-warning system. |
| **Co-leads/team** | Jadu Dash (UoS, UK) 0.05FTE, Ava Maxam (UWI-Mona, Jamaica) 0.35FTE, Kwasi Appeaning-Addo 0.05FTE<br><br>Sien van Der Plank 0.5FTE, Jayson Quashigah (0.2FTE), PDRA GIS/Mona (1.0FTE) |
| **Contribution to SARTRAC objectives** | O2. DISTRIBUTION. Monitor and map (local to regional) intra-Caribbean and West African Sargassum flows, impacts and adaptations, to identify the social and economic distribution of gains and losses from impacts and adaptations. Using Satellite imagery and drones develop an operational near real-time early warning system for the Caribbean DAC countries and Ghana for the benefit of the poorest. Develop impact pathways for different coastal archetypes, focussing on the most marginalised and poorest communities impacted. |

**Works tasks**

WT2.1. [DETECTION] Develop an improved algorithm to detect *Sargassum* stranding events across Caribbean, using freely available satellite data.

WT2.2. [MONITORING] Design a web-based automated *Sargassum* information and dissemination system, informed by stakeholder meetings and use requirement needs.

WT2.3. [IMPACTS] Identify areas (and their physical characteristics) that are prone, in the past/future, to stranding events.

WT2.4. [TRANSFERABLE FRAMEWORK] Theorise the physical, and socio-economic factors that build resilience to sargassum events.

WT 2.5. [EARLY WARNING] Co-develop a risk management strategy to build equitable resilience by considering output from WP 2.3 and WP 2.4.

WT2.6. [CAPACITY BUILD] Explore transferability of 2.1 and 2.2 to Ghana.

**Key outputs of WP2**

O2.1 An Open source algorithm to detect and map *Sargassum* stranding events across the Caribbean, available through open access publication and repository such as Github.

O2.2 Early warning system for Sargassum stranding events across Caribbean, with a research paper outlining the methodology for the development of the system.

O2.3 Academic paper outlining a classification of the socio-economic and physical factors in Jamaica, i.e. beach type and composition, associated with stranding events, and quantification of the impacts of historic stranding events on the livelihoods of coastal communities in Jamaica.

O2.4 Assessment of potential impacts of future *Sargassum* events, theorising a transferable framework to identify factors that enhance equitable resilience among the poorest communities to *Sargassum* events, and a research paper establishing a framework to identify resilience factors in all areas affected by *Sargassum* in the tropical Atlantic.

O2.5 Co-designed risk management strategy to ensure equitable resilience to future *sargassum* stranding events, including a policy paper.

O2.6 Develop a prototype of an early-warning system for Ghana, identify impacts on people in Ghana, and strengthen capacity of stakeholders in use of geospatial data in *sargassum* management and decision making

*Table 12 WP2 work task details*

| | | | | | | |
|---|---|---|---|---|---|---|
| **WT2.1** | **Detection of stranding events** | | | | | |
| | Description: | The **aim** of this WT is to develop an improved algorithm to detect *sargassum* stranding events across the Caribbean, using freely available satellite data.<br><br>**Deliverables** will be: Open access algorithm to detect and map *sargassum* stranding events across the Caribbean. | | | | |
| | WT Leads: | Jadu Dash (University of Southampton) | | | | |
| | Duration: | January 2020 – December 2021 | | | | |
| | Skills required to deliver WT: | ● Experience with satellite datasets<br>● Experience with hydrodynamic model mesh development<br>● Field collection methods, including operation of drones<br>● Knowledge in integrating satellite and drone data | | | | |
| | Sub-tasks | WT2.1.1 | Review regional tracking sources and algorithms to identify *Sargassum* | 1 Mar 2020 | | 31 Aug 2020 |
| | | WT2.1.2 | Development of field collection methodology and regime | 1 Aug 2020 | | 31 Jan 2021 |
| | | WT2.1.3 | Development of algorithm for satellite data | 1 Aug 2020 | | 31 Dec 2020 |
| | | WT2.1.4 | Collection of Sargassum beaching "training" data for model validation and continuous monitoring | 1 Jan 2021 | | 30 Jun 2021 |
| | | WT2.1.5 | Validation of algorithm | 1 Jan 2021 | | 30 Sep 2021 |
| | | WT2.1.6 | Comparison of algorithm to existing methods | 1 Jan 2021 | | 30 Sep 2021 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | WT2.1.7 | Run algorithm for set time-period and generate map of sargassum distribution | 1 Sep 2021 | | 31 Dec 2021 |
| | Deliverables | D2.1.1 | Open access algorithm to detect *sargassum* stranding events across the Caribbean. | | | 31 Dec 2020 |
| | | D2.1.2 | Map of distribution of *sargassum* in Jamaica | | | Dec 2021 |
| | | D2.1.3 | Academic paper reviewing existing methods to detect *sargassum* and proposing a new algorithm | | | Dec 2021 |
| | Internal Milestones (if useful / needed) | M2.1.1 | Database of *sargassum* tracking sources, for internal use | | | 31 Jul 2020 |
| | | M2.1.2 | Methodology for field collection | | | 31 Mar 2021 |
| | | M2.1.3 | Development of initial algorithm for satellite data | | | 31 Dec 2020 |
| | | M2.1.4 | Generation of map of *sargassum distribution* | | | 31 Dec 2021 |
| | | M2.1.5 | Completed collection of sargassum beaching "training" data | | | 31 Dec 2021 |
| | Interactions | ● Informs WT2.2<br>● Informs WT2.3<br>● Informs WT2.6 | | | | |

| **WT2.2** | **Early-warning system development and dissemination** |
|---|---|
| | Description: | The **aim** of this WT is to co-design a web-based automated information and dissemination system, informed by stakeholder meetings and user requirement needs<br><br>**Deliverables** will be: Early warning system for sargassum stranding events across Caribbean, with a research paper outlining the methodology for the development of the system. |
| | WT Leads: | Ava Maxam (UWI-Mona, Jamaica) 0.35FTE, Kwasi Appeaning-Addo 0.05FTE (University of Ghana) |
| | Duration: | July 2020 – October 2022 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Skills required to deliver WT: | ● Processing algorithms<br>● Experience in public relations and running workshops<br>● Interactive web design<br>● Science communication to the public | | | | |
| | Sub-tasks | WT2.2.1 | Review of early warning hazard systems | 1 Jul 2020 | | 31 Dec 2020 |
| | | WT2.2.2 | Develop *sargassum* early-warning system functional specifications and requirements from survey of users in Jamaica | 1 Oct 2020 | | 31 Mar 2021 |
| | | WT2.2.3 | Integrate satellite data and ocean and meteorological data to develop real-time model | 1 Jan 2021 | | 31 Dec 2021 |
| | | WT2.2.4 | *Sargassum* early-warning system development of visualisation with stakeholder input | 1 Apr 2021 | | 31 Dec 2021 |
| | | WT2.2.5 | Dissemination of *sargassum* early-warning system | 1 Jan 2022 | | 31 Oct 2022 |
| | | WT2.2.6 | Mainstreaming utilisation of early-warning system and user feedback through workshops and surveys | 1 Apr 2022 | | 31 Oct 2022 |
| | Deliverables | D2.2.1 | Transferable early warning system for sargassum stranding events in Jamaica | | | 31 Mar 2022 |
| | | D2.2.2 | Research paper outlining the methodology for the development of the system. | | | 30 Jun 2022 |
| | | D2.2.3 | Early warning system disseminated through webinar, workshops in Jamaica, and web-based application. | | | 31 Oct 2022 |
| | Internal Milestones (if useful / needed) | M2.2.1 | Completed survey of user needs for web-based system | | | 31 Mar 2021 |
| | | M2.2.2 | Identified specifications and requirements for early-warning system | | | 31 Mar 2021 |
| | | M2.2.3 | Developed initial early-warning system prototype | | | 31 Dec 2021 |
| | | M2.2.4 | Developed plan for feedback and workshops | | | 31 Mar 2022 |

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|---|---|---|---|---|
| | | M2.2.5 | Completion of dissemination and user feedback through workshops, webinars and surveys | 31 Oct 2022 |
| | Interactions | ● Links to WP1<br>● Links to WP4, regarding stakeholder identification (i.e. WT2.2.2)<br>● Depends on WT2.1 (i.e. WT2.2.3)<br>● Informs WT2.6 | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **WT2.3** | **Understanding the physical and social distribution of sargassum stranding impacts** | | | | | |
| | Description: | The **aim** of this WT is to identify socio-economic areas (and their physical characteristics) that are prone to past stranding events in Jamaica.<br><br>**Deliverables** will be: Classification of the socio-economic and physical factors in Jamaica, i.e. beach type and composition, associated with stranding events, and quantification of the impacts of historic stranding events on the livelihoods of coastal communities in Jamaica through an analysis of the social conditions within communities (likely drawing on census data). | | | | |
| | WT Leads: | Jadu Dash (University of Southampton) | | | | |
| | Duration: | June 2020 – July 2022 | | | | |
| | Skills required to deliver WT: | ● Fieldwork<br>● Census and other national database data collection (physical and socio-economic data)<br>● Knowledge in how to apply algorithm developed in WT2.1<br>● Experience in overlaying spatial datasets | | | | |
| | Sub-tasks | WT2.3.1 | Data collection from *sargassum* detection algorithm, high resolution satellite data and local records to identify location of historic stranding events in Jamaica. | 1 Jun 2020 | | 31 Dec 2021 |
| | | WT2.3.2 | Identify physical characteristics (e.g. geomorphic, orientation of coast, tides) of areas impacted by *sargassum* strandings in Jamaica | 1 Sep 2020 | | 31 Dec 2021 |
| | | WT2.3.3 | Identify socio-economic conditions of areas impacted by *Sargassum* strandings in Jamaica using census and other national data. | 1 Sep 2020 | | 31 Dec 2021 |
| | | WT2.3.4 | Overlay social conditions, physical characteristics, and previous *Sargassum* stranding frequencies and densities to develop classification of hotspots and coldspots of impacts in Jamaica. | 1 Jan 2021 | | 31 Mar 2022 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | WT2.3.5 | Quantify the impacts of historic stranding events on the livelihoods of coastal communities in Jamaica, using field-based data collection, and validate classification. | 1 Apr 2021 | | 31 Jul 2022 |
| | Deliverables | D2.3.1 | Classification of physical coastal types and socio-economic characteristics of regions impacted by *sargassum* strandings in Jamaica | | | 30 Sep 2020 |
| | | D2.3.2 | Academic paper documenting the physical and social characteristics associated with local impacts of *sargassum* strandings in Jamaica | | | 31 Jul 2022 |
| | Internal Milestones (if useful / needed) | M2.3.1 | Identification of historic stranding events through satellite data and local records | | | 31 Dec 2021 |
| | | M2.3.2 | Applied WT2.1 algorithm to identify historic stranding event locations | | | 31 Dec 2021 |
| | | M2.3.3 | Completion of field data collection regarding historic stranding events | | | 31 Dec 2021 |
| | | M2.3.4 | Classification of hot-spots and cold-spots of *sargassum* stranding impacts in Jamaica | | | 31 Mar 2022 |
| | | M2.3.5 | Paper draft characterising the physical and social characteristics of *sargassum* stranding event impacts in Jamaica | | | 31 Mar 2022 |
| | Interactions | ● Depends on WT2.1, for identification of past s*argassum* events (i.e. WT2.3.1)<br>● Informs WT2.4<br>● Informs WT2.5 | | | | |

| **WT2.4** | **Framework to assess resilience to future stranding** |
|---|---|
| Description: | The **aim** of this WT is to theorise the physical, and socio-economic factors that build resilience to sargassum events.<br><br>**Deliverables** will be: Assessment of potential impacts of future *sargassum* events, theorising a transferable framework to identify factors that enhance equitable resilience among the poorest communities to *sargassum* events, and a research paper establishing a framework to identify resilience factors in all areas affected by *sargassum* in the tropical Atlantic. |
| WT Leads: | Dr Ava Maxam (UWI Mona) |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Duration: | July 2021 – July 2022 | | | | |
| | Skills required to deliver WT: | ● Scientific writing<br>● Experience in systems modelling | | | | |
| | Sub-tasks | WT2.4.1 | Develop a conceptual framework for equitable resilience to s*argassum* strandings | 1 Jul 2021 | | 31 Dec 2021 |
| | | WT2.4.2 | Create systems dynamic model to show the complexity of the system of sargassum strandings in Jamaica and the range of variables. | 1 Jul 2021 | | 31 Mar 2022 |
| | | WT2.4.3 | Run systems dynamic model for Jamaica to identify resilience of coastal communities affected by historic events in Jamaica | 1 Jan 2022 | | 31 Mar 2022 |
| | | WT2.4.4 | Develop and expand systems dynamic model to test feasibility for wider Caribbean area and Ghana | 1 Apr 2022 | | 31 Jul 2022 |
| | Deliverables | D2.4.1 | Conceptual framework of equitable resilience to sargassum strandings in the tropical Altantic | | | 31 Dec 2021 |
| | | D2.4.2 | Systems dynamic model of *sargssum* impacts | | | 31 Mar 2022 |
| | | D2.4.3 | Academic paper on a systems dynamic model to quantify *sargassum* impacts in Jamaica and other locations | | | 31 Oct 2022 |
| | Internal Milestones (if useful / needed) | M2.4.1 | Identification of variables for systems dynamic model | | | 31 Dec 2021 |
| | | M2.4.2 | Initial version of systems dynamic model developed | | | 31 Dec 2021 |
| | | M2.4.3 | Paper draft of academic paper on systems dynamic model | | | 31 Mar 2022 |
| | Interactions | · Depends on WT2.3 (i.e. historic *sargassum* events and impacts, for WT2.4.1)<br>· Informs WT2.5<br>· Informs WT2.6 | | | | |

| | |
|---|---|
| **WT2.5** | **Co-development of risk management strategy** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Description: | The **aim** of this WT to co-develop a risk management strategy to build equitable resilience by considering output from WP 2.3 and WP 2.4.<br><br>**Deliverables** will be: Co-designed risk management strategy to ensure equitable resilience to future *Sargassum* stranding events, including a policy paper. | | | | |
| | WT Leads: | Dr Ava Maxam and Dr Janice Cumberbatch (UWI Mona) | | | | |
| | Duration: | September 2020 – March 2022 | | | | |
| | Skills required to deliver WT: | ● Policy review<br>● Policy development and impact<br>● Stakeholder engagement | | | | |
| | Sub-tasks | WT2.5.1 | Review of sargassum policies and hazard risk management strategies across the Caribbean region | 1 Sep 2020 | | 31 Dec 2020 |
| | | WT2.5.2 | Consultation and survey of stakeholder survey needs in Jamaica and Caribbean on how policies could be modified to create equitable resilience for poorest | 1 Jan 2021 | | 30 Jun 2021 |
| | | WT2.5.3 | Integration of existing policies with s*argassum* management options and opportunities for developing equitable resilience | 1 Jul 2021 | | 30 Sep 2021 |
| | | WT2.5.4 | Consultation, policy feedback and refinement with Jamaica stakeholders to create general risk management strategy for Caribbean | 1 Oct 2021 | | 31 Dec 2021 |
| | | WT2.5.5 | Preparation of Final Draft incorporating feedback | 1 Jan 2022 | | 31 Mar 2022 |
| | Deliverables | D2.5.1 | Risk management strategy for *sargassum* stranding in Jamaica and Caribbean | | | 31 Mar 2022 |
| | | D2.5.2 | Policy paper on s*argassum* stranding risk management strategy ensuring equitable resilience | | | 31 Mar 2022 |
| | Internal Milestones (if useful / needed) | M2.5.1 | Review of *sargassum* and hazard risk management strategies across Caribbean region | | | 31 Dec 2020 |
| | | M2.5.2 | Development of consultation method plan with stakeholders in Jamaica | | | 31 Mar 2021 |
| | | M2.5.3 | First draft of s*argassum* risk management strategy | | | 30 Jun 2021 |

