Assessing Sustainable Waste Management at The Island School

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Introduction

Municipal solid waste (MSW) is best described as discarded household materials such as recyclables, food waste, and human waste. This waste is typically thrown out and sent to landfills once discarded. Landfills are harmful to the environment due to the contaminants that are released into the soil, air, and groundwater, as well as the organic material (biomass) that releases methane into the atmosphere. However, the Biogas team has challenged The Island School community to think about their waste and its impact on the environment and human health. Waste is a valuable resource and can be reused, recycled, composted, or converted. The waste hierarchy (Fig. 1) shows some of the ways that waste can be managed sustainably.

Figure 1: The solid waste hierarchy depicts methods of waste management and the most to least preferred practices

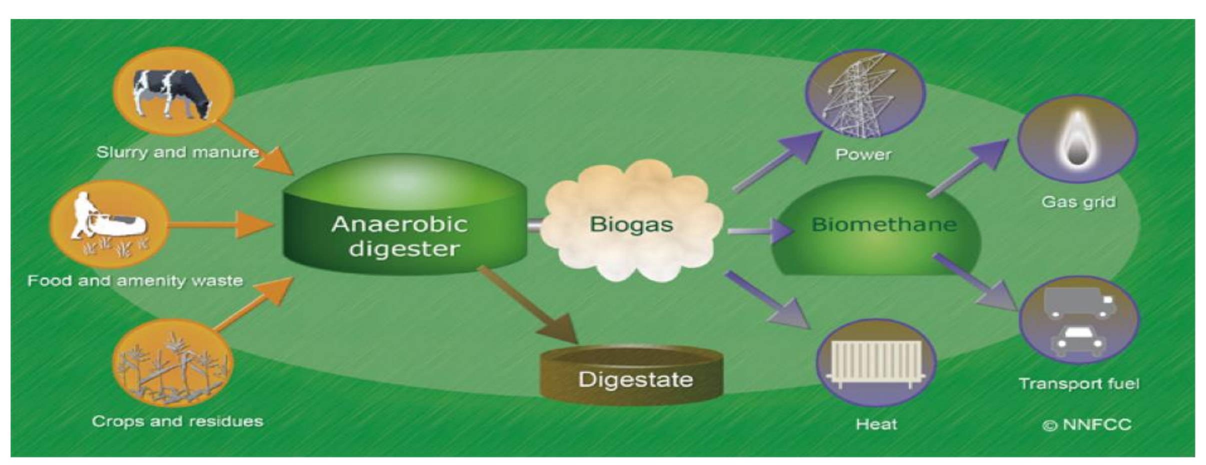

Figure 2: A schematic overview of anaerobic digestion

Anaerobic digestion (AD)is a series of natural biological processes that use a diverse population of bacteria to break down biomass (recently living matter such as food waste and human waste) into biogas in the absence of oxygen. Biogas is made up of methane, carbon dioxide, and hydrogen sulfide, and can be used interchangeably with propane. In addition to biogas, other effluents in the process of AD include the nutrient rich digestate, which can be used as fertilizer, and water, which can be used for irrigation. The class has looked into AD as a conversion technology to keep organic waste out of landfills as a conversion technology to keep organic waste out of landfills as well as ensuring waste is given a second life as bioenergy. AD is part of the objective of sustainably managing waste while eliminating WVO from the boneyard. There are many benefits to AD: it is cost effective, environmentally friendly, and reduces the amount of organic waste entering a landfill.

Figure 3: An aerial of the Boneyard, the on campus dump. Outlined within the blue circles are the containers of WVO.

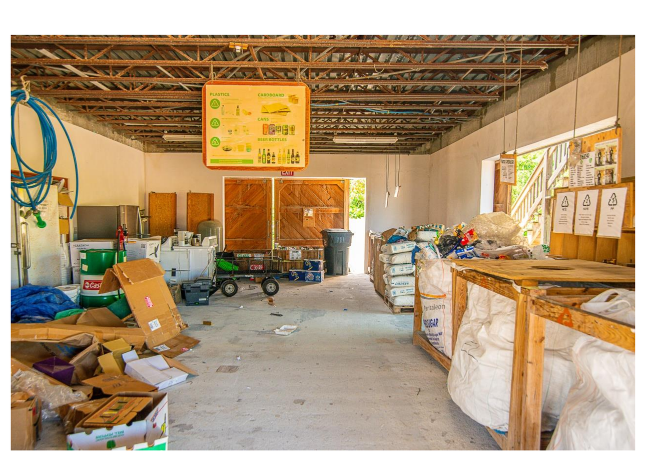

Figure 4: Bay 1 (Tingum Center), the all-campus recycling center where waste is sorted.

