2021 ANNUAL PROJECT REPORT FOR ESRC (ES/T002964/1) PROJECT: 'SARTRAC'[1]

Contents

EXECUTIVE SUMMARY

This report documents the main findings and progress on the ESRC funded project 'SARTRAC' (ES/T002964/1) covering the period 1st November 2019 to 11th March 2021. The SARTRAC project is an interdisciplinary, four-country, six-member research collaboration, comprising: (i) University of Southampton (UOS), (ii) University of Ghana (UOG), (iii) MonaGeoInformatics (MGI), (iv) Centre for Marine Studies (CMS) at the University of the West Indies, Mona Campus, Jamaica; (v) Centre for Resource Management & Environmental Studies (CERMES) at the University of the West Indies, Cave Hill, Barbados; and (vi) University of York. It is worth noting up front, that the first year of this project has been severely affected by the impact of the COVID-19 pandemic, for example, most of the team have never met in person limiting our ability to develop personal relationships that are so important in the functioning of large research collaborations. Our ability to travel has been constrained, preventing opportunities for field work, capacity building and broadening the reach of the project.

Underpinned by stakeholder engagement and capacity building, SARTRAC (Teleconnected *Sargassum* risks across the Atlantic: building capacity for TRansformational Adaptation in the Caribbean and West Africa) aims to identify transformational adaptation opportunities from *Sargassum* for the benefit of the poorest affected people in DAC countries across the tropical Atlantic basin. To do this, the project has four main areas of research answering the questions: can we predict the large-scale and long term movement of *Sargassum*? Can we develop a useable near-real time early warning system for Jamaica, with a transferable methodology? Can *Sargassum* be reused to create benefits for the poorest affected groups? How can *Sargassum* best be managed to deliver benefits equitably? The mains findings from the research so far include:

- A prototype system for large-scale tracking of *Sargassum* across the Atlantic has been developed. By combining ocean, atmosphere and remotely sensed satellite data (the 'floating algae index'), SARTRAC has identified that winds and currents are the main drivers of *Sargassum* movements

[1] This report has been produced by Professor Emma Tompkins, University of Southampton with inputs from the wider SARTRAC project team. Any errors or mistakes are my own.

(manuscript in preparation). Multiple satellite-based *Sargassum* detection algorithms have been evaluated to identify the most suitable ones for *Sargassum* monitoring, remote sensed satellite data has been downloaded, and a framework developed to apply the algorithms.

- 'Virtual' meetings have commenced with key stakeholders to identify their needs in relation to a *Sargassum* Early Warning System in Jamaica.
- Maps of past impacted areas have been created for Jamaica to show where the most frequent and worst *Sargassum* strandings have occurred since 2018.
- Experiments that test the impacts of collection and storage on *Sargassum* chemical components are on-going. Preliminary results suggest that: different morphotypes contain different chemical properties, sun-drying alters the content of different compounds, storage has an impact on the composition of the biomass.
- Experiments to test the role of *Sargassum* in supporting mangrove seedling growth have shown that *Sargassum* is not suitable for wet mangrove nurseries, preliminary findings suggest that red mangrove dry nurseries benefit from a mix of 50% *Sargassum* compost and 50% sand.
- Theoretical frameworks to assess the nature of transformational adaptation within SARTRAC, and the governance of *Sargassum* have been developed.
- Existing regional environmental governance structures in the Caribbean are well placed to support adaptation to the new volumes of *Sargassum* being experienced. Yet, the inherent vulnerabilities of small island developing states pose possible barriers that existing regional governance mechanisms cannot resolve. The polycentric system operational in the Caribbean to govern environmental management has generated significant cooperation in policy development and application across the region; yet we find that the costs of coordination are disproportionately high for small nations.

The main outputs from SARTRAC to date include:

- Three (3) academic papers relating to: (i) DRIVERS: *Sargassum* prediction in the Tropical Atlantic (Johnson et al., 2020[2]); (ii) MONITORING: Review of remote sensing monitoring of *Sargassum* (Fidai et al., 2020[3]); and (iii) TRANSFORMATION: Analysis of biomass composition of *Sargassum* (Davis et al, 2021[4]).
- SARTRAC Inception Report detailing consortium members, governance and management, monitoring and evaluation, and reporting, project structure, changes to the project since funding agreed, stakeholder engagement plan, work plan for all four Work Packages with detailed work tasks, milestones, deliverables and associated dates for delivery, and plans for creating a lasting legacy (see http://generic.wordpress.soton.ac.uk/sartrac/wp-content/uploads/sites/380/2020/10/SARTRAC_Inception_report_20_07_2020.pdf)
- 16 short podcast interviews between PI Prof Emma Tompkins and all team members highlighting their research findings up to March 2021 (https://www.sartrac.org/publications/#podcast-and-blogs)
- Website developed (https://www.sartrac.org/) and Twitter account created @SARTRAC1 (with 36 Tweets, and 40 followers)
- Two (2) externally funded grant applications to develop capacity building resources have been won by the consortium

[2] Johnson, D. R., Franks, J. S., **Oxenford, H. A**., & Cox, S. A. L. (2020). Pelagic Sargassum Prediction and Marine Connectivity in the Tropical Atlantic. Gulf and Caribbean Research, 31(1), GCFI20-GCFI30.

[3] **Fidai, Y. A., Dash, J., Tompkins, E., & Tonon, T**. (2020). A systematic review of floating and beach landing records of Sargassum beyond the Sargasso Sea. Environmental Research Communications, 2(12), [122001].

[4] Davis, D., Simister, R., Campbell, S., Marston, M., Bose, S., McQueen-Mason, S. J., Gomez, L., Gallimore, W., & **Tonon, T**. (2021). Biomass composition of the golden tide pelagic seaweeds *Sargassum fluitans* and *S. natans* (morphotypes I and VIII) to inform valorisation pathways. Science of The Total Environment, 762, 143134.

- Three (3) external capacity building workshops run for members of the public to develop mapping and social science skills to analyse *Sargassum* (https://www.sartrac.org/news/more-than-maps-at-the-festival-of-social-sciences/)
- Two (2) internal capacity building resources developed on SARTRAC Theory of Change and Transformational Adaptation
- One (1) skills inventory of all SARTRAC team members
- Nine (9) blogs uploaded to the SARTRAC website
- One (1) whole consortium meeting, including a science meeting with external scientists and policy makers invited (Annual Consortium Meeting 1), see https://www.sartrac.org/news/first-annual-consortium-meeting/

While stakeholder engagement is at the heart of SARTRAC, COVID-19 related travel restrictions have meant that stakeholder engagement has only been possible 'virtually'. This has worked successfully with those stakeholders with functioning and accessible internet connectivity. As a result, the majority of stakeholders engaged so far have been: national government departments i.e. the governments of Jamaica and Ghana; large multi-national organisations such as the United Nations Environment Programme; and other *Sargassum* researchers. Engagement with target communities has not yet been possible. Ideally, data collection will involve face-to-face interactions; however if domestic travel in partner countries remains impossible, alternative plans are in place to collect data from communities using app-based instruments that can be accessed via mobile phones.