| | | | | |
|---|---|---|---|---|
| | | M2.5.4 | First draft of policy paper | 30 Sep 2021 |
| | | M2.5.5 | Completion of consultation periods in Jamaica | 31 Dec 2021 |
| | Interactions | ● Depends on WT2.3 (i.e. to inform any targeting of specific geographic at-risk locations)<br>● Depends on WT2.4 (i.e. to inform WT2.5.3 regarding equitable resilience)<br>● Links to WP4 (i.e. identification and analysis of regional policies)<br>● Links to WP3 (i.e. biological opportunities identified from lab work) | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **WT2.6** | **Training and transfer of early-warning system to Ghana** | | | | | |
| | Description: | The **aim** of this WT is to explore the transferability of 2.1 and 2.2 to Ghana.<br><br>**Deliverables** will be: Prototype of an early-warning system for Ghana, identification of impacts on people in Ghana, and strengthened capacity of stakeholders in use of geospatial data in decision making | | | | |
| | WT Leads: | Professor Kwasi Appeaning Addo, University of Ghana<br>Philip-Neri Jayson-Quashigah, University of Ghana | | | | |
| | Duration: | January 2022 – October 2022 | | | | |
| | Skills required to deliver WT: | ● Working with remote sensing algorithms and datasets<br>● Application of systems dynamic models<br>● Stakeholder engagement | | | | |
| | Sub-tasks | WT2.6.1 | Run *sargassum* algorithm (WT2.1) using satellite data for Ghana | 1 Jan 2021 | | 31 Mar 2022 |
| | | WT2.6.2 | Develop early warning system and dissemination for Ghana, using input from 2.6.1 | 1 Apr 2021 | | 31 Jul 2022 |
| | | WT2.6.3 | Collect social and economic datasets for Ghana | 1 Oct 2020 | | 31 Mar 2022 |
| | | WT2.6.4 | Apply systems dynamic model to Ghana | 1 Jan 2022 | | 31 Jul 2022 |
| | | WT2.6.5 | Strengthened capacity of stakeholders in use of geospatial data in decision making through workshops | 1 Aug 2021 | | 31 Oct 2022 |
| | Deliverables | D2.6.1 | Strengthened capacity of stakeholders through delivery of workshops | | | 31 Oct 2022 |

| | | | | |
|---|---|---|---|---|
| | | D2.6.3 | Policy paper on the transferability of a early-warning *sargassum* system to West Africa | 31 Oct 2022 |
| | Internal Milestones (if useful / needed) | M2.6.1 | Application of algorithm to Ghana | 31 Mar 2022 |
| | | M2.6.2 | Data collection for Ghana complete | 31 Mar 2022 |
| | | M2.6.3 | Workshop development complete | 31 Mar 2022 |
| | | M2.6.4 | First paper draft complete | 31 Jul 2022 |
| | Interactions | • Depends on WT2.1 (i.e. algorithm identification, WT2.6.1)<br>• Depends on WT2.2 (i.e. early-warning system, WT2.6.2)<br>• Depends on WT2.4 (i.e. application of systems dynamic model, WT2.6.4)<br>• Links to WP4 (i.e. stakeholder analysis in Ghana, West Africa) | | |

### 3.4.3. Work Package 3: Transformational adaptation

*Table 13: WP3 overview*

| | |
|---|---|
| **WP Title** | **WP3: Using algae to generate benefits for developing countries in the Caribbean and West Africa.** |
| **Short title** | **WP3: Transformation** |
| **Rationale** | WP AIM: assessment of biological, political, social, and economic aspects to inform potential valorization routes for the Sargassum feedstock.<br>WP3 contains six work tasks relating to different aspects to take into consideration for valorization of Sargassum biomass:<br>i) Determination of Sargassum feedstock consistency in Jamaica;<br>ii) Assessment of Sargassum for production of energy by biodigestion<br>iii) Evaluation of Sargassum for soil amelioration in the context of food production and environmental applications;<br>iv) Assessing current practices in managing Sargassum (delivered by WP4/SHE team)<br>v) Identification of opportunities and barriers to the exploitation of Sargassum (delivered by WP4/SHE team)<br>vi) Integration of interdisciplinary data to identify opportunities and barriers for the management and valorisation of Sargassum in Ghana and the Caribbean (WP3/4 teams) |
| **Co-leads** | Dr T. Tonon (U. of York, UK)<br>Prof. M. Webber (UWI-Mona, Jamaica) |
| **Contribution to SARTRAC objectives** | O3. TRANSFORMATION. Evaluation of the biotechnological and political economy potential for sargassum re-use. Information on transformational adaptation pathways for Sargassum-receiving communities. |

Additional background and method information for Work Package 3 is presented in Annex VII.

*Table 14: WP3 work task details*

| | |
|---|---|
| **WT3.1** | **Determination of *sargassum* feedstock consistency** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Description: | The **aim** of this WT is to provide an in-depth characterization of the biochemical composition of the *sargassum* harvested in Jamaica, and also assess potential changes related to seasonality and storage. This will inform potential subsequent applications of the *sargassum* biomass.<br><br>**Deliverables** will take the form of four internal reports (D3.1.1, D3.1.2, D3.1.3, and D3.1.4), which will then be combined during the last months of the project to produce a manuscript on the abundance of the different morphotypes of *sargassum* during algal blooms (years 2020 and 2022), and on the associated changes in seaweed biomass composition.<br><br>**Results will provide input into:**<br>● Research paper outlining changes in biochemical composition of s*argassum* biomass according to seasons and beaching events.<br>● Training of Jamaican researchers on algal analytical procedures and thorough knowledge of algal biomass composition. | | | | |
| | WT Leads: | Dr T. Tonon, U. of York (UK). | | | | |
| | Duration: | Y1Q2 - Y3Q4 | | | | |
| | Skills required to deliver WT: | ● Understanding of research design and storage processes.<br>● Understanding of extraction and analytical procedures.<br>● Knowledge of brown algal biomass composition.<br>● Scientific writing. | | | | |
| | Sub-tasks | WT3.1.1 | Collection and storage (burlap bag, and ensilage in plastic bag) of *Sargassum* during the first year of the project. | Q2, 2020 | | Q1, 2021 |
| | | WT3.1.2 | Biochemical composition analysis of seaweeds harvested during the first year of the project. | Q2, 2021 | | Q4, 2021 |
| | | WT3.1.3 | Collection and storage (burlap bag, and ensilage in plastic bag) of *Sargassum* during the second year of the project. | Q2, 2021 | | Q1, 2022 |
| | | WT3.1.4 | Biochemical composition analysis of seaweeds harvested during the second year of the project. | Q2, 2021 | | Q4, 2022 |
| | Deliverables | D3.1.1 | Report on the most abundant morphotype(s) forming Sargassum blooms during the year 2020. | | | 31/12/2020 |
| | | D3.1.2 | Report on the changes in biochemical composition across seasons and after storage from algae harvested in 2020. | | | 31/08/2021 |
| | | D3.1.3 | Report on the most abundant morphotype(s) forming Sargassum blooms during the year 2020. | | | 31/12/2021 |
| | | D3.1.4 | Report on the changes in biochemical composition across seasons and after storage from algae harvested in 2021. | | | 31/08/2022 |
| | | D3.1.5 | Research paper outlining changes in biochemical composition of *Sargassum* biomass according to seasons and beaching events. | | | 31/10/2022 |
| | Internal Milestones (if useful / needed) | M3.1.1 | Harvesting-Year1-Spring-4 sites | | | 20/05/2020 |
| | | M3.1.2 | Harvesting-Year1-Summer-4 sites | | | 31/07/2020 |
| | | M3.1.3 | Harvesting-Year1-Autumn-4 sites | | | 31/11/2020 |
| | | M3.1.4 | Harvesting-Year2-Spring-4 sites | | | 20/05/2021 |
| | | M3.1.5 | Harvesting-Year2-Summer-4 sites | | | 31/07/2021 |
| | | M3.1.6 | Harvesting-Year2-Autumn-4 sites | | | 31/11/2021 |

| | | |
|---|---|---|
| | Interactions | Locations for collection of *Sargassum* will be driven by outputs from **WP2**. |

| | | | | | | |
|---|---|---|---|---|---|---|
| **WT3.2** | **Assessment of *Sargassum* for production of energy by biodigestion.** | | | | | |
| | Description: | The **aim** of this WT is to test anaerobic mono- and co-digestion of *Sargassum* in bio-digesters of different scales for the production of gas and electricity at the single family and community level. With our focus on equitable resilience, this is especially for those who do not have access to reliable and cheap energy at present. *Sargassum* biomass will be mixed with animal (e.g. pig) waste for co-digestion analysis. The possible useful by-products are compost/fertilizer (from the slurry or sludge), and irrigation water (from the final treated effluent). Grinding or milling of Sargassum biomass before bio-digestion will be assessed to determine if such pre-treatments can increase the efficiency of bio-digestion. The work related to this WT is to support equitable resilience in communities (sub-contract to the Scientific Research Council, Jamaica/UWI Mona).<br><br>**Deliverables** will be biomethane potential (BMP) determination for Sargassum/Sargassum and pig slurry mixes. Based on the 'bench top' experiments, pilot-scale tests at the scale that can be used in communities will be done so the technology can be transferred. | | | | | |
| | WT Leads: | UWI-Mona PDRA2 - SRC- Ja. | | | | |
| | Duration: | Y1Q2 – Y3Q4 | | | | |
| | Skills required to deliver WT: | ● Understanding in engineering of biodigesters of different scales.<br>● Understanding of the biodigestion process.<br>● Scientific writing. | | | | |
| | Sub-tasks | WT3.2.1 | Determination of the BMP and other related anaerobic digestion parameters at the bench scale (initial experiments) | Q3, 2021 | | Q2, 2022 |
| | | WT3.2.2 | Development of digesters of various scales for bioenergy production based on anaerobic co-digestion of sargassum in the Caribbean. Potential technological transfer to Ghana. | Q3, 2020 | | Q4, 2022 |
| | Deliverables | D3.2.1 | Working paper reporting on the efficiency of anaerobic digestion of Sargassum mixed with pig slurry. | | | Q4, 2021 |
| | | D3.2.2 | Digesters (litres-scale) ready to be handled to local communities. | | | Q4, 2022 |
| | Internal Milestones (if useful / needed) | M3.2.1 | Initial experiments will be conducted that will first determine the biomethane potential (BMP) of *Sargassum*. This will be conducted by the Wastewater Research & Management Unit of the Scientific Research Council (SRC), Jamaica.<br><br>The BMP experiments will be conducted at 'bench scale' followed by pilot scale tests in an actual digester.<br><br>BMP of fresh *Sargassum* mixed with pig slurry will be determined using mixes with the following percentages:<br><br>**% Pig Slurry** / **% Pre-treated *Sargassum***<br>100 / 0 | | | Q3, 2021 |

| | | | |
|---|---|---|---|
| | | | <table><tr><td>10</td><td>90</td></tr><tr><td>20</td><td>80</td></tr><tr><td>30</td><td>70</td></tr><tr><td>40</td><td>60</td></tr><tr><td>50</td><td>50</td></tr><tr><td>60</td><td>40</td></tr><tr><td>0</td><td>100</td></tr></table><br>In addition of BMP, the following parameters will be tested before and after digestion:<br>TS – Total Solids<br><br>TSS – Total Suspended Solids<br><br>TVS – Total Volatile Solids<br><br>MLVSS – Mixed Liquor Volatile Suspended Solids<br><br>COD – Chemical Oxygen Demand<br><br>VFA – Volatile Fatty Acids<br><br>pH |
| | Interactions | ● Not applicable. | |

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| **WT3.3** | **Evaluation of *sargassum* for soil amelioration in the context of food production and environmental applications.** | |
| | Description: | The **aim** of this WT is to test the influence of composts containing different proportions of *sargassum* on the growth of crop (corn) and vegetables (tomato) seedlings; The opportunity to consider such compost for restoration of mangroves will also be explored. This WT supports transformational adaptation opportunities within the poorest communities<br>**Deliverables** will be:<br>• Production of Jamaican compost and liquid fertiliser from sargassum.<br>• Implement the use of sargassum containing compost and fertiliser in public institutions; UWI-Mona and University of Technology (UTECH). Researchers and graduate students will be conducting the experiments.<br>• Educate/inform people for them to be able to make their own compost by using Sargassum.<br>• Production of research theses and reports that detail the methods and results.<br>•Transfer of knowledge to Ghana. |
| | WT Leads: | Prof Mona Weber, UWI-Mona, Jamaica. |
| | Duration: | Y1Q1 - Y3Q4 |

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| | Skills required to deliver WT: | • Understanding growth of different crops.<br>• Understanding the effect of *Sargassum* application in different forms (compost, liquid extract fertiliser).<br>• Understanding rate of production as indicated by marketable yield based on *Sargassum* application.<br>• Scientific writing. | | | | |
| | Sub-tasks | WT3.3.1 | Determination of influence of *Sargassum* compost on growth of corn (crop). | Q1, 2020 | | Q3, 2022 |
| | | WT3.3.2 | Determination of influence of Sargassum compost on growth of tomato (vegetables). | Q1, 2020 | | Q3, 2022 |
| | | WT3.3.3 | Determination of Influence of *Sargassum* compost on growth of mangrove seedlings. | Q1, 2020 | | Q4, 2022 |
| | Deliverables | D3.3.1 | Compost formulated with Sargassum | | | Q4, 2022 |
| | | D3.3.2 | Research paper describing the effects of *Sargassum* compost on the growth of crop, vegetable, and mangrove seedlings. | | | Q4, 2022 |
| | Internal Milestones (if useful / needed) | M3.3.1 | Review of results on the influence of Sargassum compost on the growth of corn. | | | Q2, 2022 |
| | | M3.3.2 | Review of results on the influence of Sargassum compost on the growth of tomato. | | | Q2, 2022 |
| | | M3.3.3 | Review of results on the influence of Sargassum compost on the growth of mangrove seedlings. | | | Q2, 2022 |
| | Interactions | For this work task to be most effective it will require stakeholder engagement, i.e. educating/informing people about the findings for them to be able to make their own compost by using Sargassum. CERMES will be involved in this work task, providing guidance on stakeholder engagement. The outputs from this WT will inform WT3.4, 3.5 and 3.6 | | | | |