Research Problems
- Surplus of waste vegetable oil (WVO) in the Boneyard (Fig. 3)
- Lack of awareness and education regarding waste management on campus

Research Objectives
- Restart anaerobic digester for consolidation of WVO
- Educate the greater community and bring awareness to waste management.

Methods

Anaerobic Digestion

The research team transported 1,000 gallons of WVO from the boneyard into the anaerobic digester. The initial WVO is tested for pH, free fatty acid content (FFA), and total dissolved solids (TDS) prior to the influent. After primary digestion, the WVO sits for 42-45 days which is the hydraulic retention time. The oil is then tested for pH, volatile acids/alkalinity, TDS, temperature, and conductivity in the effluent. These tests were vital to assessing the health and functionality of the anaerobic digester.

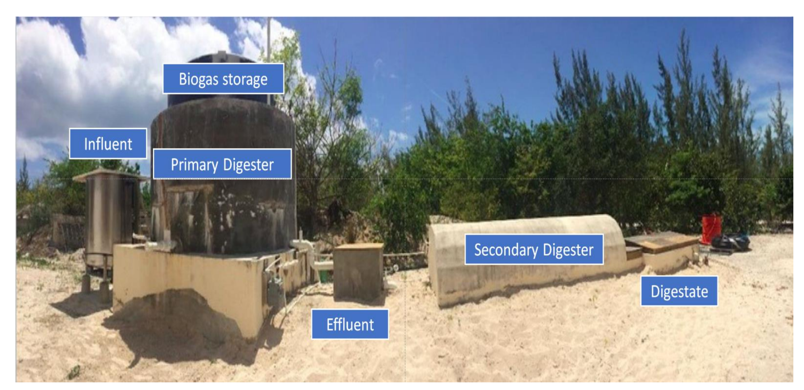

Figure 5: Anaerobic digester at Center for Sustainable Development

Waste Audit

The waste audit was performed to determine the percentage of waste in Bay 1 that was improperly sorted, as well as figuring out campus waste habits. All of the waste in Bay 1 was categorized by type, weighed, and measured. It was sorted thoroughly in order to determine the types of waste that are produced most frequently.

Figure 6: Biogas team conducting waste audit in Bay 1

Waste Knowledge Survey

The waste survey was sent out to the entire CEIS community as a way to get a better understanding of how informed the community is on solid waste management. The survey was sent out to The Island School Community electronically through Google Forms. The survey provided insight into issues that need to be addressed when creating teaching models (Fig. 11 & 12).

