Recycling for small island tourism developments: Food waste composting at Sandals Emerald Bay, Exuma, Bahamas

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**Abstract**

The ability for small islands to meet sustainability goals is exacerbated by the costs of transporting goods on, and then, wastes off the islands. At small scales, recycling can be prohibitive and complicated by labor costs; the need to profitably recycle and manage solid waste output from tourism is complicated by scale and available technologies. A multi-year study documents the amount of solid waste generated on Great Exuma (Exuma). The Commonwealth of The Bahamas since 2010 with one year of benchmarking, then limited recycling of food waste generation by an all-inclusive resort, Sandals Emerald Bay (SEB). For the island of Exuma, the rapid increase in the rate of accumulation of solid waste associated with a large destination resort has led to an increase in pests such as rats and flies, along with an increased occurrence of fires associated with unburied solid waste. Solid waste has accumulated faster than the island solid waste management can absorb. SEB kitchen and hotel operations contributes an estimated 36% of all solid waste generated on the island, about 1752 t out of a total of 4841 t generated on the island in 2013 (exclusive of vegetation waste). Based on 4 weeks of benchmarking, 48.5% of all the waste coming out of the SEB resort is compostable, organic waste, but waste composition varies widely over time. Exuma Waste Management (EWM) and Recycle Exuma (RE), both privately-held Bahamian businesses, worked for one year (2012–2013) with SEB resort to implement a benchmarking and pilot recycling project to meet Earth Check green resort certification requirements. This paper outlines the costs and resources required for food waste recycling and some barriers to implementing more effective solid waste management for the tourism industry on small islands.

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1. Introduction

The management of solid waste represents one of the most difficult challenges to the environment of small island developing states (SIDS) such as The Commonwealth of The Bahamas (Bahamas Environment, Science and Technology Commission, Ministry of Agriculture and Fisheries, 2002; SENES Consultants Limited, 2005). In 2000, it was estimated that per capita, The Bahamas generates 16.6 kg per week of refuse, with over 80% of the refuse being placed in open dumps (Firdaus and Ahmad, 2010). Recycling and composting are attractive options for islands to reduce the costs of managing landfills, pollution impacts of accumulated solid waste and public health threats. Composting can offer linked economic opportunities in agriculture and landscaping (David, 2012). However, composting can be both capital and labor intensive in tropical settings, needing management and a market for the compost. The costs associated with solid waste disposal on islands are especially challenging with the limitations of scale, labor costs, increasing energy costs, as well as the repair and maintenance of machinery (Cooney, 2012). For SIDS, determining the composition and weight of the solid waste stream is critical to formulating an integrated waste management plan that includes recycling (Gidarokos et al., 2006).

“Benchmarking” municipal waste streams is key to formulating successful recycling initiatives or determining the appropriate incentives, fees and investments needed to engage stakeholders (Gidarokos et al., 2006; Hildebrand, 1997). Islands can potentially be “zero waste” environments when trash is seen as a resource and not a problem; zero waste is especially desirable on small islands.
islands that rely on tourism as a key economic driver. Waste composting, sorting and re-purposing can all provide environmental protection, but also offer an added dimension of economic activity, support small scale agriculture as well as socio-economic wellbeing. “Zero-waste” implies that no solid waste enters a land-fill or dump, and all materials are composted, incinerated (for energy), re-purposed or sorted for export to larger markets. Zero-waste islands can be the ultimate in sustainable tourism marketing as well as be environmental and economic necessities. Integrated solid waste management can provide long-term economic benefits to SIDS governments in reduced landfill management costs, and additional revenues through regulation and waste disposal fees.

The aim of this paper is to examine the potential for private companies to benchmark solid waste, and implement recycling initiatives for small island tourism markets. The project began with the need to both benchmark the amount and quality of solid waste generated by one destination resort, and then determine the most cost-effective way to reduce the solid waste stream. Sandals Emerald Bay, a private destination resort, was motivated to partner in this project for two reasons: (1) a corporate commitment to implementing EarthCheck benchmarking and certification at all of its properties in the Caribbean2, and (2) the current trash disposal system with an unsorted waste stream entering a central compactor in a tropical environment was causing a problem with flies and other pests. The motivation of the private waste hauling company, Exuma Waste Management, was to reduce the food waste stream entering the industrial compactor used on the SEB site. Food wastes create additional costs to clean dumpsters and compactors, as well as increased weight per unit for hauling. The central question was how much food waste was going into the solid waste stream, and was there an alternative, cost-effective means of disposal through sorting and composting food wastes?

The Commonwealth of The Bahamas operates government infrastructure for solid waste management on some 28 different islands across the archipelago, mostly in the form of local dumps. New Providence, the most populous island and location of the capital city of Nassau, has the most people (about 249,000 in the 2010 census; Table 1), and most tourism activity in the form of hotels, resorts and cruise ship stop-overs. The island of New Providence has the volume of solid waste that could be economically feasible to be recycled or incinerated with waste to energy technologies (Skordilis, 2004). The greater challenge comes with less-populated islands like Exuma that rely on tourism, but lack the scale and infrastructure for integrated solid waste management. Other islands, such as Grand Bahama, Great Abaco and Eleuthera are all experiencing growth in tourism with no solid waste infrastructure beyond open dumps. Exuma is the largest island in the Exuma island chain, with 7314 residents living on the island in six major settlements (Table 1).