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| **WT3.4** | **Assess current practices in managing *Sargassum*** | |
| | Description: | The **aim** of this WT is to analyse current practices in managing sargassum: how *sargassum* is collected, stored, used, or ignored, or discarded, at the local level in Jamaica and Ghana<br>• Grey literature search<br>• Field work –interviews and surveys in affected communities.<br>• Possible use of phone calls/visits to the EC islands (Jack Corbett/Sien)<br>• Possible use of epicollect.<br><br>**Deliverable** will be: review of existing approaches to sargassum management practice |
| | WT Leads: | Emma Tompkins, Sien Van Der Plank, Jack Corbett |
| | Duration: | Y1Q1 - Y3Q4 |
| | Skills required to deliver WT: | PRA or RRA approaches for community data collection<br>Synthesising science (documenting approach, Tompkins et al, 2018) |

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| | Sub-tasks | WT3.4.1 | Review of grey and published literature on sargassum management | 04/20 | | 01/21 |
| | | WT3.4.2 | Identification of affected communities in Jamaica, Ghana (using WT2.3.3) | 07/20 | | 12/20 |
| | | WT3.4.3 | Engagement of affected communities through fieldwork (in Jamaica and Ghana) to interview affected stakeholders | tbd | | tbd |
| | Deliverables | D3.4.1 | Working paper / report on the current practices in managing/using sargassum in Ghana and Jamaica | | | Y2/Q1 |
| | | D3.4.3 | Accessible dataset on how communities are adapting | | | date |
| | | M3.4.1 | Identification of target communities | | | Date |
| | Interactions | ● WT2.3.3 | | | | |

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| **WT3.5** | **Identification of opportunities and barriers to the exploitation of *Sargassum*.** | | | | | |
| | Description: | The **aim** of this WT is to identify the opportunities and barriers to exploitation of sargassum to deliver equitable resilience within the poorest communities, both in Jamaica and Ghana.<br><br>This WT aims to explore how people are using sargassum at present (e.g. for energy or growing food/vegetables), and identify what key data are missing (is the soil fertile enough / do people have access to land to grow vegetables/do people grow vegetables or buy from markets)? This will be used in conjunction with WT3.2 and 3.3 to understand opportunities for sargassum reuse.<br><br>The work will be undertaken through design and administering questionnaires/holding focus group meetings with affected communities to determine their interest and ideas on exploitation of Sargassum biomass.<br><br>**Deliverables** will be: transferable questionnaires on opportunities and barriers to sargassum use, data set on opportunities and barriers on sargassum use, and a working paper on community level opportunity and barriers | | | | |
| | WT Leads: | Emma Tompkins, Sien van der Plank, Mona Webber | | | | |
| | Duration: | Y1Q1 - Y3Q4 | | | | |
| | Skills required to deliver WT: | ● Ability to work with communities<br>● Design of questionnaires<br>● Communication with stakeholders | | | | |
| | Sub-tasks | WT3.5.1 | Design and administer questionnaire to determine affected people's interest and ideas on exploitation of Sargassum biomass, and the constraints to their engagement. | Y1Q2 | | Y2Q1 |
| | | WT3.5.2 | Implement surveys and/or focus group meetings with local communities in Caribbean and Ghana. Hold one focus group | Y2Q1 | | Y2Q4 |

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| | | | meeting (1) with each of the 4 affected sampled communities in Jamaica (in sampling areas), and with 2 affected communities in Ghana | | | |
| | | WT3.5.3 | Make dataset accessible. | Y2Q4 | | Y3Q3 |
| | Deliverables | D3.5.1 | Working paper / report on community opportunities and barriers to exploitation of sargassum in the Caribbean and Ghana. | | | Y3Q4 |
| | | D3.5.2 | Accessible dataset for use by other researchers on opportunities and barriers to sargassum use. | | | |
| | Interactions | ● WT3.3<br>● WT4.3 | | | | |

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| **WT3.6** | **Integration of interdisciplinary data to identify opportunities and barriers for the management and valorisation of sargassum in Ghana and the Caribbean.** | | | | | |
| | Description: | The **aim** of this WT is to analyse the political, social and economic pathways to turn holopelagic sargassum into opportunity for the poorest affected communities. Analysis will be informed by results obtained in WT3.1. WT3.2, WT3.3, WT3.4, WT3.5 and WT4.1 and WT4.2. Engagement with policy and business stakeholders to identify the best routes to exploit sargassum biomass in the Caribbean to generate equitable resilience among the poorest. Supported by extensive internal SARTRAC discussions to integrate findings from WP1, 2, 3, and 4. | | | | |
| | WT Leads: | Emma Tompkins, Sien van der Plank , Janice Cumberbatch, Mona Webber, Thierry Tonon | | | | |
| | Duration: | Y1Q1 - Y3Q4 | | | | |
| | Skills required to deliver WT: | ● Stakeholder engagement<br>● Facilitated integration discussions within SARTRAC team | | | | |
| | Sub-tasks | WT3.6.1 | Identify relevant stakeholders who influence the outcomes of sargassum management /use (this will be undertaken in X-WP SHE) | 01/20 | | 06/20 |
| | | WT3.6.2 | Metro-mapping pathways through success stories through engagement with stakeholders in Jamaica (depending on COVID-19: computer-based or in person). | 03/20 | | 12/20 |
| | | WT3.6.3 | Establish transferable framework to apply lessons learned/methods to west Africa | tbd | | tbd |
| | Deliverables | D3.6.1 | Documented success stories of sargassum improving resilience of the poorest affected communities | | | Y3Q4 |
| | | D3.6.2 | Academic paper on dynamic adaptive pathways to equitable resilience from sargassum | | | tbd |
| | | D3.6.3 | White paper/communication briefing describing the most appropriate route(s) on how knowledge gained in Jamaica may be transferred to eastern Caribbean and to Ghana. | | | Y3Q4 |
| | Interactions | ● WT3.1. WT3.2, WT3.3, WT3.4, WT3.5 and WT4.1 and WT4.2. | | | | |

### 3.4.4. Work Package 4: Governance

*Table 15: WP4 overview*

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|---|---|
| **WP Title** | **WP4: Sargassum governance and management: a critical analysis** |
| **Short title** | **WP4 GOVERNANCE** |
| **Rationale** | WP aim: To identify the existing and possible future national and regional governance of sargassum (both strandings and as a floating resource) and the political economy of different sargassum responses.<br><br>This will involve the following key work tasks (WT) and deliverables (D):<br>WT4.1: Analyse national and regional policy frameworks for sargassum in the tropical Atlantic basin.<br>WT4.2: Analyse a range of property rights for sargassum, and the potential for each to create transformational adaptation opportunities under various legal arrangements, for the most marginalised in affected communities<br>WT.4.3.Political economy analysis of alternative sargassum management approaches<br>WT4.4. Future governance frameworks for sargassum management for transformational adaptation |
| **Co-leads** | **Jack Corbett (UOS) 5%**<br>**Janice Cumberbatch (UWI-CERMES) TBC**<br>**Sien van der Plank (UoS PDRA) 25%**<br>**Policy PDRA (UWI Mona) 50%;**<br>**PDRA (UWI Cave Hill) 15%**<br>**Phillip Quashigah (UOG) 25%** |
| **Contribution to SARTRAC objectives** | This WP will contribute to SARTRAC's objective to "identify the opportunities for transformational adaptation that can be generated through the management and re-use of the invasive Sargassum seaweed increasingly found across the Caribbean, Central America and West Africa" by:<br>1. Analysing sargassum policy in the tropical Atlantic basin including conflicts of interests and synergies.<br>2. Analysing the political, legal and economic implications of ongoing sargassum strandings<br>3. Analysing stakeholder perceptions of responsibilities for sargassum |

*Table 16: WP4 work task details*

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| **WT4.1** | **National and regional policy frameworks for sargassum in the tropical Atlantic basin** | |
| | Description: | The **aim** of this WT analyse sargassum governance, with a focus on policy frameworks in the tropical Atlantic basin including conflicts of interests and synergies.<br>**Deliverables** will be: an internal report on the history of the policy problematisation (deadline TBC) |
| | WT Leads: | Jack Corbett (UOS)<br>Emma Tompkins (UoS)<br>Phillip Quashigah (UOG)<br>Janice Cumberbatch (CERMES) |

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| | Duration: | 6 months | | |
| | Skills required to deliver WT: | · Existing knowledge of policy frameworks and settings in the Caribbean and West Africa<br>· Familiarity with policy systems and policy networks | | |
| | Sub-tasks | WT4.1.1 | Policy mapping of sargassum governance in the tropical Atlantic | |
| | | WT4.1.2 | Analysis of differences and synergies in national, regional and interregional policy settings as they relate to sargassum in the tropical Atlantic | End date TBC |
| | Deliverables | D4.1.1 | internal report / article on the framing of the policy problem | |
| | Interactions | · Report to be circulated prior to the UoS project meeting and discussed at that meeting | | |

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| **WT4.2** | **Property rights for sargassum, and the potential for each to create transformational adaptation opportunities under various legal and policy arrangements** | | | |
| | Description: | The **aim** of this WT is to analyse the property rights implications of the potential range of ownership regimes for sargassum, and the potential for each to create transformational adaptation opportunities for the poorest<br>**Deliverables** will be: two academic articles addressing different aspects of this issue | | |
| | WT Leads: | Jack Corbett (UOS)<br>Janice Cumberbatch (UWI-CERMES)<br>Phillip Quashigah (UOG) | | |
| | Duration: | 30 months | | |
| | Skills required to deliver WT: | · Literature and public source research and review<br>· Qualitative interviewing with policy makers in the Caribbean and West Africa<br>· Qualitative analysis of interview transcripts | | |
| | Sub-tasks | WT4.2.1 | Theoretical analysis of governance under possible property rights regimes of sargassum (open access, common good, club good, private good etc) | End date TBC |
| | | WT4.2.2 | Qualitative analysis of sargassum stakeholder perceptions of sargassum ownership and governance responsibilities (if feasible with COVID) | |
| | | WT4.2.3 | Explore the governance implications of alternative hypothetical ownership regimes on sargassum use and management the potential for transformational adaptation. | |
| | Milestones | M4.2.2 | Qualitative internal research paper on stakeholder on perceptions of responsibilities for sargassum | End date TBC |
| | Deliverables | D4.2.1 | Academic paper on who owns sargassum and its consequences | Date TBC |
| | | D4.2.2 | Academic paper on stakeholder perceptions of responsibilities for sargassum | |
| | | D4.2.3 | Academic paper on ownership regimes for sargassum and the consequences for transformational adaptation (DATES TBC) | |

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| | Interactions | · WT3.6<br>. Stakeholder mapping (WT4.1) will inform interviewing<br>· Project meetings will facilitate interview contacts |

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| **WT4.3** | **Equitable resilience implications of sargassum management approaches for the most vulnerable affected communities (with WT3.6)** | | | |
| | Description: | The **aim** of this WT is to analyse the political, social and economic pathways to turn holopelagic sargassum into potential opportunity for the poorest affected communities. Analysis will be informed by results obtained in WT3.1. WT3.2, WT3.3, WT3.4, WT3.5 and WT4.1 and WT4.2. Engagement with policy and business stakeholders to identify the best routes to exploit sargassum biomass in the Caribbean to generate equitable resilience among the poorest. We will consider how management affects the potential for transformational adaptation,<br>**Deliverables** will be: two academic articles addressing different aspects of this issue | | |
| | WT Leads: | Emma Tompkins (UOS)<br>Jack Corbett (UOS)<br>Sien Van Der Plank (UOS)<br>Janice Cumberbatch (UWI-CERMES)<br>Phillip Quashigah (UOG) | | |
| | Duration: | 30 months | | |
| | Skills required to deliver WT: | · Literature and public source research and review<br>· Political economy analysis skills<br>· Adaptation evaluation | | |
| | Sub-tasks | WT4.3.1 | Documenting adaptation (undertaken in WT3.4) | Q3/Y1-Q2/Y2 |
| | | WT4.3.2 | Identification of relevant stakeholders who can influence the outcomes of sargassum use/management (undertaken in stakeholder engagement and WT4.2) | Q2/Y2-Q4/Y2 |
| | Milestones | WT4.3.3 | Metro-mapping dynamic adaptive pathways of success stories through engagement with stakeholders in Jamaica (and possibly Eastern Caribbean, depending on COVID- computer-based surveys or in person?). | Q1/Y1-Q3/Y3 |
| | Deliverables | WT4.3.4 | Political economy analysis of alternative sargassum adaptations (in situ, ex situ etc.) – distribution, equity etc..<br>Dynamic adaptive pathways analysis of alternative adaptations on equitable resilience within poorest communities (undertaken with WT3.6) | |
| | | WT4.3.5 | Establish transferable framework to identify opportunities in west Africa (tbd) | |
| | | M4.3.1 | Creation of a typology of adaptations | Q4/Y1 |
| | | M4.3.2 | Framework for analysis of adaptation (input, outputs, outcomes, impacts) | Q2/Y2 |
| | | M4.3.3 | Metro map of pathways of adaptation | Q2/Y3 |
| | | D4.3.1 | Paper on political economy of adaptation for equitable resilience | Q3/Y3 |
| | | D4.3.2 | Academic paper on dynamic adaptive pathways to equitable resilience from sargassum | |

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| | | D4.3.3 | White paper/communication briefing describing the most appropriate route(s) on how knowledge gained in Jamaica may be transferred to eastern Caribbean and to Ghana. | |
| | Interactions | · Links with WT3.4 activities relating to identifying adaptations/uses of sargassum, and WT3.6, WT3.1. WT3.2, WT3.3, WT3.5 and WT4.1 and WT4.2. | | |

## 3.5. Research activities and findings during inception phase by work package

### *3.5.3.* Findings from WP1. Drivers of *Sargassum*

WP1 A bespoke system to predict where and when *Sargassum* will be ("Drivers")

WT1.1. Large-scale physical drivers: Analysis of ocean and atmospheric observations, spanning equatorial and subtropical Atlantic, to better understand and predict the post-2011 seasonal proliferation of *Sargassum* at basin scale

WT1.1.1 Source data and analyse climate variability in the tropical Atlantic of relevance to the *Sargassum* crisis

Activity: To understand post-2011 large Sargassum growth events in the equatorial/tropical North Atlantic, we analysed a number of large-scale atmospheric and ocean observational datasets and reanalysis products to investigate:

(1) Recent long-term trends and variability (1980-2018) in two main physical factors controlling Sargassum growth (ocean surface temperature and irradiance)
(2) The impact of climate natural variability modes

Findings: Mapping onto the two activities:

(1) Surface Warming in the Tropical North Atlantic:

- Strong warming after the mid-2000s is associated with Shortwave Radiation increase and (upward) Latent Heat Flux decrease
- Increasing Net Shortwave Radiation is highly correlated with decreasing cloud fraction over the tropical North Atlantic
- Decrease in Latent Heat Flux is predominantly due to decreasing wind speed i.e. decreasing easterly (trade) winds over this period
- Decreasing Mixed Layer Depth/increasing stratification in the upper layer due to surface warming, decreasing wind mixing and surface freshening seem to further enhance surface warming in the eastern part of the tropical North Atlantic, notably in the North Equatorial Recirculation Region

(2) Warming in Tropical N. Atlantic and Natural Variability Modes (AMO = Atlantic Multidecadal Oscillation; AMM = Atlantic Meridional Mode; NAO = North Atlantic Oscillation):

- Strong evidence that natural variability accentuated global warming effect in the tropical North Atlantic over the last 15 years
- Strong long-term warming in the tropical North Atlantic after the mid-2000s is consistent with continuously positive AMO (r = 0.8) phase and predominantly positive AMM (r = 0.7) phase.