Capacity building has occurred within the SARTRAC project, however, as with all aspects of the research, delivery has changed significantly due to COVID-19. For example, we were unable to host the first annual consortium meeting (ACM) in-person in the UK, hence we could not arrange 'wrap-around' capacity building or training. Instead this first whole consortium meeting was held 'virtually' over three days in July 2020. To address the lack of capacity building at the ACM, we created internal SARTRAC capacity building champions (Prof Kwasi Appeaning Addo and Dr Ava Maxam). Together Kwasi and Ava have undertaken a skills-audit within SARTRAC: mapping the skills needed within the consortium; identifying skills present within the consortium; and identifying who could provide training. To date online training for the consortium has been provided in relation to 'Transformational adaptation' and the 'SARTRAC Theory of Change'. Training is planned for April 2021 on qualitative data sampling, collection, coding and analysis. To facilitate easy access to the findings within each work package, project PI Emma Tompkins interviewed every member of the SARTRAC team in Feb/March 2021. The short podcasts can be found on the SARTRAC website (https://www.sartrac.org/). Capacity building was expected to be supported through the use of the Flexible Innovation Fund, however due to lockdowns hindering travel for sabbaticals and limiting fieldwork, only one project has so far been submitted to the Flexible Innovation Fund, by the University of Ghana. This is awaiting a final review and we anticipate it should be funded shortly.

Overall, despite extraordinarily difficult conditions in which to set up a new research collaboration (with significant constraints on researcher time, travel and university support) across three continents with six partners, the SARTRAC project has undertaken a solid amount of work, and is starting to be acknowledged as an important producer of knowledge in the field of *Sargassum* management.

11th March 2021

DETAILS OF AWARD

Year Under Review (example (2nd year of project, 3rd year of project, etc.)	2nd year of project
Name of Project	SARTRAC (Teleconnected *Sargassum* risks across the Atlantic: building capacity for TRansformational Adaptation in the Caribbean and West Africa)
Project Reference Number	ES/T002964/1

1.0 INTRODUCTION

This report briefly describes the project, reviews stakeholder engagement, provides an update on project progress, and reflects on the challenges faced in delivery of this project.

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 (see Figure 1.1). *Sargassum* mats float in the Atlantic washing up on beaches and cause significant reported impacts, at sea, during their landing (due to the significant volumes), and when the *Sargassum* decomposes. *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. Since 2019, there has been a significant growth in *Sargassum* research but there remain many unanswered questions.

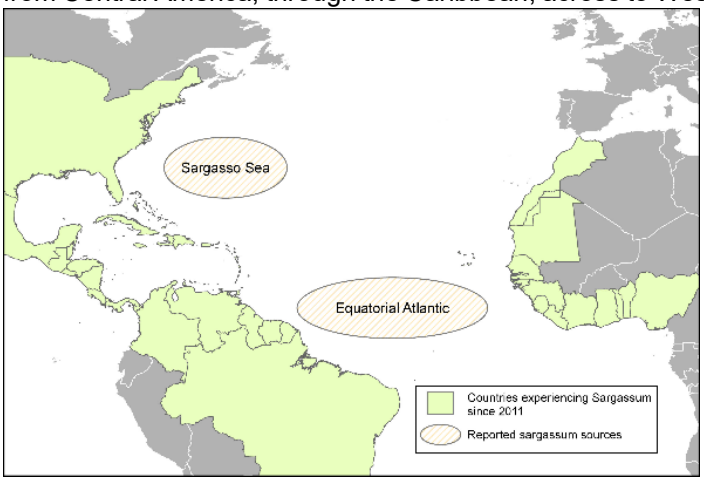

Figure 1.1: Map of Sargassum-affected areas in the Tropical Atlantic

Ongoing research on *Sargassum*, largely focusses on: tracking and monitoring the *Sargassum* at large scale in the Caribbean, the biology of the seaweed (see Figure 1.2), nearshore monitoring, management approaches, and business opportunities that may arise from use of *Sargassum*. SARTRAC, aims to complement and add value to this ongoing research, with our focus on transformational adaptation opportunities from *Sargassum* that could create equitable resilience for the poorest affected groups. Through our well-connected multi-country team, we take a different perspective, rather than duplicate others' research. 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.

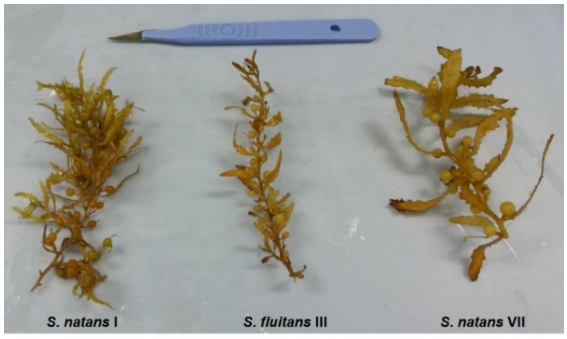

Figure 1.2: Common Sargassum species found in the Tropical Atlantic

The project has been significantly affected by the COVID pandemic (see section 4.0 on Challenges). In terms of progress on Work Tasks and Deliverables, the SARTRAC project team has to date completed 24% (4/17) of its Work Tasks, and is progressing with 65% (11/17) of other Work Tasks. Only two work tasks out of 17 have not yet been started. A summary of the main activities undertaken and outputs associated with those activities can be found in Table 1.1. A detailed description of findings can be found in Section 3.0 of this report.

Work Task	Activity (*Output*)	Complete	Progress (% complete)
1.1.	Wind and current analysis. (*Manuscript in progress*)	X	

1.2.	Data downloaded for 2000-2021	X	
1.3	Prototype tracking model developed		60%
1.4	Website development for users (www.*SARTRAC.org website created*)		10%
2.1	Framework to implement satellite based sargsssum detection algorithms developed. (i. *Successful application to access ESA Planet Scope data; ii. Field protocols developed; iii UAV acquired*)	X	
2.2	Initial meetings held with NEPA, Jamaica, and questionnaire developed. ***Delayed*** due to lockdowns		30%
2.3	Maps of historical *Sargassum* strandings have been created. Data collection protocol submitted for ethical review		50%
2.4	Systems dynamic model started.		10%
2.5	Risk identification table developed		10%
3.1	Most abundant morphotype was *Sargassum fluitans III.* ***Delayed*** due to lack of *Sargassum* in spring and autumn 2020.		50%
3.2	Scientific Research Council in Jamaica has been engaged to undertake biodigestion experiments. ***Delayed*** due to lockdowns		30%
3.3	Experiments in progress to assess role of *Sargassum* fertiliser in farming corn, tomato, and scotch bonnet peppers		50%
3.4	Conceptual framework for transformational adaptation developed. Ethical approval granted for data collection. ***Delayed*** due to PI time spent on project management due to COVID		10%
4.1	Analysis of policy frameworks. (*Manuscript in progress*)	X	
4.2	Desk based analysis started, on property rights and impact on governance.		30%
4.3	Political economy of *Sargassum*		Not started
4.4	Future governance frameworks		Not started

Table 1.1 Work Tasks completed, in progress and not yet started

A detailed work plan with work tasks, deliverables and timeline can be found in the SARTRAC inception report[5].

2.0 STAKEHOLDER ENGAGEMENT AND EQUITABLE PARTNERSHIPS

Stakeholder engagement is central to the SARTRAC project to obtain the diverse perspectives to inform the execution of the work, and to develop useful outputs that support genuine change. Effective engagement is also critical for effective dissemination of outputs, getting the right information to the right stakeholder at the right time. Stakeholder engagement was therefore initially planned to be cross-cutting across all work packages (Figure 4.1).