There are approximately 546 hotel rooms on Exuma, divided between 16 properties. Sandals Emerald Bay is the largest with 245 rooms, but other luxury condominium properties (Grand Isle and February Point) account for 114 units). Eight resorts have ten rooms or less (e.g. boutique resorts), and five hotels have 10 to 40 rooms. Tourism produces an estimated 50 to 60% of the Gross Domestic Product of The Bahamas; the hospitality industry directly or indirectly employs 50 to 60% of the total workforce (Labour Market Information Newsletter, 2011), and tourism is the primary economic focus for Exuma. This study provides an opportunity for demonstrating potential methods for resort food waste removal and composting appropriate for the available scale and resources of small islands.

All small island tourism is dependent upon the quality of the country’s natural resources, namely its native flora and fauna, beaches and coastal waters; thus efforts to promote environmentally responsible tourism have become widely embraced (Sealey and Cushion, 2009). Benchmarking is the process of comparing one’s business performance metrics to industry best practices. Solid waste benchmarking includes understanding the amount of waste generated (in tonnes) and the composition of that waste (in recoverable categories such as plastics, glass, electronics, hazardous wastes, compostable materials, aluminum, etc.). Dimensions typically measured are quantity (weight) over time as well as the cost to collect, haul and process the waste. Benchmarking is used to measure performance using a specific indicator such as tonnes of waste produced per month, or cost per tonne for disposal; recycling targets are set based on benchmarking (Firdaus and Ahmad, 2010).

Ideally, the most profitable and easiest items to remove and reuse/resell are targeted for solid waste reduction. Improper disposal of organic waste is linked to ground water contamination, coastal hypoxia as well as the multiplying of disease vectors and sporadic solid waste fires (Heileman and Walling, 2005). Modest reductions of up to 20% of the solid waste entering landfills can save millions of dollars in future landfill management and pollution mitigation costs. Benchmarking is also critical in creating a diversified solid waste stream that can offer more activity associated with the composting, re-using and recycling of waste. Integrated solid waste management, particularly large-scale composting, can also be linked to water reclamation and sewage/wastewater processing as well (Hernández and Martín-Cejas, 2005; Stan et al., 2009).

There are no Governmental requirements to recycle or sort the solid waste stream. SEB pays no waste disposal charges, thus waste disposal costs are tied to the cost of equipment and hauling fees. The costs of solid waste disposal and management on Exuma can be broken down into four areas: (a) resort labor costs to collect and store waste (resort stewarding staff), (b) resort bin and compactor rental, then waste hauling charges from the commercial Exuma Waste Management Company, (c) public environmental and health costs associated with solid waste dumping and disposal, and (d) public long-term costs of management and mitigation of island dumps (Fig. 1). Recycling initiatives have to address the labor, hauling, environmental and long-term management costs of solid waste production that now largely favor the resorts, with large, unknown costs assigned to the Government.

Resorts and hotels pay a trash hauling service, but there are no tipping fees associated with waste disposal. Exuma Waste Management (EWM) is the private company contracted by the government to haul trash for Bahamian residents; EWM offers commercial services of equipment rental and waste hauling for resorts and private companies. The increase in waste production over the past three years have prompted EWM to seek alternative waste disposal options, such as recycling and composting. Since 2012, the first cell of the Exuma Regional Sanitary Landfill (ERSL) has been filled and closed with approximately 19,950 t of solid waste accumulated over 7 years, with no construction of a second cell as of July 2014. The ERSL was planned in 2005 to receive all solid waste from Great Exuma and the Exuma Cays (Anonymous, 2005). Unfortunately, the ERSL is now a landfill in name only; all the solid waste generated on Exuma is dumped on open ground (see Fig. 2), with many small dumps throughout the Exuma Cays. Thus, recycling can reduce landfill management costs and reduce ground water pollution from dumps.

The opening of Sandals Emerald Bay (SEB) in 2010 on Exuma, and the Sandals corporate commitment to EarthCheck certification

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3 Food wastes in the SEB 20-cubic yard compactor exceeded 101 t per load.
provided an ideal opportunity to explore cost-effective means to reduce solid waste, particularly the problems associated with food waste. The largest single source of solid waste on the island of Exuma is SEB. SEB started operations in Exuma in 2010, and purchased a 20-year-old hotel infrastructure with outdated utilities, thus are motivated to make cost-effective upgrades in the physical plant. The one-year recycling initiative with SEB resort is presented to understand the costs, challenges and barriers to more effective solid waste disposal.

2. Material and methods

EWM has been responsible for the public and commercial solid-waste hauling and management of the ERLS since 2006. In 2010, truck weighing scales were installed at the ERLS to record the tons of solid waste accumulated in the landfill cells; in 2014, these scales were upgraded to solar-powered units. The entrance and exit weights of individual hauling trucks could be matched to billing records to track waste removal from SEB to determine the origin and quantity of solid waste arriving at ERLS from the resort. The recycling pilot project was carried out from May 2012 through July 2013. Table 2 presents a timeline for the project that outlines the meetings, project planning and implementation of the recycling aimed at food waste recovery.