- Positive AMO is linked with weaker trade winds (easterlies) leading to reduced dust (westward) transport and cloud fraction which in turn result in large increase of Shortwave Radiation and warming in the eastern part of the tropical North Atlantic.
- NAO (r = -0.45) and El Nino (Nino3.4, 6-month leading, r = 0.36) present no significant long-term trend but seem to largely contribute to inter-annual peaks.
- Strongly positive AMO & AMM and the record low (negative) NAO in 2010 all contribute to the warmest anomaly over the last 30 years. Strong El Nino together with strong positive AMO drive enhanced warming in tropical North Atlantic in 2015-16.

WT1.2 Seeding system development: Download (from USF SaWS) daily-available 7-day averaged, FA_density (Floating Algae Index, FAI) maps for Eastern Caribbean area (10-23°N, 60-75°W), the Central Atlantic area (38-63°W, 0-22°N) and equivalent data for the eastern tropical Atlantic (area to be determined); digitize/grid these to "seed" *Sargassum* for tracking

WT1.2.1 Initial proof of concept, demonstrating the throughput from satellite image to initialised tracking calculation, using available FA_density data (Eastern Caribbean and Central Atlantic areas)

Activity: Software has been written to extract FAI data for the Eastern Caribbean and the Central Atlantic, selecting 7-day averages for 2018 and 2020, to seed drift calculations

Findings: Data is available weekly from 2011, offering good prospects for system development; the download and gridding procedure is straightforward, currently taking a few minutes per "seeding"

WT1.2.2 Identification and use of alternative satellite data for initialising particle density in the eastern tropical Atlantic

Activity: The USF website provides "Alternative FAI index" (A-FAI) maps for the Gulf of Guinea, from April 2017; extensive cloud cover in the region restricts this data to a large extent

Findings: Selecting images for relatively cloud-free periods (e.g. 20 May 2020), some useful seeding is possible, although we ideally need more complete FAI fields.

WT1.3 Tracking system development: Development of efficient, probabilistic tracking with high-resolution ocean hindcast surface currents and winds to predict the approach of *Sargassum* to coastal Jamaica, the Lesser Antilles, and coasts of Ghana and neighbouring countries, from weeks to months ahead
WT1.3.1 Development of prototype model system; preliminary forecasts for Jamaica and the Lesser Antilles

Activity: Eastern Caribbean and Central Atlantic drift calculations over 30 days have been obtained for spring 2020

Findings: To first order, predicted particle drift (representative of Sargassum) past Barbados and Jamaica – is consistent with observations (FAI images) through April-May 2020; regional-scale, seasonal ensemble forecasts can now be developed, using the full range of hindcast data

WT1.3.2 Extension of the system and forecast to Ghana
Activity: Seeding with A-FAI data for May 2020, in the tropical east Atlantic (10-15° west of Ghana), 90-day forecasts are obtained to explore the prospects of forecasts for Sargassum beaching downstream, along the coastline of Ghana

Findings: Sargassum is predicted to arrive off Ghana after around 60 days (July 2020), although results are sensitive to the choice of windage (1% is typically chosen; further experiments will refine this choice), and we need to explore the seasonal cycle in Sargassum.

### 3.5.4. Findings from WP2. Monitoring and dissemination

**Inputs across WP2: staff and time**

- Prof Jadu Dash (5%FTE), WP lead, management of WP2, algorithm review and development of WP2 work plan
- Dr Ava Maxam (5%FTE), WP co-lead, management of WP2, drone sourcing and scoping for fieldwork, development of WP2 work plan
- Prof Kwasi Appeaning-Addo (5%FTE), WP co-lead, development and transfer of WP2 to Ghana and West Africa
- Dr Philip-Neri Jayson Quashigah (20%FTE), drone sourcing, development and transfer of WP2 to Ghana and West Africa
- Ms Sien van der Plank (50%FTE), review of existing *Sargassum* algorithms, development of WP2 work plan
- Mr Mouyton May, project manager for UWI Mona and scoping for fieldwork
- Ms Yanna Fidai, PhD student at UoS, providing input into development of algorithms

**Inputs across WP2: meetings**

- Developed detailed workplan and work tasks in May 2020, building on discussions held from November-April 2020. Discussed and agreed-upon in first fortnightly meeting of May 2020.
- As of May 2020, fortnightly meetings with entire WP2 with standing agenda:
    - Introductions of any new members or participants in the meeting;
    - Updates from each institution, including actions taken since previous meeting; and
    - Updates on any report-writing deadlines and progress.

**WT2.1. Develop an improved algorithm to detect *Sargassum* stranding events across Caribbean, using freely available satellite data.**

Outputs:

- WT2.1.1 Systematic literature review conducted by Yanna Fidai on literature identifying location of *Sargassum*
- WT2.1.1 Initial review of existing algorithms to detect *Sargassum*, as applied and developed in past papers.
- WT2.2.2 Discussions and research into field collection: feasibility and timing (with regard to COVID-19 pandemic restrictions), locations and methods.

Outcomes:

- WT2.1.1 Systematic literature review
    - Yanna Fidai conducted a systematic review of literature of 83 papers across 3 databases as a part of her PhD research, with the support of her supervisors Jadu Dash and Emma Tompkins, as well as Thierry Thonon. This review focused on research that identified Sargassum and where it is located.
    - Yanna is currently developing the results into a scientific paper for publication with Environmental Letters, but some of the key findings include that there are geographical areas receiving less focus than others, that the majority of papers focus on the open-oceans, that

calculations for quantifying Sargassum are limited and inconsistent, and that the quality of papers is often too poor to be replicable.

- WT2.1.1 Initial review of existing algorithms
  - Many papers and research identifying and/or quantifying Sargassum applies pre-existing vegetation/algae detecting algorithms and does not developed a Sargassum---specific algorithm; for example, the application of the Normalised Difference Vegetation Index (NDVI) (Lasquites, Blanco and Tamondong 2019).
  - In the past decade, algorithms have built on the work by Hu (2009) to produce a Sargassum--specific detection algorithm. Examples of these include:
    - Floating Algae Index (Hu 2009)
    - Alternative Floating Algae Index (Wang and Hu 2016)
    - Normalised Floating Algae Index (Sutton et al. 2019)
    - Maximum Chlorophyll Index, specific for *Sargassum* spectral signature (e.g. Gower and King 2012)
- WT2.2.2 Discussions and research into field collection
  - <u>Introduction:</u>
    - The objective focus of WP2 is the monitoring and mapping (local to regional) of Sargassum flows in the Caribbean, but also in West Africa. This monitoring is necessary to identify the potential impacts, adaptations, social and economic distribution of gains and losses from impacts and adaptations.
    - Resources such as satellite imagery and drones are to be used to develop an operational near real-time early warning system for the Caribbean DAC countries and Ghana. We are also tasked with developing impact pathways for different coastal archetypes, focusing on the most marginalized and poorest communities impacted.
  - <u>Drone quotations:</u>
    - MGI initially reached out to overseas suppliers of drone equipment in the USA, particularly those operating businesses in Florida as this would likely be the most cost effective option to source the drone units. Quotations were provided by DJI recognized dealer "DRONENERDS" in February 2020 for the DJI Matrice 200 drone[3] and the RGB/NIR Sensor.
    - Anticipating the lengthy flight times to monitor large stretches of coastline, the cost of additional battery units was also explored. Any drone operator will tell you that battery life is one of the greatest limiting factors to prolonged flight second only to prevailing weather conditions. As we have no control over the weather, additional batteries will provide extended flight times for monitoring activities.
    - Most recently, since the COVID disruptions, we have contacted the drone suppliers in the USA (DRONENERDS) and have requested updated quotations for the selected drone model, but have also requested alternatives that could also be explored. The update from the supplier states that the local stores have been closed due to COVID and so updated quotations will be difficult to procure, however shipping is still available. In light of this, alternative sources are being explored with the intention of engaging a supplier in short order.
  - <u>Potential Camera Sensing System</u>
    - The WP2 team had preliminary discussions regarding the potential options for camera sensing equipment to be used in monitoring the beaching of the sargassum. We had identified the Mica RedEdge-MX Sensor which was shown to be compatible with the

[3] https://www.dronenerds.com/products/drones/enterprise-drones/matrice-200-series-v2.html

drone option mentioned in the previous section (DJI Matrice 200). It is worth mentioning that the RedEdge-MX sensor also comes readily compatible with the DJI skyport enabled drones for seamless integration of drone and sensor.

- The RedEdge-MX sensor is a multispectral sensor typically used for agriculture containing both the spectral bands required for basic crop health indexes in addition to additional bands to enable further analytics and post processing of data.
- The only negative aspect to this sensor system is the cost. The price for the RedEsge-MX sensor with DJI skyport[4] capabilities is $6,900.00 USD before import duty. Alternatively, there is an option to purchase the RedEsge-MX sensor kit for $5,500.00 USD and purchase the DJI Matrice 200 Quick mount kit[5] for $599.00 USD which would bring the total to approximately $6,100.00 USD before import duty.

- Field Collection Planning
  - In light of the COVID pandemic and logistical issues with receiving suppliers overseas, the field data collection has been delayed. The suggestion coming from the WP2 group was to determine how feasible the data collection would be using observations from a marine vessel. While this option may increase time spent in the field to comprehensively assess the beaching sites, trends and other factors, in lieu of the drone and associated sensor technology it may be our best option to collect field data until we are able to purchase the drone and sensor.
  - Associated costs for marine craft rental are currently being gathered to be analysed in a cost benefit analysis. With a sense of normalcy returning to regular operations it is anticipated responses will be received from the drone suppliers, however we still have huge uncertainty in the coming months and so must plan for contingencies.
  - With recent re-opening from lock-down in Jamaica, field planning has proceeded. A sampling methodology and schedule has been developed involving the Government's National Environment and Planning Agency (NEPA).

Impacts: N/A

**WT2.2. Design a web-based automated *Sargassum* information and dissemination system, informed by stakeholder meetings and use requirement needs.**

Outputs:

- Meeting with CERMES and WP4 on stakeholder engagement requirements and procedures.

Outcomes:

- Established that stakeholder engagement with communities will be difficult to achieve during COVID-19 lockdown. Engagement and introductions to policy and science stakeholders is more feasible.
- Identified that stakeholder engagement would benefit from SARTRAC publicity campaign, including website launch.
- Multiple members attended "Sargassum Webinar: Sargassum seaweed invasion harms economies in West Africa and the Caribbean – Human Nitrogen Footprint" on Tuesday 26 May, hosted by UNEP and GPNM

[4] https://micasense.com/shop/RedEdge-MX-Sensor-Kit-with-DJI-SkyPort-p117044517
[5] https://micasense.com/shop/M200-210-Quick-Mount-Kit-p184482463

Impacts: N/A

**WT2.3. Identify areas (and their physical characteristics) that are prone, in the past/future, to stranding events.**

Outputs:

- As for WT2.2, regarding stakeholder engagement planning

Outcomes:

- As for WT2.2, regarding stakeholder engagement planning

Impacts: N/A

**WT2.4. Theorise the physical, and socio-economic factors that build resilience to sargassum events.**

*Commencing later in 2020.*

**WT 2.5. Co-develop a risk management strategy to build equitable resilience by considering output from WP 2.3 and WP 2.4.**

*Commencing later in 2020.*

**WT2.6. Explore transferability of 2.1 and 2.2 to Ghana.**

Outputs:

- Inclusion of Prof Kwasi Appeaning-Addo and Dr Philip-Neri Jayson Quashigah on all discussions developing WP2 plans and tasks, regular updates regarding West Africa and *Sargassum* (current *Sargassum* season, research).
- Contact made Prof Kwasi Appeaning-Addo with UNESCO/UNEP to raise awareness of the SARTRAC project and ensure work is coordinated, not duplicated.

Outcomes:

- Established WT2.6 should progress simultaneously to WT2.1-5, to ensure work is transferable to Ghana and West Africa.

Impacts: N/A

### 3.5.5. Findings from WP3. Transformational adaptation

General to WP3:

- Protocols for collection, identification and assessment of abundance of Sargassum have been distributed to Marine labs in Jamaica.
- Report, for the first time, of the presence of a new type of Sargassum, S. natans II, not previously observed during Caribbean Sargassum strandings since 2011.
- Completion of recruitment for a technician to start the 1st of June in York.
- Bibliographic survey: there have been a number of papers published recently on *Sargassum* reporting results that may be of importance for activities within the WP3: Saldarriaga-Hernández et al. Science

of the Total Environment 2020; Gouvêa et al. Science of the Total Environment 2020; Milledge et al. Energies 2020; Johns et al. Progress in Oceanography 2020; Rodríguez-Martínez et al. PeerJ 2020.

- Discussion between T. Tonon and Prof. Kwasi Appeaning Addo for involving Ghana in WP3. This will include harvesting algal samples and to discuss with local communities about potential use of *Sargassum*.

WT3.1:

- **No activity yet** because lock down has hampered harvesting sufficient quantity of algal biomass stranding on the Jamaican coast to implement planned storage experiments. Furthermore, quantities reported in Jamaica during the inception period have been too small for bulk storage experiments.

WT3.2:

- Engagement of the Scientific Research Council (Jamaica) who makes and conducts research into bio-digesters to explore the use of *Sargassum* in these systems: contact made with Mr Danian Hylton, Process Development Officer – Waste Research Management & Training Centre, Process Development Division, Scientific Research Council (SRC), Jamaica.
- Contract signature with SRC has been delayed due to reduced operations of the SRC caused by the situation with Covid-19.
- Biomethane potential (BMP) assessment by SRC will start as soon as the contract is signed and enough Sargassum can be harvested.