Two main confounding factors have significantly affected our stakeholder engagement: COVID-19 travel restrictions and the delayed launch of the project. As a result we were unable to: hold events to which we would have invited stakeholders (e.g. Annual Consortium Meeting and training events); formally launch the project in our partner countries until November 2020 (when many of our partners were in lockdown); accept visiting SARTRAC partners on sabbatical; support South-South travel between the Caribbean and West Africa; undertake field research; engage with community level stakeholders.

[5] The SARTRAC Inception Report can be found here: http://generic.wordpress.soton.ac.uk/sartrac/wp-content/uploads/sites/380/2020/10/SARTRAC_Inception_report_20_07_2020.pdf

Figure 2.1: Role of stakeholder engagement in SARTRAC

To consider our progress on stakeholder engagement, we reflect on what was proposed at the outset of SARTRAC, where we identified six potential groups of beneficiaries. The section below presents both the *planned* interactions and the *outcomes* to date; the latter has been significantly hindered by international and domestic travel restrictions.

2.1. Local and national government agencies involved in managing the impacts

Plan: In Jamaica: National Environment Planning Agency, Jamaica; the Planning Institute of Jamaica; in Ghana: the Ghanaian Ministry of Fisheries and Aquaculture Development (MOFAD); the Ministry of Food and Agriculture (MOFA) in Ghana. The Ministry of Environment, Science, Technology and Innovation (MESTI), Environmental Protection Agency (EPA), Coastal Development Authority (CoDA), Metropolitans, Municipal and District Assemblies (MMDAS).

Outcome: **Virtual meetings** have occurred with the **Jamaican National Environmental Protection Agency (NEPA)** and the **Ghanaian Environmental Protection Agency (EPA)**.

2.2. Marginalized and poor coastal communities affected by Sargassum strandings throughout DAC countries of the Caribbean, Central America and West Africa.

Plan: Through field work to engage with communities, and local beach user organisations, including fishers, farmers and tourism groups.

Outcome: **Leaders of one of the communities in Ghana have been engaged**, although **no community engagement has occurred in Jamaica and St Lucia.** We have identified case study communities, and intend to start our engagement in Ghana, St Lucia and Jamaica, as soon as travel restrictions are lifted.

2.3. National and regional agencies in Caribbean DAC countries engaged in monitoring and early warning schemes (MEWS) for Sargassum beaching, such as those established in Guadeloupe and Puerto Rico.

Plan: SARTRAC will work with MEWS agencies in selected Caribbean DAC countries to share best practice and to establish operational real-time prediction of events through skill development and training.

Outcome: **SARTRAC team members have made contact with other groups in Central America, Europe and the Caribbean, working on MEWS**, notably: SASAMS team (http://sasams.org/site.html) working in Mexico; Bouvier Clément and Jean-Philip Maréchal and the BRGM and CESAR *Sargassum* research programmes (https://anr.fr/Project-ANR-19-SARG-0005); Heidi Dierssen for their Hyperspectral discrimination field dataset, for the remote sensing work (https://tos.org/oceanography/article/data-needs-

for-hyperspectral-detection-of-algal-diversity-across-the-globe); and the team behind the '*Sargassum* Monitoring' website http://*Sargassum*monitoring.com/.

2.4. Internal SARTRAC capacity building

Plan: Researchers in the University of the West Indies (UWI) and University of Ghana will have the opportunity to share knowledge, to attend sabbaticals in the UK, and to bid for additional funds within SARTRAC (the Flexible Innovation Fund) to undertake additional research or capacity building as needed. Each annual consortium meeting will include scheduled training to build capacity in areas identified by partners during the inception phase.

Outcome: We were unable to host the first annual consortium meeting (ACM) in person in the UK, hence we could not arrange 'wrap-around' capacity building. Instead the first meeting was held 'virtually' over three days on July 2020. To address the lack of capacity building at the ACM, we **created internal SARTRAC capacity building champions (Prof Kwasi Appeaning Addo and Dr Ava Maxam).** Together Kwasi and Ava have identified the skills within the consortium and identifying who could provide training, as well as mapping the skills needed within the consortium. To date **online training for the consortium has been provided in relation to 'Transformational adaptation' and 'Theory of Change'**. To share findings from each work package, short podcast interviews with all team members have been undertaken, and uploaded to the SARTRAC website (https://www.sartrac.org/). Only one project has so far been submitted to the Flexible Innovation Fund, by the University of Ghana. Once COVID-related travel restrictions have been lifted we will encourage partner countries to apply to the FIF for funding to visit the UK on sabbatical, and to extend the scope of the research.

2.5. Regional organisations who may become the hub for regional Sargassum governance

Plan: to visit regional organisations such as the Organisation of East Caribbean States (OECS); the Caribbean Community Climate Change Centre; the Caribbean Institute for Meteorology and Hydrology (CIMH); the Caribbean Tourism Organisation (CTO); Caribbean Agriculture Research and Development Institute (CARDI); and Caribbean Regional Fisheries Mechanism (CRFM), Abidjan Convention Secretariat, Economic Community of West Africa (ECOWAS), West African Economic and Monetary Union (UEMOA).

Outcome: No travel has been possible, nonetheless, we have reached out to regional groups in both the Caribbean and West Africa, for example on our External Advisory Board, we have Dr Lorna Inniss, the Coordinator of the UNEP CEP.

2.6. International organisations with responsibilities for the oceans/food security,

Plan: to contact regional organisations e.g. UN Food and Agriculture Organization (FAO), and the Intergovernmental Oceanographic Commission of UNESCO, and NGOs concerned with the conservation of coastal ecosystems in the region.

Outcome: At the first SARTRAC whole team Annual Consortium Meeting in July 2020, the team invited members of the **Sargasso Sea Commission (Prof Howard Roe),** and **members of UNEP** to join the science section of the meeting. This proved valuable in raising the profile of the project. In addition, Professor Kwasi Appeaning Addo at the University of Ghana has been most active in this area. He has reached out to the **Coordinator of the Global Partnership on Nutrient Management (GPNM) at the United Nations Environment Programme (Mahesh Pradhan), in Nairobi**, and spoken at events run by this UNEP team, he has connected with: **Dr Peter Kershaw (member of Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection - GESAMP**) and **Prof Brian LaPointe at Florida Atlantic University**. Other SARTRAC researchers have met virtually with other research teams working on *Sargassum* including Prof Mike Allen and his team at **Plymouth Marine Lab** (https://www.phycomex.uk/)' and **Prof Debbie Bartlett and Prof John Milledge at University of Greenwich**, working on sustainable *Sargassum* solutions in Turks and Caicos. We have reached out to the

wider *Sargassum* research community through the 'SARGNET' mailing list and **provided training on social science approaches to *Sargassum* stakeholder engagement to this group** (March 9th 2021).

3.0 PROJECT PROGRESS

The SARTRAC project has progressed in many areas. Some activities identified in SARTRAC Inception Report timeline have changed due to travel restrictions. Achievements and changes are shown below.