SEB is a large destination, all-inclusive resort with multiple restaurants and dining facilities. The hotel area includes about 11.25 ha of outdoor areas, and 245 guest rooms. The original solid waste management plan for the SEB resort included all kitchen, housekeeping, and bar waste to enter one central 20-cubic yard (15.3 m³) trash compactor. Waste was unsorted into a single compactor to be emptied weekly or on an “as needed” basis. The undesirable features of the compactor were: (1) frequent overfilling of the compactor with dense food wastes, which often resulted in costly break-downs, (2) the open compactor with food wastes attracted flies and rats, and (3) the pickup of the compactor was initially once a week, which made the entire service

Table 1
List of area and population size for most populous islands in The Commonwealth of The Bahamas. The list contrasts the challenges in scale of solid waste management between the most populous island (New Providence) and the next six islands on the list. Less populous islands have the best potential for community-supported recycling to diversify employment and economic opportunities. Solid waste associated with tourism provides a source of compost for small scale agriculture and re-purposing resources from tourism to residents. (Department of Statistics, Government of The Bahamas, 2011). Study island of Exuma is highlighted fifth most populous island in the country.

<table>
<thead>
<tr>
<th>Island</th>
<th>Area (square kilometers)</th>
<th>Population (2011)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>New</td>
<td>210</td>
<td>248,948</td>
<td>Most populous island, Capital city of Nassau, largest harbor. Population center of the country, with limited public access to coast</td>
</tr>
<tr>
<td>Grand Bahamas</td>
<td>1373</td>
<td>51,756</td>
<td>Second most populous island with deep water port at Freeport</td>
</tr>
<tr>
<td>Abacos</td>
<td>2009</td>
<td>18,653</td>
<td>Deep water port at Marsh Harbor, with smaller offshore islands as focus of tourism</td>
</tr>
<tr>
<td>Eleuthera</td>
<td>518</td>
<td>13,728</td>
<td>Growing tourism on Harbor Island, and small resorts throughout the island, with three airports</td>
</tr>
<tr>
<td>Exuma</td>
<td>264</td>
<td>7314</td>
<td>George Town was first capital of the Bahama. The island has many settlements, small resorts and private vacation homes. Exuma has first tourism “anchor project” at Pearl Bay as large destination resort opened first as Four Seasons Resort, now operating as Sandals Emerald Bay Resort</td>
</tr>
<tr>
<td>North Andros</td>
<td>4700</td>
<td>6267</td>
<td>Many small communities, heavy reliance on fishing and farming. Several US Navy Military Installations along the coast</td>
</tr>
<tr>
<td>Long Island</td>
<td>448</td>
<td>3024</td>
<td>Resort community at Stella Maris in northern Long Island; much of island engaged in grazing and small scale agriculture, and formerly salt production. Includes Deadman’s Cay and Clarence Town</td>
</tr>
</tbody>
</table>

Fig. 1. Concept diagram of the costs of solid waste management on Exuma, Bahamas. Large resorts such as Sandals Emerald Bay are not paying any direct waste disposal fees for long term solid waste management or broader island-wide environmental impacts. The direct costs for solid waste management are primarily associated with labor costs and hauling costs. The greater environmental and solid waste management costs are assumed by the Government of The Bahamas; though not in a satisfactory manner.
Fig. 2. Photos of solid waste dumping from Sandsals Emerald Bay (SEB) resort in summer 2012 at the Exuma Regional Sanitary Landfill (ERSL). The Exuma Regional Sanitary Landfill was designed to have a four lined cells, the first cell was filled and closed in 2011. With the escalating rate of solid waste accumulation on Great Exuma, waste management capacity has been exceeded. There is no funding for the construction of the second cell, and in the interim, solid waste has to be dumped on open ground.

Area malodorous and fly infested. Fig. 3 illustrates the service area at SEB resort that combined the solid waste accumulation areas with the loading dock for food and supply deliveries. The design of this service area, with the unsorted solid waste in an open compactor, provided an opportunity for rodent and insect pests to proliferate. The food waste recycling project was aimed at reducing the open containers of solid waste, reducing the amount of wet, organic material entering the compactor, and reducing the food wastes that enter the ERSL. With limited resources to manage the ERSL, organic wastes created pest issues there as well. The question addressed was, “Could the benefits of recycling and sorting solid waste outweigh the convenience and low cost of unsorted solid waste disposal?”

Recycle Exuma developed a benchmarking plan, and employed recycling managers for ten months from June, 2012 to April 2013 to document the staff behavior and waste stream patterns. Recycle Exuma collected quantitative data on the composition of unsorted waste entering the compactor, and interviewed kitchen staff about their views on sorting waste. The kitchens were the focus of solid waste issues because of the volume of food waste generated by the all-inclusive resort events. Benchmarking was initiated to understand the rate and amount of food waste generated over the weekly routine in seven kitchens. The hours of operations for the kitchens were divided into four-hour blocks. Stratified random sampling was used to select four-hour times from about 5 AM to 10 PM to document the volume of trash generated, and photograph the contents of the 40-ga trash container as it was filled.

Using an image processing program, items in the trash photos were identified as “food and compostable waste” or “not compostable”. Data points were accumulated to look at the percent food waste out of the total volume of waste coming out of the kitchen. Volumes were converted to waste weights using hauling scale records and International Solid Waste Association (ISWA)
Volume to Weight conversion tables. Box plots were used to show the spread of data over the two-week periods to capture the variability in the amount of compostable waste in the solid waste stream over time and space for the SEB kitchens. The trends in waste generation from the kitchens illustrate temporal and spatial variability (over the full day at different kitchens) for seasonal changes in occupancy and events. The box plots can indicate two aspects of waste generation: the central tendency of a parameter, and the range of variability of these parameters (food as a percent of total solid wastes generated). The variability in solid waste composition can translate to challenges to supply the quantity of containers needed in the right place at the right time for food waste sorting.