WT3.3:

- A limited trial of *Sargassum* compost with mangrove seedlings in a dry nursery has been conducted, with plan to assess survival of the mangrove seedlings. This will be scaled up in the near future.
- New experiments on agricultural crops have been paused due to Covid-19, but these have been designed. This will include replication and scaling-up of experiments organized before the beginning of the Sartrac project.

WT3.4:

- One questionnaire (targeting farmers) has been developed and is at the stage of seeking ethical approval.

### 3.5.6. Findings from WP4. Governance

Since the beginning of the project, the following activities have taken place under the auspices of WP4:

1. Participation in monthly reporting and team meetings;
2. Facilitated discussion within the project team about changes to WP4 in light of the evolving governance regime;
3. Facilitated discussion within the project team on the interaction between different work tasks and the implications for stakeholder engagement;
4. Redesigned WP4 based on partner feedback and emerging trends in governance and policy networks;
5. Shortlisting, interview and induction of UOS based WP4 PDRA;
6. Meetings with regional stakeholders, including the OECS in St Lucia
7. Preliminary desk based analysis for WT4.1 and 2

### 3.5.7. Findings from Cross-cutting Stakeholder Engagement theme

Stakeholder engagement is central to the SARTRAC project (see Fig 2.2). Stakeholder input and feedback inform the execution of the work toward the development of outputs that are useful and support genuine change. Effective engagement is also critical for dissemination of outputs to stakeholders. Stakeholder engagement is therefore cross cutting over all work packages.

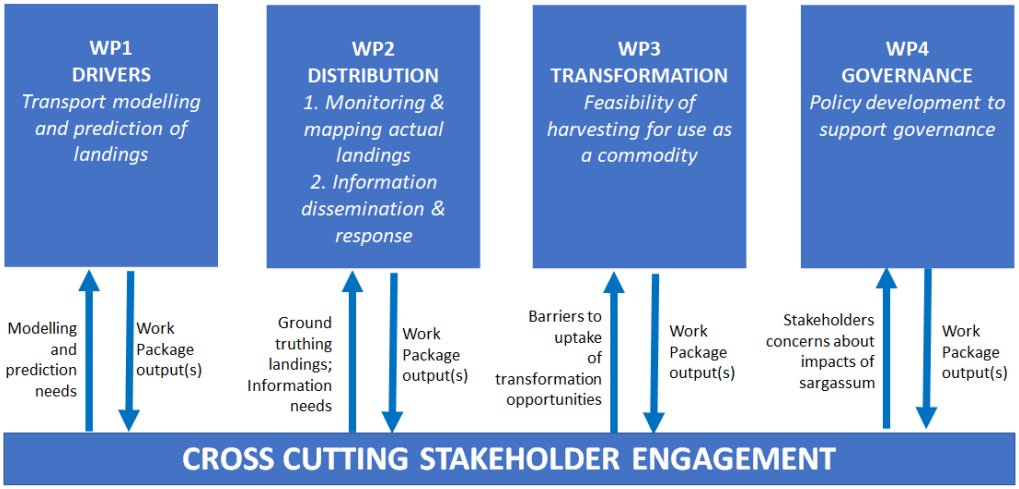


*Table 17 Role of stakeholder engagement in SARTRAC*

Stakeholder engagement for SARTRAC is also complex because of the transregional and transnational scope of the beneficiary countries, and the interdisciplinary nature of the project (see Fig 2.3).

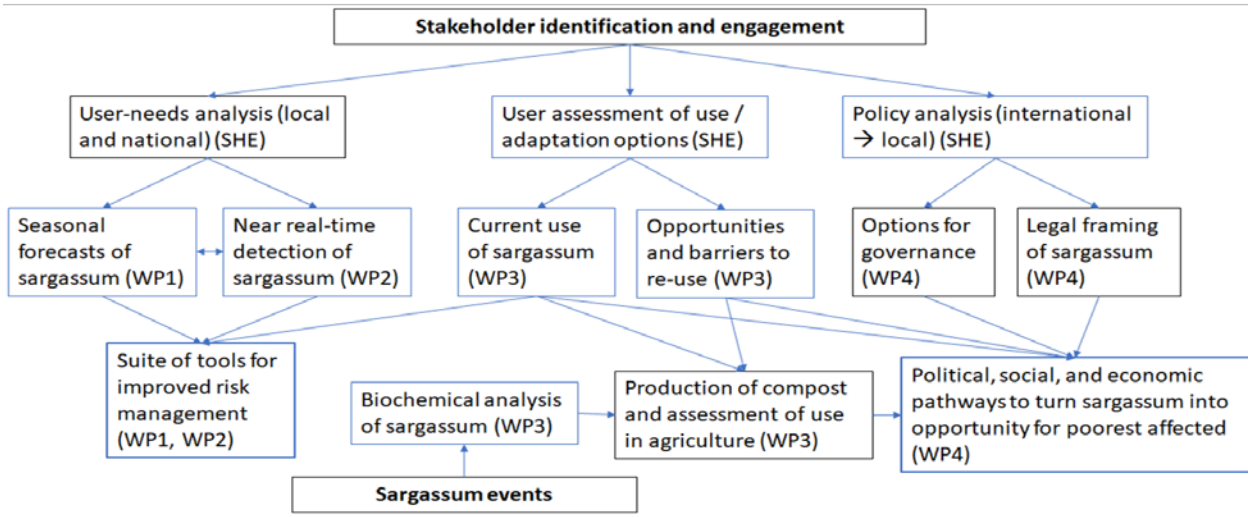


*Table 18 Complexity of stakeholder engagement within SARTRAC*

The Caribbean region is extremely geopolitically diverse and complex (Mahon, Cooke, et al. 2013). There are varying definitions of the 'Caribbean Region,' depending on whether one is discussing physical geography, oceanography, geopolitics, economy, culture etc. The term is used to "*describe spaces of different dimensions (physical, cultural, political etc.) which are often not perfectly juxtaposed*" (Cruse, 2013). Notwithstanding shared geography and history, the region is far from homogenous. It contains the largest number of small island developing states (SIDS) of any region, as well as several overseas territories or dependencies of hegemonic developed countries. There are a variety of languages spoken across the region. The various organisations assembled at the political level for regional integration and

cooperation reflect the varying definitions of the region (http://atlas-caraibe.certic.unicaen.fr/en/page-122.html).

As per the proposal, SARTRAC focussed on the English speaking DAC Caribbean countries, all of which are small island developing states (SIDS). In general, Caribbean SIDS have higher levels of per capita income and rank more highly on the human development index (HDI) than most other SIDS. However, these metrics obscure real development challenges and vulnerabilities (Bourne 2015). Notwithstanding these classifications, Caribbean SIDS are still subject to the well known sustainable development challenges of SIDS, and climate change exacerbates these. SIDS, those in the Caribbean included, are among the countries most impacted by the adverse effects climate change while contributing the least to its causes.

The Caribbean Sea is a unique resource that links and is shared by the countries and territories of the region. There are no international waters in the Caribbean Sea; it is entirely divided into territorial waters or Exclusive Economic Zones of adjacent territories. While the importance of integrated and coordinated marine governance is broadly recognised, there are numerous and diverse institutions and networks involved, and there is a marked lack of integration and alignment of purpose at regional, sub-regional, national and local levels (Fanning, et al., 2013). Such deficiency in integration leads to gaps in coverage for key issues. Clear institutional mandates and explicit guidance to address integration and bridge gaps is also lacking (Fanning, et al., 2013)

Against the background of such complexity and diversity, it is important that engagement be focused and targeted in order seek input from and deliver outputs to the stakeholders that need it. The plan and methodology for stakeholder engagement must therefore be co-developed with work packages to clearly define key informants, target audiences and end users.

It is also key to note that the COVID19 global pandemic has significant implications for stakeholder engagement:

- The feasibility of international and inter-regional travel as well as face-to-face meetings and workshops is restricted. Most Caribbean countries are in the process of opening their borders to external markets and the impacts of this in terms of virus reintroduction are yet to be seen. Furthermore, inter-regional travel in the Eastern Caribbean is challenged because the main inter-regional air carrier for the Eastern Caribbean – Leeward Islands Air Travel (LIAT) -has gone into liquidation during COVID lock down, and alternative services are in nascent stages.
- While the pandemic was in its acute phase, stakeholder organisations were unlikely to be in a position to provide useful feedback amidst prevailing uncertainty. It is also important that we demonstrate understanding and sensitivity to stakeholders many of whom have been preoccupied with other priorities while the pandemic was in its acute phase. The possibility of a second acute phase resulting from reintroduction of the virus cannot be excluded.
- The economic cost of the pandemic could be massive, and the impacts are expected to have major and long lasting impacts on the global economy and therefore the national economies of the participating countries. Long term impacts on key sectors impacted by sargassum like tourism are likely. This has implications for the economics of sargassum, but the details of how this will manifest are not yet known.

Even before the pandemic, stakeholder fatigue is a genuine concern. Especially with the added need to be sensitive (above), it is critical that project messaging be clear and consistent, with clear articulation of expected outcomes, and what is requested from stakeholders.

# 4. Next Steps and legacy from SARTRAC

## 4.1. Information, Engagement, and Knowledge Legacy

This section considers how SARTRAC will identify and maps its impact and legacy.

### 4.1.1. Theory of Change/pathway to impact

Our theory of change (TOC), allows us to: clearly unravel the problem (the direct and indirect causes and their interrelations); show a roadmap (or pathway of change), change process; and states assumptions. It also describes less easily quantifiable change e.g. awareness raising, power changes, and clearly spells out: Inputs/Activities, Outputs, Outcomes (both short term and medium term) and long term Impacts. See Annex II.

### 4.1.2. Capacity building plan

Activities that may have impact individual or institutional capacity include:

- Co-Is for each work package across institutions, to create a culture of collaborative team working across the project.
- New research opportunities sought, through new partnerships or funding
- ACMs will include capacity building activities around them.

### 4.1.3. Flexible Innovation Fund (FIF)

The Flexible Innovation Fund is a fund of £25,000 that is accessible to members of the SARTRAC team (Co-Investigators and Early Career Researchers alike). The Flexible Innovation Fund (FIF) provides small grants from £1,000 to £5,000 GBP, over the three years of the SARTRAC project. The FIF can be accessed at multiple stages in the project timeline, or accessed more than once. This call does not sit in isolation but links to the entire research and capacity building objectives across SARTRAC; specific training can be provided on writing research proposals at ACMs if demand exists.

The FIF requires submission of a Concept Note followed by a Full Proposal, after feedback is incorporated. The aim of the review process is: to build capacity in writing proposals for research and associated funding; to ensure a high standard of FIF-funded research is conducted; and to ensure that FIF-funded research projects fit within the broad objectives of SARTRAC.

This initial internal Call for Proposals to the FIF requires two parts to the submission: i) a Concept Note and; ii) a Full Proposal. Feedback will be provided after the Concept Note is submitted. Concept Notes need to be approved before a Full Proposal is submitted. The Full Proposal needs to be approved before any funds are released. A review panel (from the PMB) will consider Concept Notes every three months, and will endeavour to review all Full Proposals submitted within a 6 month cycle, with the first panel set for ACM1 at Southampton in July 2020.

### 4.1.4. Stakeholder engagement plan

SARTRAC depends on stakeholder engagement; it is a cross cutting activity over all four Work Packages. The role of stakeholder engagement in SARTRAC is outlined in Section 2.5, along with findings to date, consisting mainly of background information.

UWI-CERMES is responsible for leadership of cross cutting stakeholder engagement. UWI-CERMES will work with WP leads to develop an overall stakeholder engagement plan, agree institutional

responsibilities for engagement within the geographic subregions of the project in execution of the plan, and provide overall guidance and coordination of the engagement plan implementation. In general, UWI-Mona will be responsible for engagement in Jamaica, and UoG will be responsible for engagement in Ghana. UWI-CERMES will also play a direct role in implementation of the plan, as the focal point institution for engagement with stakeholders in the English speaking DAC Caribbean. In this regard, UWI-CERMES will act as a clearinghouse to disseminate project information to stakeholders in the DAC Caribbean through existing networks etc.

At this stage, we provide an outline methodology and framework for stakeholder engagement over the course of SARTRAC. This will be further developed to a detailed engagement plan that will guide the process over the course of the project.

Stakeholders' inputs will feed into the various work packages, and work package outputs will be disseminated to stakeholders. Currently, a mapping exercise to identify and categorise key stakeholders is in progress (Annex IV). UWI-CERMES is working with WP leaders to populate and verify the stakeholder map and to develop an understanding of the target audiences/end users of project outputs (e.g. the coastal transport models being developed under WP1). This collaboration will also help to identify stakeholder input needs for each WP, how it is envisaged that stakeholder input will inform the work, who the key informants are, and what information/outputs will be disseminated to stakeholders.

The stakeholder engagement plan will:

- Develop a broad mapping framework by identifying relevant sectors or categories of stakeholders with interest in sargassum (see Stakeholder Map, Annex IV)
- Identify stakeholder organisations by populating the framework developed. This will be accomplished by drawing existing institutional knowledge accumulated by working with stakeholders throughout the region, utilizing existing networks and listservs, and possibly snowball sampling if necessary
- Identify and articulate the specific stakeholder engagement needs of SARTRAC: inputs to WPs required e.g. understanding barriers to uptake of transformation opportunities to inform WP3, key informants, target audiences and end users of project outputs, parties that can influence the project execution
- Cross reference the engagement needs of the project with the broad mapping to identify project specific target/focus groups and specific engagement objectives (inputs and output dissemination) for each group
- Develop a strategy for communications with stakeholders according to the groups and needs identified (Table 13). This will comprise identification type and frequency of engagement and appropriate communications media for each target group, e.g. workshops (virtual or face to face), surveys etc. This will include outlining arrangements for ongoing engagement after initial contact, including regular updates or circulation of draft components for feedback, as well as a process for dissemination of final outputs
- Develop a framework for assessment of the interest and influence of stakeholders (Table 14), this will follow the ODA (1995) guidance on stakeholder engagement, identifying stakeholder interests in sargassum, and their importance to the SARTRAC project. For each of these variables, stakeholders will be ranked low, medium or high.
- Define roles and responsibilities for the implementation of the engagement plan

*Table 19 Example Generic Stakeholder Communication Strategy*

| Stakeholder Groups | Recommended Engagement Technique | Topics | Engagement Frequency |
|---|---|---|---|
| Stakeholder groups | • Formal meetings<br>• Site visits<br>• Progress reports<br>• Webinars | • Update on project progress and activities<br>• Plans for next period<br>• Issues and changes | Quarterly / When changes occur |

*Table 20: Example framework for assessment of Stakeholders' interest and influence*

| Stakeholders | Interest in the project* | Power to influence the project process and outcome** |
|---|---|---|
| **Technical areas of interest** | | |
| | | |
| **Policy** | | |
| | | |
| | | |
| **Geographic locations** | | |
| | | |
| | | |
| | | |

Source: based on ODA (1995)

Notes:

**High* – critical to the process and outcomes; *Moderate* – under some circumstances they would have an interest in the project; *Low* – Very low interest in the process or outcomes

** *High* – critical to the success of the project; *Moderate* – under some circumstances they could influence the project; *Low* – no power to influence the project

Once the plan has been developed and agreed, it will be operationalised. An adaptive management approach will be used to identify and implement corrective adjustments if/as needed along the way.