WP1: DRIVERS WP1 (Drivers) comprises four work tasks. Summarised outcomes are detailed here:

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

- *Outcome*: current and wind data from reanalysis projects have been downloaded and analysed alongside 'floating algae index' distributions, in the Central West Atlantic region considered a major source of *Sargassum*; **a manuscript is in preparation, and an abstract submitted for conference presentation of results** (April 2021).

WT1.2 Download satellite data specific to Sargassum, across the tropical Atlantic, and prepare these for use in WT1.1 and WT1.3.

- *Outcome*: **satellite data spanning 2000-21 have been downloaded, re-gridded and time-averaged** for use in WT1.1 and WT1.3

WT1.3 Develop efficient, probabilistic tracking with high-resolution ocean hindcast surface currents and winds to predict the approach of Sargassum to Barbados, Jamaica and Ghana, up to 90 days ahead.

- *Outcome*: **A prototype system for large-scale tracking of *Sargassum* has been developed** and evaluated with subsequent observed *Sargassum* at downstream locations over 90 days.

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

We have made considerable progress with WT1.1, WT1.2 and WT1.3. Progress with WT1.4 is limited to date, pending progress with the other three WTs.

We have engaged with an active international community that has been working to understand the drivers and drift of *Sargassum* over the last decade. We summarise the proliferation of *Sargassum* in the Central West Atlantic (CWA: 0-22°N, 63-38°W) in Fig. 3.1, and most recent month-by-month development of *Sargassum* in this key region during 2020 in Fig. 3.2 (part of WT1.2).

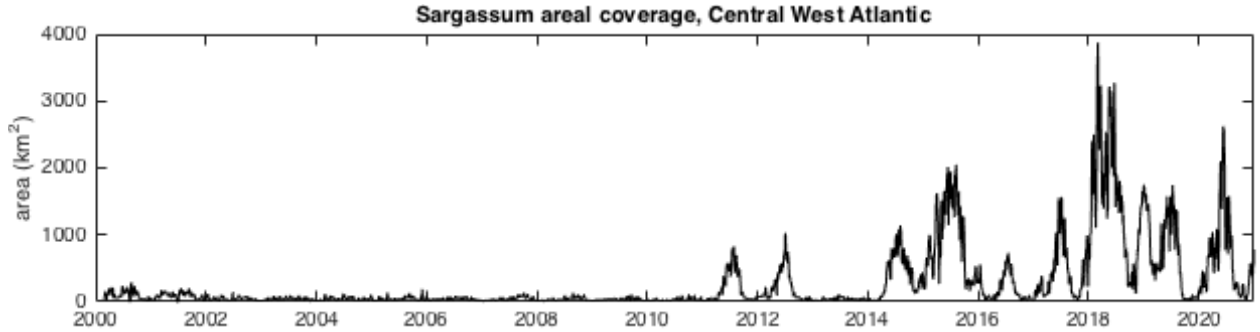

Figure 3.1 Sargassum areal coverage in the Central West Atlantic over 2000-20, based on daily maps available from Optical Oceanography Laboratory, College of Marine Science, University of South Florida.

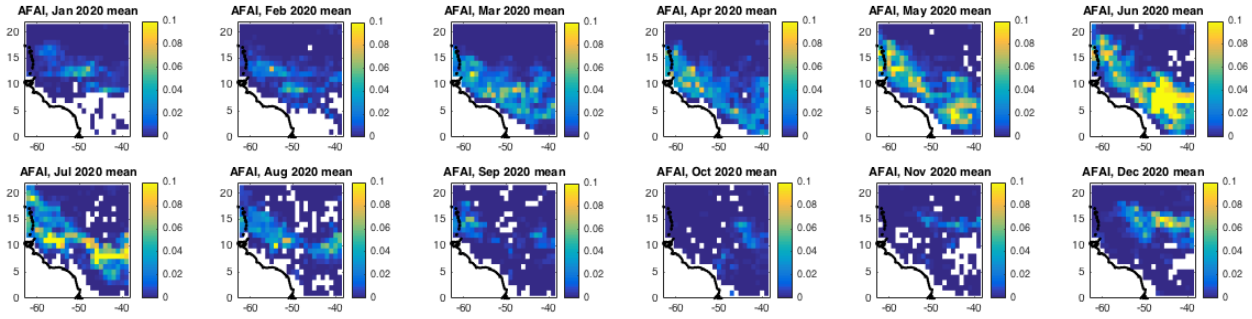

Figure 3.2 Monthly mean Sargassum areal fraction (0-0.1%) in 2020, data source as in Fig. 1.1, averaging 1-km data to 1° mesh.

Based on Alternative Floating Algae Index (AFAI) datasets developed at the Optical Oceanography Laboratory of the University of South Florida (USF), the CWA data – along with further AFAI data for East Caribbean and Gulf of Guinea regions (also from USF), provide us with the basis for tracking calculations (WT1.3). Based on a skill-assessed climatology of currents inferred from drifters, 3-month predictions of pelagic *Sargassum* events in the Eastern Caribbean sub-region are issued via the *Sargassum* Sub-regional Outlook Bulletin, led by Co-I Oxenford and colleagues at CERMES, in collaboration with the University of Southern Mississippi. **We are developing a complementary approach to prediction to other researchers, tracking *Sargassum* across the wider region at seasonal and longer timescales, using numerical model data.**

Without seasonal or longer-timescale weather and ocean forecasts at the high resolution needed to correctly represent *Sargassum* drift, we are using currents and winds from a high-resolution global ocean hindcast (currently spanning 1988-2010) to explore the scope for skilful probabilistic forecasts. The goal is to provide useful early warnings of *Sargassum* arrival at selected locations (Barbados, Jamaica, Ghana), updated monthly and communicated to stakeholders in partnership with WP2 and WP4. At Barbados, our new predictions will be 'trained' alongside the existing drifter-based predictions. Combining observations (drifters) and more extensive calculations with a high-fidelity model should improve confidence in both CERMES and SARTRAC predictions, with prospects to include biological processes in the latter.

In brief here, drifting *Sargassum* is represented in proportion to areal fraction with virtual 'particles' that are carried by ocean currents and blown by winds (from a selected hindcast year), in proportion to an optional 'windage' factor (0-2%). In Fig. 3.3, we illustrate an example of this tracking for *Sargassum* moving into the Caribbean during spring of 2020.