EWM kept records on the total weight of solid waste removal from the SEB hotel area. Based on the data collected on kitchen waste streams, a recycling plan was formulated to focus on removing food and compostable wastes. Sorting the organic (food and kitchen) wastes from the solid waste stream was determined to be a method of removing the greatest single category of solid waste from the hotel.

Earth Check certification requires at least two years of benchmarking documenting the amount of solid waste generated by a resort. SEB determined after three months of initial observations that action was needed to reduce the flies in the loading dock area. Two recycling methods were developed with the SEB Director of Environmental Management, the kitchen staff and the steward department staff. First, food wastes and compostable materials were to be sorted in the kitchens into plastic 7-ga (26.5l) buckets with sealing lids (Fig. 4). The buckets were selected because the full 7-ga (26.5l) bucket fell within an acceptable weight (less than 50 pounds or 23 kg) for the steward department to lift and transport.

The current 45-ga trash containers in use were emptied (using two plastic bags) when only 30% full to avoid excessive weights (one 45-ga (170.3l) trash can filled with wet food wastes could weigh over 400 pounds or 181 kg). Food waste and compostable materials were identified to staff using short presentations and training posters, then the separation of trash began in November of 2012. The sealed buckets were moved to the compactor room for collection by EWM. EWM employees then moved the buckets to a large compost area, the waste was composted with equal volumes of flattened cardboard, and then the buckets were washed and returned to the SEB resort for re-use.

Washing the food waste buckets was a critical step to insure hygienic and odorless conditions for the waste buckets which were returned back into the kitchens. An initial inventory of 740 buckets was imported into Exuma for the project. Buckets were labeled “Food and Compost Waste Only” and numbered for tracking purposes. RE designed and implemented a bulk composting project utilizing a large quarry pit and water from a wastewater processing facility. Bulk composting was used for large volume accumulation of food, vegetation and cardboard waste. The composting operation required a full-time composting technician to collect the food and vegetation waste, manage the compost pit, and wash the food waste buckets to be returned to SEB. Considerable effort and expense was put into constructing a composting site using an abandoned quarry. Flattened cardboard from other sources (local grocery retailers) was used as a carbon source for the food waste, and secondary treated sewage water was used to maintain moisture levels as the compost accumulated in the dry season. The quarry pit could accommodate over 920 m³ of compost, and was designed with a ramp for using heavy equipment to turn and remove composted material. Composting methods were highlighted in (Stan et al., 2009) and (Seadon, 2010), the method employed was the layering food waste between layers of damp cardboard.

The second recycling method developed was the disposal of waste grease from deep fat fryers. Warm fat was drained into
5-ga metal buckets with sealing lids (Fig. 5). SEB resorts used lard (animal fats) instead of oils (plant triglycerides) so the recycling focused on recycling the waste grease into the manufacturing of soaps and degreasing cleaners. Lards and animal fats are generally a less expensive alternative for frying foods. If oils had been used in the deep fat fryers, the conversion of waste oil to biodiesel would have been an option. The methodology was developed for using the waste grease to make bar soap by adding lye to the rendered grease. The cost of soap production using waste grease was evaluated as a small business opportunity.

3. Results

A summary of total weight of solid waste arrivals to ERSL was produced as part of the benchmarking from landfill records and EWM billing records. Island-wide, the amount of solid waste entering the ERSL has increased by 25% each year since 2010. Fig. 6 presents the total amount of solid waste entering the ERSL from 2006 through 2013. The amount of solid waste generated monthly on Exuma increases significantly (ANOVA; p = 0.1) each year after 2010 with the opening of SEB resort. The ERSL was designed to have four cells, only the first cell was constructed and lined. Tourism contributed directly to solid waste accumulation through resort operations, and indirectly through increased jobs, businesses and infrastructure to support the resort. The operation of SEB resort accounted for as much as 35% of total solid waste generated on Exuma (directly and indirectly) over the past three years in a single, unsorted waste stream (based on pre- and post-opening of SEB records).

The benchmarking data on the composition of solid waste generated by SEB resort is presented in Fig. 7. Survey methods used both photographed and weighed kitchen trash; these methods could be continued for waste stream benchmarking with trained and dedicated staff. The box plots from the two 10-day data collection periods (July 2012 and October 2012) illustrate the variability in the amount of food waste generated from seven kitchens. The box plots illustrate the challenge in management of food waste production between sites (kitchens) over the course of the day for benchmarking periods. For the month of July 2012, the median amount of compostable material was 56% of all solid waste generated. In October, with a lower occupancy rate at the resort, the median was 44% of all solid waste generated at the resort.

The year-long pilot recycling project cost approximately US$63,850, exclusive of management and staff time. About 62% of the costs were incurred to RE and EWM, the pick-up charge by EWM to collect, empty and clean the buckets was US$5 per bucket was incurred by SEB. The overall cost analysis of the food and grease waste collection is outlined in Table 3. The costs of recycling food and grease wastes were about US$710 per tonne. This cost did not compare favorably to the cost of the 15.2 m³ (20-cubic yard) compactor rental and twice-per week pick up; the unsorted compactor solid waste cost about US$63 per tonne. However, the compactor cost represents only a hauling charge, and does not include any...
costs associated with landfill management, pollution mitigation or costs associated with long-term impacts of solid waste disposal on the island of Exuma.

