QUARTERLY PROGRESS REPORT
[Year 1: July1, 2021 to December 31, 2021 (year 1 extended to March 31, 2022)]
[Year 2: July 1, 2022 to June 30, 2022 (year 2 extended to March 31, 2023]

PROJECT TITLE: FEASIBILITY STUDY OF A FULL SCALE SEAWEED COMPOST SYSTEM (Year 2)

PRINCIPAL INVESTIGATOR: Dr. Helena Solo-Gabriele
AFFILIATION: University of Miami, Dept. of Chemical, Environmental, and Materials Engineering
CONTACT INFORMATION: hmsolo@miami.edu, 305-284-3467

CO-PRINCIPAL INVESTIGATOR: Dr. Peter Swart
AFFILIATION: University of Miami, Dept. of Marine Geosciences - Rosenstiel School of Marine and Atmospheric Science
CONTACT INFORMATION: pswart@rsmas.miami.edu, 305-421-4103

CO-PRINCIPAL INVESTIGATOR: Dr. Amanda Oehlert
AFFILIATION: University of Miami, Dept. of Marine Geosciences - Rosenstiel School of Marine and Atmospheric Science
CONTACT INFORMATION: aoehlert@rsmas.miami.edu, 305-421-4405

CO-PRINCIPAL INVESTIGATOR: Dr. Trent Blare
AFFILIATION: University of Florida, Food and Resource Economics Department
CONTACT INFORMATION: tblare@ufl.edu, 786-217-9248

LEAD GRADUATE STUDENT: Afeefa Abdool-Ghany
AFFILIATION: University of Miami, Dept. of Chemical, Environmental, and Materials Engineering
CONTACT INFORMATION: aaa625@miami.edu, 954-298-4073

PROJECT WEB-SITE: https://hmsolo.miami.edu/?page_id=722

Work accomplished during this reporting period:

- Phase I of the year 2 project is almost complete, which includes conducting interviews with individuals that manage the maintenance of beaches.
- Interviews were conducted with individuals from 3 cities, 1 county, and 1 private enterprise.
- Items have been organized for Phase II of the study.
- An enterprise budget was put together for the operation of a Sargassum compost pile. Numbers collected from the interview process and a literature review were used to compile the budget.
    - A document is currently being drafted for a UF/IFAS EDIS publication, which is a publication written for policy makers and the public that summarizes the information from the enterprise budget.
- All samples from our Year 1 funding were processed for nutrients. Samples from Phase 2 of the year 1 funding were washed, freeze, dried, and homogenized for the metals analysis.
- Items for the multiple tube fermentation (to be conducted on the year 2 samples) were collected and a practice round is scheduled to be completed before samples from the Fort Lauderdale pile is collected.

TAG Meetings:

- Year 1: The first TAG meeting was held on December 15, 2020.
- Year 1 and 2: The second TAG meeting for Year 1 and the first TAG meeting for Year 2 was held on July 14, 2021.

- Year 1 and 2: The third TAG meeting for Year 1 and second TAG meeting for Year 2 was held on March 17, 2022.

Metrics:

1. Research publications from THIS Hinkley Center Project.

JOURNAL ARTICLES

- In Progress

ABSTRACTS

- 2021 FSBPA Annual Conference Abstract
    - **Title:** Sargassum Invasion: Composting as a Solution
    - **Description of material**

Sargassum spp. is one of the dominant forms of marine macroalgae (seaweed) found on beaches throughout Florida. Excess *Sargassum* is washing up on the shores of Florida beaches and originates from the Sargasso Sea in the Northern Atlantic Ocean near Bermuda. Recently there have been large quantities of *Sargassum* reported in the central Atlantic Ocean and the Caribbean Sea. During the summer of 2018 and 2019, record amounts of *Sargassum* spp. were documented along beach coastlines resulting in local authorities hauling this seaweed to the nearest landfill. Hauling and landfill disposal of seaweed can cost the cities and municipalities hundreds of thousands of dollars per year.