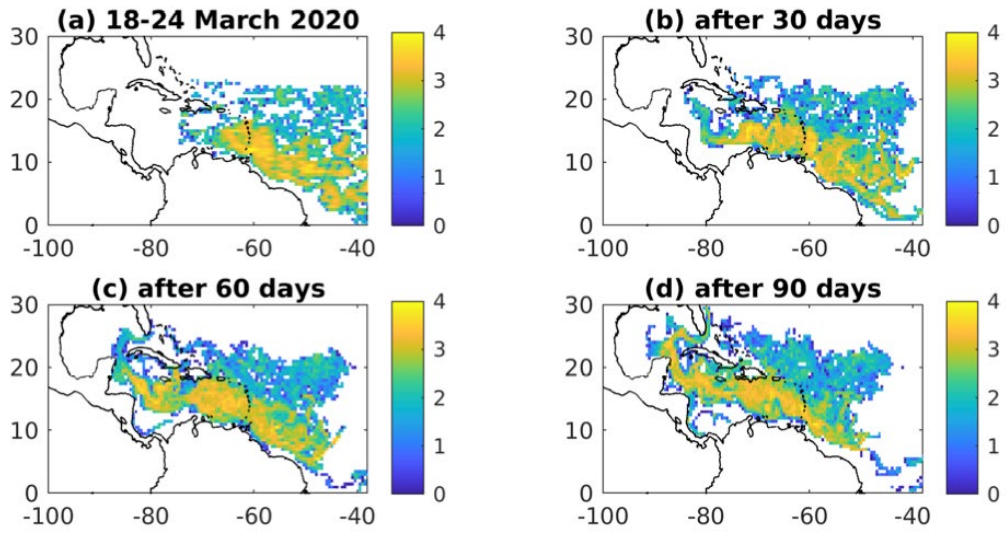

Figure 3.3 Preliminary forecasts of Sargassum drift under 1% windage: (a) initial distribution in CWA and East Caribbean regions with AFAI data for 18-24 March 2020; forecast drift over 90 days, illustrated after (b) 30 days, (c) 60 days, and (d) 90 days. We use a logarithmic scale for the areal fraction of Sargassum.

On a seasonal (90-day) timescale, swift ocean currents and trade winds convey particles rapidly westwards, reaching Jamaica around 30 days after entering the Caribbean Sea. These forecasts vary according to the selected hindcast year and windage factor and are best evaluated as an ensemble. A more limited number of 90-day forecasts have been undertaken for *Sargassum* drift with the Guinea Current and beaching along the coast of west Africa, including Ghana, although a challenge in this region is to improve the AFAI data available for initialising the forecasts.

With a focus on the CWA region, we are also analysing the extent to which considerable variability in the AFAI data (and hence *Sargassum*) since 2011 is related to seasonal and interannual changes in ocean currents and winds as primary drivers (WT1.1). Tropical Atlantic winds and currents are subject to several 'modes' of variability, on timescales from seasonal to decadal, which are to an extent predictable. If we can link some of the post-2011 variability in *Sargassum* to physical changes associated with these modes, incorporating seasonal-decadal predictability, we can add confidence to our seasonal forecasts and possibly make longer-term predictions. These may inform the ongoing development of commercial uses for *Sargassum* (see WP3). In addition to physical drivers, *Sargassum* is subject to biogeochemical drivers, in particular through variable nutrient levels. We are therefore also exploring the extent to which *Sargassum* growth is favoured in the presence of high nutrient concentrations that are associated with variable upwelling (estimated from winds), and the fresh plumes from major rivers (Amazon, Orinoco, Congo) which have been most clearly observed by satellite since late 2009. Quantities will also vary through natural growth/decay cycles. Tracking calculations may be refined to include growth in the presence of fresh (nutrient-rich) waters, and a natural mortality rate, in collaboration with CERMES.

WP2: DISTRIBUTION

WP 2 aims to co-develop a monitoring and dissemination system and a risk management strategy with stakeholders, to provide information on *Sargassum* strandings to create transformational adaptation opportunities for the poorest. It is divided into 5 work tasks, progress against each is summarised below:

WT 2.1. Detection of floating Sargassum and stranding events: Within this task **a framework has been developed in the cloud computing platform Google Earth engine to implement a number of existing**

satellite-based *Sargassum* detection algorithms (see Fig 3.4). In parallel a GIS based workflow has been developed to create a database of known floating *Sargassum* from ground photographs and high spatial resolution satellite images. Within this framework **an application has been submitted to the European Space Agency to access high spatial resolution data from Planet Scope. This has been successful**.

Figure 3.4 (A) A GIS framework to develop an in-situ database, (B) Data from Planet Scope high spatial resolution images showing beaching and floating Sargassums, (c) Output from a Coarse spatial resolution (Sentinel 2) (images taken 04/06/2018, Hellshire, St. Catherine.

Fieldwork protocols have been developed to (i) collect ground data of *Sargassum* beaching and (ii) Unmanned Aerial Vehicle (UAV) based data collection. An UAV with a Red edge sensor has been acquired for the project.

WT2.2. Early-warning system development, dissemination: Key stakeholders for the Early warning systems has been identified. **Initial meeting held with one of the key stakeholders, the National Environmental Prevention Agency (NEPA), to introduce the project and understand the current *Sargassum* monitoring capabilities in Jamaica. A questionnaire has been developed to gather user requirements regarding the Early warning system which has been submitted for ethical approval in Jamaica.**

WT2.3. Understanding the physical and social factors affecting distribution of Sargassum stranding impacts: As a key requirement of this work task a **map of historical *Sargassum* strandings has been created from a combination of field reports and high spatial resolution satellite imagery in Jamaica**. This map is used to identify sites for socio economic data collection: 4 sites has been identified and a **detailed socio-economic data collection and analysis plan has been submitted for ethical approval** in Jamaica. Draft field method protocols have been developed for collecting both social and physical data. Similarly, four study sites have been identified in Ghana based on previous beaching reports and poverty levels. Application has been submitted for ethical approval.

WP 2.4. Framework to assess resilience to future stranding: a conceptual model has been developed to capture the influence of various factors in *Sargassum* management. A system dynamics model will be used to capture these interactions and will input to the risk management strategy.

WP 2.5. Development of risk management strategy: A review of *Sargassum* management policies and hazard risk management strategies across the Caribbean region was undertaken, which resulted in a risk identification table. This has been further refined to capture impact (and benefit) to poorest-of the poor.

WP3 – TRANSFORMATION

WT3.1 Determination of Sargassum feedstock consistency in Jamaica (Deliverables 3.1.1 and 3.1.2).

Clarification of species of Sargassum in Jamaica: Analysis of *Sargassum* biomass harvested in Summer 2020 in three locations in Jamaica shows that the **most abundant morphotype was *Sargassum fluitans* III**, as it was the case in 2019.

Impact of collection and storage method on biomass composition: Biochemical composition was compared between fresh *Sargassum* samples immediately frozen with liquid nitrogen and stored in a freezer at -20 C and samples sun-dried for one day. This comparison shows that **sun-drying alters the content of different compounds**. The quantities of sugars, which are the main constituents of *Sargassum* biomass, were lower in sun-dried samples compared to frozen samples, while the content of antioxidant compounds (phenolics, phlorotannins, and pigments) increased in the former compared to the latter. This shows that **storage has an influence on the composition of the biomass**, an important result to consider for further use(s) of *Sargassum*, notably based on the quantities of sugars contained in this biological resource. As part of the strategy for management of the *Sargassum* biomass by the most vulnerable and impacted local communities, we are planning some raking and re-collection experiments to see how this could influence the biochemical composition of the feedstock.

Seasonal composition of Sargassum: Unfortunately, it has **not been possible yet to compare how the seasons may affect the biochemical composition** of the blooms since no *Sargassum* shored during the spring and the autumn 2020. Seaweed strandings are expected in spring 2021 to start a new set of feedstock assessment experiments and for working on the WT3.2 (see below).

WT3.2 Assessment of Sargassum for production of energy by biodigestion (Working towards achieving deliverable 3.2.1).