Monthly ERSL solid waste weight arrivals are shown for four years in Fig. 8. Specific spikes in solid waste generation can be seen in 2011 associated with large remodeling and construction at SEB, with over 630 t entering the ERSL in June, 2011. This single month solid waste arrival at the ERSL represents a 204% increase from the previous month (May 2011), and is attributed to remodeling renovations at SEB based on waste hauling receipts. An average of 12% decrease in the monthly solid waste arrivals to the landfill was seen during the seven months of food waste recycling in 2012 through 2013. Although the food and waste grease recycling was a significant reduction in solid waste generation for SEB, this effort would likely need to expand to other hotels and private homes on Exuma to further reduce solid waste accumulation at the landfill. The total recycling effort for SEB is summarized in Table 3. In all 71 tonnes of food waste was composted, and the compost is used for private tropical fruit tree business on the island. 33001 (870 ga) of waste grease was collected in 8 months (Table 4 presents seven months when food and oil were both collected).

The challenges with the waste food collection were (1) the physical investment of time in moving, storing and redistributing buckets by the SEB stewarding staff, (2) the high cost of hauling and processing the food waste in 7-ga buckets and (3) the logistical coordination of bucket pick-up and re-distribution with highly variable food waste accumulation patterns. A surprising consequence of the food waste recycling was the rapid fermentation of the food, causing buckets to explode when left outside in the waste accumulation areas for more than 12 h. Reliable coordination of the bucket distribution, management and pickup was the responsibility of the SEB staff, and there was no staff dedicated to this task over the project life.

The challenge with the waste grease recycling was the variable quality of the grease used in the SEB kitchen. Some fryers had filters that prevented food particles from entering the metal grease buckets, but many fryers did not. The animal fat used in the fryers was highly variable in quality, not consistently changed, and highly contaminated, thus the waste grease proved challenging for producing a consistent quality of soap. Most of the soap produced was suitable for industrial purposes (cleaning the food waste buckets and the garbage trucks) but not for commercial sale as a body soap. The energy required to clean the grease (heating grease with water to remove food particles) decreased the economic viability of grease recycling, even when using a solar oven. An overview of the soap making process is shown in Fig. 9.

Outreach and educational material developed by RE was useful in communicating the magnitude of the solid waste challenge (Fig. 10). Few SEB employees had ever visited the ERSL, and no SEB management staff has actually seen the disposal of the solid waste at the ERSL. Because kitchen staff worked only selected shifts, the cumulative weight of food waste coming from all the kitchens was surprising to SEB employee (Fig. 10A). Most people simply did not understand the economics of solid waste management, and did not separate the costs of hauling from the cost of managing solid waste. Bahamians living on islands with small human populations had a history of using simple dumps for all solid wastes, resulting in long-standing problems with feral dogs, rats and insect pests (Fielding, 2009).

4. Discussion and summary

Solid waste management should include recycling or reuse of material for both cost savings, environmental protection, and revenue enhancements. Unfortunately for SIDS, the long-term environmental costs of dumps and landfills are seldom considered. Removal of food and compostable waste was the easiest and more efficient way for solid waste reduction and improved sanitation near resorts. However, the volume of food and compostable wastes needs to be carefully calculated to allow for removal, composting and sorting systems that can respond to changes in hotel occupancy. The recycling pilot project direct benefits were to reduce solid waste entering the ERSL and eliminate the unsorted solid waste compactor used at SEB associated with the flies and rats associated with unsorted solid waste. Indirect benefits included consumption of fewer plastic bags in waste management, reduction in pest management costs, and improved morale in employees seeing the foreign-owned corporation investing in the Bahamian island environment.

EWM and RE entered a partnership with SEB resort to recycle compostable food and cooking grease wastes as a component of EarthCheck benchmarking for hotel green certification. A one-year pilot project illustrated some of challenges and barriers to recycling and solid waste reduction on Out Islands of The Bahamas. Those challenges can be considered in terms of logistics and labor costs, the economy of scale for island recycling, and lastly the outreach and education requirements. Successful integrated solid waste management requires the essential components of government regulation, producer accountability and consumer awareness (See Table 5 for description of stakeholders).

First, perhaps the greatest barrier to island recycling is economics—the short-term costs and re-training required to change old habits and embrace new technologies. Recycling would be ideally implemented in steps, and issues of environmental health would mandate a timetable for integrated solid waste sorting by location. Labor issues are understandably an issue for SEB; there are no resources to re-train and re-design service collection areas for sorted waste streams. Although the kitchen staff could make the change to sort food waste into the buckets relatively quickly, the stewarding staff had to keep up with removal of full buckets and re-supplying empty buckets. The waste buckets required an increased work load. The stewarding staff was less enthusiastic about additional work with limited resources, citing the problems of storage of empty buckets, and the additional time needed to collect, and distribute empty buckets to all the kitchens. SEB management was not in a position to re-negotiate labor relations with stewarding staff; thus recycling or solid waste management initiatives are hard to retro-fit. The message from SEB management was, “Sandals wants to be EarthCheck certified, but not put any new resources into this effort”. New resorts and hotels can consider recycling needs (that can be mandated by the government) at the start of operations.

SEB management failed to support the recycling initiative by identifying trained staff with appropriate resources. As in most resorts, the Environmental Health and Safety Manager must work across departments and has few resources; thus environmental initiatives have to bring immediate economic benefits to individual departments (e.g. less money spent on plastic trash bags, or less staff time spent cleaning the compactor room). The turnover of SEB staff and management proved to be an issue in long-term environmental program implementation.