Figure 7: Site assessment at Hatchet Bay Landfill

Results

Anaerobic Digestion

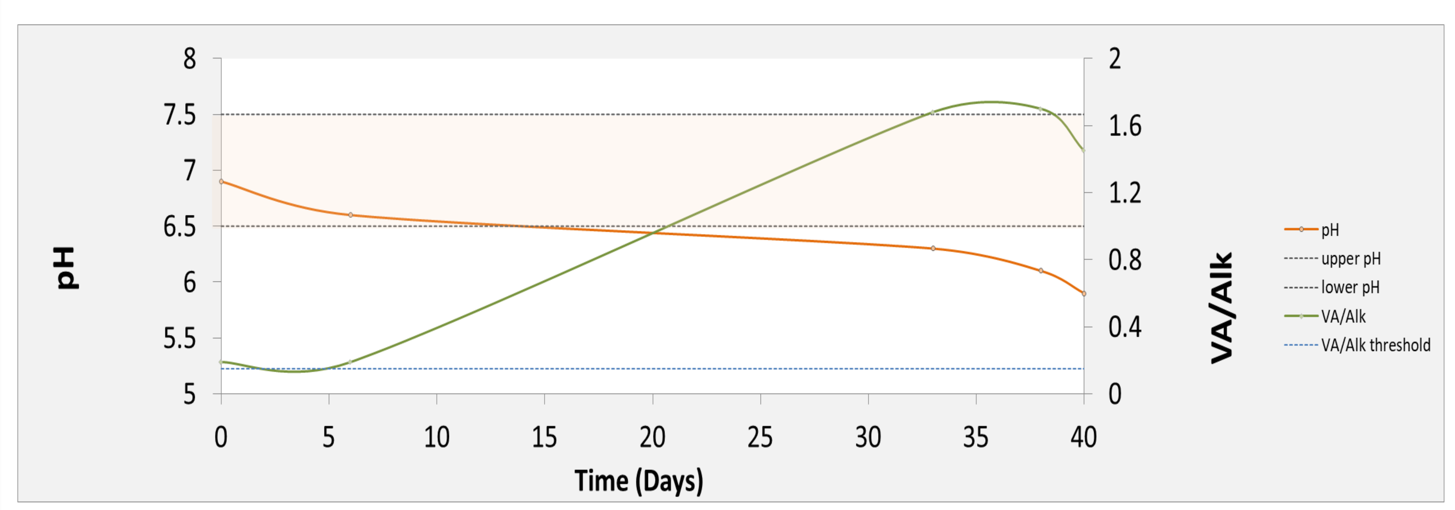

Figure 8: A comparison of alkalinity and pH collected from the CSD anaerobic digester over the span of 40 days. The ideal pH ranges are indicated on the graph (6.5 – 7.5).

Figure 9: Oil samples taken from three different stages of AD. (Left) the influent, (middle) the effluent from primary digestion, and (right) the effluent from secondary digestion.

Waste Audit

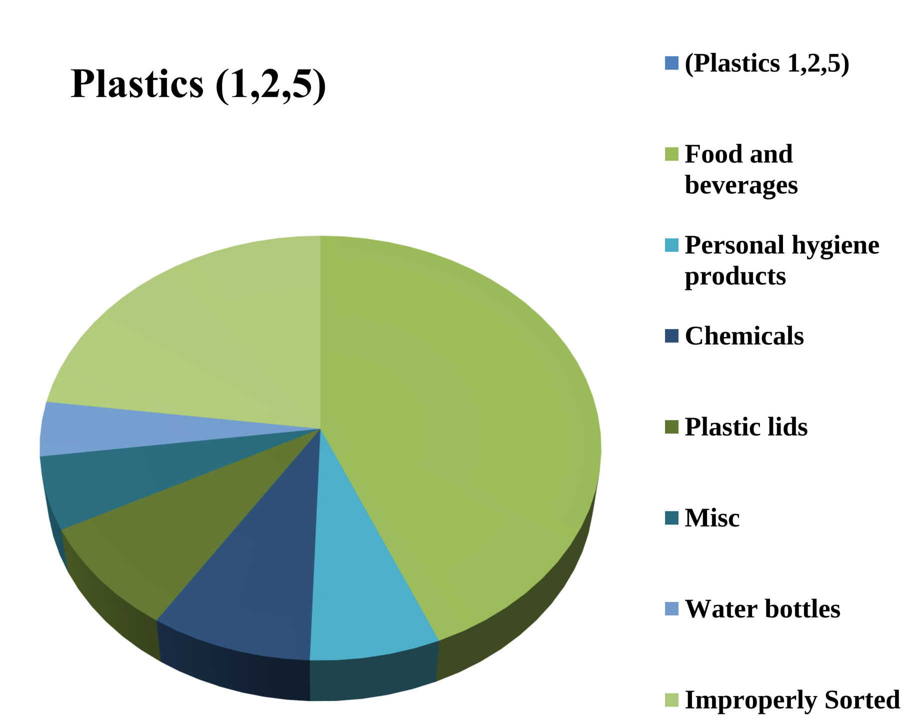

Figure 10: The results from the sorting of plastics #1, #2, #5 shows that food and beverage containers are used in abundance and need to be targeted when addressing solid waste management.