The influx of *Sargassum* onto the shores is important to maintain the ecological balance. The difficulty has been when the amounts of seaweed stranding onshore are excessive. When excessive, the local ecology suffers and the aesthetics of the beach decline. In extreme conditions, the seaweed is so thick on the water surface that turtles are unable to surface for air, thus drowning in embayments where the Sargassum accumulates. When excessive amounts of *Sargassum* are found on the sand, it also contributes to a decline in the aesthetic quality of Florida beaches and ultimately impacts on the tourism industry. When left on the shore to decompose, the *Sargassum* will release unpleasant odors (hydrogen sulfide) into the environment. It also attracts insects, e.g. sand flies, as it decomposes. Bacteria levels in the seaweed also tend to increase. When the decomposing *Sargassum* is washed back to the water it results in the issuance of beach swim advisories due to elevated bacteria levels further impacting the economy of the area by limiting access to safe recreational waters along the coast. Thus, coastal communities are looking for alternative ways to handle the material once removed from the beach.

Alternative methods are needed for handling excessive amounts of Sargassum that are found on Florida's coastlines. In order to combat this problem, local government agencies are exploring how to remove the seaweed and are looking for beneficial uses. Composting offers one potential and beneficial alternative. Instead of leaving the seaweed to decompose on shore, or hauling it off to landfills via trucks, Sargassum can be potentially composted. Compost consists of decomposed organic matter. This natural process of recycling organic matter can be used to produce a rich soil amendment. Compost maintains moisture more effectively and provides a rich environment for plants to grow. Seaweed is rich in nutrients that are absorbed from the sea and from the energy from the sun, making it a potentially rich soil amendment. In addition to its use as a soil amendment, it should be ensured that the composting of seaweed is within the standards of heavy metals and bacteria levels so that the constituents are within satisfactory health-based levels. The objective of this project is to evaluate the suitability of producing compost from seaweed in tumbler composters.

Four experiments were conducted to evaluate the need for pre-washing and suitable mixes. The recipes included: no washing of *Sargassum*, washing *Sargassum* with freshwater, grass clippings mixed with *Sargassum*, and mulch mixed with *Sargassum*. These recipes were sampled biweekly and measured for bulk physical-chemical parameters, nutrients, metals, and bacteria. Once the compost was cured, radish bioassays were setup to evaluate the plant growth in each of the recipes. Results indicate that electrical conductivity (saltiness) is not an issue when composting the seaweed (values are well below

the U.S Composting Council standards). Preliminary carbon to nitrogen results show that the compost can be used to grow plants. Results from the radish bioassays indicate that the compost is able to support growth of plants.

- Goldschmidt 2022
  - **Title**: Is composting a feasible disposal option for beach-stranded Sargassum in South Florida?
  - **Abstract**: Over the last decade there has been increased proliferation of Sargassum in the north Atlantic Ocean, with massive strandings occurring on near annual frequency in the Caribbean, western Africa, and United States since 2011. Such events have environmental, health, and economic impacts, because Sargassum is known to have a high capacity to absorb metals from the environment [1]. A common disposal method is mechanical collection of the stranded Sargassum and subsequent landfill disposal. Thus, leachates of degrading Sargassum can contribute to contamination in soils and groundwater near landfills. Compost can be a potential solution and can present a sustainable management method if concentrations of potentially toxic metals are below EPA guidelines. The objective of this project is to determine whether composting is a feasible management solution for Sargassum strandings. We assessed compositional characteristics of the compost [nutrient ratios (C:N, P), elemental concentrations, abundance of indicator bacteria] in both small-scale and large-scale settings. The first phase (small-scale) of study involved experiments using tumbler composters, which independently evaluated the impacts of washing the Sargassum prior to composting, as well as the impact of mixing with other vegetative wastes (grass, mulch, etc). The second phase (large-scale) involved two 4 yd3 compost piles with different additives (a control pile and vegetative waste) in a municipal setting. In the first phase, the mixture of Sargassum and grass clippings produced compost with the best C:N ratios and lowest concentrations of toxic metals. Bacteria levels did exceed EPA regulatory limits in this treatment. Preliminary radish bioassay experiments also suggested best growth in the compost treatment mixed with grass clippings. Unwashed Sargassum produced compost with moderate C:N but the highest concentrations of toxic metals. Within the larger scale experiments conducted in the second phase, the Sargassum treatment produced the best C:N ratios and lowest bacteria levels compared to the Sargassum and vegetive waste treatment.