Delayed progress on biogas potential: **Experiments on assessing the biomethane potential of *Sargassum* biomass mixed with pig slurry for future use in biodigestion have been delayed by the absence of seaweed biomass** when such experiments were due to start. However, the Scientific Research Council in Jamaica has been engaged to undertake these experiments, this group has expertise in development and implementation of biodigesters at different scales that could be produced for community level applications. This may provide an alternative supply of energy, e.g. for cooking and heating water, and help releasing financial pressure on household regarding energy demand and cost.

WT3.3 Evaluation of Sargassum for soil amelioration in the context of food production and environmental applications (Deliverable 3.3.1).

Assessment of Sargassum in mangrove nurseries: Regarding the re-use of *Sargassum* for soil amelioration in the context of environmental applications, the focus is on restoration of red mangrove. Being at the seaward edge of the forest, red mangroves provide more ecosystem services than the other species. Indeed, the protecting and provisioning ecosystem services of these mangroves benefit the poor directly and indirectly (many fishers reap oysters, catch fish and make their living in the mangroves). During storms, fishers hide their boats in the mangroves for protection. In addition, there is a current project in Jamaica seeking to involve communities (especially fishers) in mangrove rehabilitation inclusive of replanting. For many this could be an alternative activity to fishing as they can be paid to assist in the mangrove nursery and to help to plant seedlings or remove solid waste that threatens the mangrove. In this context, two lines of research have been explored. The first relates to red mangrove wet nursery experiments (1) in which mangrove seedlings were grown in soil containing different percentage of *Sargassum* and waterlogged for at least 12 hours. This caused rotting of the mangrove plants and H_2S production from the seaweed. Therefore, we concluded that ***Sargassum* is not suitable for use in wet mangrove nurseries.** As such study was halted to focus on red mangrove dry nursery experiments (2) using different quantities of *Sargassum* compost mixed with sand. These experiments started in September 2020 in Jamaica and will run for another 6 months at least. **Preliminary data indicate 50% *Sargassum* compost gave best growth**, while control (0% compost-100% sand) showed poorest growth.

Sargassum mulch for agricultural use: In addition, experiments have been planned to assess the use of dried *Sargassum* mulch, fresh *Sargassum* liquid puree, and *Sargassum* compost mixed in soil for growing crops and vegetables currently considered by Jamaican local farmers: corn, tomato, and scotch bonnet peppers. This has involved collection and establishment of compost pits and purchasing materials to construct temporary greenhouses to begin the experiments as soon as the compost is available. Use of compost, mulch or liquid fertilisers based on *Sargassum* may increase yield of production of vegetables and crops. This could benefit the most vulnerable communities, in particular farmers, by increasing their own food supply, as well as providing surplus that would be sale to generate additional income. However, there are **no results from this analysis yet**.

WT3.4: Integration of interdisciplinary data to identify opportunities and barriers for the management and valorisation of Sargassum in Ghana and the Caribbean.

Assess current practices in using and managing Sargassum: **Theoretical work completed to develop a conceptual framework to assess how *Sargassum* might create transformation adaptations** has identified three main areas of impact: i) by minimising the negative impacts of *Sargassum* landings on the poorest; ii) by improving the adaptive capacity of the poorest to natural hazards; and iii) by maximising economic benefits for the poorest (see Fig. 3.5).

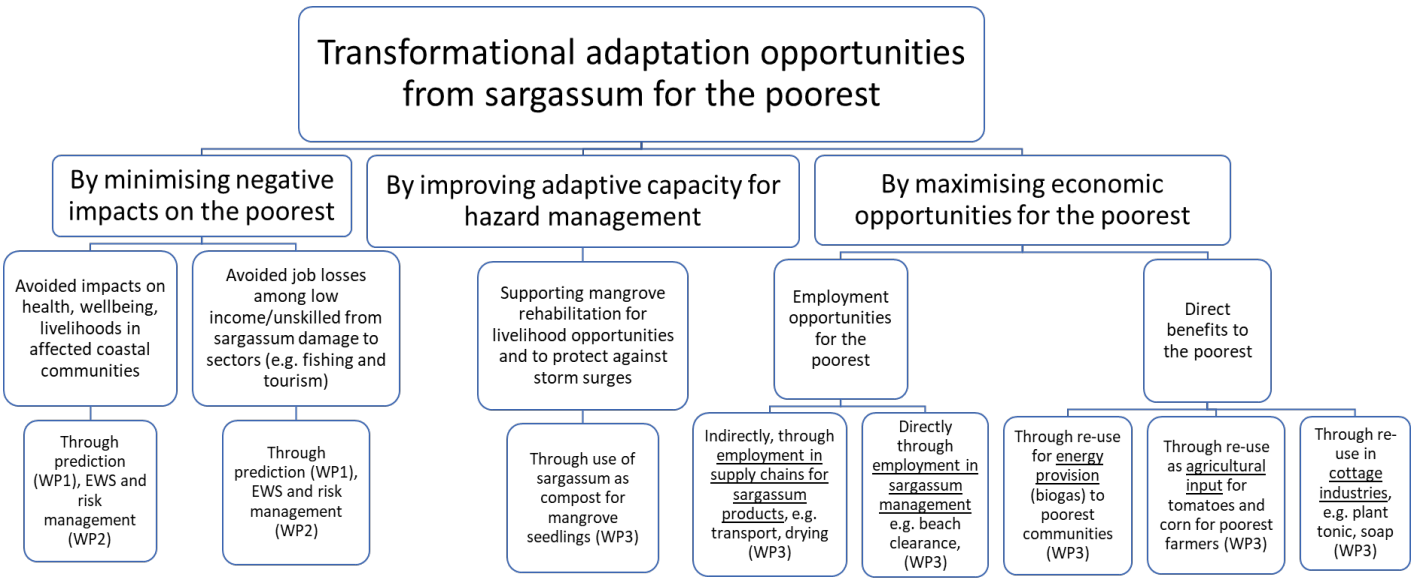

Figure 3.5: Three elements of transformational adaptation opportunities from Sargassum re-use.

This intellectual framework has shaped the design of the planned fieldwork. Questionnaires have been prepared and submitted for ethical approval. This has been granted in Ghana, and for the UK team. We are awaiting approval in Jamaica.

Assess opportunities and barriers: Focus group questions have been prepared and ethical application submitted to assess the barriers and opportunities to re-use *Sargassum* with a focus on home energy production and soil amelioration for mangrove restoration and stimulating growth of crops and vegetables. **Ethical approval has been granted in Ghana, and for the UK team.** We are awaiting approval in Jamaica.

Assess success stories of Sargassum re-use. A research methodology has been designed to identify stories of success relating to the re-use of *Sargassum* in St Lucia.

WP4: GOVERNANCE

Work Package 4 (WP4) of the SARTRAC research programme 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. By identifying the national and regional governance of *Sargassum*, and analysing the political, legal and economic implications of ongoing *Sargassum* strandings, this work package can provide critical advice on effective governance systems for *Sargassum* management, and identify barriers and opportunities within existing systems. This involves the following work tasks:

- WT4.1 Analyse national and regional policy frameworks for *Sargassum* in the tropical Atlantic basin.
- 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
- WT4.3 Political economy analysis of alternative *Sargassum* management approaches (*not yet started*)
- WT4.4 Future governance frameworks for *Sargassum* management for transformational adaptation *(not yet started)*

To date, the work of WP4 has focused on WT4.1 and WT4.2, and the progress made against each of these goals is outlined below.