There are larger labor issues associated with island tourism: many workers are brought in from other countries or other islands in The Bahamas, and there is little investment in the local environmental quality of Exuma. Most workers associated with solid waste management are paid minimum wage in The Bahamas, meaning that a full time worker (40 h per week) earns about $11,429 per year3. However the cost of living on the Out Islands of

Fig. 8. Four years of monthly solid waste weights arriving at the Exuma Regional Sanitary Landfill, Exuma, Bahamas. (A) 2010 monthly totals with 2860 t entering the Landfill; (B) 2012 monthly totals with 3775 t entering the Landfill; (C) 2012 monthly totals with 4460 t entering the Landfill, with two months of active food waste removal (yellow bar); (D) 2013 monthly totals with 4842 t entering the Landfill, with five months of food waste composting (yellow bar indicates the months of active food waste removal from SEB Resort). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.).

Table 3

Estimated costs of pilot food waste recycling at Sandals Emerald Bay, Exuma. The recycling pilot project sought to initiate food composting through re-use of local materials, and modifying an abandoned rock quarry as a composting pit. The project costs are broken down into three steps: Benchmarking, capital equipment purchases and actual recycling operations. Dates and durations are given.

<table>
<thead>
<tr>
<th>Item/action</th>
<th>Units/number</th>
<th>Approximate costs in US dollars</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>a. Benchmarking and planning (June through September 2012)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University-level interns working full time for 12 weeks collecting baseline data</td>
<td>3 Months</td>
<td>$6000</td>
</tr>
<tr>
<td>Housing and food for interns (2)</td>
<td>3 Months</td>
<td>$2400</td>
</tr>
<tr>
<td>Transportation and travel</td>
<td>3 Months</td>
<td>$1800</td>
</tr>
<tr>
<td>Director of Environmental Services—weekly meetings with interns</td>
<td>Part time</td>
<td>$2400</td>
</tr>
<tr>
<td><strong>b. Purchase of buckets, labels and posters</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seven gallon plastic buckets with lids</td>
<td>520 buckets</td>
<td>$3750</td>
</tr>
<tr>
<td>Five gallon metal buckets for deep fryer oil</td>
<td>220 buckets</td>
<td>$1965</td>
</tr>
<tr>
<td>Stickers and labels for recycling buckets</td>
<td>1000 stickers</td>
<td>$475</td>
</tr>
<tr>
<td>Preparation of composting pit and water pump</td>
<td>2 days heavy equipment</td>
<td>$2500</td>
</tr>
<tr>
<td><strong>c. Food composting and recycling (November 2012 through May 2013)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recycling coordinator = working 3 days/week at Sandals with training costs</td>
<td>3 Months</td>
<td>$5760</td>
</tr>
<tr>
<td>Collection of buckets, Sandals was charged $5 per bucket to haul, empty, clean and return; An average of 449 food buckets and 25 grease buckets picked up per month</td>
<td>7 Months</td>
<td>$16,590</td>
</tr>
<tr>
<td>Maintenance of compost pit, including hauling cardboard</td>
<td>7 Months</td>
<td>$6300</td>
</tr>
<tr>
<td>Cleaning buckets</td>
<td>7 Months</td>
<td>$2800</td>
</tr>
<tr>
<td>Processing grease (partial) into soap and degreasers</td>
<td>7 Months</td>
<td>$3200</td>
</tr>
<tr>
<td>Cost of lost buckets</td>
<td>63 buckets</td>
<td>$1260</td>
</tr>
<tr>
<td><strong>Estimated project costs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Recycle Exuma</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$41,910</td>
</tr>
</tbody>
</table>
The Bahamas is well over $37,500⁶. The declining purchasing power of Bahamians on Out Islands is exacerbated by the decline of near shore fisheries resources as a supplementary food and income source (Sealey, 2004; Sealey et al., 2014). Although The Bahamas is widely considered the wealthiest independent country in the wider Caribbean, the escalating cost of imported food, utilities and transportation (fuel) costs on the islands that has outstripped the earning power of the population (ILO, 2014). The issue of income inequity and declining purchasing power of employees makes the additional labor commitment without compensation to recycling a serious challenge.

In essence, the Government of The Bahamas has been giving away something for free (solid waste management and processing) and now SEB is being asked to pay or contribute to waste processing costs through green certification programs such as EarthCheck. Employees are not likely to “donate” their time or work on recycling initiatives that they perceive to benefit primarily the (subsidized) resorts. The broader impacts of improper solid waste disposal linked to declining fisheries resources puts The Bahamas on an unpleasant trajectory to increased poverty and environmental degradation. New resorts and hotels could be mandated to begin recycling and solid waste management strategies from the planning and construction stages; the initiation of recycling requires labor union discussion and consideration. The benefits from recycling and integrated solid waste management on islands are long-term, largely appreciated by government regulatory agencies and future residents. Without regulatory directives, there are few incentives for resorts to implement recycling. Even SEB, with a corporate commitment to EarthCheck, discovered recycling and solid waste management cumbersome and expensive to implement. The solution is to seek seed funding to link the government and private businesses in supporting a sustainable infrastructure within the country. Studies emphasize that successful waste management in SIDS is achievable via a multi-stakeholder partnership approach.

Pursuing a multi-stakeholder approach reduces the difficulty of securing adequate resources such as financial and human capital (Willmott and Graci, 2012).