[1] Rodríguez-Martínez, R. E., et al., (2020). PeerJ, 8, e8667.

2. Research presentations resulting from THIS Hinkley Center Project. The interim results from this study have been presented during the following meetings:

- "Sources of Enterococci to a Coastal Beach Experiencing Elevated Background Levels" Webinar organized by SOP Technologies, Miami FL. July 2020. (Speaker presentation by H. Solo-Gabriele and A. Abdool-Ghany). [This webinar was attended by over 70 individuals.]
- "Sources of Enterococci to a Coastal Beach Experiencing Elevated Background Levels" Webinar organized by the City of Hallandale Beach, Hallandale Beach, FL. August 2020. (Speaker presentation by A. Abdool-Ghany).
- "Sargassum Seaweed Management in the State of Florida" Webinar organized by Recycle Florida Today. March 18, 2021. (Speaker presentation by A. Abdool-Ghany and H. Solo-Gabriele).

- "Sargassum Composting- A Solution" Presentation organized by Ana Zangroniz of Florida Sea Grant for Miami Dade County Parks and Recreation. June 24th, 2021. (Speaker presentation by A. Abdool-Ghany and H. Solo-Gabriele).
- "Sargassum Composting" Annual Conference organized by Recycle Florida Today. September 8th, 2021. (Speaker presentation by A. Abdool-Ghany).
- "Sargassum Invasion: Composting as a solution" Annual conference organized by Florida Shore and Beach Preservation Association. September 17th, 2021. (Speaker presentation by A. Abdool-Ghany).
- " Is composting a feasible disposal option for beach-stranded Sargassum in South Florida?" Annual Goldschmidt conference. July 10-15, 2022. (Speaker presentation by A. Abdool-Ghany).

3. List who has referenced or cited your publications from this project. Pending

4. How have the research results from THIS Hinkley Center project been leveraged to secure additional research funding?
    - We submitted a pre-proposal to EREF but it was not awarded.
    - We have also submitted a proposal to Commissioner Raquel Regalado of Miami-Dade County. It was intended to evaluate a composting operation located in Crandon Beach. The objective of the proposal was to evaluate the suitability of producing compost from seaweed on a large scale.
    - Additional proposals are pending.

5. What new collaborations were initiated based on THIS Hinkley Center project?
    - Upon initiation of this project, we have been in contact with the City of Fort Lauderdale. Mark Almy and his team have been gracious enough to show us their composting operations.
    - One of our TAG members (Chip Jones) has allowed us to tour his facilities and see the machines that are used in operation. We met with him and took a tour of his operations on December 11, 2020.
    - Another TAG member (Mark Richards) offered for us to tour Crandon Beach to get an idea of the influx of seaweed that plagues the unique area. We toured Crandon Beach with Mark Richards on December 29, 2020.
    - We are in contact with Dr. Kimberly Moore, from the University of Florida, IFAS. She has provided guidance on the quality of compost and helped to design the radish bioassay experiments. We are working with her to establish a set of standards that can exclusively be used for sargassum compost.
    - Afeefa works in Dr. Amanda Oehlert's lab to analyze the metals and phosphorous found in the tumbler composters as well as the compost piles.
    - Dr. Peter Swart invited us to be a part of the proposals submitted to Commissioner Regalado. We also analyze for nutrients in his lab.
    - Through Dr. Blare, we have collaborated with individuals in the agricultural community who are helping to set up interviews with growers that work with Sargassum compost.
    - Recycle Florida Today and the Organic Compost Council have been big supporters of our research by promoting our work through meetings they organize.
    - We have met with the CEO/founder of Sustainscape Inc, Dennis de Zeeuw. His company produces fertilizer from Sargassum. He has two products that he uses throughout his jobs in Broward County. Dr. Blare and Afeefa met with him on September 20, 2021.
    - The CEO/founder of Algas Organics, Johanan Dujon, reached out to us to hear more about our research. We will also hear more about the operation he is running and how he deals with Sargassum. We plan on meeting him on September 22, 2021.