To analyse policy frameworks for *Sargassum* in the tropical Atlantic basin, the team has initially focused their work on policy in the Caribbean. The work to synthesise existing policy documents has taken place as a desk-based operation, supported by meetings with members of CERMES (Centre for Resource Management & Environmental Studies, Barbados). The synthesis of *Sargassum* management policies for the Caribbean has been analysed using climate change governance literature and consideration of regional relevant environmental governance mechanisms. A draft paper on the transboundary governance of *Sargassum* in the region, including coordination and capacity issues, has been circulated within the team and has again benefitted from collaboration with CERMES. The paper will be submitted for publication in Spring 2021.

Key findings from this work will be further clarified in the coming months, but currently include:

- **Climate change governance literature, especially the framework of polycentric governance, shares similarities to the governance of *Sargassum* (transboundary in nature, rapid rate of change, and as yet hard to predict)** and we therefore propose examining the *Sargassum* management challenge through a polycentric regime lens.
- There are **numerous existing regional environmental governance structures in the Caribbean well placed to support the adaptation to the new volumes of *Sargassum* being experienced.** Yet, the inherent vulnerabilities of small island developing states still pose possible barriers that existing regional governance mechanism cannot resolve.
- **The polycentric system operational in the Caribbean to govern environmental management has generated significant cooperation in policy development and application across the region; nevertheless, the costs of coordination are also disproportionately high for small nations.**
- Moving forward in the management of *Sargassum*, **advocates of a polycentric climate regime need to consider how capacity deficits inhibit participation to the advantage of the largest and strongest.**

WT4.2 entails numerous tasks, and the primary progress to date has been pursued regarding existing legal arrangements for *Sargassum* adaptation, and the possible barriers to transformational adaptation opportunities inherent in existing governance mechanisms. This part of WT4.2 is being carried out as a desk-based activity, using policy documents, liaison with CERMES and attending the latest seminars on *Sargassum* management policy to explore the extent to which different legal systems, especially pertaining

to sovereignty and statehood, explain the effectiveness and limitations of existing *Sargassum* adaptation. Initial findings from this work will be forthcoming in Spring 2021.

4.0 CHALLENGES, RISKS AND MITIGATION MEASURES AND LESSONS LEARNT

The SARTRAC project has faced a number of issues in the delivery of the planned research relating to COVID-19; delayed official launch of the project; and election disruption in Ghana.

COVID – challenges faced. 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. Second, and in some countries, third lockdowns have since been implemented in Jamaica, Barbados and St Lucia. At the time of writing the UK is in its third national lockdown (Jan 2021-April 2021). Other partners have experienced periodic sudden surges in cases of COVID and have been subjected to other restrictions and/or complete lockdown again. COVID-19 has had five main impacts: (i) not being able to travel for fieldwork; (ii) for many on the team having to work from home and juggle child care and research roles; (iii) having to work from home and not having a good internet connection; (iv) not being able to meet as a team to create effective working relationships; (v) extremely slow, or absent university research office support in partner countries. The impact of these factors has had 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 (e.g. due to school closures, or other caring roles).
(2) Research support services: for the University of Ghana, UWI, and UOY closed completely during the first lockdown, which meant that no support was 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 was delayed and then completely cancelled. Instead the first meeting was held virtually over three days. The lack of a face to face meeting has hindered the process of cross-work package working.
(4) Delayed team building: the SARTRAC team are spread internationally across six sites in four countries (Ghana, Jamaica, UK and Barbados), three continents (the Americas, Europe and Africa), and seven disciplines (politics, geography, social science, oceanography, marine science, remote sensing, biology). The inability to travel and meet collectively has slowed the process of understanding the work of others within the team and prevented researchers from properly positioning themselves within the bigger picture of SARTRAC.
(5) Fieldwork: people affected by *Sargassum* were not prioritising *Sargassum* during the acute phase of the pandemic impacts, and in most countries (in the initial lockdown) – the beaches were closed and tourism 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 2021, 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.

(6) Website development: due to a focus on priority issues within the university of Southampton it was not possible to immediately identify a web person to develop a SARTRAC webpage. When we were finally able to identify a web person, she produced the preliminary shell of a webpage (https://generic.wordpress.soton.ac.uk/sartrac/) before she left the university through the voluntary redundancy scheme. We were unable to find someone else to take this role over, due to staff cuts

in the University of Southampton. The lack of a website hindered our ability to communicate our research.

COVID – mitigation measures. To address the issues raised by COVID we have undertaken the following mitigation measures:

(1) Budget reallocation: supported the research teams and advised that budgets could be reallocated to later on in the life of the project when activity could be speeded up (to show more expenditure later in the project).
(2) Online inception meeting. The first annual consortium meeting, due to be held in Southampton in July 2020, was held online. While not ideal, not as comprehensive, and not involving any capacity building, the meeting was successful in bringing the team together for the first time, and to start to get a sense of the relative contributions of the different groups.
(3) Quarterly whole consortium meetings online. To address the lack of whole team interaction, we started quarterly (2 hours) whole consortium meetings to discuss progress on work package outputs since the last meeting. This has helped create a sense of teamwork.
(4) Fieldwork and ethics. All fieldwork has been postponed until it is safe to proceed. In Feb 2021, we have now submitted all ethics applications within all partner universities. Aspects of the field research which required face to face engagement (e.g. to assess users' preferences for the early warning system, *Sargassum* impacts experienced, and development of the risk management strategy), will instead rely on remote surveys. Focus group work/surveys will not start until summer 2021 at the earliest.
(5) Collaboration. To encourage easy access to each others' research, consortium members were asked to engage in a brief (2-4 minute) interview with SARTRAC PI Emma Tompkins. These interviews focussed on the main research findings about *Sargassum* to date, and planned research over the next year. These can be found here: https://www.sartrac.org/publications/#podcast-and-blogs
(6) Website: we have paid an external web developer to create a more accessible webpage for us (https://www.sartrac.org/).

Elections in the UK in December 2019 – challenges faced. As a result of the UK elections, the UK government administration was placed in purdah, preventing any partners from launching the project. Partner teams in Ghana, Barbados and Jamaica urged us repeatedly from January 2020 to formally launch our project so that they could publicise it, raise awareness about it, and start the activities which relied on a formal launch – most notably stakeholder engagement. The lack of a formal launch announcement by ESRC until November 2020, has meant that the project took a long time to develop a profile in partner countries.

Elections in the UK – mitigation measures. Soft launch material (2 page flyer) produced in May 2020, http://generic.wordpress.soton.ac.uk/sartrac/wp-content/uploads/sites/380/2020/09/SARTRAC-2pp-draft-summary-pre-launch.pdf. Website was developed to improve our visibility. Team members actively engaged in networks e.g. Sarg'net to raise the profile of the project. As publications have started to be generated through the project (3 to date) we are increasingly being contacted by other researchers to enquire about our work.

Elections in Ghana in December 2020 – challenges faced. The presidential and parliamentary elections in Ghana on 7th December 2020 resulted in street protests and clashes with the police. Some of the protestors lost their lives and others got injured. The opposition is challenging the presidential results in Ghana's Supreme Court.

Elections in Ghana – mitigation measures. We are monitoring the situation to determine whether it will have an impact on the project delivery in Ghana.