Table 15 provides a preliminary overview of stakeholder engagement needs of the WPs, to be expanded and refined in collaboration with UWI-CERMES in development of a stakeholder engagement plan.

*Table 21 Preliminary stakeholder needs by WP*

| WP | WT number and text | Types of Stakeholders | Engagement Needs* | Timing, delivery |
|---|---|---|---|---|
| 1 | WT1.3.4 Co-development of the system as a framework for local application - Phase 1 (scoping, testing) | High level end users of the system<br>Academics, researchers<br>Policy makers in Caribbean and W. Africa | ____ | Y2, Q1-4 |

| WP | WT number and text | Types of Stakeholders | Engagement Needs* | Timing, delivery |
|---|---|---|---|---|
| | | Sectors and communities interested in using predictions in their management and planning e.g. tourism | | |
| 1 | WT1.4 Co-development of an integrated system (interactive website) for end-users in Jamaica; extend to Ghana | High level users of the system<br>Academics, researchers<br>Policy makers in Caribbean and W. Africa | Stakeholder input to website design and testing<br><br>Dissemination of output (website) | Y3, Q2 |
| 2 | WT2.2 *sargassum* early-warning system development | High level end users of the system<br>Sectors and communities interested in using early warning system in their management and planning e.g. tourism | Stakeholder needs to inform pre-development of the system;<br>Stakeholder feedback to guide post-development;<br>Dissemination of system output | Y1-Q3 |
| 2 | WT2.5 Development of *Sargassum* risk management strategy | High level users<br>Policy makers in the Caribbean | ____ | Y2, Q1-4 |
| 2 | WT2.6 Strengthened capacity of stakeholders in West Africa in use of geospatial data in decision making | High level users?<br>Policy makers in W. Africa | ____ | Y2-Y3 |
| 3 | WT3.2 Educate and inform people about *Sargassum* uses | Affected Communities<br>General Public<br>Universities, public institutions | ____ | Y3 |
| 3 | WT3.4. Working with the poorest sargassum-effected communities to identify the opportunities and barriers to exploitation of sargassum to | Affected communities<br>Sectors that may be interested in or benefit uses sargassum e.g. agriculture, energy | Identify interest in, capacity for, and potential supply/value chain entry points for use | Y1, Q4 |

| WP | WT number and text | Types of Stakeholders | Engagement Needs* | Timing, delivery |
|---|---|---|---|---|
| | deliver equitable resilience within the poorest communities. | | of sargassum as a raw material/ commodity | |
| 3 | WT3.5. Analyse the political, social and economic pathways to turn holopelagic Sargassum into opportunity in the Caribbean: | Policy and business stakeholders | Identify the best routes to exploit Sargassum biomass in the Caribbean to generate equitable resilience among the poorest. | Y1, Q4 |
| 3 | WT3.6. Current practices in managing sargassum. How is sargassum collected, stored, used, or ignored, or discarded, at a local level within Ghana and at a regional level in West Africa? | Regional authorities and local communities affected | Stakeholder verification/ perceptions relative to objective data.<br>Effectiveness of current practices in management<br>If possible estimate how much sargassum is landing on beaches? | Y1, Q2 |
| | WT4.1 Sargassum stakeholder mapping for governance | Regional institutional stakeholders involved in governance | Identification of conflicts and synergies | Y1, Q1 |
| 4 | WT4.2 analysis of potential for an inter-state / regional governance mechanism | High level policy stakeholders? | | Y1, Q4 |
| 4 | WT4.3 analysis of the property rights issues, exploring issues of loss and damage and exploitable common property resources | High level policy makers | | Y2, Q3 |

Note: * Continuously running activity meeting needs of WPS as/when required

## 4.2. Legacy building activities

SARTRAC is committed to having an impact on the well-being of the poorest, and a longer term beneficial legacy, however the extent to which the project can deliver on its objectives and hence deliver a lasting legacy is dependent on the progress of COVID19, as this will affect stakeholder interaction and fieldwork.

### 4.2.1. SARTRAC legacy

Ultimately, we are working towards several key outputs from SARTRAC:

- identification of the atmospheric and oceanographic drivers of sargassum events
- development of an operational monitoring system at local to regional scale

- analysis of the biological composition of the Sargassum biomass and the implications of Sargassum re-use
- a political economy analysis of issues associated with Sargassum re-use and management, recognising there are potentially conflicting access rights, and multiple perspectives amongst regional stakeholders on how to address this
- improved risk management and adaptation best practice guidelines
- Transferable methods developed for use in other DAC country affected areas in the tropical Atlantic basin

Steps have been taken to develop the project structure, governance, reporting and work packages. In addition some outreach materials have been drafted e.g. high level slides, and a two page flyer (see Annex VIII). On completion of this inception report, the content will be uploaded to the website.

### 4.2.2. SARTRAC Website and Twitter

A draft website has been created and a Twitter account has been set up (@SARTRAC1). The SARTRAC website (https://generic.wordpress.soton.ac.uk/sartrac/) will provide information on four main areas:

(i) About SARTRAC. This will contain: Project info; team info with links to institutes; Project timeline; Project work package descriptions; Team roles (including co-I champions)

(ii) Outputs / publications. This will contain: Blog, Conference presentations, Papers and Media reports.

(iii) News. This will contain: Short quarterly reports from teams, and social media engagement.

(iv) Internal SARTRAC users only (Password protected part of website), This will contain: All PMB agenda, All minutes from meetings, Inception report, Internal working documents.

High level slides that describe the project have been developed for circulation within the team for improvement. We are in the process of developing a brochure to send out to interested parties.

We are excited to be embarking on this journey with SARTRAC and will be focussing our attention on delivering high quality outputs which have an impact on the delivery of equitable resilience for the poorest affected sargassum-receiving communities.

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# 6. List of Annexes

I. Consortium Gantt Chart
II. Consortium Theory of Change
III. ESRC project summary
IV. Stakeholder Mapping – current draft
V. Institutional Inception Reports
VI. Consortium Risk Register
VII. Additional WP3 information
VIII. 2 page flyer for SARTRAC

## Annex I: Consortium Gantt Chart

| | | | Y1 Q1 | Y1 Q2 | Y1 Q3 | Y1 Q4 | Y2 Q1 | Y2 Q2 | Y2 Q3 | Y2 Q4 | Y3 Q1 | Y3 Q2 | Y3 Q3 | Y3 Q4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Activity | Description | Name | 1Nov19 | 1Feb20 | 1May20 | 1Aug20 | 1Nov20 | 1Feb21 | 1May21 | 1Aug21 | 1Nov21 | 1Feb22 | 1May22 | 1Aug22 |
| WT1.1 | Large-scale physical drivers | Skliris | x | x | x | x | x | x | x | x | x | x | x | x |
| WT1.2 | Seeding system development | Marsh | | x | x | x | x | | | | | | | |
| WT1.3 | Tracking development | Marsh | | x | x | x | x | x | x | x | | | | |
| WT1.4 | Framework development | Marsh/ End-users | | | | | | x | x | x | x | x | x | x |
| O1.1 | Papers, Reports | Skliris | | | | x | | | | x | | | | x |
| O.1.2 | Seeding system and datasets | Marsh | | | | | x | x | x | x | x | x | x | x |
| O.1.3 | Model system and forecasts | Marsh | | | | | x | x | x | x | x | x | x | x |
| O.1.4 | Integrated framework | Marsh/ End-users | | | | | | | | | | x | | |
| WT3.1 | Sargassum feedstock consistency | Tonon | | X | X | X | X | X | X | X | X | X | X | X |
| WT3.2 | Bioenergy production | UWI-Mona PDRA2 (SRC- Ja) | | X | X | X | X | X | X | X | X | X | X | X |
| WT3.3 | Soil amelioration | Webber | X | X | X | X | X | X | X | X | X | X | X | X |

| | | | Y1 Q1 | Y1 Q2 | Y1 Q3 | Y1 Q4 | Y2 Q1 | Y2 Q2 | Y2 Q3 | Y2 Q4 | Y3 Q1 | Y3 Q2 | Y3 Q3 | Y3 Q4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Activity | Description | Name | 1Nov19 | 1Feb20 | 1May20 | 1Aug20 | 1Nov20 | 1Feb21 | 1May21 | 1Aug21 | 1Nov21 | 1Feb22 | 1May22 | 1Aug22 |
| WT3.4 | Economic opportunities | UWI-Mona (Sargassum Group-NEPA) | X | X | X | X | X | X | X | X | X | X | X | X |
| O3.1 | Research paper, training | Tonon | | | | | | X | | | | X | | X |
| O.3.2 | Digesters/Bio-energy, briefing | UWI-Mona PDRA2 | | | | | | | X | | | | X | X |
| O.3.3 | Research paper, production /use compost | Webber | | | | | | | X | | | | X | X |
| O.3.4 | Briefing | Webber | | | | | | | | | | | X | X |
| SHE | Preliminary mapping analysis of SHs | Cumberbatch | | | | X | | | | | | | | |
| SHE | Discussions w. WPs to define SHE needs | Cumberbatch | | | | X | | | | | | | | |
| SHE | Communication / dissemination plan | Cumberbatch | | | | X | | | | | | | | |
| SHE | Implement SH engagement activities | Cumberbatch | | | | | X | X | X | X | X | X | X | X |

## Annex II: Consortium Theory of Change

| Activities | Outputs | ST Outcomes | MT Outcomes | Impact |
|---|---|---|---|---|
| Develop and maintain a well-functioning research consortium. | Research consortium functions well, i.e. regular meetings, two-way knowledge transfer. | Publications in high-impact journals, methods / skills developed across members. | SARTRAC consortium seen as trusted / high-quality source of evidence on sargassum. | Strengthened capacity of research partner to conduct high quality research. |
| Align research plans / questions w. national priorities in Jamaica, Ghana and E. Caribbean. | Policy relevant, high quality, innovative research for partner countries. | Key stakeholders are aware of and supportive of SARTRAC and research produced by members. | Research by SARTRAC informs policy and management decisions in partner countries. | Policy choices in partner countries are made using SARTRAC outputs that create benefits for the poorest. |
| Stakeholders identified and user-needs analysed to shape research. | Long-term forecast and early-warning system for sargassum, informed by user-needs and tested by key stakeholders. | Research users understand evidence produced by SARTRAC to help them build equitable resilience. | Widespread use of SARTRAC early-warning system by target stakeholder groups in partner countries. | Poorest groups in partner countries use SARTRAC tools to adapt to sargassum events to improve their livelihoods |
| Co-develop plans / strategies with key stakeholders incl. policy makers, to improve the wellbeing of the poorest. | Research outputs accessible to different stakeholder groups, including synthesis for international stakeholders. | Strengthened relationship with policymakers / other stakeholders at all scales. | SARTRAC research or team engaged in national and international dialogues and actions on sargassum | Sargassum risk management strategies implemented by partner country governments |
| Analyse datasets, incl. local data on sargassum drivers, distribution, opportunities and governance. | Open access database of primary and secondary data and evidence on sargassum. | High quality publications and engagement on sargassum risk management by the SARTRAC team. | Co-develop risk management strategy with key stakeholders for sargassum events. | SARTRAC research shapes national and international policy to enhance the resilience of the poorest to sargassum. |

## Annex III: ESRC 150 word summary of SARTRAC

Is climate change already causing strange explosions of species in unexpected locations and at surprising times? We think the answer is yes. Massive football pitch sized mats of a common seaweed 'sargassum' have been washing up on beaches throughout the Caribbean, Central America and West Africa in spring months since 2011. The seaweed rots giving off toxic gases, affecting residents health, tourism on beaches, fishing access to the sea, and beach access. All of which can damage small or vulnerable economies in the Caribbean and Africa. We want to know: where does the seaweed come from? What has caused its explosive growth in the last decade? How can we best manage and govern it? Can it be harnessed as a tool for good to help poor communities access a natural resource that they can convert valuable goods e.g. fertiliser or energy? Our project runs from 2019 to 2022 to answer these questions.

## Annex IV: Stakeholder Mapping

Stakeholders will be identified at the regional, national and sub-national/community levels as follows:

| Regional | Caribbean | | West Africa | |
|---|---|---|---|---|
| National | Jamaica | Other DAC | Ghana | Other |
| Sub-national/ Community | TBD | TBD | TBD | TBD |

Caribbean regional stakeholder consultation will focus primarily on the English-speaking DAC Caribbean. SARTRAC will work with partners in Ghana to identify stakeholders in West Africa.

At the regional and national levels, stakeholders will be categorised by their interest in sargassum issues. At this stage, the following categories or sectors have been identified:

| **Category of Interest In Sargassum** | | **Public sector** | **Private Sector** | **NGO/CSO/ "Third Sector"** |
|---|---|---|---|---|
| Broad interests in sargassum both in terms of hazard management/ adaptation as well as a potential opportunity | Sargassum Research/ R&D | | | |
| | Metocean | | | |
| | Economic Considerations | | | |
| | Funding / Investment | - | | |
| Stakeholders responding to sargassum as a risk or hazard requiring management, mitigation or adaptation | Tourism | - | - | |
| | Fisheries | | | |
| | Agriculture (terrestrial, i.e. not fisheries) | | | |
| | Public health | | | |
| | Beaches/ public areas management | | | |
| | Coastal ecosystems management/ conservation | | | |
| | Marine pollution | | | - |
| | (Solid) Waste management | | - | |
| | Climate Change | - | - | |
| | Port services/ maritime transport | | | |
| | Marine Protected Areas management | | | |
| | Marine surveillance/ patrol | | | |
| | Emergency management/ Response | - | | |
| Stakeholders responding to sargassum as | Small business/ SME affairs | | | |
| | Energy (renewable) | - | - | |

| Category of Interest In Sargassum | | Public sector | Private Sector | NGO/CSO/ "Third Sector" |
|---|---|---|---|---|
| resource/ commodity/ opportunity | Harvesting - nearshore (national) vs offshore regional cooperation | | | |
| | Uses - post harvest production | | | |
| | Mitigaiton, cleanup, barriers (collection vessels, booms etc) | | | |

National and sub-national stakeholder mapping will focus on Jamaica and Ghana. Stakeholder identification at the sub-national level will focus on the vulnerable communities within those countries that are directly impacted by sargassum influxes and that may benefit from transformational adaptation.

Stakeholders also include executing agencies and partners in ongoing projects who may be key informants and/or potential partners in the execution of SARTRAC. Therefore, such existing projects in the Caribbean have been identified to inform stakeholder mapping as listed below. Existing projects in Ghana will be similarly identified.