- Ana Zangroniz who is a Florida Sea Grant Extension Agent at the UF/IFAS Extension Miami-Dade County, reached out to us requesting that we present our research to Miami-Dade County. From this presentation we also were in contact with Tom Morgan, who is the Chief of Operations for Miami-Dade County Parks, Recreation and Open Spaces Dept.
- Rebecca Wakefield who is the Chief of Staff in the office of Commissioner Raquel Regalado, reached out to us to find out more about our research. She has indicated an interest in developing a coalition to address the seaweed disposal issue.

6. How have the results from THIS Hinkley Center funded project been used by the FDEP or other stakeholders?
    - Members of the FDEP have participated in our TAG meetings and in meetings organized by our collaborators. They include Karen Moore, Lauren O'Connor, and Chris Perry. The FDEP has provided us with guidance in the process for obtaining permits for on-beach composting projects. They have also provided us with guidance in terms of applicable regulations. Currently they are considering classifying sargassum compost as yard trash. The regulations for yard trash do not include arsenic and as a result seaweed compost would pass FDEP regulatory thresholds. The FDEP is interested in our work because it will help guide the agency in terms of classifying Sargassum compost. They appear to want to encourage recycling and have been keeping up with our work on this project.
    - Representatives from the FDEP indicated during our TAG meeting on March 17, 2022 that they plan to develop regulatory guidelines specific for Sargassum compost. A key component of their decision making will be the results reported from the Hinkley Seaweed projects.

Appendix: TAG Member List

Sargassum Composting
TAG Member List
Version dated: July 14, 2021

RESEARCH TEAM MEMBERS

Name	Affiliation and Address	Phone Number	Email
Helena Solo-Gabriele	Professor, Principal Investigator University of Miami, 1251 Memorial Drive McArthur Building Room 252, Coral Gables, FL 33146	305-284-3467 (office) 305-989-9103 (cell)	hmsolo@miami.edu
Peter Swart	Professor, Co-Principal investigator University of Miami		pswart@rsmas.miami.edu
Amanda Oehlert	Assistant Professor, Co-Principal investigator University of Miami		aoehlert@rsmas.miami.edu
Trent Blare	Assistant Professor, Co-Principal investigator University of Florida		tblare@ufl.edu
Afeefa Abdool-Ghany	Lead Graduate Student University of Miami		aaa625@miami.edu

HINKLEY CENTER

Name	Affiliation and Address
John Schert	Director University of Florida, Gainesville, FL
Ana Pak	Media Specialist University of Florida, Gainesville, FL

Name	Affiliation	Email
Kimberly Moore	Professor in Environmental Horticulture, Distinguished Teaching Scholar University of Florida, IFAS|Fort Lauderdale Research and Education Center	klock@ufl.edu
Ligia Collado-Vides	Senior Lecturer; Associate Chair Department of Biological Sciences, Florida International University	colladol@fiu.edu
Dan Meeroff	Professor and Associate Chair Department of Civil, Environmental & Geomatics Engineering, Florida Atlantic University	dmeeroff@fau.edu
Ana Zangroniz	Florida Sea Grant Extension Agent UF/IFAS Extension Miami-Dade County	azangroniz@ufl.edu
Shelly Krueger	Florida Sea Grant Agent II University of Florida IFAS Extension, Monroe County	shellykrueger@ufl.edu
Randall Penn	UF IFAS Extension Agent - Sarasota County	rpenn@ufl.edu
Armando Ubeda	UF/IFAS Extension Sarasota County	aubeda@scgov.net
Michelle Mularz	Extension Services-Environmental Horticulture Agent	mularz-michelle@monroecounty-fl.gov
Vincent Encomio	Sea Grant- Martin and St. Lucie Counties Extension Agent	vencomio@ufl.edu
Ashley Smyth	Assistant Professor, Biogeochemistry Tropical Research and Education Center	ashley.smyth@ufl.edu
Emilio Lopez	CEO of SOP Technologies	emilio@soptechint.com
Alejandro Quintás	NEAT Sand	aquintas@neatsand.com
Chip Jones	President of Beach Raker	Chip@floridabeachraker.com
David Hill	Co-Chair Organics Recycling Committee Recycle Florida Today	hilldm@gmail.com