Second, islands face a serious challenge in the economy of scale for integrated solid waste management. Outside of New Providence, there is space on islands like Exuma for the storage and accumulation of sorted waste. Aluminum, scrap metal and electronic wastes can be held, and exported when economic thresholds are met. However, this takes infrastructure and funding to accomplish. The long-term national costs of solid waste management are undocumented for The Bahamas. Waste haulers charge a fee for service, but funds are not collected for the processing or pollution mitigation of accumulated solid waste. The accumulation of solid wastes in dumps across the country represents a growing cost to mitigate and manage for future generations. The cost of solid waste management has not been adjusted to account for changes in consumption and tourism. Exuma alone produces an astounding 12.7t solid waste per day. Tourists coming to The Bahamas predominantly from North America or Europe expect recycling to occur, and would self-sort high value items like aluminum cans or compostable waste (Gidarakos et al., 2006; Hernández and Martín-Cejas, 2005). The Bahamas as a Small Island Developing State with globally significant marine resources is especially vulnerable to the degradation of the groundwater, and near shore environments. Collectively, government agencies, NGOs, private individuals and companies can begin with new private–public partnerships that focus on the long-term environmental and economic benefits of recycling (Table 3). Specifically, successful solid waste management must address (1) stronger government oversight of waste management, and (2) extended producer (resort) responsibility for all waste on all islands.

The EarthCheck⁷ Standards incorporate an on-going system of benchmarking and goal-setting to reflect the progress of any

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⑦ EarthCheck is a registered trademark of EarthCheck Pty, Ltd. See [http://www.earthcheck.orgwww.earthcheck.org](http://www.earthcheck.org).
Fig. 10. Examples of outreach material generated from benchmarking and food waste removal for SAB staff. (A) Illustration of the amount of food waste recycled monthly relating weight to size of African elephant. The challenge for outreach material was to graphically illustrate the volume and weight of waste that was generated by the SAB resort; and (B) solid waste photos illustrating the composition of unsorted trash, including the loss of cutlery, plates and kitchen utensils. The photos were used to illustrate the benefits of sorting solid waste at the point of the origin.

individual resort in meeting the best science and technology available for a sustainable tourism and travel industry. EarthCheck benchmarking protocols allow for a resort to meet the social, economic and environmental components of present sustainable tourism standards (Ball and Taleb, 2011). Tourism in the Out Islands of The Bahamas has always been a challenge in cost and air travel availability. The cost of doing tourism business on an island must be less than comparable experiences on a mainland (e.g. Florida or Mexico) to compensate for increased travel time and cost to journey to an island destination. Islands must offer exceptional value in the environment and services to make the trip worth the costs. The Government of The Bahamas can actually encourage and facilitate the EarthCheck certification process by installing and maintaining scales at all regional landfills and transfer stations and requiring weight records to be maintained and reported (Table 5).

There is a national system for review and approval of tourism developments, but there is no systematic approach to the monitoring of developments for environmental impacts once the resorts are in operation (Wells-Moultrie, 2006). An assessment of pollution and environmental threats to The Bahamas lists the contamination of freshwater lenses (groundwater) and near shore marine waters by nutrients and organic wastes as the greatest danger based on the carbonate geology of the islands (Buchan, 2000). The Bahamas has signed numerous international environment agreements, clearly highlighting the adoption of global environmental responsibilities.
### Table 5

**Major stakeholders and partners for integrated solid waste management and recycling on Exuma, Bahamas.** A partnership of private, public and not-for-profit groups is needed to implement a wider recycling plan that would include voluntary sorting as well as investing in new waste management technologies.

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Group</th>
<th>Description of interests</th>
<th>Regulatory</th>
<th>Management</th>
<th>Economic</th>
<th>Educational</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exuma residents</td>
<td>Citizens, voting public</td>
<td>Residents have an interest in both environmental protection from pollution, cost of pest management, especially rats, and cost-effective public services in solid waste removal Small businesses need diversified opportunities and rely on high quality environment for tourism</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Exuma local businesses</td>
<td>Small businesses</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local government</td>
<td>Government (local, elected)</td>
<td>Local government responsible for the management of family island settlements, some with oversight of harbors and ports. Local Government desires to provide cost-effective waste hauling services</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exuma foundation/Exuma educational resource center</td>
<td>Private–nongovernment organization (NGO)</td>
<td>Local foundation for education and community development, with interests in promoting sustainable lifestyles. The foundation can apply for grants and community funding opportunities to support recycling, and recycling-related businesses</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>BEST—Bahamas Environment, Science and Technology Commission</td>
<td>Government (central ministry)</td>
<td>Agency charged with enforcement of international treaty obligations and advisement on environmental issues, now part of the Ministry of the Environment. BEST can facilitate recycling or set standards for direct foreign investment projects to recycle</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Local school, district office, Ministry of Education</td>
<td>Government (central ministry with local office)</td>
<td>Ministry responsible for curriculum and educational initiatives, can play a key role in longterm public awareness. Schools can operate at lower cost if sustainability practices were employed</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Ministry of Tourism</td>
<td>Government (central ministry with local office)</td>
<td>Ministry responsible for the promotion and support of the tourism industry. This is the “Ministry with the money”; Ministry of Tourism can facilitate benchmarking, or rewarding green initiatives in the industry</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Department of Environmental Health Services</td>
<td>Government (central ministry with local office)</td>
<td>Responsible for the oversight of the landfill management and managing environmental hazards</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Department of Environmental Health Services (DEHS)</td>
<td>Government (central ministry with local office)</td>
<td>Responsible for enforcement of environmental regulations and public health issues. DEHS provides the primary regulatory oversight for solid waste management on Exuma</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Bahamas National Trust (BNT)</td>
<td>Private with government support</td>
<td>Non-government organization with legal mandate to manage national parks and protected area. Great Exuma has one large National Park (Moriah Harbor) and a number of important bird areas. BNT wishes to recycle within National Parks but requires local support</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hotel owners, resort operators</td>
<td>Private</td>
<td>Large and small resort owners need to be concerned with the fate of solid waste on Great Exuma. Resort owners can educate visitors on the available resources to recycle, re-use and reduce solid waste</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tourists and foreign visitors/residents</td>
<td>Private</td>
<td>Diverse group of beachgoers, water sport enthusiasts and fishermen; people with limited local knowledge or experience in The Bahamas short-term, but most come from countries that do recycle or mandate solid waste sorting and reduction practices</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