1. **SARG'COOP**

- *Title:* International Conference on Sargassum to Launch an Ambitious Cooperation Program in the Caribbean. Article of the Regional Council of Guadeloupe. 23-24 october 2019
- *Date:* starting October 2019
- *Aim*: to determine the state of the art of science and technology, improving the sharing of knowledge and existing expertise, experiments and tools used in the Caribbean and in the regions affected by this phenomenon. To strengthen cooperation in the realm of the protection of the environment among Caribbean states and territories. In the medium term, the objective is to significantly improve the resilience of island territories affected by this natural phenomenon, which seems to be linked to increasing polluting human activities and climate change.
- *Contact*: **Coline MARCHINI** Project Manager for Innovation and Internationalisation, Regional Council of Guadeloupe
    - Email: cmarchin@cr-guadeloupe.fr
    - Web: regionguadeloupe.fr
- *Partners/funders*: The Organisation of Eastern Caribbean States (O.E.C.S.), has initiated a Caribbean Cooperation Program against Sargassum (SARG'COOP). This program, financed by INTERREG Caribbean, includes partners such as the local authorities of French Guiana, Martinique, Saint-Barths and Saint-Martin, the French government (Ministries of Overseas France, Ecological and Solidarity Transition and Higher Education, Research and Innovation) and the ACS (Association of Caribbean States), OECS (Organisation of Eastern Caribbean States), the Dominican Republic, Mexico, ADEME (Environment and Energy Management Agency), AFD (French Development Agency), AFB (French Biodiversity Agency), ANR (National Research Agency) and Université des Antilles.
- *Project objectives:*
    - *Establish a Forum:* A Caribbean Sargassum Forum will bring together governments and local authorities, civil societies, companies, researchers and academics involved in the Sargassum issue. This network of experts will make available to the public, through an Internet platform, state of the art of science and technology, the national and regional

plans put in place, both successful and unsuccessful actions, innovative processes, etc. in all areas related to Sargassum: prediction, prevention of strandings, collection, storage, treatment and recycling.

- Es*tablish a Caribbean Monitoring and Warning Center* to better anticipate strandings and manage risks if necessary. The center will be based on an innovative remote sensing tool enabling the partners to anticipate strandings and adapt their public (communication with the population, evacuations, preparation of collection teams, etc.) and private (for companies dependent on strandings for their economic activity) actions.
- *Decision making tools:* The data produced by the Center will then be translated into newsletters offering a decision-making tool, with exchange, training and awareness-raising for partners. These two tools will make it possible to pool, co-construct and disseminate monitoring, Sargassum risk prevention and climate change adaptation approaches.
- *Discuss regional strategy:* Finally, the last day, which will be of an institutional nature, will bring together Caribbean Heads of State as well as regional and international organisations and will provide an opportunity to reflect on the definition of a common geopolitical strategy.
- *Annual Sargassum expos*: the first international trade show, Sarg'Expo, will bring together international companies presenting innovative techniques for forecasting, monitoring, surveillance, collection and recycling of Sargassum seaweed.https://www.sargexpo.fr/

**2. SAMtool**

- *Title:* Sargassum Detection and Monitoring
- *Date*: started 2018
- *Aim:* Daily detection of sargassum in the Caribbean Sea at 300m and 20m resolution
- *Contact*: Email: sargas-ops@groupcls.com < sargas-ops@groupcls.com>; Web: https://datastore.cls.fr/products/sargassum/
- *Partners*: European Space Agency, meteo France, cnes, Dept of Environment at Guadeloupe
- *Objectives*:
  - Monitor daily the Sargassum situation over the Caribbean area, using State of the art and operational combination of satellite data using 7 optical sensors and SAR sensors. Region to basin scale
  - Raise awareness on the upcoming sargassum influx, using A proven operational drift model for landing prediction, Close monitoring using drifting buoys
  - Prepare the mitigation plan in advance to reduce the devastating effects of sargassum stranding on local economies

**3. Sustainable Solutions to Food Security Challenges**

- *Title:* Sargassum removal and conversion to fertiliser
- *Date:* started October 2019
- *Aim*: Removal and industrial conversion of Mexico's problematic seaweed bloom biomass into high-quality, low-cost sustainable agricultural fertiliser products. University of Exeter Total award value: £615,572
- *Contact*: PI: Dr Mike Allen. Email: mija@pml.ac.uk
- *Partners*: University of Exeter **(**GCRF Global Research Translation Award)

4. **SARGADAPT**

- *Title:* Adapting to a new reality: Managing responses to influxes of sargassum seaweed in the Eastern Caribbean as ecosystem hazards and opportunities
- *Date:* started December 2019
- *Aim*: To reduce the impacts of and improve adaptation to sargassum influxes in the Eastern Caribbean with emphasis on converting a climate linked ecosystem hazard into an asset that supports opportunities for socio-economic development
- *Contact*: Hazel Oxenford
- *Partners*: UWI CERMES, [CBF, EbA Facility grant]

5. **SARG-NET**

- *Title:* Mailing list on Sargassum
- *Date:* started May 2019
- *Aim*: Provide a sargassum-specific LISTserve connecting researchers
- *Contact*: To subscribe: https://listserv.fiu.edu/cgi-bin/wa?SUBED1=SARGNET&A=1
- *Partners*: Florida International University

6. **SAWS**

- *Title:* Sargassum Watch System (SaWS)
- *Date:* started Jan 2018
- *Aim*: The Sargassum Watch System (SaWS) is designed to use satellite data and numerical models to detect and track pelagic Saragassum in near-real time.
- *Contact*: https://optics.marine.usf.edu/projects/SaWS.html
- *Partners*: University of South Florida

7. **SEAS**

- *Title:* Sargassum Early Advisory System (SEAS)
- *Date:* started 2013
- *Aim*: The SEAS Program specializes in Sargassum seaweed movement and migration patterns, as well as identifying and understanding potential growth factors behind the blooms. This Program was created in 2013 by Robert Webster to help with forecasting large Sargassum landings for Texas. As of 2017, the SEAS Program has performed forecasting for all of the Gulf Coast, Mexico, Grand Cayman, Jamaica, Haiti, Dominican Republic, Puerto Rico and various Caribbean Islands, in order to aid local coastal zone management efforts by providing publicly available data regarding the windrow's whereabouts.
- *Contact*: http://seas-forecast.com/
- *Partners*: Texas A&M Galveston (TAMUG)

8. **CERMES Sargassum Sub-regional Outlook Bulletin**

- *Title:* Sargassum Sub-regional Outlook Bulletin
- *Date:* started October 2019
- *Aim*: Provide easy to understand sargassum forecasts for the eastern Caribbean islands, comment on sector-specific implications for Fisheries and Tourism, and provide summary highlights and links to latest sargassum science and innovation.

- *Contact*: https://www.cavehill.uwi.edu/cermes/projects/sargassum/docs/bulletin/sargassum_outlook_bulletin_trial_issue_one_cermes.aspx
- *Partners*: FAO CC4FISH project, CBF-EbA Facility SargAdapt project

**9. CERMES directory**

- *Title:* Directory of people working on Sargassum
- *Date:* started xxx
- *Aim*:
- *Contact*: https://www.cavehill.uwi.edu/cermes/projects/sargassum/directory.aspx
- *Partners*:

- SAVE_C project: Study of holopelagic sargassum responsible for massive beachings: valorisation and ecology on Caribbean coasts. Solene Connan and Valeria Stiger-Pouvreau

- SAREDA-SSS

- FORESEA Please more details at : https://www.researchgate.net/project/SAREDA-SSS

- Other project advertised on SARGNET a few days ago, involving the UK:

**Sustainable solutions for Sargassum inundations in Turks & Caicos.**
**Funded by Darwin Plus Round 7: April 2019 – March 2021.**
RATIONALE: Sargassum drift on the beaches of Turks & Caicos is detrimental to the tourist- based economy. It involves the University of Greenwich, there is a poster on this project (see Thierry Tonon for more information).

## Annex V: Institutional Inception Reports (UOG, UOS, UWI, and UOY)

Work undertaken in the first 8 months of the project within each institution.

**University of Southampton**

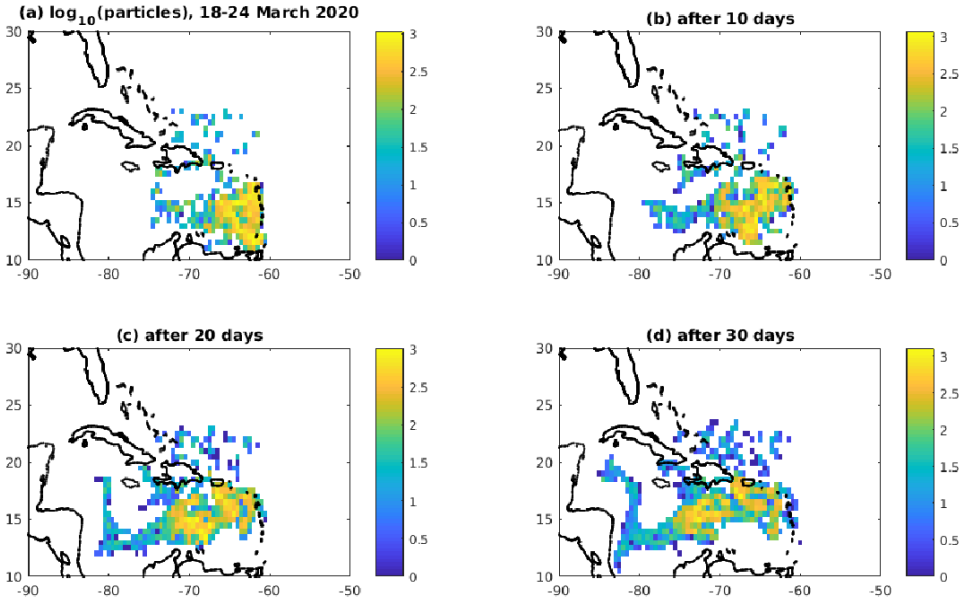
The first eight months of the SARTRAC project were complicated by a variety of reasons, and significant amounts of time were spent on project management associated with: establishing project governance structures and gaining buy-in from partners to the governance structures; embedding notions of equitable resilience and transformational adaptation across the project; developing work package teams; developing working relationships with new partners in Jamaica and Barbados. We were then significantly challenged by COVID-19 lockdown.

PDRA for WP1 (Skliris) started from project start. PDRA for WPs 2 and 4 successfully recruited and started in May 2020. Three UoS meetings have been held to cascade information from the monthly PMB to the wider UoS team, and to encourage development of a UoS centre of expertise across the disciplines. Monthly reporting rates have been at 100% since Feb 2020.

Marsh and Skliris (WP1) have:

- Developed a detailed work plan for WP1.
- Re-visited analysis of ocean and atmospheric observations, spanning equatorial and subtropical Atlantic, in light of latest publications
- Focussed on variability in cloud cover (for light) and winds (for nutrient upwelling)
- Started drafting manuscript
- Downloaded (from USF SaWS) daily-available 7-day averaged, FA_density (Floating Algae) maps (.png format images) for Eastern Caribbean area (10-23°N, 60-75°W), and digitize/grid these to "seed" Sargassum for tracking (see Figure V.I)

*Figure V.I: preliminary 10-daily forecasts of the 30-day drift of Sargassum that was observed by satellite over 18-24 March 2020*




- Downloaded and use "Data Theif" software by 1 April
- Working system for converting maps to input data by 1 June
- Extend Ariane software to include Stokes drift (ongoing)

- Explore viability of using Parcels (ongoing)
- Streamline scripts and ancillary codes for ease of operation (download .png file > convert to initial Sargassum "particles" in proportion to density, ready for tracking > run tracking > post-process and plot maps/analyses of coastal ingress, specific to Jamaica

Since the recruitment of PDRA for WP2 and 4, significant progress has been made. In WP2 including: establishment of a working group on algorithms for identification of sargassum, collated relevant data sets for ground-truthing. WP4 has started to collate a list of legislation affected sargassum management, and identify the main actors involved in the legal frameworks. Thinking has begun on the implications of different ownership regimes.

**University of York**

Completion of recruitment for a technician to start the 1st of June in York.

Bibliography survey: there have been a number of papers published recently on Sargassum reporting results that may be of importance for activities within the WP3, i.e.: Saldarriaga-Hernández et al. Science of the Total Environment 2020; Gouvêa et al. Science of the Total Environment 2020; Milledge et al. Energies 2020; Johns et al. Progress in Oceanography 2020; Rodríguez-Martínez et al. Peer J 2020-

Preparation of a publication on biomass composition analysis of S. natans and S. fluitans funded by UoY

GCRF pump priming project and that will support the work to be done within WO3.

Discussion with Prof. Kwasi Appeaning Addo, re extending WP3 work to Ghana.

Attendance at each PMB meeting and ESRC contract signed off in March 2020.

Regular discussions with WP3 team/Mona Webber in Jamaica.

**University of Ghana**

Completion of recruitment of PDRA.

Co-I champion of pastoral care. Emails sent regularly to check on colleagues well being.

Identification of researchers in UoG willing to be involved in harvesting some algal samples and to discuss with local communities about potential use of Sargassum. This needs now to be organized in more detail.

Participation in WP1 meetings with Marsh and Oxenford.

Participation in WP2 meetings with Dash, van der Plank, and Vaughn.

Discussion between Tonon and Appeaning Addo for getting Ghana involved in WP3.

**University of West Indies (Mona Campus)**

Webber (WP3) has undertaken the following:

Begun a limited trial of Sargassum compost with mangrove seedlings in a dry nursery, with plan to assess survival of the mangrove seedlings. This will be scaled up in the near future.

New experiments on agricultural crops have been paused but the design of those experiments were given, and will be replicated or scaled up. Probable starting date is currently June to September 2020.

The determination of feedstock consistency and changes in biochemical composition with storage will not start until sufficient quantities of Sargassum become available. This may happen in June or July 2020.

Contract not yet signed yet with the Scientific Research Council to conduct experiments on biomethane potential of Sargassum.

Maxam (WP2) has:

Participation in WP2 meetings. Contribution to reports.

Drone and sensor research carried out with quotes received for equipment.

Fieldwork plan drafted that incorporates chosen sites, key stakeholders and methods for sargassum detection, quantification and hydrometeorological data capture.

The GIS-RS PDRA is now in place to use drones to gather data, integrate satellite and drone data, as well as carry out knowledge transfer to Ghana.

The GIS Programmer PDRA is now in place to begin developing the systems and functional requirements design of the early-warning system.

**University of West Indies (CERMES)**

The impacts of the COVID19 pandemic have been significant. Public health measures related to the global COVID-19 pandemic were introduced in Barbados after the first case was reported on 16 March 2020. Measures were progressively increased until the country was placed under a mandatory 24-hour curfew (with specific exemptions for essential services) that lasted from 03 April until 3 May 2020, at which point restrictions were relaxed but not lifted altogether. Beaches were closed. The tourism industry, a key sectoral stakeholder in sargassum issues, was at a complete standstill for several months and will likely be negatively affected to an unknown degree for at least the next tourism season and possibly longer. For an extended period of time, it was uncertain when that would change. Similar though not identical measures and circumstances obtained in the other SARTRAC Caribbean countries. The Cave Hill Campus of the University of the West Indies was officially closed from 24 March through 08 June 2020. Although CERMES technical staff and project personnel continued to work from home, auxiliary services including administrative and financial functions of the broader University were not available as long as the Campus was closed. Furthermore, while we worked from home, we found ourselves dealing with additional domestic and family concerns associated with safeguarding our health, obtaining necessary supplies and carrying out basic functions under curfew restrictions.