Waste Knowledge Survey

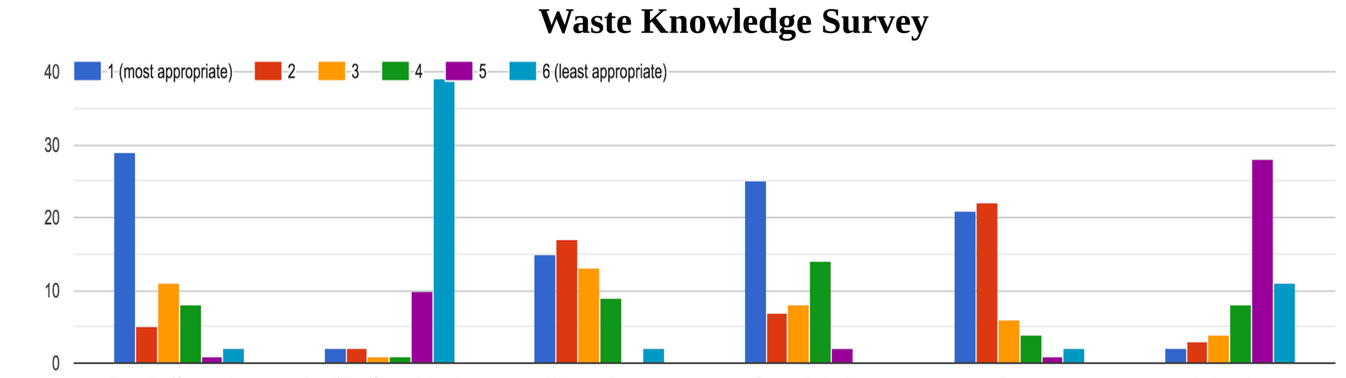

Figure 11: CEIS community's awareness of the waste management hierarchy based on responses from the Waste Knowledge survey.

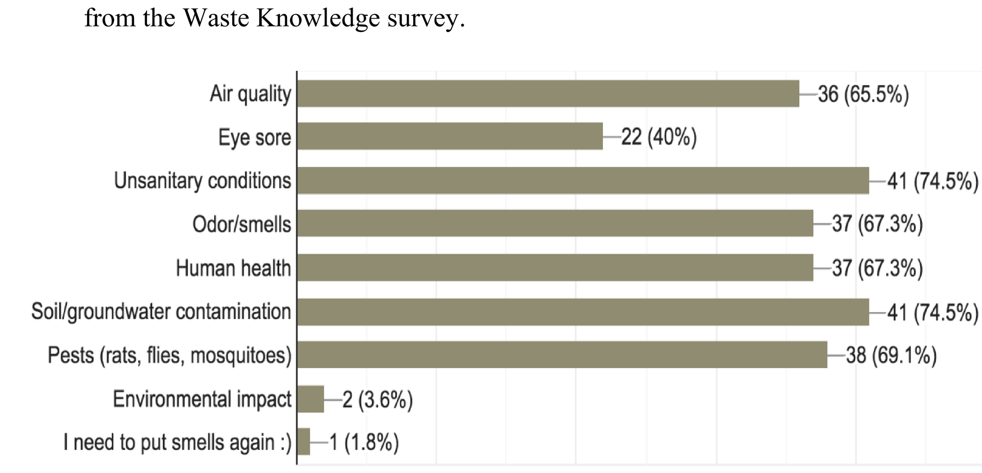

Figure 12: The primary concerns of solid waste pollution in the CEIS community from the Waste Knowledge survey.

Discussion

The results from the waste audit and community survey indicate that source reduction needs to be the primary concern when educating the community. Based on the solid waste management hierarchy, source reduction is more preferred than anaerobic digestion. Although implementation and enforcement of source reduction is difficult, it is one of the strongest solutions to the global issue of waste management. The results from the waste audit identify which solid waste streams need to be targeted when implementing source reduction on campus: plastics and scrap metals. The high rates of improperly sorted waste (35% on average) determined by the waste audit suggest that improvements to CEIS education around solid waste management are necessary. In our survey we found that 74.5% of people were concerned about the unsanitary conditions and the soil/groundwater contamination. However, only 3.6% of people said they were concerned about the environmental impact of solid waste pollution. This is further evidence that the community is not educated enough to understand the effects of solid waste pollution.

Next Steps

Anaerobic Digestion

Anaerobic digestion is an ideal solution to the abundance of waste vegetable oil (WVO) unfit for biodiesel production on campus. The reinstallation of the CEIS digester would address this problem and utilize this WVO for biogas production to be used on campus in place of propane.

Updated Educational Strategies

Through the waste audit and community survey, it is clear that steps toward source reduction need to continue on campus. Education strategies such as classes or posters would be efficient when paired with the avid discouraging of single-use plastics. Additionally, as new employees, students, and visitors come to CEIS, this new educational curriculum could help negate the amount of improperly sorted waste.

Upcycled Resource Bins and Signs

Furthermore, in order to address the problem of improperly sorted waste on campus, new green resource bins with cohesive labels were created. Taking the community's feedback into account as changes to the set-up and signage are made in Bay 1 will have an impact on the amount of improperly sorted waste. Moreover, green bins were made to establish an efficient sorting system prior to the all-campus recycling center, which will eliminate some human error and disinterest.

Figure 12: Current waste sorting signage in Bay 1

Figure 13: Upcycled green resource bins, previously used to store WVO, to be sourced as campus waste sorting bins

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