We ask that the impacts of COVID and political change within are taken into account, when considering the delivery of research in this first formal SARTRAC report.

5.0 CONCLUSION

This report is the first formal report of the SARTRAC project to the ESRC. Despite significant impacts of the COVID pandemic on the establishment of the SARTRAC project, the recruitment of staff, the efficiency of staff, the administration of the grants in partner institutions, and travel and communications, much progress has been made. The mains findings from the research so far include:

- A prototype system for large-scale tracking of *Sargassum* across the Atlantic has been developed. By combining ocean, atmosphere and remotely sensed satellite data (the 'floating algae index'), SARTRAC has identified that winds and currents are the main drivers of *Sargassum* movements *(manuscript in preparation*). Multiple satellite-based *Sargassum* detection algorithms have been evaluated to identify the most suitable ones for *Sargassum* monitoring, remote sensed satellite data has been downloaded, and a framework developed to apply the algorithms.
- 'Virtual' meetings have commenced with key stakeholders to identify their needs in relation to a *Sargassum* Early Warning System in Jamaica.
- Maps of past impacted areas have been created for Jamaica to show where the most frequent and worst *Sargassum* strandings have occurred since 2018.
- Experiments that test the impacts of collection and storage on *Sargassum* chemical components are on-going. Preliminary results suggest that: different morphotypes contain different chemical properties, sun-drying alters the content of different compounds, storage has an impact on the composition of the biomass.
- Experiments to test the role of *Sargassum* in supporting mangrove seedling growth have shown that *Sargassum* is not suitable for wet mangrove nurseries, preliminary findings suggest that red mangrove dry nurseries benefit from a mix of 50% *Sargassum* compost and 50% sand.
- Theoretical frameworks to assess the nature of transformational adaptation within SARTRAC, and the governance of *Sargassum* have been developed.
- Existing regional environmental governance structures in the Caribbean are well placed to support adaptation to the new volumes of *Sargassum* being experienced. Yet, the inherent vulnerabilities of small island developing states pose possible barriers that existing regional governance mechanisms cannot resolve. The polycentric system operational in the Caribbean to govern environmental management has generated significant cooperation in policy development and application across the region; yet we find that the costs of coordination are disproportionately high for small nations.

The main outputs from SARTRAC to date include:

- Three (3) academic papers relating to: (i) DRIVERS: *Sargassum* prediction in the Tropical Atlantic (Johnson et al., 2020[6]); (ii) MONITORING: Review of remote sensing monitoring of *Sargassum* (Fidai et al., 2020[7]); and (iii) TRANSFORMATION: Analysis of biomass composition of *Sargassum* (Davis et al, 2021[8]).

[6] Johnson, D. R., Franks, J. S., **Oxenford, H. A**., & Cox, S. A. L. (2020). Pelagic Sargassum Prediction and Marine Connectivity in the Tropical Atlantic. Gulf and Caribbean Research, 31(1), GCFI20-GCFI30.

[7] **Fidai, Y. A., Dash, J., Tompkins, E., & Tonon, T**. (2020). A systematic review of floating and beach landing records of Sargassum beyond the Sargasso Sea. Environmental Research Communications, 2(12), [122001].

[8] Davis, D., Simister, R., Campbell, S., Marston, M., Bose, S., McQueen-Mason, S. J., Gomez, L., Gallimore, W., & **Tonon, T**. (2021). Biomass composition of the golden tide pelagic seaweeds *Sargassum fluitans* and *S. natans* (morphotypes I and VIII) to inform valorisation pathways. Science of The Total Environment, 762, 143134.

- SARTRAC Inception Report detailing consortium members, governance and management, monitoring and evaluation, and reporting, project structure, changes to the project since funding agreed, stakeholder engagement plan, work plan for all four Work Packages with detailed work tasks, milestones, deliverables and associated dates for delivery, and plans for creating a lasting legacy (see http://generic.wordpress.soton.ac.uk/sartrac/wp-content/uploads/sites/380/2020/10/SARTRAC_Inception_report_20_07_2020.pdf)
- 16 short podcast interviews between PI Prof Emma Tompkins and all team members highlighting their research findings up to March 2021 (https://www.sartrac.org/publications/#podcast-and-blogs)
- Website developed (https://www.sartrac.org/) and Twitter account created @SARTRAC1 (with 36 Tweets, and 40 followers)
- Two (2) externally funded grant applications to develop capacity building resources have been won by the consortium
- Three (3) external capacity building workshops run for members of the public to develop mapping and social science skills to analyse *Sargassum* (https://www.sartrac.org/news/more-than-maps-at-the-festival-of-social-sciences/)
- Two (2) internal capacity building resources developed on SARTRAC Theory of Change and Transformational Adaptation
- One (1) skills inventory of all SARTRAC team members
- Nine (9) blogs uploaded to the SARTRAC website
- One (1) whole consortium meeting, including a science meeting with external scientists and policy makers invited (Annual Consortium Meeting 1), see https://www.sartrac.org/news/first-annual-consortium-meeting/

While stakeholder engagement is at the heart of SARTRAC, COVID-19 related travel restrictions have meant that stakeholder engagement has only been possible 'virtually'. This has worked successfully with those stakeholders with functioning and accessible internet connectivity. As a result, the majority of stakeholders engaged so far have been: national government departments i.e. the governments of Jamaica and Ghana; large multi-national organisations such as the United Nations Environment Programme; and other *Sargassum* researchers. Engagement with target communities has not yet been possible, although contact has been made with leaders of one community in Ghana. Ideally, data collection will involve face-to-face interactions; however if domestic travel in partner countries remains impossible, alternative plans are in place to collect data from communities using app-based instruments that can be accessed via mobile phones.

Capacity building has occurred within the SARTRAC project, however, as with all aspects of the research, delivery has changed significantly due to COVID-19. For example, we were unable to host the first annual consortium meeting (ACM) in-person in the UK, hence we could not arrange 'wrap-around' capacity building or training. Instead this first whole consortium meeting was held 'virtually' over three days in July 2020. To address the lack of capacity building at the ACM, we created internal SARTRAC capacity building champions (Prof Kwasi Appeaning Addo and Dr Ava Maxam). Together Kwasi and Ava have undertaken a skills-audit within SARTRAC: mapping the skills needed within the consortium; identifying skills present within the consortium; and identifying who could provide training. To date online training for the consortium has been provided in relation to 'Transformational adaptation' and the 'SARTRAC Theory of Change'. Training is planned for April 2021 on qualitative data sampling, collection, coding and analysis. To facilitate easy access to the findings within each work package, project PI Emma Tompkins interviewed every member of the SARTRAC team in Feb/March 2021. The short podcasts can be found on the SARTRAC website (https://www.sartrac.org/). Capacity building was expected to be supported through the use of the Flexible Innovation Fund, however due to lockdowns hindering travel for sabbaticals and limiting fieldwork,

only one project has so far been submitted to the Flexible Innovation Fund, by the University of Ghana. This is awaiting a final review and we anticipate it should be funded shortly.

Overall, despite extraordinarily difficult conditions in which to set up a new research collaboration (with significant constraints on researcher time, travel and university support) across three continents with six partners, the SARTRAC project has undertaken a solid amount of work, and is starting to be acknowledged as an important producer of knowledge in the field of *Sargassum* management.