Since early May, curfew restrictions in Barbados have been gradually lifted as active cases of COVD19 have decreased. As of 01 July 2020, there are no longer any curfew restrictions, and most operations within country have resumed, with various safety protocols as mandated by the authorities. A state of emergency nonetheless remains in place until the end of August in order to maintain restrictions with respect to physical protocols and to allow for adjustments if and as necessary. Commercial air travel from North America and the United Kingdom resumes Barbados between 12 July – 05 August 2020, albeit with new safety protocols in place and with fewer flights than pre-pandemic. Some SARTRAC Caribbean countries have already resumed commercial air travel from external tourism markets. This represents a tentative resumption of tourism operations, but there remains uncertainty as to visitor numbers as well as potential reintroduction of the virus and the Government's response to this. Furthermore, inter-regional travel is challenged because the main inter-regional air carrier for the Eastern Caribbean - LIAT - has gone into liquidation and alternative services are in nascent stages.

CERMES participated in the project kick off meeting in November, as well as six Project Management Board (PMB) subsequent meetings between December 2019 and June 2020.

CERMES investigators have participated in meetings Work Package specific meetings:

- WP 1 – participation by Hazel Oxenford
- WP 2 – participation by Janice Cumberbatch
- WP4 – participation by Janice Cumberbatch

CERMES submitted in writing a review of work packages with an attempt to understand CERMES role (5 December 2019) as well as proposed outline scope of work for CERMES on and 26 March 2020.

CERMES has completed a draft mapping of stakeholders broadly interests in and/or impacted by sargassum as shown in Annex IV.

# Annex VI: SARTRAC Risk Register

| Risk Number | Risk Name | Consequences (costs, benefits, quality, time) | Risk mitigation (transfer, tolerate, terminate, treat) | Responsibility/ Ownership | Risk Likeliho-od (1-5) | Risk Severity (1-5) | Risk Accept-ability | Notes |
|---|---|---|---|---|---|---|---|---|
| strategic | | | | | | | | |
| 1 | Failure to engage with stakeholder interests | No Knowledge Transfer; lack of relevance of project, would severely impact on Theory oft and funders | Extensive consultation and involvement with stakeholders; regular formal meetings and ad-hoc meetings when neede | Lead PI / WP4 / SHE champion | 2 | 2 | 4 | |
| 2 | Intellectual Property Rights not agreed | Confusion over IPR leading to authorship disputes and delay in publication. Inability of uptake in impact area | Ensure good communication between PIs and clear definition of IPR in contracts. Agreement to use 'Vancouver rules' for authorship. | Lead PIs / Soton | 2 | 3 | 6 | |
| 3 | Adequate balance and links between bio-physical, geographic and socio-political work | Imbalance of project giving rise to gaps in knowledge | Monitoring of links through regular integration meeting and the PMB | WP Leads / PMB | 2 | 1 | 3 | |
| external | | | | | | | | |
| 4 | Failure to provide information to stakeholders | Lack of communication with stakeholders could lead to breakdown in relationship | Ensure that regular updates either through meetings or written communication are given to all stakeholders | PMB/ SHE Coord/ PIs | 2 | 2 | 4 | |
| 5 | Failure of data centres to engage with and store project data | Delays to data deliverables. Final outputs may extend beyond project horizon | Ensure the problem is raised with the PMB and funders as soon as possible to minimise the impacts from the risk | PI/Co-Is | 2 | 1 | 3 | |
| 6 | Lack of cooperation from Key Stakeholders who may use the product outputs | Inability to host outputs and provide capacity building trianing within countries | Ensure engagement of muliple levels of stakeholders and communicate regularly (two way) with them | SHE coord/ Lead PIs/PMB | 3 | 2 | 6 | |
| Financial | | | | | | | | |
| 7 | Budget underspend/overspend | Regular monitoring | Grant holders receive money at start; develop plans for expenditure early. Budget to have monitoring reports regularly to ESRC | PI/Co-Is | 2 | 2 | 4 | |
| 8 | Reduction / increase of budget during programme | Reduction / increase of work programmes | Re-allocate funds | PMB/Pis | 1 | 1 | 1 | |
| 9 | Limit of travel spend will hinder project communication and dissemination | Not being able to travel between countries and hold consortium workshops, or fully disseminating at conferences | Possibility of applying for external funding or reallocating budget before end of project | PI/Co-Is / PMB | 2 | 2 | 4 | |
| operational | | | | | | | | |
| 10 | Non-availability or lack of co-operation between PIs and/or WP Leads | No co-ordination; lack of results | PMB to hold regular Reviews. Refer to RAC / funders. | Lead PI / PIs / WP Leads | 1 | 1 | 2 | |
| 11 | Failure of Work Packages to deliver on key outputs for consortia | Redefinition and initiation of project deliverables. Knock on effect on time line | Careful monitoring of projects to ensure that key outputs are declared promptly and risk is of delay is identified early (by PMB) | PMB | 2 | 3 | 6 | |
| 12 | Inadequate dissemination of results; poor communication policy | Stakeholders, scientific community and general public not made aware of results / impacts | Ensure active communication (including dissemination) plans is completed, monitored and revised | PMB / high level comms champion | 1 | 2 | 3 | |
| 13 | High-visibility leading edge science might fail | Novel techniques or approaches might prove to be invalid | Difficult to control; acceptance that this is normal for cutting edge science | PMB/ Lead PI | 1 | 4 | 4 | |
| 14 | Scientific disagreements halt or delay progress | Could lead to serious delay if not resolved | Arbitration by Lead PI with help from PMB and ESRC if required | Lead PI / PMB | 1 | 3 | 3 | |
| 15 | Fieldwork Problems | Depending on the severity may have major implications for project as data is needed for all WPs from SHE | Plan well in advance and have a back-up plan. Enusre ethical/ H&S approval is gained early | Pis / WP leads / ethics and risk champions | 2 | 3 | 6 | |
| Human Resources | | | | | | | | |
| 16 | Managing mandatory leave (maternity/paternity/secondment/ illness) | Leave may come at critical time for the project | Good planning and recognition of the need in advance. All key members of staff to have informed deputies in place. | PIs | 1 | 3 | 3 | |
| Specific Project Risks (aded when identified/removed when resolved) | | | | | | | | |
| 17 | Lack of staffing in relation to WP1 | Under resourced WPs lead to work not been done in study sites. | All members to review their split of funds acoss WPs and suggest reallocation of funds to address issue | PMB / country leads | 3 | 4 | 12 | Added 05 February 2020 |

## Annex VII: Work Package 3 Additional Information

**Information relevant to WT3.1: Identification of the most abundant morphotypes during algal bloom events.**

During harvesting, three bulks of biomass (about 1-2 kg of wet biomass, each bulk = one biological replicate) will be collected, and each bulk will be individually considered to separate the 3 known morphotypes of Sargassum, based on well-described morphological characters described in the literature, until there is no bulk left. Such an approach will be repeated for each site, season, and year. Each fraction of each bulk will be sundried, then weight to establish the quantity of each morphotype in each bulk. This should enable us to assess which morphotype is the most abundant according to seasons and year.

Samples will be considered before and after storage under two conditions:

1. Air-drying + burlap bags: this first method is based on raking of medium to small volumes of *Sargassum* onto the dune area behind the beach, and then allowing them to dry on wooden pallets for later removal and bagging. Solar drying of seaweed is easy in Jamaica due to year-round high temperatures and low rainfall especially in coastal areas. Burlap bags of dried *Sargassum* will then be stored in the dark at constant temperature (25 °C) for two months before subsequent analysis.

For each year – no need to separate the 3 morphotypes: 3 seasons X 4 sites X 2 (before and after storage, 8 weeks) X 3 replicates => 72 samples for determination of all/some of the parameters descibed below.

2. Ensilage in plastic bags: freshly harvested algae will be spread on large plastic sheets, allowing it to dry partially, then rolling the relatively even sheets of *Sargassum*, and wrapping in small plastic sealable bags. Bags will be kept in the dark and in a temperature-controlled environment (25 °C) for two months.

For each year – no need to separate the 3 morphotypes: 3 seasons X 4 sites X 2 (before and after storage, 8 weeks) X 3 replicates => 72 samples for determination of all/some of the parameters described below.

Parameters to be considered: fucan content, phenolic and phlorotannin content, alginate content, carotenoids and lipids content, monosaccharide composition, enzyme digestions (York, CNAP). Metal composition (UWI-Mona: MIAS and ICENS).

Comment: the carotenoid and lipid analysis will need to be done on fresh algae not on sun-dried/stored algae, we can see how to organize this when it will be time to harvest the samples. These can be additional samples compared to those to be used for the storage experiments.

**Information relevant to WT3.2: Assessment of *Sargassum* for production of energy by biodigestion**

Relevant information:

- Engagement of the Scientific Research Council (Jamaica) who makes and conducts research into bio-digesters to explore the use of *Sargassum* in these systems: contact already made with Mr Danian Hylton, Process Development Officer – Waste Research Management & Training Centre, Process Development Division, Scientific Research Council (SRC), Jamaica.
- The plan is to obtain estimates and a research proposal from SRC as well as hold discussions in February and March so that experiments can start as soon as *Sargassum* is available.

# Annex VIII: 2 page flyer for SARTRAC

SARTRAC: Teleconnected SARgassum risks across the Atlantic: building capacity for TRansformational Adaptation in the Caribbean and West Africa 2019-2022

## SARTRAC: Teleconnected SARgassum risks across the Atlantic: building capacity for TRansformational Adaptation in the Caribbean and West Africa

***Overview:*** SARTRAC is a 3 year, ESRC GCRF-funded, £1 million programme of applied research that runs from Nov. 2019 to Oct. 2022. SARTRAC focusses on identifying the opportunities for transformational adaptation that can be generated through the management and re-use of sargassum seaweed increasingly found across the tropical Atlantic. Since 2011, there have been major beaching events of sargassum, whereby huge sargassum seaweed mats wash up on beaches across the Tropical Atlantic, affecting North, South and Central America, the Caribbean and West Africa, see Figure 1.

Figure 1. Sargassum affected areas

The beached sargassum has damaging effects on human health, beach access, fishing, tourism and nearshore marine communities. The influxes of sargassum mats are unpredictable, with their landings varying seasonally, annually and spatially across the Tropical Atlantic. Living with these influxes is potentially the 'new normal' to which affected countries must adapt. What can be done to help those affected? We want to see what opportunities exist to use sargassum seaweed to create opportunities for the most vulnerable affected communities.

The SARTRAC project will analyse the drivers of sargassum in the Tropical Atlantic, will determine the impacts and adaptation options in Jamaica and will develop enhanced early warning systems and long-term forecasts specifically targeted at vulnerable coastal communities. SARTRAC will explore the transferability of methods to Ghana and consider how to create equitable benefits from sargassum use across the Tropical Atlantic Basin.

***Aims:*** SARTRAC has two distinct aims:

**(1) To identify opportunities for transformational adaptation that can be generated through the management and use of sargassum seaweed.**

**(2) To build capacity both within and outside of the consortium to support use of the seaweed by vulnerable coastal communities.**

***Methods***: Drivers of sargassum influxes will be examined using ocean and atmospheric data and models. Monitoring will involve remote sensing and ground truthing. Identifying adaptation options will occur through biochemical analysis of the seaweed and participatory research with communities affected. Governance issues will be explored through analysis of legal and policy frameworks, as well as through direct data collection with affected communities in Jamaica and Ghana and with sargassum policy makers. The research will be stakeholder-driven and will generate co-produced outputs.

**The SARTRAC Consortium comprises: University of Southampton, University of Ghana, University of the West Indies, and University of York**

SARTRAC: Teleconnected SARgassum risks across the Atlantic: building capacity for TRansformational Adaptation in the Caribbean and West Africa 2019-2022

***Outcomes:*** This project will: identify sustainable and equitable uses of sargassum; strengthen the sargassum research capacity in Jamaica and Ghana; shape sargassum policy choices in Jamaica and Ghana, and internationally; produce SARTRAC tools for adaptation to sargassum events to improve the livelihoods of vulnerable coastal communities in the Caribbean and West Africa; and generate sargassum risk management strategies for partner country governments to enhance the resilience of vulnerable communities to sargassum.

***Structure***: The project comprises 4 Work Packages (WP), with 2 cross cutting themes (Fig. 2)

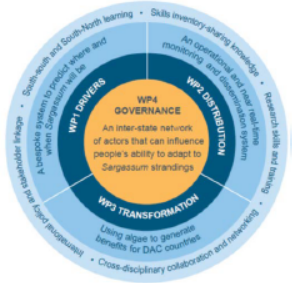


Figure 1. Workpackage Structure

***WP1: Drivers of events***. Aim: to co-develop with stakeholders a bespoke long-range prediction system. Contact: Prof Bob Marsh, University of Southampton (r.marsh@soton.ac.uk)

***WP2: Monitoring and dissemination.*** Aim: to co-develop with stakeholders a transferable and scalable near real time monitoring and dissemination system for Jamaica with application to Ghana. Contact: Prof Jadu Dash, University of Southampton (j.dash@soton.ac.uk)

***WP3: Transformational adaptation.*** Aim: to identify the bio-chemical characteristics of the seaweed to identify appropriate alternative uses, and to find the barriers to uptake by vulnerable communities. Contact: Prof Mona Webber, University of West Indies (mona.webber@uwimona.edu.jm)

***WP4: Policy and governance.*** Aim: to explore the implications of framing sargassum as a beneficial resource or a hazard, and to identify opportunities and constraints for use of sargassum. Contact: Prof Jack Corbett, University of Southampton (j.corbett@soton.ac.uk)

***Cross-cutting: Stakeholder engagement***. Aim: to identify and engage appropriate stakeholders across the SARTRAC programme. Contact: Dr Janice Cumberbatch, University of the West Indies (janice.cumberbatch@cavehill.uwi.edu)

***Cross-cutting: Equitable resilience***. Aim: to ensure that all work packages are focussed on delivering outputs that are aimed at the most vulnerable communities to sargassum beaching events. Contact: Prof Emma Tompkins (e.l.tompkins@soton.ac.uk)

***Contacts***: SARTRAC Principal Investigator: Prof. Emma Tompkins, School of Geography and Environment, University of Southampton. Follow us on Twitter @SARTRAC1. Website: https://generic.wordpress.soton.ac.uk/sartrac/For more information, please contact Lucy Graves: l.graves@soton.ac.uk

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