Name	Affiliation and Address	Email
Nandra Weeks	GeoSyntec Consultants	NWeeks@Geosyntec.com
Alyssa Jones-Wood	Green Initiatives Coordinator for the City of Hallandale Beach	ajoneswood@hallandalebeachfl.gov
Cathie Schanz	Director of Park, Recreation, and Open Spaces	cschanz@hallandalebeachfl.gov
Mary Beth Morrison	Director of Environmental Programs, Solid Waste Authority of Palm Beach County	mmorrison@swa.org
Enrique Sanchez	Deputy Director, Parks and Recreation of the City of Fort Lauderdale	ESanchez@fortlauderdale.gov
Mark Almy	Park Operations Superintendent Parks and Rec. Admin.	marka@fortlauderdale.gov
Roland Samimy	Chief Resilience and Sustainability Officer	rsamimy@keybiscayne.fl.gov
Tom Morgan	Chief of Operations, Miami Dade Parks and Rec	tom.morgan@miamidade.gov
Paul Vitro	Division Chief at Miami-Dade County Parks, Recreation and Open Spaces Department	paul.vitro@miamidade.gov
Mark Richard	Senior Region Manager, Miami Dade County Parks and Rec	mark.richard@miamidade.gov
Heather Tedlow	Interpretive Nature Coordinator, Miami Dade Parks and Rec	heather.tedlow@miamidade.gov
Samir Elmir	Director of Environmental Health & Engineering Service Florida Department of Health in Miami-Dade County	Samir.Elmir@flhealth.gov
Karen Moore	Environmental Administrator-FDEP Division of Waste Management	Karen.s.moore@floridadep.gov
Lauren O'Connor	Government Operations Consultant-FDEP Division of Waste Management	Lauren.OConnor@floridadep.gov
Chris Perry	FDEP Division of Waste Management	Christopher.Perry@floridadep.gov

Appendix B: Latest TAG Meeting Attendance and Minutes/Agenda

Minutes of the Technical Awareness Group Meeting (3rd meeting)
For the Seaweed Composting Research
Supported by the Hinkley Center for Solid and Hazardous Waste Management

Meeting held, March 17, 2022, 10:30 to 12:00 pm (eastern)
Meeting Participation was through Virtual Connection
Registration was required to attend this meeting via Zoom

Attendees:

Speakers:
Afeefa Abdool-Ghany, University of Miami
Amanda Oehlert, University of Miami-RSMAS
Helena Solo-Gabriele, University of Miami
Peter Swart, University of Miami-RSMAS
Trent Blare, University of Florida-IFAS-Homestead

Attendees via computer webinar:
Abby Crombie, Georgia Institute of Technology
Alejandro Quintas, NEAT Sand
Ashley Smyth, University of Florida, Tropical Research and Education Center in Homestead
Danielle Jimenez, Division of Environmental Resource Management (DERM)
Dan Meeroff, Florida Atlantic University
Emilio Lopez, SOP Technologies
Evan Blanchard, Brizaga
Jeffrey A Davis, Georgia Institute of Technology
John Schert, Hinkley Center for Solid and Hazardous Waste Management
Kimberly Moore, University of Florida, IFAS-Fort Lauderdale
Lauren O'Connor, Florida Department of Environmental Protection
Ligia Collado-Vides, Florida International University
Mark Almy, City of Fort Lauderdale
Mark Richard, Miami-Dade County Parks
Mary Beth Morrison, Solid Waste Authority of Palm Beach County
Michael Antinelli, Brizaga
Rebecca Wakefield, Commissioner Regalado's Office in Miami Dade County
Samir Elmir, Florida Department of Health in Miami-Dade County

Agenda
TAG Meeting, Sargassum Composting

Date: March 17, 2022
Time: 10:30 am to 12:00 am (Eastern)
Location: Virtual

1. Welcome and introductions PPT Video

2. Year 1 Updates
    - Tumbler Composters, Phase I PPT Video
    - Hallandale Compost piles, Phase II PPT Video

3. Year 2 Updates PPT Video
    - Objectives
    - Economic Analysis
    - Approach for Phase II

4. Next Steps PPT Video

5. Additional questions and answers, wrap up

6. Adjourn

Questions: hmsolo@miami.edu

Minutes

Questions, Answers, and Comments #1 (After item 2 on agenda, Year 1 Update)