The Bahamas has signed the following international conventions, agreements, and protocols relating to solid waste management, including the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, United Nations Framework Convention on Climate Change, Vienna Convention for the Protection of the Ozone Layer and the United Nations Convention on the Law of the Sea (LOS). The Government of The Bahamas has the responsibility to minimize the amount and
toxicity of wastes generated, and to work toward environmentally-sound solid waste management (SENES Consultants Limited, 2005).

The Inter-American Development Bank has worked with the Ministry of Works and the Environment to fund solid-waste management improvements through the development of regional landfills and waste transfer stations8. However, there is no dedicated revenue stream to operate, improve or expand present waste management facilities; this would include a costly option of moving all solid waste to one island for processing.

Lastly, the issues of outreach and education are crucial to managing expectations and encouraging compliance in recycling. Workplace education needs to be implemented with department heads and unions to ensure a smooth implementation of a sorted solid waste stream from resorts and hotels. Resorts such as SEB as well as island residents need to embrace the consumer limitations of island life, and reduce the solid waste accumulation. The public receives a mixed message about trash, illegal dumping and littering when communities pay residents to clean up road verges and illegal dumping instead of fining violators. Solid waste management and recycling education needs to be developed as a food security and poverty reduction issue for Exuma residents facing high costs of living. Any discussion of agriculture can include solid waste management and the availability of compost as a fertilizer alternative. Large resorts should facilitate or fund industrial scale composting, including waste water sludge that could reduce reliance on imported fertilizers, allow water recovery, and reduce the threat of nutrient loading to near shore marine environments. This study did not address the expectations and attitudes of tourists coming to SEB. The all-inclusive buffet-style meals that required food orders to be placed weeks in advance for shipment to Exuma are certainly contributing to the amount of food wastes.

Other categories of solid waste, such as plastics, glass and metal cans, were documented, and benchmarked, but this report addressed only food and grease wastes. Plastics were the second major material category produced in the SEB kitchens, but plastics are the most difficult category to recover or to re-use; over 85% of plastics globally are not recycled and much of the material ends up in the oceans (Shamshiry et al., 2011). Resorts like Sandals are looking to build brand reputation, and innovate to new markets. Tourism companies can be strongly motivated by “trustworthy” solid waste management, as an alternative to government regulation. This issue of “trustworthy” trash management was especially pertinent to The Bahamas. Producers have no concerns with solid waste beyond having the waste hauled away. Trash Haulers get paid to move trash, and then governments are left with the long-term costs and consequences of waste management (Mateu-Sbert et al., 2013). Recycling can seem to be a futile effort. Recycling bins and transfer stations are designed to sort individual commodities, but this reprocessing is very expensive for small islands. Recycling equipment investment is very expensive, and unwarranted by current resort operations or government guidelines. Recycling requires a “clean” and secure supply chain to be profitable; moving of solid waste from island to island would require clean, sorted streams of commodities such as aluminum cans or scrap metal. Movement of derelict cars to a central location for export does occur when market conditions make the scrap metal transport profitable. The Bahamas could overcome these transport costs to re-purpose waste at one central location; however the investment in barges or hauling vessels would need to be offset by documented environmental valuation of protecting wetlands, preserving groundwater or mitigating pollutants.


The next phase of the recycling initiative on Exuma will focus on local communities that would receive small financial incentives to recycle and compost food wastes. SEB would need to improve staff relations and management commitment to begin the benchmarking process in earnest and work toward an Earth-Check certification. Small islands typically lack waste disposal sites because of a shortage of appropriate land (e.g. not wetlands or adjacent to wetlands) as well as lack of capacity. Population growth and increases in tourism are generating more solid waste. Existing regulations have proven ineffective because island governments have inadequate staff and resources to enforce violations of illegal dumping and waste management. In addition, islands have little capacity to deal with the growing volume of toxic and hazardous wastes.

Progress can be made with innovative private sector partnerships that build community support for recycling plastics, metals, paper and used oil. Sanitary landfills are expensive to construct and maintain, but this full cost of solid waste management is not apparent to residents or tourists. Delayed maintenance and expansion of the local landfill only increases the long-term costs of mitigation and pollutant remediation. Expansion of tourism can include improving infrastructure related to waste management systems, landfills and sewage systems. One of the most effective ways to reduce solid waste costs is to reduce the volume of waste by large-scale composting and recycling. Government regulations on waste disposal need to identify long-term funding mechanisms to support partnerships that focus on solid waste reduction.

Recently, The Bahamas has begun to accept solid waste from cruise ships in the port of Nassau. The Bahamas has for several years had a policy of not accepting waste of any kind to be imported into the country. This policy is regardless of whether the waste is for disposal or recycling. The recent change in the Government policy toward solid waste and the change in management structure has allowed for a possible budget source for the solid waste management.

Costs for waste removal need to include hauling and disposal/recycling. Recycling is going to be key component of island tourism into the future, though the implementation will be slow, with setbacks and many “lessons learned” in the process.

Acknowledgements

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