1. Q:Were the nitrogen levels reached for both phases of the project?
   A: Under the guidelines outlined by the USCC, the total nitrogen percentage is about 0.5% to 2.5%.Within the first phase of the project, the final samples all were within the range outlined. For phase II, the final samples were also within the range outlined. Overall, the C:N ratios were not within the range outlined by the USCC, which is less than 20. The samples from phase I were a little light on the nitrogen side.
2. Q: Are radishes used for cleanup methods of heavy metals?
   A: Radishes may be used as a cleanup technology because it does have the ability to bioaccumulate. The radishes grown in this project will be harvested and tested for trace metals to assess the metal content and levels. There is potential for there to be a study for the agricultural use of *Sargassum* compost as it is not your typical compost material. Perhaps the *Sargassum* compost can be recommended for plants that are not known to bioaccumulate heavy metals.
3. Q: Is the *Sargassum* a source of bacteria to the beach or is it a source of food for the bacteria and how does the bacteria levels change? How important is the locality of where the *Sargassum* is collected and the bacteria levels?
   A: The main conclusion that we have come to with this study and other studies dealing with bacteria levels at the beach is that when there are large influxes of *Sargassum* to the beach it acts as a substrate for the proliferation of bacteria. As the fresh *Sargassum* makes its way on to the shore, it has relatively low levels of bacteria. When the *Sargassum* starts to decompose, the bacteria levels begin to increase. The large mats of *Sargassum* act as an insulation and the temperatures within the *Sargassum* reach temperatures that are equivalent to the incubation temperature of enterococci. In terms of locality of the *Sargassum*. The *Sargassum* for phase I was collected from the City of Fort Lauderdale and was decomposing while the *Sargassum* for phase II was collected from Hallandale and was fresh. Within the closed tumbler composter systems, the bacteria levels were higher than the outdoor compost piles. This can be attributed to the piles being open to the atmosphere and solar inactivation of the bacteria can occur in the piles.
4. Q: How broadly can this research be applied? If someone wants to use the *Sargassum* in a similar fashion, what guidelines must they follow and what additional testing should they be aware of?
   A: The concentrations of elements will vary from region to region. *Sargassum* also changes with seasons as well. The arsenic levels from this study were lower than other studies and can vary even within Florida. Levels of arsenic can vary even within a batch. For example, samples in April 2020 were as high as 75 ppm and then decreased to 40 ppm later that year.
5. Q: Are we looking at commercial or residential use once this material is composted?
   A: It all depends on who is the target end user. From the results collected from the outside laboratory, the levels of arsenic are within what is outlined by FDEP for the Soil

Cleanup Target Levels for commercial/industrial use. Now for an agricultural use, there are different guidelines that need to be followed.

6. Q: How was the seaweed washed during the first phase?
   A: The *Sargassum* was collected from the City of Fort Lauderdale. Once collected, it was brought back to the University of Miami, RSMAS campus. A 5-gallon bucket was filled and timed to estimate the amount of water used for washing. Sargassum was then placed on a tarp and sprayed down with a house and shaken to remove as much of the sediment as possible.
7. Q: After a long period of time the arsenic levels start to increase, if this was to be used in a residential area, how would we track the levels?
   A: Soil cores can be taken in the area and see how arsenic profiles change with depth.

Questions, Answers, and Comments #2 (After item 3 on agenda, Year 2 Update)

1. Q: What are beach cleaning companies doing to clean the beach and how would this work impact their methods?
   A: Some companies in South Florida do implement composting of *Sargassum* once collected from the beach, but it is not done with all *Sargassum* collected. It is only done in batches. Most of the *Sargassum* does make its way into landfills.
2. Comment: There should be a health risk analysis conducted on the end product, especially if it will be used on a residential setting and parks. An assessment would be useful to see the arsenic levels in the compost and how it affects health.

Questions, Answers, and Comments #2 (After item 4 on agenda, Next Steps)

1. Q: Does the City of Fort Lauderdale collect vegetation and add it to their compost pile?
   A: From what we observed when visiting their pile, it was only *Sargassum* that was collected from the beach that was added to their pile.
2. Comment: One challenge that composting facilities face is acquiring a piece of property to build such a facility. Zoning requirements are usually the challenge because people don't want things of this nature in their backyards.